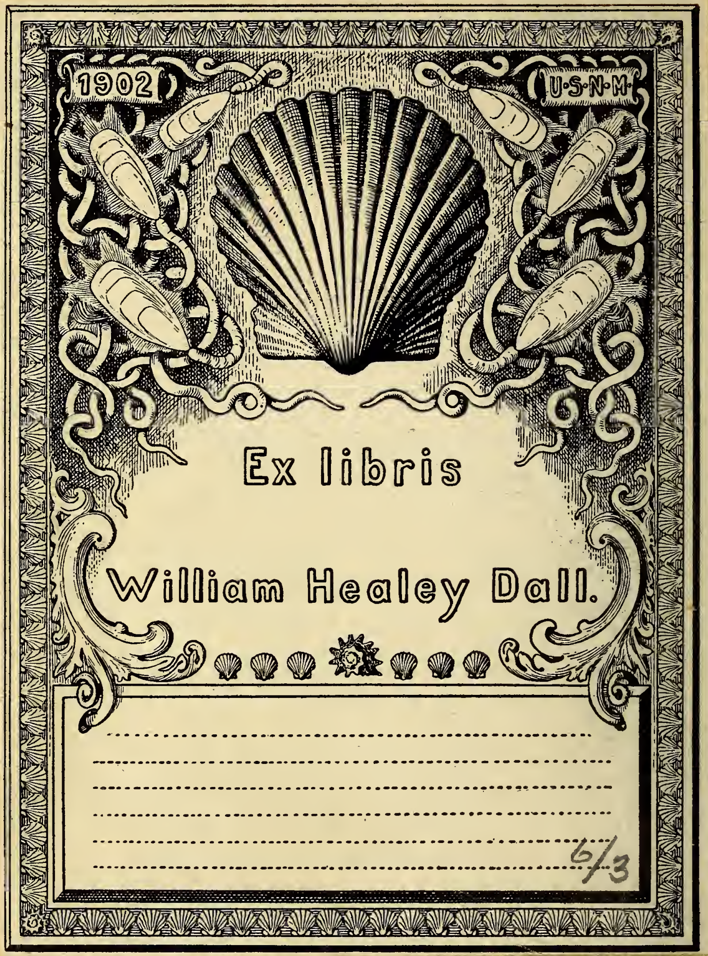
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MEMOIRS

OF THE

WERNERIAN

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MEMOIRS

OF THE

WERNERIAN

NATURAL HISTORY SOCIETY.

Vol. III.

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List of Engravings in Vol. III.

MEMOIRS, &c.

I. *Observations on the Anatomy of the Orang Outang.*

By Dr Thomas Stewart Traill, Liverpool.

(*Read 7th February* 1818.)

An opportunity of examining the internal structure of the Orang Outang, so rarely occurs to the British anatomist, that I eagerly availed myself of the permission granted by Mr Bullock, proprietor of the Museum in Piccadilly, to dissect a specimen of this animal, which was his property, and had recently died at Liverpool. A slight examination of its external appearance convinced me of the inaccuracy of the engravings of the Orang Outang in our best works on Natural History. Under the name of Orang Outang, or its supposed synonymes, most naturalists appear to have confounded two distinct animals, the Indian or Brown Orang, and the African or black species. The figures published by Tyson and Buffon, are intended to represent the latter, which also forms the subject of this paper; but these representations differ in several important particulars from the specimen now under consideration. The rude, though (I believe) faithful, delineations of Camper, as well as the more finished engravings of Edwards, Vosmaer and Allamand, were taken from the Indian Orang, and decidedly point it out as a different species from the specimen before us. The seeming inaccuracy of Dr Tyson's figure led me to suspect that some of the minute details of its internal structure might have escaped that accomplished anatomist; and the discrepancies of authors induced Mr Bullock to take casts and drawings of the animal after death.

Anxious to render the examination of its internal structure as complete as possible, I requested the assistance of my friend Dr Vose, a very able and zealous anatomist, who immediately lent his co-operation; and we resolved to devote the intervals of our professional avocations to this interesting subject. The following observations are chiefly drawn up from notes which we took on that occasion; and a former dissection of the Simia Maimon, or rib-nosed baboon, enabled us to compare its structure with that of the Orang Outang. The few remarks on the manners of this animal, are collected from conversation with the late Captain Payne, an intelligent and respectable mariner of this port, who brought it from the coast of Africa to Europe.

The subject of this paper is a female, and was procured in the Isle of Princes in the Gulf of Guinea, from a native trader, who had carried it thither from the banks of the Gaboon. It was represented as a young animal, far inferior in size to the specimens often seen in the recesses of its native forests; and Captain Payne observed, that it was at least eight or ten inches lower in stature than another which he had seen in the Isle of Princes. The natives of Gaboon informed him, that this species attains the height of five or six feet; that it is a formidable antagonist to the elephant, and that several of them will not scruple to attack the lion and other beasts of prey, with clubs and stones. It is dangerous for solitary individuals to travel through the woods haunted by the Orang Outang; and instances were related to Captain Payne of Negro girls being carried off by this animal, who have sometimes escaped to human society, after having been for years detained by their ravishers in a frightful captivity. These reports confirm the narratives of the early voyagers, who have often been suspected of exaggeration *; and similar facts have been recently stated very circumstantially by gentlemen who have lived in Western Africa. The general belief of the Negroes is, that this animal is rational, and can speak, but cunningly avoids the exercise

* See Purchas' Pilgrims, Dampier, Battel, Schoutten, Froger, Bosman, De la Brosse, &c.

of this faculty, lest he should be compelled to labour.

"When first our animal came on board, (says "Captain Payne,) it shook hands with some of the "sailors, but refused its hand, with marks of anger, "to others, without any apparent cause. It speedily, however, became familiar with the crew, except one boy, to whom it never was reconciled. "When the seamen's mess was brought on deck, "it was a constant attendant; would go round and "embrace each person, while it uttered loud yells, "and then seat itself among them, to share the repast." When angry, it sometimes made a barking noise like a dog; at other times it would cry like a pettish child, and scratch itself with great vehemence. It expressed satisfaction, especially on receiving sweetmeats, "by a sound like *hem*, in a "grave tone;" but it seemed to have little variety in its voice. In warm latitudes, it was active and cheerful, but became languid as it receded from the torrid zone; and on approaching our shores, it shewed a desire to have a warm covering, and would roll itself carefully up in a blanket when it retired to rest. It generally walked on all fours; and Captain Payne particularly remarked, that it never placed the palm of the hands of its fore extremities to the ground, but, closing its fists, rested on the knuckles; a circumstance also noticed by Tyson, which was confirmed to me by a young navy officer, who had been for a considerable time employed in the rivers of

Western Africa, and had opportunities of observing the habits of this species. This animal did not seem fond of the erect posture, which it rarely affected, though it could run nimbly on two feet for a short distance. In this case, it appeared to aid the motion of it legs, by grasping the thighs with its hands. It had great strength in the four fingers of its superior extremity; for it would often swing by them on a rope upwards of an hour, without intermission. When first procured, it was so thickly covered with hair, that the skin of the trunk and limbs was scarcely visible, until the long black hair was blown aside. At that period, the skin was free from any disease: but after it had been some time at sea, much of its hair fell off, its body was attacked by a scaly eruption, resembling *psoriasis guttata,* and attended by excessive itching. This might partly be owing to improper diet, as it was often fed on salted beef and biscuit. It ate readily every sort of vegetable food; but at first did not appear to relish flesh, though it seemed to take pleasure in sucking the leg-bone of a fowl. At that time it did not relish wine, but afterwards seemed to like it, though it never could endure ardent spirits. It once stole a bottle of wine, which it uncorked with its teeth, and began to drink. It shewed a predilection for coffee, and was immoderately fond of sweet articles of food. It learned to feed itelf with a spoon, to drink out of a glass, and shewed a general disposition to imitate the actions of men. It was attracted by bright metals; seemed to take pride in clothing, and often put a cocked hat on its head. It was dirty in its habits, and never was known to wash itself. It was afraid of fire-arms; and, on the whole, appeared a timid animal.

It lived with Captain Payne seventeen weeks, two of which were spent in Cork and Liverpool. At the former place it was exhibited, for the benefit of the soup-kitchen, for a few days, but seems to have been there neglected. On coming to Liverpool, it languished a few days, moaned heavily, was oppressed in its breathing, and died with convulsive motions of its limbs.

I shall now proceed to describe its

External Appearance.

When erect, this animal is about thirty inches high. The skin appears of a yellowish-white colour, and is thinly covered with long black hair on the front; but it is considerably more hairy behind. The hair on the head is rather thin, and is thickest on the forehead, where it divides, about an inch above the orbitar process of the frontal bone, and running a little backwards, falls down before the ears, forming whiskers on the cheeks. Here the hair measures nearly two inches long, but that on the occiput is not above an inch in length. There are a few stiff black hairs on the eye-brows, and a scanty eye-lash. A few whitish hairs are scattered on the lips, especially on the under one. The rest of the face is naked, and has whitish and wrinkled skin. There is scarcely any hair on the neck; but commencing at the nape it becomes somewhat bushy on the back. The abdomen is nearly naked. The hair on the back of the head, and the whole trunk, front of the lower extremities, back of the legs, and upper part of the superior extremities, is directed downwards, while that on the back of the thigh and fore-arms is pointed upwards; appearances well represented in Tyson's figure. The longest hair is just at the elbows. There is none on the fingers or palms of either extremity. Around the anus and genitals is a patch of whitish hair, which is longest just over the anus *.

The ears are remarkably prominent, thin and naked, bearing a considerable resemblance in shape to the human, though broader at the top. The projection of the process above the eyes, is very conspicuous, but has not been sufficiently marked in any engraving or drawing which has fallen under my observation. The nose is quite flat, or rather appears only as a wrinkle of the skin, with a slight depression along its centre. The nostrils are patu-

* These observations may appear too minute, but several naturalists have laid much weight on the manner in which the hair of the Orang Outang is directed.

lous, and open upwards, which would be inconvenient, did the animal usually assume the erect posture. The projection of the jaws is excessive; and though much less so than in the baboon, yet the profile of the face is concave. It may be remarked, however, that the projection of the lower jaw is caricatured in the first and second figures of Camper's second plate. The mouth is wide, the lips rather thin, and destitute of that recurvation of the edges which add so much to the expression of the human countenance. The whole contour of the head bears no inconsiderable resemblance to some Egyptian figures of the god Anubis.

The spread of the shoulders is distinctly marked; but the width of the lower part of the chest is proportionally greater when compared to the upper, than in man. The mammæ in our subject are perfectly flat, and the nipples very small, as is also the umbilicus.

From the lower ribs, the diameter of the abdomen decreases rapidly to the loins, where the animal is peculiarly slender;—a circumstance in which it approaches the other simiæ. The pelvis appears long and narrow; another approximation to the rest of the genus. The genitals present striking peculiarities, which shall be afterwards particularly described. There are no callosities on the buttocks.

With regard to the limbs, the chief difference between our specimen and Dr Tyson's figure, consists in the excessive length of the arms; which in this animal, descend below the knees, by the whole length of the phalanges of the fingers, which are above three inches in length. The same observation applies to almost every figure of this animal which I have seen. The proportions in the work of Camper, approach nearest to the present instance in this particular. The hand differs from the human, in having the thumb by far the smallest of the fingers. The foot is more properly a hand appended to a tarsus. The thumb of this extremity is very long, powerful, and capable of great extension. The legs are certainly furnished with calves; but they scarcely resemble the human in form, because they are continued of equal thickness nearly to the heel. When the animal is erect, the knees appear considerably bent, as is the case with the other simiæ, and it stands with the limbs more apart than man.

Internal Structure.

In the following observations, our intention is rather to describe the peculiarities of the Orang Outang, than to dwell on those circumstances in which it accords with the human subject; and according to the plan most commonly adopted by anatomists, we shall commence with the bones, as the basis of the body.

The Bones.

The general appearance of the skeleton is pretty accurately given by Dr Tyson. The chief difference between his figure and the present specimen, is the greater length of the arms, the prominence of the orbitar processes of the frontal and of the maxillary bones, and the consequent greater concavity of the profile of the face in the latter.

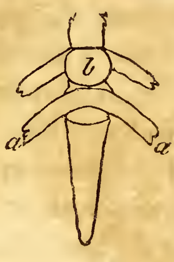
The Bones of the Head.—The general form of the head certainly approaches nearer to that of man, than in any other species of this genus; but the top of the head is more flat, and the union of the spine with the head is rather farther back. The different pieces of the cranium are united by indented sutures, that have the same position as in man. In the lambdoid suture, at its junction with the sagittal, we found an os triquetrum of small size. The squamous suture of the temporal bone is smaller, and rather less overlapping than in the human subject. The orbitar processes of the os frontis, project about half an inch beyond the general convexity of that bone; and the orbits of the eyes are proportionally larger, and rounder than in man. On taking off the upper part of the cranium, the fossæ for the lodgment of the brain, seem less strongly marked than in man, and have fewer inequalities of surface. The frontal fossæ have smoother bases, which slope down toward the temporal fossæ. The frontal spine is continued a little farther down, and the depression which receives the cribriform plate of the œthmoid bone, is much deeper and smoother on the sides; while the apertures in that bone, for the passage of the olfactory nerves, are considerably larger. The crista galli is smaller. The temporal fossæ differ from the corresponding parts in man, in being much less marked by inequalities, and they extend more toward the base of the skull. The pars petrosa is less prominent, and smoother. The sella turcica is almost in the centre of the cranium; the posterior clinoid process being two inches from the edge of the frontal, and but 2.3 from the occipital spine; whereas, in a human skull, the proportions were found to be as 2.5 to 3.8. Though the cerebellum is large, the fossæ which lodge it are not very distinctly divided from the posterior fossæ, destined to receive the cerebrum. Indeed, instead of the well defined boundaries traced in the human skull by the crucial ridge, we found them marked by a flat undulation of the occipital bone. The cavity of the cranium measures from the interior edge of the frontal spine, to the middle of the crucial ridge, 3.9 inches; and from side to side 3.5 inches. The foramen magnum of the occipital bone, is situated considerably farther back. There is no mastoid, and scarcely a vestige of a styloid process. The situation of the former is marked by a roughened surface, and the latter is represented by a minute point on the temporal bone.

The ossa nasi, are nearly similar in shape to those of man; but they are placed perfectly flat on the face, so as not to be visible in a profile of the skull. In the Baboon, there is only one proper nasal bone, which is applied flat to the upper part of the nose; and the cavity formed by the removal of the soft parts of the nose is oval; whereas in the Orang, it is circular; and it is triangular in man.

The ossa maxillæ superioris, project considerably beyond even the remarkable orbitar processes of the frontal bone, and bring the form of the lower part of the face more nearly to that of quadrupeds. We found the ductus incisivus; which occasionally occurs in man, is very distinct in the rib-nosed baboon, and is constantly found in the larger quadrupeds. The teeth strongly resemble the human; but the alveolar processes of the upper jaw, project the cutting teeth more forward. The incisores are strong, and placed a little remote from the canine teeth. When the mouth is shut, the canine teeth lock into each other; those of the lower passing before those of the upper-jaw. The molares are four on each side of the two jaws, but the two last are still lodged in the bone. The lower jaw is stronger and narrower than in man. It is thicker toward the symphysis, and has a shorter coronoid process.

The Bones of the Trunk.—The cervical vertebræ agree in number with the human skeleton ; but they form a more flat column; their spinous processes overlap less ; the atlas has no spinous process, in which the Orang Outang agrees with the baboon, though it differs from the latter in wanting the foramina, which pass obliquely from each side of the transverse processes of the atlas, to the passage for the vertebral arteries. The cervical column = 2 inches. The dorsal vertebræ are thirteen in number ; but the inferior oblique processes of the lower vertebræ are only two, as in man, not four, as in the baboon. In the latter animal, the two last vertebræ may be said to be without transverse processes. The length of the dorsal column in the Orang = 5.7 inches. There are only four lumbar vertebræ. The intervertebral cartilages below, differ in thickness from those of the upper vertebræ, more than in the human body. The cartilage between the thirteenth dorsal and first lumbar vertebra, measures upwards of an inch in front, while those between the cervical vertebræ are about 0.2 inch in thickness ; but the general dimensions of the cartilages of the back and loins, are from 0.2. to 0.3 inch.

The ribs are thirteen on each side ; of these eight are united to the sternum by their proper cartilages, and five are joined to the cartilages of the superior ribs. The ribs are placed rather on the body of the vetrebræ, than on the interstices between them, as is also the case in the Simia Maimon. The cartilages of the eighth pair, unite below the last piece of the sternum, (which was here cartilaginous,) as in this figure, *a a*.



The sternum consists of five pieces. The figure of the fourth piece is nearly globular, (as at b). The different pieces were united by cartilage; the xiphoid measured 1.3 inch, and the whole sternum 4.2 inches.

The general curvature of the vertebral column and of the ribs, does not materially differ from the human subject. The chest appears to be rather more roomy below, in proportion to its upper diameter; and the lower lumbar vertebræ are more suddenly inclined backward, to enlarge the brim of the pelvis. The following are the dimensions of the thorax.

	Inches.
Circumference of the thorax at its widest part, when the skin is removed, -	= 18.0
Diameter from the root of xiphoid cartilage, to the external side of the 8th rib,	= 6.0
Lateral diameter of the thorax at the 2d false rib, - -	= 6.5

The pelvis approaches much nearer to that part in the baboon than in the human skeleton. The ossa ilia, instead of forming a cavity by the incurvation of their upper portion, are flat anteriorly, and extend considerably above the sacrum, reaching to within a short distance of the lowest ribs. The upper part of the ilia in our specimen, was surrounded by a cartilaginous rim, 0.2 inch in diameter. The brim of the pelvis is much longer from the pubis to the top of the sacrum, than from side to side. The ossa pubis, with the ischia, are of a more square form than in man; the former is deeper at the symphysis; and the foramen thyroideum has its smallest angle pointing upward. The lower aperture of the pelvis is extremely different from the form in the human body. It is a very large and patulous opening, as bounded by the crura of the pubis, and the tendons stretched between the coccyx and the tuberosities of the ischia. The sacrum and coccyx, are placed so high above the tuberosities of the ischia, that they can scarcely be said to form any part of the boundary of the bottom of the pel vis. This peculiar form of the basin, militates against the erect posture being considered as the natural one of this animal; for it would thus be more liable to abortion in the gravid state. The sacrum is narrow, like that of the baboon; and like it consists of five vertebræ, which probably are united into one in the adult animal. The coccyx consists of three pieces; but two were cartilaginous. In the number of pieces in the coccyx, the Orang resembles man. The coccyx of the baboon consists of at least five pieces.

The ends of the ossa ilia are united to the pubis and ischium, by distinct cartilages, which are fully 0.3 inch in width externally; but though this shews the youth of the animal now under consideration, the ischia and pubis have no line of separation. The dimensions of the pelvis will be best understood from the following measurement.

	Inches.
Os innominatum from the top of ilium to the tuber ischii,.. =	5.8
Os ilium from its junction with the pubis to its top,..	3.7
Diameter of the pelvis across the broadest part of the ilia,.........	4.5
Inside diameter of the brim of the pelvis from pubis to sacrum,............................	2.5
Inside diameter of do. from side to side, at the union of ilia and pubis,..................	1.4
Ditto, a little higher between the crura of the ilia, ...	1.6
— from the point of the coccyx to the insertion of the sacro-sciatic ligament in tuber ischii, ...	2.0
— between the tuberosites of the ischia, ...	2.2
— from the point of the coccyx to inside of arch of pubis, ...	2.4

	Inches.
Ditto from do. to the inside of the upper part of symphysis,	= 2.0
Length of the symphysis pubis,	1.4

These dimensions differ considerably from those in the pelvis of the baboon, which is extremely narrow between the crura of the pubis and tuberosities of the ischia, so that the point of the finger cannot be introduced at the most depending part of the pelvis, even in the skeleton. The union, too, of its sacrum and ilia, is more towards the centre of the latter than in the Orang Outang; and the lower parts of the ischia are reflected outward.

The Bones of the Superior Extremity.—The clavicles present nothing peculiar, except that they project rather more forward than in man, at their junction with the sternum. The scapula is much narrower, in which it resembles the Baboon; but I cannot agree with Dr Tyson, who thinks it probable, that this deviation would be less considerable in an adult animal; for there is no appearance of cartilages, that, when converted into bone, could materially affect the form of the scapula. The Glenoid cavity is rather of an oval shape, and the form of the humerus is less round than in the human skeleton. The fore-arm and wrist present nothing remarkable. There are two rows of bones in the carpus, each consisting of four pieces, but some of these were cartilaginous in our specimen, by reason of its time of life. The hand is long and slender;

and has an extremely small thumb, which scarcely reaches down two-thirds of the length of the metacarpal bone of the fore finger. When the arm is hanging by the side, the points of the fingers are full three inches below the knees. The following measurements give the proportions of different parts of the superior extremity.

	Inches.
The whole extremity from top of the humerus to the top of the middle finger,......... ..=	18.5
Length of the scapula from the acromion to its base,...	3.7
Greatest breadth of the scapula directly across,	1.5
Length of the humerus,...............................	6.6
——— ulna,..	6.4
——— radius,...	6 1
——— carpus,..	0.7
——— hand including the carpus,......	5.7
Breadth of the hand across the lower extremity of metacarpus,..	1.7
Length of the thumb, (metacarp. 0.9, first phalanx 0.7, second phal. 0.3,)	1.9
——— 2d finger, (metacarp. 2.2, first ph. 1.3, second ph. 0.9, third ph. 0.3,)	4.7
——— 3d finger, (metacarp. 2.1, first ph. 1.6, second ph. 1.2, third ph. 0.3,)	5.2
——— 4th finger, (metacarp. 1.9. first ph. 1.5, second ph. 1.1. third ph. 0.3,)	4.8
——— 5th finger, (metacarp. 1.7, first ph. 1.1, second ph. 0.8, third ph. 0.3,)......	3.9

The Bones of the Inferior Extremity.—The structure of this part of the Orang Outang, chiefly differs from man in the foot, which is to be considered as a hand united to a leg and ankle. The head of the femur is round, as in man, and the neck terminates below in two distinct trochanters. The patella is bony. The fibula differs little from the human, except that it is less angular; but the tibia is contorted at about one-third of its length from the ankle. The tarsus consists of seven pieces; which, with the exception of the heel-bone, resemble these parts in man. The os calcis is narrower; the projection forming the heel is less broad; the whole bone is proportionally longer; and the groove for receiving the flexor tendons is deeper. Its position is also different. It lies immediately at the extremity of the fibula; and being in a line with it, is on the *outside* of the upper part of the ankle.

The hand of this limb approaches more nearly to the human hand than that of the superior extremity; but the proportion of the thumb in size and strength, seems rather greater, and the first phalanges of the fingers, especially of the fore-finger, are much bent. The metatarsal bone of the fifth or little finger, projects as in the human foot, beyond the outer edge of the tarsus.

Proportions of the Lower Extremity.

	Inches.
Length from the top of the great trochanter to the tip of the middle finger,	= 17.8
Length of leg and thigh from the same point, to the lower end of fibula,	12.0
——— of femur, following its curvature,	6.8
——————— in a straight line,	6.4
Length of the head and neck of the femur,	1.4
——— of the tibia,	5.7
——— of the fibula,	4.9
——— of the foot, from extremity of os calcis to tip of middle finger,	5.7
Breadth of the foot across the lower end of the metatarsus,	1.4
Length of the foot along its upper surface, from end of tibia,	4.4
——— of the thumb, (metacarp. 1.3, first ph. 0.8, second ph. 0.4),	2.5
——— of the 2d finger, (metacarp 1.6, first ph. 1.0, second ph. 0.5, third ph. 0.2),	3.3
——— of the 3d finger, (metacarp 1.5, first ph. 1.2, second ph. 0.7, third ph. 0.2),	3.6
——— of the 4th finger, (metacarp 1.5, first ph. 1.1, second ph. 0.7, third ph. 0.2),	3.5
——— of the 5th finger, (metacarp 1.6, first ph. 0.8, second ph. 0.5, third ph. 0.2),	3.1

The Joints, Ligaments, &c.

Neither the joints nor the ligaments present any very peculiar appearances. The head is articulated, as in man, and moves on the tooth-like process of the second vertebra of the neck. The motions of the humerus are free on the glenoid cavity; the joints of the elbows, wrists and fingers, are capable of all the varieties of motion we find in the human body. As our subject was young, the connecting cartilages of the whole body were large, and those of the pelvis so shrivelled in drying, as to distort the form of the basin. The symphysis pubis is more firmly united than in the Simia Maimon; where it was only closed by a broad cartilage of little thickness. The acetabulum is round, but not quite so deep as in man. The round ligament is fixed to the under and inner side of that cavity, but approaches nearer to its lower edge than in the human subject. The hip-joint has a very free motion upward and outward; and may be easily rolled, so as to bring the femur parallel with the parieties of the abdomen; but the knees cannot be so easily approximated as in man. This causes the animal to stand with its feet more asunder; and instead of the slight inward curvature of the knees, which occurs in our bodies, they are bent outward in the Orang Outang, which must make it *waddle* when it walks erect. The motion of the knee-joint is free backwards; but the animal does not seem capable of perfect extension of this joint, from the contraction of the posterior muscles of the limb. The tarsus possesses much more freedom of motion than in man. The ankle may be bent, so as to form a very acute angle with the tibia;—a circumstance favourable to the prone posture of the animal in walking; and it may be turned very freely inwards and outwards.

The Muscles.

In examining the muscles of this animal, are found several which seem to have escaped the researches of Tyson, as well as the more recent observation of Camper and of Cuvier. How far this may be owing to peculiarities in our specimen, I shall not presume to determine; but shall be contented to mark such discrepancies as may be between what occurred during our dissection of the Orang Outang, and the descriptions of preceding anatomists; commencing with

The Muscles seen on the Front of the Head, Neck and Trunk.—We found no trace of an occipito-frontalis muscle; a remark also made by Dr Tyson. The orbiculares and recti palpebrarum, as well as the muscles about the nose, the most of the muscles of the lips, with part of the buccinator and the platysma myoides, had been removed, by the person who flayed the animal in order to preserve the skin. The muscles which move the eye-ball, do not differ from the corresponding parts in man.

There is a striking similarity between the Orang Outang and man, in the number and position of the small muscles about the palate, tongue, pharynx, and larynx. There is not one wanting in the ape; but as there is no styloid process in this animal, the stylo-hyoideus, the stylo-glossus and stylo-pharyngeus, take their origin from the base of the pars petrosa of the temporal bone. The temporal and masseter muscles are stronger than in man, but not so powerful as in the Simia Maimon. The principal peculiarities that we observed about the muscles of the head, are in the digastricus and mylo-hyoideus.

The digastricus has anteriorly a single flat belly, attached to the lower jaw, for about half an inch on each side of its symphysis, and passing toward the larynx; near which it is bordered by a semicircular tendon. The extremities of this tendon are carried to the os hyoides, and attached to it at the insertion of the stylo-hyoideus; where, uniting with additional fibres, they form the long round tendons of the two smaller bellies of the digastric muscle, which (as the mastoid process is wanting in this animal) are carried farther back than in man, and inserted among the inequalities at the base of the occipital bone. A disposition nearly similar was observed in the digastricus of the Simia Maimon. It seems intended to give greater power in depressing the jaw in animals, where the antagonist muscles, the temporalis and masseter, are so powerful.

On removing the digastric muscle, the peculiar shape of the mylo-hyoideus is perceived. It is not composed of two sets of fibres uniting in the centre of the jaw, and filling up the space between the sides to the chin, as in man; but has a single set of very delicate fibres crossing the jaw, and leaving a space an inch in width, between the symphysis menti, and the anterior edge of the muscle. This edge is slightly concave, and bordered by most delicate tendinous film.

The small muscles about the thyroid, arytænoid and cricoid cartilages, do not sensibly differ from those of man.

The sterno-cleido-mastoideus, resembles the human, except in being inserted into the pars petrosa. The sterno-hyoideus and thyroideus, the omo-hyoideus, the longus colli, and the three scaleni, are quite similar, as is the levator scapulæ; but the latter is assisted in its action by a muscle not observed in man, which Tyson has judiciously named Elevator claviculæ. It arises from the transverse processes of the second and third vertebræ, and is broadly inserted into the outer end of the clavicle. A muscle of the same kind was observed in the baboon, and seems to be generally found in quadrupeds.

The pectoral muscles are much less fleshy than in man; and the P. major does not descend so low upon the ribs. The rectus abdominis is proportionally broader at its upper extremity than in man, measuring not less than 2.8 at the point of the xiphoid cartilage. Its three transverse tendons do not, as in man, penetrate and divide its internal fibres. In our subject, there existed no pyramidalis. The external oblique in its origin from the cartilages of the eight inferior ribs, its descending fibres, and its union with its fellow at the linea alba, resembles that muscle in the human subject. The same may be said of the internal oblique. Both of them are extremely thin. The small size of the umbilicus has been already noticed. It is distant from the top of the sternum, 8.4 inches, and 3.3 inches from the superior edge of the symphysis pubis. We observed a small quantity of fat on the site of the mons veneris.

The intercostal muscles in both layers, and the muscular heads of the inferior part of the diaphragm, resemble the corresponding parts in man; but the whole of this organ is larger than in man, on account of the greater extent of the lower part of the thorax in this animal. The psoas magnus, and psoas parvus, present nothing peculiar.

The Muscles seen on the posterior view of the Neck and Trunk.—The trapezius and latissimus dorsi, the rhomboidei, the trachelo-mastoideus, the longissimus dorsi, are situated as in man. The splenii capitis et colli resemble the human in form and insertion; but when the two muscles are traced upwards, we find that they unite just above the spine of the first cervical vertebra, and continue in union to where they originate in the occipital bone. The complexus and sacro-lumbalis, with all the subdivisions enumerated by anatomists, are precisely as in man. Tyson says, that the inter spinales colli were wanting in his specimen; but we found in ours distinct interspinales colli, dorsi et lumborum, with the intertransversales of the neck, back and loins, and the levatores costarum. Tyson also observes, that the quadratus lumborum is *longer* in the Orang Outang than in man; but to us it appeared *shorter*, corresponding to the distance between the spine of the ilium and the ribs, which scarcely exceeds an inch.

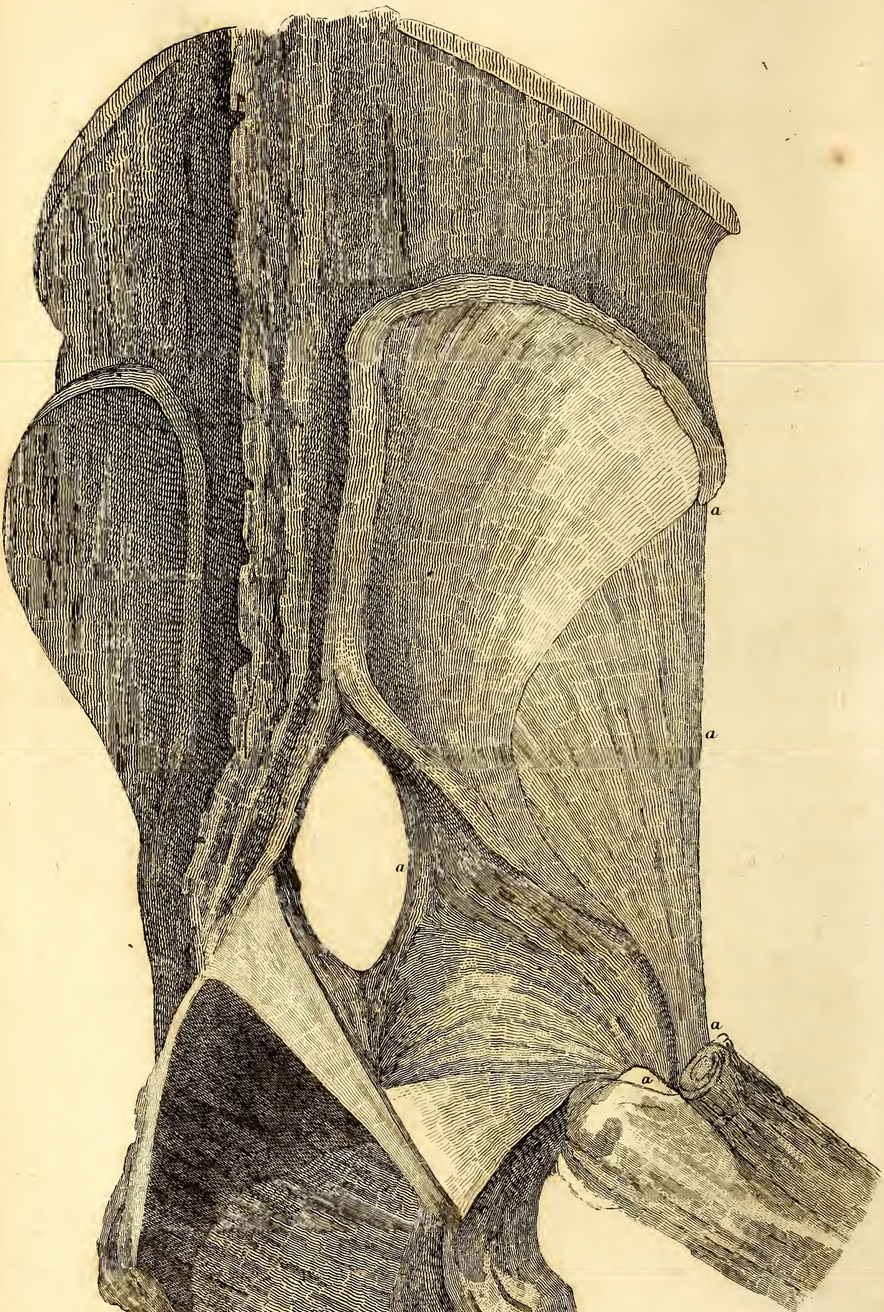
The recti posteriores capitis differ, in having the muscles corresponding to the minores in man considerably larger than those answering to the majores; that is, they contain more muscular substance though they are shorter than the latter. The relative proportions also of the obliqui capitis in this animal are reversed, when compared to man; for the obliquus superior is at least double the size of the obliquus inferior.

Muscles of the Superior Extremity.—The deltoid muscle arises from a larger portion of the scapula than in the human subject, descending posteriorly to within an inch of its inferior angle. The supra and infra spinatus, the teres minor, subclavius, and subscapularis, present little peculiar. The teres major is very strong, and proportionally broader than in man. The levatores scapulæ et claviculæ, have been already described. The two last are united by cellular substance, so as to resemble one muscle. The biceps flexor and triceps extensor cubiti, the coraco-brachialis, the brachialis internus and anconæus, exactly resemble the human. The same may be said of all the muscles of the forearm, except that there is no opponens pollicis in this animal, and that the flexor longus pollicis seems rather a part of the flexor profundus than a separate muscle. The palmaris longus, which did not occur in Dr Tyson's Orang, was very distinctly formed in one arm of our animal, but wanting in the other. The elbow-joint in this animal is capable of perfect extension, which is not the case in the baboon. In the latter, it seems to be chiefly owing to the manner in which the supinator radii longus is attached to the external condyle of the humerus and the neighbouring ridge. The pronation and supination of the hand, with the flexion and extension of the wrist and fingers, are performed by a mechanism so similar to the beautiful contrivances employed in man, that one might almost study human anatomy in those parts of the Orang Outang.

Muscles of the Pelvis and Inferior Extremity.—The muscles of the inferior extremity differ more from the human subject than any other part of this animal. The iliacus internus, and insertion of the psoas magnus, have nothing peculiar. The gluteus externus, which is called *maximus* in man, is much smaller than the *medius*, being very thin, while the latter is extremely thick and fleshy. From the elongated form of the ilia, they also differ much in form from the human glutei. The externus does not come so far forward, nor does it arise from so large a portion of the ilium. Tyson did not perceive a gluteus minimus; but we found an extremely thin muscle, answering to it in office, which might easily be overlooked in a hasty examination. Its origin is from the posterior edge of the ischium, instead of the dorsum of the ilium. Its fleshy fibres are most distinct along the sciatic notch; and as it descends toward the obturator internus, it becomes a thin tendinous expansion. It is attached to the capsular ligament of the hip-joint, both at the edge of the acetabulum and where it joins the neck of the femur; the insertion is into the great trochanter, as in man. This muscle, therefore, is to be considered partly as aiding the rotation of the thigh, pulling it outward, but seems principally intended to prevent the pinching of the ligament in the motions of the joint. See fig. G e.

The most remarkable muscle about the top of the thigh, has not been noticed by Tyson, Camper, Cuvier, or the older anatomists. It is a flat triangular muscle, arising from the whole anterior edge of the ilium to within half an inch of the aceta-

PLATE I.



J.S. Traill delt. Octr. 24th. 1817.

W. & D. Lizars Sculpt.

bulum, and is inserted just below the fore-part of the great trochanter, between the head of the cruralis and vastus externus, a little below the origin of the former. It is thin and fleshy through its whole extent, except where it is inserted by a very short-flattened tendon. At its upper part, it is united by cellular substance to the iliacus internus. The action of this muscle, which appears to be peculiar to this animal, is to draw the thigh up toward the body; and it seems especially to be intended to assist in climbing. On this account we propose to name it the *scandens*, or *Musculus scansorius;* and we are disposed to regard it as one of the principal peculiarities in the Simia Satyrus. Whether it exists in any of the other simiæ, we are unable to decide, but we did not observe it in the Simia Maimon; see fig. G, where *a* gives a posterior view of this muscle. The obturator internus is much more fleshy than in man, lining the whole internal surface of the pubis and ischium. The portion which becomes *external,* is more pyramidal, its tendon is broader, and it has a few fleshy fibres almost to its insertion at the root of the great trochanter. The pyriformis is a strong fleshy muscle as in man. The gemini, the quadratus femoris, the coccygeus and levator ani, are similar to the human, and the obturator externus is larger considerably, as might be expected from the form of the pubis. The pectinalis is less distinctly marked; the rectus femoris is not so broad and fleshy; the sartorius is more slender; the semi-membranosus is less membranous, and the semi-tendinosus less tendinous than the corresponding muscles in man. These two last in the Orang approach nearly to the same muscles in the Simia Maimon. In the latter animal, they descend lower on the anterior part of the tibia than in the Orang, which, in this respect, is a medium between man and the baboon. The gracilis has nothing remarkable. The vasti muscles are much weaker than in man, being thin and flat, especially toward the patella. The triceps adductor femoris, and biceps flexor cruris, resemble those parts in the human subject; but the muscles on the lower part of the leg are considerably different, especially those on its front, which overlap the upper part of the tibia, so as to give the appearance of a convex shin-bone. This is chiefly owing to the fulness of the tibialis anticus; the lower part of which is much larger and more fleshy than in man, though less so than in the Simia Maimon. The peroneus longus and brevis, are also rather more fleshy below in both the simiæ now under consideration, than in the human body. The gastrocnemius externus is flatter and thinner, and its belly descends almost to the heel in the Orang. The gastrocnemius internus descends fleshy to the os calcis, giving the animal but little appearance of a calf to the leg. We found no plantaris, nor did we perceive a popliteus. The extensor longus digitorum sends tendons to four of the fingers, one of which passes to the little finger; a circumstance not found in Dr Tyson's animal.

The extensor brevis digitorum sends tendons to all the fingers; thus supplying the deficiency of an extensor brevis pollicis. In Tyson's subject, the extensor brevis digitorum was wanting, and the extensor brevis pollicis was peculiarly strong. In our animal, the thumb had two long extensors of its phalanges, and a long extensor of its metacarpal bone. These muscles arise in common with the extensor communis. In these respects, the thumb of this extremity in the Orang Outang differs from the great toe of man, and resembles his pollex manus.

The flexion of the toes or fingers of the lower extremity in the Orang, is accomplished by a curious, and in some respects a more complicated mechanism than in man. This structure has not been noticed by Tyson, nor by any other anatomist, until the time of Cuvier, by whom it is well described *, as it occurs in the Mandrell, which appears to differ but little in this respect from the Orang.

The flexor brevis arises from the heel-bone, by a strong muscular head, covered by a firm aponeurosis, and sends strong perforated tendons to the four smallest fingers. The tendon going to the fore-finger, is continued more directly from the belly of the

* Anatomie Comparée, tom. i. p. 394.

muscle than the others, which, however, are most firmly united to the aponeurosis of the flexor brevis; while their action is assisted by some muscular slips attached to the body of the muscle, and descending along these three tendons for about half an inch.

The muscle corresponding to the flexor communis in man, arises from the whole posterior part of the tibia to within an inch of its lower extremity, and sends off a tendon, which, passing through a notch in the lower extremity of the tibia, descends toward the root of the metacarpal bone of the thumb, and then divides into two branches, destined to become the perforating tendons of the fore and little fingers.

There is no flexor *proprius* pollicis; but the corresponding muscle arises from the whole posterior part of the fibula, and ends in a strong tendon, passing through a groove in the os calcis, so deep as almost to conceal it even when the softer parts are removed, and running below the other flexors, is subdivided into three tendons, which are thus distributed: The first and strongest is sent to the thumb, where it passes between the double insertion of the flexor brevis; the other two form the perforating tendons of the middle and ring fingers. The tendons of the three flexors are all firmly united in the palm, by condensed cellular substance, to each other, and to the little fleshy appendages of the flexor brevis.

PLATE II.

Wernerian Mem^s. Vol. III. P. 32

POSTERIOR EXTREMITY OF THE ARM.

a. Flexor brevis
b. Muscular Slips
c. Flexor Communis
d. Flexor Pollicis

J. S. Traill del^t 24^th Oct^r 1817.

W. & D. Lizars Sculp^t

This complicated structure may be readily understood from an inspection of the accompanying drawings, in which each set of tendons is distinguished by different colours.

The flexor brevis pollicis is strong, and, as in the human hand, has a double insertion, forming a sheath for the reception of the tendon of the flexor longus. It is intimately united to the adductor pollicis. The adductor pollicis is a large muscle extending nearly along the whole length of the metacarpus of the fore-finger.

There is no transversalis pedis in this animal. Indeed, it was hardly to be expected in an organ so analogous to a hand.

The lumbricales, the abductor indicis, the abductor minimi digiti, its flexor parvus, and the interossei, are of a more lengthened form than in man; but we found neither an indicator muscle nor a palmaris brevis in either extremity of this animal. The aponeurotic expansions in its palms, and the annular ligaments of the wrist and ankle, are sufficiently marked.

The Brain and Principal Nerves.

On removing the upper part of the cranium in the usual manner, the brain was observed to fill the cavity completely. The skull is perhaps thinner than in man. The dura mater has the same texture. The convolutions of the brain are externally less strongly marked; the pia mater seems less vascular but penetrates deeper into the cerebrum than in the human subject; the protuberances lodged in the superior fossæ of the occipital bone are remarkably pointed; the cerebellum bears a larger proportion to the cerebrum; and the latter appears somewhat less deep. The veins supplying the great longitudinal sinus run from behind forward, as in man.

In examining the internal parts of the brain, the usual horizontal sections were employed.

The cineritious matter near the top of the brain, bears rather a larger proportion to the medullary than in the human body; because the fissures between the convolutions are deeper in this animal: but the proportional quantity of medullary substance becomes greater on penetrating to the level of the corpus callosum, the centre of which is only 0.9 inch below the upper surface of the brain. The lateral ventricles do not essentially differ from what is found in man. The corpora striata are less prominent and smaller, as is the choroid plexus. The fornix, with its pillars, the septum lucidum, and the corpora quadrigemina, are exactly like the corresponding parts in man. The pineal gland is remarkably large, but is similarly situated behind the posterior commissure of the cerebrum. It had no gritty substance in it; a circumstance often noticed in the human brain. The glandula pituitaria and infundibulum are very well marked.

The situation and communications of the third and fourth ventricles, the appearance of the crura cerebri and corpora albicantia, resemble the same organs in the human subject; but the pons Varolii is rather more flat. The cerebellum, as we have said, bears rather a larger proportion to the cerebrum than in man. It shews, when laid open, a very perfect arbor vitæ. The whole quantity of brain in this animal is considerable, weighing 11 ounces avoirdupois *. Unfortunately, the body was not weighed before dissection, so that I am unable to state the proportion between it and the brain; but conjecture that the latter is from $\frac{1}{30}$th to $\frac{1}{40}$th part of the whole body. This proportion approaches pretty nearly to that of man, in whom it varies from $\frac{1}{22}$ to $\frac{1}{31}$ †. The quantity of brain, however, gives no indication of the intellect of animals, else monkeys, the mole, the mouse, the dolphin, and several birds, should be greatly superior to the dog, the horse and the elephant, which last of all qua-

* The brain in Tyson's animal weighed 11 oz. 7 drachms; but the animals dissected by the Parisian anatomists must have been small monkeys; for the brain, though "large in proportion to the body," is stated only to weigh 2½ oz.

† See Cuvier, Anatomie Comparée, tom. ii. p. 149.

drupeds, seems to have the smallest brain in proportion to his body.

The position of the falx and tentorium in the Orang, have much resemblance to those parts in man; but the anterior portion of the former reaches farther down than in man, dividing the two branches of the olfactory nerve near the crista galli. The breadth of the falx from the back of the head to the anterior edge of the tentorium measures 1.4 inch; and from that point to the spine of the frontal bone, in a straight line, = 2.6 inches: proportions somewhat different from those of the human head. The nerves arising from the brain come off as in man. The first pair, or olfactory nerve, are larger and broader than in the human subject. The second pair, or optic nerve, are considerably less divergent than in man. The third, fourth and fifth pairs, the last of which consists of two fasciculi in each, and the sixth pair, are precisely like the corresponding nerves in man. The seventh or auditory nerve has a portio dura and mollis, with the intervening fibrils. The eighth pair, consisting of the glosso-pharyngeus and the small fasciculi of the par vagum, aided by the accessory nerves, present nothing different. The ninth pair consist each, as in man, of three bundles of fibres.

In pursuing the course of the nerves, we found the distribution of the great sympathetic, and the position of its great ganglion in the neck, very similar: but this ganglion was of a deeper ash colour, resembling a small lymphatic gland. The par vagum, the descendens noni, the recurrent branch of the eighth pair, the cardiac and phrenic nerves, all run in the same manner as in man. The pes anserinus of the portio dura of the seventh pair is extremely well defined. The great sphlanchnic nerve, with the semilunar ganglion, are entirely similar to what they appear in the human body. The course of the nerves of the extremities in general, strongly resembles their distribution in man. The only perceptible difference is, that those of the thigh, which, with the bloodvessels of that extremity, lie much more superficial, pass over the head of the femur in immediate contact with the capsular ligament.

The Heart, Lungs, and Principal Bloodvessels.

The size and position of the heart and lungs present nothing peculiar. The apex of the heart is toward the left side, and the pericardium, as in man and the baboon, is attached to the diaphragm. The left lobe of the lungs had been inflamed, and sunk in water. There are three lobes in the right lung, and two in the left, as in man. The course of the great arteries, of the vena cava and azygos, are very like what we meet with in the human subject. The two carotids and the jugulars, with the subclavian and axillary arteries, and the corresponding veins, are as in man. The external iliac follows the same course over the femur as the nerves.

Organs of Sense.

The great size of the olfactory nerve, and the extensive surface of the turbinated bones, lead to the inference that the animal was endowed with an acute sense of smell.

The ball of the eye is full as large, if not more so, than in man. The iris of a dark hazel colour, the pupil round. The ball did not project beyond the orbits of the eyes. We perceived in this animal, as well as in the Simia Maimon, a thin external film of black paint, 0.2 inches in diameter, surrounding the junction of the cornea and sclerotic coat, and easily removeable with a knife. The lens, the choroides with its black pigment, the insertion of the optic nerve, are just as they are in man. There is a small lachrymal gland, with the usual apparatus for disposing of the tears. The suspensor oculi, which occurs in quadrupeds, is wanting in the Orang.

The internal structure of the ear was not examined.

The organs of taste differ little from the human. The tongue is large and fleshy, as in man, and its surface is covered with numerous papillæ. Near its base are eight papillæ, rather larger than the rest, and arranged in this manner,

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Each consists of a mushroom-shaped body, supported on a short pedicle in the centre of a circular cavity, which they nearly fill up. They are not so large in the Orang, as three which we found in the baboon, arranged thus,

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The salivary glands, which are intimately connected with the organs of taste, approach to those of man. The parotid is a longish mass, of a deeper colour than in the human body, and consisting of large granulations, intermixed, as is usual, with common lymphatic glands. Its duct, and the submaxillary gland, are just as in man.

Organs of Voice.

The passage to the larynx is very similar to that part in man. The uvula consists of a small single papilla; but in the baboon, it is composed of two equal, but minute bodies, arranged from side to side. The amygdala and epiglottis are not peculiar.

The os hyoides differs from that of man, in being anteriorly more prominent and dilated, and by containing in its body a cavity capable of holding a large pea; a structure still more remarkable in the baboon. On laying open the posterior part of the larynx, the two apertures at the base of the epiglottis, and leading to the double sac or laryngeal pouches discovered by Camper, are visible. These apertures occupy the situation of the ventricles of the human larynx, between the superior and inferior ligaments of the glottis; are 0.4 inch in length, and are placed a little obliquely; their posterior angles being depressed below the level of the anterior, which approximate each other within less than 0.2 inch, and are distant from the free extremity of the epiglottis 0.8 inch. The above-mentioned ligaments of the glottis form the boundaries of these apertures, and are provided with evident longitudinal muscular fibres, by which the apertures can be contracted at the will of the animal. The apertures lead to two ventricles, considerably larger than in man, extending upward and forward to the cavity of the os hyoides, and terminating in two short membranous tubes, which run between the latter bone and the top of the thyroid cartilage, forming communications from the larynx to the two pouches or double sac, so well described by Camper. In our subject the *left* sac appeared to be the largest, and communicated freely with the cavity of the os hyoides, which was separated by membrane from the right sac. This mechanism, as is well remarked by Camper, appears to be intended to augment the power of the voice. A structure somewhat analogous has been detected in most of the other simiæ, and some other animals; but the peculiar structure of the larynx of the Orang escaped the researches of Tyson.

The epiglottis of our subject is rather broader and shorter than in man; and the thyroid cartilages are something more flat anteriorly. The muscles and ligaments about the larynx and os hyoides, have much affinity to the corresponding parts in the human subject *.

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* In the Simia Maimon, the arytænoid cartilages are much more elevated; and by their union, form what seems a second epiglottis, which is smaller than the true one, and has its inside remarkably corrugated or *fluted*. The true epiglottis is attached to the upper and inner part of the os hyoides, as in man. Under the base of the epiglottis is a very large cavity, projecting forward, and communicating with the upper part of the larynx. It is about half an inch in length. Its extremity is rounded, and lies in the os hyoides, which is hollowed to form it. In the baboon, the os hyoides is also peculiar, in having a perpendicular triangular projection, which overlaps the top of the thyroid cartilages. The top of the larynx seems composed of one piece. There is no thyroid gland; and the palate, like that of quadrupeds, is much corrugated. Not being, at the time of this dissection, familiar with the discoveries of Camper, the pouch connected with the larnyx was not carefully examined.

The thyroid gland is somewhat peculiar in its form. It lies like a small leech along each side of the thyroid, cricoid, and four first rings of the trachea; and the two portions communicate anteriorly by a delicate film of glandular substance, which crosses the upper rings of the trachea, obliquely from left to right. The trachea is like the human windpipe.

On reviewing the structure of the organs of respiration, of the tongue and larynx, there does not appear any reason why the Orang Outang should not speak. The organization, as far as we can judge, seems perfect; yet this animal, according to the best evidence, has never been known to make any attempt at articulate sounds. Indeed, in this respect it seems inferior to several other animals, which have been taught to imitate and repeat words or sentences. If animal organization were alone necessary to speech, the Orang Outang, from its striking approach to man, ought to possess this faculty in an eminent degree. We must, therefore, refer its deficiency in this respect, not to corporeal, but to mental peculiarities. It would be, perhaps, extremely difficult to point out the exact boundary between human intellect, and the faculties of the lower animals; but one grand distinction peculiar to the human species, is the possession of that intellectual power, by metaphysicians denominated *abstraction*. As the expression of ideas by arbitrary sounds, implies the exercise of this faculty, which does not seem granted to the brute creation, it may not be going too far to conclude, that the want of speech in the Orang and other animals, with a corporeal organization so similar to that of man, is wholly to be attributed to the absence of the faculty of abstraction.

Chylopoëtic Viscera, &c.

The upper part of the alimentary canal has nothing peculiar, except, that the pharynx seems rather more contracted and corrugated than in man. The stomach resembles the human in form; having its great curvature toward the left side. Its pylorus seems placed somewhat lower than in the human body. The stomach measures (when distended,) from the cardia to the pylorus, along its great curvature, 14 inches, and 5 inches along its superior edge. It might contain about a pint and a-half of fluid. The intestines were covered by a very thin omentum, which scarcely contained any fat.

The position of the small intestines resembles what is perceived in man. The biliary and pancreatic ducts, penetrate the duodenum nearly at the same place as in the human subject. In our specimen, there were a great number of very large worms, the Ascaris lumbricoides, in the upper part of the intestines. They completely distended the duodenum; and three of them had penetrated by the ductus communis choledochus, and hepatic duct, to the liver. The head of one was traced through a ramification of the latter duct, at least half an inch within the liver; and two had penetrated a considerable way through the pancreatic duct, which they completely blocked up. Along with those observed in the biliary ducts, were several young ones about half an inch in length, and of a pale flesh colour. Linnæus and others, have mentioned the occurrence of lumbrici in the pancreatic duct as not uncommon; but their penetration through the biliary ducts is a rare occurrence. With respect to these worms, it is difficult to decide, whether they found their way from the intestines after the death of the animal, or contributed to its dissolution by their unusual situation.

In structure, the great intestines generally resemble those of man. The cœcum is large and distinct; and the appendix vermiformis, which is wanting in the baboon, is remarkably long. It is not, however, hanging loose in the abdomen; but is gathered into spiral convolutions, by a separate mesenteric expansion peculiar to itself. The appendix, measured along its convex edge=7.7 inches; and the circumference of the great arch of the colon, when inflated moderately = 5.7 inches, while that of the caput coli, at its greatest diameter = 8 inches. The attachment of the cœcum to the right side is just as in man; but it is quite free in the baboon.

The coats of the intestines, the peritonæum, the glands of the mesentery, with the lacteals and thoracic duct, are similar to those parts in man. The course and termination of the latter, are precisely the same.

	Feet.	Inch.
The length of the small intestines, from pylorus to cœcum..............................	= 18	8
The length of the colon,..............................	5	5
The length of rectum,..............................	0	3
Making the length of the whole intestines,	= 24	4,

or upwards of nine times the length of the body of the animal;—a proportion fully greater than what we find in man, even in persons of short stature *.

The liver is a large viscus, situated as in man. It differs, in a few respects, from the description of Dr Tyson. The sulci, in our animal, are deeper than in the human liver; and, in this respect, more nearly resemble those of the baboon. The sulcus, which divides the right and left lobes, penetrates through two-thirds of the substance of this organ. The lobulus Spigelii is very distinctly marked; and there is a very small heart-shaped lobule loosely attached to the posterior part of the great fissure on the concave side of the liver. The left lobe is proportionally smaller than in man; but the substance

* It may not be improper to observe, that the measurements were made by a string applied along the convex edge of the intestines, after the mesentery was divided.

and colour of the whole viscus exactly resemble the human. If we omit the small heart-shaped appendix above mentioned, the liver of the Orang may be said to consist of three lobes; but, in the baboon, we found the liver divided into four distinct portions.

The hepatic duct comes from each great lobe, by a distinct branch. These two unite close to the liver; and, joining the cystic duct, form the ductus communis, which penetrates the coats of the duodenum by a very oblique opening. The spleen is similarly situated to the human; but it is much thinner.

The pancreas is about two inches long, whitish, and uneven on its surface, and sends its duct to the duodenum, near the entrance of the hepatic duct.

Urinary Organs.

The kidneys nearly resemble those organs in man, having distinct cortical and uriniferous portions, papillæ, infundibula, and pelvis. Their form is rather rounder, and the fissure at the entrance of the vessel rather less deep. The glandulæ renales are large, and similar to the human. The bladder is proportional in size; but is rather more oval than in man, and the ureters enter it rather nearer to its cervix.

The Organs of Generation.

The external organs in the Orang, at the first view, scarcely bear any resemblance to the female organs in the human species. It can scarcely be said that there is a mons veneris. The vulva is wholly concealed, when the animal is in a supine posture, by a pendulous flap, of a pale flesh colour, which, on examination, proves to be an elongated clitoris. It is composed of two cavernous bodies, firmly united and contained in a sort of sheath, which is folded at the extremity. Its general form is cylindrical; but the divergence of its crura makes it a little broader at its root, where alone it is attached to the pubis. Its body hangs quite free for 1.5 inch from the arch of the pubis, and its extremity is nearly half an inch in diameter *.

On raising up the clitoris, the labia are visible; but they are thin, and do not include the base of the clitoris. The vulva appears circular, with slight diverging rugæ passing from the entrance to the

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* The elongation of the clitoris is great in most of the simiæ, and has been by some compared to *the flap* of Hottentot women: but the latter peculiarity is now well known to be produced by an elongation of the *nymphæ*, more frequent among that race than in any other part of the world.—See Barrows T'ravels; and Med. Chur. Trans. vol. vii.

vagina, toward the circumference of the labia, which give these parts a considerable resemblance to the anus. The crura of the labia become extremely thin as they descend toward the anus, which is provided with its proper sphincter, and is divided from the pudenda, by a perinæum rather more than half an inch in breadth.

There are no vestiges of nymphæ, or labia interna, unless we suppose the labia already described to correspond to them; in which case, the labia externa must be considered as wanting in this animal.

At the entrance to the vagina, is a small duplicature or fold of the skin lining the parts, which perhaps may be considered as a hymen.

The vagina presents nothing peculiar. It leads to a very small uterus, which, in form, is just the human womb reversed. Its fundus is the apex of the *pear*, and its greatest diameter is just at the cervix. The ovaria are large in proportion to the uterus, and have a greenish-grey colour. The Fallopian tubes are shorter and flatter than in the human subject, and have their extremities much fimbriated. The ligaments of the uterus generally resemble those that connect the human womb with the pelvis.

Between the ovaries and the Fallopian tubes, we found on each side a small yellowish body of a flattened irregular shape. It is placed in the broad ligament, and was very tender in its structure.

After the great length to which these observations have extended, it is not my intention to offer any general remarks upon the structure of the Orang Outang. For the tedious prolixity of this paper, I must offer as an apology, a wish to communicate every information in my power respecting so rare and interesting an animal.

Liverpool, March 1817.

II. *On the Connection between the Primitive Forms of Crystals and the Number of their Axes of Double Refraction.*

By DAVID BREWSTER, LL. D. F. R. S. Lond. and Edin.

(*Read 20th March* 1819.)

IN examining the structure of crystallised bodies, mineralogists do not appear to have observed the slightest connection between their primitive forms and any of their physical or chemical properties *. Without the guidance of a general principle, their determinations have often been at variance, and even the same observer has at different times as-

* When speaking of doubly refracting crystals, LA PLACE makes the following observation :—" L'Ellipsoide qui leur est " relatif, doit être determinée par l'experience ; et sa position " par rapport aux faces naturelles du crystal, *peut repandre un* " *grand jour sur la nature des molecules integrantes des substances* " *crystallisées ;* car ces molecules doivent, chacune, avoir les " memes proprietés que le crystal entier."—*Mém. de l'Institut.* xii. p. 302. It will be seen from the following paper, that the sagacious conjecture of this illustrious mathematician has been fully verified, but in a very different way from that which he anticipated. The existence of more than one axis had not been ascertained when his paper was published.

signed a different nucleus to the same body. In a very extensive examination of the optical constitution of minerals and artificial crystals, I was led to ascertain their number of axes of double refraction; and I had proceeded only a short way in this inquiry, when it became obvious, that a very unequivocal connection existed between the form of the primitive nucleus and their number of axes of double refraction. Every new experiment added to the truth and generality of this result; and when I had examined the greater number of those bodies whose primitive nucleus was known, I had the satisfaction of observing that all the crystals with *one axis* arranged themselves under a certain series of primitive forms; and that those with *two axes* arranged themselves under another series; while the remaining primitive forms were occupied by those crystals whose doubly refracting forces were in equilibrio by the combined action of *three equal and rectangular axes.*

This singular coincidence, to which there is only one or two exceptions, will be readily seen in the following Table.

Table

Table shewing the Connection between the Primitive Forms of Crystals, as determined by Haüy, and the Number of their Axes of Double Refraction.*

IST CLASS OF PRIMITIVE FORMS.

CRYSTALS WITH ONE AXIS.

1. *Rhomboid with Obtuse Summit.*

Carbonate of lime.
Carbonate of lime and magnesia.
Carbonate of lime and iron.
Tourmaline.
Rubellite.
Ruby Silver †.

2. *Rhomboid with Acute Summit.*

Corundum. Bournon, *Phil. Trans.*
Sapphire.
Ruby.
Cinnabar, *Annal. de Chimie*, tom. viii. p. 60.

D 2

* *Traitè de Mineralogie*, tom. i. p. 273.; and the EDINBURGH ENCYCLOPÆDIA, art. CRYSTALLOGRAPHY, vol. vii. p. 474.

† In the crystals printed in Italics, the number of their axes has been deduced from an examination of the tints, and not from the direct exhibition of the system of coloured rings; so that it is possible that they may have a different number of axes from what is here assigned to them.

3. *Regular Hexaedral Prism.*
   Emerald.
   Beryl.
   Phosphate of lime.
   Nepheline.
   Arseniate of Copper. Bournon, *Phil. Trans.*

4. *Octohedron with a Square Base.*
   Zircon.
   Mellite.
   Molybdate of lead.
   Oxide of tin. Philips, *Geolog. Trans.*
   Octohedrite.
   Tungstate of lime.

5. *Bipyramidal Dodecahedron.*
   Quartz.
   Phosphate of lead.

IId CLASS OF PRIMITIVE FORMS.

CRYSTALS WITH TWO AXES.

1. *Right Quadrangular Prism,—Base a Square.*
   Sulphate of magnesia.
   Chromate of lead.
   Mesotype.
   Nadelstein.
   Sulphate of zinc. Bournon, *Cat.* p. 185.
   Prussiate of potash. Bournon, *Cat.* p. 181.
   Muriate of barytes. Bournon, *Cat.* p. 187.

2. *Right Quadrangular Prism,—Base a Rectangle.*
Cymophane.
Peridot.
Prehnite.
Stilbite.
Anhydrite. Bournon, *Journ. des Mines,* vol. xiii. p. 346.
Tartrate of potash. Bournon, *Cat.* p. 191.
Tesselite or Prismatic apophyllite *. *Journ. des Mines,* vol. xxiii. p. 385.

3. *Right Quadrangular Prism,—Base a Rhomb.*
Topaz.
Staurotide.
Datholite. *Journ. des Mines,* vol. xix. p. 362.
Mica.
Talc.
Spodumene.
Sulphate of barytes.
Sulphate of strontian.
Sulphate of soda. Bournon, *Cat.* p. 183.
Citric acid. Bournon, *Cat.* p. 194.
Tartrate of potash and soda. Bournon, *Cat.* p. 193.

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* See the *Edinburgh Philosophical Journal,* 1819, N° I. p. 5.

4. *Right Quadrangular Prism,—Base an Oblique Parallelogram.*

Sulphate of lime.
Epidote.
Axinite.

5. *Oblique Quadrangular Prism,—Base a Rectangle.*

Borax.

6. *Oblique Quadrangular Prism,—Base a Rhomb*

Diopside.
Augite.
Glauberite.
Sulphate of iron*. Wollaston, *Annals of Phil.* vol. xi. p. 284.
Super-sulphate of potash. }
Acetate of copper. }
Tartaric acid. } Bournon, *Cat.* p. 181, 190, 191, 195.
Oxalic acid. }
Sugar. }
Grammatite.

7. *Oblique Quadrangular Prism,—Base an Oblique Parallelogram.*

Felspar.
Kyanite.
Sulphate of copper.

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* Sulphate of iron is supposed by Haüy and Beudant to have the acute rhomboid for its primitive form; but Dr Wollaston ha shewn it to be a rhombic prism. Although M. Beudant persists in his first opinion, yet we consider the existence of two axes as a proof of the correctness of Dr Wollaston's result.

8. *Octohedron, with a Rectangular Base.*

Nitrate of potash.
Topaz.
Arragonite.
Carbonate of lead.
Sulphate of lead *.
Muriate of copper.–*Edin. Encyc.* vol. vii. p. 478.

9. *Octohedron with a Rhombic Base.*

Sulphur.
Sphene.
Carbonate of soda.

IIId CLASS OF PRIMITIVE FORMS.

CRYSTALS WITH THREE AXES.

1. *Cube.*

Muriate of soda.
Boracite.
Leucite.
Analcime.

2. *Regular Octohedron.*

Diamond.
Spinelle.
Alum.
Ruby copper.
Fluor spar.
Muriate of Ammonia.
Pleonaste.

* Bournon and Philips make the primitive form of this crystal a right prism with rhombic bases.

3. *Rhomboidal Dodecahedron.*
Garnet.
Blende.

As the preceding table contains all the transparent crystals whose primitive forms have been determined, I have not been able to introduce into it a variety of other crystals, the number of whose axes I have carefully ascertained. Relying on the correctness of the general principle which is established by the preceding comparison, the crystals which I have examined may be referred to certain classes of primitive forms, as shewn in the following table; and hence, the individual primitive form may be easily deduced, from an examination of the secondary crystals.

1st class of primitive forms.

Mica with Amianthus, and some other kinds of Mica. See Biot, *Mem. Inst.* 1816, p. 275. Read 22d June 1818.
Idocrase*,
Hydrate of magnesia.
Hydrate of strontites.
Arseniate of copper.
5 Arseniate of potash.
Muriate of lime.

* Haüy makes the primitive form of *Idocrase* a right prism with a square base; but as this form is incompatible with one axis, it is more likely to be the same as that of *Zircon.*

Muriate of strontian.
Nitrate of soda.
10 Subphosphate of potash.
Sulphate of nickel, certain specimens, } probably
Sulphate of potash, certain specimens, } impure.
Super-acetate of copper and lime.
Ice.
15 Apophyllite surcomposée.
Apophyllite from Uto.
Titanite*.

IId CLASS OF PRIMITIVE FORMS.

Dichroite.
Mother of pearl.
Indurated talc.
Sulphate of copper and iron.
5 ———— ammonia.
———— cobalt.
———— ammonia and magnesia.
———— soda and magnesia.
———— manganese.
10 Carbonate of ammonia.
———— — potash.
———— — barytes*.
———— — strontian†.

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* Haüy makes the primitive form of *Titanite* a right prism, with a square base; but this form is incompatible with its optical structure.

† Haüy makes the primitive form of the *Carbonates of Barytes* and *Strontian,* a hexaedral prism, a form which is directly excluded by their having two axes.

Nitrate of silver.
15 ——— — ammonia.
——— — lime.
——— — strontian, certain specimens.
——— — copper.
——— — zinc.
20 ——— — mercury.
——— — bismuth.
Muriate of mercury.
——— — magnesia.
Acetate of lead.
25 ——— — zinc.
Hyper-oxmuriate of potash.
Phosphate of soda.
Oxalate of ammonia.
Super-oxalate of potash.
30 Crystallised Cheltenham salts.
Murio-sulphate of magnesia and iron.
Benzoate of Ammonia.
Chromic acid.
Benzoic acid.
35 Boracic acid.
Succinic acid.
Hydrate of Barytes.
Super-tartrate of potash.
Tartrate of potash and antimony.
40 Diallage.
Spermaceti.
Hypo-sulphite of lime *.

* See *Edinburgh Philosophical Journal,* N° I. p. 15.

IIId CLASS OF PRIMITIVE FORMS.

Nitrate of lead.
——— — strontian, octohedral crystals.
——— — barytes
Nitrite of lead.
5 Muriate of potash.
Uranite.
Sodalite.
Essonite*.
Sulphate of alumina and ammonia.
10 Cinnamon-stone.

The examination of the optical structure of minerals, enables us to go still a step farther in approximating, by exclusion, to their primitive forms.

The crystals in the following table, I have ascertained only to possess double refraction, without ha-

* Haüy makes the primitive form of *Essonite* a right rhomboidal prism, which is quite incompatible with its optical structure. I would propose to restrict the name of *Essonite* to those pure and perfectly transparent Hyacinths, which are distinguished from the Zirconian Hyacinths, by their being destitute of double refraction; and to apply the name of Cinnamon-stone to a class of Hyacinths, in which I have discovered an imperfect transparency, like that which arises from the mixture of alcohol and water, or any other fluids of different refractive powers. The portions of the cinnamon-stone thus imperfectly combined have a slight depolarising structure; and I consider the *Essonite* to have the same relation to *Cinnamon-stone,* as *Quartz* has to *Chalcedony.*

ving been able to discover whether they have one or two axes. By this property, therefore, they are excluded from the three primitive forms of the *Cube*, the *Regular Octohedron*, and the *Rhomboidal Dodecahedron*; and therefore they must belong either to the first or second class of primitive forms.

Table containing Crystals that must belong either to the Ist or IId Class of Primitive Forms.

Acetate of nickel.
Euclase.
Pycnite.
Chlorite.
5 Cubizite.
Native orpiment.
Actynolite.
Harmotome.
Macle.
10 Wavellite.
Calamine.
Anthophyllite.
Laumonite.
Asbestos.
15 Serpentine.
Steatite.
Tabular spar.
Cryolite.
Carbonate of copper.

20. Muriate of gold.
——— of silver.
——— of iron.
——— of lead.
Nitrate of magnesia and ammonia.
25. Acetate of soda.
——— of potash.
Phosphate of iron.
——— of copper.
——— of lead.
30. ——— of magnesia.
Arseniate of lead.
Calomel.
Oxymuriate of mercury.
Emerald copper.
35. Topazulite.
Haüyne.
Meionite.
Wernerite.
Hyposulphite of strontian.
40. Specular iron.
Petalite.
Subsulphate of alumine.

The connection between the external forms of crystals and their optical properties, naturally leads us to enquire, if any reason can be assigned, why particular forms should be distinguished by a particular number of axes.

It appears from the general principle of the resolution and composition of polarising forces which I have explained in another place*, that a single polarising axis may be the resultant of any number of equal axes of an opposite character.

When the separate axes lie in the same plane, the single axis may be produced by the joint action of any odd or even number of equal axes, situated symmetrically around it; and the polarising force F of the resultant axis, will be $F = \frac{nf}{2}$, n being the number of axes, and f the force of each axis acting separately. The planes which pass through each axis cut one another at the poles of the resultant axes, at angles equal to $\frac{360}{2n}$; but as the real angle of the forces, or the virtual inclination of the axes, is double of this angle, or $\frac{360}{n}$†, it follows, that if A a, B b, C c, D d, are the axes, the action of A a, and B b, at the pole O of the resultant axes, will not be according to the directions AO, BO, but according to the directions AO, CO; for, AOB $= \frac{360^{\circ}}{2n}$ and AOC, $= \frac{360^{\circ}}{n}$. Hence it appears that the virtual directions of the planes passing through each axis are transferred, as it were, to the real directions of the plane passing through the next axis; so that the virtual directions of the axes A a, B b, C c, D d, instead of being AO, BO, CO, DO, will be AO, CO, a O, c O, which being all equal and

* See *Phil. Trans.* 1818, p. 245. † *Id.* p. 239, 240.

symmetrical round O, will be *in equilibrio,* or destroy one another at that point.

A similar result will be obtained when the separate axes are not in the same plane, but are all equally inclined to the resultant axis, provided they are equal, and symmetrically arranged round that axes; or, to view the subject in a still more general aspect, *the action of several separate axes, of the same character, whatever be their intensity, or their number, or their inclination, may be resolved into one axis, either of the same, or of an opposite character, provided the intensities, the inclinations, and the directions of the separate axes are all symmetrically related to the line which is the resultant axis.*

In the *First Class of Primitive* Forms, the very nature of the geometrical solids which compose it, seems to limit them to a single axis, either real, or resulting from several separate actions.

In the *Obtuse Rhomboid,* the line joining the obtuse summits is the only line which can be placed symmetrically in the solid, and is at the same time the axis of the crystal, and the axis of double refraction.

The line joining the acute summits of the *Acute Rhomboid,*—the line joining the centres of the hexagonal bases of the *Hexaedral Prism,*—the line joining the summits of the two pyramids of the *Octohedron with a square base,*—and the line joining the apices of the two pyramids which compose the

Bi-pyramidal dodecahedron, all enjoy the same property of being the only lines which can be placed symmetrically in these different solids, and which can be regarded as the axes of polarisation *.

In all these forms, however, the axis of the crystal may be the resultant of several axes which possess the conditions required by the general principle.

In the Obtuse Rhomboid, for example, the *single axis* may be resolved into

1. *Three axes* in the direction of lines joining the six acute solid angles of the rhomb, which have their inclinations and their directions symmetrically related to the short diagonal, or into
2. *Three axes*, perpendicular to any of the three planes which contain the obtuse angle; or into
3. *Three axes*, parallel to the common sections of these three planes; or into
4. *Three axes*, perpendicular to these common sections, and bisecting the angles formed by the planes; or into
5. *Three axes*, parallel to these common sections; or into
6. *All these axes*, taken together, or any number of them taken symmetrically.

These axes will be of the same character as the single axis, if their inclination to the axis of the

* There is an exception to the generality of this remark, which will be presently explained.

rhomboid is less than 54° 44′ 8″; but they will be of an opposite character at greater inclinations.

The very same results are true of the ACUTE RHOMBOID, *mutatis mutandis.*

In the HEXAEDRAL PRISM, the *single axis* may be resolved into

1. *Three axes,* perpendicular to its sides; or into
2. *Three axes,* perpendicular to its edges; or into
3. *Six axes,* joining the opposite angles of its upper and under hexagonal base; or into
4. *Six axes,* joining the opposite edges of its upper and under hexagonal base.

In the BI-PYRAMIDAL dodecahedron, the *single axis* may be resolved into

1. *Three axes,* perpendicular to the sides of the hexagonal base, and lying in the plane of it; or into
2. *Three axes,* joining the opposite angles of the hexagonal base; or into
3. *Six axes,* parallel to the faces of the pyramids; or into
4. *Six axes,* parallel to these common sections.

In the OCTOHEDRON, with a square base, the *single axis* may be resolved into

1. *Two axes,* perpendicular to the sides of its square base, and lying in its plane; or into
2. *Two axes,* coinciding with the diagonals of its square base; or into

3. *Four axes,* perpendicular to the four faces of the pyramids; or into
4. *Four axes,* parallel to the four faces of the pyramids, and perpendicular to the sides of the square base; or into
5. *Four axes,* parallel to these common sections.

These four axes will be of the same name with the single axis, when their inclination to the resultant axis is less than 54° 44′ 8″; and of an opposite name when the inclination is greater.

The very same results are true of the ACUTE RHOMBOID with a square base, *mutatis mutandis.*

The obtuse and acute octohedron may also have three axes coinciding with the three rectangular axes of the solid, and having their intensities proportional to their lengths, as will afterwards be explained.

In these cases, all the lines supposed to possess the dignity of an axis, have a *symmetrical position* in the solid; and it must be allowed to be a singular fact, that, without a single exception, all the primitive forms which compose the first class, cannot possibly have more than one axis, whether we consider this axis as an independent line, or as the resultant of various other lines, occupying a symmetrical position around it.

If we now extend the same reasonings to the SECOND CLASS OF FORMS, it will be found that if we give the hypothetical axes a symmetrical position in the solid, and consider their intensities as represented by their lengths, the resultant of these forces cannot possibly be one axis, but must necessarily be the same as two rectangular axes, which they are known to possess.

The only exception to the generality of this observation, is in the case of the *Right Prism with a square base*, which, in reference to the general hypothesis, ought to have had only one axis of polarisation. We do not pretend to explain this very singular exception, but it is worthy of remark, that Idocrase, Titanite and Uranite, to which Haüy has assigned this as the primitive form, have not two axes, and therefore that it is within the limits of probability that all the crystals which are ranked under this form may have another primitive nucleus.

In the Third Class of Primitive Forms, the general principle has a very remarkable application. All the crystals belonging to this class, have neither double refraction nor polarisation; and I have demonstrated, that if any crystal possesses three equal and rectangular axes, either all positive or all negative, the forces which emanate from them will be in perfect equilibrium in every part of the crystal, and consequently there can be neither double refraction nor polarisation. Now, it is very singular, that the *cube*, the *regular octohedron*, and the *rhomboidal dodecahedron*, which compose this class, are the only solids in which neither more nor less than three such axes can be placed *. In the *cube*, each of the three axes is perpendicular to three opposite pair of square surfaces by which the solid is contained. In the *regular octohedron*, each of them coincides with a line joining the two opposite solid angles of the figure; and in the *rhomboidal dodecahedron*, each of the three axes coincides with the lines which join two of the opposite solid angles of the figure, which are bounded by four acute angles of the rhomboidal planes. Hence the reason is obvious, why the crystals belonging to the third class of primitive forms have three axes, and consequently have neither double refraction nor polarisation.

If we examine the results of the various combinations of three equal axes in the whole series of rhomboids, from the most obtuse to the most acute, we shall find them connected together by a very beautiful law.

In the first or most obtuse rhomboid with which the series commences, the angle of the rhomboidal planes is 120°, and the three axes perpendicular to these planes, are parallel to each other, and consequently form a resultant axis of the same character, whose intensity is equal to thrice the intensity of any of the separate axes. As their angle increases, and the rhomboid becomes less obtuse, the three axes become inclined to the axis of the rhomboid, and compose a resultant axis

* See pages 71, 72.

coinciding with the axis of the rhomboid, and of the same character as the separate axes. The intensity of the resultant axis gradually diminishes with the obtuseness of the rhomboid, and from its maximum intensity of $3f$, it descends to 0, its character remaining always the same.

When the angle of the rhomboidal planes becomes 90°, the rhomboid is converted into the cube: The three axes which were formerly inclined to one another at an acute angle, are now perpendicular to each other: Each of the three is inclined 54° 44′ 8″ to the axis of the rhomboid, which is now one of the diagonals of the cube; and the intensity of the resultant axis is 0, the forces being every where in a state of perfect equilibrium.

The series of obtuse rhomboids having now terminated in the cube, the series of acute rhomboids commences; and as the angle of the rhomboidal planes decreases below 90°, the three axes become inclined to one another at an obtuse angle; the intensity of the resultant axis begins to increase from 0; but its character is now changed, and is opposite to that of the three axes by which it is produed.

The acute rhomboids terminate in the hexaedral prism, when the angle of the rhomboidal planes has become 0. The axes are now all in the same plane, and the intensity of their resultant is equal to $1\frac{1}{2}f$, its character being still of an opposite nature.

The following Table will shew the intensity of the resultant axis in the Rhomboid for different inclinations.

Number of the separate axes.	Inclination of each separate axis to the resultant axis.	Intensity and character of the resultant axis.
Three + axes,..................	0° 0′	3 + axes
Three + axes,..................	28° 8′	2 + axes
Three + axes,..................	41° 48′	1 + axis
There + axes,..................	54° 44′ 8″	0
Three + axes,..................	70° 32′	1 — axis
Three + axes,..................	90° 0′	1½ — axis

It is a singular circumstance, that all the crystals in our table, which have the obtuse rhomboid, the acute rhomboid, and the hexaedral prism for their primitive form, have all a negative axis. Hence, it will follow, if this axis is the resultant of three axes, that in calcareous spar, bitter spar, carbonate of lime and iron, and tourmaline, the three axes are *negative*, while in ruby, sapphire, corundum, cinnabar, arseniate of copper, apatite, beryl, emerald, and nepheline, the three axes are *positive*.

A similar law takes place in the octohedral crystals with a square base; and the regular octohedron forms the passage between the acute and the obtuse octohedron, in the very same manner as the cube does between the acute and the obtuse rhomboid. In tracing this law, we may adopt either of two hypotheses. If we consider the octohedral crystals as having three rectangular axes of the same character, coinciding with the three axes of the solid, and having their intensity proportional to the length of these axes, then in the obtuse octohedron, where the principal axis of the solid is shorter than the rest, we shall have the resultant axis coinciding with it, and equal to either of the other axes, but of an opposite character at the commencement of the series of obtuse rhomboids. The character of the resultant axis will continue the same, and its intensity will diminish as the rhomboid becomes less obtuse, and when it becomes the regular octohedron, by all the three axes becoming equal, the three axes of polarisation will be *in equilibrio,* or destroy each other. The series of acute octohedrons now commences: The principal axis of the solid is larger than the other two, and therefore the resultant axis reappears, but with an opposite character, and gradually increases as the rhomboid becomes more acute.

The other hypothesis consists in supposing the axes to be four in number, and to be of the same intensity, but placed at right angles to the four faces of the pyramid. At the commencement of the obtuse series, these axes will be parallel to one another, and will form a resultant whose intensity is 4 *f*, and of the same character as the separate axes. As the octohedron becomes less obtuse, the inclination of the separate axes to the resultant increases, the intensity of the latter diminishing, and its character remaining the same. When the inclination becomes 54° 44′ 8″, which takes place when the obtuse changes into the regular octohedron, all the four axes are *in equilibrio*, or destroy one another. Beyond this inclination the acute octohedrons commence. The four axes compose a resultant of an opposite character; and when the octohedron terminates in the quadrangular prism, the intensity of the resultant becomes 2 *f*.

The following Table will shew the intensity of the resultant axis in the Octohedron for different inclinations:

Number of the separate axes.	Inclination of each separate axis to the resultant axes.			Intensity and character of the resultant axis.
Four + axes,...................	0°	0′	0″	4 + axes
Four + axes,...............	24	5	42	3 + axes
Four + axes,...............	35	15	52	2 + axes
Four + axes,...............	45	0	0	1 + axis
Four + axes,...............	54	44	8	0
Four + axes,...............	65	54	20	1 — axis
Four + axes,...............	90	0	0	2 — axes

The preceding results respecting the rhomboid and the octohedron, are true, *mutatis mutandis*, of all pyramids, whatever be the number of their sides.

The general law may be expressed in the following manner:

If any number N of axes of the same character, is placed symmetrically round a given line *, then, when they form an angle of 0° with that line, or coincide with it, they will compose a resultant axis in the

* Two axes can be placed symmetrically only when they are at right angles to one another.

direction of that line, equal in intensity to $\pm$ N f, (f being the force of each separate axis,) and of the same character with each of the separate axes. As the angle which the axes form with this line increases, the intensity of the resultant axis diminishes. At an inclination of 54° 44′ 8″ the angle which the faces of a cube, a regular octohedron, and a rhomboidal dodecahedron, form with the axis of these solids, all the separate axes will be in perfect equilibrium, or will destroy each other, and the force of the resultant will be 0. At a greater inclination, the resultant axis reappears with an opposite character, and gradually increases in intensity, till the angle is 90°, when all the axes are in one plane, and the force of the resultant is $\mp \frac{N f}{2}$.

This law may be represented by the following formulæ:

$$\text{Sin.}^2 \varphi = .6666 \mp \frac{n \; .6666}{N}, \text{ and}$$

$$n = N \left(1 - \frac{3 \, \text{Sin.}^2 \varphi}{2}\right);$$

where N is the number of axes combined, n the number of axes to which the intensity of the resultant is equal, and φ the inclination of each axis to the resultant. The sign + is to be used when n is of an opposite character to N.

Edinburgh, March 1819.

Wernerian Mem^s. Vol. III p. 75

HEAD OF DELPHINUS TRUNCATUS.

Fig.^s 1.2.3. Teeth belonging to different parts of the Jaws. Nat^l. size.
1&2 different views of the same Tooth.

Lizars Sculp^t.

III. *Description of a Species of Delphinus, which appears to be new.*

By the late George Montagu, Esq. F. L. S. & M. W. S.

(Read 20th March 1815.*)*

Delphinus Truncatus,

With numerous Teeth, closely connected, truncated, and on a level with the gums: In form resembling the Dolphin.

In the summer of the year 1814, a cetaceous animal was exhibited as a show at Totness, which I was informed belonged to the genus Delphinus, but that it possessed some characters which did not appear to belong to any of the species hitherto known.

As I did not hear of the circumstance till after the animal had been boiled for obtaining its oil, I could only endeavour to collect the best information concerning it, and, if possible, obtain its jaws, in which its principal distinction from Delphinus delphis appeared to consist. The first information of the capture of this animal, I received from Mr Dyer of Totness, and afterwards a more detailed account of the capture and description of the animal from Mr James Cornish of the same place. From the very great resemblance the animal bore to Delphinus delphis in its form, situation and shape of its fins, it was generally considered as that species; but Mr Cornish very properly doubted it, from the very different appearance the teeth exhibited from what the dolphin is described to possess. Mr Cornish describes it to be twelve feet in length, and about eight feet in circumference in the largest part; the colour of the back black, with a purplish tinge, gradually becoming dusky on the sides, and sullied white on the belly; the spiracle or blow-hole was placed between the eyes, it was semi-oval with the convexity forwards, and was two inches in length; its distance from the point of the snout, fourteen inches and a half. But the remarkable part of Mr Cornish's observation was, that the teeth were numerous in each jaw, placed close together, with their surfaces circular, perfectly flat and even with the gums. For a good representation of the contour of the animal, I was referred to the figure of the Dolphin in Shaw's Lectures.

Being extremely anxious to examine any remains of the head that could be obtained, Mr Cornish undertook to recover it, if possible, from the Dart, into which river the bones of the animal had been thrown after boiling; and I am happy to say, that after the indefatigable research of that gentleman, by dragging the river, the skull, with the connected upper jaw, and also the lower jaw, were the fruits of his labour, both of which he obligingly sent to me, accompanied by some teeth *.

The possession of the head is of considerable interest to science, as it obviates all doubt as to the accuracy of the relation given some time after the examination of the subject. The appearance of this part fully confirms what has already been said of it.

The length of the skull, including the upper jaw, is twenty inches and a half; the breadth of the jaw across the hinder teeth, is nearly five inches; on each side there are sockets for twenty teeth, besides a long depression behind the posterior socket, for some other purpose. The under jaw is somewhat longer, containing twenty-three sockets on each side, making collectively in both jaws eighty-six teeth, a number little inferior to what has hitherto been noticed in any cetaceous animal described †.

The sockets are variable in size, without order, shewing that some teeth were double the size of others, and the approximation of the sockets evinces

* The teeth of the animal had been all knocked out to satisfy the curiosity of the spectators, when it was exhibited as a show; and were so distributed, as to render it difficult to obtain many.

† The Delphis is said to have from 88 to 112. The Phocæna about 96 at the utmost. The Orca about 60, some only 50. In a specimen in the French Museum, each jaw had 22; but Artedi enumerates 40 in the lower jaw.

the contiguity of the teeth, so that the teeth of both jaws must have opposed their surfaces to each other, there being no intermediate space, as described in the Grampus and Dolphin, for the reception of the teeth of the opposite jaw. All the teeth I have examined, except one, have nearly a flat surface, some a little sloping or obliquely truncated, and quite flat; others truncated at right angles, and slightly convex, and one, not half so large as any other, is obtusely conic; this appears from the corresponding sockets to have been a fore-tooth; for in the upper jaw there are two small sockets in the front, and in the lower jaw four; but even these could scarcely protrude beyond the flesh, as not above a quarter of an inch projects above the jaw-bone when placed in the socket. The hinder teeth appear to have stood nearly perpendicular; others evidently stood obliquely forwards, both by the appearance of the teeth and the sockets; and I am of opinion, that none of the teeth, the six smaller ones before mentioned excepted, could have been scarcely elevated above the gums, both by the appearance of the teeth themselves, and by replacing them in their sockets.

The blow-hole in the skull is situated as described by Mr Cornish, but a central septum or longitudinal division, cuts the aperture into two equal parts.

By comparing the number, disposition and shape of the teeth of this species, with those of the grampus, the porpesse, and the dolphin, the dissimilarity is so great, that there is no hesitation in deciding the distinction; all those animals being furnished with teeth more or less sharp or conic, projecting above the gums, and sufficiently distant, to admit those of the opposite jaw to lock in between them, when the mouth is closed*. In the Delphinus gladiator, (described by La Cepede in his Histoire des Cetacées, from a specimen taken in the Thames in the year 1793, said to have been communicated by Sir Joseph Banks, accompanied by a drawing, and lately introduced into the British Fauna, in the last edition of Pennant's British Zoology,) the snout is said to be short, and the teeth sharp; so that any further comparison with this species would be useless to mark a distinction.

Another species of Delphinus is mentioned by Dr Shaw in his General Zoology, by the title of *rostratus*, the jaws of which appear to be the only parts that have come under examination. All we obtain from the description, is, that the jaws are extremely narrow in proportion to their length, which is about two feet, and that the teeth are small, not numerous, distant, and shaped like the molares of quadrupeds. From this very imperfect description, nothing decisive can be drawn, except that the atte-

* So described by most authors, but there is some confusion about the distance of the teeth. I have seen an instance of the porpesse, where the teeth could not intersect each other.

nuated snout and truncated teeth, are similar characters to those related of the present species; but the teeth being distant and not numerous, cannot belong to the present subject. The teeth of the delphinus in question, have a perfectly smooth surface, not irregular, as in the molares of quadrupeds; they are, indeed, formed with annular marks or faint concentric circles, which are only apparent when closely examined, the central one excepted.

Upon the whole, I do not find any species of delphinus described, to which this has sufficient affinity to induce a reference; and therefore trust it will be found to be a nondescript species. It must, however, be observed, that I have not been able to consult Cuvier's dissertation on this tribe of animals.

The Delphinus truncatus was captured on the 3d of July 1814, in Duncannon Pool, near Stoke Gabriel, about five miles up the river Dart. It was killed with great difficulty, resisting the efforts of eight men with spears and guns, assisted by dogs, from nine in the morning till one in the afternoon, when, being partly exhausted by the loss of blood, it was secured in a net, and, after receiving another shot, its throat was cut. When wounded, it made a bellowing like a bull.

I cannot conclude this subject without noticing, that there does not appear to be the least similitude between this species and the *ca'ing whale* of the Orkneys, originally described by Mr Neill in his Tour through the Orkney and Shetland islands;

and since described and figured by Dr Traill of Liverpool, in Nicholson's Journal, vol. xxii. No. 97. under the title of Delphinus melas. The remarkable length of the pectoral fins or swimming paws of the Delphinus melas, being above one-third the length of the whole animal, is sufficient to separate it from all those hitherto described*. It is worthy of remark, that amongst a great many of Delphinus melas, that were stranded at the same time, the young as well as some of the largest were destitute of teeth. From this and other observations made by different naturalists, there should appear to be no criterion of species by the number and situation of teeth. If we are well informed, the generic characters of Physeter and Delphinus do not hold good; and, in fact, these should form but one genus. Fabricius and others have declared, that the former have small teeth in the upper-jaw, obscured by the flesh. It has also been said, that some species of Delphinus have been observed

* There is little doubt of this Delphinus being the same as is described and figured in Cuvier's dissertation on the French species of Delphinus, under the title of *Globiceps*. The rounded front, and slender pectoral fins, are pretty evident characters; but the latter are not sufficiently long in the figure. To Dr Leach I am obliged for outlines of the several Delphini figured by Cuvier, by whom, I understand, no mention is made of their teeth; but none of the figures correspond with that of the subject of this paper.

with teeth in one jaw only. In fact, this class of mammalia appears to be in great obscurity. Few naturalists have the means of examining many species; and, therefore, their writings are borrowed mostly from old and imperfect descriptions. Even the more common species of Delphinus, the Orca, Phocæna* and Delphis, are by no means sufficiently defined to admit of our deciding, that there are not some very nearly allied species confounded with them,—a consideration worth the attention of such naturalists as may frequently have the means of examination and comparison of the species.

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* How shall we account for the reversed form of the dorsal fin of the porpesse, originally figured by Jago, and afterwards copied into Borlas's History of Cornwall? Surely this must be one of the innumerable errors handed down to us from the infancy of science.

IV. *Observations on the Mineralogy of the Neighbourhood of Cork.*

By the Rev. JOHN FLEMING, D. D. F. R. S. E. &c.

(Read 2d May 1818.)

THE city of Cork is situated on an extensive alluvial deposite, formed from the sediment of the river Lee. This river runs in a direction from west to east, meets the tide at the city of Cork, and after forming a frith interspersed with numerous islands, empties itself into St George's Channel, about fifteen miles to the eastward of the city.

The vale in which the Lee flows is parallel with the direction of the hills which occur in the neighbourhood. To the north of the city, there is a high continuous ridge of slaty rocks, which forms the northern boundary of the river for several miles. To the south of the city, there is another ridge, of lower elevation, consisting chiefly of limestone.

The strata are nearly vertical, scarcely ever observed declining above ten degrees towards the horizon. The dip is toward the south. The line of bearing is by the compass, from W. N. W. to E. S. E., and this direction is observed by all the strata of the district with surprising regularity.

In stating the few particulars which I have it in my power to communicate, respecting the minerals of this district, I shall arrange my observations under three heads, corresponding to the three kinds of rocks which chiefly prevail, and to which the others may be considered as subordinate. These rocks are grey-wacke-slate, limestone, and clay-slate.

I.—*Grey-Wacke-Slate.*

The rocks which I here denominate *Grey-wacke-slate,* occur principally in the ridge to the north of the city, where, from having been quarried in several places, the arrangement of the strata is very distinctly exhibited. The rock is termed by the inhabitants Brownstone, from the colour which it usually exhibits.

The stratification of this rock appeared to me to present some peculiarities which deserve to be mentioned. I have already stated, that the strata are nearly vertical, and the direction of the stretch uniform; and the structure and fracture correspond, as usual, with these characters of position. But besides this primary direction of the strata, there may frequently be observed another, or secondary direction, at right angles to the former, by which the vertical strata are divided horizontally. The vertical primary strata experience considerable variations in their composition, beds of a harder stone being included in strata of softer materials, or the reverse. But the secondary horizontal strata are uniform, the stratum above being similar to the one below. Sometimes, however, these horizontal strata differ a little in colour for a few yards, but seldom to a greater extent.

These subordinate horizontal beds are short, the lines of separation ceasing, and new ones, parallel, but not continuous, appearing, at short intervals of a few yards. These lines of separation are distinct and waved, and are carefully attended to by the quarrymen, whose operations they contribute to facilitate.

The appearances which these subordinate strata exhibit when the section is at right angles to the line of bearing, are apt to lead an observer, at first sight, to conclude that the rock is disposed in true horizontal strata; nor will he be convinced of the mistake, until a more minute examination of the fracture of the stone has pointed out the true structure of the beds.

Two forces have been operating upon the matter of the rock when entering into its present state: One, disposing the strata to assume a vertical position, and exercising absolute controul in arranging the slaty structure and fracture of the stone; while the second, less powerful in its influence, and irregular in its operations, has given rise to those waved horizontal divisions which the vertical strata exhibit.

The colour of this stone is intermediate between brownish purple-red and brownish-red. It is often clouded with irregular spots of greenish-grey.

The principal fracture, or rather structure in this case, is irregular curved slaty. The surface of the laminæ is often spotted with dendritic delineations, and is glimmering, owing to scales of mica, which are in general obvious to the eye. The cross fracture is fine earthy and dull. It is easily scratched with the knife, and the streak is light-coloured and dull.

This Brownstone exhibits several varieties of character, according as the siliceous or aluminous earths prevail. In the former case, the stone is coarse-grained, thick, slaty and hard, in the latter, it is fine-grained, softer, and divides into thinner laminæ. In some portions of the last variety, there are galls of a brownish-coloured powder.

This rock is intersected by numerous contemporaneous veins of quartz, from the size of a thread to upwards of a foot in breadth. In the larger veins, the quartz is compact, but in many of the smaller veins it is parallel fibrous, the direction of the fibres being perpendicular to the walls of the veins. This is precisely the manner in which the fibres of ice are arranged, when water has crystallized in a narrow crevice. In some places the quartz contains chlorite, and near Mallow Bridge, I observed small quantities of iron-mica.

Where this rock is disposed to present any variety of colour, it is in general greasy to the feel, and likewise contains steatite.

Subordinate to the rock which we have now described, occur large masses of SLATE-CLAY. It is seldom found as a regular bed of any extent; and, at the line of junction, it coalesces with the preceding rock. It is readily distinguished, however, from that rock, by its colour and fracture. It is bluish-grey, with a tinge of green or black. In the finer kinds, the laminated structure cannot be perceived, and the fracture is even, inclining to large conchoidal. It is dull,—sometimes glimmering from intermixed scales of mica,—fragments indeterminately angular, rather sharp-edged,—opaque,—soft in a slight degree,—streak dull, and light coloured,—adheres feebly to the tongue,—easily frangible,—and feels somewhat meagre. This variety is sometimes used as a whetstone for the coarser kinds of cutlery.

In many instances, this rock becomes fine earthy in its fracture; glimmering in its lustre; considerably harder; and the fragments more blunt-edged. Some varieties of this sort bear a close resemblance to those floetz rocks which are intermediate between sandstone and slate-clay.

Subordinate likewise to the brownstone, already described, is a rock which may be called Grey-wacke, although destitute of many of the important characters of that rock. It exhibits two very distinct varieties.

The first has a basis of coarse slate-clay, with mica and iron-pyrites, and contains numerous irregular rounded masses of compact limestone. The limestone is of a dark bluish-grey colour, with a fine splintery fracture, destitute of lustre, and having a light-coloured dull streak. These pieces are of no determinate shape, and pass, by imperceptible degrees, into the basis in which they are imbedded. Hence these masses, and the basis, are to be considered as of contemporaneous formation.

Perhaps this test of contemporaneously formed masses, is not much to be depended upon. The petrifactions of shells which occur in the older rocks, are often so intimately united with the matter in which they are imbedded, that they appear to pass into it by insensible degrees, it being impossible to detect the line of separation. Yet, in these cases, we do not consider them as of contemporaneous formation; but conclude, that some action has taken place in the matter of the bed, subsequent to its deposition, which has exerted its influence on the substance of the imbedded shells. Examples of such changes may frequently be met with in flœtz limestones; and they, perhaps, occur in other rocks containing fragments; although in these last, we have not the means of determining the original form of the imbedded masses; and, consequently, cannot trace the extent of the changes which they have experienced.

The second consists of a basis of granular quartz, with irregularly shaped pieces of bluish-black clay.

These pieces resemble the finest kind of slate-clay first mentioned; only they are of a darker colour, and rather harder. Its structure in the great is irregular slaty. It abounds in natural rents, and short contemporaneous veins and nodules of quartz.

There is another variety which approaches to thick slaty in its fracture, and contains a few scales of mica. In this are imbedded numerous reed-like films of a dark colour, and so closely resembling some of the varieties of sandstone, belonging to the independent coal formation, as not to be distinguished from them in hand specimens. The surface of these reed-like films exhibits rather indistinctly the appearance of vegetable impressions. The resemblance. however, to some of the impressions on the sandstone of our coal-fields was so close, that I was disposed, without further evidence, to assign to them a vegetable origin. A more minute examination enabled me to decide the question.

The surface of these films was often shining, and the black matter, ignited with nitre, proved to be glance-coal. A more diligent search, led me to discover in the rubbish of a quarry, a large cylinder, upwards of eighteen inches in diameter, consisting of glance-coal, iron-pyrites and calcareous spar. Upon breaking the mass, it was easy to discover its woody texture, by the fibres of the pyrites, and the concentric circles of which it consisted. When fresh broken, the pyrites exhibited its usual colour; but after exposure for a few days, it changed to bronze. The calcareous spar was distributed, so as to exhibit the concentric layers of growth; and the glance-coal appeared chiefly in angular grains in the spar, and likewise in the pyrites.

In examining vegetable petrifactions, with the view of determining, whether they are the remains of monocotyledonous or dicotyledonous plants, we must be influenced by the structure of the stem, and the arrangement of the nerves of the leaves. The first of these characters only, was here exhibited; so that, judging from the concentric layers of growth, we are disposed to refer this vegetable petrifaction to the class of dicotyledonous plants.

These specimens of vegetable petrifactions were collected, about a mile to the eastward of the city, on the Glenmire road. About five miles south from Cork, at Ballenhassig, a variety of the same rock contains bivalve shells, but too much incorporated with the rock to exhibit their peculiar characters.

The nomenclature which I have assigned to these rocks, is perhaps faulty, as being in some measure influenced by theoretical views. The striking resemblance between some of the rocks here described, and those of some of the sandstone districts of Scotland, appeared obvious to me at first sight; and had I been guided by this analogy, I would have regarded all these rocks of grey-wacke-slate as varieties of sandstone and slate-clay. But when we attend to their relations and their position, it might, perhaps, be more convenient to regard them all as varieties of grey-wacke, verging to quartz on the one hand, and to slate-clay on the other. The occurrence of numerous contemporaneous veins of quartz, so characteristic of grey-wacke, gives encouragement to the adoption of such a nomenclature.

II.—*Limestone.*

The beds of limestone occur chiefly on the south side of the Lee. They observe the same line of bearing as the strata of grey-wacke on the north side of the river. The limestone is in general compact,—of a bluish grey colour,—of various degrees of intensity, — massive,—dull, or feebly glimmering, from an intermixture of calcareous spar,—fracture compact, even, with a slight tendency to splintery,—fragments indeterminately angular, rather sharp edged,—feebly translucent on the edges,—streak light coloured, inclining to ash grey. It is universally used for building, and is sometimes polished as a marble. In some cases, from an intermixture of the *brownstone,* the marble is variegated.

In some varieties, especially those containing petrifactions, the fracture is granularly foliated, and the lustre glistening. Some varieties are darker in the colour, and become fine-grained in the fracture, and pass into common compact lucullite.

The beds of limestone are of considerable extent, appearing on the surface nearly a mile in a direction across the strata. These beds are divided rather indistinctly into strata, and are with difficulty quarried.

Subordinate to this compact limestone, there occurs COMMON COMPACT DOLOMITE, or Magnesian Limestone; having the colour intermediate between yellowish-white and ash-grey,—the lustre glimmering inclining to glistening,—and the fracture fine granularly foliated,—it is harder than the compact limestone.

In some cases, the dolomite appears in the common limestone in the form of a thick bed, seldom continuing to any great extent. In other places it appears as large irregular-shaped contemporaneous masses.

It is frequently full of drusy cavities, the sides of which are covered with different kinds of crystals. In this state it is usually darker coloured and more brittle.

The most common sort of crystals found here are of brown-spar, or pearl-spar, of the same colour as the surrounding rock, sometimes of a brownish orange. Super-imposed upon these may be observed crystals of dolomite-spar, in the form of oblique rhombs. These crystals are middle-sized,—occur from transparent to opaque, and in some cases are rough on the surface.

In the same cavities are found crystals of quartz intermixed with the brown-spar and the dolomite. These are either short six-sided prisms, terminated by six planes, or simply six-sided pyramids. They are middle-sized, and adhere to the rock on one side.

In some of the larger druses, crystals of amethyst have been found of considerable size and beauty. Some of these have exceeded two inches in diameter and four inches in length. In one place, close by the marshy banks of the river, and near the town, the best crystals have been found; but in consequence of a dispute between the King and the proprietor of the soil, with respect to the right of search, all access to the cavity is prevented.

Returning again to the compact limestone, we may observe, that besides the contemporaneous masses of dolomite, it is traversed by numerous contemporaneous veins of calcareous-spar, and of massive brown-spar. Both these are pure white, while the rock in which they occur retains its usual grey colour. These veins sometimes have a brecciated aspect, containing portions of the rocks intermixed. In one place I observed snow-white fine *granular limestone*, in the form of a contemporaneous vein.

The calcareous spar at a place called Ballanloch, occurs in globular distinct concretions, from a few inches to several yards in diameter. Each concretion consists of numerous angular pieces, diverging from the centre, and increasing in size to the circumference. In general, each large concretion consists of a number of smaller ones. The surface of the columns is a little rough, and the angles blunt.

At the same place, there are numerous crystals of quartz, consisting of six-sided prisms, terminated by six-sided pyramids, imbedded in the limestone. These crystals are nearly opaque, dull, and the angles are blunt. They consist of concentric layers of quartz and limestone. In one of these crystals, not more than $\frac{1}{8}$ of an inch in thickness, I have counted nine different layers. It is obvious, that, in this case, the matter of the quartz, though in very small quantity, has been able to act upon the calcareous matter, in such a manner, as to impart its own natural arrangement, instead of the structure peculiar to calcareous minerals.—This subject will be resumed in a subsequent part of the paper.

Not far from the city, and to the south of the Lunatic Asylum, there is a bed of *Hornstone*. It varies in colour; being light brownish-red, where related to the brownstone; and bluish-grey, where influenced by the limestone; the fracture is fine splintery, approaching to conchoidal, and it is translucent.

The bed is only a few feet in thickness, and preserves its direction to a considerable distance, and with great regularity. In its immediate neighbourhood, the limestone is much mixed with siliceous matter; and, in some places, appears in a state of decomposition, the calcareous portion having been, in a great measure, abstracted, and the siliceous matter left behind, in the form of a light porous mass. In this state, my acute friend Mr Davy, the Professor of Chemistry in the Royal Institution of Cork, found the specific gravity of a very porous piece, to be 2.07, and of a more compact specimen, 2.208. He has tried its effects as a material for polishing metals, and had reason to be satisfied with the results. The siliceous limestone thus decomposed, approaches the mineral termed *float-stone*, transitions to which may frequently be observed in the weathered fragments of the flœtz limestones.

The surface of these limestone rocks is, in many places, covered with the Lichen immersus of Withering, the shields of which, by means of some solvent, are sunk in the rock. In every crevice and quarry, the Helix rufescens and virgata, were common.

In this limestone numerous remains of the testaceous mollusca are found imbedded. Some of these exhibit very striking peculiarities of structure, and may probably characterise the formation to which they belong. I attempted to collect as many species as possible, and was kindly assisted by Mr Wright of the Cork Institution, who has formed a very instructive cabinet of these petrifactions. Many of these have been figured by Sowerby in his "Mineral Conchology," from specimens sent by Mr Wright.

Multilocular Univalves.

1. Nautilus.—One species only of this restricted genus was observed, of an oval form, the partitions distant and slightly waved.

2. Ellipsolithus,—A genus instituted by Sowerby, contains two species from this quarter. E. funatus, Sowerby, tab. 32.. and E. ovatus, Sowerby, tab. 37. This species is subject to considerable variation in shape and markings.

In my specimens, the partitions are obvious, although they could not be detected in those which Mr Sowerby possesses.

3. Orthocera.—Two species occurred in this district. The first resembles the O. striata of Sowerby, tab. 58. In the specimen he describes, the striæ are longitudinal; in the one now before me, they are transverse, and the pipe somewhat lateral. The characters of the other species are nearly obliterated.

4. Amplexus.—This is a new genus instituted by Sowerby, for the reception of the *A. coralloides*, tab. 72., a shell from this district, and one of a very peculiar character. At first sight, it may readily be mistaken for one of those corals which, in this country, are known by the name Fungites. But the chambers are distinct, although no perforation can be observed. We may add, that the history of this fossil is far from complete, and we

fear that its true structure has not as yet been sufficiently explained.

Unilocular Univalves.

5. EUOMPHALUS.—This genus was instituted by Sowerby. It appears to be nearly related to the genus Planorbis, so far as the character depends on the shell. The E. pentangulatus, tab. 45. fig. 1, 2. is not uncommon.

Two or three specimens of other unilocular univalves occurred, but in too imperfect a state to enable any one to assign them their true genus.

Bivalves.

6. CARDIUM.—One singular species occurs here, nearly resembling the recent C. cardissa. It is figured by Sowerby under the name *C. Hibernicum.* It belongs to the genus Hemicardia of Cuvier.

7. TEREBRATULA.—The rocks of this district furnish many species of this genus, one of which, *T. lateralis,* is figured by Sowerby, tab. 83. fig. 1. Many of the species have the valves so strangely distorted, in comparison of the recent species, as to lead one at first sight to conclude that they had been bruised in their present repository.

8. PRODUCTUS. This genus was likewise instituted by Sowerby, for the reception of several fossil-shells, formerly considered as anomiæ. Some of the species found here approach near to the character of those found in the limestone of the independent coal for-

mation. Indeed, in three species which I have compared, I could not discover any definite specific difference.

9. Plagiostoma of Sowerby.—Some of the species of this genus occur more frequently than any other. They are readily distinguished by the hinge line.

10. Spirifer of Sowerby.—The S. cuspidatus, tab. 120., occurs here. It is the Anomia cuspidata of Martin, Linn. Trans. vol. iv. p. 45. tab. 3.

There is one striking character which these petrifactions exhibit, namely, their oval shape, by which they may be distinguished from the recent testacea. Neither this oval form, nor the oblique position of the valves of the terebratulæ, arise from any bruise, but is quite natural, as I proved by numerous observations. All these shells are much incorporated with the rock, and the matter of the shell is usually changed into calcareous-spar.

I observed only one zoophyte, which did not occur in great abundance. It appeared to be conico-tubular,—the surface reticulated, the pores round in one variety, and lengthened in another. I could not perceive in the centre any traces of an organic structure.

III.—*Clay-Slate*.

The rocks of clay-slate occur to the south of the two formations, whose characters have been given in detail, separated, however, by another extensive deposition of grey-wacke-slate and subordinate beds of limestone. The character of the rocks are well exhibited in the neighbourhood of Springhill, and on the north side of Ringabella Bay towards the Lee.

The prevailing colour of the clay-slate is bluish-black,—lustre feebly glistening,—fracture thin straight slaty. This is quarried and dressed as roof-slate.

About midway between Cork and Springhill, the clay-slate may be observed to include some very thick beds of *talc-slate*,—of an ochre-yellow colour,—glistening, somewhat pearly lustre,—straight slaty fracture,—greasy feel,—and very soft. When this slate is broken in a slightly oblique direction, the fractured surface appears splintery. In the collection of Mr Wright, I observed very perfect, rectangular parallelopepidal crystals of iron-pyrites, in a rock of this kind, from Glandore, in the west of the county of Cork.

In some cases, this rock becomes thick slaty, dull, and the fracture inclining to earthy. Some varieties are light in the colour, being bluish-grey, inclining to smoke-grey. Others are darker in the colour, approaching raven-black. These varieties are in general harder than the common clay-slate. Their fracture, lustre, and colour, and appearance when decomposed, reminded me of black chalk. Upon inquiry, I found that black chalk occurred to the south, near Kinsale, in rocks of a similar kind, and through the goodness of Mr Jennings of Cork, I had an opportunity of inspecting specimens from that quarter.

It is in the thick slaty varieties of the slate-clay, that the WAVELLITE of Ireland is found, and in this district, at a place called Springhill, near Fracton Abbey. The appearances which the wavellite of this place exhibit, are so minutely detailed by my friend Dr Fitton, in his "Notes on the Mineralogy of Dublin," p. 55., that few observations are here necessary. It occurs in three distinct states.

1. As a coating on the surface of the natural joints or rents of the stone. In this situation, it is diverging, radiated, translucent, nearly colourless, or with a slight tinge of green.—2. As a cement, uniting small angular pieces of the rock, and exhibiting its natural stellular, radiated appearance.—3. In the form of contemporaneous veins in the rock. In this last situation, it has a tendency to form spherical concretions. These are sometimes separate, sometimes united in pairs, or grouped, so as to exhibit botryoidal and reniform appearances.

These concretions are from the size of a pin's head to an inch and quarter in diameter. They consist of angular wedge-shaped spiculæ, which proceed from the centre to the circumference. The surface is sometimes smooth, but generally rough with the projecting ends of the spiculæ.

The globular concretions of wavellite are sometimes homogeneous, or consist of spiculæ of the same colour, extending from the centre to the surface; other balls are composed of numerous concentric layers, distinguishable from one another, by bands of a different colour, and of different degrees of transparency.

Sometimes a small portion only of the wavellite may be observed in the concretion, the remaining part consisting of the matter of the rock, on which (unable to bestow a radiated) the wavellite has impressed a fibrous fracture *.

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* It appears now to be ascertained, that a certain portion of one substance, having a tendency to crystallize, is able to exert an influence over other substances contiguous, and to impress upon these its own definite forms. This is very strikingly examplified in the case of arragonite; the crystals of calcareous sandstone from Fountainbleau, and the imperfect crystals of garnets and andalusite in the mica-slate of our own country.

The specimens sent to the Society, furnish other two very remarkable examples of the same power; the quartz influencing the calcareous matter, in the construction of the crystals in the limestone; and the matter of the wavellite giving to the clay-slate its own peculiar spherical form, and internal stellular structure.

It is probable, from these circumstances, that the crystals, which are termed *Suppositition*, instead of being formed in a space formerly occupied by a true crystal, are in fact *true crystals*, in which the crystalline substance is concealed in the quantity of foreign matter which it has fashioned.

The wavellite is likewise associated in these contemporaneous veins, with common white quartz. In one mass, which I obtained from a cottager in the neighbourhood, and which weighs upwards of nine pounds, the quartz and the wavellite occur in nearly equal proportions, indicating a simultaneous formation.

This mineral passes from nearly colourless, through greenish-white to apple-green. In one specimen, I observed it of a deep honey yellow. When exposed to the weather, it loses its lustre, and decomposes into a greyish-white powder.

In the clay-slate, petrified shells are found, belonging to the genus orthocera. These, however, are so much incorporated with the rock, that I could not obtain characteristic specimens. They abound in a quarry a little to the south and west of the town of Cove of Cork.

Viewing the characters of the rocks now enumerated in connection, I have little hesitation in referring them to the transition class. They occupy a considerable portion of the south of Ireland. In travelling from Cork to Dublin, the same rocks present themselves throughout the greater part of the journey. Between Mitchelstown and Cashel, however, I observed numerous blocks of common *red sandstone conglomerate*, with which the summits of the Galtee mountains appear to be caped. But I must here stop, as I am aware the members of the Wernerian Society do not attach much value to mail-coach mineralogical observations.

I request the Society to accept of the few specimens which accompany the paper; and to receive the paper itself with indulgence, as it is merely the outline of the subject, to have filled up which, would have required more time than I could possibly bestow.

V. *Mineralogical Notices and Observations.*

By the Rev. Thomas Macknight, D. D. F.R.S.E.

(Read 4th Jan. 1817.*)*

During an excursion to the north part of Scotland, in 1813, I made some observations on the mineralogical structure of the alpine country along the course I took; of which the following is a short account.

From many opportunities of examination which have occurred to me, I have been led to infer, that the Mica-slate, the prevailing rock of the Southern Highlands, is covered to a great extent, by an overlying formation, composed of Felspar, in various forms, both of massive and of crystallized aggregation, including syenite and porphyry. Of this description is the range of mountains from Glencoe to Ben Nevis inclusive, and the country towards the head of the Spey. The same appearances may also be traced eastward from Ben Nevis, to the distance of the highest hills between Braemar and the Spitall of Glenshee, and probably extend still farther in the same direction. Beyond this line, on the north-east, Granite appears in the mountains of

Braemar and Cairngouram. At the opposite point of the alpine range, towards the south-west, we find it again in the vast mountain of Cruachan, which, from its peculiar position, presents a remarkable and interesting subject of examination to the mineralogist.

Cruachan, reckoned the loftiest mountain in Argyleshire, and evidently an object of great geognostic curiosity, lies sixteen miles north of Inverary. It is generally computed to be about 3500 feet in height; and is bounded by Loch Etive on the north-west; by the river Awe on the south; and by Loch Awe on the south-east. Towards the north and north-east, its boundary is less precisely defined; but its circumference at the base, may be estimated at not less than twenty miles. Facing the inn at Dalmaly, the mountain presents, on the east-side, a great hollow, surmounted by a bent and waving ridge, of which the extremities lie in the direction of north and south; and the convexity is towards the west. The highest point of this ridge, seen from Dalmaly, is commonly considered as the top of the mountain. This, however, is not the fact; as the real summit, which is several hundred feet higher, stands westward, at least a mile and a half behind the elevation now mentioned, and forms the termination of another ridge, ascending rapidly from the former, in a direction nearly at right angles. To the north-west of the highest point, at the distance of more than a mile, there is another summit, of a conical form, evidently the second in elevation; and these two are the tops of the mountain which strike the eye, when Cruachan is viewed at any considerable distance from its base.

The country around Cruachan, for many miles, as well as the body of the mountain itself, consists chiefly of primitive rocks; although portions of newer formations occasionally present themselves.

Of these rocks, or strata, it is for the most part extremely difficult, if not impossible, to ascertain exactly the relative positions and directions. In general, however, they correspond to the usual bearings, and geognostic relations of the Highland strata:—with this character to be remarked, that they exhibit great varieties of dip and inclination, according to the diversities of base, on which they rest.

Inverary.—Commencing our observations in the direction northward from Inverary, we find, as the ground rock, mica-slate, with an unusual proportion of imperfectly crystallized quartz; owing to which, it is extremely hard, and difficultly frangible, like a similar species, found at Loch Katterin, and on Ben Vorlich. One of the substances in this district, is a clay-stone porphyry, coloured with hornblende. Clay-slate, sometimes inclining to talc-slate, also appears; with various subordinate beds of greenstone, chlorite, hornstone-porphyry, and rarely limestone. The first of these substances probably extends, in detached masses, as far eastward through the alpine district, as Glencroe; in which primitive greenstone seems to be abundant, throughout the mica-slate.

Dalmaly.—At Dalmaly, limestone occurs near the inn: likewise greenstone, compact chlorite, and a substance consisting of hornblende and chlorite mixed. The limestone and greenstone form hills, containing veins and beds of quartz. But the prevailing rock, *in situ*, is newer mica-slate, and clay-slate, or clay-slate passing into talc-slate; including beds of chlorite, sometimes intermixed with felspar, and with iron pyrites. The same substances, along with greenstone and hornblende rock, are found in the mica-slate, of which Ben Loy, a lofty mountain to the eastward of Dalmaly, is chiefly composed; and which exhibits great variety of structure, from its different proportions of quartz. Some specimens of it contain iron pyrites, and small portions of hornblende. The strata incline to the north-west, at an angle of about 40°.

Cruachan.—Of Cruachan itself, the fundamental rock, I presume, is granite; which appears also at the summit; but, in the lower parts of the mountain, on the south and east, is covered by a variety of other substances or formations, among which are syenite, and hornblende rock. Along the base, at the head of the river Awe, we have beds or strata of clay-slate, alternating with chlorite, hornblende, and greenish-coloured felspar-porphyry, with crystals of felspar. The clay-slate is found westward, as far as Inverawe, where it appears in the neighbourhood of granite, as at Balahulish, and other places in this district of Scotland. Higher up the side of the mountain, the clay-slate passes into a species of very quartzose and compact mica-slate, containing beds of greenstone, and veins of felspar mixed with hornblende. Above this, common felspar, and porphyry, with base of felspar, sometimes approaching to hornstone, and decomposed in masses of various shapes, chiefly tabular and rectangular parallelopipeds, occupies a great extent of surface, and forms some of the highest points. The specimens of granite, collected towards the summit of Cruachan, present considerable varieties of character. Sometimes the ingredients appear mixed in the usual proportion. In other places, the crystals of quartz and felspar are found imbedded in common felspar, with little mica ;—thus passing into porphyry. Felspar, indeed, as already remarked, is, in general, at this elevation, the prevailing substance of the rocks. And the compact species, tinged with hornblende, appears in the same geognostic relations as it does in the upper part of Ben Nevis.

Bunawe.—On the west side of Cruachan, the granite and quartzy mica-slate descend to the level of the sea, and are found accompanied with a variety of different rocks, at the sides of Loch Etive, and around Bunawe. In this direction, I observed the following substances; syenite, quartz, greenstone, serpentine, quartzy felspar, felspar coloured with hornblende, felspar-porphyry, containing chlorite, and light green coloured steatite; and a granular rock, sometimes slaty and sometimes compact, composed of felspar and hornblende, or small masses of hornblende in a base of felspar; with other subordinate primitive rocks allied to these. The syenite formation opposite to Bunawe, alternates with porphyry and greenstone.

Bridge of Awe.—At the bridge of Awe, and within a short distance from the mouth of the river, there is felspar, both compact and amygdaloidal. Here also, we observe the commencement of an unexpected formation of newer rocks, belonging to the flœtz class; which extend over a considerable range of country, stretching southward, or south-west. Of this formation, a great part consists of a species of trap clay-stone, or iron-clay, as the base of the rock. Below the bridge, a mass of conglomerate rises up, evidently formed by the river itself, from the debris of the higher rocks, at a period probably not very remote. It contains rounded and angular masses of quartz, clay-slate, felspar, &c. in a base of trap clay-stone. Another rock, with the same kind of base, is amygdaloidal, including pistacite, calc-spar, and sometimes hornblende and steatite. Along with these, a formation occurs of old red sandstone, variously striped, spotted, and coloured: and the whole form round-backed elevations, and precipitous fronts, on the right bank of the water, below the bridge.

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Tainuilt.—Advancing in the direction of south-west, we find, near the inn of Tainuilt, a coarse compact felspar, approaching to clay-stone, and containing small portions of steatite.

Connal Ferry.—As we approach the Connal Ferry, the rocks assume a different aspect. The felspar becomes more crystalline in its structure, and appears as a subordinate ingredient in quartz rock, of a darkish colour: the claystone or iron-clay, takes a deep violet hue, and is frequently amygdaloidal, containing innumerable specks or portions of steatite and calcspar. It is also found passing into clinkstone and slaty compact felspar. At the Ferry itself, the rock is a hard and dark coloured slaty compact felspar, which is brittle and easily frangible, when exposed to the action of the air and water. This substance occurs sometimes amygdaloidal.

Conglomerate.—We come now to the line of coast, where, for many miles from south-west to north-east, the ground rock is clay-slate, with a mass of Conglomerate lying over it; and exhibiting similar geognostic relations, to those of the same kind of rock on the south-east side of the great Highland range, which have been noticed in some late mineralogical descriptions. It occurs, for example, at Oban and Beregonium; and is, probably, the formation to which the substance already described at the Bridge of Awe may be referred. The base of this conglomerate, is the trap claystone which has been mentioned; and its fragments correspond to the neighbouring primitive substances, namely, clay-slate, quartz, felspar, &c. It must, at the same time, be acknowledged, that from the oryctognostic characters of some specimens of this conglomerate, we might be entitled to conclude, that it is entirely a chemical deposit.

Beregonium.—Beregonium, the reputed ancient capital of Scotland, if we may judge from any remains that are now to be traced, seems to have been nothing else, than one of those vitrified forts, which are observed in different parts of the Highlands. This is indicated by the nature of the ground on which it stands, and of certain substances taken out of the soil, in the line of what appear to have been the walls. These substances, it is more than probable, are pieces of the neighbouring amygdaloid, both massive and slaty; which have been altered by fire, though not partially vitrified like the other substances, along with which they had been piled up for that purpose, and which submit more easily to an imperfect vitrification, such as the different kinds of greenstone. Or, perhaps, they may have been a species of clay-slate, containing a great proportion of lime, similar to that, of which, as we shall presently see, the island of Lismore is composed. The materials filling the vesicular cavities, being more fusible or easily driven off, than the rest of the mass, seem to have yielded to the heat, leaving the substance now observed. In some fragments, the stratified structure may still be discerned; but the specimens are porous, resembling pumice-stone; and so light, that some of them are found to swim in water.

That they have undergone the action of fire, can hardly be doubted, when it is known, that no such mineral is found in Scotland except on the site of Beregonium, which has many appearances of having been a vitrified fort. And to this may be ascribed the tradition respecting its destruction by fire; not to any volcanic appearance that can be observed on the neighbouring hill. The mistake on this subject, seems to have been occasioned by the wild and rugged aspect of the conglomerate rock, decomposing and tumbling down in huge fragments.

It is said, that the remains of wooden pipes have been discovered under ground, which had conveyed water to the fort from the hill now mentioned. If this be fact, we may date the existence of Beregonium as long subsequent to the Roman period of our history. It had, probably, been distinguished as a residence or stronghold of some of our kings, while hostilities subsisted between Ireland and Scotland, or at the commencement of the Norwegian and Danish invasions of the western isles; and hence, the origin of the traditionary title it has so long enjoyed.

Beneath the clay-slate of Beregonium, a species of extremely compact mica-slate is discoverable, containing hornblende intimately mixed. I found here a fragment of syenite, with large and beautiful crystals of hornblende, and also very distinct ones of sphene. Near Lochnell, there is a rock of granular quartz with a slaty structure, resembling a fine grained sandstone. A similar rock occurs at Airds and Portnacroich, where it is frequently quarried for building.

Lismore.—The island of Lismore is composed of foliated granular limestone, with small crystals of iron-pyrites, evidently subordinate to, and exhibiting the characters of, the great clay-slate formation, which extends as far as Easdale on the south-west, and through the district of Appin to Balahulish on the north-east, and even farther in that direction. The rock, in many instances, appears to be only clay-slate, with a greater than usual proportion of lime. Lismore seems to have been a favourite spot in former times, and was long the seat of the Bishop of the Isles, the remains of whose residence are still to be seen.

Balahulish.—But by far the most interesting field of observation which occurs in this direction, is the district around Balahulish. Here granite and syenite appear together, followed by gneiss, mica-slate and clay-slate, which occur in succession. The granite and syenite are found to the east and south-east of the proprietor's house, and of the inn, both situated on the south side of Loch Levin. I discovered the junction of the granite and adjoining gneiss or mica-slate on the height, about a mile eastward of the mansion-house; and traced it running in a direction north-east to a short distance from the water's edge. The mica-slate is dark-coloured, very quartzose and small grained; it includes magnetic pyrites and small garnets; and assumes various aspects in the different strata occurring eastward, till it passes into the clay-slate of the great quarry, which presents an object of much interest and curiosity to the mineralogist. On the south-west of the granite mass, and along the road from Appin to Balahulish, I observed a similar succession of rocks, including also talc-slate. The gneiss that occurs on either side, is but imperfectly characterised, being very compact, and containing little felspar. A similar remark applies to the mica-slate. But the granite and syenite are extremely beautiful; and the clay-slate in general, very fine. The syenite contains crystals of sphene. Some specimens obtained near the inn, may be compared to the celebrated Egyptian syenite.

In this formation, there are different beds of limestone, quartz, greenstone, and other usual subordinate rocks. The great vein of greenstone in the slate of the quarry, cannot fail to attract notice.

Fort-William.—Of the rocks that occur from Balahulish to Fort-William, I have formerly given a general sketch *. I found, then, that the porphyry and clinkstone of Ben-Nevis, are a formation overlaying the mica and clay slate; the granite appears

* Wernerian Memoirs, vol. i. p. 319.

to be connected with the great central mass, which may be traced intersecting the Highlands, from the north-east shoulder of Scotland, to the south-western Isles. On the route northward from Fort-William, portions of mica and clay slate still present themselves, as far as Highbridge. Around Letter Finlay, mica-slate is found passing into gneiss. But the rock in general, is a mixture of granular quartz and compact felspar, associated with granite, and intersected by veins of that substance: the quartz has a dark greenish colour, and the presence of mica in some specimens, shews its transition into granite. This continues to be the principal rock, till we reach Loch-Oich; where it assumes a singular character, that may be described as a sort of granitic conglomerate, with angular and rounded masses of felspar, in a base of greenish-coloured quartz. Here, too, specimens are afforded of a granite, consisting chiefly of reddish crystallized felspar.

Fort-Augustus.—At Fort-Augustus, gneiss, with a great variety of characters, shewing its transition into mica-slate, presents itself in abundance; and granite occurs to the north-east.

Corryaraik.—Turning now towards the east, we find a tract of primitive country, reaching to the mountain of Corryaraik, and along the whole course of the Spey. On Corryaraik, besides granite and mica-slate, inclining to gneiss, we observe a fine variety of syenite.

GARVIEMORE.—Near the inn of Garviemore, there is *in situ* a beautiful granite, with large crystals of all the ingredients, particularly mica, and resembling that of Portsoy. A bed of quartzy compact gneiss at a little distance, having a dark bluish colour, has been mistaken, and attempted to be quarried for limestone.

THE SPEY.—Along the Spey, the same kind of granite as that observed at Garviemore, frequently occurs, particularly at Cluny. Below Laggan, there is a rock of white coloured granular quartz, beautifully interspersed or spangled with scales of mica. As we advance towards Pitmain, the hills on the left side of the river, present vast and rugged fronts of compact gneiss, and mica-slate penetrated with hornblende, of which the strata, particularly of gneiss, are piled above each other to a great height; and have covered the ground at the foot of the acclivities, with enormous masses of debris. The same substance, associated occasionally with mica-slate, forms the greatest part of the rocks on the left bank, till we arrive at Aviemore. Here, the mountains of Cairngouram, situated on the south or opposite side of the Spey, arrest the attention of the mineralogist.

CAIRNGOURAM.—The great mass of this magnificent and extensive range, whose summit appears little inferior to Ben-Nevis in height, is composed of granite, in general uncovered with soil, and unaccompanied with other rocks; but containing a rich store of the precious stones, so well known by the name of the mountain, where they are found in veins and drusy cavities, associated chiefly with rock crystal, of which, indeed, for the most part, they are only varieties of different colours, as yellowish-white, clove-brown, or brownish-black, &c. Accordingly, in traversing this range for a considerable distance, I had an opportunity of verifying Professor Jameson's conjecture, respecting the original repository of the Scotch topaz *. I was shewn a number of places, where the crystals had been extracted from the rock, by means of blowing and the pick-axe, &c.; and could observe many openings in the rocky fronts, where, if at all accessible, the adventurous searcher would, it is likely, find his labour and risk amply repaid, by valuable treasures of the same kind.

We can, therefore, now easily understand, how the topaz of Aberdeenshire (for a particular description of which, I must refer to Mr Jameson's paper already quoted,) has so often been found, as well as amethyst, and precious beryl, in the alluvial soil. The fact, however, I believe, is, that by far the greater number of these gems, are gathered among the debris of the granite rocks, in the beds or ravines of the small streams which issue from the mountains in this district. Those who employ themselves in

* Wernerian Memoirs, vol. ii p. 452.

searching for the stones, pay the proprietors a small rent for the liberty of searching. The part of the range which lies to the east, and is called Ben-Aven, is at present reckoned the most productive; yielding the proprietor, I was told, about L. 150 or L. 200 a-year. What is properly called Cairngouram, opposite to Aviemore, and skirted on the north by the extensive woods of Rothiemurchus, has now been so completely stripped of its products in the ordinary track of examination, that a mere traveller, limited in time, has little chance of meeting with specimens of much value; but the people in the neighbourhood, have always a number to offer for sale.

The granite of Cairngouram, consists chiefly of quartz and felspar, both compact and crystallized; the mica occurs but sparingly. In some places, the materials of the rock appear to be disposed in layers or strata, almost horizontal. I remarked, that, perhaps, there are few instances, in which a mineral substance, spread over so great an extent of surface, exhibits so little variety of oryctognostic character, as the granite of this range. Specimens collected at the distance of several miles, can often scarcely be distinguished from each other, by the nature or appearance of their constituent parts. If the zealous mineralogist could submit to spend days in traversing the dreary untrodden regions, and to pass his nights among the bare rocks of Cairngouram, there is little doubt, that his toil and patience would be rewarded, by the discovery of many valuable gems and curious minerals.

The Don.—The country which stretches from Aviemore to Grantown, and thence south-eastward across the hills to the course of the Don, has little variety in the great scale of primitive rocks. But towards the ancient castle of Kildrummy, a change takes place, from gneiss and mica-slate, on the west or Highland side, to transition rocks, on the east or lowland direction, where a rock occurs which is evidently grey-wacke. Kildrummy stands near the junction. On the north side of the ruin, and in the neighbourhood of the gneiss and mica-slate, there are beds or strata of a sandstone, which appears to be an intimate granular mixture of quartz and felspar, with small scales of mica. Of this stone Kildrummy seems to have been built; and it is still quarried for use. Does it belong to the old red sandstone formation?

Corgarff.—Higher up the course of the Don, the gneiss contains beds of quartz, and is sometimes found mixed with hornblende. Near to Corgarff, there are rocks of hornblende, spotted with crystals of light coloured felspar. Another is composed of chlorite and quartz; and a third of quartz and felspar intimately mixed.

The Dee.—Crossing the country to the bed of the Dee, similar mineralogical appearances occur. At the pass of Balater, one of the entrances into the Highlands from the east, there is on the right or north side, an unusually splendid front of granite; which indeed is found along the course of the river for many miles, sometimes finely porphyritic.

Gairnbridge. — Immediately adjoining the bridge of the Gairn, one of the tributary streams of the Dee, a very remarkable and striking junction of granite and gneiss, on the face of the bank to the north-east, is laid bare for the inspection of the curious. I have never, indeed, seen any thing better calculated to exercise the controversial talents and ingenuity of geological theorists. There is a substance, consisting of hornblende, felspar, and mica, which, along with syenite, and a fine felspar-porphyry, overlies the primitive rock.

Cluny water.—The mica-slate near Invercauld, contains much granular quartz. On the mineralogy of Braemar, Professor Jameson has lately given us his observations. Leaving the granite of this district, felspar compact and porphyritic, and granular quartz, are found in beds, alternating to the southward of Castleton. Along the road, by the Water of Cluny to the Spitall of Glenshee, about seven miles from Braemar, I observed another junction of the same kind with that of Gairnbridge. Still farther southward, the bed of the stream, near a bridge, and not far from its source, presents an interesting alternation of beds of granular quartz, foliated granular limestone, and felspar compact and porphyritic.

Here, it is observable, that the highest rocks appear to be composed of a felspar similar to that of Ben Nevis. It passes, in some places, into a small grained or compact syenite; and, at others, into greenstone. All these overlie, or are subordinate to, mica-slate, as the general rock; which, in many specimens, seems to contain much hornblende in a state of intimate penetration. The mica even, in some places, disappears entirely; leaving only hornblende and quartz disposed alternately in thin layers.

Spitall of Glenshee.—Half a mile south of the inn, I discovered a bed of graphite, associated with gneiss, mica-slate, hornblende, chlorite, &c.; but I was unable to ascertain the substances in immediate contact. To the localities, therefore, of this mineral already noticed, may now be added the Spitall of Glenshee.

The lower district, till we reach Blairgowrie, gives the usual indications of primitive, transition, floetz, and alluvial country. We find mica-slate, with small garnets, and hornblende with pyrites; another species with veins of quartz; also chlorite and talc, near Cally. At the Bridge of Cally, the rock is clay-slate, inclining to chlorite; with veins of a dark-coloured felspar, which is porphyritic, and approaches to hornstone.

From the particular localities which have now been observed and specified, of granite in Scotland, it appears that this rock traverses the centre of the great Highland range, in a direction chiefly marked by the course of the Spey, from Portsoy and Buchan-Ness on the north-east, to the Island of Arran on the south-west. On either side of this line, innumerable portions of the great central mass,—which is nowhere so extensively laid bare, as in the mountains of Cairngouram,—may be traced beneath the superincumbent strata of gneiss, mica-slate, clay-slate, &c. In the direction now mentioned, we find along the lower districts conglomerate, transition, and floetz-rocks, skirting the clay-slate, which is succeeded by mica-slate and gneiss, as the rocks in general placed contiguous to the granite.

To the north-west of the granite line, the same relations may be discovered; so far, at least, as my observation has extended.

VI. *Additional Observations on the Coal Field of Clackmannanshire, and a Description of the absolute Shape or Form of the Coal Fields in Great Britain.*

By Robert Bald, F. R. S. E, M. W. S, &. G. S.

(Read 1st May 1819.)

A number of years have elapsed since I had the honour of submitting to this Society, through the medium of my friend Mr Neill, several Essays regarding the Coal Formation of Clackmannanshire. Since that period, I have made many additional observations on the strata of that district, in particular, at that point where the coal formation joins the Ochill Mountains.

In order to bring the whole under review, I shall recapitulate very briefly the leading points of the before-mentioned essays, adding, as I go along, such particulars and observations as have occurred to me during the last years.

The Coal Field of Clackmannanshire is situated upon the north-west boundary of the Great Coal

Field of Scotland, and, according to every observation, no coals of workable thickness have been found on the north side of the River Forth, farther than about a mile to the westward of Alloa. This north line of the Great Coal Field of Scotland, extends from near St Andrew's in Fife, passes a few miles to the south of Kinross, skirts the face of the Ochill Mountains in Clackmannanshire, passes to the westward of Craig Forth beyond Stirling Castle, and from thence by the Campsie Hills to the River Clyde near Dunbarton.

Two sections were formerly produced; the one a profile from the top of the Wood Hill of Alva to the River Forth, being a distance of six miles, shewing the chief beds of coal and dislocations of the strata; the other a perpendicular section of all the coals and accompanying strata, to the depth of 703 feet, containing no less than 142 beds or alternations of strata. These sections were made from exact measurements taken by myself, and are now referred to, with additions and alterations.

With regard to the alluvial cover, I stated that it was of two kinds, viz. the Recent Alluvial, formed by the Rivers Forth and Devon; the other what is termed the Old Alluvial, which forms the higher part of the country. The surface of the alluvial betwixt the Ochill Mountains and the sea, is bold arable, hill and dale, the ridges and valleys lie parallel to the Ochill Mountains in an east and west direction, and the brows of the alluvial hills have their steep acclivity always to the west, and a long easy slope in an easterly direction. The alluvial cover is of very various depth, viz. from a few inches to many fathoms. At one place to the westward of Alloa, I found the recent alluvial cover upon the side of the River Forth, to be 90 feet deep; and in one place, a little to the north of Alloa, the old alluvial cover is no less than 162 feet deep. In the recent alluvial cover of the River Forth, are found trunks and branches of large trees, beds of sand, with sea-shells, particularly of the oyster, cockle, mussel, donax, &c. These beds of shells not only abound at and below Alloa, but are found several miles to the westward of Stirling in the same situation. The oyster-shells are very large, and many of them of uncommon thickness; no recent specimens are now found so large, nor are any recent oysters ever found above the Queensferry. Horns of the stag, and bones of large animals, have also been found, several of which were produced when the former essays were read. About three years ago, several very large bones were found upon the rock-head, under a cover of clay, in a bed of sand and oyster-shells at the foot of Clackmannan Hill, which I particularly examined. Some of these are now produced. Adjoining these were two teeth, about five inches in length, shaped like a cock's spur, about three-fourths of an inch diameter at the base, and rounded at the point.

These bones are supposed to belong to the whale or grampus tribe. From the size of the bones, the animal must have been at least thirty feet in length.

In the recent alluvial cover of the River Devon, oak-trees of immense size have been occasionally found; and at the line of junction betwixt the alluvial soil of the River Forth and the old alluvial, a great quantity of drift-wood is found, consisting of the spray of different trees, and entire hazel-nuts.

The old alluvial cover, named Till by agriculturists, is a strong heterogeneous mass, composed of clay, sand, gravel, and large stones, smooth and rounded; but besides these stones, there are fragments of all the strata which are found in the coal-field; and it is worthy of remark, that these fragments of sandstone, slate-clay and coal, have sharp angles, and have not, in any degree, suffered from attrition, though comparatively very soft. It is also remarkable, that in this old alluvial cover, no re-remains of shells, trees, or any of the vegetable tribes have been found, although the strata of the coal-field below, and upon which it rests, contain innumerable organic remains of both the animal and vegetable kingdom; and the recent alluvial, as before mentioned, also abounds with these. This, I conceive, to be a most remarkable fact, worthy of the consideration and investigation of the geologist.

In the former essays, which are inserted in the first volume of the Transactions of this Society, I described particularly the dip and rise of the coals, and each particular stratum which accompanies them. I then described and exhibited the various organic remains which are found in the strata, the most remarkable of which are, the oysters contained in the clay-ironstone, and the forms of exotic reeds in the slate-clay. The impressions of minute plants are in vast profusion.

There is one remark regarding the stratification deserving particular attention, which is, That the immediate stratum or pavement on which the beds of coal rest, is almost, without exception, a greyish-black rock or fire-clay, which, when made into bricks, strongly resists the effects of fire. This fire-clay is found from the thickness of the tenth of an inch to several fathoms. In no instance have I seen the coal in direct contact with any other of the strata, excepting where the coal was intersected with numerous slips and dislocations: and this particular observation I have found to hold, in all the coal-fields I have examined in Great Britain. When this fire-clay is of any considerable thickness, it abounds with the remains of the vegetable kingdom, with a few kidney-shaped pieces of clay-ironstone.

The various strata represented in the section, lie in a very regular manner; and we very seldom find one of these strata passing gradually into the other adjoining. In general they are distinct and easily separated at the line of junction, named by miners the *parting*. This parting is sometimes composed of a very thin leaf of clay, or of loose sand. The strata betwixt the coals, do sometimes vary in thickness, being in one place an inch or two in thickness, and gradually thickening to many fathoms, forming a wedge-shaped bed; but this is by no means general.

With regard to the profile and section herewith produced, Fig. 1. Plate IV., made in the crop and dip-line of the strata, it will be seen from it, that the main coal-field of Clackmannanshire, consists of three subordinate coal-fields, formed by two great slips or dislocations of the strata; yet, independently of those great dislocations, the strata continue perfectly regular, with very little alteration in the angle of inclination with the horizon. It will be seen from the section, that the south coal-field dips northerly, until interrupted by the great south-slip, which dislocates the coal and accompanying strata no less than 1230 feet, by which all the coals are not only thrown up or *out to day*, as it is termed by the miners, but are not found again till we pass nearly a mile northward, upon the line of the dip where the same identical coals are found again regularly dipping. These coals of the middle field dip regularly northward, until interrupted by the great north slip which dislocates the strata, and throws them up 700 feet. Immediately adjoining which slip, the coals and coal-field commence again and dip regularly northward, to a much greater extent than the other two fields, until they arrive at the valley of the Devon, at the foot of the Ochill Mountains, where they form a Trough, as it is termed by the miners, and rise very quickly, nearly in a vertical direction. There the coals, with the whole of their accompanying strata, are found in a conforming situation, and parallel with the strata which compose the Ochill Mountains; which strata lie at the elevated angle of 73 degrees with the horizon. The coal strata next the mountains, are denominated in the miners language Edge Metals; that is, strata nearly vertical.

In this coal-field, which has been accurately ascertained by pitting and boring to the depth of 703 feet, there are no fewer than 142 beds or distinct strata, variously alternating, as represented Plate V. Fig. 1., and minutely described in the first volume of the Society's Transactions. Of these, there are 24 beds of coal; which in thickness, amount to 59 feet 4 inches; the thinnest bed of coal being only 2 inches, and the thickest 9 feet. The strata in this section contain numerous varieties of sandstone, slate-clay, bituminous shale, indurated clay or fire-clay, and clay ironstone. There are neither greenstone, limestone, nor any of the trap-rocks to be found connected with the workable coals; but an immense bed of greenstone, named Abbey Craig, is found on the western boundary of the county next Stirlingshire, under which are regular strata of slate-clay, sandstone, thin beds of limestone, and large spheroidal masses of clay ironstone, with a mixture of lime. These contain beautiful impressions of bivalve shells. Under these strata, a thick bed of red sandstone exists; but to what part of the series of the the coal strata this red sandstone belongs, I have not yet been able to determine with accuracy. I have no doubt, that there are thin beds of coal alternating with these strata, the same as observed in the strata under the high greenstone cliffs of Stirling Castle, which are also within the range of the Scotch coal-field, which coal is of the species Glance coal.

In the section of the strata in the Westertown Glen of Tillicoultry, the junction of the coal formation with the Ochill Mountains is beautifully displayed; and there a bed of greenstone rock, about 100 feet thick, is either the lowest bed of the coal formation, or is the first of the Ochill Mountain rocks. This Westertown Glen, in particular, and all the glens in the vicinity, exhibit the most beautiful and distinct sections of the coal formation, and its junction with the mountain rocks, interesting in the highest degree to the geologist.

With regard to the south coal-field next to the river Forth, the strata there have a contrary dip to the south in place of the north; and form the strata into the mantle shape, or what is commonly termed a Saddle.

One particular feature in this coal-field, is the abundance of red-coloured sandstone, many fathoms in thickness, which has been frequently mistaken for the old red sandstone; and as it is generally admitted, that no beds of coal of any value have ever been found in or under the old red sandstone, many mineralogists have considered the valuable beds of coal found under red sandstone in Clackmannanshire as an anomaly in this particular. This mistake originates from not examining the structure of the red sandstone of this coal-field minutely. When viewed at a distance as in the mass or in a building, it has a blush-colour, very different from the old red sandstone, and is now termed the Blush-coloured Sandstone. On examining it minutely, the quartz particles are of a white-colour; and the red colour is produced by a soft red oxyd of iron, disseminated through the texture of the stone, which easily rubs off, and soils the clothes and fingers. The character of this stone is so well known by those acquainted with the collieries of Scotland, that in many districts it is considered as the index to the coal-fields, as at Glasgow. The appearance of this stone led Dr Mackenzie, a member of this society, into a misconception, in his Essay on the Mineralogy of the Ochill Mountains, inserted in the Wernerian Transactions; for the Doctor having examined the old red sandstone in the eastern part of the Ochill Mountains, concluded, that the red sandstone which is so distinctly seen at Harvieston, to the east of the Westertown Glen, lying above a thick bed of coal, and dipping towards the Ochills, passed under these mountains, as is the case with the Old Red Sandstone on the eastern part of the range; whereas, in place of passing under the Ochills, it rises with the coal and other accompanying strata at a short distance to the north of where the coal is seen, and lies in a conforming situation with the face of the mountains, at a great angle with the horizon, exactly similar to the coal strata adjoining the Woodhill of Alva, as represented in the section. This blush-coloured sandstone frequently contains masses of sandstone of a deep red colour, with mica: and sometimes these darker coloured portions, found in the soft sandstone, are of *adamantine* hardness, and are perforated by the miner with the greatest difficulty. The hardness is so great, that I have seen twenty-seven steel boring chisels blunted, in boring a shot-hole 20 inches in depth. This is a fact worthy of remark. The same case occurs in the white and yellow coloured sandstone. These hard portions found in beds of sandstone, are named by the miners, Tongues or Yolks, according to their shape, as represented Fig. III. Plate VI. Granite and greenstone compared with these Yolks, are very soft.

With regard to the great slips which dislocate the strata, these lie in the direction of the line of bearing of the strata, and are nearly parallel with the Ochill Mountains. The great north slip dislocates or throws down the strata 700 feet; and the great south slip dislocates or throws down the strata no less than 1230 feet, as before mentioned. This last is the greatest dislocation I have met with, or know of, in Great Britain. These slips are fissures, which extend from the surface of the strata or Rock-head, to an unknown depth; and vary in width from a small fraction of an inch, to 4 or 5 yards. The fissure is filled up with heterogeneous matter, composed of all the rocks composing the strata. In the fissure of the great north slip, several thin strata are to be seen lying nearly in a vertical direction. Besides these great slips, there are many other small slips parallel to these, and many lying in an oblique direction with the dip and rise line of the coal. Several of these oblique slips produce also great dislocations.

With regard to slips in coal-fields, we find that there is a general law connected with them as to the position of the dislocated strata, which is this: When a slip is met with in the course of working the mines,—if, when looking at it, the vertical line of the slip or fissure forms an acute angle with the line of the pavement upon which the observer stands, we are certain that the strata are dislocated, or thrown downwards upon the other side of the fissure. On the contrary, if the angle formed by the two lines above mentioned is obtuse, we are certain that the strata are dislocated or thrown upwards upon the other side of the fissure. When the angle is 90°, or a right angle, it is altogether uncertain whether the dislocation throws up or down on the opposite side of the slip. When dikes intersect the strata, they generally only separate the strata the width of the dike, without any dislocation either up or down; so that if a coal is intercepted by a dike, it is found again, by running a mine directly forward, corresponding to the angle or inclination of the coal with the horizon.

The three subordinate coal-fields, before mentioned, have all the same general characters; but the coals, and the strata which separate them, vary sometimes in thickness. The distinct and leading characters of these three fields, is the coal which is 9 feet thick, marked with a stronger line than the other coals in the section. This coal is alike thick in all the three fields; is of the precise same texture and quality; has bituminous shale in the roof, with numerous compressed impressions of oyster shells, named, from their colour, *Tobacco Leaves* by the miners, with regular bands and balls of fine clay iron-stone. All the coals in the north and middle coal-fields are very similar in quality, and vary only a little in thickness; whereas, in the south coal-field, all the coals, except the 9 feet coal, are thinner than in the other fields: and, in particular, the coal marked ×, is about 6 feet thick in the north and middle fields, and is composed of cubical and splint coal; whereas, in the south field, the corresponding coal, marked ×, is uniformly only 3 feet thick, without any splint coal, but is proportionally richer, and of finer burning quality. All the coals of this extensive coal-field are cubical and splint coal; no caking coals or glance coals have been yet found amongst them.

With regard to the Ochill Mountains, the highest of these is Bencleuch, about 2400 feet above the level of the sea. It is immediately north, and adjoining the Wood-hill represented in the section, which is about 1800 feet in height above the same level. They are composed of rocks, which, according to the celebrated Werner, belong to the Transition class. The first of these, upon which the coal strata rest, is Greenstone, as before mentioned, about 100 feet thick; the upper part of which is composed of large globular concretions, which exfoliate very much. The lower part of it is strong compact greenstone, with the fissures as usual at right angles to the bed on which it rests. From the vertical position of this bed of greenstone, and the fissures being very distinct, one might be led to conclude erroneously, that it was a bed of regularly stratified greenstone. This greenstone contains many minute particles of pyrites, which are evidently the cause of its exfoliation. The next bed in succession, is Clinkstone, of a darkish green colour, about 140 feet in thickness. Next to this, is a very thick bed of Sienite, in which are found narrow veins, containing fine iron ore, or hæmatites, exactly similar to the Cumberland ore, having a beautiful radiated structure. Below the sienite, are numerous thick alternating beds of Clinkstone-Porphyry, and Sienite.

This range of the Ochill Mountains in Clackmannanshire, besides veins of iron-ore, contain veins filled with various metals.

In the clinkstone porphyry of the Wood-hill, represented in the section, a rich vein of Silver was wrought many years ago, and silver extracted to the amount of L. 60,000. Along with the silver-ore, peach-blossom coloured Cobalt-ore was found in abundance. Veins of copper have been wrought to the westward, at Blairlogie; and particularly of late at Airthry, where the vein was found in a rock of dark brown-coloured trap-tuff. Veins of lead have also been wrought to the eastward, in the Gloom Hill at Castle Campbell.

I have here to remark, that I have examined minutely the coals and accompanying strata immediately adjoining the Ochill Mountains, and found that the coal, even within a few fathoms of the mountain-face, is of good burning quality, similar to the coals found in the south part of the coal-field. Fine shistose micaceous sandstone is also found near the mountain-face, with common clay ironstone, abounding with organic remains of reeds and bivalve shells. The only distinct difference to be observed in the coal strata at this place, from the strata in the south part of the field, is, that several of the thin beds of sandstone are exceedingly hard, and so close-grained, that they have the appearance of compact quartz; but this circumstance occurs in other coal-fields, particularly in Glamorganshire, South Wales, and at Brora in Sutherlandshire. In the rocks of the Transition Mountains, immediately adjoining the coal-field, I never could discover the least appearance of organic remains.

The Clackmannanshire coal-field, as represented in the sections, gives a good example of the general form and situation of the coal-fields in Great Britain, with this exception, that beds of greenstone are not found overlying any of the thick coals. No limestone has yet been found; but I have reason to conclude it will be found in the lower series of the strata, at a great depth under the strata which have been ascertained.

The coal-fields which differ in a very remarkable manner from all the other coal-fields in Great Britain, are, the coal-field at Johnstone, near Paisley, in Renfrewshire; the coal-field at Brora in Sutherlandshire; and the Staffordshire coal-field. Of these singular and most interesting coal-fields, I have made several sections. To describe these coal-fields properly, would require distinct and minute descriptions. We can only remark here, that, in the Johnstone coal-field, the upper stratum of rock is compact greenstone, above 100 feet in thickness, not in conforming position with the coal strata, but overlying; then a few fathoms of soft sandstone and slate-clay, alternating and uncommonly soft. Under this, in one place, there are no fewer than ten beds of coal lying one immediately above the other, with a few divisions of dark-coloured indurated clay.

These beds of coal are in thickness, no less than 100 feet: this is a mass of combustible matter, in the form of coal, unparalleled in the world, so far as I know. The greater part of this field contains only five beds of coal; but, at the place where the section is taken, these five coals have most evidently overlapped each other, as represented Plate V. Fig. 3. The sections, Fig. 1. and 2. Plate VII. shew distinctly all the phenomena of this remarkable coal-field. The original general section was made by a Mr Watson from England, and does him great credit, as being the result of much labour and patient investigation. Mr Houston of Johnston, the present proprietor of the colliery, most politely permitted me to take a copy of the sections. I have been frequently at this colliery, and have examined all the mining operations, which are wonderful. Of late, coals also of great thickness have been discovered under the high greenstone cliff, represented in the section, Fig. 2. Plate V. A section of the Cliff, and coals thus discovered, is represented Plate VII. Fig. 2. From this recent discovery, we would be led to conclude, that the high cliff, and the greenstone in the lower part of the country, had at one time been united, and that the coals now discovered, are the same as those which have been already wrought.

Brora coal-field is remarkable, not only in being far disjoined from the main coal-field of Scotland, but, in particular, for the few beds or strata above the coal. The coal is 5 feet thick, with a division of slate-clay. In the depth of 80 yards, there are only 14 strata, all of them are of a dark colour, composed of slate-clay and ferruginous limestone, indurated clay mixed with lime and limestones, and these contain organic remains in vast abundance, in particular, large cornua ammonis, belemnites, bivalve shells, from the most minute to a large size, and great quantities of fossil wood. Even the coal is remarkable in its texture and quality, and, when burning, has the smell of rotten wood, when placed in a fire. Above the strata exhibited in the section, and more in the line of dip, thin beds of blue-coloured limestone first occur, and above these a very thick bed of soft yellow-coloured sandstone. In the sandstone, a particular bed is found about 18 inches thick, approaching in its texture to compact quartz, having a conchoidal fracture; under this is a very soft sandstone, containing casts of small bivalve shells. A section of this coal-field is represented Plate V. Fig. 4. This coal lies closely adjoining mountains of red granite.

In the section of the Clackmannanshire coal-field, the strata of the mountains are drawn according to the exact angle at which they are found at the surface; but there is an important fact in a geological point of view, which has yet to be ascertained, which is, whether the greenstone and other rocks of these transition mountains, form a curve line somewhat parallel to the curvature of the coals and their accompanying strata, as represented by the curved dotted line a a, Fig. 1. Plate IV. Upon considering all circumstances connected with this point, I am inclined to think, that these mountain rocks do form a curve at a considerable depth from the surface, and that the coal-fields represented in the section lie in a conforming situation with the transition rocks.

It is of importance here to remark, in particular, that this section of the Clackmannanshire coal-field and its position with the transition rocks, exactly corresponds with the geological views and statements of Werner, regarding coal-fields, and accords precisely with the distinct and clear statements given by Professor Jameson, the President of this Society, in his Geognosy.

In taking a general view of the section, and of the three coal-fields formed by the two great slips or dislocations of the strata, we are very naturally led to conclude, from each coal-field being so nearly similar to each other as to the coals and accompanying strata, that the three coal-fields once formed a connected whole; but if this was the case, a very interesting inquiry arises: What has become of all the coals and accompanying strata which must have then existed betwixt the dip part of the coals adjoining the slips in the one coal-field and the crops of the same coals now found at a great distance from them? perhaps the fragments of coal and of their a companying strata, which are found so abundant in the old alluvial cover, as before mentioned, are part of the strata which are now awanting; and we have further reason to conclude, that the coals and strata now awanting at the surface, once existed, as we see the lower coals of the middle field again formed, though at a much higher level, immediately adjoining and close to the north side of the great north slip, so that these coals and lower strata are in one continued stretch, only separated a foot or two by the width of the slip and vertical dislocation.

With regard to the absolute shape of the Clackmannanshire coal-fields, they are similar to the shape or form which I have found to exist in all the coal-fields I have examined in Great Britain, which is, that every bed of coal, with the accompanying strata, is either bason-shaped, or portions of a bason formed by the dislocations of the strata, and by the mountain rocks on which the coal-fields rest. Where the strata assume the mantle-shape, which is rather an exception to the general form, the coal-field is then termed the Inverted Bason form. The most complete and simplest form of a coal-field, is the entire bason-shape, which we have in some instances, without a dislocation. A beautiful example of this is to be seen at Blairengone, in the county of Perth, immediately adjoining the western boundary of Clackmannanshire, as represented Fig. 3., Plate IV. where the elliptical line marked A C B D, represents the crop or outburst of the lower coal, and the inner elliptical line represents the crop or outburst of the upper coal. Fig. 4. is the longitudinal section of the line A B, and Fig. 5. the transverse section of the line C D. All the accompanying coal-strata partake of the same form and parallelism. These basons are generally elliptical, sometimes nearly circular, but are often very eccentric, being much greater in length than in breadth, and frequently the one side of the bason upon the narrow diameter having a much greater dip than the other; which circumstance throws the trough or lower part of the bason much nearer to the one side than to the other. From this view of an entire bason-shape, it is evident, that the dip is in every direction, and all the strata regularly crop out, and meet the alluvial cover in every point.

It is from this bason-shape that all the other coal-fields are formed, which are portions or segments of a bason produced by slips, dikes or dislocations of the strata. If the coals Fig. 3. Plate IV. were dislocated by two slips *b c* and *d e*, the slip *b c* throwing the strata down to the east, and the slip *d e* throwing them as much up in the same direction, the crops of the coals would be found in the form represented in Fig. 6.; of which Fig 7. is the section in the line A B, and Fig. 8. the section in the line C D.

The chief difficulty which arises in exploring a country in search of coal, or even where coal-fields are known to exist, arises from the great thickness of alluvial cover, which completely hides the crop or outburst of the strata, termed generally by miners the Rock-head, from our view, and also completely hides the fissures, dikes and dislocations of the strata, which produce such material alterations in the coal-fields, and which are frequently the occasion of great loss to the mining adventurer. The alluvial cover is to the strata which exist underneath, as the flesh upon the bones in animals: if the flesh is removed, the whole structure of the bones, their situation and connection, are at once discovered; in the same manner, were the alluvial covering removed, the whole strata would be distinctly seen, and the effect of every dislocation immediately ascertained. Though the total removal of the alluvial cover might, in one view, appear to be of great advantage, in affording facility in ascertaining the strata existing in any district, yet this advantage would be greatly outweighed by the disadvantages, not only in the want of soil for cultivation, but by the strata being denuded, the coal-mines would be deluged with water every rainy season, whereas the alluvial cover affords protection, by causing the water to flow along the surface till it join the rivers, which are the great natural drains for the water on the surface of the earth.

The absolute shape of the coal-fields in Great Britain, has been ascertained with a precision beyond that of any other mines in the globe, and that for this very obvious reason, that no mineral whatever has been wrought to such an extent, and in every direction, as coal; for at whatever depth a coal-mine is drained of its water, the mines are wrought from that depth to the rise of the water-level line, and each miner perseveres in carrying forward his room or working place, until the coal meets the alluvial cover of the crop, or is cut off by a dislocation of the strata. It is from this circumstance we can state, in a decided manner, the absolute shape of coal-fields. It is the opinion of many, that the beds of coal contained in a coal-field are tabular masses, which lie evenly between their bounding planes, like a slab of marble; and this no doubt appears to be the case, if a partial and limited view be taken of a bed of coal wrought upon a small scale; but to form an accurate conception of the form of a coal-field, it must be viewed in its whole extent, and in all its bearings, as pointed out and particularly enforced by Professor Jameson, in his Lectures. There are, I am informed, instances of coal being found in the form of insulated tabular masses; but this occurs in another series of rocks described by Werner, and not in the Independent Coal-formation, of which we are now treating. The Hamilton coal-field, according to what I conceive of Werner's views, does not belong to the Independent Coal-formation, but appears to be of a more recent formation. The section, Fig. 1. Plate VII. shews abrupt endings of the coal, without coming in contact with the alluvial cover; but this coal is altogether an exception to any other coal-field I know of.

It is proper here to make a remark upon a statement generally given in describing the favourable situation of coals found in any extensive district of country, That the coals are found very near the surface; whereas it is evident that every coal whatever, excepting when cut off by a slip or dike, is found at the rock-head immediately under the alluvial cover, perhaps at a few feet from the surface, corresponding exactly to the depth of the alluvial cover; at the same time, each coal thus found at the rock-head, is found also at a great depth, according to the angle at which the strata of the coal-field dips.

Although I have only represented in the section the two great slips or dislocations of the strata which form the three subordinate coal-fields, there are many other dislocations comparatively very small, not only running in a parallel direction with the great slips, but in every various oblique direction. These I have not inserted, as they would only have rendered the section exceedingly intricate, and not easily understood. The section, however, shews the great prominent features connected with the natural phenomena of the coal-field. Fig. 2. Plate IV. represents a horizontal plan of the Clackmannanshire coal-field, as if the strata at the rock-head were denuded of the alluvial cover. For the sake of perspicuity I have only represented two of the beds of coal in each of the coal-fields, marked *a a*. At the same time, all the coals, and all the very numerous accompanying strata, lie exactly in the same situation. This plan represents the Ochill Mountains, with the north coal-field, of a long elliptical bason-shape, the side next the mountains being very steep, and the south, the east and west edges of the bason shelving out at a great distance from the lower part of the bason, which is termed by miners the *Trough*. It is therefore evident, that the coals and accompanying strata in the north coal-field, dip in every direction to the line of the trough. The middle coal-field, which is formed by the great north slip, is only the segment of an elliptical bason, as represented in the plan, where the strata dip in every direction to the middle marked x, being the deepest part of the segment. The south coal-field formed by the great south slip, is also the segment of another elliptical bason, similar in all respects to the middle coal-field. Beyond the crop of the coals and strata of the south coal-field, the counter dip of the strata takes place, producing the mantle-shaped form, which causes the coals in the Dunmore coal-field in Stirlingshire, to lie in a direction directly contrary to the coals and accompanying strata of the south coal-field of Clackmannanshire.

In order, however, to represent the effects of dikes, great slips lying in the line of bearing of the strata, and of the slips or dislocations in an oblique direction, Fig. 1. Plate VIII. represents an extensive district of country, containing a coal-field divided into numerous subordinate coal-fields, by these dislocations. The lines marked *b* are slips; the broad lines marked *c* represent dikes: the former dislocate the strata, the other, viz. the dikes, only separate the strata the thickness of the dike from each other. The two parallel lines marked *a*, represent two seams of coal, variously thrown up and down by the slips; whereas the dikes pass through the strata without altering their position. In this manner, coal-fields extend over a district of country to the extent of many miles in every direction.

The only exception which I have observed from this form of the coal-fields in Great Britain, is the Inverted Bason-shape, and this comparatively very seldom occurs: examples of it, however, are to be seen in Fife, and in several districts in England; but even in extensive coal-fields, the inverted bason-form is only a partial occurrence, or a deviation from what we conceive to be the general and ordinary form. Fig, 1. Plate VI. is an example of this formation of the coal-field, as it exists in Staffordshire, at the Castlehill, close to the town of Dudley, upon which Dudley Castle is built. Through this hill, canals have been cut for working the great beds of limestone, and in it immense excavations have been made. These beds of limestone are found in the lower series of the strata of the coal-field, and of course are to be found at many miles distance from the Castlehill, and beyond the crop and outbursts of all the workable coals in the true bason-shaped part of the field; at the same time, by this inverted bason-form, these beds of limestone are found elevated far above the level of the common surface of the country, and consequently above the level of all the coals. The numerous beds of coal, one of which is of the very great thickness of 30 feet, lie next the Castlehill, in a conforming situation with the beds of limestone, as represented in one side of this section. This hill is of an elliptical form, and the coals are found all around it. Besides the Castlehill thus described, there are two other hills which, with the Castlehill, lie in a direct line through the coal-field: These are named Wrensnest Hill and Hurst Hill. Fig. 2. Plate VI. represents Wrensnest Hill, with the same beds of limestone as found in the Castlehill, which have also been wrought to a great extent, by means of a canal cut through the hill, which gave me an opportunity of examining the internal form of the strata of the hill, as represented in the figure, which are completely mantle-shaped. This hill is also of an elliptical form, and the beds of coal with their accompanying strata, lie all around it, conforming with the beds of limestone, cropping towards the summit of the hill. From the truncated figure of the top of the hill, which is now arable land, it would appear, that at one time it had been much higher; but whether it was ever completely of a conical shape, is now impossible to determine Hurst Hill, which lies to the westward of the two hills before described, is similar in its structure to those already described. Excepting where these hills occur, forming the strata into the inverted bason shape, the great Staffordshire coal-field is of the true bason form. The strata betwixt and under the beds of limestone, is named by the miners Bavin. It is a grey-coloured, indurated clay, with a mixture of lime in its composition, and contains numerous small bivalve shells. Plate V. No. 5. is a section of this astonishing coal-field, the upper coal of which is 30 feet thick; and this coal extends seven miles in length and four in breadth. Coals of five and six feet in thickness, are there denominated *Thin* Coals.

The whole of the strata connected with the beds of limestone, forming the lower series of the strata of this most interesting coal-field, abound with numerous organic remains of the animal and vegetable kingdoms; in particular, Molluscæ, Madrepores, Corals, and casts of a singular animal, termed by the miners a Locust, but known to naturalists by the name of *Pediculus marinus*, or the Dudley Fossil. It is, I believe, only found in that district, and we know of no recent species now existing. There are also numerous bivalve shells; and in the slate-clay, more immediately connected with the coal, are numerous impressions of Filices, Equiseta, Reeds, and impressions of trees; and in the beds adjoining these, bivalve shells of the Mya genus are found*.

We have to remark, that when coals and their accompanying strata, are found in a situation altogether vertical, or nearly so, adjoining primitive or transition mountains, the coals, with their accompanying strata, sometimes for a considerable distance, run in a line exactly parallel with the face of the mountains; and the beds of coal appear to be of a true tabular shape, lying evenly or straight within their bounding planes, as is clearly exemplified in the Edge-coals, which stretch along the south side of the Pentland Hills, in the vicinity of Edinburgh. We have, however, strong reasons for concluding, that this tabular form of these beds of coals, extends only in a limited longitudinal direction, conforming with the face of the mountains; for, after many examinations of the strata of the Mid-Lothian coal-field, I am led to conclude, that these edge-coals, at the depth of several hundred yards from the surface, deflect or bend southward

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* In making my investigations of this most interesting district, I was greatly aided by the very polite attention of Francis Downing, Esq. who not only gave me every facility in viewing the mines of coal and of limestone, but communicated to me in the most liberal manner, every information connected with my inquiries. It is to him I am indebted for the accurate sections of this mineral field.

from the perpendicular direction, assume the trough form in the Valley of the Esk, and there rise to the surface along the side of the rising ground which stretches east and west from Dalkeith. These coals rise there at the rate of one in three, and in their quality and thickness have a strong resemblance to the edge-coals upon the north side of the valley. The flat seams presently working in the middle of the valley, have a very moderate rise of from 1 in 7 to 1 in 10, and are of a superior quality compared with the edge-seams. They appear to be a distinct formation or upfilling of the deep trough formed as before mentioned by the edge-coals; and I have no doubt, that this trough sweeps round at both extremities, and forms a long elliptical bason. Fig. 6. Plate V., represents the ideas I have formed of this coal-field. The lines at A and at B, represent the coals ascertained to a certain depth. The dotted lines in continuation, are the supposed direction of the coals forming the bason shape; but the edge-coals may be formed by a slip or dislocation, as is the case with the Quarrelton Coal, at the slip B, Fig. 2. Plate VII.

From what has been thus stated, and from the sections and plans exhibited in elucidation of the subject in hand, we may legitimately conclude, that all the coal-fields in Great Britain, of the independent coal formation, are of the bason shape, or are segments of that form : That all beds of coals, and their accompanying strata, consequently rise in all directions, till they meet the alluvial cover at the surface, or are cut off by slips or dislocations: and that no part of the beds of coal and their accompanying strata, are of a straight tabular form, excepting in very limited portions, particularly when lying along the face of primitive or transition mountains, as before stated.

The bason form of the coal-fields involves theories which have been brought forward by geologists. This particular form appears to be connected with the form of the mountain-rocks upon which the coal strata rest; and, perhaps, the great slips or dislocations, such as are found in the Clackmannanshire coal-field, one of which produces a dislocation of not less than 410 yards perpendicular, may be occasioned also by the form of the mountain-rocks, which, we conclude, lie underneath all the coal strata; and we are warranted to draw this conclusion from what we so distinctly see to be the case, along the faces of mountains adjoining coal-fields.

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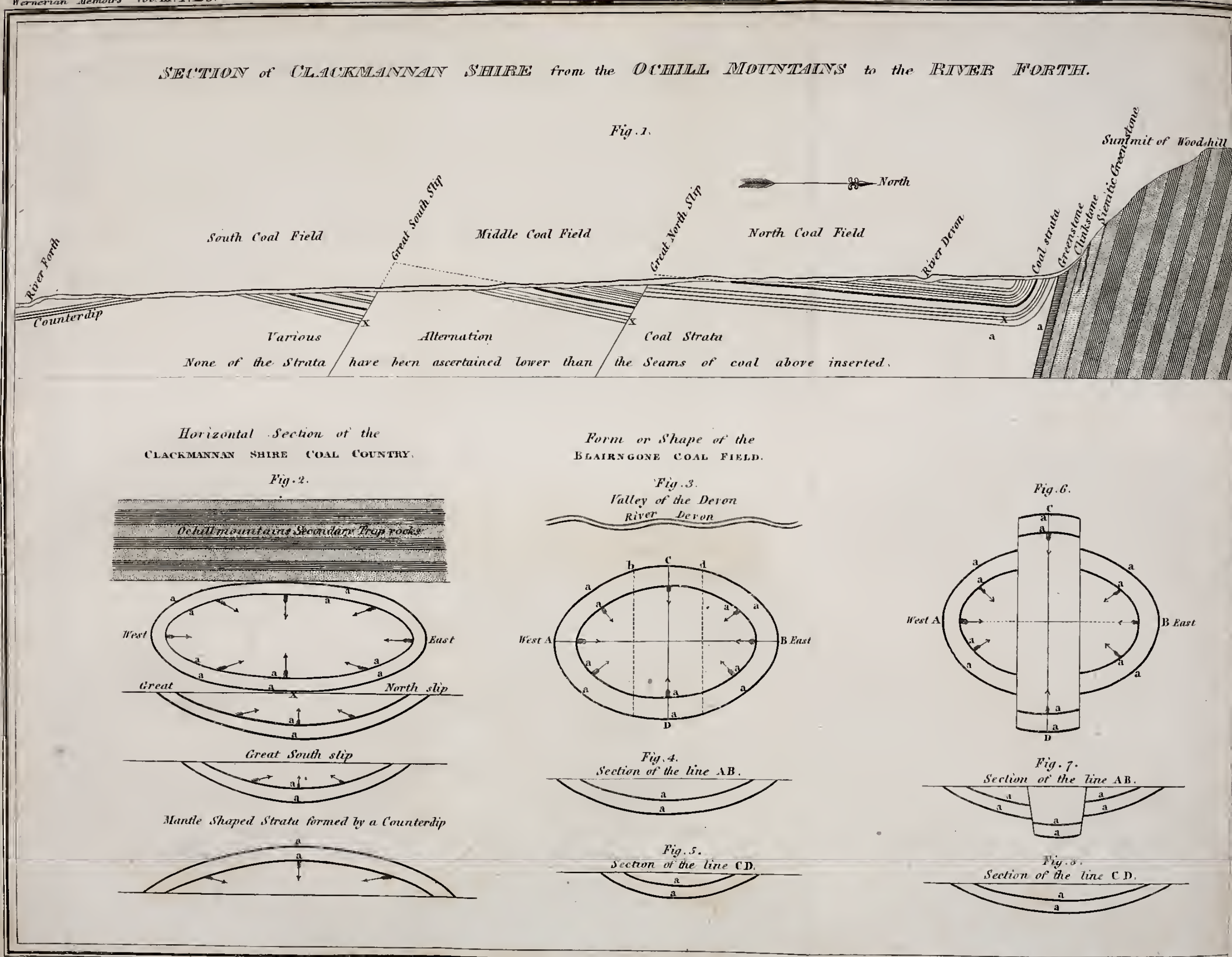


R. Bald M. W. S. Delt.

W. & D. Lizars Sculpt.

INS to the RIVER FORTH.

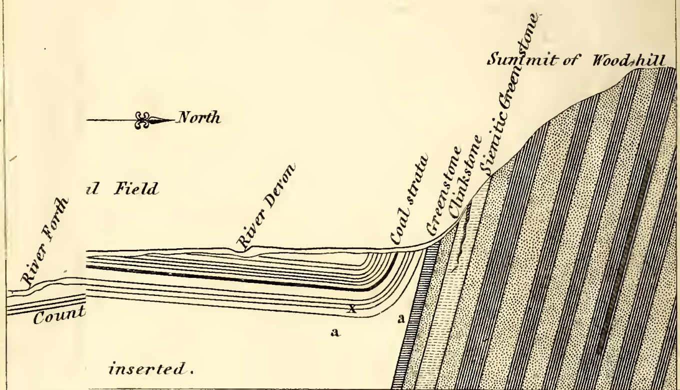


Fig. 6.

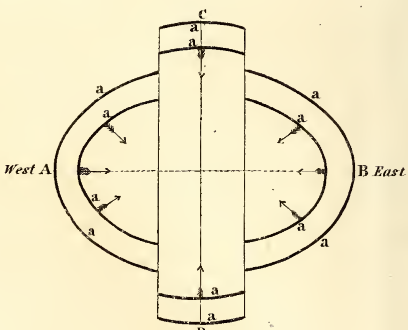


Fig. 7.
Section of the line AB.

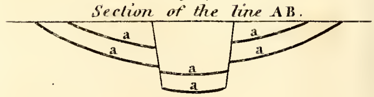
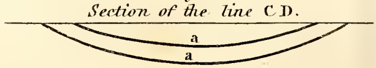


Fig. 8.
Section of the line CD.



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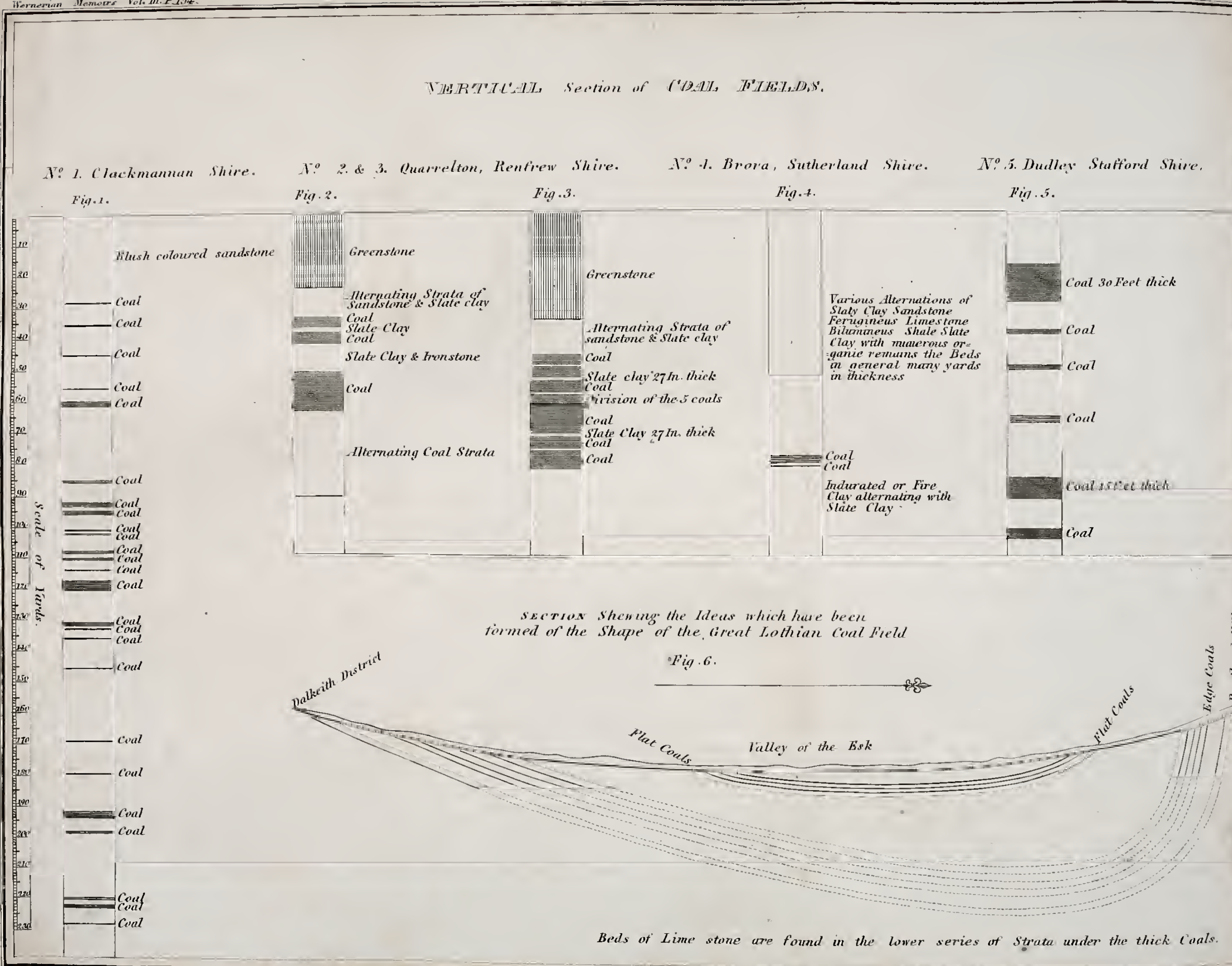

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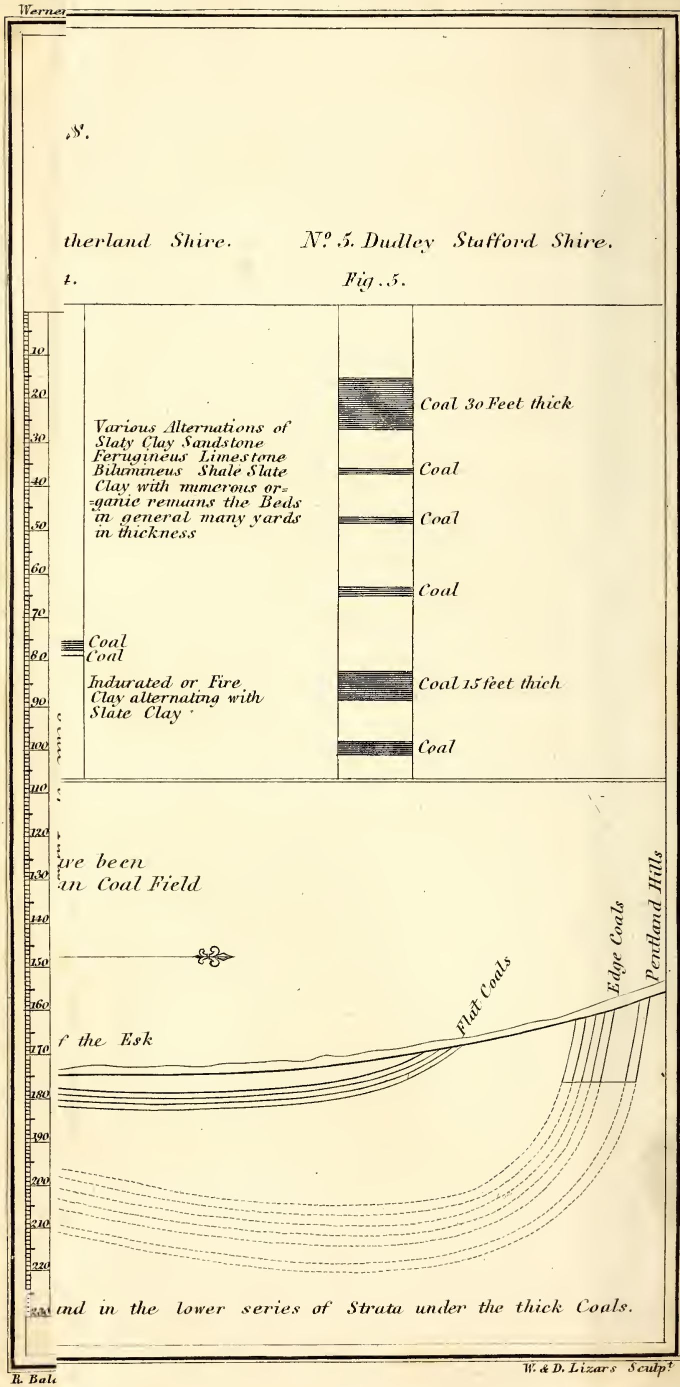
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Fig. 5.
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Various Alternations of Slaty Clay Sandstone Feruginéus Limestone Bitumineus Shale Slate Clay with numerous or=ganic remains the Beds in general many yards in thickness
Coal
Coal
Indurated or Fire Clay alternating with Slate Clay
Coal 30 Feet thick
Coal
Coal
Coal
Coal 15 feet thick
Coal
ve been
an Coal Field
f the Esk
Flat Coals
Edge Coals
Pentland Hills
nd in the lower series of Strata under the thick Coals.
R. Bal
W. & D. Lizars Sculpt

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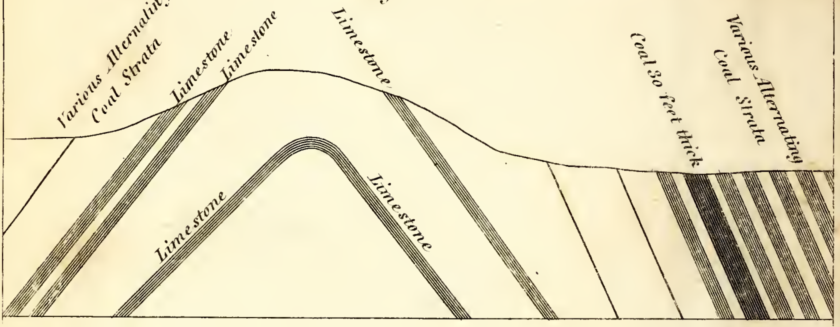
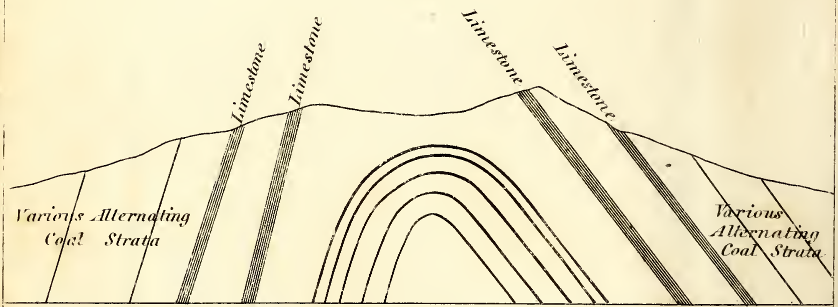
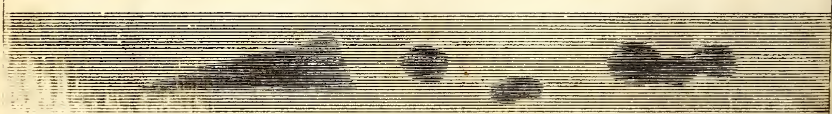
SECTION of the Castle-hill of Dudley Staffordshire.
Fig. 1.



SECTION of Wrens-nest-hill Dudley Stafford-shire.
Fig. 2.



STRATUM of Sandstone with portions of it of uncommon hardness.
Fig. 3.



R. Bald M.W.S. Del.

W. & D. Lizars Sculp.

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SECTION of the QUARRELLTON COAL in the COUNTY of RENFREW.

Fig. 1.

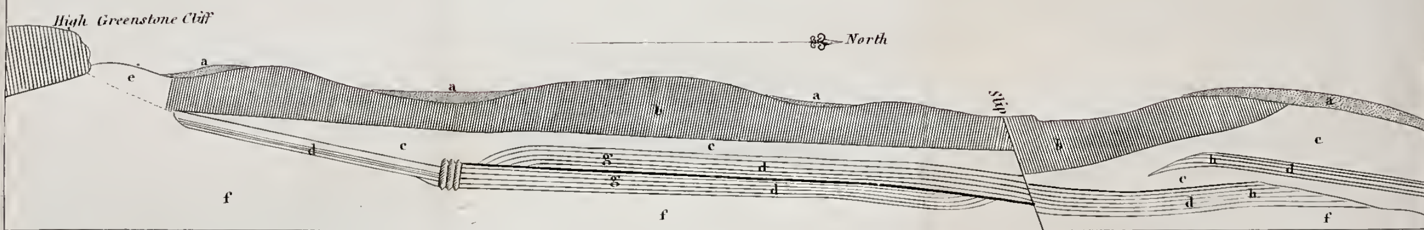
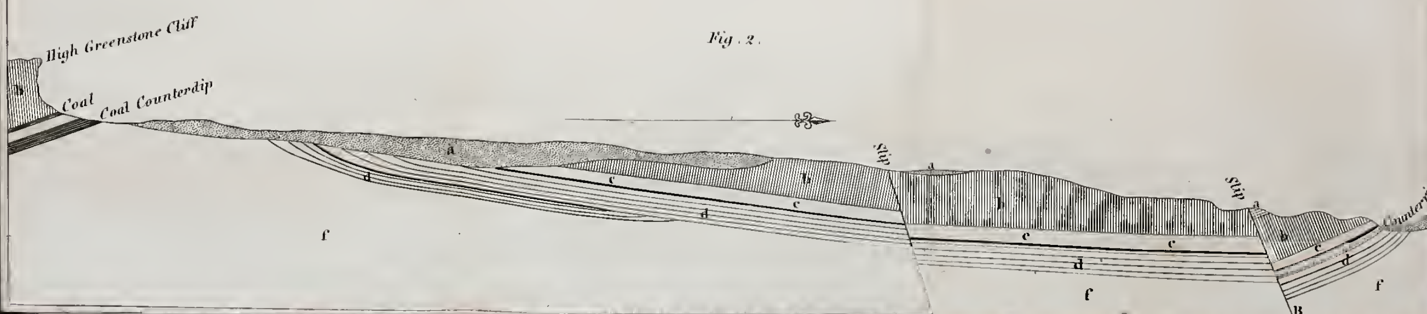


Fig. 2.



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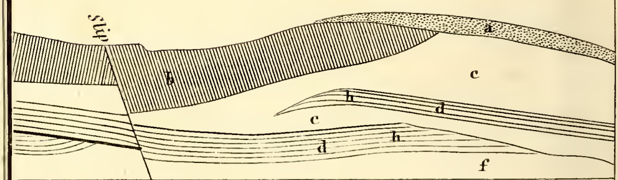
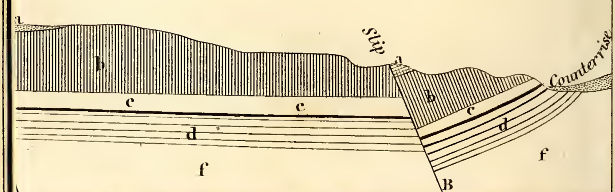
W. & D. Lizars Sculp.t

TY *of* RENFREW.





W. & D. Lizars Sculp^{t}

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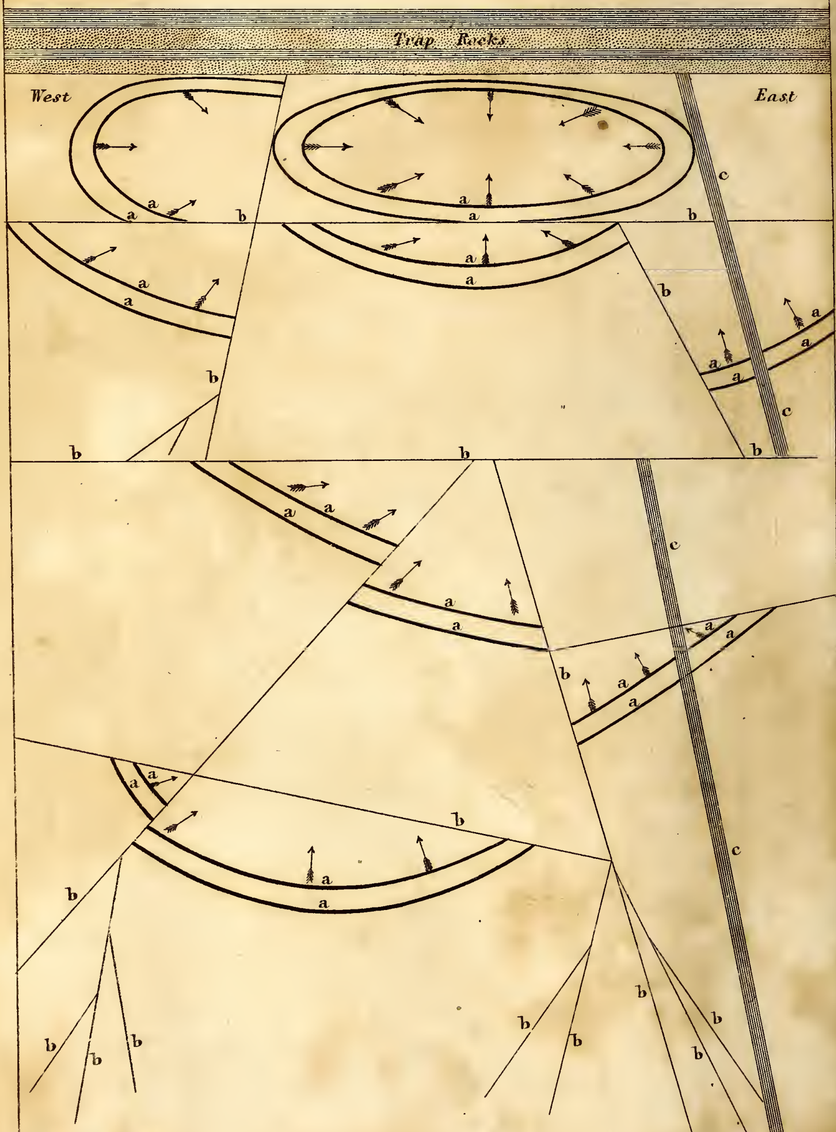
HORIZONTAL SECTION of a COAL COUNTRY.

Fig. 1.



R. Bald M.W.S. Delt

W. & D. Lizars Sculpt

It may be convenient to the reader to have the Sections represented in Plates IV. V. VI. VII. and VIII., here explained in one connected view.

Plate IV.

Fig. 1. is a profile of Clackmannanshire from the summit of the Woodhill of Alva, one of the Ochill Mountains, southward to the River Forth, the line being nearly at right angles to the general bearing of the strata, comprehending a space of six miles and sixty-three yards. It also contains a section of the beds of coal, and great slips or dislocations of the strata, in so far as they have been ascertained. This section comprehends the main coal-field of Clackmannanshire.

Fig. 2. is a horizontal section of the Clackmannanshire coal-fields, shewing their junction with the Ochill Mountains, the direction of the great slips or dislocations, and the form of the coal-fields.

Fig 3. is the Blairngone coal-field, of an entire bason-shape.

Fig. 6. is a plan shewing the effect produced upon a coal-field of a bason-shape, by two slips or dislocations of the strata.

Plate V.

Nos. 1, 2, 3, 4, 5. are vertical sections of coal-fields. No. 1. corresponds with the ordinary arrangement of coals in the coal-fields of Great Britain. Nos. 2, 3, 4, and 5. are sections of coal-fields, which differ much from No. 1.

Fig. 6. Section of the great coal-field of the Lothians.

Plate VI.

Fig. 1. Section of the Castlehill, Dudley, Staffordshire.

Fig. 2. Section of Wren's-nest Hill, Dudley, Staffordshire.

Fig. 3. Stratum of sandstone, with portions of it of uncommon hardness.

Plate VII.

Fig. 1. Section of the Quarrelton coal, in the county of Renfrew, shewing the overlapped coal and the double coal, with the thick bed of greenstone overlying the coal-field.

a, Alluvial cover.
b, Bed of greenstone.
c, Alternating coal strata.
d, Coals.
e, Position of greenstone not ascertained.

f, Strata in which no coals have been found.
g, The overlapped coal.
h, The double coal.

Plate VIII.

Fig. 1. is the horizontal section of a coal-country, shewing the effects produced by dikes, slips and dislocations of the strata, by which coal-fields are extended over a great district of country, which prevent the coal *running out* (as it is termed), or dipping to an unfathomable depth.

Edinburgh, 1*st May* 1819.

VII.—*Account of some Sandstone Petrifactions found near Edinburgh.*

By the Rev. JAMES GRIERSON, M. D. M. W. S.

(Read 16th May 1818.)

MY chief object at present is to mention to the Society, some recently discovered sandstone petrifactions which have been found in this neighbourhood. The occurrence of such substances in our common sandstone quarries is, we know, not unusual;—particularly petrifactions of a sort of flattened reed, of a gigantic size. These I have frequently seen, both in the sandstone of Ayrshire, and of Mid-Lothian, viz. in the coal formation sandstone of these districts. The originals of the petrifactions alluded to, are thought by many to have been of the palm tribe. But this, I believe, no one has yet fully ascertained. With respect to the coal formation in general, it is observed by our President, in one of his many interesting and valuable publications, that it is well characterized by the great number and variety of its vegetable petrifactions. He informs us, that these are principally of such plants as flourish in marshes and woods, and that they occur abundantly in the *sandstone* of this formation.

An instance is given by Habel, in his Natural History of Nassau, of a petrified vegetable stem, as having been seen by him rising 40 feet through coal formation rocks, and measuring a foot in diameter at one of its extremities. Now, though the petrifactions to which I allude, are not nearly of so great a *length* as this, they are of a diameter still greater; one of them being 3 feet 10 inches in circumference at the thickest extremity.

They were found on the 9th of February last, a little way from Harvieston, ten miles to the south of Edinburgh, by some workmen, while engaged in making a drain. They were in a horizontal position, imbedded in a mass of what I would call sandy-clay, about 3 feet below the surface. The petrifactions are three in number, and have evidently been the trunks of trees. They were lying with their tops towards the east, and in a conformable position to the strata, which are here coal-sandstone, and dip gently to the west. One of the trunks is 5 feet 9 inches long; and, as already said, 3 feet 10 inches in circumference at the bottom; it tapers rather suddenly, being 2 feet 2 inches in girth at the middle, and 1 foot 6 inches at the upper end. About 18 inches from the top, there has issued a large branch. This petrifaction is somewhat flattened or compressed, as all those generally are, which lie conformably to the strata. It has, when set on end, and viewed at a few yards distance, completely the appearance of the decayed stump of a tree. From the shape, I should pronounce it an oak; but the bark has rather more of a dotted appearance than is usual in the oak. The large branch going off about 4 feet from the root, strongly characterizes it as the trunk of a tree. The next largest petrifaction is 2 feet 7 inches long, and 3 feet 1 inch in circumference at the bottom, having much the same appearance on the surface as the first. But the third, which is in length 2 feet 6 inches, and in girth at the bottom, 3 feet 5 inches, has the very appearance of a peeled oak; in so much, that any person whose eye is familiar with such objects, would at once refer it to this tree.

The sandstone into which these vegetables have been converted, is rather fine-grained, and so hard as to approach the kind commonly called Quartzy Sandstone. It may be thought rather singular, that the petrifactions themselves should be so much harder and more solid than the stratified matter in which they were imbedded. This, as I said before, is a soft loose mixture of sand and clay. I remember some years ago, meeting with a petrifaction of this sort, in the firm sand, on the sea-shore, to the west of St Andrew's, in Fife. It was the stock of a tree seemingly *in situ*, about 20 inches diameter, laid bare by the waves, and the roots running nearly horizontally in all directions. It appeared to have been cut over by the surface of the ground. I cannot pretend to say, whether the great African Desart is of the same formation with that in which the petrifactions I have been speaking of are found ; but it appears from travellers, particularly Mr Horneman, that this immense sandy deposit is, in many places, full of innumerable fragments of petrified wood. Trunks of trees 12 feet in girth are mentioned : and Horneman says, that though these petrifactions are generally black, yet, in some cases, they are ash-grey, and resemble natural wood so entirely, that they are sometimes brought in by mistake for fuel.

By what process of Nature does the wood, on such occasions, disappear, and particles of quartz, cemented by clay, or marl, or other quartz, take its place? This appears to me to be a matter by no means easily accounted for, on any principles at present recognized. And the difficulty is augmented in a very high degree, when we adopt the commonly received doctrine of the mechanical formation of sandstone. For how can we conceive, that small pieces of quartz, so large, however, as to be sufficiently discernible by the naked eye, should make their way into the densest parts of an oak tree, and in time so completely displace all its woody fibres, as that nothing of these should appear, but the whole become a uniform mass of these little pieces of quartz, connected together as before stated? We cannot admit, certainly, that a particle of sand, or piece of quartz, so large as to be visible by the naked eye, should at once make its way into the interior of the wood, and there take up its residence, accompanied or followed by other pieces of the same kind. No expansion of the vegetable pore that we can conceive, would be adequate to allow this. And, therefore, if the petrifaction of the wood takes place by means of the gradual accumulation and cementation of particles of sand already formed; or, in other words, small pieces of quartz already formed, we must suppose the process to go on in some such manner as the following. The wood dissolves in the surrounding medium, whatever that medium may be; and there can be no doubt, that the outer parts of it, as being most exposed to the action of the medium, will dissolve first. The particles of sand then take the places of the particles of the wood, and are deposited exactly in the same situation. Moreover, we must suppose, that they are at the same time fixed together by the cement, be this what it will, clay, or marl, or other quartz; for, if that were not the case, how could the places of the sandy particles be so exactly preserved? But if they are cemented together as soon as they are deposited, a close coating of sandstone will thus be formed all around the tree; and how shall the interior of it afterwards be petrified? The particles of sand can no longer reach it. They cannot make their way through the sandstone already formed. And though we might thus, in some sort, see how a thin coating of sandstone might be deposited round a piece of wood, or other organized matter, we cannot possibly see how the inner part of it should be petrified. But when we inspect the petrifactions of which I am speaking, we find the inner parts of them equally solid, and equally converted into stone with the exterior:—nay, if any difference, more so. It also appears to me, to be difficult to apprehend how the particles of sand should penetrate the lower parts of the wood equally with the upper, contrary to the law of gravity; though, perhaps, the principle of pressure may help us out here.

But if we reject the opinion of sandstone being a mechanical deposit, and conceive it to be a chemical precipitate, in the same way as some other stony substances undoubtedly are, then, I think, the explanation of sandstone petrifactions, though by no means divested of difficulty, will be very much facilitated. For, on the supposition that the quartzy or siliceous matter of which the particles of sandstone are composed, were dissolved in a fluid, then we can more readily form an idea of the manner in which this solution, having penetrated the wood, might there precipitate its contents, and so produce the appearances we observe. And though even here a difficulty presents itself, (for what becomes of the carbon and other indestructible parts of the vegetable?) yet the difficulty is not, I think, so great as when we suppose the *mechanical* formation of the sandstone. We know that all the different parts of wood except the carbon, can be resolved into gaseous bodies, and even it, by combining with oxygen, becomes gaseous also. In this way, therefore, the vegetable matter may all escape, and the quartzy or siliceous take its place. And if it be asked, whence the carbon should receive the oxygen, to render *it* gaseous, or to form carbonic acid? the answer is obvious—from the water; for water seems always to be present during the petrifying process.

Few, I believe, will now be startled at the idea of sandstone being a chemical deposit. Our President's two ingenious papers, "On the Mineralogy of the Pentland Hills," and "On Conglomerated Rocks," published several years ago in the Memoirs of this Society, have rendered it familiar to us, and have, I think, proved that sandstone is, in some instances at least, a chemical deposit. The Professor has there shewn, that what have been taken for fragments of previously existing rocks cemented by a basis, are in fact contemporaneously formed concretions, as much as the masses of felspar, of quartz and of mica in granite, or of the quartz itself in granular quartz, and other crystalline rocks. I shall not attempt to go over the ingenious arguments by which this position is made out, and by which it is shewn to be very highly probable, that grey-wacke also and trap-tuff, and in many cases sandstone, as well as conglomerated rocks of the primitive class, such as granite, gneiss, mica-slate, porphyry, and limestone, have had a chemical origin, and are not, as has been commonly thought, made up of water-worn or fractured pieces agglutinated by a basis. I shall only observe, that one of the strongest of these arguments appears to me to be the gradual passage of the apparent fragments into the basis by which they appear to be cemented; and this, I think, indeed, so strong, that scarcely any thing more is wanted. But as abundance of evidence can do no harm, I would take the liberty to suggest, that the occurrence of petrifactions in the situation of those I have before described, seems to me to form an additional proof of the correctness of Mr Jameson's opinion. I have attempted to shew, that these appearances may be accounted for on the hypothesis of sandstone being a chemical deposition, but that they are quite inexplicable, on the supposition of its being a mechanical formation. Now, the argument stands thus: Sandstone petrifactions do occur; but these cannot have been formed mechanically. They must, therefore, have been formed chemically; and hence sandstone has, in them at least, had a chemical origin. But if it has had a chemical origin in one instance, it may have had the same in another.

The importance of the study of petrifactions will not now be disputed. For as it was owing to the observation of these in the strata in which they occur, that people were first led to speculate on the manner on which these strata must have been formed, (and hence our different *Theories* of the Earth,) so it is only by the study of petrifactions that we are likely to be able to account for the formation of strata, or to ascertain the relative ages of the mineral masses of the crust of the earth. If there had not existed any petrifactions or fossil remains of organized bodies, it is not easy to see how a theory of the earth should ever have been thought of. Philosophers would naturally have rested satisfied (as the vulgar do,) with the notion that all things were originally formed in the state in which they now are.

But when they observed the remains of organized bodies in situations in which, beforehand, they could not have been expected to be; when they observed sea-shells many hundred miles distant from the sea, and some thousands of feet above its level; when they found those and other fossil remains many fathoms below the surface of the ground, and imbedded in vast masses of solid mountain rock; nay, when the remains of animals were discovered, of which no prototypes now appear, or whose species we have every reason to conclude have been long ago extinguished; what philosopher would not speculate on the causes of such surprising effects? Hence arose, as I already noticed, our various theories of the earth. But it was the celebrated WERNER, the great Founder, we may say, of Experimental Mineralogy, that first pointed out with precision, the importance of the study of the fossil remains of organized bodies, towards enabling us to arrive at any thing like a rational theory. It was he who first observed,—and the observation is of the utmost importance,—that different petrifactions characterise different Formations.

But on this subject I shall not at present enlarge, as I may, perhaps, at a future period, trouble the society with some observations on it in a different shape.

Cuvier has done much in this department, and apparently without knowing what Werner had done before him. He has demonstrated, not only that, without the existence of petrifactions or extraneous fossils, we never could have known, or in all probability never would have suspected, that there were successive formations or depositions of the strata and other enormous masses which compose the crust of the Globe; but that by observing these, we pursue the track which is alone likely to conduct us to a knowledge of the causes of these depositions: Or rather (in more precise language, perhaps), which is likely to lead us to the knowledge of the real order of their succession.

It is his opinion, however, that other causes besides those which we at present observe to operate in nature, must have then existed. But this is evidently giving up the question; it evidently amounts to the assertion, That the laws of the physical world were formerly different from what they now are. And if so, then I am afraid we never can understand how these laws operated. It is the same thing as to tell us, that petrifactions were formed, we know not how. For a law of nature different from any that we at present know, is, I apprehend, to all intents and purposes, the same thing to us as no law at all. On this principle, therefore, we must for ever despair of being able to account for petrifications; or to refer them to any law of nature now known to exist. With all deference, however, to this very great man, I would not so readily abandon the hope that the presently existing laws of nature may be found sufficient, under certain modifications, to account for all the phenomena we observe. I would not yet say with him, that "in physical history the "thread of operation is here broken, the march of "Nature is changed, and none of the agents that "she now employs were sufficient for the production of her ancient works." I would rather join with him in a hope which he elsewhere expresses, "that a Newton may arise in Natural History as "well as in Astronomy," and think it probable that some principle, as little suspected of the power of doing so, as Gravity once was of the power of explaining the planetary motions, may one day enable us to explain all the phenomena of Geology. At any rate, let us not too hastily cut the Gordian knot, especially after M. Cuvier himself has done so much towards enabling us to untie it.

Wernerian Mem. Vol. III. P. 167.

J. S. Traill delt.

W. & D. Lizars Sculpt.

JACKETED MONKEY.
(SIMIA SAGULATA.)

VIII.—*Description of the Simia sagulata,—or Jacketed Monkey.*

By Thomas Stewart Traill, M.D. F.R.S.E. M.G.S. &c.

(Read 27th November 1819.*)*

Character:

Simia caudata; capite barbata nigra; caudâ non prehensili, nigra villosissima, claviformi; corpore subtus nigro; dorso pilis ochraceis bene tecto.

Monkey, with head black and bearded; tail not prehensile, thickly set with black hairs, claviform; body below black; back well clothed with an ochry-coloured fur.

This animal resembles *Simia Beelzebub*, the Preacher Monkey of Pennant, in several respects; but is distinguished by the form of the tail, and the colour of the upper part of the body. Though it be found in great numbers in the forests of Demerary, it appears to have hitherto escaped the notice of our writers on natural history.

The skin of the face is black; and there are a few straggling hairs of the same colour on the cheeks and lips. The hair on the scalp divides, as in man, at the crown, whence it passes down in every direction ;—a circumstance not common in the monkey tribe. A small tuft of hair rises from the upper part of the nose for about half an inch, and meets the descending hair of the front. A bushy beard of glossy black hair descends from below the ears, and clothing the sides of the face, meets below the chin. The nose is slightly prominent; the nostrils are placed flatly on the face, at its base, and present circular apertures. The canine teeth are very large and strong. The ears are naked, black, thin, lie flat on the head, and in shape resemble the corresponding human organs.

The fur is thickly set on the body of the animal; and its general colour may be reckoned black. The head and tail are of a jetty blackness. The lower parts of the body of a nearly similar tint. The four extremities, with the exception of the backs of the hands, are blackish-brown ; but the shoulders and back present a strong contrast to the other parts, and give this animal the appearance of being covered with a jacket; from which the proposed trivial name is derived. The colour is brightest on the shoulders, where it is intermediate between wood-brown and yellowish-brown ; and, on the back and sides, passes into the latter. The back of each hand is of a ferruginous brown, as in the Preacher monkey. The fingers of all the extremities are very slender; and the thumbs the smallest and least powerful of all the phalanges. The nails are much compressed, and sharp-pointed.

The tail is long, but not prehensile. It is thickly covered all round with jet black hairs, and is club-shaped, or thickest toward the extremity. The tip of the tail in the Simia Beelzebub, is reddish-brown, in which it differs from this species.

This description is equally applicable to five different specimens brought to this country in 1817, by my friend Charles Edmonston, Esq. from the interior of the colony of Demerary.

Dimensions of Simia sagulata.

	Feet.	*Inches.*
From the point of the nose to shoulder over the crown of the head,..........................	0	6
From shoulder to root of tail,.....................	1	1
Length of the tail,....................................	1	4
	2	11
Circumference of chest,..............................	1	1
Height of shoulders when the palms are at the ground, about..................................	0	9
Length of hair on shoulders and beard, about	0	1
Hair on tail, about....................................	0	1½

IX.—*Description of a New Species of Felis from Guyana.*

By Thomas Stewart Trail, M.D. F. R. S. E. M. G. S. &c.

(Read 27th November 1819.*)*

Felis Unicolor.—Spotless Cat. (Pl. ix.)

Char. Specif.

Felis cauda elongata; toto corpore immaculato, ex fusco rubescente.

Cat with a long tail; the whole body spotless, and of a clear reddish-brown colour.

A comparison of the character just given, and that of the Puma in our best systematic authors, might lead to a suspicion that there is but little difference between the two animals. This, however, is a consequence of the imperfection of the systematic character usually prefixed to descriptions of the Puma. In the Gmelinian Edition of Linnæus, the latter is defined, " *Felis cauda elongata, corpore immaculato fulvo;*" to which Shaw has added, " *subtus* " *albido;*" and Brisson characterizes it as, " *Felis* " *ex flavo rufescens, mento et infimo ventre albi-*

PLATE X

Wernerian Memoirs Vol. III p.170.

THE SPOTLESS CAT.

(*FELIS UNICOLOR.*)

W & D Lizars Sculpt

"*cantibus.*" At the time when these general characters were given, it might have been objected, that they did not sufficiently distinguish the Puma from the lioness; but the discovery of the animal now under consideration, renders the definition as unappropriate, as the trivial name *concolor,* imposed on the Puma by Linnæus. This designation has been altered by Shaw; but to prevent the confusion which might arise from the application of any name, already appropriated by the illustrious author of the Systema Naturæ, to a new species, I propose to give this the trivial name *unicolor,* as expressive of its remarkable uniformity of colour.

The general hue of this new species, is a beautiful glossy reddish-brown. The colour of the whole upper part of the body, including the head and tail, has a considerable resemblance to that of a very dark bay horse; the tint becomes gradually paler on the sides and under part of the neck, and passes by imperceptible shades into an ochry brown on the belly. When closely examined, the darker colour of the back is partly owing to an intermixture of blackish brown hairs with the rest of the fur. The hair over the body is rather short, like that usually seen on a smooth Spanish pointer. The only species of felis with which this animal can be confounded, is the Puma; but a short comparison will shew, that they are totally different. The specimen from which this description is drawn up, was brought from Demerary, by my friend Charles Edmonston, Esq. who, during a residence of near forty years in that part of America, has devoted a considerable portion of his time to the practical study of Zoölogy. He represents this as a full grown animal. The recent skin had been very well stuffed by the person who killed the animal*; and a comparison of its dimensions with that of a Puma prepared by the same individual, will serve to mark the difference between the two species.

	Spotless Cat.		Puma.	
	Ft.	In.	Ft.	In.
Length of the body from nose to tail,...	2	8½	4	9
Length of the tail, ...	1	8	2	6
Length of the head,........................	0	6½	0	11½
Extreme length, ...	4	4½	7	3
Circumference behind the shoulders, ...	1	4	2	11
Height at the shoulders,....................	0	10	1	7

The head of the Spotless Cat is much more pointed, its nose more elevated, and its limbs are much more slender, in proportion to its size, than in the Puma. The strength of the jaws and size of the teeth, are likewise proportionally less. In the Puma, the backs of the ears are black; in our animal,

* In this specimen, as in many others prepared under Mr Edmonston's eye, the bones of the head and feet are preserved, and the greatest attention paid, to mark the general habit of the living animal.

they are of the same colour as the adjacent parts. The tail of the Puma is claviform, or appears thickest towards the tip, which is black; but the tail of the Spotless Cat is nearly of one thickness throughout; and it wants the conspicuous black tip, which appears constantly in the Puma. The general colour of the two animals is also different. This new species is of a clear but deep reddish-brown: the colour of the Puma is of a fulvous hue; and when about the size of the animal in question, the young Puma is marked on the body with many black spots, which disappear as the animal advances to maturity. Even in its earliest stage, the tip of the tail in the Puma is black. The eyes of this new species, which are large, are said to have a pale yellowish iris. The beard is slender and scanty; the teeth sharp and long.

What I have been able to collect of the habits of this animal, is, that it is an inhabitant of the deep recesses of the forests, that it climbs trees to prey upon birds, monkeys, &c. but that it will boldy attack the larger quadrupeds.

Liverpool, March 1819.

X.—*On the Water-Rail.*

By the Rev. John Fleming, D. D. F. R. S. E. & M. W. S.

(Read 27th November 1819.*)*

In examining the characters of our native birds, as they are delineated in the works on British Zoology, we find reason to lament the want of original descriptions. Few naturalists have examined, with their own eyes, the discriminating marks of the genera and species, or have attempted to supply the deficiencies and correct the errors of their predecessors. To the labours of Willoughby, Ray, and Montagu, we are almost exclusively indebted for the minutest and most accurate descriptions of the species which we possess. The two first named naturalists laid the foundation of British Ornithology; and their writings, variously modified, have furnished our popular authors with their most valuable materials. Even Pennant, whose name ranks so high in public opinion, in the compilation of his British Zoology, has copied so largely from these sources, that the original matter which he communicated, bears but a small proportion to the borrowed contents of his work. We are in this case tempted to quote the mortifying interrogatory of the Roman satyrist, "Expende Annibalem: quot libras in duce summo invenies?" But many of our systematical naturalists, in borrowing from these sources, have omitted those characters which relate to structure, and which these Fathers of the Science were so anxious to ascertain, and have almost exclusively retained those only, which relate to colour and form. The progress of the science has thus been retarded: nay, we have reason to deplore its retrogression.

Having been engaged, for many years, in the examination of our native animals, I have often felt the evils here complained of, especially when attempting to ascertain the specific differences between nearly allied species. I have, therefore, been in the habit of writing out descriptions, more or less complete, according to the condition of the specimens of the individuals of those species which have come under my inspection.

As these descriptions may be of use to those who are engaged in similar pursuits, by furnishing standards of comparison, I hope that a few pages of the Wernerian Natural History Society's Memoirs may not be considered as improperly occupied in occasionally recording them.

The Water-Rail was considered by the older naturalists, as belonging to a different genus from the Corncrake. Linnæus, however, included both in the same genus, Rallus; but his example in this case, has been followed by few ornithologists. The Corncrake has been restored to its proper place; and the Water-Rail is now regarded as the type of the genus Rallus, now characterized by the following marks:

Bill slender, lengthened, slightly arched, compressed at the base, rounded towards the tips where the edges of the two mandibles are incurved.

Nostrils, pervious, linear, placed at the inferior margin, towards the base of a groove which extends two-thirds the length of the upper mandible.

Tongue narrow, nearly the length of the bill, and jagged at the ends.

Legs and claws compressed, and the outer toe at the first joint united with the middle one by the rudiment of a web.

The Water-Rail bears a near resemblance to the Corncrake, in the remarkable compressed shape of the body; but it differs in the superior length of the bill and toes, and in the structure of the nostrils. It differs in another circumstance still more remarkable, the bastard wing being armed with a spine about an eighth of an inch in length.

This last character appears to have been hitherto overlooked by naturalists, although it is by no means difficult to detect. Cuvier, indeed, in his late admirable work, "Le Regne Animal distribue d'après son Organisation," t. i. p. 500, has placed the genus Rallus in the second section of his family Macrodactylæ, and which includes those birds whose wings are not armed with spines. But, since this character has now been detected in the Water-rail, the genus Rallus must be removed to the first section of the family, distinguished by spinous winglets, and associated with the genera Parra and Pala media. There is but one British species of this restricted genus.

1. R. aquaticus.—*Water-rail.*—Under-side of the bill and irides, orange; breast ash-coloured; wings dusky, with the base white; sides black, with white bars; beneath the eye, a pale spot; length from 9 to 10 inches; breadth from 14 to 16 inches; weight from 3 to 4½ ounces.

This species is known by the following provincial names in England:—Runner, Velvet Runner, Oar-cock, Bill-cock, Brook-ouzel, and Skiddy-cock.

Ralla-anglor, the Rail, or King of the Quails, Merret's Pinax, p. 173.

Rallus aquaticus. Will. Orn. p. 234.

——————— Ray. Syn. Av. 113.

Water-rail. Penn. Brit. Zool. vol. ii. p. 284. tab. lxxv. 214.

The bill is an inch and three quarters in length in the gape. The upper side of the upper mandible, and the tip of the under mandible, dusky black; the remaining part of the latter, and the edges of the former, orange-red; the upper mandible is the longest; and, at the base, it is depressed, slightly wrinkled across, with the feathers forming a projecting angle on each side; the irides are reddish-orange, and the tarsi are narrow, and greenish black; the legs are pale-dusky, and bare for about three quarters of an inch above the knee; the toes are long, slightly webbed at the base of the two external ones; the skin on the soles is loose, and slightly carinated, and they are furnished with two, three, four, and five joints.

The plumage above, is black; but as each feather is bordered with olive-brown, the dark colour appears in irregular stripes; the tips of the shafts of the feathers on the front, are destitute of webs, and are even a little swollen and spinous,—a circumstance in which this species resembles the Corncrake; the chin, a spot under each eye, and a stripe from the base of the bill, towards the eyes, are greyish-white; the breast, throat, cheeks, sides of the neck, and breast, are of a deep bluish-grey; —the feathers on the throat, with pale edges, and the ear-coverts slightly tinged with olive-brown; on the fore part of the neck, there are several white hairs mixed with the feathers; belly, deep orange-white; the sides black, barred with white, and tipped with orange-white; the wings are dusky, with the outer webs broad; the margin of the wing is white, and the under coverts pale dusky, barred with white; the bastard wing consists of four feathers; and, as already noticed, is armed with a projecting spine, about an eighth of an inch in length; the tail, which is fan-shaped, consists of twelve feathers, about two inches in length, dusky, with olive-brown margins; the under coverts white; the oil-bag is prominent, and surrounded with a tuft of pale feathers.

The inside of the bill is reddish-orange; the throat pale. Willoughby says, " Vesicula fellea grandis, longa, recurva. Porus biliarius magnus. Appendices longæ, excrementis repletæ. Ventriculus musculosus."

The bird described above, was a male. The female, according to Montagu, has a shorter bill, of a paler colour; and the young ones bear a near resemblance to the adult birds.

This species is subject to slight variations of plumage, as appears from another specimen which we have examined, in which a few of the upper wing-coverts were barred with white, and the edges of the feathers on the neck and breast, were edged with white. Montagu, in his description, states, that the middle tail-feathers were wholly olivaceous brown.

" The nest," according to the observations of Montagu, " is rarely found. It is made of sedge and coarse grass, amongst the thickest aquatic plants; frequently in willow-beds. In such a situation, we found one with six eggs, of a spotless white, and very smooth, rather larger than that of a blackbird; the shape a short oval, with both ends nearly alike."

The food of this species consists of worms, slugs, and insects. We have seen the stomach filled exclusively with the fry of the Helix lucida, a snail which likewise furnishes the family of Thrushes with an agreeable repast.

The Water-rail is not often met with, as it is a very shy bird. It frequents the margins of pools and rivulets, and secretes itself among the rank grass. Like the other species of the natural family to which it belongs, it runs nimbly, and, even when pursued by dogs, seldom takes wing, until its rapid and complicated evolutions among the reeds, have failed to secure it protection. It flies slowly, with its legs hanging down, and generally alights at no great distance from the place where it first arose. When running, it flirts up its tail, and thus exhibits the under tail-coverts, in the form of a white spot. It wades in the water, and swims, and even dives occasionally.

On the continent of Europe, it is considered as a summer bird of passage, and has been observed crossing the Mediterranean Sea in the spring, going northwards, and in autumn retiring southwards. It has, on many occasions, been found in the Atlantic Ocean, far from land, and in an exhausted condition,—a situation into which it had probably been driven by stress of weather.

According to Montagu, it remains in England throughout the year.

The Reverend Dr Stuart of Luss, in his valuable catalogue of the animals found in his parish, (Statistical Account, vol. xvii. p. 247.), considers this bird as migratory. It is probable, however, that its scarcity in his country, and its shy habits, have occasioned it to be considered as a summer visitant only. In support of this conjecture, we may mention, that three specimens have occurred to us during the winter season; the first on the 16th November 1803; the second, 25th November 1807; and the third, 23d January 1818. We are, therefore, disposed to consider it as one of our resident species.

This species is a native of the Old World. It was first noticed, as an English bird, by Merret; and, as a native of Scotland, by Pennant. Sibbald, indeed, in his Scotia Illustrata, enumerates the Rallus aquaticus among our northern birds; but the description which he subjoins, obviously belongs to the common gullinule.

I shall conclude these observations, by adding a synoptical view of the British species of the family Macrodactylæ.

A. Winglets furnished with a spine.

1. Rallus. Rail.

    1. Rallus aquaticus. Water-rail.

B. Winglets without spines.

a. Front, without a fleshy plate.

2. Ortygometra. Crake.

1. O. Crex. Corncrake.
2. O. Porzana. Spotted crake.
3. O. Minuta. Little crake.
4. O. Folgambei. Olivaceous crake.

b. Front, with a fleshy plate.

1. Toes bordered.

3. Gallinula. Gallinule.

1. G. Chloropus. Common gallinule.

2. Toes lobed.

4. Fulica. Coot.

1. T. atra. Common Coot.

XI.—*An account of the change of Plumage exhibited by many Species of Female Birds, at an advanced period of life; intended as a Supplement to Mr John Hunter's Memoir upon that Subject, in the Philosophical Transactions.*

By John Butter, F. L. S. M. W. S., Member of the Royal College of Surgeons in London, and Surgeon to the South Devon Militia at Plymouth.

(*Read* 10*th January* 1818, *and* 15*th January* 1820.)

Whenever any circumstances hitherto unobserved, or at least not generally known, are brought forward, regarding the original form and character stamped upon all animals by Nature, we are too apt to bestow on them the term "monstrous." Mr Hunter has begun his description of an extraordinary Pheasant, in the paper above alluded to, which has been reprinted and published in his Animal Economy, in the following words: "Every devia-

" tion from that original form and structure, which gives the distinguishing character to the production of Nature, may not improperly be called Monstrous *."

The object of the present short memoir, is to endeavour to shew, by means of such facts as I have been enabled to collect, that the remarkable change of plumage, which takes place in certain *hen*-birds at an advanced period of their lives, so as to make them resemble the *cock* of their own species, is not a monstrous, but a perfectly natural occurrence. I may observe, that I consider the illustration of this subject as more necessary, because it is evident, from a perusal of his observations, that Mr Hunter doubted whether the instances which he adduced, really deserved to be considered "monstrous" or natural in their occurrence.

The Hen-pheasant and Pea-hen, are the only two examples of female-birds assuming the plumage of the male, in old age, given by that great physiologist. Had Mr Hunter been acquainted with any instances of a similar nature, occurring in other hen-birds, he would, of course, have described them; for it cannot well be supposed, that he would have omitted to notice the common Domestic Hen, if he had been aware, that at a certain advanced period of her life, she regularly discards her dusky plumage, for the more beautiful attire of the cock.

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* *Vide* Animal Economy, p. 75.

In drawing more particular attention to this subject, I shall briefly relate such instances of the change of plumage in the females of the domestic fowl, as have fallen within my own knowledge.

Mr Corham, who resides at Compton near Plymouth, has, for a long series of years, possessed an excellent breed of game-fowls; the cocks of which are of a beautifully dark-red colour, and the hens of a dusky brown.

One hen of this breed was allowed to live as long as possible, because her chickens became so renowned in the battles of the cock-pit. When, however, she had attained the age of fifteen years, she was observed, after moulting, to have acquired some arched cock's feathers in her tail, whilst others (old feathers) remained straight and brown as formerly. By degrees, and during one moulting season, the whole of her dusky plumage was thrown off, and succeeded by a covering of red and more beautiful feathers, quite like those of the cocks of her own breed. In the course of the single season, the change was so fully accomplished, that, as she walked about, any stranger might have pronounced her rather to have been a cock than a hen. Spurs likewise sprouted out on her legs; she acquired a comb and wattles on her head, and even crowed hoarsely, not unlike a young cock.

Her wattles were, however, cut off afterwards, for the purpose of making her look like a fighting-cock.

After the completion of this change of plumage, she discontinued to lay eggs; and lived no very considerable time to enjoy her recently acquired, but splendid costume. She was found dead one morning under her roost, from which she had fallen.

The novelty of the fact, induced Mr Corham to have the hen stuffed; and the person who prepared the specimen, informed me, that he found within the body *three* consolidated eggs.

The truth of this history cannot be questioned; for the hen was well known throughout Mr Corham's family, and the change is exactly described by them all. Mr Corham had never observed nor heard of such an instance before; but he never kept any fowl to so great an age as this. The specimen is now at Plymouth in my collection.

Mrs Adams of Bowdon near Totness, hearing of this circumstance, very obligingly sent to me one of her hens, which had partly assumed the cock's plumage.

Although the change in this hen was quite decided, not only in the arched feathers of the tail, but also in the comb and spurs, which had sprouted out, yet I thought that the male feathers might come out in greater perfection, provided that the hen could be kept over another moulting season; and I, therefore, returned her to Mrs Adams, making that request. Unfortunately, however, a turkey-cock took such a dislike to this hen after her return, that he attacked and killed her, whilst the change of plumage was every day becoming more like that of a cock. The hen, after death, was again sent to me; but in such a mangled state, that I could not preserve her by stuffing. I dissected the body, however, and found the perfect organs of a hen, with an ovarium and oviduct, quite flaccid, but destitute of eggs.

I expressed my opinion to Mrs Adams, that this change was merely the effect of age, and as conformable to the established laws of nature, as the differences of plumage existing between the cock and hen at a more early period of life. With all that ready kindness which invariably distinguishes the conduct of this lady, she offered to keep some of her oldest hens for me, in order to ascertain if my surmises were well founded; and I have been lately favoured with a letter from her upon this subject, which I shall transcribe in part, as it is written with the utmost clearness, and illustrative of a similar change which took place in another of her old hens.

"I will, most readily give you every information in my power, on the subject of my two curious hens, although I fear it will not be so particular as you require. One was fifteen years old, the other thirteen. I bought them both when pullets. They were of the common domestic breed, and excellent layers, which was the reason I kept them so long.

"I first observed the change in them, after an absence of five months, when I enquired of my dairy-maid, from whence came those two young cocks, for such they appeared to me in their plumage and crowing. I was greatly surprised at being informed, that they were my two old hens. The appearance of cock's feathers in their tails, and the change of their voices, were the first signs of their alteration. They had laid no eggs for two years; and how long they might have lived it is impossible for me to say; for that sent to you was killed by a turkey-cock, and the other by a servant, (unknown to me), who thought it right to get rid of any thing so useless. She told me that on drawing it, the bag containing the eggs was quite closed, and become a hard substance. Two of my servants, who have lived in farm-houses, inform me, that this change of plumage is by no means uncommon; but that, as soon as it is observed, the hen is immediately killed, because it is looked upon as an omen of ill-luck to any family, where the hens crow."

There is some similarity between this account of Mrs Adams's servant, and that of the person who stuffed Mr Corham's hen, as far as regards the state of the cloac, oviduct, &c. after death.

I regret that I could discover nothing of the sort in the cloac of the hen which I dissected; the season of the year might possibly account for the difference; but upon this point I am not prepared to speak decidedly.

In a work entitled "Ornithologia Danmonien-"sis," commenced by A. G. C. Tucker, Esq. of Ashburton, there is given a brief account of a domestic hen, which changed her feathers after moulting, to those of the cock; but as the dissection is not furnished, little positive inference can be drawn from it, except that it adds another fact to those before stated. I may likewise remark, that I have not found this circumstance mentioned in any other English work which I have consulted.

It is somewhat remarkable, that our ornithological writers have not extended their observations upon this subject, beyond the pheasant and pea-hen; at least almost all who speak of the changes of plumage in the pheasant, &c. and who make allusions to Mr Hunter's paper, fail to notice those changes in the domestic hen that I have now described.

White, in his Natural History of Selbourne, after describing what he calls a Hybrid Pheasant, asks, if it be not likely, that it is an old hen-pheasant, just beginning to assume the plumage of the cock. Mr Latham also observes, that pea-hens, after they have done laying, sometimes assume the plumage of the male-bird, and gives a figure of a male-feathered pea-hen, which was then to be seen in the Leverian Museum. Bewick quotes Mr Hunter's paper on this subject when speaking of the pheasant; but none of these writers, nor Shaw nor Pennant, allude even to the probability of the change taking place in old domestic fowls.

Buffon, with his usual diffuseness, enters largely into the varieties and descriptions of common fowls, but does not notice their age, nor any changes they undergo like those in question, nor does he mention, in any of the editions of his works that I have seen, the fact, of old hen pheasants changing their plumage for that of the male; and yet there are specimens to be seen in almost every collection of birds.

The circumstances which I have now advanced, I have been in the habit of mentioning to many of my friends and acquaintances,—gentlemen well versed in the science of zoology; and I have learnt, that no facts similar to those now detailed, exist in the writings of British naturalists; or at least that those authors who have given a history of the sexual characters, varieties and peculiarities of the different species of British birds, have not remarked, that the common hen ever assumes the plumage of the cock, whereas this change in the female pheasant they seldom omit to mention.

In the spring of 1817, as I was passing through London to the Continent, my much valued friend, Dr Leach, introduced me to Sir Joseph Banks, to whom I mentioned such facts as I had ascertained respecting the changes in old domestic hens; and remarked, that they seemed not to have been generally known. Mr Brown, however, being present, had the kindness to refer me to a work, (the title of which I have forgotten), in which it was recorded, that female "Gallinæ" exchanged their feathers at an advanced period of life for those of the cock.

When I was at Paris, I conversed with MM. Cuvier, Blainville, and other distinguished zoologists upon this subject; all of whom seemed to be perfectly well acquainted with the change of plumage known to take place in old hen-pheasants, and some other gallinaceous birds, but had not observed that common hen-fowls ever adopted in their old age a similar change. Neither could I see a specimen of the sort in the fine collection of birds at the Garden of Plants, nor in any Museum at Turin, at Florence, Milan, Naples, or Geneva. I have also examined the British and the Hunterian Museums both in London and Glasgow, and not found any specimen of a domestic hen with the cock's plumage, though there are such examples of hen pheasants. If I remember correctly, Mr Bullock told me, in the year 1817, that in his collection there was not a specimen of this sort, nor had he ever seen one.

My late correspondent, Colonel Montagu of Kingsbridge, has remarked in his Ornithological Dictionary, that female pheasants in confinement sometimes assumed the plumage of the male, and at that time became barren, and were equally buffeted by both sexes; yet he did not consider that this change was merely the effect of age; for he speaks of having been assured by Lord Caernarvon, who had many pheasants in this state, that it takes place at three or four years old. How far these alterations in wild birds may be expedited or changed by confinement, I cannot venture to say; but of this I am satisfied, that all hen-pheasants, as well as common hen-fowls, would assume the plumage of the cock, to a certain degree, if they were kept to a proper age. The sexes in partridges (*vide* Montagu, Dictionary and Supplement) have a more early disposition to resemble each other in plumage; for after the third year, the hen cannot be distinguished from the male, by what is termed the Horse-shoe mark; as, after that time, this mark is equally strong in both sexes.

If I remember correctly, Colonel Montagu has also stated, that he once shot nine partridges belonging to the same covey, late in the season, and that every one had the horse-shoe mark on the breast, characteristic of the male sex, but that on dissection, several of them proved to be females. I may here mention, that I once shot several partridges in the month of December, with the horse-shoe mark on the breast, and found one, which I dissected and stuffed, to be a female bird. In winter, therefore, it should seem that the distinctions between male and female partridges are not so visible as in summer. The same observation may apply to other birds.

Upon the whole, therefore, I am disposed to conclude, that this change of plumage in old hens, is not alone confined to one, two, nor three different species, but that probably the same disposition is common to numbers of the feathered race, the variations and changes of whose plumage, as influenced by age, climate, food, confinement, or disease, have not yet occupied a sufficient share of attention; and that the change is almost always natural, produced either by the effects of age, of sterility, or other causes, which tend to work some changes in the constitution of birds.

I am disposed to allow with Mr Hunter, that something similar takes place in the human species; for that increase of hair, observable in the faces of many women advanced in life, is certainly an approximation towards a beard, which is one of the most distinguishing secondary properties of men.—To this observation I may likewise add another, viz. That mares, when old, approach the form of the entire horse, by rising more fully at their necks.

Without seeking to multiply these observations, by going farther into the animal creation, I think that I have advanced enough to warrant the following conclusions.

1*st*, That in order to separate and distinguish the sexes, Nature has affixed certain external characters proper to each.

2d, That in early life, the differences between the male and female, are scarcely observable, but that at a certain period the male assumes characteristic distinctions, denominated by Mr Hunter, "Secondary Properties," which the female then wants.

3d, That the female seldom makes an advance towards these secondary properties, until her powers of procreation are gone, when an inclination to resemble the masculine form takes place. Thus we see that the males and females of animals in general, and of birds in particular, closely resemble each other for some time after their birth; that towards the middle or more vigorous period of their lives, Nature gradually stamps upon the former certain external characters expressive of the sex to which they belong; and that after the chief purposes of life have been fulfilled, the latter (females) also converge into an imitation of those external marks previously assumed by the males. The principle, therefore, appears to me just as clear and well established, as that death should ultimately resolve each into the same elementary substances.

One observation I have made upon old birds is, that they die soon after they change the colour of their feathers, and cease to lay eggs.

I therefore repeat, that the change is never a *monstrous* occurrence, but always the natural result of age and time. It would be idle, however, to cavil about words, as it is my desire that this paper should form a sort of supplement to that of Mr Hunter, whose object ever was to illustrate truth by rational inquiry, and to display his own information as far as he thought it correct.

Nature, no doubt, admits of occasional *lusi*, but I believe that her changes are neither so frequent nor so extraordinary as people imagine. Many persons may traverse her fields without discovering any thing unknown, or even the regular order and course of her proceedings; whilst patient observation will sometimes point out phenomena which might have escaped general notice, but which, nevertheless, do not deviate from the established laws of nature.

Plymouth, December 1817.

January 1820.

SINCE December 1817, when I had the honour of laying before the Wernerian Natural History Society, some observations relating to such changes of plumage as I had observed to take place in several old domestic *hens*, I have been enabled to get a drawing made of the stuffed fowl in my possession, by a very ingenious young lady, residing in the neighbourhood of Plymouth; and I have had much pleasure in forwarding it to the Society as a corroborative proof of the observations I once made on this fowl.—See Plate XI.

The result of my subsequent inquiries are, that many persons have noticed the circumstance of old domestic hens beginning to crow when they get very old, and likewise that their feathers are apt to change in colour. These changes have generally been considered as a signal of its being full time for killing such fowls.

I therefore regard it as an established law of Nature, as certain in its results as any other, that almost every domestic hen-fowl would make advances at least, to assume the cock's plumage, if kept to an advanced period of life, when such changes generally occur.

I have reason to think, that, in some hens, this change of plumage would be very decided, whilst in others it might be but imperfect, depending perhaps upon the season of moulting and other circumstances. Let the change be ever so complete, and the resemblance of the female's plumage to that of the male ever so close, the more straight beak of the female would at all times distinguish her from the cock, which has its beak more arched, with the upper mandible more hooked over the under. The annexed drawing, (Pl. XI.) which has been executed with great fidelity and care, will satisfactorily illustrate the appearance of the stuffed hen in my possession, with the cock's plumage, arched feathers in the tail, spurs, &c. The comb and wattles were cut off by the owner, previously to the death of the bird, as I have already stated.

PLATE XI.

Wernerian Mem.s Vol. III. P. 196.

M.E.H. Gosling Del.t

W. & D. Lizars Sculp.t Edin.r

DOMESTIC HEN WITH MALE PLUMAGE

With the view, however, of exciting more general investigation into this subject, and of bringing together as many species as have been known to undergo this change, I subjoin a small list of such female birds as have, in advanced life, assumed the plumage of the male, with the names of those authors who have noticed the fact.

Class II.—Aves,—*Birds.*

Ord. 4.—Gallinæ.—*Domestic Birds.*

Gen. 1. Pavo, Pea-hen..*Hunter.*
2. Meleagris, Turkey..*Bechstein.*
3. Phasianus colchicus, Pheasant, common,...........*Hunter.*
—— pictus, golden......*Blumenbach.*
—— gallus, Fowl, domestic.......*Aristotle,*
[*Tucker, Butter.*]
4. Tetrao Perdrix, Partridge..................................*Montagu.*
5. Columba, Pigeon..*Tiedemann.*

Ord. 5.—Grallæ.—*Waders.*

2d Family, Prepirostres, Gen. 1. Otis, Bustard......*Tiedemann.*
3d ——— Cultrirostres, 3d Tribe, Gen. 4. Platalea, Pelican of America*..................................*Catesby.*

Ord. 6.—Palmipeda.—*Web-footed.*

4th Family, Lamellirostres, soft skin on the beak,
Gen. 1. Anas, Duck, (Common and Wild).......*Tiedemann.*

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* Platalea aiaia.—Enl. 165.—" A le visage nu, et des teintes rose-vif de diverses nuantes sur le plumage, qui deviennent plus intenses avec l'age; elle est propre à l'Amerique meridionale." P. 482. t. 1. *Regne Animal.*

In this species, the young bird has its head and neck covered with feathers, the old one bare, not peculiar to either sex.

The species contained in this list are arranged according to the system of Cuvier, in his "Regne Animal," published in 1817, which is certainly the most complete arrangement of the animal kingdom that has ever yet been offered to the world.

When the foregoing observations were made, I was not acquainted with the information which had been published on this subject by various authors, particularly by Aristotle, Schneider, Varro, Ausonius, Blumenbach, &c.

I could only judge of the novelty of these facts, by the inquiries I made of other persons, who had directed their attention more particularly to the habits, economy, and peculiarities of birds, than I myself had done. Through the kindness of Mr James Wilson, of Edinburgh, I was favoured with a communication last year, (1818), from him, containing the result of his knowledge, which appeared to be very extensive, on this subject; and also with an extract from the writings of Schneider *. This extract I shall take the liberty of transcribing, as it has enabled me to add some species to the list which I had before made.

" Aves *viduas* dictas domi altas bis in anno plumagium mutare vidit clarissimus Gallus; vernalis quidem mutatio maribus colorem plumarum

* The writings here alluded to, are appended by Schneider, in the form of notes and illustrations to the last edition of the treatise " *De Arte Venandi cum Avibus,*" by Emperor Frederick II.

pulchriorem et pennas caudæ longas addit, quas autumnalis mutatio pallidas reddit et prorsus adimit. Fœminæ senescentes maribus magis magisque similes efficiuntur; quod item accidere fœminis phasianarum, cum ovare aut desierunt aut pauca modo ova edunt, annotavit. cl. Mauduyt, p. 3. sub voce, "Faisan." Plumarum colorem tum induunt eundem cum maribus, sed pallidiorem, et a venatoribus "Faisans coquars" appellantur. Eandem rem observare licet in fœminis senescentibus phasiani aurei. Prioris speciei fœminæ cultro anatomico subjectæ, oviductus manifestos, ovaria vero aut plane nulla aut fere oblitterata, monstrabant. In gallinis vulgaribus et pavonibus, eandem Aristotelis observationem et Ausonii, pluribus veterum et recentiorum, imprimis Joanni Hunteri testimonio confirmatam, illustrare atque explicare conatus sum, in Promptuario Lipsiensi anni 1786, quibus exemplis nunc phasianorum fœminarum, anatum quarundam et viduarum exempla accedunt. Denique, in Pelecano Americano, Catesby, 1. tab. 81. senectute caput et colli duæ tertiæ partes calvæ membrana crassa teguntur, in juventute vero plumis vestiuntur.—Sub voce Couricaca."

The protection which man affords to many gallinaceous birds, may make some difference in their constitutions; but neither climate, food, nor captivity, has ever been proved to work the changes I have described as peculiar to the plumage of old henbirds. The circumstance, therefore, is wholly natural. Willoughby has said, that hens may be brought into an "effete or barren state in three years," by forcing them to lay eggs oftener than they would naturally do, by the practice of removing their eggs as fast as laid, and dipping the hens in cold water when they cluck, or shew a disposition to hatch their eggs by sitting; but he does not speak of having observed any changes in their plumage at this time. It is evident, however, from the following quotation, that Aristotle had observed changes similar to those already mentioned, to take place in old domestic hens; but ornithological writers subsequent to him, (especially in England), have seldom or never adverted to the circumstance in their writings. For a knowledge of Aristotle's remarks, as well as those of many other authors, I am indebted to the kindness of Professor Jameson, who has favoured me with the following extract from his Lectures, which are rendered most interesting to all classes of persons, from the abundance of facts they contain, and which have afforded me the most important and useful information in the various departments of Natural History, during my residence at the University of Edinburgh. "Gallinæ cum vicerint gallos, cucurrunt, maresque imitandi subagitare conantur. Attollitur etiam crista ipsis, simul et clunes (uropygium); adeo ut non jam facile dignoscantur, an fœminæ sint. Quibusdam etiam calcaria parva surriguntur."—Aristotle, His. Anim. lib. ix. c. 36.

Blumenbach mentions, that the female of the common and golden pheasant, when old, occasionally assume the plumage, and voice of the male.—Blumenbach, Commentatio de Anomalis et vitiosis quibusdam Nisus formativi aberrationibus.—Gottingen, 1813, p. 8.

It may here be mentioned, that an example of the golden hen-pheasant taking on the male plumage in old age, lately occurred at Dalkeith, in the pheasantry of the Duke of Buccleugh.

Tiedemann mentions the same of the domestic pigeon, bustard and domestic duck ; and *Bechstein*, in his Natural History of the Animals in Germany, informs us that the old Turkey-hen sometimes assumes the tuft of hair on the breast, which characterizes the male.—*Vide* Bechstsein, in Naturgeschichte Deutchlands, b. 3. s. 116.

I have also been informed by Mr James Wilson, that Mr Falconer of Carlowrie, a member of the Wernerian Society, is acquainted with a change of plumage, like that already described, having taken place in the common domestic duck. A nobleman in Devonshire, whose name I am not at liberty to mention, assured me, not long ago, that a wild duck, which was kept in his park, had assumed the plumage of the drake.

I may also mention, that a pea-hen, beginning to assume the male plumage, has been lately presented by Lord Glenlee to the Museum of the University of Edinburgh. It is not so good a specimen of the sort as I have seen in other collections, but still it illustrates the principle very well, and corroborates my observation, viz. that old hen-birds die soon after they have assumed the plumage of the male. My friend Mr Tucker of Ashburton, Devon, a most acute observer of the habits and economy of birds, has lately made known to me another instance of a common hen, besides the one described in his "Ornithologia Danmoniensis," which took on the male plumage in old age. These facts I mention just in the order of their occurring to me.

If I had not confined myself almost exclusively to birds in this paper, I might have mentioned that the coat of every young grey horse becomes of a milk-white colour in advanced life. The same remark may apply to the major part of the human race; but this change in the colour of the hair only illustrates the effects of age*, and not the disposition of the female to resemble the male.

Most authors have observed, that birds change their plumage, as well as animals their hair, twice a-year; but no one, as far as my information goes,

* Grief is also said to turn human hair grey at an early period of life. How far grief or fright may operate upon birds in confinement, and dispose them to exhibit the characteristic marks of age sooner than they might do if allowed to range without restraint, I am not prepared to say; but I deem the subject worth inquiring into, by those persons who are emulous of advancing this part of our knowledge of the animal economy.

has clearly remarked, that feathers themselves change colour after having been maturely formed, until lately; and yet it is a well known fact, that many birds have their feathers mottled or grey in summer, and white in winter; the summer covering being thin and light, the winter thick. The Ptarmigan and Hare are examples. In volume XII. of the Linnean Transactions, there is an interesting paper by the Reverend William Whitear of Sterston, Norfolk, stating, that in some birds, the full grown feathers themselves change colour, without being replaced by new ones. From this paper it is to be inferred, that a change in the colour of the plumage of birds, does not always arise from the 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 *.

It seems to be probable, that birds gaining their winter plumage, have their feathers partly changed in this way. The colour of the feathers, therefore, may be formed at two different times, viz. either when the feathers themselves are growing, or after the feathers have been properly formed; in the one instance, the colour is co-existent with the growth of the feather; in the other, superadded to its structure. In the changes of old age, the colour accompanies the growth of the feathers, because it appears with or

* *Vide.* p. 526. Vol. 12. Part ii. Trans. Lin. Soc.

soon after moulting. The differences of colour in the plumage of many birds in winter and summer, Mr Whitear supposes may be referable to the second way, or the acquirement of colour after the structure of the feather itself has been completed. I should, however, conceive, for example, when a Ptarmigan changes the mottled colour of its plumage to white, as it does in autumn, that a second crop of white-feathers grow out; and that those which previously existed in a mottled colour, also become white. Therefore I infer, that the colour in this instance may both accompany the growth of some, and be changed after it has actually been exhibited upon the substance of other feathers.

The mottled-ashed colour of the spring-crop of feathers, probably accompanies their growth, which takes place whilst the winter or white plumage is casting off; and the autumnal crop seems to become white from both processes, viz. the one forming with the feather, the other after it has been matured. Mr Whitear's observations, therefore, may not, on reflection, seem so novel as they appear at first sight; for no remark is more common, than that the plumage of birds and coats of animals inhabiting Arctic Regions, become thicker and whiter on the approach of winter, without either feathers or hairs being shed at this period.

Respecting the changes of plumage in winter, some good remarks will be found in the same volume of the Linnean Transactions, by Captain Sabine, who accompanied the late expedition to Greenland. As the colour of the feathers of many birds, in winter and summer, is still involved in much confusion, so we may suppose, when the same bird is sometimes described as two distinct species (Tringa, Cinclus and Alpina, were described as distinct species, until Montagu shewed them to be the same bird, in its winter and summer plumage); and as the changes peculiar to the plumage of certain female birds, seem not to have met with a sufficient share of attention, I have dwelt longer upon the subject than I had intended; and now quit it with the hope, that some other person will more satisfactorily prosecute the investigation, by making an addition of other facts and observations to those which I have been enabled to collect.

Age of Domestic Fowls.

Some inferences may perhaps be drawn from the foregoing remarks as to the age of fowls. Natural historians seem to have greatly overlooked this point. Aldrovandus, however, supposed, that the domestic fowl seldom or never exceeded ten years of age. In the instances given of Mrs Adams's hens, one lived to the age of thirteen, and the other to fifteen years, and both were killed.

Mr Corham's hen died a natural death, in the fifteenth or sixteenth year of her age.

Professor Jameson, in his lectures, gives a well attested instance from the writings of Tiedemann, of a domestic cock which lived twenty-five years.

The computed age of a fowl, correspondent to that of man, whose days are said to be three score years and ten, I would average at 15 years, viz. as about 1 to 5, or 15 to 72.

Most fowls would probably die under that age, by accident or disease ; but some few may live to the extraordinary age of 25, as old Parr lived to 152, and Henry Jenkins (both of whom died in the county of York) to 169 years of age.

XII.—*Account of some Fossil Remains of the Beaver, (Castor Fiber L.) found in Perthshire and Berwickshire, proving that that animal was formerly a native of Scotland.*

By the SECRETARY.

(Read 1st May 1819.)

It has generally been believed, that the beaver was once indigenous to different parts of Britain, particularly Wales and Scotland. I shall first notice the evidence of the existence, in former times, of the beaver in Wales; for, in this way, as will presently appear, some light may be thrown on the question of its having likewise been one of the native quadrupeds of Scotland.

The earliest written authority on this subject, is contained in a document of the 9th century, which has been published in the Leges Wallicæ of Dr Wotton. In Book iii. § 11, 12. of the Laws of

Hywel Dha, where the prices of furs are regulated,

The Marten's skin is valued at..................24 *d.*

The Otter's (Ddyfrgi or Lutra) at.............12 *d.*

The Beaver's (Llosdlydan or Castor) at no less than 120 *d.* or at five times the price of the marten's fur, and ten times the price of the otter's. It thus appears, that the beaver was then hunted in Wales for the sake of its fur; that this skin was held in high estimation; and that the beaver had already, before the close of the 9th century, become a scarce animal in this country.

The next authority is contained in the "Itinerarium Cambriæ" of Giraldus de Barri. This writer, it may be remarked, made his journey into Wales, towards the end of the 12th century, as the attendant of Baldwin, Archbishop of Canterbury, whose zeal led him personally to excite the Welchmen to join in the projected crusades. That Giraldus was inclined to be an observer of nature, is proved by the single fact, that when he arrives on the confines of the river Teivi in Cardiganshire, he immediately makes a long digression on the natural history of the beaver. Although he rehearses some of the exploded fables of the ancients, yet other parts of his account are very accurate, and may be considered as bearing the marks of a description made from actual observation. In the simple and bold language of a man who knew the truth of what he was writing, he says of the Teivi, "Inter universos Cambriæ seu etiam Llœgriæ fluvios, solus hic castores habet;" and adds, "In Albania quippe, ut fertur, fluvio similiter unico habentur, sed rari *." We may perhaps infer from this cautious mode of expression, that the author intended to contrast the nature of his evidence, and to intimate, that the fact previously mentioned depended on surer grounds, or on his own observation. But the very cautiousness of the language in which the report relative to Albania is repeated, ought, perhaps, to increase our reliance on its authenticity. It would appear, therefore, that in the 12th century, the beaver probably still existed in Scotland, but was then a scarce animal.

The first of the native topographers and historians of Scotland whose works assumed a printed form, and have come down to us, is Hector Boece, who wrote his Description and History towards the end of the 15th century. After describing the dimensions of Loch Ness, he says, "Ad lacus latera, propter ingenta nemora ferarum ingens copia est, cervorum, equorum indomitorum, capreolorum: ad hæc, marterellæ, fovinæ ut vulgo vocantur, vulpes, mustelæ, *fibri* lutræque, incomparabile numero, quorum tergora exteræ gentes ad luxum immenso pretio coëmunt †." Here the *fibri* are enumerated with such perfect confidence among the other quadrupeds whose furs were in request for exportation, that we

* Itin. Camb. lib. ii. cap. 3. † Boethius, Scot. Hist.

may seem fastidious as to evidence, if we hesitate to admit that beavers were still to be found at Loch Ness, in the time of the author. But the "incomparable number" of Boethius, may well stagger our belief; and forms a singular contrast with the "single river" and "rarity" mentioned by Giraldus three centuries before.

It may further be remarked, that Bellenden, in the translation of Boethius which he undertook (probably about the year 1536) at the request of King James V., while he omits the *cervi, capreoli,* and even the *lutræ,* mentions *bevers* without the slightest hesitation. His words are: "Mony wyld hors, and amang yame ar mony martrikis (pine-martens), bevers, quhitredis (weazels), and toddis (foxes), the furrings and skynnis of thayme are coft with great price amang uncouth (foreign) merchandis *." It must be confessed, however, that the carelessness of the translation, as evinced by the very passage in question, detracts from the conclusiveness of Bellenden's testimony; for it seems at least fully as probable that there were fallow-deer and roes in the forests of Loch Ness, as that there were wild horses there; and it admits of no doubt whatever, that otters were then to be found on the banks of the lake, for they are so to this day.

After diligent inquiry, I have not been able to find, that any trace of the remains of these animals

* Bellenden, Croniklis of Scotland.

has ever occurred in the neighbourhood of Loch Ness. What is more remarkable, in the extensive excavations along the line of the Caledonian Canal, from Inverness to Corpach, and in the course of deepening, by means of a dredging-machine, the bed of Loch Dochfour, no bones of the beaver have occurred.

The accuracy both of Boece and of Bellenden seems to be strongly impugned by this important fact, that no mention of beavers occurs in any of the public records of Scotland now extant. In an act dated June 1424, c. 22. "Of the custome of furringis," mertricks, fowmartes (pole-cats), otters, and tods, are specified; but not a word is said of beavers, although these, had they existed, must have been the most valuable of all, not only for their furs, but for the substance called castor, which in those days still retained its repute as a medicine. As it is pretty plain from their writings, that neither the historiographer nor his translator had the slightest claim to the character of being naturalists, and as both give abundant proofs of their nationality, in boasting beyond measure of the products of their country, it may be considered as not improbable that the beaver had been exterminated in Scotland before their time, although the tradition regarding its existence in former days was so strong and general, as to lead them to enumerate it without hesitation among the wild animals of the country.

Sir Robert Sibbald does not, on this topic, show any of that precision, and zeal for inquiry, which characterize many other parts of his writings. He contents himself with referring to Boece, in proof of the beaver having formerly been found in Scotland, and adds, with seeming indifference, "An nunc reperiatur nescio *."

No modern writer on the natural history of Scotland, seems to have examined the subject. The late Dr Walker, Professor of Natural History in the University of Edinburgh, in his "Mammalia Scotica †," merely says, that beavers formerly existed in this country, but are not now to be found. In his lectures, however, the Doctor used to mention, that the Scots Highlanders still retain, by tradition, a peculiar Gaelic name for the animal.

In order to satisfy myself with regard to the value of this traditionary evidence, I applied to the venerable and learned Dr Stuart of Luss,—a gentleman distinguished both as a naturalist and a Celtic scholar,—and the friend and fellow traveller of Pennant and of Lightfoot in their principal excursions through Scotland. From him I received a confirmation of Dr Walker's statement, that the ancient Gaelic name of the beaver is still known to the Highlanders in the remote western districts of

* Scotia Illustrata, Pars II. lib. iii. p. 10.

† Posthumous Essays on Natural History, &c. 8vo, p. 490. edited by Mr Charles Stewart.

Scotland. "The name (says the Doctor) is *Losleathan*, derived from *los*, the tail, point or end of a thing, and *leathan*, broad; or *Dobhran losleathan*, the broad-tailed otter." The similarity between this Gaelic name, handed down by tradition to the 19th century, and the Welsh name (Llosdlydan) recorded in the Leges Wallicæ of the 9th century, is very striking: the etymology of the names is evidently the same; and indeed they may be regarded as identical. Dr Stuart adds, that he recollects to have heard of a tradition among the Highlanders, which he thinks is probably still preserved in the country, that the "beaver or broad-tailed otter once abounded in Lochaber."

I have now to state, that the evidence, written and traditionary, which has just been detailed, tending to show that beavers formerly inhabited Scotland, has received the most ample confirmation, from the occurrence of unaltered fossil remains of the animal on two occasions; first to the north, and next to the south of the Forth.

The first instance I have to mention, occurred a good many years ago. From an entry in the minutes of the Society of Antiquaries of Scotland, dated 16th December 1788, it appears, that "Dr Farquharson presented to the Society the fossil skeleton of the head and one of the haunch-bones of a beaver," dug up in Perthshire. These bones are still preserved in the Museum of the Society; and I was liberally allowed to examine them, and compare them with others. The back part of the cranium is gone; and the zygomatic arch of the left orbit is shattered; a part of one side of the lower jaw-bone is likewise broken; of the incisores, only some remains of those of the lower jaw now exist. The " haunch-bone," or left os innominatum of the pelvis, is quite entire. All the bones are dyed of a deep chocolate colour. From the state of the sutures of the cranium, and from the size of the bones of the nose, which are complete, this animal appears to have been of full growth, but not aged.

The remains were found in the parish of Kinloch, near the foot of the Grampian Mountains. The Loch of Marlee, on the property of Mr Farquharson of Invercauld, is the last or lowest of a series of small lakes, extending almost from Dunkeld to Blairgowrie, nearly in the direction of the high road between these places. This loch had been partly drained, for the sake of the marl which it contained. In one of the marl-pits on the margin of this loch, under a covering of peat-moss between five and six feet thick, the beaver's skeleton was discovered. The bones already mentioned, being the firmest and most perfect, were found by the workmen; and being accidentally seen by Dr Farquharson, were carried by him to Edinburgh, and presented, as already mentioned, to the Antiquarian Society.

In a neighbouring marl-pit, a pair of deer's horns, of large dimensions, and branched, were found nearly at the same time; and, along with these, two "leg-bones, so deeply grooved as to appear like double bones." These last, it has been suggested to me by Dr Barclay, were probably the metatarsal bones of a large species of deer, which appears to have been contemporary with the beaver, and perhaps to have been exterminated much about the same period with that animal.

The second instance occurred so lately as October 1818, on the estate of Kimmerghame, in the parish of Edrom, near the head of that district of Berwickshire called the Merse. Since this estate was acquired by the present proprietor Mr Bonar, banker in Edinburgh, he has made important improvements. In the course of these, he drained a morass called Middlestot's Bog. Under the peat-moss here, a layer of shell-marl occurs, varying in thickness from four to eight feet. Different marl-pits have been opened; and in one of these, the remains of the beaver were found. They were situated at the depth of seven feet from the surface, under a layer of peat-moss of that thickness. It is remarked in a letter from Mr Thomas Dickson, overseer at Kimmerghame, to Mr Bonar *junior* (who took a lively interest in this investigation), that a layer of a kind of loose whitish substance, generally occurs between the bed of compact peat-moss and the bed of marl. From a specimen sent to Edinburgh, this substance appears to consist of several musci which grow in marshy situations, much decayed, but among which Sphagnum latifolium, S. capillifolium, and Hypnum cuspidatum can be readily distinguished. The bones of the beaver were imbedded partly in this loose and spongy matter, and partly in the marl below. Only the hard bones of the cranium and face, and the jaw-bones, retained enough of their firm texture to fit them for being removed and preserved in a dry state. Around these, however, dispersed in rather a promiscuous manner, were many bones, which, from their size and appearance, evidently belonged to the same animal. Several of the long bones and vertebræ, while they remained *in situ*, seemed perfect; but on being touched, they were found to be nearly in a state of dissolution; and though some were carefully taken out, they speedily mouldered down on being exposed to the air, and becoming dry. The apparent dislocation of the skeleton is not to be ascribed to violence, but to the gradual separation of the parts by unequal subsidence. The appearance of the marl, in which delicate shells, of the genera Lymnea and Succinea, could be traced, indicates a long continued state of tranquillity.

Mr Bonar *junior* having carried the skull and lower jaw-bone to Edinburgh, presented them to Professor Jameson, for the College Museum; and at his request I have drawn up this notice. Mr Bonar subsequently transmitted specimens of the different layers of the peat-moss, and of the vegetable remains which occur in it, and also of the marl. Among the vegetable remains, common filbert nuts, or at least the shells of the nuts, were abundant. A large specimen of Boletus suberosus so greatly resembled the hoof of some animal, that it had been laid aside as such by the workmen; but the tubes and pores are sufficiently distinct to afford characters. The overseer mentions in his letter, that the fossil-wood which is found, is "principally birch and alder; with some oak, though not much of it; but no kind of fir-cones have been observed."

Mr Bonar has in his possession a pair of horns belonging to the large species of deer already mentioned, of great size, and with fine antlers, found in the same marl-pit, and near the same spot, only two days before the occurrence of the beaver's remains.

The head of the beaver from Berwickshire is in a much more perfect state than that from Perthshire. The cranium and bones of the face are entire; so is the lower jaw-bone; all the four incisores are perfect, retaining the peculiar kind of coloured enamel which clothes the outer half of the circumference of the tooth; the cutting edges remain fully as sharp as in recent specimens from Hudson's Bay. The molares are also complete: It is considered as almost characteristic of the beaver that the grinders are without distinct fangs; but in this specimen, root-like bases are seen projecting from some of the teeth, through their sockets into the orbits. The bones are dyed of a brownish hue, but not nearly so dark as those from Perthshire: the exterior enamel above mentioned, which in recent specimens is of a brownish-yellow or dull orange colour, has become almost jet black.

On comparing these fossil heads with recent ones from Hudson's Bay and Canada, in the possession of Professor Jameson and of Dr Barclay, it appears that they all belong to the same *species* of Castor; but although there seem to be no sufficient *specific* distinctions, it may be mentioned, that the two fossil specimens have a greater resemblance to each other in general shape and proportions, than to any of four recent specimens with which they have been compared. In the fossil specimens, in particular, the nasal bones are proportionally larger than the same parts in the recent specimens.

Both the fossil heads appear to have belonged to full grown animals. This opinion rests on two grounds: 1. On a comparison, in regard to general dimensions, with recent specimens from Hudson's Bay, brought home by Mr Auld of Leith, and known to have belonged to full grown beavers; and, 2. On the state of the sutures and ridges of the cranium. In the Perthshire specimen, the squamous sutures of the parietal bones are partly obliterated; and in the Berwickshire specimen, although these sutures are distinct, yet the crest or ridge between the two temporal muscles, in the course of the sagittal suture, is considerably raised;

and in the Hudson's Bay skulls, both these characters are known equally to indicate the adult or perfect state. Neither of the fossil skulls, however, had belonged to an *old* animal; for, in a Canadian specimen in Dr Barclay's collection, not only are several of the sutures nearly obliterated, but the component pieces of the cuneiform bone, and the cuneiform process of the occipital bone, are united; while in both the fossil specimens, the divisions remain evident; circumstances which satisfactorily show that this Canadian specimen had been older than any of the others, although it is certainly not of larger dimensions.

The Scottish specimens, it may be remarked, seem very much to agree with a fossil beaver's head described and figured by M. Cuvier, in his "Recherches sur les Ossemens fossiles de Quadrupèdes," vol. iv. sect. *De rongeurs fossiles.* This specimen was found by M. Traullé, in a peat-moss in the Valley of the Somme in Picardy. The same peat-moss afforded, as with us, large horns of deer.

XIII.—*On the Rocks of Sandside in Caithness.*

By Professor JAMESON.

(Read 24th December 1819.*)*

THE crust of the earth is almost entirely composed of five simple minerals, viz. Quartz, Felspar, Mica, Limestone, and Hornblende *. These, either variously aggregated, or in simple unmixed masses, form the various kinds of mountain-rocks. All the other simple minerals described in Systems of Mineralogy, occur in comparatively small quantities, distributed through these mountain-rocks, in the form of beds, veins, imbedded masses, disseminated, or in drusy cavities. Of the five simple minerals already enumerated, the most generally and widely distributed are quartz and felspar; limestone is more abundant than mica and hornblende;

* Under this title I also include, in a geognostic sense, Augite.

and therefore these two latter are the least frequent. Quartz, which is probably the most abundant mineral in nature, is met with in all the rock-formations, from granite to the newest alluvial deposites; and in many regions, in the form of quartz-rock, sandstone, gravel and sand, it occupies districts of immense extent. This quartz-rock passes into gneiss, mica-slate, porphyry and granite; and sandstones which, in a general view, are to be considered as members of the quartz series, also occasionally pass into granite. This transition of quartz or sandstone into highly crystallized rocks of the nature of granite, although very interesting, has not hitherto been much noticed by geologists. I shall therefore now lay before the Society a short account of an appearance of this description which occurs in Sandside Bay, on the north-west corner of Caithness.

The Bay of Sandside is situated in the parish of Reay, and near the confines of Sutherland. It is open to the north; but on the south there are several low rugged hills, and on the east and west precipitous sea-cliffs. Three rivulets flow into the bay; one on the east is named Isald; the second, in the middle, is Reay-burn; and the western, the Burn of Sandside. We walked several miles up the burn of Sandside, and found the rocks in every place where we had an opportunity of examining them, to be syenite, granite, hornblende-rock and gneiss. Of these the syenite appeared to be the most abundant. The granite occurred in veins and masses in the syenite; and the gneiss was only observable in large and small cotemporaneous masses imbedded in the syenite. The hornblende-rock, like the gneiss, did not appear forming regular beds or strata, but only disposed in masses imbedded in the syenite. Many blocks of red-sandstone, and of granitic conglomerate, were observed in the bed and on the sides of the burn, but we did not discover them *in situ*. We crossed eastwards over some low hills of syenite and gneiss, to Reay Burn, and traced it to its termination in the bottom of the bay. Every where in its bottom, sides, and neighbourhood, where, rocks could be seen, these were of syenite, with hornblende-rock and gneiss. Several of the beds or masses of the syenite, had a brecciated or conglomerated structure, from the numerous rouendish, blunt and sharp angular portions of hornblende-rock distributed through them. We crossed the small bridge over the burn, at the Manse of Reay, and walked along the east side of the bay, towards Isald Burn; but, owing to the deep cover of loose blowing sand, we did not discover any considerable fixed rocks, until near the mouth of the burn, when strata of grey quartzy sandstone, slate-clay, often inclining to clay-slate, and coarse grey limestone, frequently variously convoluted, made their appearance. These strata continued to the extremity of the bay, where they formed lofty precipices and cliffs, facing the Pentland Frith.

On walking up the course of the burn, a bed of syenite was observed rising from under the limestone; and, in the limestone, were numerous portions of the syenite, varying from the size of a fist to several feet in diameter. The syenite contains much hornblende, with flesh-red felspar, small scales of mica, and grains of grey quartz. The limestone resting on it, and intermixed with it, is fetid, and contains small disseminated grains of iron-pyrites. Farther up the burn, the syenite, in several places, assumes the conglomerated character. There are two varieties of this conglomerate: in the one, the ovoidal and roundish masses are connected together by a basis of smaller granular syenite; in the other, they are immediately joined together, without any basis or ground. Another variety of syenite-conglomerate was observed a little distance from those just described, in which the apparent fragments were of syenite, and of a coarse sandstone, of the same variety as that which occurs in strata Intermixed with, and passing into these conglomerates, there is a fourth variety, in which both the roundish and ovoidal masses, and the basis or ground in which they are imbedded, are of red granite. These four kinds of conglomerate, do not form separate and distinct beds. On the contrary, they appear to be mutually imbedded in each other, in masses of greater or less extent; and all of them are included in a general and greater mass or bed of compact syenite, which is either of a red or grey colour.

In the vicinity of these conglomerated syenites, we observed a fine section of the rocks, displaying a transition from the syenite and granite into conglomerate, and from this latter rock into sandstone.

The lowest rock in this section is compact syenite, in some places passing into the conglomerated variety; and above it, is a mass of pure conglomerated syenite. Over these is a thick bed, the lower part of which is very coarse granular red granite, which gradually passes into a superincumbent conglomerated granite; and this graduates into a fine granular sandstone conglomerate, forming the upper part of the bed. The highest rock of the section, is the common sandstone of Caithness, which, in its lower part, has the same characters as the upper part of the subjacent bed.

The facts just stated shew, that these syenites, granites, conglomerates, sandstones and limestones, pass into each other; and are, therefore, to be considered members of the same formation.

The syenite is traversed by veins of flesh-red heavy-spar, which contain disseminated leadglance; and both the syenite and the limestone, contain veins of calcareous spar, in which are brown-coloured rock-crystals, with needles of titanium shooting through them.

PLATE XII.

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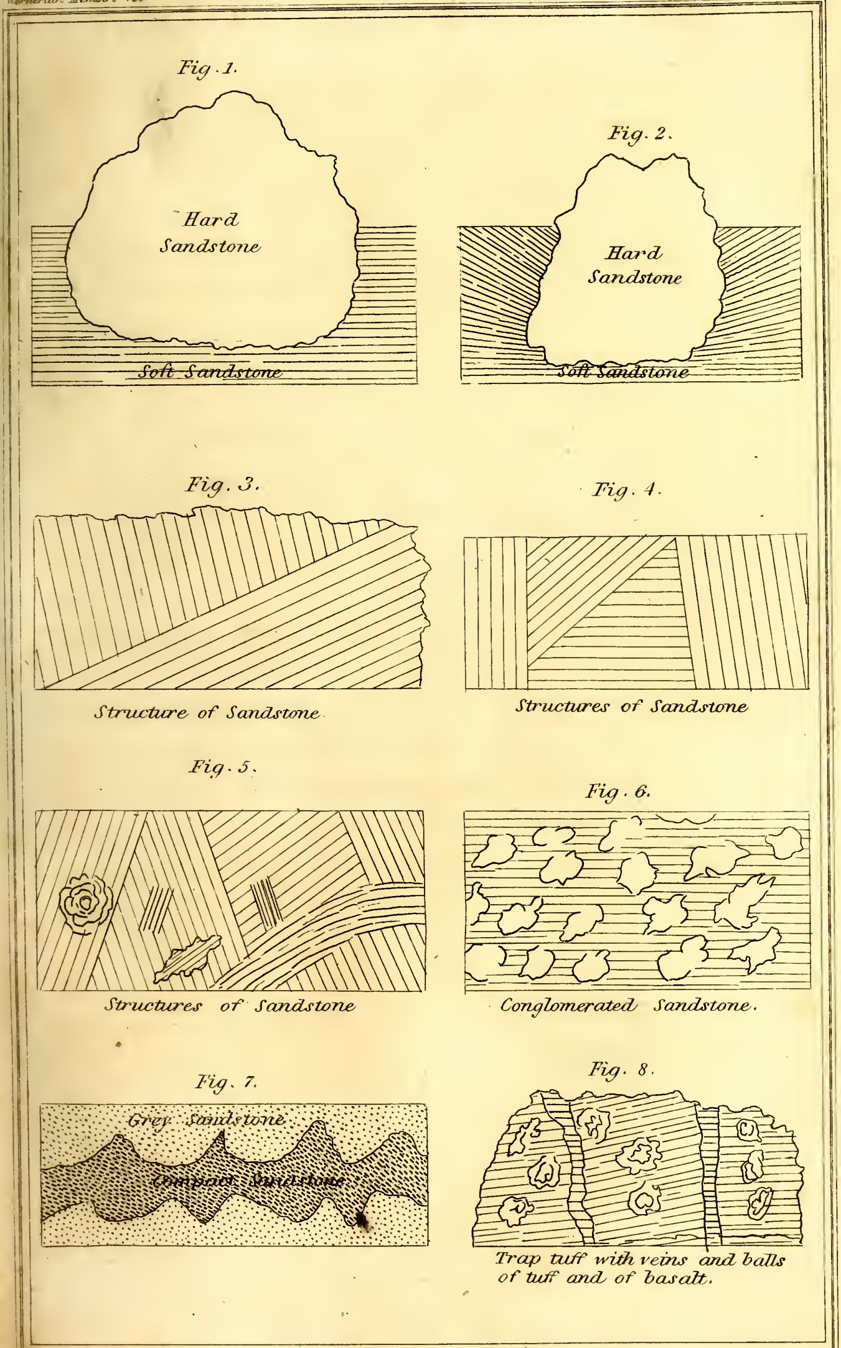

W & D. Lizars Sculp^t

XIV.—*Geognosy of East Lothian* *.

By Professor JAMESON.

(Read 11*th March* 1815.*)*

ALL that part of Scotland which lies to the south of the Frith of Forth, is denominated the Southern Division; and the tract betwixt the Frith of Forth and the chain of lakes which extends from Inverness to Fort William, the Middle Division. It is my intention to lay before the Society, in a series of papers, observations on several of the districts that occur in these divisions.

We shall begin with the Mineralogy of the Southern Division.—This division of Scotland is more simple in its structure, and its mountains and valleys are, on a general view, less elevated, and less rugged, than those that occur in the middle division. Its rivers also are smaller, and its lakes fewer in number, and inferior in magnitude, to those that

* See Memoirs of Wernerian Society, vol. ii. p. 618.

occur to the north of the Frith of Forth. The rock formations belong to the Transition, Secondary or flœtz, and Alluvial classes. The *transition rocks* are Granite, gneiss, syenite, porphyry, trap, limestone, clay-slate, sandstone, and grey-wacke: the *secondary* or *floetz rocks*, are Red Sandstone, with its accompanying porphyry, pitchstone, tuff, amygdaloid, basalt, greenstone, clinkstone, limestone, slate, coal, and conglomerate; and the coal formation, with its various subordinate beds and strata of coal, limestone, sandstone, slate, basalt, amygdaloid, tuff, greenstone, &c.; and the *alluvial rocks*, are rolled masses, gravel, sand, clay, loam, peat, and calcareous tuffa.

These classes of rocks present many very important mineralogical relations, some of which are confined to particular limited districts: others extend through more extensive tracts of country, and many of them occur in similar formations in all parts of the globe.

We shall begin with an account of the mineralogy of East Lothian.

East Lothian.

The geographical characters of this county are well known; and its physiognomy, or external aspect, has been frequently described. We shall here, therefore, confine ourselves entirely to its mineralogical structure.

No fixed primitive rocks have hitherto been discovered in this part of Scotland. The oldest of the fixed rocks are those of the transition class, of which the following species have been observed; granite, syenite, porphyry, greenstone, clay-slate, greywacke, and flinty-slate.

These transition rocks having been already described by a member of our Society, it will not be necessary to enter into any further details in regard to them. We shall, now, therefore, proceed to give an account of the Secondary rocks.

1.—*Red Sandstone.*

The first of these is Red Sandstone. This rock forms a considerable portion of the county; and, where its junctions can be observed, it is found to rest on transition rocks, and to be covered with the coal formation. Its most frequent colours are red, inclining to brown; and sometimes it is yellowish or greyish white. Its principal ingredient is quartz, which is in grains; and these are either joined together, without a basis or ground, or they are imbedded in a red-coloured clay. It alternates from very fine to very coarse granular, thus passing into conglomerate. It is distinctly stratified, and the strata vary from a few inches to several yards in thickness. The strata are either horizontal or inclined; but the angle of inclination seldom exceeds 45°. The general direction is from N. E. to S. W., but the dip varies. It contains, as subordinate beds, limestone, slate-clay, red-coloured clay-ironstone, greenstone, amygdaloid, basalt, trap-tuff, and clinkstone.

A comprehensive view of the relations of the rocks of this formation to each other, will be obtained by attending to the following description of the strata, as they occur along the coast of the county, from the neighbourhood of Dunbar to the westward of North Berwick.

Rocks in the Neighbourhood of Dunbar, and onwards to the Westward of North-Berwick.

The harbour of Dunbar is situated in a red coloured trap rock, which forms a single bed of very considerable thickness, whose direction is N. E. and S. W. and dip to the S. E. This rock, which is an iron-shot porphyritic greenstone, is beautifully columnar, and the structure is well seen all around the harbour, but particularly on the north-west side. From the harbour, a low rocky coast extends to the eastward; but, to the north-west, the coast is higher and more rugged. If we proceed along the shore from the harbour, towards the south, the first rock we meet with is a red conglomerated sandstone, which is immediately under Mr Hay's manufactory. It extends N. E. and S. W.; and, like the trap of the harbour, dips to the S. E. It is succeeded by a bed of red coloured trap tuffa, having the same direction and dip. The next bed is a conglomerated-like sandstone. It is of a reddish colour, and imbedded in it are patches and spots of a white-coloured sandstone, which, at first sight, appear to be fragments; but, on close examination, we find them gradually passing into the basis in which they are contained; and even the red-coloured sandstone, in some places, presents the conglomerated character,—facts which shew that these are not fragments, but cotemporaneous masses. The portions of sandstone vary in size from half an inch to several inches; and they also differ in shape, being roundish, ovoidal, blunt-angular, and massive, as represented in Fig. 6. Pl. xii. This curious sandstone is succeeded by a greenstone rock, which is partly porphyritic, partly tuffaceous. It is much intermixed with the red conglomerated sandstone, and is traversed by veins several inches wide, of white quartzy sandstone;—facts which shew that here the sandstone and tuff are of cotemporaneous formation. This tuffaceous rock is succeeded by a red-coloured sandstone, which is sometimes very clayey and soft, and even appears to pass into a sandy red coloured slate-clay. All the varieties are marked with beautiful celandine or mountain-green coloured spots, from half an inch to two inches and upwards in diameter. They vary in shape, being either circular or oval, and sometimes we observe them of an irregular form; and not unoften this red sandstone contains layers of a green-coloured clayey variety of the same rock. As we advance along the shore, the red sandstone becomes more compact; and, in several places, is quarried as a building-stone. The direction of the strata is still S. W. and N. E., and dip to the south; but, as we proceed south-eastward, the strata become more inclined; at length are nearly vertical, and are succeeded by a bed of porphyritic basaltic greenstone. The red sandstone does not appear beyond this point, its place being now occupied by a greyish-white sandstone, which is disposed in nearly horizontal strata, and contains beds of limestone. The lower strata of sandstone are calcareous, contain vegetable and animal impressions, and include large cotemporaneous masses of bluish-grey compact splintery limestone. This limestone decays yellow. In the sandstone there are numerous supposed vegetable moulds, and some varieties of the sandstone are entirely composed of these. This latter fact would intimate, that these are crystallizations of the sandstone, and not true casts of organic bodies.—Such are the rocks that occur immediately to the south and south-east of the harbour.

Let us next describe those that extend from the north-west side of the harbour. Immediately under the ironshot porphyritic greenstone pillars, already described, a bed of red-coloured trap-tuff is to be observed, having the same direction as the bed of trap in which the harbour is situated, and, like it, dipping to the south-east. It rests on strata of sandstone, which have the same dip and direction.

The sandstone in some places is of a red colour, but it is more frequently grey, spotted with red. It often contains reddish-brown-coloured spots; and these are sometimes so numerous, as to give the rock a deep brownish-red tint of colour.

Sometimes the deep red portions are in the form of veins, which run in every direction, and present a variety of curious appearances; and in other instances, the imbedded red sandstone is not in veins, but in masses, that vary in size and shape. When the softer yellowish-grey sandstone decays and falls out, the remaining mass acquires a singular cavernous or cellular aspect. This sandstone forms low ledges of rock covered at high-water, which are succeeded by rugged and lofty rocks of the trap series, on which are situated the ruins of the old Castle of Dunbar. These rocks are very steep, and in some places completely perforated by the action of the waves, forming beautiful natural arches. They are not composed of one variety of the trap series, but of several, viz. red-coloured trap-tuff, amygdaloid and of a basalt, which contain red diallage and olivine, which, by the action of the weather, has acquired a red colour. They form one inclined bed of great thickness, which rises above the lower superincumbent and subjacent red sandstone.

Advancing along the shore from these high traprocks, we find the sandstone forming a number of low rocky ledges, which are partly covered at high-water, and extend onwards to striking cliffs of red-coloured trap-tuff. The strata have the same direction and dip as those already mentioned; and the sandstone has the usual characters. Nearly in the middle of the tract, there is a pyramidal mass of trap-rock, which appears to rise through the sandstone strata. It is partly tuff, partly basalt inclining to greenstone.

The strata of sandstone immediately in contact with the mass of trap, are curved, and inclined towards it. This fact, of a mass of trap rising through the strata of sandstone, will be viewed by some as favourable to the volcanic theory of its formation, while others will be inclined to consider it as illustrative of its Neptunian origin.

The rocks and cliffs of trap-tuff continue along the shore, until they are succeeded by cliffs, and then by ledges of red and white sandstone. The tuff is in general fine granular, here and there formed into concretions, from the size of an apple to that of a man's head, and upwards. These concretions are, in general, round; and at first sight appear like balls of basalt. It is sometimes traversed by veins of very hard and compact tuff, several inches wide, and also by veins of compact felspar, of the same magnitude. In some places the tuff is quarried for oven-stones, and is known to the quarrymen by the name of *Leckstone*. It is worthy of remark, that varieties of tuff are quarried for the same purpose, in other parts of Scotland; and in some districts on the Rhine, this stone is quarried to a vast extent, and is exported to Holland, and other countries. Fig. 8. Pl. xii. represents several of the characters of the trap-tuff.

The sandstone cliffs that succeed these rocks of tuff, are low, and of but inconsiderable extent; but the ledges of this rock continue onwards to Belhaven Bay, where they disappear under the loose sand, which extends onwards from thence to Whitberry.

In a low cliff of the sandstone, we observed an oval concretion of the same rock; and, in many places, the sandstone was observed to alternate with slate-clay and thick beds of bright red clay-ironstone, like that in the red sandstone at the Cock of Arran. The ledges of sandstone at Wilkiehaugh, are traversed by veins of greenstone and amygdaloid. These trap rocks contain amethyst, either in veins, or imbedded; and one variety is particularly beautiful, having a dark coloured ground, with beautiful violet-blue coloured imbedded portions of amethyst.

From Belhaven Bay, to the commencement of the rocky coast which extends from Mr Brodie's, at Scougal, to North Berwick, the coast is sandy, with the exception of Whitberry and Ravensheugh, which are of trap and sandstone. These points I had not an opportunity of examining; but Dr Macknight has promised to lay a description of them before the Society *.

* This has been done since the reading of the paper.—*Vide* Memoirs of Wernerian Society, vol. ii. p. 404. *et seq.*

Immediately below Mr Brodie's house, the sandy coast terminates, and the rocks, in the form of cliffs, and of ledges, running into the sea, make their appearance. The first rocks are of red coloured trap-tuff, which contains cotemporaneous globular masses of grey compact limestone, and also of a porphyritic variety of tuff. The limestone concretions are from a few inches to 3 feet and upwards in length; and, at their junction, are frequently intermixed with the tuff. The red tuff is distinctly stratified, and the strata are from a foot to several feet thick. The direction of the strata is S. W. and N. E. the dip to the south, and they appear traversed by veins of basalt and greenstone.

The cliffs of tuff, which extend for several hundred yards, are succeeded by ledges and low cliffs of sandstone. The sandstone is stratified, and sometimes saddle-shaped; but the direction of the strata is still S. W. and N. E. It is sometimes of a dark-red, sometimes of a bright-red colour. The bright-red variety is the most highly impregnated with clay, and contains abundance of green circular spots, which appear in some degree to characterize the red sandstone of this formation. It frequently contains globular and tuberose shaped concretions of red-coloured limestone. Such cotemporaneous formations, on a great scale, in this and in other rocks, in other districts, appear as mountain masses or even forming hills. Beds of a green-coloured arenaceous clay, alternate with the sandstone. This red sandstone is succeeded by, and alternates with, a greyish and red spotted sandstone, which contains imbedded portions, and also beds of clay and cotemporaneous portions of compact grey limestone. Another interesting fact in regard to the sandstone on this part of the coast, is the occurrence of large masses of hard sandstone in the softer. The imbedded masses are so hard as to resist the influence of the weather, whilst the softer are carried away. Such compact or hardened sandstones, when in contact with greenstone, have been improperly considered as proofs of the volcanic origin of trap rocks. About 50 yards beyond this, the red sandstone is to be seen alternating with red coloured trap-tuff, and the tuff and sandstone are intermixed at their line of junction. In the tuff, imbedded portions of foliated granular brown-coloured limestone occur; and some varieties of it are so fine granular, that they might be mistaken for red sandstone. A little to the north-west of Sea Cliff, immediately beside the rocks we have been describing, there is a cliff about 40 or 50 feet in height. It is a bed of amygdaloid, containing much green-earth, and cotemporaneous portions and veins of calcareous spar. Over it rest several strata of red sandstone, and rocks of the same kind probably run underneath it.

As we continue our journey along the shore towards Tantallan Castle, the cliffs become high, rugged and romantic. Long ledges of rock run from the cliffs into the sea, and isolated rocks or *stacks* rise above the water at some distance from the cliffs. The cliffs, ledges and stacks are formed of red sandstone and red trap-tuff, which are intermingled in various ways. The cliffs continue to be principally of red tuff, until nearly opposite Sheep Craig, when the colour changes to greenish-grey, and vast cliffs of this variety extend along the coast, and form the rock on which are situated the striking ruins of Tantallan Castle. Veins of tuff of a cotemporaneous nature traverse the tuff of which the cliffs are composed, and in the same rocks there are many veins of calcareous ironstone, varying from a few inches to two feet in width, and red and white zeolite and amethyst *, and jaspers of various descriptions. Tantallan Bay is bounded, on both sides, by lofty cliffs of trap-tuff; but, on the beach, a number of sandstone strata, in a nearly horizontal position, are to be observed. These strata, where they appear on the north side of the bay, when examined at low-water, can be traced a considerable distance, until at length they disappear under the tuff. The tuff on the north side of the bay is sometimes very coarse ; and in it, in one place, there is a mass of yellowish-grey sandstone, several fathoms in extent, and five or six feet thick ; and, in another, a cotemporaneous bed of columnar basalt, terminating on both extremities in the form of

* Mr Sligo *junior* of Seacliff, informs me he has collected fine specimens of red zeolite, and also of amethyst, in these cliffs.

a wedge. The tuff continues onward around the coast to Canty Bay, forming cliffs of considerable magnitude. At Canty Bay, the tuff alternates with basaltic greenstone, and is traversed by veins of green and red coloured tuff. The tuff is to be observed gradually passing into a red sandstone, which alternates with white sandstone. This sandstone exhibits much variety in structure; alternates with beds of red and green coloured clay; and is traversed, in some places, by veins of amygdaloid.

The sandstone at Canty Bay, and along the coast, for some distance, varies, not only in colour, but also in structure. In some places it is reddish brown; in others, yellowish or greyish white, or of a mountain-green colour. Quartz is the predominating constituent part; and felspar and mica are occasionally intermixed with it. The basis, or cementing material, is clay, or calcareous marl, or the quartzy particles are immediately joined together, without any perceptible basis. Frequently, beautiful circular spots are to be observed in the sandstone. These are either of green coloured clay, or of particles of felspar and quartz joined together, without a basis, thus forming a variety of granitic rock *. They vary

* Masses of this description, when they appear in the great scale, form mountain masses or hills of granite in sandstone. In the primitive slaty rocks, as gneiss and mica-slate, there is a series of the same description, formed by imbedded cotemporaneous masses of granite, varying from the size of a nut to several fathoms or miles in extent.

in size from a quarter of an inch to upwards of two inches in diameter. Sometimes the sandstone has a conglomerated aspect, appearing, at first sight, as if composed of fragments of sandstone, contained in a sandstone basis; but a careful examination proves that this curious variety of rock is not brecciated; on the contrary, the fragments are cotemporaneous portions of sandstone, of a harder or softer nature than the basis in which they are included.

These cotemporaneous masses vary in shape and size, being spherical, oval, blunt-angular, sharp-angular, and tuberose; and are from an inch to several yards in length and breadth. It is particularly interesting to observe the laminæ of the slaty varieties of sandstone terminating in the sides of the massive cotemporaneous varieties. Fig. 1. and 2. of Pl. xii. represent laminæ of slaty-sandstone terminating on massive and hard sandstone. Viewing the sandstone as a chemical formation, this appearance shews how the slaty, and consequently the stratified structures, may be frequently unaffected by the rock they surround. Veins of sandstone occasionally occur, traversing all the varieties of that rock. They terminate in the rock, and are intermixed with it at the line of junction; hence are of cotemporaneous formation with it. The strata vary in thickness from a foot to several yards, and have the general dip and direction of the rocks already described. The individual strata often exhibit great variety in structure, being waved, disposed in zig-zag lines, in concentric laminæ, like basalt, and in apparent fragments. Fig. 5. Pl. xii. represents several of these varieties of structure. In the same stratum of sandstone, one part will be red, and very compact; and another grey, and rather loose in its texture; and the two varieties, at their lines of junction, present differences in form. These resemble the appearances that frequently occur at the junction of granite and gneiss, and are probably to be explained on the same principle, viz. that of cotemporaneous formation. Fig. 7. Pl. xii. represents a bed of compact red sandstone contained in another of a grey colour; and, at same time, shews the waved line of junction of the two rocks.

But we have not yet described all the different kinds of structure exhibited by the strata of sandstone in this district. In some places, the sandstone, within a short space, exhibits so great a variety in dip and direction, that we are puzzled whether to ascribe the appearances to changes induced in the strata after their formation, or to refer them to original formation. These perplexities, however, vanish, if we view these different dips and directions, not as belonging to different strata, but as the structure of a stratum, or set of rocks, composed of distinct concretions. Fig. 3. 4. and 5. Pl. xii. represent several of these structures.

Many slips are to be observed in these strata, and these vary from a few inches to some yards. It is worthy of remark, that these changes occur in the structure of individual strata, and also in masses of strata; and hence incline us to consider many of them as original varieties of structure, and therefore not produced by the action of any after mechanical cause. These various structures of the sandstone, afford interesting views in regard to the formation of strata in general; and are particularly valuable, as illustrating the connection of sandstone, in a chemical point of view, with quartz-rock and granite.

From Canty Bay, the cliffs along the shore become lower, and are often covered with sand. The rocks of which they are composed, are principally trap-tuff, which contains cotemporaneous masses and veins of basalt, or basaltic greenstone. Rather more than half a mile from North Berwick, and a short distance from the shore, there is a quarry of that kind of limestone named *Stinkstone,* which is wrought to a considerable extent, and burnt into lime. It appears to form a great bed in the red sandstone. From the quarry, which is named Rhodes' Quarry, to North Berwick, the prevailing rocks, both on the shore, and in the country, are red sandstone, and red tuff, containing beds and imbedded masses of a basaltic greenstone. The rock at the harbour of North Berwick is amygdaloid. Immediately to the westward of the harbour, the amygdaloid is succeeded by a sandy beach, in which a few ledges of red sandstone and red tuff are to be observed. These ledges are succeeded by beds of compact greenstone, several fathoms thick, in which the direction is N. E. and S. W. The greenstone is sometimes amygdaloidal, and the amygdaloidal portions are of calcareous spar. Strata of white sandstone and of clinkstone follow the greenstone; and these are succeeded by a great bed of porphyritic greenstone. These various greenstone-beds are observed running into the sea, and rising above its surface in different parts, forming the rocks named Craig Leith, and the Lamb.

North Berwick-Law.

Immediately above the town of North Berwick, rises the beautiful conical hill named North-Berwick-Law, whose summit is 500 feet above the level of the sea. The district around the hill is low, and slightly undulated, so that it forms a striking and very beautiful object to the surrounding country. The lowest rock visible, is a variety of trap-tuff. Higher up, is amygdaloid. The middle and upper parts of the hill are of a beautiful and very sonorous variety of clinkstone-porphyry; and the summit rock is clinkstone-porphyry, intermixed with crystals of augite; thus forming a transition into greenstone *. The clinkstone is, in some

* *Vide* Dr Ogilvy's interesting observations in his Paper on the Trap Formation of East Lothian, vol. i. p. 469. Wern. Mem.

places, columnar, and forms cliffs of considerable magnitude *.

But we naturally inquire, What are the relations of the rocks of this hill to those of the surrounding and lower country? In no place did we observe any junction of the trap rocks of the Law with the surrounding sandstone; nor was sandstone visible in any part of the body of the hill. This being the case, we must rest satisfied, at present, with what may appear as the most plausible conjecture in regard to its geognostic situation. The sandstone strata, if not altered in their direction, would run under the hill, and appear again emerging from the opposite side, and thus the rocks of the Law would rest over them, in an overlying position. But we are not always to infer an overlying position from the circumstance of the strata appearing to shoot under, and emerging on the opposite side of the hill; because the mass of the hill may be a great mass contained in the strata. Is it probable that North Berwick Law is such a mass? At a former meeting, I described a considerable cotemporaneous mass of trap, which occurs in the red sandstone

* This, and other similar porphyries, it is probable, may one day become of great importance, in an economical point of view, as it contains about 9 *per cent.* of mineral alkali or natron. Should a cheap mode be discovered of separating the alkali from the other constituents of the rock, this hill alone would afford alkali sufficient to supply Great Britain for a long series of years.

near Dunbar. It appears rising through the sandstone, and, had its junction with the neighbouring rocks been hid by debris, it would have been a miniature representation of North Berwick Law.

The hard sandstone contained in the soft sandstone, presents a similar appearance. There we observe the hard sandstone rising through the soft, and standing in the form of small eminences above the softer stone. Had the line of junction of the two sandstones been concealed, we would have been inclined to believe that the hard sandstone was a different formation from the soft, and rested upon it.

But appearances of this kind are not confined to sandstone districts. They are common in mountains composed of primitive and transition rocks. Of these, we shall now mention an example, by way of illustration of our idea in regard to the geognostic position of North Berwick Law.

Near Portsoy in Banffshire, there are several hills of quartz, that rise rapidly from the surrounding flat country, which is composed of highly inclined strata of gneiss, hornblende rock, granite, &c. When we trace these strata from the shore to the base of the quartz hills, we observe them apparently shooting under them; thus leading to the notion of these hills being overlying masses over the highly inclined strata. But the same quartz occurs in other places, in beds, and these beds vary in magnitude and extent, and often appear as mountain masses in the strata, and terminating in the rock at the extremities;—a fact which leads us to infer, that the quartz hills are large cotemporaneous masses contained in the strata, not resting over them.

We have now stated examples of trap rising through sandstone, and forming small eminences; of hard sandstone rising through soft, giving rise to large projecting masses; and, lastly, we have shewn, that quartz is arranged in a similar manner in the older rocks.

These facts lead me to suppose, that North Berwick Law does not overly the sandstone, but rather rises through it, and may be the upper part of a great imbedded mass.

XV.—*Account of the Effects of the Juice of the Papaw Tree,* (Carica Papaya), *in Intenerating Butcher's-meat.*

By the late Dr HOLDER.

(Read 30th March 1816.*)*

THE effects of the juice of the *Carica Papaya*, or Papaw Tree, whether of the fruit, stem, or leaves, or even of the exhalation from the plant, in lessening the cohesion of the muscular fibre, and acting on the fibrin of the blood, are matters of common observation in the Island of Barbadoes; the inhabitants availing themselves of this property, to render more delicate, when thought necessary, the beef, mutton, pork, and poultry of their tables. If the milky juice, which is readily procurable by incision into the tree, or unripe fruit, be thoroughly rubbed on the flesh of a tough or old animal, and the animal be cooked by roasting, the fibres so completely lose their cohesion, that the flesh will fall from the bones, or be separated by the slightest force. If a smaller quantity of the juice be used, the flesh will be rendered tender; but so great is the effect, and so difficult is it to ascertain the degree to which it may be carried, if the milky juice be directly applied to the flesh, that another and more certain mode has been resorted to, for procuring the inteneration of the flesh of different animals. By simply suspending the animal to a bough of the tree, for a space of time proportioned to the size of the animal, or of the joint of meat, the flesh is found to be sufficiently intenerated. A particular friend of mine, was in the constant habit of having his meat so prepared for his table, and was particular enough, (or thought it necessary), to use his watch to regulate the time of suspension.

This quality of destroying the cohesion of the muscular fibre, probably resides chiefly in the milky juice, or in the vapour, which, I conjecture, is exhaled from the tree, since the boiled fruit, when given to animals, does not produce this effect to such a degree as to be sensible. The fruit is used by all ranks of people; cooked in its unripe state, as a vegetable; or served up, when ripe, as part of the dessert, with perfect impunity.

It is a common practice with some of the farmers of the Island of Barbadoes, to give an infusion of the raw fruit; or, to speak more exactly, a diffusion of the milky juice in water, extracted from the fruit, to horses, with a view, as they express it, "of breaking down the blood;" and it is a fact, well established, that if given to a horse, whose blood exhibits the cupped buffy coat, it will, after some time, produce a loose coagulum, and reduce the inflammatory symptoms which gave rise to it. I understood, from my friend, the late Dr Jones of Barbadoes, well known in this University, by the publication of an ingenious experimental Thesis, that he had ascertained this to be the effect of the papaw juice on a horse, which had cough, and whose blood was buffy; and this account has very recently been confirmed to me, by a near connection of Dr Jones's, a gentleman who formerly lived with him, and who is at present a residenter in this city, as a student of medicine.

That this remarkable effect is independent of putrefaction, or of a process verging to putrefaction, is rendered extremely probable, by the fact, that it is not confined to dead muscular fibre, but is produced on the circulating blood; or, at least, on one of its constituent parts. At the same time, the consequence of this effect will no doubt be, by its mechanical operation, to promote and hasten putrefaction, on account of its destroying the cohesion of the flesh, and separating the fibres. This is a fact so well known to the housewives of the colony, that they will not purchase, for salting, pork which has been partly fattened on the boiled fruit of the papaw, (a practice commonly followed by the negroes of the colony), on account of the flesh not being sufficiently firm for salting; or, at least, because they find, by experience, that, after having undergone the process of salting, it will not keep as long, or as well as flesh of hogs which have been fattened on any other aliment. What is remarkable, this effect is observable, although the flesh of a recently killed animal, fed on the boiled papaw fruit, is not sensibly intenerated: For a society of gentlemen, who were in the habit of dining periodically with the late Governor of Barbadoes, Sir George Beckwith, fed several animals in this way, with a view to ascertain the effect on the flesh. We found, that when the animals so fattened, were served up, their flesh was not, to the taste, more tender than that of other animals at the table, fed in the common mode.

The health of animals fed on the papaw, is not injured by that diet.

I may add, that the juice of the papaw has been, by some, administered as a vermifuge to children, whether with marked success I am doubtful.

The chemical analysis of the juice of the Carica Papaya has given, in the hands of Vauquelin, some very curious results: from them, he draws the following conclusions.

"I think," says he, "that there cannot be any doubt that the juice of the papaw is a highly animalized substance; at least it possesses all the characters, and yields all the products of one. I confess that it has no perfect similitude with any known animal matter. Nevertheless, I believe that which it resembles most, is animal albumen; since dried, it dissolves, like it, in water. Its solution is coagulated by heat, by the acids, by the alkalies, the metallic solutions, and the infusion of nut-galls. And, in fine, because, by distillation, it yields the same products as any animal substances whatever. It is not the animal nature of this substance which ought to surprise us; for the juices of almost all plants contain some of it; but its abundance and its purity in that of the papaw."

To the preceding account, I may add, that since it was written I have had confirmed to me, a fact respecting the effect of the fruit of the Papaw in its unripe state, (when eaten uncooked), on the muscular fibre of animals, which I did not mention, as I was in some doubt respecting it. I have been informed by a gentleman of the first respectability of the island of Barbadoes, who happened to be passing through Edinburgh, that he knew two instances of animals which had taken the Papaw in its uncooked state into their stomachs; and the flesh of which was thereby so much intenerated, as to be unpleasant to himself and others, who partook of it. This fact clearly shews, that the effect of the Papaw juice is the same on the muscular fibre, whether taken internally by the living animal, or applied topically to the animal when recently killed; and that, as this effect is so general, as to extend itself universally to every muscular part of the body, and to the fibrin of the blood of a living animal, which happens to take it internally in its uncooked state; and that the same effect is not sensibly produced on the flesh of animals which may eat the Papaw fruit, after it has been cooked, we must infer, that the action of fire, in a great measure, destroys the active principle on which this effect depends; and as this principle, whatever it may be, evidently exhales from the tree, it most probably is easily volatilized by heat.

PLATE XIII.

M. S. Baird Fecit

XVI.—*Account of the Travelled Stone near Castle Stuart, Inverness-shire.*

By Thomas Lauder Dick, Esq.

In a Letter to Professor Jameson, communicated through the late Dr John Gordon.

(*Read* 17*th May* 1817.)

My Dear Sir,

I have many apologies to offer, for not having earlier fulfilled a promise I made you when last in Edinburgh, of examining into the circumstances which attended the transportation of the Travelled Stone near Castle-Stuart, in Inverness-shire; and of satisfying that curiosity which I appeared to have awakened in your mind, by the imperfect account I was at that time enabled to give you of it from report; by transmitting to you a more accurate and particular detail of the phenomena accompanying that event, from my own personal research. It was on this very day of last year, that I had an opportunity of visiting the spot; and now, without trespassing on your patience by an enumeration of the various sources of procrastination which have produced so considerable a delay between the period of my investigation, and my present communication, I shall proceed to offer you the result of my inquiries and remarks made on the spot.

This stone is a large mass of conglomerate, being a concretion composed of distinct irregular fragments of granite, gneiss, quartz, and other rocks of the primitive series, cemented together by a highly indurated and ferruginous claystone. It is, apparently the very same conglomerate, as that forming the rocks through which the romantic burn of Cawdor cuts its deep and narrow bed, near Cawdor Castle in Nairnshire; nor am I aware, that any rock of the same nature with that of the Travelled Stone, exists much nearer to it than seven or eight miles. Its present situation is on the sands, in the little bay near Castle-Stuart, on the Moray Firth; and as it is left entirely dry by every retreating tide, the sea retiring a great way beyond it, it is easily approached over the sands at low-water. Its size is very considerable; being, as near as I could guess, above five feet high at its most elevated point, calculating from the surface of the sand, and being, to all appearance, about one foot imbedded in it. In its two horizontal diameters, it may probably measure between five and six feet one way, by six or seven the other. Its shape, which is very particular, is peculiarly well adapted to admit of the mode of transportation it underwent, as it has a projecting ledge running all around it, (marked AA. in the accompanying pen-and-ink sketch) *, the lower edge of which is above a foot in perpendicular height from the surface of the sand; and from this edge downwards, the stone is suddenly bevelled off, in a form something resembling that part of the bottom of a boat which is under the belly, and approaching the keel. The upper surface of the stone is gradually rounded into a ridge, rising into a peak towards the one extremity. The annexed sketch, taken from the south-side, will give a tolerable idea of this mass, which, on a rough calculation, (formed by weighing about a square inch of the stone), may weigh about eight tons.

This large mass is remarkable, for having been removed from a situation which it formerly occupied, about 260 yards farther to the E. S. E. by natural means, and in the course of one night, to the position where it now stands. It had formerly served as a boundary stone (or as it is called in Scotland, a march-stone) between the properties of Castle-Stuart and Culloden; the former belonging to the Earl of Moray, and the latter to Duncan Forbes, Esq. As it is too ponderous to have been moved by human power, at least in that part of the country, it must have been originally deposited in that, its first place of rest, by causes si-

* Plate XIII., etched by Miss Baird, Ramsay Lodge.

miliar to those which have covered whole countries with boulders, the nature of which bespeaks their having belonged to rocks nowhere existing *in situ* in their entire and native state, in the vicinity of their present place of repose. The stranger easily recognises the spot from which it was last removed, (just within flood-mark), it being marked by a wooden-post, which the two contiguous proprietors were under the necessity of erecting, in order to supply the place of the stone, and to serve as an object for defining the line of march. At the fishing village of Artirloss, situated on a point above a mile to the westward of the stone, I learned several particulars regarding its extraordinary migration; but it was recommended to me to call on the miller of the Sea-mill of Petty for a fuller detail of the facts, who, living much nearer the stone, and having had it constantly in his view for a long series of years, not only recollected every circumstance about it, but was the first person who, on the ensuing morning, noticed that it had been removed during the night.

I lost no time, therefore, in visiting this old man, whose name is Alexander Macgillivray; and I was lucky enough to find him at home. His information on the subject, and his replies to my interrogatories, were in every respect perfectly distinct and satisfactory. He informed me, that this remarkable circumstance took place on the night between Friday the 19th and Saturday the 20th February, of the year 1799. There had been a long continued and severe frost; and the greater part of the little bay had been for some time covered with ice, which was probably formed there the more readily, owing to the quantity of fresh water from the stream running near to Castle-Stuart, emptying itself into this inlet of the sea in the immediate neighbourhood. The stone was by this means fast secured, by the ledge I have already described, being bound round by a vast cake of ice, of many yards in extent, which, being frozen hard under the projection (A A), must have produced an admirable mechanical means for its elevation, for which purpose it afforded an extensive raft. The miller told us he had measured some of this ice, and found it no less than 18 inches thick. The stone was thus surrounded, when the sea left it at its ebb, and the whole of the circumjacent sand was left covered by this extensive, solid, and unbroken glacier. It is evident, that as the sea began again to flow, this would be naturally enough buoyed up in some degree by the returning water insinuating itself underneath it. On the night between the 19th and 20th of February, already noticed, the tide, which happened to be remarkably high, was full about 12 o'clock. About this hour, the wind began to blow a hurricane, which the miller described as having been perfectly unparalleled in the memory of the oldest men living, accompanied at the same time by a furiously drifting snow. The old man stated, that this tremendous storm blew directly from Dolcross Castle, an ancient building conspicuously situated on the ridge of the country at some miles distance; and accordingly I found, on examination, that by placing myself at the stone, and looking at Dolcross, the post marking the former situation of the mass, appeared quite in the line between these two points, and on trying the bearing with a pocket-compass, I found that the direction of the wind must have been from the E. S. E., and that the straight line or furrow described by the stone in the course of its voyage across the sands, lay in a direction from E. S. E. to W. N. W.

When the old miller got up on the morning of Saturday the 20th, the storm, and the drifted snow, were such, that he could hardly make his way to his barns, though they are but a few yards distant from his dwelling-house. He found all his doors blockaded, and buried under the wreathes of snow, so much so indeed, that there was not the vestige of an entrance left to any of them, and the drift still continued to be so very violent, that he, and a boy who was with him, had nearly lost themselves in returning again to the dwelling-house. When the weather had moderated in some degree, and the storm and snow had cleared away, so that he could see across the little bay, he remarked to his wife with much astonishment, and no inconsiderable alarm, "that the mickle stane was awa'," and the good woman could hardly believe her eyes when she looked out and saw that it was in reality gone from the spot it had occupied the day preceding, and that it had been removed much nearer to the low-water mark, to the position where it now remains. General surprise and curiosity were now excited, which were no doubt mingled with various superstitious fancies, and the neighbours flocked out to see and examine the subject of so extraordinary a prodigy. To their astonishment, the hole in which it had been for so many ages embedded, still remained to mark distinctly its yesterday's site, whilst its track across the flat oozy sand was very perceptible, extending in a line all the way from its old to its new situation.

In addition to these particulars, gathered from the miller of Petty, I have since understood from my friend Mr Brodie of Brodie, that he visited the stone either that day (the 20th) or the day after, when he found all these traces remaining quite apparent, and that an extensive cake of ice was still adhering to the stone being attached to its surrounding ledge.

It is evident, that this vast mass of stone must have been so far rendered specifically lighter than the water, by the great cake of ice within which it was bound, and by which it was supported, as to be in some degree buoyed up; and that, whilst in this state, it was carried forward by the outgoing tide, assisted by the impelling force of a tremendous hurricane from the E. S. E. So very uncommon was the violence of this storm, that the 20th

February 1799, is still called in the language of the country, "The Blowing Saturday."

By the circumstances just detailed, we are furnished with a comparatively recent and perfectly well attested example of one mode by which large masses of detached rock may be carried to considerable distances. For, although the waters of the tide which fill the bay in question were, on account of their shallowness, incapable of buoying up the extensive float of ice supporting the stone, so perfectly as to prevent the keel of it from ploughing the sand in the course of its progress over it; yet there is no reason to doubt, that if it had been once fairly carried into deeper water, it might have been ultimately transported to a much greater distance. And if we can suppose the float of ice to have been sufficiently tough and tenacious, we may even conceive it possible that the stone might have been deposited upon some remote shore, where no rock of the same nature was to be found, and where it might have furnished future geologists with subject for most interesting speculations. These would have been naturally the more puzzling, that its peculiar mode of transportation would have totally precluded all chance of its acute angular projections being destroyed by attrition, and so would have prevented the possibility of its exhibiting those appearances of having been rounded and polished, so manifestly displayed by most of those stones denominated Boulders. How far the causes which are thus known to have operated in producing the removal of this vast fragment, may appear to tally with the relative situation of similar masses in other places which cannot be so easily traced to their parent rock, or to ascertain whether such means may not have had some share in transporting these to their new situations, may perhaps merit investigation; and with such a view, an accurate and well attested narration of the particulars of the conveyance of the Travelled Stone near Castle-Stuart, from its former to its present place of quiescence, cannot be considered as altogether useless in the pursuit of geology. Yours, &c.

Relugas,
3d May 1817.

XVII.—*Abstract of a Paper on the Scale of Being, and particularly on Organization and the Living Principle.*

By JOHN CAMPBELL, Esq. of Carbrook, F. R. S. E. & M. W. S.

(Read 6th March 1819.*)*

In tracing that chain of connection which, amidst an almost endless variety, binds the different parts of creation together, we can perceive, in the material world, the progressive links, from inert matter, to the living principle superinduced on the most delicate organization; and in the intellectual world also, from instinct, ascending through those faculties which are exhibited, by animals, to the rational responsible soul, which, with or without the human body, identifies Man. We shall limit this Abstract to what relates to the material division of the Scale, and, noticing very briefly the three lower points in the gradation, enter more at large into the characters which distinguish the Living Principle from Organization and Instinct, which have been generally blended together in one common confusion. The main object of this paper, indeed, is the extrication of these from their entanglement, and the fixing them respectively in their proper places in the Scale of Being.

Immediately connected with the individual particles of matter which lie at the bottom of the scale, stands the principle of *aggregation*;—a principle altogether dependent on gravity. Its operation is not without a tendency to determinate form; but as that tendency is not sufficiently strong to resist the surrounding counteracting attractions, the merely aggregated masses are amorphous.

Stratification succeeds. All stratified rocks are more or less crystallized; but the regularity with which, amidst all their anomalies, and occasional insubordination, these great masses are deposited, and the mighty preparation required for dissolving and re-forming the whole exterior of the globe, and that without destroying the homogeneity of the strata, lead us to a higher agency than mere gravity and affinity; and while we admit the operation of these principles, and the efficacy of that operation, in circumstances adapted to the attainment of the end, we can only, in the spirit of sound philosophy, refer the full accomplishment of the work to their agency under the direct and controlling influence of that Almighty Word which commanded matter itself into existence.

Crystallization, the next point in the Scale, is a principle more precise in its operation, depending chiefly on chemical affinity. Under its influence, matter always assumes determinate forms. Its adherence to this law, indeed, is so unbending, that the ingenuity of man has not yet been able, by any intermixture or management, to produce the slightest change on the angle appropriate to any one crystal. There is an analogy between the peculiar angles of crystals, and the peculiar angles at which the buds and branches of plants are protruded; but in plants, the law is modified by a number of circumstances.

We now arrive on debatable ground; for, on ascending the step to *Organization*, we come into collision with the opinions of my distinguished friends Dr Barclay and Dr Thomson; and it is with no small degree of diffidence that I venture to oppugn their philosophy. Referring to Dr Barclay's paper on Organization, the opinions expressed by that learned gentleman may be stated to be, That the principle of organization is a Being which discriminates, which forms the organs, keeps them in repair, and of design deserts them altogether, when they become irreparable *. And nearly to the same effect with regard to the discriminating faculty of the agent, Dr Thomson appears to have expres-

* Wernerian Transactions, vol. ii. p. 543.

sed his opinion as to the principle which assimilates the food, and repairs the waste in the animal frame *. That the phenomena of digestion and assimilation are wonderful; that they exhibit evidence of the operation of mind possessing infinite power, can scarcely escape the perception of the most stupid insensibility; though the reason why they are so arranged, and not otherwise, must be referred to the pleasure of Him who made them so. It must also be at once conceded, that the changes which take place in the living body, require, in order to account for them, something more than the mere existence of chemical affinities. But it is another, and a very different question, Whether that Being who has confessedly formed matter, has introduced a *thinking* principle into the animal frame, with the charge of superintending the chemical changes to which its different parts are continually subjected? That the living principle is not the soul, seems decisively proved by the fact, that vegetables, which (except with poets) have no souls, have unquestionably the living principle; the process of digestion going on in the laboratories of the leaves. The whole difficulty seems to arise from the ascription of a *discriminating* power to that arrangement by which the food is assimilated, and the breaches and injuries of the frame counteracted and repaired. But there seems to be no necessity

* Thomson's Chemistry, 5th edit. vol. iv. p. 638, *et seq.*

for the introduction of any such power. It is admitted, that all the changes produced, are chemical changes, and that they are proximately produced by chemical affinities: but it is asked, in the tone of a negative assertion, How do the digestive powers adapt themselves to varied circumstances? How are the elements of the different substances forwarded through their successive stages, and preserved, unaltered, through all the windings of their devious course, till brought within the sphere of chemical action, exactly at the places where their decomposition and new combinations are useful? Yet why should we hesitate about these things? They are not more inexplicable than many other phenomena, which, though calculated to excite the admiration of every intelligent observer, do not suggest to him the necessity of introducing the faculties of mind to account for their appearance. The naturalization of exotic plants is quite analogous to that alteration in the digestive process, produced by a change of food on carnivorous or granivorous animals, and which appears to Dr Thomson to be so inconsistent with material functions. But it is only necessary for us to recollect, that the difference between different kinds of food, arises more from the difference in the *proportions* of the ingredients, than of the ingredients themselves. It is true, that animal food contains azote, which is not a constituent of the vegetable. But azote is not poisonous; and, to the granivorous tribe, will be merely superfluous, like iron, sulphur, and other extraneous substances in plants; whilst the want of this ingredient in vegetables, will be made up by a supply from the atmosphere, and other sources, to such carnivorous animals as require it. It agrees with all the analogy of Nature, however, that it should require frequent repetition to effectuate this change. And a satisfactory reason why it should do so, is suggested by the very nature of the thing. All the organs and secretions by which the food is digested, are compounded of materials proportioned to the nature of the accustomed food. A change in the proportions of the food, must, therefore, gradually change the proportions of the organs and juices. There can be no doubt but it does so. By the selection of the food, the grazier can, to a very considerable degree, lay on fat or flesh on his stock as he pleases. Now, the food he gives them, differs only in the proportions of the ingredients; but these differences are sufficiently influential to determine the particular substance which is to be formed. It is to be remembered, that it is the feeder of the cattle who makes the choice; and therefore we must conclude, that the digestive operation is a necessary one, like mechanical attraction, or chemical affinity; and that, though it may be produced by neither of these, there is no occasion to look for its immediate cause beyond the agency of a law of matter.

Neither is it more unaccountable, that the bile should mix only with one part of the food which leaves the stomach; and that, when mixed with bile, that particular portion should not combine with chyle, though in mechanical connection with it. It is only necessary to suppose, what is not only possible, but very probable, that at whatever point in its progress, a change takes place in the food, there is placed at that spot, by the original constitution of the frame, some new chemical agent, by whose peculiar affinity with the chyle, the new combination is formed. But this agent has no power of direction. It is a mere principle, like all the organs and principles of the material world, accomplishing the determinate object for which it is constructed or impressed.

The reasoning applicable to the phenomena of assimilation, goes far to explain the manner in which the waste of the body may be supplied; the fractures repaired; and, in some instances, its disorganization counteracted or corrected. When the vessels are emptied by the daily waste, it is apparent, that they will be fitted to take up more of those particles with which the juices lodged in them have a tendency to combine, than when these juices are already saturated, and the vessels full; hence, a constant supply will be secured, as long as food is presented, and the vessels are in condition to secrete the juices, and perform their functions for disposing of the supply. The very same explanation may suffice, for the cure of wounds and fractures, where an extra stimulus may be supposed to augment the secretions, and, consequently, the depositations.

These are simple views, and draw but little on the imagination for their support. There is, however, a greater difficulty remaining; not as to the existence of a thinking or discriminating power, but as to a living principle, distinct from sentient existence, and from mere mechanical and chemical agency. We can comprehend how the chyle and the blood may, in their progress from stage to stage, supply all the varied demand of membrane, muscle and bone; but it remains unexplained, by any of the principles with which we are familiar, in what way are generated or continued, those motions which carry the nourishment to these different stages, and expel what is either superfluous or unfit for use. The peristaltic motion, the pulsation of the heart, and the involuntary movements of the muscles, exhibit phenomena inconsistent with the idea of inert matter, and equally distant from the effects of attraction or repulsion. These motions may all, indeed, be referred to muscular motion; and it seems also to be true, that all muscular motion depends on nervous energy or irritability; but this only leads us to a more wonderful contemplation. The whole animal frame is ramified with nerves; and their universal efficiency is proved, by the immediate destruction of those parts, the nervous fabric of which is destroyed. How the nerves communicate information we do not know; but in whatever way effected, the change of state of the smallest nerve being communicated at that point, from whence all the nerves originate, and where they are all concentrated and united, an action may naturally, and must be produced on the whole system, corresponding to each peculiar excitement. That this is the very mode in which the animal machinery works, we by no means assert. While the operations are in progress, they are beyond our observation; and whilst we are in doubt, whether the nerves contract or vibrate, or contain a fluid, or are altogether solid, it is not to be expected, that we can offer proof of the manner in which their active agency is exerted. Yet we may hazard an opinion, that whatever be their peculiar composition, or their means of communicating over the whole, an impulse applied to one particular point, it must be by some such connection as we have attempted to describe, that the principle does operate; and that, though a law or principle *sui generis*, it is still only a law or quality impressed on matter *.

In pursuing this investigation, one can scarcely avoid perceiving the distinctive characters, which prove that there is a structure peculiar to the organs; and that it is inaccurate to say, that it is the

* From Dr Ure's description of the phenomena exhibited on the application of the galvanic stimulus to the nerves of Clydesdale the murderer, after his death, we have reason to suppose, that, under such influence, muscular motion and secretion, and consequently assimilation, might be produced and continued.

living principle which determines that structure. What we have contemplated is the fact, that by the structure of these organs, actuated by a living principle, certain functions are performed, which, without such structure, or such living energy, neither the one nor the other alone, could have accomplished. The structure is the *organization;* the *living principle* is something else. They are intimately connected together, no doubt; but so is the mind with the body. The one is the substance moved; the other the moving power. Holding, then, organization to refer to the structure of the organs, we may perceive, that, though more complex and delicate in its arrangements than crystallization, it maybe equally resolved into a principle or law, impressed on matter, for the application of mechanical power, and the evolution of chemical affinities.

There is one point of view, however, in which crystals and organized bodies materially differ. The original specific character of each animal and vegetable, in the thousand and ten thousand varieties that overspread the earth, is no effect of chemical affinity. The peculiar character of each of these, could only be impressed by that Great Being, who, when he commanded the world into existence, willed, that the tribes of the animal and vegetable kingdoms, should each be brought forth after their kind. The parent, therefore, in each of these, in reproducing the species, has not to create, but to continue the specific character already created; and as that specific character can alone depend on the difference in combination, in proportion, in quantity, and in position of the few ingredients of which all are composed, there can be no difficulty, we apprehend, in forming an idea of such a structure of the organs, as may fit them for being mechanically and chemically employed in the assimilation and deposition of food, for the continuance of life, and reproduction of the species.

Dr Barclay does not seem to me to have sufficiently attended to this important circumstance. He appears to hold the opinion, that the origin of the animal fœtus, is an unorganized fluid, with a little active being inclosed in it, which forms the organs. But that the animal rudiment is a fluid, is by no means clear; the presumptions, to my mind, lie quite the other way. The thing itself, of which this is the origin, is not fluid, but solid; and all our ideas connected with its nature, relate to solid body. That it is immersed in fluid, is true; this is a wise provision for preserving it in safety. In plants, where in many cases it must be scattered by the winds to become productive, the pollen is a dry solid body, which flies like dust; but in that case, nature has provided a fluid in the pistil, to facilitate its passage into the interior of the seed-vessel. If any thing on this subject admits of being concluded upon as certain, it seems to me to be the proposition, that in the animal, as well as in the vegetable tribes, the parent produces the organized fœtus or seed. It may be, that some of the organs are perceptibly developed sooner than others. It is natural to suppose, that those immediately employed in secreting the nourishment, should be first displayed, especially in those animals which are hatched without deriving subsistence from the mother. But in all cases, the direct conclusion from analogy is, that the parent prepares the organized rudiment of its offspring, which requires only the common operation of its organs to complete the animal.

From organization, then, which is a lower point in the scale, we ascend to the Living Principle or *vis vitæ*;—terms which may be safely adopted, provided we keep in view, that it is not by this principle the soul lives; and that when our bodies shall be mouldering in the dust, and our souls existing in a disembodied state, this living principle shall have ceased to live. A concomitant only on animal and vegetable life, it must vanish with it, like the corresponding portion of gravity, which would cease to exist on the annihilation of the particles of matter on which it was impressed.

XVIII.—*On the Nutrition of Cuticle, Nails, Hair, Feathers and Plants.*

By H. Dewar, M. D. F. R. S. E. & M. W. S.

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(Read 26th February 1820.)

The object of the present Essay is, to bring together a few physical considerations which may assist us in forming rational conceptions of the mode of nutrition of some descriptions of animal organs which physiologists have in this respect either neglected or misunderstood.

The group of phenomena implied in assimilation presents two aspects, which vie with one another in their claims on our admiration. The one aspect consists in the great variety and extent of the subject. It comprehends the whole range of animal and vegetable life, exhibiting varieties commensurate not only with the enumerated species of plants and animals, but with the product of this number multiplied by that of the organs, and the sorts of texture which occur, together with those casual deviations which arise from rarer combinations of circumstances, and go under the name of morbid or preternatural.

The other aspect which the facts of assimilation present consists in the recondite nature of the process by which it is accomplished. The change induced is chemical. Certain affinities are brought into action, which nothing short of life can develope. For this reason, we ascribe them to a peculiar set of agents. But the effects are more or less persistent after life is extinguished. Though the changes do not continue, the altered state remains, or is followed by changes of a nature totally different from all that occurs in matter which has never been subjected to the influence of life. The properties thus developed belong to matter as such, but they are not capable of being elicited by matter alone. Whatever opinions may be held relative to the connection between a substance and its properties, or between matter and the agencies which are constantly found attached to it, and which have sometimes occasioned perplexity to the ambition of philosophic subtlety, a clear distinction presents itself between those properties which matter always exhibits, and those which only appear on particular occasions, and which the mere contact or influence of other matter is not adequate to produce.

In attending to the chemical phenomena of life, and, we may add, all the other phenomena, more trivial or more stupendous, which are conjoined with life from its lowest to its highest forms, one fact ought never to be lost sight of,—and the consideration of it will never fail to insinuate a degree of salutary influence into the views of the most rigid and the most sceptical reasoners,—that the properties of life do not necessarily reside in any portion of matter whatever. There are no elements in a living body which we do not find in dead matter. The perpetuity of particular specimens of living form and function depends on laws which are not attached to matter, and which might cease to operate though all the materials of the organs remained. The extinction of a whole species is an event which we easily conceive, as the effect of the cessation of coincidences which we may call fortuitous; and, on the occurrence of such an event, which even human co-operation seems competent to accomplish, none of the existing powers connected with all the matter known to us, (even that which has been animated by the numerous individuals of the extinguished pattern), and no combination of these powers, is adequate to reproduce a similar set of individuals. Every species of living beings owes its origin to a series of events connected together as cause and effect, operating intimately on matter, and yet liable to be easily removed from the whole material world. There is no visible law of necessary operation, affording security for the permanence of any organized species. The mode of its introduction in the former history of things, or of its supposable re-introduction at a future epoch, eludes inquiry, excepting in so far as the history of organic remains shews that organization, in its forms and laws, has undergone revolutions which force us to recognize the operation of causes to us unseen, being removed from the range of all that we can discover by the most acute reflections on such laws as fall within our view.

The naturalist, therefore, in extending his inquiries, dwells at greatest leisure on objects which his senses can discover. Every thing else is general. These alone are particular. In these inquiries, he can only make more or less near approaches to a knowledge of the nature of organic assimilation. He cannot reach this knowledge itself. He cannot any farther estimate the functions of the parts, than by observing them in a stage as near as possible to the accomplishment of their object, and by instituting a due examination of the nature of the change that is effected.

This humble occupation derives a dignity and an excellence, from placing the inquirer in the porch of the great temple of Creation and Providence, the *penetralia* of which he is forbidden to enter, and procuring for him a knowledge of many facts of which the more distant and careless spectator remains ignorant.

It is thus that the physiologist and the naturalist study the function of nutrition. The physiologist traces those general facts which are found to accompany the process, calling to his aid the minutiæ of anatomy, and sometimes chemical research. He surveys the results, that he may see the extent of the changes effected, aud draw from them such leading inferences as they are fitted to furnish: while the naturalist records and arranges the facts themselves, for the purpose of enjoying the magnificent spectacle which they exhibit. The easiest, and apparently the most satisfactory subjects for this part of physiological investigation, occur in the soft organs of the human species, and of those animals which differ least from man in the texture of the organs. Here we perceive the progress of the nutriment in the alimentary canal, in the chyliferous vessels, and in the sanguiferous system. In this last, we follow the course of it, now fully prepared, to its ultimate destination in the extremities of the arteries; in which vessels, or in their immediate vicinity, nutrition is, in every such organ, accomplished. But whether does the nutritious matter, in this final stage, add to the animal texture by attaching itself to the interior surfaces of the vessels which convey it, and of which the different textures ultimately consist? Or is it passed through small orifices to the outsides of the vessels, there to be expended on its proper object? Or is there a looseness of fabric at this stage of structure, by virtue of which the minutely divided blood passes and re-passes, to supply the place of whatever is decayed, leaving full room for the decayed particles to proceed to the veins, to the contents of which they move, either in consequence of mechanical or of chemical arrangements, in order to be expelled from the body? These are points which we cannot determine. If the texture is thus loose, the degree of its looseness is exquisitely adjusted to the purposes of nutrition, as well as to the other ends to which the organs are respectively adapted. It is of such a determinate nature, that no room is left for the transit of other matter across their substance. This adjustment is not purely mechanical, nor purely chemical, nor a mixture of the two. It is chiefly vital, and immediately dependent on the activity of the functions; for the same organs which thus accurately perform their part, are quickly changed at death;—an event which deprives the vessels of the power of retaining their fluids, and allows transudation to take place in all directions.

The circumstance to which I wish chiefly to call the attention of the Society, is, That physiologists seem to have had their views in some degree fettered, by entertaining too strict ideas of the connection between the circulation of fluids and nutrition. It is in cases in which the circulating apparatus is clearly traced, that the conveyance of aliment to the organs is most satisfactorily observed; and they seem to have been unable to conceive any other mode by which this purpose could be effected. But, when we attend to some organs, particularly hair and feathers, we find them too dry to admit the supposition that fluids are circulated through every part of their substance. Physiologists must always have supposed that, in these organs, the proportion of the fluid to the solid matter is much smaller than in the muscular and nervous substance; but they have not supposed that there was any limit to the tenuity of vessels by which fluids are conveyed. This view is sometimes applied to the physiology of the smallest insects. They are described as possessed of vessels equally numerous as in larger animals, and carrying to every organ the nutritious fluid in streams which obey the same vital and hydraulic laws.

We shall, find, however, that, in the laws of capillary attraction, limits are set to the tenuity of sanguiferous vessels. In consequence of these laws, a small portion of the area of the contained fluid adheres to the parietes. This attraction is not, indeed, incompatible with a relative motion among the particles. A drop of fluid adhering by capillary attraction to the end of a glass rod often exhibits intestine motions from the admixture of minute particles of dust, or from containing animalcula. But it retards and restrains such motions; and there undoubtedly is a minute distance from the surface of the solid, at which motion becomes impossible. The motions of fluids encounter greatest impediments from this cause in the smallest vessels of any animal. This circumstance counteracts the effect of the more ample space provided for the blood in that set of vessels, the sum of the areas of which always much exceeds that of the trunks and larger branches. Capillary adhesion contracts that part of the calibre in which the motion is free, and must always bear the greatest proportion where the calibre itself is smallest. Hence the motions of the blood form only a minute stream in the axes of these vessels. There is unquestionably a point of minuteness at which the practicability of circulation ceases; and nothing except the want of attention to this consideration, or the absence of any other hypothesis, could have led physiologists to believe in the existence of a circulation in situations in which neither vessels nor fluids can be discovered.

It has been supposed, that a circulation is conducted in the minutest animals, exactly similar to that of large ones, and that the minuteness of this system bears some proportion to the diminutive size of the whole body. It is taken for granted, that the circulation may be equally brisk and free as in larger ones. This seems to have been simply inferred from the indefinite divisibility of matter; and it is true that we are not authorized to set any limits to our conceptions of the minuteness of organic texture. But when we turn our attention to aqueous fluids, we find them governed by this law of capillary attraction, which is susceptible of admeasurement, and which must impose a limit on the minuteness of the vessels through which streams of such fluids can be transmitted. When hard pressed, indeed, a reasoner who is unwilling to give up such opinions might allege that the circulating fluids, in such cases, are not aqueous, but consist of a more tenuious matter, more allied to spirit, governed by a capillary attraction which operates at much smaller distances, or altogether exempt from that influence. Aqueous and oleaginous humours, however, are the only ones on which we are entitled to pronounce as existing in animal bodies. Where they differ from pure water, it is not in possessing greater tenuity; but, on the contrary, in deriving a greater viscidity from the animal matters with which they are impregnated.

If any other supposition, therefore, can be maintained, it may be fairly concluded from these considerations, that we are not entitled to believe in the necessity of a circulation of fluids, for the purposes of nutrition.

Before stating the hypothesis which I propose to substitute on this subject, I shall briefly recall a few prominent facts, relative to the growth of Hair, Nails, and Feathers.

It is well known that no vessels can be traced in many of their parts. If there is something like bloodvessels in the soft ends of feathers, near to the body of the animal to which they belong, there are certainly no traces of such an apparatus towards the extremities. Many of the organs now mentioned are too dry to allow us to believe in a circulation, even while their growth is most vigorous.

At the same time, it must be remarked, that there are facts which forbid us to suppose, that these organs are mere secretions formed at their roots, or the parts by which they are attached to the animal body. Mere secretion and successive propulsion, never could have been maintained to constitute the growth of feathers; because it is well known that a developement takes place over all the extent of their expanded substance, each pinion and each serrature receiving a proportional enlargement during growth. But while physiologists confine their attention to the hair and the nails, they are sometimes disposed to conclude that these organs are mere secretions or depositions; and that their growth consists entirely in a successive propulsion of the existing parts, by the new parts succeeding at the root or point of secretion. This idea receives some countenance from the circumstance, that a scratch on the nail of one of the fingers, gradually changes its situation, by proceeding in a direction from the root to the extremity of that substance. In the hair, however, no such appearances have been observed; and there is this fact adverse to such a supposition, that, when the hair changes from dark to grey, we do not find the change beginning at the root, and proceeding toward the extremity of the hair, but taking place simultaneously over its whole length.

Another fact is, that the hairs have a maximum length at which the growth is arrested: and this differs in different individuals, and still more in different parts of the same body. That of the head appears somewhat vague, because the *tout ensemble* presents no marked outline, the whole falling down in one flaccid congeries; but that of the eye-brows, and that of the eye-lids, have a determinate length, which contributes at once to utility and to the highest elegance. When cut short, it quickly reaches its full length, and there invariably stops. These circumstances shew, that each hair has a particular constitution, by which all its parts, from the root to the extremity, exercise a regulated reciprocal influence. We cannot suppose that the case is different with the nails of the fingers and toes. We are never told that those personages in the East who preserve the nails of the fingers without paring receive a constant accession to the length of these organs during the whole of their lives. Indeed, we find that, when the paring of the nails of the toes is utterly neglected, although their length becomes inconvenient, it reaches a *ne plus ultra*. In these particulars, therefore, the nutrition of hair, nails and feathers, must be concluded to obey similar laws.

The only question which remains is, How can we suppose the nutriment to be conveyed to all the parts of these organs?—The answer which I return to this question, is, that this matter is sent to the parts by vaporization, and appropriated by hygrometric attraction. The halitus is maintained, and prevented from escaping by various circumstances.

In some of these organs, it is kept up by the close apposition of all their parts to organs which are pervaded by flowing liquids. This is the case with the cuticle and the nails, which lie flat upon the *cutis vera*.

In those organs which are connected with the body by a minute area, such as hairs and feathers, the halitus is retained partly by hygrometric attraction, and partly by the close envelope afforded by their own most superficial stratum. These two properties bear an inverse proportion to one another;

where the one is in a small degree, the other makes up for the deficiency, by being in itself more considerable. The sum-total of retentive powers of moisture thus possessed, may not be strictly equal in all, but proportioned to the degree of adaptation of the different substances to circumstances of external condition.

We are, therefore, to conceive, on the whole, that there is in the interior of all such organs, a constant dampness without any flowing liquidity; and that this dampness contributes to the transmission of all nutritious impregnations; in the same manner in which we find, that the presence of moisture promotes the evolution of those exhalations which announce to the sense of smell certain differences of character in the properties of different animal substances. The quantities of matter thus conveyed must be more minute than those which pass in the state of blood. But the transmission is constant; the assimilating functions of the nourished parts are always active; and we are not authorised to pronounce on the maximum of the proportion which is taken from the transmitted substance for the purpose of assimilation.

The structure, though thus open, must not be conceived to be indeterminate. There are passages of various qualities, through some of which the halitus is conveyed more readily, and through others less. These passages differ not only in width, but in the constitution of their parietes, both with respect to hygrometric properties, and to the degree and kind of their assimilating power. In short, we are warranted to conceive a nutrition to go on in this manner with as exquisite niceness and as rich variety, as by means of circulating liquids. Here, however, we must stop. The particular laws by which the ultimate minutiæ of the process are accomplished, elude our inquiry. But they are not more mysterious in the epidermis, in nails, in hair, and in feathers, on the doctrine which I have ventured to advance, than in the organs in which the circulating apparatus is traced in the most satisfactory manner.

This doctrine, it is obvious, may be also called in to the aid of the physiology of insects and of that of plants. To many of the latter, it will be found indispensably requisite; as, for example, those of the class Cryptogamia, and more especially the tribe of lichens.

If it should occur to any person as an objection, that we know the process of nutrition to be conducted in substances, which show that they possess no hygrometric power, since they rapidly dry, as soon as a communication with the animal body or the vegetable root is cut off; I have only to observe, that this hygrometric power is to be considered as regulated by the living activity, and for the most part depending entirely upon it. This supposition is equally admissible with any other facts of secretion and assimilation, in which we have chemical qualities and effects which owe their existence to living agency.

A doctrine somewhat analogous may be extended to many substances, both animal and vegetable, which are wholly immersed in fluids, of which we have a good exemplification in the submarine tribe of fuci. It is not incumbent on us to presume that, in all such species, a mechanical propulsion of the nutritious fluid must take place, similar to that which obtains in the sanguiferous system of large animals, or even to that which some scanty experiments are considered as having substantiated in certain vegetables. The transmission may be conducted by solution and precipitation alone. The motions may be exactly similar to those in which a saline matter, taken up from the concrete state at the bottom of a liquid solvent, gradually ascends during solution, while the liquid remains steady, its particles either suffering no change of place, or such a change as we may call chemical because it is strictly corpuscular, arising from chemical attraction and communication. It would be unphilosophical to say that nutrition is nothing else than solution and precipitation; yet the local transmission of the nutriment is sufficiently accounted for by this set of causes; and the mechanical propulsion of a body of fluid is not wanted for the completion of our physiological explanations. That such a propulsion in any case occurs, is to be proved by particular experiments, and not inferred from the general nature of the subject.

XIX.—*Observations on the Genus* Picus *of Linnæus, with Descriptions of two New Species from the Interior of Brazil.*

By William Swainson, F. L. S.

(Read 25th March 1820.*)*

The birds composing the Linnæan Genus *Picus* or Woodpecker, form, like a few others, a Natural Group, distinguishable to the most casual observer, and possessing such marked and decided characters, that the best modern ornithologists have refrained from separating them. The *Picus tridactylus* of Linnæus, it is true, possesses only three toes, and on that account has been made a distinct genus by Mr Stevens, in the 9th volume of "General Zoology;" but I am assured by Professor Temminik, whose works must place him among the first ornithologists of the age,—that, from an attentive inspection of a large number of this family in his superb collection, he has found the inner hind-toe to vary so much in size, that in many species it is almost obsolete,—thus tracing the affinity, he considers this character by no means constant; and it is remarkable, that Mr Stevens' *Tridactyla undata* should be described by Brisson with three toes, and figured by Buffon with four *. Future observations, however, will confirm or clear up this point. In the mean time, the descriptions of the two following species of genuine Pici, will add to our knowledge of this interesting family.

PICUS CHRYSOSTERNUS.—*Golden-breasted Woodpecker.*

Specific Character.

P. griseus, albido-fasciatus, capitis lateribus, collo, et pectore aureis, vertice et jugulo nigris.

Grey Woodpecker, banded with whitish, sides of the head, neck and breast, golden-yellow, crown and throat black.

* The Alcedo tribrachys of Shaw, (Azure Kingfisher of Latham) has likewise only three toes, but in all other respects might serve as a type of the genus Alcedo, though, by the same principle of artificial classification, this bird should stand in a genus by itself.

Description.

Total length 12½ inches; bill near 1½ inches, wedged, smooth, black, straight; crown deep glossy-black, which extends to the hind-head, and there ends in a point. At the nostrils begins a whitish stripe, which includes the eye, and then becomes a rich orange-yellow, uniting behind the head, and spreading over the sides and lower part of the neck and breast. A black patch occupies the chin, and throat freckled near the bill with white. Upper part of the body, including the wing-covers, greyish-brown, transversely striated with greyish-white; quills the same, but darker and immaculate; near their tips, the 1st, 2d and 3d shorter than the 4th; the shafts of all golden-yellow; inner wings pale-yellow; rump white; under part of the plumage grey, with brown arrow-shaped lines pointing downwards, two on each feather; upper and under tail-covers equally banded with black and whitish; tail 4½ inches long, and black; the two middle feathers partially banded with dirty yellow; the two outermost pair the same on the exterior web only; the shafts of the last golden in the middle; legs and feet obscure olive. This was a female.

I only observed this rare bird in the dry and arid tracts of table-land in the *Sertem* or inland country of the Province of Bahia. Unlike the rest of its tribe, it has a short plaintive cry while flying, and frequently perches on the tops of the straggling stunted trees, which afford such a contrast to the luxuriant vegetation of the coast. In size, and in the beautiful golden colour of the quill-shafts, it resembles *Picus melanochloros* and *cayanensis*, near which it should be placed. I have seen it in no other collection than my own.

PICUS BRAZILIENSIS.—*Brazilian Woodpecker.*

Specific Character.

P. olivaceus, subtus flavescens, nigro-fasciatus, capite subcristato supra rubra, utrinque lineis olivaceis, fulvis, et rubris.

Olive Woodpecker, beneath tawny, with transverse black striæ, head sub-crested above red, the sides with olive, yellow, and red streaks.

Description.

Total length 9 inches; bill, near one inch, black, very straight, the sides angulated; irides yellow; head above, as far as the nape, crimson; orbits and cheeks olive-brown; beneath this, and commencing from the nostrils, is a narrow line of golden-yellow, terminating with the neck; below this is another stripe, crimson at the base of the lower mandible, and olive beyond, ending with the former, leaving the chin and throat yellow; all the upper parts of the plumage are yellowish-olive, the inner shafts of the quills being black, except the edge, which is pale, rufous, almost their entire length; tail $3\frac{1}{2}$ inches long; the feathers black and immaculate, tinged with olive at their base; breast, body and under parts, tawny-yellow, transversely banded with blackish lines; feet and legs olivaceous; inner wing-covers tawny.

Inhabits the same situations as the former; the only specimen I have found was a male. In classification, it will come near to *P. ictero-cephalus*, under which name, by the way, two very distinct birds are placed.

The Genus *Dendrocolaptes* of Illiger * (the Picacule of the French) have, in all the species I found in South America, precisely the same manners and habits as the *Pici*, climbing the trees with even greater facility, although their feet are those termed *ambulatorii*. The type of this excellent genus is *Gracula cayennensis* of Linnæus. M. Viellot, some years after, without taking any notice

* Caroli Illigeri Prodromus Systematis Mammalium et Avium, Berolini, 1811.

of the previous distinction given to these birds by Illiger, calls their genus *Dendrocopus*, a name evidently borrowed from Illiger; nor is this the only plagiarism committed by an ornithologist whose intrinsic merit requires no such dubious aid to increase his fame.

XX.—*Descriptions of several New or Rare Native Plants, found in Scotland, chiefly by the late Mr George Don of Forfar.*

By David Don.

(Read 8th April 1820.)

Although a few additions to the Flora of one of the regions of Europe, whose vegetable productions are already well known, may not be interesting to botanists in general, yet they nevertheless deserve regard from the botanist who confines himself to the study of the plants of that particular country. To him they are highly interesting, not perhaps on account of their varied beauty and singular form, qualities in which plants of more favoured climes excel, but probably as illustrating certain points of botanical geography, and the relations which the plants of other countries within the same zone bear to those of his own. Those who are well acquainted with the peculiar habitats of plants, will observe some which are confined to a very narrow space, and are sometimes even almost solitary. This curious fact has not hitherto been sufficiently explained. This circumstance, however, occasionally occurs in every region of the globe, in both hemispheres, within the tropics, as well as in the temperate and frigid zones. *Chærophyllum aromaticum*, a native of Austria, Silesia, and other parts of Germany, has also been found in Scotland, although only in one spot, and there but sparingly. The late Mr George Don of Forfar first observed this habitat about twenty-five years ago. *Lychnis alpina*, which is found on the Alps of Lapland, Siberia, Switzerland, and the Pyrenees, has also been detected in Scotland. Although it has hitherto only been observed in one spot, yet I have no doubt that hereafter it will be met with in other parts, considering the many relations which these countries have in common. *Potentilla opaca*, which is found on Mount Baldo, the mountains of Switzerland, Austria, and Germany, is also found in considerable plenty on the Braes of Balquhidder, and other hills in Perthshire.

Many alpine plants were formerly regarded by botanists, as only varieties of those found in the plains, altered by their elevated situations; but, by gradually becoming more minutely acquainted with their characters, we are enabled to establish them, with propriety, as distinct species. Thus, for example, *Myosotis rupicola*, was at first considered only as a variety of *M. scorpioides*,—a heterogeneous species which has very justly been subdivided into several species. Among the pedatifid-leaved Saxifragæ, we are apt to confound many very distinct species, merely on account of the similarity in their external appearance. Thus, for example, in Scotland, *Saxifraga hypnoides* has been confounded with *S. elongella*, and with other two new species, (as I shall have an opportunity of shewing elsewhere).

The Gramineæ form a tribe whose general appearance is very much alike, and on that account many real species have been regarded as mere varieties. The *Poa alpina glomerata* of Hull's British Flora, discovered by the late Mr G. Don, on rocks by the side of the river Esk, about six miles north of Forfar, Angusshire, is the *Poa Badensis* of Willdenow's "Species Plantarum." Although regarded by Wahlenberg as only a variety of *Poa alpina*, yet I have no doubt it will soon be admitted as a distinct species.

Without further preface, I shall now describe several new or rare plants, most of which were first observed by my late Father. The descriptions of these, I have drawn up from the original native specimens preserved in my father's herbarium; and I may mention, that I have seen all of them in a recent state, when originally brought home by him from their native habitats.

1.—Veronica setigera.

Caule repente, racemis lateralibus tenuifloris; pedicellis rectis brevibus; capsula apice integerrima; stylo persistente.

Tota planta pilis rigidis patentibus tecta; caules repentes humi patentes radicantes, florigeris ascendentibus; folia opposita brevi-petiolata ovata utrumque acuta integra medio serrata; racemi laterales stricti tenuiflori, pedicelli recti breves bracteis minutis instructi; flores pallide rosei nervis violaceis striati, segmento superiore et inferiore lineare duobus lateralibus latioribus, foliola calycina elliptica acuta margine ciliata duo, superiora breviora; capsulæ subrotundæ apice integræ nec emarginatæ stylo persistente coronatæ.

This species approaches near to V. officinalis, from which I should have been disinclined to separate it, had not the entire capsule crowned with the persistent style warranted it, notwithstanding it has many other points of distinction from that species; but as distinctions in the fruit are of the utmost importance in so intricate a genus, they are by no means to be disregarded. It is not half the size of V. officinalis; the flowers are also much smaller and paler, and when in flower is beset with stiff rigid spreading hairs. In cultivation, it sometimes alters in size, but its other characters are always permanent. It was found some years ago on dry hilly pastures in Angusshire, by Mr James Smith, nurseryman et Monkswood Grove, near Ayr, a very diligent practical botanist. Mr Hopkirk has described and figured it in his Flora Glottiana under the name of *V. hirsuta.*

2.—Poa stricta.

Panicula ramosa, spiculis 3-floris ovatis; glumis lanceolatis trinervibus subæqualibus mucronatis carinatis, paleis quinquenerviis apice truncatis flosculis basi villosis.

Culmus erectus bipidalis gracilis teres glaber articulatus; folia radicalia anguste-liniaria glaberrima pallide viridia striata margine inermia, caulina brevia pungentia longe vaginantia, vaginis lævibus striato sulcatis; ligula brevissima apice obscindenti lacerato-ciliata; panicula compacta ramosa fusco-rubra ramulis pedicellisque spinuloso asperis, spiculi 3-flori conferti ovati, glumæ subæquales lanceolatæ trinerves mucronatæ carinatæ (carina aspera) margine ciliatæ, paleæ 5-nerviæ apice truncatæ margine scariosæ; flosculi basi villis longis retrofractis tecti. Affinis Poæ pratensi, attamen posterior videtur distincta, spiculos 4-flores, glumas ovato-lanceolatas, 5-nervias, paleas acutiusculas nec truncatas, folia latiora, spiculos majores habere.

This species was discovered many years ago in pastures in Angusshire, by the late Mr G. Don of Forfar.

3.—POA LEPTOSTACHYA.

Panicula contracta subracemosa; pedicellis brevissimis glaberrimis, flosculis 2-floris, glumis lanceolatis mucronatis æqualibus trinervibus, apice incurviis, paleis lanceolatis apice acutiusculis.

Radix fibrosa perennis cæspitosa; culmi decumbentes geniculati teretes lævissimi; folia brevia liniaria, plana nervosa læte-viridia glaberrima margine inermia basi vaginantia, vaginis foliis longioribus glabris striatis; panicula contracta subracemosa depauperata, ramis brevibus, pedicellis brevissimis glaberrimis; spiculæ 2-floræ, glumæ lanceolatæ mucronatæ æquales trinerves (nervis nigrescentibus conspicuis) apice incurvæ dorso carinatæ carina sub microscopum spinuloso aspera, paleæ lanceolatæ apice acutiusculæ, flosculis nudis.

This Poa is totally distinct from any British species, and there is none with which it has a near affinity. Found on the banks of the Tay, to the west of Dundee, by the late Mr G. Don of Forfar, who cultivated it many years, under the name of *P. depauperata*,—a name which I should have wished to retain ; but as it is already applied to a very distinct species, found by Humboldt and Bonpland in Equinoctial America, and described under that name in their "Nova Genera et Species Plantarum," I have been obliged unwillingly to alter it.

4.—CHÆROPHYLLUM AROMATICUM,—Jacq. Aust. t. 150. Matt. Sil. p. 209. Hoffm. Germ. 104. Willd. Sp. pl. 3. p. 1654.

Foliis radicalibus subbipinnatis, pinnis lateo-vatis duplici-serratis, pedicellis involucello brevioribus, fructibus fuciformibus cylindricis obscure striatis.

Caulis erectus ramosus bi vel tri pedalis firmus, foliosus, sulcato-angulatus, hispidus maculatus geniculatus, geniculis tumidiusculis; folia radicalia subbipinnata petiolata, petiolis angulatis supra canaliculatis dorso carinatis, pinnis oppositis imis pinnatis externis simplicibus, late-ovatis acuminatis basi cordatis subtus hirsutis supra rugoso-venosis nudiusculis margine subduplici serratis (serraturis aristatis); caulinis petiolatis, petiolis basi ramis vaginantibus, vaginis subcylindrico-angulatis glabris; umbella laxa plana medio subconcava; pedunculi striati glaberrimi, pedicelli involucello breviores; involucella lanceolata cuspidata (cuspis longis aristæformibus) margine membranaceo lacerato-ciliato purpurascenti, medio viridi uninervo, nervo albo; petala subrotunda alba extus viridia apice fissa; fructus fuciformis cylindricus obscure striatus, stylis brevibus persistentibus coronatus.

This species, hitherto undescribed as a British plant, is found near the village of Guthrie, near the margin of the road leading from Forfar to Arbroath, in Angusshire, where it was first observed by the late Mr G. Don of Forfar. It agrees, in every point, with the figure of it given by Jacquin in his Flora Austriaca. Although the circumstance of the persistent styles crowning the seed after maturity, giving it the appearance of having two awns, is recorded by authors in their specific character; yet it ought not to be admitted, as the same thing is often observed in other species of this genus. The bruised leaves and stem, emit a heavy aromatic odour.

5.—OROBUS TENUIFOLIUS. Roth. Germ. i. 305, ii. 170. Hoffm. Germ. 253.

Foliis impari-pinnatis, pinnis anguste liniaribus supra canaliculatis apice mucronatis; stipulis lanceolatis mucronatis, posticibus bidentatis; racemis paucifloris.

Radix tuberosa, caules decumbentes debiles angulati angulis alatis, folia alterna impari-pinnata, pinnis anguste liniaribus supra canaliculatis nervo-sis subtus hirsutis apice mucronatis externo minutissimo; stipulæ semisagittatæ lanceolatæ mucronatæ margine ciliatæ, posticibus bidentatis; racemi axillares pauciflori; flores lilacini, vexillo alisque striatis.

This plant is very nearly allied to Orobus tuberosus, and is considered by Willdenow as only a variety of it; but as it never changes its characters and habit in cultivation, I have here given it as a distinct species. Orobus tuberosus is distinguished from it, by having lanceolate flat pinnæ, stipulæ ovate, posterior lobes with 3 or 4 teeth; plant taller and stronger, more erect, flowers larger.

This plant was first observed by the late Mr G. Don of Forfar, near Kinnaird, in Angusshire.

6.—Lychnis alpina. Linn. Sp. Pl. 626. Lam. Encycl. iii. p. 613. Willd. ii. p. 809. Ait. Kew. ii. p. 117. E. B. xxxii. t. 2254. L. petalis bifidis fl. corymbosis, Fl. Suec. ii. p. 410. L. petalis bifidis fl. tetragynis, Oed. Dan. lxv. Silene Lapponica alpina, facie viscariæ, Fl. Lapp. N. 185.

Floribus congesto-capitatis, petalis bifidis, unguibus petalorum membranis destitutis glabris; calycibus lævibus.

Planta dense cæspitosa. Radix crassiuscula ramosa fibris tenuissimis numerosis tecta; caules erecti rigidi glabri cylindrici geniculati; folia radicalia liniaria canaliculata (ante anthesin plana) glaberrima, apice acuta basi parum ciliata, caulina opposita basi connata vaginantia, vaginis brevibus; flores subsessiles congesto-capitati bracteati, bracteis floribus subæqualibus; calyx lævis, dentibus calycinis scariosis membranaceis; petala apice bifida, unguibus membranarum destitutis glabris; squamæ coronatæ brevissimæ bi vel tri dentatæ.

Lychnis viscaria differs from this species in the following characters: Radical leaves, much longer, apices obtuse, stem much taller, flowers thin-spiked on short peduncles; bracteæ twice as short as the flowers; calyx rugose; petals entire; claws of the petals furnished with longitudinal membranes at their margins; margins ciliated; squamæ of the crown larger.

This beautiful little plant was discovered many years ago, by the late Mr G. Don of Forfar, who found it on the highest mountains of Clova, Angusshire, on rocks facing the south, near their summits, but very sparingly. The Scotch plant exactly agrees with the figure in Flora Danica, except in the number of pistils, the Scottish specimens having uniformly five: I am fully convinced, that a specific character, taken from the numbers of pistils, must be inadequate. The figure of this species, in English Botany, is tolerably good, considering its having been taken from a dried specimen; the representation in the Botanical Magazine conveys no idea of the plant.

7.—Potentilla opaca. Linn. Sp. Pl. ed. 2. i. p. 713. Willd. Sp. pl. ii. p. 1103. Decand. Flor. Fran. iv. p. 460. Spreng. Fl. Hall. p. 148. Wahlenb. Fl. Carpath. p. 155. M. A. Bieberst. Fl. Taur. Caucas. i. p. 408. Nestler, Monog. p. 55. E. B. vol. xxxv. t. 2449.

Caule decumbente filiformi; foliis radicalibus septennato-digitatis. Foliolis oblongo-cuneiformibus profunde serratis rugoso-venosis pilis setosis patentibus adspersis; stipulis lanceolatis; pedunculis elongatis subunifloris; petalis obcordatis calyce subæqualibus.

Radix ramosa, fibris lignosis instructa; planta cæspitosa; caules plurimi decumbentes filiformes teretes rubescentes ramosissimi piloso-setosi; folia radicalia septennato-digitata longe petiolata rectiuscula; petiolis pilis rigidis patentibus tectis; foliola oblongo-cuneiformia profunde serrata rugosa venosa utrinque pilis setosis adspersa; folia caulina inferiora alterna quinata petiolata, superiora opposita subsessilia; stipulæ lanceolatæ apice obtusiuscula; pedunculi elongati axillares subunifloræ; segmenta calycina exteriora lanceolata acutiuscula ante anthesin laxe patentia, interiora late-ovata acutiuscula ante anthesin imbricata; petala aurea obcordata multinervia (nervis ramosissimis) calyce subæqualia.

This species of potentilla was first discovered in Britain by the late Mr G. Don of Forfar, who found it on the Braes of Balquhidder, and other hills in Perthshire, in considerable plenty.

This species has often been confounded with P. verna, although the habits of the plants are widely different. Potentilla verna is three times smaller, always spreading flat on the ground; the stems are very short and thick; the petals are much shorter; the leaves are quinate, the leaflets obovate, slightly serrated, shining on the upper surface, never rugose; the stem-leaves all alternate, never opposite; stipules ovate, smooth, obtuse; segments of the calyx shorter; petals smaller and paler; the whole plant is slightly clothed with very fine adpressed hairs. The figure given of it in English Botany, is extremely good and accurate. Willdenow is wrong in quoting Hudson for a synonym of P. opaca, Hudson's plant being nothing else than P. verna.

XXI.—*On the Rocky Mountain Sheep of the Americans.*

By Professor Jameson.

(Read 18th April 1819.*)*

The Spanish missionaries in California, so early as 1697, make particular mention of a "remarkable species of sheep" as occurring in that country; and it is again noticed by Venegas, in his History of California. Lewis and Clarke also heard of it, and obtained some skins from the Rocky Mountains. I now present to the Society, a skin of this animal, which was sent from Hudson's Bay, by Mr Auld, formerly of that country, and who obtained it from the Rocky Mountains. It appears to be the Rocky Mountain Sheep of the Americans. A simple inspection of the specimen before us, proves that it cannot be a species of the genus Ovis, and the form of the horns, and shape of the body, will not allow of its being placed with the Capræ or goats; while its form, beard, and fur, remove it from the genus Antelope. We are of opinion, that it forms a species of a genus intermediate between the antelope and goat. On examining the fleece, I was particularly struck with its uncommon fineness; and it occurred to me, that an animal inhabiting the temperate regions of the Rocky Mountains, with so valuable a fleece, might be easily procured, and readily introduced into this country, and form a valuable addition to our wool-bearing animals. Strongly impressed with this view, I now beg leave to suggest to the Society, providing they agree with me in opinion as to the value of this animal, to take steps for procuring live specimens from America, in order to make the experiment of introducing it into Scotland.

The Society having taken this proposal into consideration, appointed a committee of its members to consult with the Directors of the Highland Society of Scotland, on this important proposal; and also to request Mr Thomas Laurie, who has long been distinguished for his intimate aquaintance with rural affairs, to report as to the value of the wool, &c.

The following is the report of Mr Laurie.

Remarks for the Wernerian Society on the Skin of the Rocky Mountain Sheep.

The skin submitted to us, is, in the minutes of the Society, denominated that of "The Rocky Mountain Sheep;" and, from the wool with which it is covered, it may certainly be considered as nearly allied to that genus of quadrupeds, though, had it wanted this woolly covering, we would probably have been inclined to consider it as more allied to the goat. The general figure of this skin is very different from that of any sheep's skin I have ever seen. The difference is perhaps most remarkable in the length and figure of the neck, which, in no slight degree, resembles that of a thorough bred horse. The general structure of the head, externally viewed, does not appear to vary from that of other sheep, more than might be ascribed to accidental circumstances. To this remark, however, the horns form a remarkable exception. Their position is very different from what is observed in the common sheep. Their curvature is also different,—circumstances which deserve more particular notice, on account of their being connected with other important diversities of character: These are the smoothness of the horns, and their circular, or rather conical shape,—two particulars in which they differ from the horns of every species of sheep with which either history or observation has made us acquainted. The blackness of the horns, compared with the whiteness of the wool, may also be mentioned, though, in other circumstances, unworthy of notice. The legs, too, of this skin, are covered with longer and coarser hair than what is to be found on those of the common sheep. The horns resemble those of a common goat, more than of a sheep, in regard to position, colour, and texture. But the goats horns are flat on the under part, or that next the neck, so as to form the side of a pyramid. In other respects they are conical. The horns of the Rocky Mountain Sheep are completely conical, and in shape resemble the horns of an ox more than those of either a goat or any of the varieties of sheep.

There is another circumstance of apparent resemblance to the goat, which may be noticed. The skin exhibited has a ridge of hair along the back, considerably longer than the general covering, which is continued up the neck, in the form of a mane, thicker and longer than that on the back. It has also a thick long beard, and a space on each quarter covered with long shaggy hair. In these particulars, there is a resemblance to the male of the common goat; and I think it probable the skin belongs to the male sex. In the length of the neck, compared with that of the body, there is also a resemblance to the common goat. But, in all these points of resemblance, there are specific differences, which a comparison would best illustrate.

The wool forming the principal covering of the skin, is a strong reason for not classing the animal with the family of goats. It is no doubt true, that the goat of the East, yields a fur in many respects resembling wool; and it may be difficult, in some cases, to distinguish between hair and wool, especially from small specimens. But, in judging from any considerable quantity, such as the covering of a whole skin, there would be little difficulty in determining whether the substance should be called hair or wool; and, so far as I know, there is no good authority for any species of goat ever having been found with a covering wholly or chiefly of wool.

It may be unnecessary to enlarge farther upon the classification of the animal, as the question cannot be satisfactorily decided without the possession of a living specimen.

The skin seems to be that of a full grown animal. A number of observations might be offered in illustration of this opinion. But it may suffice to state, that the horns and general aspect of the head, have all the appearances of maturity. The teeth, in particular, are evidently fully grown, and such as are observed in a sheep upwards of three years old. Four of them, on one side, are more or less broken, which may have occurred either from accident or age.

The wool, which forms the chief covering of the skin, is fully an inch and a half long, and is of the very finest quality. It is unlike the fleece of the common sheep, which contains a variety of different kinds, suitable to the fabrication of articles very dissimilar in their nature, and requires much care to distribute them in their proper order. The fleece under consideration is wholly fine. That on the fore part of the skin has all the apparent qualities of fine *wool.* On the back part, it very much resembles *cotton.* The whole fleece is much mixed with hairs; and, on those parts where the hairs are long and pendant, there is almost no wool.

The wool, if separated from the hairs, would, I think, be adapted for the finest purposes of manufacture. But, in its present state, it could not be so applied, though many of the hairs would fly off in the manufacturing processes. It is, however, highly probable, that, by a careful selection of breeding stock, the hairs might, in a great measure, or perhaps entirely disappear in the course of a very few generations. It has always been observed, that where sheep have been neglected, their wool has been comparatively coarse; and wherever they have been properly treated, and due advantage taken of the accidental finer varieties, the quality of their wool has been proportionally ameliorated. Indeed the improvement in the qualities of wool has uniformly been marked as keeping pace with the progress of arts and civilization. I am, therefore, of opinion, that the wool of the Rocky Mountain Sheep would soon become a great acquisition to the manufacturers of this country, were the animal which yields it, to experience the judicious treatment of many British flocks; and there can be no doubt, that such an experiment would be well worth trying. Under this impression, I cannot help expressing a wish, that the Society, to whose consideration these remarks are submitted, would exert their influence for accomplishing an object which may prove of national importance.

At the same time, it is proper to observe, that sheep are not to be considered as valuable for their fleece alone. They merit attention as furnishing *food* as well as *clothing* to man, and any particular race is of value only in so far as these important objects are combined. How far the Rocky Mountain Sheep might prove useful as furnishing food, I have had no opportunities of ascertaining. As to the value of the wool, if obtained in purity, there seems no room for doubt; and I may state, that I have shewn specimens to different wool-dealers, all of whom expressed their admiration of their quality, and even an anxiety to purchase. From these specimens, however, it may be fair to add, the hairs had been in a great measure extracted.

It may be mentioned, in conclusion, that it cannot be known from the skin exhibited, whether or not the Rocky Mountain Sheep produces what dealers would call *long wool*. The longest observed on the skin is scarcely exceeding two inches, being about one-half the usual length of the full-grown fleeces of the mountain sheep of Great Britain, or what is called the carding and clothing wool, which is even much shorter than the combing sort used for worsted stuffs, &c. The comparative shortness, however, of the wool under consideration, proves nothing. Sheep cast their wool annually, if not shorn, and a new coat springs up. This generally takes place in this country about the month of June. If, therefore, the animal which produced the wool under consideration, was killed soon after casting its old wool, the new wool would not be at its full growth. This, too, is a point which could best be determined by procuring living specimens of the animal, and observing their habits and changes.

THOMAS LAURIE.

STOCKBRIDGE,
16*th April* 1818.

Professor Jameson's proposal having been submitted to the Directors of the Highland Society, they expressed their willingness to co-operate, and appointed a Committee to confer with a Committee of the Wernerian Society on the business; and it is in contemplation, to communicate with the Right Honourable the Earl of Dalhousie, (a Vice-President of the Society, and now Governor-General of Canada), and request the good offices of that patriotic nobleman towards the sending home of living specimens of the animal.

XXII.—*On the Bed of the German Ocean, or North Sea.*

By Robert Stevenson, Esq. F. R. S. E. & M. W. S.
Civil Engineer.

(Read 8th April 1820.)

In a former paper, I had the honour of laying before the Society, a pretty full account of the wasting effects of the sea upon the margin of the land, on all the shores of Great Britain, and a part of Ireland. From personal observation since the date of that paper, (read 2d May 1816, and inserted in vol. ii. p. 464. of the Society's Memoirs,) I have been enabled to add many striking examples bearing upon the same point, not only on the British coast, but as referable to all quarters of the globe; the result of which is, that the encroachment of the sea upon the land, may be received as a general principle. On account of the details already given in the former paper, it might appear tedious and unnecessary to enumerate these additional instances; and I shall therefore content myself with referring to it, in so far as regards the wasting effects of the sea, and proceed to notice the particular tendency of these upon the bed of the German Ocean or North Sea; and endeavour to account, agreeably to the laws of Nature, for the immense quantity of water which must thus be displaced by the deposition of debris, and the consequent elevation of the bottom of the sea.

We are therefore to view the ocean as the great receptacle for the waste of the globe, produced not only by the direct effects of the sea on the margin of the land, but also by the more latent effects arising from the changes of the atmosphere, acting, to a certain extent, in mouldering away the firm ground, which is afterwards transferred to the bed of the ocean. At first sight, the deposition arising from this process, may appear to be a trivial quantity, compared with the great expanse of the ocean; but if we confine our attention to the bed of the North Sea, we find, in the course of our inquiries, that it is by no means so inconsiderable. Great Britain alone, is estimated to contain about 20,000,000 acres of cultivated land; and it is further estimated to possess an extent of about 25,000 miles of principal roads, which expose a surface of upwards of 1000 acres to the constant action of the weather, and to the wearing of carriages. Now, when we consider that every river and rill of water, after the slightest shower of rain, is charged with mud, and that the furrows of every field are silted up with the finer particles of the soil, the quantity of debris which is annually carried from all quarters of the globe into the ocean must be altogether astonishing. We cease, therefore, to be surprised, when we come to calculate the contents of the various extensive sand banks which are found almost universally to pervade and encumber the bottom of the North Sea.

Our knowledge of the bottom of the ocean, however, remains still very imperfect; and, with little exception, the simple apparatus of the mariner, consisting of a plummet and line, continues to be chiefly in use for ascertaining the depth of the sea, and the nature of the ground. With these, and the addition of a little grease applied to the lower extremity of the plummet, which strikes against the bottom, we learn the quality of the soil, though imperfectly, by the particles which adhere to the grease.—What the navigator has yet been able to discover regarding the depth, and the nature of the bottom of the German Ocean, I shall now endeavour to notice, being myself enabled to offer the result of a pretty extensive acquaintance with this field of inquiry.

It may be necessary to premise, in treating of a subject so extensive, and in comparing great things with small, that we are obliged to speak of the North Sea as a bay or basin, and of the immense

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collection of debris which we meet with, extending over a great proportion of its bottom, under the common appellation of Sand-Banks. We must also be allowed to consider the undulating line, or the irregularities of the bottom, to arise chiefly from the accumulation of deposited matters; and, in most of the situations connected with these banks, we are supported and borne out in this conclusion, by their local positions relatively to the openings of friths, and the line of their direction in regard to the set or current of the ebb-tide.

The accompanying Map (Pl. XIV.) of the eastern coast of Great Britain, with the opposite Continent, though upon a small scale, exhibits numerous soundings of the depth of the German Ocean; and the sections delineated on it, will perhaps be found to give a pretty distinct view of the subject. This chart extends from the coast of France, in latitude 50° 57′ to 61° N. On the east, this great basin is bounded by Denmark and Norway, on the west by the British Isles, on the south by Germany, Holland and France, and on the north by the Shetland Islands, and the Great Northern or Arctic Ocean. The term *German Ocean,* though in very common use, is certainly not so comprehensive in its application to this great basin, as that of *North Sea,* now more generally used by the navigator. The extent of this sea from south to north, between the parallels of latitude quoted above, is 233 leagues, and its greatest breadth from west to east, reckoning from St Abb's-Head, on the coast of Scotland, to Ring Kiobing Froid, on the opposite shore of Denmark, is 135 leagues. The greatest depth of the water in this basin, seems to be upon the Norwegian side, where the soundings give 190 fathoms; but the mean depth of the whole may be stated at only about 31 fathoms.

To be more particular with regard to the depth of the German Ocean, or North Sea, it will be observed by the sections and soundings marked upon the chart, that the water gradually deepens as we sail from south to north. The first of these sections which we shall notice, is on the parallel of 3 degrees of east longitude, running from Ostend to the latitude of the northmost of the Shetland Islands, being an extent of 227 leagues. The depth, as will be seen from this section, (which, to avoid confusion in the body of the chart, is traced along the western side of it,) varies rather after an irregular progression, from 120 fathoms towards the northern extremity of this sectional line, to 58, 38, 24 and 18 fathoms, as we proceed southwards, to within five miles of the shore, nearer which we do not approach in our remarks regarding the soundings. Notwithstanding the irregularity of the depth, from the occurrence of numerous sand-banks, it is curious to observe the increase upon the whole, as we proceed from south to north, by which this sea exhibits all the characteristic features of a great bay, encumbered with numerous sand-banks.

In the same manner, though not strictly connected with our present purpose, we may observe, that the English Channel deepens progressively from Dover to its entrance, formed by the Land's-End of England and the Isle of Ushant, on the coast of France; so that the Strait between Dover and Calais may be said to form a point of partition between two great inclined planes, forming the bottom of these seas.

Besides the longitudinal, or north and south sectional line described above, we have also six other sections delineated in an easterly and westerly direction, across the accompanying chart, which are as follow. One between the Shetland Islands and the coast of Norway; a second between Tarbetness in Ross-shire and the Naze of Norway; a third extends from the Frith of Forth to the coast of Denmark; a fourth from the mouth of the river Tyne to Sylt Island, also in Denmark; a fifth from Flamborough-Head, in Yorkshire, to the mouth of the river Elbe; and the sixth is from Yarmouth to Egmond-op-Zee, on the coast of Holland.

On examining the accompanying cross sections, of the depths of water on the same parallel, they will be found to vary considerably. It may, however, be stated as a general conclusion, that there is a greater depth of water on the eastern and western sides of the German Ocean, than its cen tral parts, and that, upon the whole, it is deeper on the British, than on the continental shores, the coast of Norway excepted.

We have already observed, that this sea is much encumbered with sand-banks, or great accumulations of debris, especially in the middle or central parts, and also along the shores towards what may be termed the apex of the bay, extending from the river Thames, along the shores of Holland, &c. to the Baltic. One of these great central banks, delineated on the chart, and known to mariners as the Long Forties, trends north-east in the direction of the ebb-tide from the entrance of the Frith of Forth, no less than 110 miles, while the Denmark and Jutland banks may also be traced on the chart from the entrance of the Baltic, upwards of 105 miles in a north-western direction. Besides these, we have also another great central range of banks, which is crossed by no fewer than four of our sectional lines. These are known under the common appellation of the Dogger Bank, which is subdivided by the navigator into the Long-Bank, the White-Bank, and the Well-Bank, including an extent of upwards of 354 miles from north to south. There are also a vast number of shoals and sand-banks, lying wholly to the southward of our section, between Flamborough Head and Heligoland. Altogether, therefore, the superficies of these extensive banks is found to occupy no inconsiderable portion of the whole area of the German Ocean; the surface of which, in making these investigations, has been estimated to contain about 153,709 square miles, while the aggregate superficial contents of the sand-banks alone, amount to no less than 27,443 square miles, or include an area of about $5\frac{3}{4}$ of the whole surface of the North Sea.

But to render these dimensions a little more familiar by comparison, we may notice, that the Island of Great Britain contains about 77,244 square miles, being not quite one-half of the area of the North Sea; so that the area of the Sand-banks bears a proportion equal to about one-third of the whole *terra firma* of England and Scotland; and they are, therefore, perhaps, far more considerable in their extent than has been generally imagined.

In speaking of the dimensions of sand-banks situate in the middle of the ocean, we are aware that great allowance must be made in forming a proper estimate of their extent, especially in speaking of their cubical contents. From a vast number of observations and comparisons relative to this subject, I have, however, been enabled to determine, that the average height of these banks measures about 78 feet, from a mean taken of the whole. In ascertaining their height above the surrounding bottom, the measurement has been taken from the general depth around each respectively. Now, upon taking the aggregate cubical contents of the whole of these immense collections of debris, supposing the mass to be uniformly the same throughout, it is found to amount to no less a quantity than 2,241,248,563,110 of cubic yards, being equal to about 14 feet of the depth of the whole German Ocean, or to a portion of the firm ground of Great Britain, on a level with the sea, taken 28 feet in perpendicular height or depth, supposing the surface to be a level plane.

These calculations at least tend to shew, that an immense body of water must be displaced, in consequence of these banks occupying so very considerable a proportion of the bed of the North Sea, the unavoidable effect of which must give a direct tendency to the tidal waters, and the flux produced by storms in the Atlantic, to overflow the bed of the German Ocean, in the same manner as if stones or other matter were thrown into a vessel already nearly brimful of water. This may further be illustrated by considering the actual state of any of the great inland lakes, as those of Geneva, Lochness, Lochlomond, &c. which for ages past have been receiving the debris of the surrounding mountains. We must doubtless allow that they contain a smaller portion of water, or are actually of a less depth than they were at an earlier period of the history of the globe. Accordingly, from inquiries, which, in the prosecution of this subject, I have been led to make regarding the two last mentioned lakes, it has satisfactorily appeared that their waters are subject to overflow or rise upon their banks. On Lochlomond, in particular, the site of a house at the village of Luss was pointed out to me, which is now permanently under *the summer-water-mark,* while the gable of another house in its neighbourhood is in danger of being washed down by the increase of the waters of the loch. Whether this striking appearance (an account of which I laid before the Society in the session of 1818,) is to be attributed wholly to natural causes, or partly to artificial operations upon the bed of the River Leven, flowing from the loch, I have had no opportunity of inquiring. But the great bench or flat space around the margin of the loch, which is left partly dry during summer, fosms altogether such a receptacle for debris, as to be sufficient to affect the surface of the loch, and indeed permanently to raise its waters. We also infer, though by a different process, that the constant deposition going forward in the bed of the German Ocean, must likewise displace its waters, and give them a tendency to enlarge their bed and to overflow their banks or boundary.

In this view of the subject, it will appear that we have not only to account for the supply of an immense quantity of debris, but we must also dispose of the water displaced by the process of deposition which is continually going forward at the bottom of the ocean.

With regard, then, to the supply of the debris of which these banks are composed.—We find that a very great portion of it consists of siliceous matters in the form of sand, varying in size from the finest grains to coarse bulky particles, mixed with coral and pounded shells, the quantity of these calcareous matters being altogether astonishingly great; and being specifically lighter than the particles of sand, the shells generally cover the surface of these sunken banks. With regard to the vast collection of siliceous particles connected with the banks, our surprise ceases when we consider the receptacle which the North Sea forms, to an almost unlimited extent of drainage from the surrounding countries, as before noticed, on which the change of the seasons, and the succession of rain and of drought upon the surface of the earth, are unceasingly producing their destructive effects. All have remarked the quantity of mud and debris with which every rill and river is charged, even after the gentlest shower, especially wherever the hand of the agriculturist is to be found. His labours in keeping up the fertilizing quality of the ground, consist in a great measure in preparing a fresh matrix for the chemical process or the germination of the seeds of the earth, in lieu of that portion of the finely pulverised soil which the rains are perpetually carrying to the sea, as the grand receptacle and storehouse of nature for these exuviæ of the globe. From the effect of rills and rivulets, we should, perhaps, be apt to expect a greater deposition in the bed of sheltered bays and arms of the sea, than we really observe. So that we can readily believe that the quantity of debris, even for a single year, along such an extent of coast, may bear some consideration in respect to the bed of the German Ocean; what, then, must these effects amount to, in the lapse of ages?

Whatever be the cause, the fact is certain, that on almost every part of the shores of Great Britain and Ireland, and their connecting islands, from the northmost of the Shetland to the southernmost of the Scilly Islands, and also upon the shores of Holland, and part of France, particularly in the neighbourhood of Cherbourg, this wasting effect is going forward. These shores I have myself examined. But my inquiries have not been confined to the coasts which I have personally visited, having also, through the kind attention of some nautical friends, been enabled to extend my investigations even to the remotest parts of the globe. The general result has been, that, equally in the most sheltered seas, such as the Baltic and Mediterranean, and on the most exposed points and promontories of the coasts of North and South America, and the West India islands, abundant proofs occur, all tending to shew the general waste of the land by the encroachments of the sea. Such wasting effects are quite familiar to those locally acquainted with particular portions of the shores; and I have often received their testimony to these facts, as the sad experience of the removal of buildings, and the inundation of extensive tracts of land by the encroachment of the sea.

Indeed, by a closer inquiry into this department of the subject, we shall, perhaps, find ourselves rather at a loss to account for the *smallness* of the quantity of this deposition, considering the waste which is constantly going forward in the process of nature, and even be led to seek for its wider distribution over the whole expanse of the bed of the ocean, as has been supposed in that theory of the globe, so beautifully and so ably defended by our late illustrious countryman Professor Playfair.

One of the most striking and general examples of this kind may perhaps be found in the abrupt and precipitous headlands and shores which we every where observe along the coast, and which we suppose to have once been of the same sloping form and declining aspect with the contiguous land. In the production of these effects alone, an immense quantity of debris must have been thrown into the bed of the ocean. The channels which are cut by the sea in the separation of parts of the mainland, and the formation of islands, no doubt make way for a considerable portion of the displaced fluid; but still these channels, when filled with water, come far short, in point of bulk, when compared with the portions of the elevated land which are thus removed. Now, it has been alleged by some, that while the land is wasting at certain points, it is also gaining in others; and this is a state of things which is freely admitted to take place in various quarters; yet these apparent acquisitions are no more to be compared with the waste alluded to, than the drop is to the water of the bucket. But accurate observations regarding the formation of extensive sand-banks, and the accumulation of the debris, of which they are formed, are not to be made in a few years, perhaps not in a century, nor indeed in several centuries; for although the short period of the life of man is sufficient to afford the most incontrovertible proofs of the waste of the land where we become observers, yet when we extend our views to the depths of the ocean, and speak of the events and changes which are there going forward, we must not be supposed to set limits to time.

We have many convincing proofs in the natural history of the globe, that the sea has at one time occupied a much higher elevation than at present. On the banks of the Frith of Forth, near Borrowstounness, for example, I have seen a bed of marine shells, which is several feet in thickness, and has been found to extend about three miles in length, and which is now situate many feet above the present level of the waters of the Forth. A recent illustration of this subject occurred also in the remarkable discovery of the skeleton of a large whale, found on the lands of Airthrey, near Stirling. The present surface of the ground where the remains of this huge animal were deposited, having been ascertained (by my assistants, when lately in that neighbourhood) to be no less that 24 feet 9 inches above the present level of the Frith of Forth at high water of spring-tides. Now, whether we are to consider these as proofs of the higher elevation of the waters of the ocean in the most general acceptation of the word, at a former period, I will not here attempt to enquire. But aside from these anomalous appearances, there is reason for thinking, that the waters of the higher parts of the Frith of Forth, like those of the Murray Frith, may at one time have formed a succession of lakes, with distinct barriers, as we find in the case of Lochness, and the other lakes forming the track of the Caledonian Canal. My object on the present occasion, however, is simply to notice the wasting effects of the North Sea upon the surrounding land, its deposition in the bottom of the sea, and the consequent production of surplus waters at the surface, and to endeavour to account for these appearances consistently with the laws of nature. The opinion accordingly which I have formed, and the theory which I have humbly to suggest, (for I am not aware that this subject has been before particularly noticed), is, that the silting up of the great basin of the North Sea, has a direct tendency to cause its waters to overflow their banks.

Referring to the chart, we find that the North Sea is surrounded with land, excepting at two inlets or apertures, the one extending about 100 leagues between the Orkney Islands and the Norwegian coast, and the other between Dover and Calais, which is of the width of 7 leagues. The aggregate *water-way* of these two passages forms the track for the tidal waters, and also for the surplus waters produced during storms which affect the Atlantic and Arctic Oceans. It is also obvious that this water-way must remain nearly the same, and admit a constant quantity; or, to speak more correctly, by allowing these inlets to follow the general law, they must be enlarged by the waste or wearing of their sides, in a ratio perhaps greater than the silting up of the bottom in those particular parts, while the anterior and central portions of the German Ocean are continually acquiring additional quantities of debris, along with the drainage water of the widely surrounding countries. If therefore the same, or a greater quantity of tidal and surplus waters continue to be admitted from the Atlantic and Arctic Seas into this great basin, where the deposition is constantly going forward, it is evident that the surface of the German Ocean must be elevated in a temporary and proportionate degree, and hence the production of those wasting and destructive effects which are every where observable upon its shores.

This reasoning is also applicable, in a greater or less degree, to all parts of the world; for as the same cause every where exists, the same effects, when narrowly examined, must every where be produced. In the Southern or Pacific Ocean, we have wonderful examples of great masses of land formed by madrepores and extensive coral banks, which in time assume all the characteristic features of islands. These occupy considerable portions of the watery bed of the ocean, and displace corresponding portions of the fluid. Immense quantities of mud are also said to be deposited in the Yellow Sea of China, in the great deltas formed at the mouths of the Ganges, the Plate, the Amazons, the Missisippi, the St Lawrence, the Nile, the Rhine, and other large rivers, whose joint operation both at the surface and bottom of the ocean, are continually carrying forward the same great process of displacing the waters of the ocean; for it matters not to this question whether the debris of the higher country which are carried down by the rains and rivers, or are occasioned by the direct waste produced by the ocean itself on the margin of the land, be deposited at the bottom or surface of the ocean; they must still be allowed to displace an equal or greater bulk of the fluid, and have therefore a direct tendency to produce the derangement which we are here endeavouring to describe.

A striking illustration of this doctrine may be drawn from M. Girard's able and ingenious observations on the delta of Egypt, made in 1799, and published in the *Mem. de l'Acad.* for 1817, in a memoir *Sur la Vallée d'Egypte, et sur l'exhaussement séculaire du Sol qui la recouvre.* It appears that the whole soil of the "Valley of the

Nile" is very considerably increased by the alluvium deposited annually by the inundations of the river, as ascertained by the marks on some ancient nilometers and statues, the dates of which have been traced and compared by Girard, with the corresponding historical periods. In the quarter of Thebes, where the statue of Memnon is erected, the increase of the soil since the commencement of the Christian era, is $1^{m}.924$ (6 feet 3.7 inches), or this process may be stated as going forward at the rate of $0^{m}.106$ (4.17 inches), in the course of each century. The magnitude of the deposites at the mouths of the Nile in the bed of the Mediterranean appears to be no less surprising. It is remarked, that the Isle of Pharos, which, in the time of Homer, was a day's journey from the coast, is now united to the continent.

If, then, we compare these effects with the same process, going forward in a certain proportionate rate over all parts of the globe, and where the same facilities for these depositions being made on firm ground are not afforded, we shall find that the quantity of deposite in the bottom of the ocean must be so considerable as to affect the level of the waters of the ocean.

In thus disposing of the waste of the surrounding land beyond the accumulation of the sunken banks of the German Ocean, we are not left at any loss for a distributing cause, as this is provided by the tides and currrents of the sea; and with regard to their action, we have many proofs, even at very considerable depths, by the breaking up of the wrecks of ships, the occasional drift of sea-weed, and also drift timber, nuts, &c. into regions far distant from those in which they are spontaneously produced. The dispersion of fishes, evinced by their disappearance from the fishing grounds in stormy weather, tends to shew the disturbance of the waters of the ocean to the depth of 30 or 40 fathoms. This observation I have frequently had an opportunity of making near the entrance of the Frith of Forth. Numerous proofs of the sea being disturbed to a considerable depth have also occurred since the erection of the Bell Rock Lighthouse, situate upon a sunken rock in the sea, 12 miles off Arbroath, in Forfarshire. Some *drift stones* of large dimensions, measuring upwards of 30 cubic feet, or more than two tons weight, have, during storms, been often thrown upon the rock from the deep water. These large boulder-stones are so familiar to the lightkeepers at this station, as to be by them termed *travellers*. It is therefore extremely probable, that a large portion of the debris is carried down with the drainage water of the higher country, as before noticed, and ultimately washed out of the North Sea into the expanse of the ocean.

The question which naturally arises as to the result of all this waste or transposition of the solid matters of a large portion of the globe, is, What has become of the body of water displaced by this wasting process? Without attempting to go into all the minutiæ of this part of the subject, I shall here briefly observe, that there seems to exist (if I may be allowed so to express myself) a kind of compensating arrangement between the solid or earthy particles of the globe in the one case, and the waters of the ocean in the other. Thus by the process of evaporation, and the universal application of water, which enters so largely, in its simple or chemical state, into the whole animate and inanimate creation, the surface of the ocean may be kept nearly at a uniform level. Phenomena of this description are, no doubt, difficult in their solution upon the great scale, being met by the process of *decomposition*, which resolves bodies into their constituent parts, and also by our theory of the atmosphere, by which its limits and operations are determined. But were we to abstract our attention from the more general view of the subject, and confine our inquiries to the German Ocean, the Baltic, the Mediterranean, the Red Sea, or to any other inland and circumscribed parts of the ocean, this difficulty seems to be lessened. Indeed, the probability is, and it is a pretty generally received opinion, that a greater quantity of water is actually admitted at the Straits of Gibraltar and of Babelmandel, than flows out of the Mediterranean and Red Seas. We consider water, therefore, as the great *pabulum of nature*, which, as before noticed, enters either simply or chemically into the constitution of all bodies, and appears to be held, almost exclusively, in solution, in the formation and maintenance of the whole animal and vegetable kingdoms, and is found to exist largely in the composition of all mineral substances. The quantity of water, consequently, that is required, and is continually supplied from the ocean by the process of evaporation, both for the support and reanimation of nature, must be immense, and may of course be supposed permanently to absorb a very large proportion of the surplus waters of these circumscribed seas, while the remaining portion of surplus water, if not thus wholly accounted for, may be distributed over the general expanse of the ocean.

But if we suppose with some, that in nature there is neither an excess nor diminution of the waters of the globe, and that the united and counterbalancing processes of evaporation, condensation, decomposition, and regeneration, so completely equalize each other, that the surplus waters, arising from the displacement of a portion of the solid surface of the globe, must again be wholly distributed and intermixed with the waters of the ocean, the portion of water remaining thus to be accounted for becomes more considerable, and, upon the great scale, must be permanently disposed of, independently of the process of evaporation.

Another view has been suggested as applicable to the distribution of the surplus waters produced by the gradual filling up of the bed of the ocean. These waters, in place of being elevated in any sensible degree, may be naturally disposed to find their level in the great Polar Basins, or oblate portions of the surface of the globe which are known to exist next the poles. The oblate figure of the earth at the poles makes these imaginary points the nearest to the centre of the earth, and consesequently, with regard to level, they are also the lowest. It therefore appears to follow, that any filling up of the bed of the sea near the equator, or at a distance from the poles, will have the effect of promoting the retiring of the surplus waters to the polar regions by their own gravity, while the centrifugal force occasioned by the earth's diurnal motion, will prevent their being farther removed from the equator, without a corresponding elevation of the waters in the great polar basons.

In this manner, such an accumulation of water may, at a former period of time, have taken place at the then Poles of the Globe, as to have altered the position of these points, and given rise to the Flood or temporary general overflowing of the waters over the earth's surface, producing a change in the beds of the seas or oceans of former times. In this way may have been produced many of the phenomena observable in the crust of the earth.

which are otherwise with much difficulty accounted for.

Of what has now been advanced, regarding the waste of the land by the operations of the sea, it will be proper to notice, that much consists with my own personal observation. The consequences of this process must be the deposition of debris, and a tendency to raise the bottom of the ocean, and produce a proportional elevation of the water. With regard, however, to the distribution of the surplus waters that is produced, what I have now said is offered with much deference, in hopes that some one better qualified than myself will turn his attention to this curious subject.

XXIII.—*Additional Observations on the Connection between the Primitive Forms of Minerals and the Number of their Axes of Double Refraction.*

By David Brewster, LL. D. F. R. S. Lond. and Sec. R. S. Edin.

(Read 5th August 1820.*)*

In a paper printed in another part of this volume, I have pointed out the connection between the primitive forms of Crystals, as determined by Haüy, and the number of their axes of double refraction.

In attempting to assign a reason why particular forms should be distinguished by a particular number of axes, I found that the only exception to the generality of the principle existed in the case of the *Right Prism* with a square base, which, in reference to the general hypothesis, ought to have had only one axis of double refraction and polarisation. As most of the crystals, however, to which Haüy assigned this as the primitive form, such as *Chromate of Lead, Mesotype, Sulphate of Magnesia*, &c. had actually TWO axes, while *Idocrase* and *Titanite* had only ONE, I was compelled to suppose that these two last crystals must belong to a different primitive form, though I at the same time remarked, on the strength of the general principle, " That it was within the limits of probability that all the crystals which I had ranked under the Right Prism might have another Primitive Nucleus."

This opinion ceased to be a conjecture, when I found that the primitive form of *Mesotype* and *Needlestone* was a *Right Prism with a Rhombic Base;* and it acquires additional probability when *Chromate of Lead* was found by M. Soret to have an *Oblique Rhomboidal Prism* for its fundamental Crystal *.

As all the mineral bodies, therefore, which I had arranged under the *Right Prism with a Square Base,* have been removed to other primitive forms, the general explanation which I have given in my former paper †, is now without an exception; and the First Class of Primitive Forms will now include the *Right Prism with a Square Base,* and will stand thus:

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* This had formerly been the opinion of Bournon; (see his *Catalogue,* p. 355.) and Haüy now considers it as correct. See *Annales des Mines,* 1818, tom. iii. p. 479.

† See page 68.

First class of primitive forms.

crystals with one axis.

1. *Rhomboid with obtuse Summit.*

Carbonate of Lime.
Carbonate of Lime and Magnesia.
Carbonate of Lime and Iron.
Carbonate of Manganese.
Tourmaline.
Rubellite.
Ruby Silver.

2. *Rhomboid with acute summit.*

Corundum.
Sapphire.
Ruby.
Cinnabar.

3. *Regular Hexahedral Prism.*

Emerald.
Beryl.
Phosphate of Lime.
Nepheline.
Arseniate of Copper.

4. *Octohedron with a Square Base.*

Zircon.
Mellite.

Molybdate of Lead.
Oxide of Tin.
Octohedrite.
Tungstate of Lime.

5. *Right Prism with a Square Base.*

Idocrase.
Titanite.
Meionite.
Uranite*.
Wernerite.

6. *Bipyramidal Dodecahedron.*

Quartz.
Phosphate of Lead.

As Crystals with one axis of Double Refraction are divisible into two great classes, viz. *Positive* and *Negative*, according to the nature of the action which they exercise upon the extraordinary ray, I was anxious to ascertain if any relation existed between this character and their primitive form. Although no general relation has presented itself, yet it is worthy of remark, that *not one positive crystal is found in the three first primitive forms;* and that *the three last contain both positive and negative crystals.*

* This mineral has a very weak double refraction. In consequence of its imperfect transparency, I was formerly obliged to use very thin plates of it; and as its axis is perpendicular to the laminæ, the double refraction was not then perceptible.

The new and beautiful system of crystallography, proposed by Professor Mohs of Freyberg, and of which a general account has been published in the 5th number of the *Edinburgh Philosophical Journal,* harmonises in a very singular manner with the optical arrangement of minerals*.

M. Mohs divides crystals into four great Series, viz.

1. The Rhomboidal system.
2. The Pyramidal system.
3. The Prismatic system.
4. The Tessular system.

None of these forms are capable of being derived from one another, and therefore each of them, as well as their combinations, must remain entirely distinct from the rest.

The following Table will point out the relation between the Primitive Forms of Haüy, the Fundamental Forms of Mohs, and the classes derived from the number of axes of Double Refraction.

* It is peculiarly remarkable, that M. Mohs' system renders it necessary, that the right quadrangular prism with a square base should be transferred to the First Class of Primitive Forms, and placed beside the octohedron with a square base.

Tabular

Tabular Comparison of Haüy's Primitive Forms, with Mohs's Fundamental Forms, and the Classes derived from the number of Axes of Double Refraction.

Haüy's Primitive Forms.	Mohs' Fundamental Forms.	Optical System.
1. Rhomboid, { Obtuse, Acute, } 2. Regular Hexaedral Prism, 3. Bipyramidal Dodecahedron,	I.—Rhomboidal System,	I.—Crystals with one axis of Double Refraction.
4. Octohedron, } With a square base, 5. Right Prism, }	II.—Pyramidal System,	
6. Right Prism, { Base a Rectangle, Base a Rhomb, Base an oblique parallelogram, 7. Oblique Prism, { Base a Rectangle, Base a Rhomb, Base an oblique parallelogram, 8. Octohedron, { Base a Rectangle. Base a Rhomb,	III.—Prismatic System,	II.—Crystals with two axes of Double Refraction,
9. Cube. 10. Regular Octohedron, 11. Rhomboidal Dodecahedron,	IV.—Tessular System,	III.—Crystals with three Rectangular axes in a state of equilibrium, & therefore producing no double refraction.

It appears from this Table, that the First Class of the Optical System includes Mohs's *first* and *second* systems of fundamental forms. Although the system of crystallizations deduced from these two forms appears at present to be different, yet we think that some mode of connecting them together may still be discovered. The rhomboidal and the pyramidal systems resemble one another, in so far as they have both only one axis symmetrically situated in the solid; and even if this resemblance had not been strengthened by their having both only one axis of double refraction, it might entitle us to unite them into one class, and thus identify the crystallographic with the optical system.

The agreement between Mohs' System of Fundamental Forms, and that which is derived from optical structure, will appear still more striking, if we compare the individual determinations of primitive forms which each of them have furnished; and as the forms which Haüy has ascribed to several minerals are incompatible with their optical structure, we shall thus be able to estimate the relative values of the French and the German systems of crystallography.

The following Table will point out the deviations of Haüy's primitive forms from those which I have given in this and a former paper.

LIST OF MINERALS

Which ought to have a Primitive Form different from that assigned to them by Hauy.

Names of Minerals.	Form according to Hauy.	True Fundamental Form, as predicted from their Optical Structure.
Sulphate of Magnesia, Chromate of Lead, Mesotype,	Right Prism with a Square base,	Prismatic System.
Carbonate of Barytes, ——— of Strontites, Iolite,	Hexaedral Prism,	Prismatic System.
Cryolite, Harmotome, Chabasie,	Obtuse Rhomboid,	Prismatic System.
Sulphate of Iron,	Acute Rhomboid,	Prismatic System.
Essonite,	Right Rhomboidal Prism	Tessular System.

The following Table contains the fundamental forms, as ascertained by Mohs, of those transparent and translucent crystals, in almost all of which I have determined the number of axes of double refraction.

Table of the Fundamental Forms of Minerals as determined by Professor Mohs of Freyberg *.

Rhomboidal System.

Carbonate of Lime.	Oligist Iron-ore.
—— —— of Lime and Magnesia.	Spinellane.
—— —— of Lime and Iron.	Ruby Silver.
—— —— of Manganese.	Cinnabar.
—— —— of Zinc.	Tourmaline.
Phosphate of Lime.	Rubellite.
—— —— of Lead.	Dioptase.
Rhomboidal mica.	Chabasie.
Nepheline.	Iolite.
Beryl, Emerald.	Quartz.
Corundum, Ruby, Sapphire.	Specular Iron-ore.

* The results in this Table are taken from a work newly published, and entitled *Die Charactere der Klassen, Ordnungen, Geschlechter und Arten oder die characteristik des Naturhistorischen Mineral-Systemes*, von Friederich Mohs. Dresden, 1820. This interesting work has been translated into English, and is now publishing in Edinburgh.

Pyramidal System.

Tungstate of Lime.	Zircon.
Molybdate of Lead.	Mellite.
Oxide of Tin.	Uranite.
Apophyllite.	Titanite.
Meionite.	Octohedrite.
Wernerite.	Sulphate of Zinc.
Idocrase.	

Prismatic System.

Carbonate of Soda.	Phosphate of Iron.
Sulphate of Soda.	Talc.
Nitrate of Potash.	Diallage.
Sulphate of Lime.	Electric Calamine.
——— of Iron.	Amblygonite.
——— of Copper.	Aphrite.
——— of Barytes.	Diaspore.
——— of Strontian.	Hauyne.
——— of Lead.	Kyanite.
——— of Magnesia.	Spodumene.
Borate of Soda.	Prehnite.
Glauberite.	Datholite.
Cryolite.	Harmotome.
Anhydrite.	Laumonite.
Arragonite.	Mesotype.
Carbonate of Strontian.	Stilbite.
——— of Barytes.	Petalite.
——— of Lead.	Felspar.
——— of Copper.	Augite.
Chromate of Lead.	Epidote.

Tabular Spar.	Euclase.
Cymophane.	Red oxide of Zinc.
Axinite.	Tantalite.
Peridote.	Oxide of Manganese.
Essonite.	Sulphur.
Staurotide.	Muriate of Copper.
Sphene.	Wavellite.

TESSULAR SYSTEM.

Muriate of Soda.	Spinelle.
Muriate of Ammonia.	Ceylanite.
Diamond.	Alum.
Boracite.	Fluor-Spar.
Garnet.	Blende.
Arseniate of Iron.	Sodalite.
Helvin.	Ruby Copper.
Aplome.	

When we examine the determinations contained in the preceding Table, we cannot but be struck with the coincidence which almost universally obtains between Mohs's results and those which I have deduced from the optical structure of minerals. No fewer than *nine* out of the *eleven* minerals which constitute the exceptions to Haüy's Table, (see page 344.), have been found by Mohs to have the same primitive forms which I assigned to them; and the other two minerals, namely, *Iolite* and

Essonite, he will no doubt find, upon re-examination, to belong to the Prismatic System *.

An agreement so striking between the results of a system purely Crystallographic, and a system purely Optical, cannot fail to be regarded as a demonstration of the principles upon which both of them are founded.

I shall now conclude this supplementary paper, with a Table of the Primitive Forms of Minerals and Crystals, which I have determined from their optical structure.

Table of the Primitive Forms of Minerals and Crystals hitherto undetermined.

I. & II.—Rhomboidal or Pyramidal System.

Hydrate of Magnesia.	Nitrate of Soda.
Arseniate of Copper.	Subphosphate of Potash.
Mica from Kariak, &c.	Sulphate of Nickel, } Certain specimens.
Apophyllite from Uton.	——— Potash, }
——— surcomposée.	——— Zinc. }
Muriate of Lime.	Superacetate of Copper and lime.
——— of Strontian.	Ice.
Arseniate of Potash.	

* I have reason to believe that Mohs did not examine these two minerals himself, but adopted the primitive forms assigned to them by Haüy.

III.—Prismatic System.

Iolite.
Diallage.
Carbonate of Barytes.
——— Strontian.
——— Ammonia.
——— Potash.
——— Copper.
Petalite.
Harmotome.
Chromate of Lead.
Apophyllite from Faroe.
Mesotype from Auvergne.
——— Iceland.
——— Glenarbuck.
Nadelstein from Faroe.
Chabasie.
Indurated Talc.
Sulpho-carbonate of Lead
Sulphate of Copper and Iron.
——— Ammonia.
——— Cobalt.
——— Ammonia and Magnesia.
——— Soda and Magnesia.
——— Manganese.
——— Zinc, (certain specimens.)

Nitrate of Silver.
——— Ammonia.
——— Lime.
——— Strontian, (certain specimens.)
——— Copper.
——— Zinc.
——— Mercury.
——— Bismuth.
Nitrite of Lead, (certain specimens.)
Muriate of Mercury.
——— Magnesia.
——— Barytes.
Acetate of Lead.
——— Zinc.
Hyper-oxymuriate of Potash.
Phosphate of Soda.
——— Iron.
Oxalate of Ammonia.
Super-oxalate of Potash.
Super-chromate of Potash.
Crystallized Cheltenham Salts.
Murio-sulphate of Magnesia and Iron.
Benzoate of Ammonia.
Chromic Acid.
Benzoic Acid.

Boracic Acid.
Succinic Acid.
Hydrate of Barytes.
Super-tartrate of Potash.
Tartrate of Potash and Antimony.
Spermaceti.
Camphor.
Comptonite.
Electric Calamine.
Lepidolite.
Realgar.
Yellow Orpiment.

Tessular System.

Essonite.
Haüyne.
Sodalite.
Cinnamon Stone.
Nitrate of Lead.
——— of Strontian, (octahedral crystals.)
Nitrate of Barytes.
Nitrite of Lead, (certain specimens.)
Muriate of Potash.
Sulphate of Alumina and Ammonia.

XXIV.

XXIV.—*An Account of some of the Cryptogamous Plants of Devonshire.*

By Robert Kaye Greville, Esq. M. W. S.

(Read 5th August 1820.*)*

The county of Devon has been always regarded, even from the days of our earliest botanical writers, as particularly favourable to the growth of many extremely rare plants; and the face of the country is, indeed, admirably adapted to such as are found in peculiar habitats. The high and extensive tract of Dartmoor, yielding a great variety of mountain scenery, affords a considerable number of alpine species; and the warm and shaded valleys in the lower parts of the country, are equally prolific in characteristic productions; whilst the sea-coast, abounding with the most beautiful bays, and the boldest cliffs, is more favourable to marine botany, than any other coast in the kingdom. The great variety of soil, also, resulting from numerous modifications of granite, slate, limestone, sandstone, &c. all favourable to particular vegetable productions, bestows upon this county a pre-eminence in a botanical point of view, which is farther confirmed by its humid atmosphere and southern latitude. All these advantages taken into consideration, along with its great extent and acknowledged botanical riches, render it a singular circumstance that no Flora of it has been published. There are many private individuals, who have done much towards an undertaking of this kind; but they, unfortunately, want either leisure or inclination, to give their labours to the public. The indefatigable industry, and the acuteness of Mrs Griffiths, have, however, been made known to the world, through the medium of the Historia Fucorum, and of the singular plant which so deservedly bears her name.

The following *Phœnogamous* Plants, which may be considered as almost peculiar to Devonshire, will contribute to shew the value of that county to the botanist:

Scirpus holoschænus.
Cynoglossum omphalodes.
Oxalis corniculata.

Polycarpum tetraphyllum.
Bupleurum odontites.
Lobelia urens, &c.
Erica vagans, has been also found near Axminster.

A few years only have elapsed, since *Cryptogamous* Botany began to engage general attention. It is still in its infancy; but at the present moment, is, perhaps, advancing with more rapid strides, than most other branches of botany. Besides many eminent Continental Cryptogamists, we have one* recently appointed Professor of Botany in the College of Glasgow, who is devoting his time to, and exercising his unrivalled acuteness, upon the recondite treasures of this department; and has already presented to the world above 170 new *musci*, many of them collected in the recesses of Nepal,—many in the wilds of South America,—the former by the Honourable D. Gardner, the latter by the indefatigable Humboldt and Bonpland. Minute and worthless as this part of the vegetable creation may appear to be in the eyes of the multitude, those who have particularly studied them, have been amply repaid for their trouble. *Cui bono hæc omnia?* We might, indeed, be contented to answer

* Dr William Jackson Hooker, author of *Recollections of a Tour in Iceland*, a *Monograph on the British Jungermanniæ*, *Musci exotici*, &c. &c., and who is now engaged not only in continuing the *Flora Londinensis,* but in a *Flora Scotica.*

with our valuable countryman Dillenius, "*Ut cognoscamus sapientiam Creatoris, quæ in minimis non minus elucet, quam in magnis plantis;*" for we find in these diminutive objects, the most beautiful and the most unexpected structures, admirably fitted for their respective functions. We find external habit as strongly marked in the slender Hypnum,—in the almost invisible Phascum, as in the Lord of the Forest, the old Oak grown hoary in many centuries. We find them various in their fruit and in their foliage, each fitted to its peculiar residence, and changing their character like the higher vegetables, as they approach the southern or northern hemisphere. Yet we will not be contented with mere beauty and fitness: Uses have been discovered in these obscure tribes of plants that were unlooked for; and we may reasonably conclude, that *other* uses will still be found, perhaps important ones, from the influx of new species.

I now proceed to lay before the Society, an enumeration of such Cryptogamous Plants as fell under my notice, during a three months residence in Devonshire. In the form of notes, I shall insert occasional observations, with a few new facts relative to some of the Fuci of that county,—a tribe of plants, of which I hope to be able to publish a Synopsis at no very distant period.

In order to render a part of my enumeration more complete, I shall introduce a few plants that I neither saw nor gathered myself, but in every instance shall annex my authority.

MUSCI.

Andræa Rothii.	Abundant on Cawsand, the highest part of Dartmoor.
Sphagnum latifolium.	Common.
acutifolium.	Ditto.
cuspidatum.	On Cawsand.
Phascum alternifolium.	Near Torquay, rare.
axillare.	About Exeter.
muticum var. β.	Near Torquay, — *Hooker, Musc. Britt.*
cuspidatum.	Torquay, Ilfracombe, &c.
Gymnostomum viridissimum.	About Exeter.
truncatulum. (1.)	Common.
fasciculare.	Foot of Cawsand.
pyriforme.	About Exeter.
Anictangium ciliatum.	Dartmoor.
Schistostega pennata. (2.)	Between Zele and South Tawton,—*Mr Newberry.*
Splachnum ampullaceum.	Between Sidmouth and Exeter,—*Turner.*
Polytrichum undulatum.	Common.
piliferum.	Haldon and Dartmoor.
commune.	Common.
urnigerum.	On Haldon and Dartmoor.
aloides.	Ditto do.
nanum. (3.)	Ditto do.
Tortula rigida.	Babbacombe.
muralis.	Common.
ruralis.	Ditto.

Tortula subulata.	North Bovey, near Exeter.
cuneifolia.	Torquay, Torpoint, &c.—*Hooker.*
tortuosa.	Babbacombe.
unguiculata.	About Exeter.
Grimmia apocarpa.	Common.
maritima.	Ilfracombe.
pulvinata.	Common.
Pterogonium Smithii. (4.)	Maidencombe, Torabbey, &c.
gracile.	Lustleigh Cleve.
Weissia starkeana.	Near Torquay.
lanceolata.	Near Exeter.
cirrhata.	Torabbey.
controversa.	Common.
Dicranum bryoides.	Ditto.
adiantoides.	Dartmoor,–Lidford Waterfall.
taxifolium.	Near Exeter,—North Bovey.
glaucum.	On Dartmoor.
flexuosum.	Dartmoor.
flavescens.	Lidford Waterfall.
pellucidum	Near Lidford.
scoparium.	Common.
varium.	Near Exeter.
heteromallum.	Near Dartmoor.
Trichostomum lanuginosum.	Haldon,—Dartmoor.
heterostichum.	Ditto do.
microcarpon.	Ditto do.
aciculare.	Ditto do.
fasciculare.	Haldon.
Leucodon sciuroides.	Abundant in Ugbrook Park, covering most of the trees, but I could find no capsules.

Didymodon purpureum.	Common.
rigidulum.	Ilfracombe.
heteromallum.	On Cawsand.
Funaria hygrometrica.	Common.
Orthotricum anomalum.	Babbacombe,—South Tawton.
crispum.	Haldon,—Lidford Fall.
affine.	Common.
diaphanum.	South Tawton, near Exeter.
striatum.	About Exeter.
Lyellii. (5.)	Near North Bovey; near Okehampton, and near Lidford Waterfall.
Neckera crispa.	Not unfrequent.
pumila.	Ditto.
Anomodon curtipendulum.	Dartmoor.
viticulosum.	On the wall of Ugbrook Park, abundant.
Daltonia heteromalla.	Not unfrequent.
Fontinalis squamosa. (6.)	Lustleigh Cleve,—No. Bovey.
Bartramia pomiformis.	Common.
fontana.	Dartmoor.
arcuata. (7.)	On Cawsand, and near Lidford Fall abundantly.
Hookeria lucens.	Lidford Waterfall.
Hypnum trichomanoides.	Ditto.
complanatum.	Common.
undulatum.	Dartmoor.
denticulatum.	About Exeter.
medium.	Near Exeter.
tenellum.	On the wall of Ugbrook Park, near the gateway, and on a wall by the foot-path leading from Torquay to Torabbey Sands.

Hypnum serpens.	Common.
schreberi.	Haldon and Dartmoor, &c.
murale.	Frequent.
purum.	Ditto.
fluitans.	Dartmoor.
sericeum.	Common.
lutescens.	Ditto.
alopecurum.	South Tawton, — Lustleigh Cleve.
dendroides.	Dartmoor.
curvatum.	Common.
myosuroides.	Near Torquay.
splendens.	Common.
proliferum.	Near Torquay, &c.
prælongum.	Common.
rutabulum.	Ditto.
velutinum.	Ditto.
ruscifolium.	Dartmoor.
striatum.	Common.
cuspidatum.	Dartmoor.
loreum.	Ditto.
triquetrum.	Common.
squarrosum.	Dartmoor.
filicinum.	South Tawton lime quarries.
aduncum, et var. revolvens.	Dartmoor.
commutatum.	Ditto.
cupressiforme.	Common.
molluscum.	Lidford Waterfall.
Bryum palustre.	Dartmoor.
argenteum.	Common.
roseum.	North Bovey, &c. no fruit.
capillare.	Common.

Bryum cæspititium.	Common.
nutans.	On Cawsand.
punctatum.	Lidford Fall.
ligulatum.	About Dartmoor.
hornum.	Lustleigh Cleve.
cuspidatum.	In a little wood at South Tawton quarries.

MUSCI HEPATICÆ.

Jungermannia julacea.	Dartmoor,—*Newberry.*
furcata.	Common.
epiphylla.	Dartmoor.
asplenoides.	Near Exeter.
complanata.	Common.
albicans.	About Dartmoor.
bidentata.	Common.
dilatata.	Lustleigh Cleve.
tamarisci.	Common.
tomentella.	Lidford Waterfall.
platyphylla	Lustleigh Cleve.

FILICES.

Osmunda regalis.	Foot of Cawsand.
Polypodium phegopteris.	Lidford Fall.
Aspidium aculeatum. spinulosum.	Near Torquay.
dilatatum.	Lidford Fall.
Gramitis ceterach.	Babbacombe.
Asplenium marinum.	Coast,—*Hudson.*
Hymenophyllum Tunbridgiense.	Dartmoor.
Pilularia globulifera.	Blackdown,—*Polwhele.*

FUCI.

Fucus sinuosus.	Exmouth, Torquay, &c.
ruscifolius.	Ditto, rejectamenta.
hypoglossum. (8.)	Ditto, Torquay.
palmetta.	Torquay, rejectamenta.
membranifolius.	Ditto.
ovalis.	Grows at Torquay, and Ilfracombe.
tenuissimus.	Torbay,—*Mrs Griffiths.*
dasyphyllus.	Ditto, do.
obtusus.	Ditto, do.
siliquosus.	Ditto,—Exmouth.
abrotanifolius.	Near Torquay.
tamariscifolius.	Ditto. do.
fibrosus.	Ditto, near Torquay and Ilfracombe.
ligulatus.	Torbay,—*Mrs Griffiths.*
serratus.	Torbay, &c.
vesiculosus.	Common.
ceranoides.	River Dart,—*Mrs Griffiths.*
membranaceus. (9.)	Sidmouth, do.
alatus.	Torquay, &c.
laceratus.	Torquay and Exmouth, rejectamenta.
laciniatus. (10.)	Ditto, do.
reniformis.	Torquay, rejectamenta.
ulvoides?	———— *Mrs Griffiths.*
ciliatus.	Exmouth, Torquay, and Ilfracombe.
palmatus.	Common.
edulis.	Torquay.
saccharinus.	Ditto, &c. &c.
digitatus.	Common.
bulbosus.	Torquay.

Fucus rubens.	Torquay,—Exmouth.
norvegicus.	Ditto.
crispus.	Common.
mammillosus.	Ditto.
canaliculatus.	Ditto.
loreus.	Torquay.
nodosus.	Not unfrequent.
pygmæus.	Common.
aculeatus.	Ilfracombe,—Torquay.
pinnatifidus.	Torquay, &c.
corneus.	Torquay, Ilfracombe, &c.
coronopifolius.	Ditto, rejectamenta.
coccineus.	Ditto, Exmouth, &c.
plumosus.	Ditto, do.
tomentosus.	Ditto, do.
bursa.	Ditto,—*Mrs Griffiths.*
tuberculatus.	Ilfracombe,—*Hudson.*
rotundus.	Torquay and Ilfracombe.
lumbricalis.	Common.
plicatus.	Ilfracombe, &c.
confervoides.	Torquay and Ilfracombe, &c.
flagelliformis β.	Sidmouth,—*Mrs Griffiths.*
filum.	Exmouth, rejectamenta.
pinastroides.	Torquay.
purpurascens.	Ditto.
pedunculatus.	*Mrs Griffiths.*
capillaris.	*Hudson.*
kaliformis.	Torquay.
articulatus.	Common.
opuntia.	Near Torquay.
amphibius.	River Dart,—*Mrs Griffiths.*
fruticulosus.	} *Mrs Griffiths.*
viridis.	
crinalis.	
rhizodes.	

Fucus Griffithsiæ.	Torquay.
glandulosus.	Ditto.

ULVÆ.

Ulva pavonia.	Torquay,—*Mrs Griffiths.*
atomaria.	Ditto.
dichotoma.	Ditto.
plumosa.	Ditto.
plantaginea.	Dawlish, } Turner's Botanist's Guide.
coccinea.	Plymouth, } Turner's Botanist's Guide.
filiformis.	Ilfracombe, } Turner's Botanist's Guide.
rubens.	Torbay,—*Mrs Griffiths.*
umbilicalis.	Teignmouth.

NOTES AND OBSERVATIONS.

(1.) *Gymnostomum truncatulum.*

In the course of last summer, I gathered a tuft of Gymnostomum truncatulum, deviating so much from its usual appearance, that I was at first induced to consider it as a new species, until a more accurate investigation discovered my mistake.

Instead of the very simple stem belonging to Gymnostonum truncatulum in its proper type, the plants I found, were much branched, each branch producing a capsule; so that, on some plants, there were five or six capsules. In December following, I found a considerable number of specimens near Exeter, some bearing as many as eight capsules.

The branches had not the character of innovations, *Vid. Hedw. St. Cr. vol.* 1. *Tab.* 5. *Fig.* 7. for they all produced fruit at the same time. For distinction's sake, this variety may be called *Ramosum.* It is a strong instance of the absolute necessity of attending most closely to the generative organs.

(2.) *Schistostega pennata.*

Very little about this curious moss appears to be hitherto known. Hedwig mentions, that it was found in Germany not long after its discovery by Mr Newberry in Devonshire, and subsequent publication by Dickson. *Vid. Hedw. St. Cr. vol.* 1. *Tab.* 29. At *Fig.* 11., he gives so magnified a representation of the laciniated structure of the operculum, that few would imagine it did not actually exist. Yet I am informed by Dr Hooker, that this structure is now denied by German botanists; and if they are correct, the plant must be carried back to the genus *Gymnostomum,* from which *Mohr* removed it.

(3.) *Polytrichum nanum.*

The excellent authors of the *Muscologia Britannica,* (p. 28.) have already signified their readiness to consider P. *aloides* and P. *nanum,* as the same species; an opinion in which I heartily concur, though Mr Hobson of Manchester, who possesses an extensive acquaintance with our British mosses, still continues to think them distinct. I have examined no trifling number of each, and can detect no permanent distinguishing characters. As a variety, P. *nanum* will always be remarkable for its sub-globose capsule, larger peristome and smaller calyptra.

(4.) *Pterogonium Smithii.*

This beautiful moss is of rare occurrence even in the southern counties. It is most abundant in Devonshire, but is confined apparently to a few districts. At Maidencombe, a small village on the coast, about three miles south of Teignmouth, it begins to be plentiful, and, continuing along the coast, may be gathered a few miles south of Torabbey; but although I travelled, chiefly on foot, between 300 and 400 miles in various parts of the country, I never met with it in any other place.

(5.) *Orthotricum Lyellii.*

For an account of this fine Orthotricum, *vide Musc. Britt.* p. 76. I thought myself peculiarly fortunate in discovering this rarity in Devonshire, where it does not appear to be of very unfrequent occurrence,—producing fruit however sparingly.

(6.) *Fontinalis squamosa.*

Much doubt, for a long time, existed, whether this plant was truly entitled to its place as a good species. Its general character is so different from that of Fontinalis *antipyretica*, that it is noticed by early writers. *Bauhin* calls it *F. minor lucens*, from its beautifully glistening appearance, and *Dillenius*, who gives a figure, Tab. 33. fig. 3. *F. squamosa, tenuis sericea atro-virens.* All doubt promises at length to be dispelled, and Fontinalis *squamosa* will probably be soon regarded as an established species, and not of that extreme rarity that was formerly imagined. Among the hills above Buxton in Derbyshire, I found it in a state well adapted for investigation. There had been no rain of any consequence for many weeks, so that the young plants I gathered had not been exposed to any strong current, but so far from it, not unfrequently grew in small pools formed by the floods of the preceding winter. These young plants were from 2 to 4 inches long, and had leaves as large as those figured in *Eng. Bot. t.* 1801; being very luxuriant, they were more open to observation and accurate examination. After a patient search, I could find not the least trace of a keel in any of the leaves. From the period of germination, these plants had not been subject to any attrition, but every part had been gradually and perfectly evolved. Along with the young, were old plants having the usual appearance of F. squamosa, but rather more luxuriant, very long, and in fine fructification. I may here mention a circumstance that I have hitherto uniformly observed in this moss, viz. that when dry it has a strong smell, not very unlike that of some woollen cloths before the oil is washed out. This smell I never could find in F. *antipyretica.*

In Devonshire, I gathered the same plant in the stream in which Dr Hooker had before found it; it was most abundan, but produced no fruit.

(7.) *Bartramia arcuata.*

This splendid Bartramia, peculiar to this country, produces fruit in the greatest abundance, on a bank on the left-hand side of the road, as you go from the village of Lidford to the Water-fall. The bank is a few yards on the opposite side of the stream which crosses the road, and supplies the fall. This moss produces capsules also on Cawsand, but not freely.

(8.) *Fucus hypoglossum.*

Mr Turner, in his *Synopsis of the British Fuci*, as well as in his admirable *Historia Fucorum*, seems to have fallen into an error in supposing that this plant appears only at a certain time of the year,—from June to September. He adds, that this circumstance is another distinctive mark between F. hypoglossum and F. ruscifolius; *Synop. vol. i. p. 9., and Hist. Fuc. vol. i. p. 28.* I have no doubt that F. hypoglossum may be gathered in the months above named; but I have to observe, that among the rejectamenta of the sea at Exmouth, I could have collected many hundred specimens in the months of December and January, and many of them in fruit. In February, I found it growing at Torquay. F. *ruscifolius* I met with at the same time, retaining all Mr Turner's characters of discrimination attached to it.

(9.) *Fucus membranaceus.*

I have here an opportunity, from the valuable information I derived through the kindness of Mrs Griffiths, of correcting an error relative to this uncommon plant, in the *Hist. Fuc. vol. ii. p. 42.*, undoubtedly arising from the well-known difficulty of describing marine plants from specimens not perfectly recent.

Mr Turner describes the root as a callous disk; but Mrs Griffiths assures me, that it is an extension of a soft spongy substance, somewhat resembling the root of F. *tomentosus*, and covering the rocks in the same manner.

From this account, it would appear, that F. *membranaceus*, in regard to its root, bears some relation to F. *tomentosus* and F. *bursa*, of which a new

Genus has been constituted by *Olivi,* under the name of *Lamarkia,* with the following character: L. *stirps radicata sub-coriacea mollis, composita utriculis in axim perpendicularibus.* The nature of the *frond* in F. *membranaceus,* would not lead any one to expect a *root* of so dissimilar a structure; yet if we consider the many anomalies in the vegetable kingdom, such an occurrence appears far from impossible.

(10.) *Fucus laciniatus.*

A curious circumstance has been observed by Mrs Griffiths respecting this Fucus, which places it among those species which bear two kinds of fructification. In the common mode of fructification in Fucus laciniatus, the seeds are contained in tubercles situated in the marginal processes; but many instances occur where these processes are entirely wanting, and it is in such cases that Mrs Griffiths has remarked a narrow line of a darker colour than the rest of the frond, to be continued along the whole margin. This line, under the microscope, is evidently formed by very minute seeds, apparently single, and immersed in the substance of the frond. This mode of fructification Mrs Griffiths has found to take place in many hundred plants that she has examined. I have since observed the same arrangement, and I have many in my possession presented to me by her, as well as many of my own collecting, which illustrate the discovery.

Vide Pl. XV.

Fig. 1. Plant of Fucus laciniatus, with the common fructification.
2. A portion of the frond with the fructification, magnified.
3. A tubercle highly magnified.
4. Plant of F. laciniatus with the second mode of fructification.
5. Portion of the frond with seeds magnified.
6. Do. highly magnified.
7. Seeds.

(11.) *Fucus rubens.*

Of this plant Mrs Griffiths gave me specimens to examine, bearing very curious bodies on peduncles, resembling some of the microscopic fungi, and not unlike the urceolate pods of Fucus dentatus in their young state, (for at first they are not urceolate). After the most minute scrutiny, I am utterly unable to decide whether they are seed-vessels or zoophytic productions. They vary in their shape, some being obovate, some peziziform, and some globular, sessile at first, afterwards supported upon peduncles, tapering downwards; the substance is cartilaginous, and a section shows nothing but an obscure radiated structure; when forcibly removed, the frond does not appear to be lacerated, which would support the opinion that they are zoophytic. But in dried specimens we must be careful in our decisions. Some learned botanists on the Continent are of opinion, that the urceolate pods observed on Fucus dentatus are of a zoophytic nature; but here I certainly differ from them, having traced them from an early period of growth to maturity, and examined them minutely in the most recent state.

Vide Pl. XVI.

Fig. 1. Fucus rubens with the small bodies on peduncles,
2. Portion of the frond magnified with ditto.
3. One of the bodies more highly magnified.
4. Section of do. do.

Plate XVI.

R.K. Greville Del

E. Mitchell sc

XXV.—*Account of a Beluga or White Whale, killed in the Frith of Forth.*

By Dr Barclay and Mr Neill.

(Read 7th and 21st December 1816.*)*

I.—*Notice regarding the Capture of the Animal, and Description of some of its External Characters.—By Mr Neill.*

On the 7th of June 1815, I received a letter from Mr Robert Bald of Alloa, saying, that "for about three months past, an animal of singular appearance has very frequently passed and repassed this harbour, apparently of the grampus kind, but very white. It was often observed at Kincardine also, and many attempts were made to kill it, but without effect. I heard, however, at an early hour this morning (6th June,) that it was killed near Stirling. I set off immediately, and found this to be the case. It is, indeed, a very singular animal, altogether white," &c.

Mr Bald proceeds to mention that he had purchased the specimen, and that it was on the way for Professor Jameson. It accordingly arrived at Leith by the Alloa Packet on the afternoon of the 7th. The absence of a dorsal fin, at once proved the animal to be (what Mr Bald's description led us to suspect) the Beluga of naturalists.

Great praise is due to Mr Bald, for his ready attention to the interests of natural history on this occasion. In a letter of the 9th, he says, " I am highly gratified to find, that the beluga I sent is so rare. It was most fortunate I went direct to Stirling; for had I put off but two hours longer, it would either have been off to Glasgow, or cut to mince-meat for a soap-work adjoining where it lay."

In still a subsequent letter Mr Bald informs me, that the animal generally passed upwards when the tide was flowing, and returned down the frith with the ebb: this sometimes happened every day, and sometimes once in the two or three days: it came frequently to the surface, and was well known for about three months by the name of the White Whale. It was supposed to run up the river in pursuit of salmon, and it was at last killed by the salmon-fishers near the Abbey of Cambuskenneth.

The animal had been attacked both with firearms and spears. A musket ball had entered the lungs, and was found lodged in them by Dr Barclay in the course of dissecting; and several gashes, made with some pointed weapon, appeared in different parts of the body.

It was a male, and seemed to be nearly at full growth.

I shall now give an account of the dimensions and general exterior appearance of the animal. The measurements were taken with a measurer's line, while the animal was lying on one side, and while all the soft parts were quickly passing into a state of putrefactive fermentation. Of course the measurements are given only as nearly correct; butthey are sufficiently so for the purposes of the naturalist.

The shape of the animal was highly symmetrical, and at once suggested the idea of perfect adaptation to rapid progressive motion in the water. It resembled generally a double cone, one end of which was considerably shorter than the other. The head was small and lengthened; but over the forehead, as in the narwhal and porpesse, was a thick round cushion of flesh and fat:—the body continued to swell as far as the pectoral fins; and from this point gradually diminished to the setting on of the tail or organ of motion. On the middle of the back, as in other whales, there was a longitudinal ridge, partly bony, partly soft.

The extreme length of the animal, in a straight line, as it lay on the floor, (the line being measured on the floor,) was 13 feet 4 inches.

When measured along the side, from the tip of the snout to the cleft of the tail, the length was found to be 13 feet 6 inches.

From the tip of the upper jaw, along the back to the beginning of the dorsal ridge, measured 6 feet 3½ inches.

From the same point, along the curvature of

	Ft.	In.
the back to the root of the tail, the measurement gave,	12	8½
To the cleft of the tail,	1	1
	13	9½
To the end of the lobe of the tail, additional,	0	7½
Giving as the total length of the superficies,	14	5

The hard part of the dorsal ridge measured in length 1 foot 4 inches; and the soft part extended nearly 3 inches farther at both extremities. The hard part of the ridge where highest, projected about an inch.

The tail was, as in other cetæ, horizontal, and divided into two lobes: the breadth from tip to tip of the tail, was 3 feet and ½ inch nearly.

The curvature of the lower part of the body was somewhat greater than that of the back, although it did not appear so to the eye; for, from the tip of the lower jaw, along the middle of the belly to the cleft of the tail, measured 13 feet 9¼ inches, while the measurement along the back gave only 13 feet 6 inches.

From the upper edge of the pectoral fin or swimming-paw, to a point opposite to the anus, measured 7 feet 8½ inches; and from the anus to the penis 8 inches.

The fin or paw, from the root to the apex, along its exterior margin, measured 2 feet. Its greatest breadth was 1 foot 1 inch; where narrowest, at its root, it was 6½ inches. It was, therefore, of an oval shape. Five interior bones, analogous to fingers, could be felt; and after the animal had lain for two or three days, they could easily be traced by the eye, the putrefactive process having gone on with remarkable rapidity. There was likewise a small projection at the point of each bone.

From the angle of the mouth to the root of the fins measured 2 feet nearly. From the angle of the mouth to the eye, 2¾ inches. From the angle of the mouth to the tip of the upper jaw, following the curvature, 10 inches; and to the tip of the lower jaw, the same.

In the common whale, the head forms about a third of the whole bulk of the animal; in the beluga, as already noticed, it is small. From the blow-hole to the tip of the upper jaw, measured 1 foot 10 inches; and from the blow-hole to the eye, measuring in somewhat an oblique line, the distance was $11\frac{1}{2}$ inches.

In circumference, the specimen measured, near the eyes and blow-holes, 4 feet 4 inches;—a very little in front of the fins, 7 feet 2 inches;—almost immediately behind the fins, at what appeared to be the thickest part of the body, 8 feet 11 inches; —at the termination of the ridge on the back, 8 feet 10 inches;—at the anus, 4 feet 4 inches; and at the root of the tail, 1 foot 7 inches.

The colour of the whole animal was a cream white; this colour depending on a white rete mucosum, in many places about half an inch thick, and which is covered with a thin transparent cuticle.

Next to the muscles was a layer of blubber, in general about three inches thick; so that, between the rete and fat, the animal is pretty well prepared against the rigour of the Arctic Seas.

There was no visible external ear; nor were we successful in tracing any kind of meatus auditorius. The eyes and the mouth were small in proportion to the size of the animal.

In the under jaw were six teeth on each side, broad and blunt. In the upper jaw there were nine on each side, but none immediately in front; the three backmost sharp, and without any to match them in the lower jaw.

The penis was not bony, but wholly composed of soft substance.

Very few other remarks remain to be made by me.

Linnæus ranked the beluga under his general and ill-defined genus Balæna, by the title of B. *albicans*. Otho Fabricius, in the Fauna Groënlandica, very properly transferred it to the genus Delphinus, retaining the specific name *albicans*. Gmelin, in his edition of the Linnæan System, placed it also under the genus Delphinus, but distinguished it by the specific name *leucas*. He observes, that it seldom ascends rivers, is gregarious, of a white colour; but, when young, "parumper nigricans." De la Cepede considered the want of a dorsal fin in the beluga as a sufficient *generic* mark of distinction, and therefore constituted a new genus, entitled Delphinapterus, which is an expressive name, signifying *Dolphin without a fin*, or back-fin. He describes two species; D. beluga, with the opening of the mouth small, the teeth obtuse at their points ; and D. senedetta, with a large mouth, and the teeth pointed. Our specimen belongs to the former.

M. De La Cepede has collected from books almost every previous notice concerning the history of the beluga. To his ample details only a few gleanings can be added.

It may very generally be observed, that it is a native of high northern latitudes; it abounds in the seas near Disco Island in Greenland, and is not uncommon off Spitzbergen, in latitude 77°. Mr

Scoresby never observed it lower than Jan Mayen's Land. That gentleman informs me, that it is very seldom seen among the ice; but frequents places where the water is clearest and smoothest. Thirty or forty belugas are often observed in a herd together. They are very seldom pursued by the whale-fishers, because they find it difficult to strike them, on account of the great rapidity of their motions, and because, to our adventurers, they are comparatively of little value when killed.

Sir Charles Giesecké, in the article *Greenland*, lately published in the Edinburgh Encyclopædia, gives some particulars concerning the beluga. It comes in herds to the coast of West Greenland every year about the end of November, its arrival being hastened by the prevalence of storms from the south-west. It is, next to the seal, the most useful animal to the Greenlanders. The flesh is said to be somewhat similar to that of beef, though oily; and the "skin," we are told, is "eaten either raw, dried, or boiled:" By skin, however, is probably meant the thick white substance analogous to a rete mucosum above mentioned *. The belugas are described as "not shy," but often tumbling themselves round near the Greenlanders' boats."

* Crantz evidently uses the term in this sense, when he says, "The white wrinkled skin is the thickness of a finger." Crantz, 8vo. edit. vol. i. p. 114.

They are, however, very rapid in their motions, "darting along with the velocity of an arrow."

These animals may occasionally stray to the southward in pursuit of fish, or be impelled far in that direction by long-continued north easterly winds. When they happen to get entangled among the drift-ice, if the wind prevail in one di rection for several days, a straggler may be led so very far from his haunts as to be unable to rejoin his party. Several healed wounds, the scars of which were quite distinguishable, indicated that this individual had probably been struggling among drift-ice. In some places, the cuticle and rete mucosum remained in a divided state, while the true skin had healed.

It may be remarked, that Mr Pennant intimates a suspicion that the beluga occasionally visits our seas; and he was right. Colonel Imrie of this Society informs me, that in August 1793, he saw two young belugas which had been cast upon the beach of the Pentland Firth, some miles to the east of Thurso. The length of the one, from the front of the forehead to the tip of the tail, was seven feet; and of the other, seven feet and a half. They were both males. "The principal colour of their skin," (I quote the words of the Colonel's description taken on the spot at the time,) "was white, but that was mottled with a brownish-grey colour." It will be observed, that Fabricius, Crantz, Giesecké, and others, who have seen the young animals, describe them as blackish, mottled, dusky, or pearl-grey, becoming white as they advance to maturity.

I have only to add, that, at the request of Professor Jameson, Mr Syme, our painter, took a sketch of the animal, when entire, and in a fresh state, and afterwards made the beautiful finished drawing now on the table. Dr Barclay examined the interior of the animal, and the structure of its various organs; and Mr Lizars, took a sketch of the abdominal viscera *in situ.*

II.—*Account of the Dissection of the Beluga.—By Dr* Barclay.

I have to regret that the following account of the dissection of the beluga is so very incomplete, owing to the putrid state of the body, and the shortness of the time which I had to examine it.

Integuments.

The epidermis, about the thickness of common writing paper, of a whitish colour, and somewhat transparent, was in many places separated by putrefaction. When put in spirits, it became opaque, and when dried, rigid like horn, transparent, brittle and elastic.

Beneath it, was a soft substance of about the consistency of new cheese when taken from the press. It was formed of two layers of equal thickness, not easily separable, but distinguished by their colour. When taken together, they measured in thickness rather more than one-third of an inch. Of the two, the one next to the epidermis was white as milk, and exhibited nothing of either a fibrous or a membranous structure; the one beneath, of a darker shade, displayed both. Its fibres were observed at right angles to the stratum above and the cutis beneath; and united laterally, formed laminæ or membranes, which were seen running at small distances in undulated lines, uniting and separating, and leaving cellular interstices between them, extending through the whole depth of the stratum. The two substances here described occupied a place corresponding to that which is assigned to the rete mucosum, and which, in the negro, is also divisible into two layers.

Beneath the cutis, which was thick and strong, was found every where a stratum of blubber; and, in several places, some inches deep. This was the adipose substance of the animal, of a greenish colour, arising from a fluid and limpid oil, that, instead of adeps, was here diffused in large quantities, through that part of the cellular texture interposed between the cutis and muscles. In other parts of the cellular texture, whether from natural or accidental causes, it seemed to be wanting: nor did this circumstance occasion surprise, as different species have their adipose substance differently disposed, of different colours, consistencies and qualities. The most similar I have seen to the blubber of this animal is the adipose substance, or the green fat, of turtle.

Tongue, Alimentary Canal, &c.

In its general appearance, the tongue was similar, in many respects, to that of a great number of fishes; short and thick; situated far back in the mouth; fixed down to a given position; and with little or no freedom of motion.

The œsophagus, when very moderately inflated, was twenty-one inches in circumference; and its farther extremity, where it was approaching towards the stomach, was lined with a coat as white as milk, of a brittle texture, and somewhat like that which lines the cardiac extremity of the stomach of a horse.

The stomachs were four; and the white coat lining the last part of the œsophagus was continued through the whole of the first stomach, exhibiting every where numbers of rugæ. Before I saw it, it had been separated by putrefaction, from which circumstance it was removed almost entire, and preserved in spirits, where it still continues to retain its rugæ. The central coat of the second stomach, was of a brownish colour, not separable from the one peripherad, but raised into a number of tumours or eminences by extricated air, though the cellular substance between it and the ambient coat was no where destroyed. The tumours, in general, were about the size of a walnut; and, from the laxness of the cellular substance that appeared within them, it was supposed that, in their natural state, they might have formed rugæ. The central coat of the third stomach was similar in colour, but presented neither eminences nor rugæ; and it seemed to be continued without any change through the whole of the last stomach, which was the least of the four, and somewhat of a cylindrical form. Where it terminated in the intestine, it was, with a moderate inflation, about nine inches in circumference.

The *intestines* were twenty-eight yards and a half in length, and without a colon or cæcum; and, with moderate dilatation, between four and five inches in circumference. Neither they nor the stomachs contained any thing, but here and there a very small quantity of thin brownish matter.

A *spleen* was attached to the first stomach, on the left side, but not larger than the ordinary size of a human spleen.

The *omentum* was large, and chiefly interposed between the stomachs and the intestines, a small portion only being found between the intestines and abdominal parietes.

The *pancreas* was found stretching across from left to right, but extremely putrid, and every where blown up into cells by extricated air.

The *liver* was situated on the right side as in man and quadrupeds. It had become a mere mass of putrefaction. We sought for the gall bladder, but were disappointed.

In a large liquid mass of putrid matter, as the *kidneys* did not obviously obtrude themselves, amidst our pressure for time, our search after them was unfortunately omitted, and has since been regretted.

The *testicles* we found within the abdomen, of an oblong shape, and lying close by the sides of the intestine, near its extremity. They were four inches in length, and the same in circumference.

The *penis* was conical; at the apex an inch and a half in circumference, but four in circumference towards the base, near to which it exhibited a sigmoid flexure, owing to two very powerful muscles that seemed to have performed the office of retractors. Through its whole extent it was soft and flexible, without either a bone or a cartilage.

Heart and Bloodvessels.

The heart presented nothing remarkable in its shape; the columnæ carneæ within the ventricles were proportioned to its size; and the pectinated muscles within the auricles proportionally large. The valvular apparatus, at the commencement of the two ventricles, was but slightly noticed, not presenting any thing that was obviously striking or peculiar. A considerable portion, however, of the two great arteries, with their semilunar valves, was separated from the ventricles, and afterwards preserved as dried preparations. The coats of these arteries were divisible into a number of strata, though the least minute and easiest division was into four, which is still illustrated by a preparation preserved in spirits. In its dried state, the circumference of the aorta opposite to the valves, was nine inches and a half; beyond the valves, where the diameter was suddenly diminished, the circumference was seven and a half. From that point, the diameter increased to the middle of the arch, where the greatest circumference was thirteen inches. From the middle of the arch, decreasing gradually to the place where it rested on the dorsal vertebræ, its circumference was diminished to six inches and a half.

The circumference of the pulmonic artery over the valves, was eleven inches and a half. Immediately beyond the valves, nine inches and a third; at its greatest diameter, eleven inches and a half.

Our limited time did not permit us to examine the veins.

Os Hyoides, Larynx, Trachea and Lungs.

The first three of these organs are preserved in a dried state. The body of the os hyoides is of a triangular shape, somewhat like the first bone of the human sternum. The base points towards the larynx. To each of the angles at the base, which are obtruncated, is joined by suture an osseous cornu, extending sacrad and laterad four inches. From the atlantal angle spring other two cornua, which, diverging laterad and atlantad, continue cartilaginous for four inches, and then become osseous, flattened and curved; in strength equal to the human clavicle, and in length five and a half inches each. There were likewise cartilages continued from these bones, but inadvertently removed.

The cartilages of the larynx are five; the cricoid, thyroid, the two arytenoid, and the epiglottis. What is called their depth in the following measurements, is their extent from above downwards, or from their atlantal to their sacral aspect. The depth of the larynx on the sternal aspect, is four inches and a quarter. On this aspect the cartilaginous structure of the cricoid is interrupted at the mesial plane, and the deficiency supplied by membrane. On the dorsal aspect, it is similar in appearance to that of man, and two and a third inches in depth. The depth of the thyroid cartilage sternad, is likewise two inches and a third, but suddenly diminishes in depth as it extends dorsad. The arytenoid cartilages, as in man, appeared at first view to rest on the atlantal margin of the cricoid ; but, on opening the larynx, were observed to enter more than an inch within the cricoid, and to form the fissure which corresponds to our *Rima Glottidis.* From the atlantal margin of the cricoid, they gradually converged till they came into contact and inclined dorsad ; their length was seven inches. The epiglottis was six inches in length, inclining dorsad to the arytenoids: the three meeting with a membrane interposed, formed a tube that crossed the pharynx, and pointed to the orifice of the spiracula in the roof of the mouth, through which this species of animal breathes. At this extremity, the orifice of the tube was somewhat like a fissure from right to left, and thickened at its margin by what appeared to be a glandular substance.

The trachea was four inches in circumference, and composed of thin cartilages, overlapping one another at several places, and few or none of them preserving any uniformity in their breadth. A number of these cartilages near to the cricoid, were imperfect rings, the deficiency of cartilage being supplied by membrane. Before the trachea advanced half way to its general division into two branches, it sent off a branch from its right side on the dorsal aspect, in some respects analogous to the azygous bronchial branch in the cow and the deer, two species which, like this animal, have also four stomachs. The ramifications of this branch, and the other two of the general division, were not traced far into the lungs, but traced at the same time until they diminished to less than the eighth of an inch in diameter; but we should certainly have traced them farther had we been only aware of a circumstance which we learned afterwards, that the rings of which they are formed are complete, and entirely osseous. The lungs in which they terminated were in two lobes, a right and a left, without any subdivisions.

The Head, Vertebral Column, and Ribs of the Skeleton, which have been preserved.

The head, measuring along the base from the foramen magnum, which is situated between the inial and basilar aspect of the cranium, is, to the farther extremity of the jaws, twenty-one inches; the breadth of the upper jaw from right to left, at the spiracula, eleven inches; at its farther extremity, two and a half. Its depth from the facial plane to the palate, three inches at the spiracula; at its farther extremity, scarcely one inch. The lower jaw is without a ramus or coronoid process, very thin from right to left, across the alveolar processes, and always the thinner the nearer to the articulation. Its depth from the line of the alveolar processes to the base, is, near the articulation, about four inches and three quarters; at its farther extremity, two inches and a half. There are no alveoli in the front part of the upper jaw, and I suspect there were no teeth, which, if it was the case, would, besides the azygous branch of the trachea, be another analogy between this animal and the ruminating animals that have four stomachs. I once observed the front teeth in the lower jaw, but before we proceeded to the dissection, some person had secretly extracted them; the alveoli, however, in which they were lodged, are large and distinct, and are what causes the depth of this jaw to exceed so much that of its fellow at its narrowest extremity. The other teeth do not extend iniad or backwards above two-thirds of the length of either jaw; are flat on the corona; have each but one fang, and stand at small distances, nearly a quarter of an inch from one another; from which circumstance they remind those who have seen both, of the scattered teeth in the morse or walrus.

The bones composing the vertebral column are obviously distinguished into Cervical, Dorsal, Lumbar and Caudal. The cervical are seven in number; the dorsal, eleven; the lumbar, thirteen: but the caudal vertebræ have not been enumerated, as part of them was carried away with the cutis.

The cervical vertebræ, excepting the atlas, have no well marked transverse processes, and, excepting the atlas, are all uncommonly thin at the sides, in the space between their bodies and articular processes. The bodies, too, from above downwards, have so little depth, that, with the assistance of intervertebral substance, the whole neck, measuring longitudinally, does not exceed, even at the utmost, seven inches. In an animal of much larger size of the same order, if not of the same genus, whose vertebral column I procured last season from the Island of Inchcolm, the length of the neck, consisting of seven distinct vertebræ, the first three of which are, however, anchylosed, does not amount even to six inches; and, what is more, excepting the atlas, the sides extending between their bodies and articular processes, are not thicker than the edge of a half-crown piece. This fact should teach us to be cautious how we proceed to general conclusions, in transferring our reasonings from a single individual to a whole species, or from a species to a whole genus.

The dorsal vertebræ are principally distinguished by articular surfaces at the extremities of their transverse processes, where they join with the ribs. Many of the ribs are likewise articulated with the bodies of the vertebræ, as in quadrupeds and birds; but in this animal the three last ribs on each side are articulated only with the extremities of transverse processes.

The lumbar vertebræ are distinguished by the want of articular surfaces at the extremity of their transverse processes, and could be otherwise easily distinguished in the beluga, by these transverse processes increasing in breadth at their extremity; but this probably is merely a character belonging to the species, as it is wanting in the transverse processes of the lumbar vertebræ of the other animal to which I have alluded.

The caudal vertebræ are distinguished by processes projecting sternad, and bifurcated at the base, leaving a pasage in their bifurcations for the transmission of the large bloodvessels. The first of these vertebræ is likewise distinguished from all the rest, by the largeness of its size, and by deep grooves upon the lateral and dorsal aspects, for lodging the tendons that pass towards the tail.

All the spinous processes of the cervical and dorsal vertebræ, have a distinct inclination sacrad, and several from the last of the dorsal vertebræ, as well as the whole arising from the lumbar and caudal vertebræ, are placed at such distances from one another, that not one-half of the spinal canal is covered at the sides, nor at the back in the caudal region, by these processes. In the caudal region, no oblique or articular processes are to be observed; and even in the lumbar, and the sacral half of the dorsal region, we discover only two for each vertebræ, and these originating from the atlantal margin of the spinous processes, and in some cases, as in the loins, near to their extremity, receiving between them the sacral margin of the spinous process, immediately before. In this structure, as in that of a great number of fishes, where the general appearance is somewhat similar, the spinal marrow may be examined, without disturbing the vertebræ or their processes. In this animal, a considerable portion was taken out from the lumbar vertebræ, and was found to be covered with a semicylindrical mass on each side, formed of a tough, spongy, elastic substance, with large bloodvessels running through it, and anastomosing frequently and freely at very small distances. From the elasticity of this substance, the mouths of the bloodvessels remained quite open on a transverse section; and from that circumstance were very easily discovered and injected, although they might have been easily traced without such assistance. These two semicylinders occupied by far the greater part of the spinal canal; the medullary cord, where we examined it, not being larger than that of a man at the middle of the neck.

The intervertebral ligaments, though deeper, are in structure similar to that of man and of various quadrupeds, composed of a number of concentric layers, and these layers of a fibrous structure, the fibres of the contiguous layers decussating like the layers of the intercostal muscles. In the centre of these ligaments was a soft substance resembling a mixture of jelly and cartilage. In the back and in the loins, the surfaces which the bodies of the vertebræ opposed to one another, was somewhat concave towards the centre, but in the caudal vertebræ convex, as we see in the last coccygeal vertebræ of many quadrupeds. The true ribs continued to the sternum, are six on each side; and the false five. The sternum is broad and flat, but becomes narrower as it advances towards the false ribs. Instead of sternal cartilages, we have here, as in birds, sternal ribs, which are articulated with the vertebral ribs by synchondrosis. In the sternum of the other animal of the same order, to which I have alluded, there was a large oval foramen in the middle, its greatest diameter between right and left, and not far from its atlantal aspect. The scapula, the only part we have yet procured of the atlantal extremity, is without any spinous process, but the base and superior costa meet at an angle that resembles a process; besides, a considerable process arises from the superior costa opposite to the cervix, and another in the same line close to the margin of the glenoid cavity, and which, without any strained analogy, might be named the *Coracoid Process.*

Organs of Sense.

The brain was putrid;—the eyes not so large as the human; and if the tongue was the organ of taste, the food must have entered far into the mouth before it could have reached it. Excepting the spiracula, we saw nothing that had a resemblance to nostrils; and that resemblance consisted in nothing but simply in this, that they were organs of breathing. Cuvier informs us, that he never yet has found olfactory nerves in this genus: "Marsouins et les Dauphins, n'ont point du tout de nerfs olfactifs." He ought to have said, that the nerves ramified upon their spiracula, are neither in their course nor in their origin similar to the olfactory nerves of other animals. All the lateral parts of the head were examined repeatedly, and by several gentlemen, for an external ear, but not a vestige of one could be found.

Explanation


BELUGA
Fig.1.
Fig. 2.
P. Syme del.^t

PLATE XVIII.

Fig. 1.

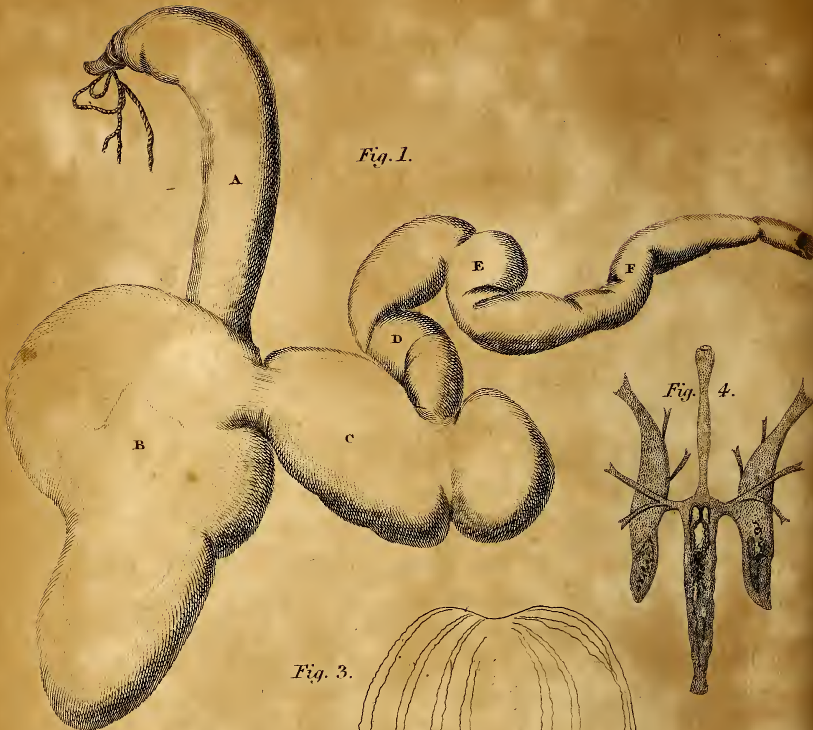

Fig. 4.

Fig. 3.

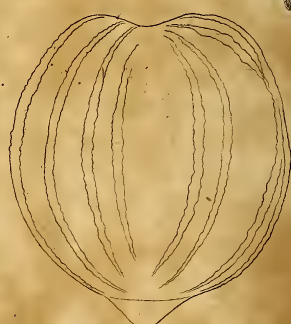

Fig. 2.

Eng.d by W.H. Lizars

Explanation of Plates XVII. & XVIII.

Plate XVII.

Fig. 1. Sketch of the Beluga.
A The Penis

Fig. 2. Dissection of the Beluga.
A Trachea.
B Oesophagus.
C c Lungs.
D First Stomach.
E Second Stomach.
F Third Stomach.
G Fourth Stomach.
H H H H Intestines.

Plate XVIII.

Fig. 1. & 2.
A Œsophagus.
B First Stomach.
C Second Stomcch.
D Third Stomach.
E Fourth Stomach.
F Intestines.

XXVI.—*Description of a New Species of Fucus, found in Devonshire.*

By Robert Kaye Greville, Esq. M. W. S.

(Read 5th August 1820.)

Fucus fronde cartilaginea, enervi, dichotoma; ramis linearibus, integerrimis, apice rotundatis; tuberculis sphæricis, ad apices, immersis.

Fucus Devoniensis. Frond cartilaginous, nerveless, dichotomous; branches linear, entire, rounded at the apices; tubercles spherical, situated at the apices and immersed.

Hab. In Torbay, Devonshire. *Mrs Griffiths.*

Desc. *Root,* A small expanded callous disk.

Fronds numerous from the same base, nerveless, from two or four inches long, linear, about two lines wide. At first they are cylindrical, and about the thickness of a sparrow's quill, but at two or three lines distance from the base, the stem becomes flat and expands into the frond, which is dichotomous, the distance between the dichotomies being very irregular, sometimes more than half an inch, often so small that three branches appear to spring from the same centre. The *branches* are patent, with their apices rounded; those producing fructification are rather narrower than the barren ones; the extreme dichotomies producing tubercles, are sometimes so crowded as to give the summits a palmated appearance. The fructification consists of sphærical tubercles, immersed in the substance of the frond, and scarcely so large as small poppy seeds. They contain a mass of very minute red seeds, surrounded by a semitransparent mucus. The *substance* is cartilaginous, tough, but less coriaceous than that of *F. Norvegicus*. *Colour* deep blood-red, turning in decay to a yellowish or greenish white. In drying, it assumes a remarkable tinge of purple, and does not adhere to paper.

Duration. Perennial.

This is one of the many additions to the British Flora, for which we are indebted to the acuteness and indefatigable industry of Mrs Griffiths, from whom I received specimens in April 1820. In its mode of growth, F. Devoniensis most nearly resembles *F. Norvegicus,* and might be easily mistaken for it; but upon a closer investigation, an essential difference is immediately discernible in its crowded and smaller tubercles, which appear to be confined to the apices, and are equally prominent on both sides the frond; a sufficient character to distinguish it from *F. Norvegicus,* the only plant with which it is liable to be confounded, unless, perhaps, we except some of the varieties of *F. crispus,* from which Mrs Griffiths observes, its substance and mode of ramification sufficiently distinguish it, independent of its totally different fructification. F. Devoniensis appears to have a strong proliferous tendency; and, after suffering an injury, will throw out three or four new fronds from the same extremity. From one specimen in my possession, I am inclined to believe, that an old frond may produce new stems from its summit, without any previous injury; for I have detected capsules in the centre of the plant, that were once evidently at the extremity.

Mrs Griffiths, to whom I am indebted for many of the above observations, discovered this plant on Waldon rocks, Torbay, on the 14th of February 1820.

Explanation of PLATE XIX.

Fig. 1. Plant *natural size.*
2. Portion of frond, }
3. A tubercle, } magnified.
4. A tubercle divided, }

BUCCLEUCH PLACE, *Edinburgh,*
7th June 1820.

XXVII.—*On the British Species of the Genus Beroe.*

By Dr Fleming of Flisk.

(Read Nov. 18. 1820.*)*

As none of the species of the genus Beroe have hitherto found a place in the systematical works on British zoology, any information concerning their occurrence in our seas, cannot fail to be acceptable to those who are investigating the physical and geographical distribution of animals, or who are desirous of extending the limits of our native Fauna *. The Beroe which forms the subject of the present communication, was found a few days ago in the Frith of Tay, in a pool left by the tide. It was in

* In reference to the British Fauna, I may here mention, that I have lately found, in this neighbourhood, the *Hirudo tessulata* and *H. lineata* of Müller, Hist. Verm. 173. and 169.

an exhausted state,—a circumstance which I much regret, as it prevented me from obtaining satisfactory information regarding the structure and uses of the internal organs.

The body was of an orbicular form, slightly depressed at the summit, and a little protuberant at the base. There were eight vertical bands or ribs, extending from the summit to the base. These were narrow, denticulated on the margin, confined to the surface, and of a denser substance than the gelatinous interior. From the central surface of the ribs, a number of filaments proceeded, which were lost in the substance of the body. The mouth, or the opening at the base, had some appearance of having its margin divided into four lobes. The tube which conducts from the mouth to the centre of the body, and is prolonged in its axis to the summit, had on each side a compressed organ adhering to its walls. These terminated in the centre, each in an ovate head, apparently containing air. Immediately below each head, there were numerous twisted vessels, some of which contained a reddish fluid. The tube which descended from the summit, as it approached the centre, suddenly expanded, and sent off a branch to a vesicle on each side; after which it appeared to unite with the one from the mouth. Each of the lateral vesicles terminated below in a blind cavity, which contained a glandular body, to the upper surface of which, several white threads were attached. The upper extremity of each vesicle was open, and terminated on the surface, on each side, in the space between two ribs. From each side of the vesicle, near its connection with the central vessel, there arose a tube, which, after dividing, sent a branch to each contiguous rib. The cavity of these tubes, at their union with the ribs, appeared to be filled with a whitish-coloured pulp. Each rib is furnished with a tube, uniting with it near the middle.

In consequence of this peculiar structure, I could easily observe the water enter the tube at the summit, pass into the lateral vesicles, and go out at their external openings; and, in some cases, the motion of the current was reversed. There did not appear to be any external opening at the extremity of the tubes joining with the ribs, although water obviously moved backwards and forwards in them. While the animal was active, there were numerous small spaces in the different tubes where the contained fluid circulated in eddies. This was particularly observable towards the centre, and in the tube which descends from the summit. I was unable to detect, with the naked eye, any structure in the tubes which could produce these partial motions; and the orbicular form of the animal prevented the application of high magnifiers. The outline of the body, given in Plate XVIII. fig. 3. and of the internal vessels, fig. 4. will convey to the reader an idea of the parts described.

The species here described, approaches, in many respects, to the *Beroe ovata* of Baster; Opuscula Subseciva, vol. i. p. 123. tab. xiv. f. v. It differs, however, in having only eight ribs, apparently smooth on the surface, with denticulated margins; whereas the species which Baster notices, has nine ribs, thickly set with moveable hairs *. The season in which ours was found, would likewise intimate that it is distinct from Baster's species, provided we attach much importance to his remarks. "In nostris hæc Beroe invenitur littoribus, et in ipsis hujus urbis portubus, Aprili potissimum mense; singularis enim variarum medusæ specierum proprietas est, quod aliæ aliis frequentissime inveniuntur mensibus."

Ellis appears to have been acquainted with this species, when he says, "The Beroe is a marine animal found on our coasts; of a gelatinous transparent nature; and of an oval or spherical form; about half an inch to an inch diameter; divided, like a melon, into longitudinal ribs, each of which is furnished with rows of minute fins, by means of which this animal, like the *animalia infusoria*, can swim in all directions, with great swiftness." — Phil. Trans. vol. lix. p. 144.

* It is not improbable that the ribs may have been furnished with ciliæ, and that the exhausted state of the animal prevented it from displaying their presence by their motion.

The *Beroe fulgens*, described and figured by Mr Macartney, in the Philosophical Transactions for 1810, p. 264. tab. xv. f. 7.–8., probably belongs to the same genus as the one whose characters we have attempted to deliniate.

"This most elegant creature is of a colour changing between purple, violet, and pale blue; the body is truncated before, and pointed behind; but the form is difficult to assign, as it is varied by partial contractions, at the animal's pleasure. I have represented the two extremes of form that I have seen this creature assume. The first is somewhat that of a cucumber, which, as being the one it takes when at rest, should perhaps be considered as its proper shape. The other resembles a pear, and is the figure it has in the most contracted state. The body is hollow, or forms internally an infundibular cavity, which has a wide opening before; and appears also to have a small aperture, posteriorly, through which it discharges its excrement. The posterior two-thirds of the body are ornamented with eight longitudinal ciliated ribs, the processes of which are kept in such a rapid rotatory motion, while the animal is swimming, that they appear like the continual passage of a fluid along the ribs. The ciliated ribs have been described by Professor Mitchell, as arteries in a luminous beroe, which I suspect was no other than the species I am now giving an account of.

" When the Beroe fulgens swam gently near the surface of the water, its whole body became occasionally illuminated in a slight degree; during its contraction, a stronger light issued from the ribs; and when a sudden shock was communicated to the water, in which several of these animals were placed, a vivid flash was thrown out. If the body were broken, the fragments continued luminous for some seconds; and, being rubbed on the hand, left a light like that of phosphorus. This, however, as well as every other mode of emitting light, ceased after the death of the animal."

Mr Macartney observed this species in Hearne Bay, on the northern coast of Kent, in October 1804. None were to be found in the same place in the month of September, in the following year, although some medusæ occurred which had been the companions of the beroe in the preceding season.

There is a third animal, nearly related to the genus beroe, which is figured by the late Reverend Charles Cordiner of Banff, in his " Remarkable Ruins," No. xi. Patella, fig. *g* G. The magnified representation which he has given, appears to intimate a subcylindrical animal, open at both ends, with a raised disk near one end, surrounded with diverging spines, and exhibiting two spots, whence probably issue tentacula. The author has failed in this, as in many other instances, to give descriptions, in illustration of the designs of his pencil.

The last species which has a claim to a place in the British Fauna is the *Beroe pileus* of naturalists. The late George Montagu, Esq. in a letter to me, dated 22d November 1812, says, "I have lately added Beroe pileus to the British Fauna." My friend, Dr Leach, who subsequently met with the same animal, sent me, last year, an outline drawing of its form. It differs very remarkably from the others already described, in possessing two long, flexible, ciliated tentacula.

This species is figured and described by Baster, in the work quoted above, vol. i. p. 124. tab. xiv. fig. 6.; and by Scoresby, in his "Arctic Regions," vol. i. p. 549. tab. xvi. fig. 4. It is true, that these figures do not bear a very close resemblance; but when we consider the mutability of its forms, we can scarcely expect an agreement in the representations given of it by different authors.

The necessity of separating the species with long ciliated tentacula, from such as are destitute of these organs, and forming them into a separate genus, appears to be generally acknowledged; and if no other term has been proposed to designate the new category, *Pleuro-brachia* may be adopted.

Manse of Flisk,
August 1820.

XXVIII.—*Descriptions of several new Plants from the Kingdom of Nepaul, taken from Specimens preserved in the Herbarium of* Aylmer Bourke Lambert, *Esq.*

Communicated by Mr David Don.

(Read 18th November 1820.)

The Kingdom of Nepaul, which has only of late begun to excite the attention of Europe, promises to be highly interesting, not only to the Geographer, but likewise to the Geologist and Botanist. The extent of its surface, the size of its valleys, and the elevation of its mountains, (some of which exceed the height of Chimborazo,) give it a more varied and mixed Flora than perhaps any other country on earth. Its plains, which extend into those of Hindostan, present the rich Flora of India. In its extensive valleys, are to be found the peculiar forms of the North American, Japanese, and Chinese Floras; and on the flanks of its lofty mountains, plants possessing the types of those of the North of Tartary, Siberia and Europe, make their appearance. But notwithstanding the striking similitude of its plants with those of the above-mentioned countries, they are found, on examination, to form very distinct species. The extensive Herbarium of the celebrated Professor Pallas, collected in various parts of the Russian Empire, now in the possession of Mr Lambert, has afforded me an opportunity of comparing the different plants of these countries with those of Nepaul. Without such aid it would be almost impossible to ascertain satisfactorily the limits of the various species. The botanical world is wholly indebted for a knowledge of its vegetable productions, to Dr Francis Hamilton (formerly Buchanan), and more recently to the exertions of Dr Nathaniel Wallich, the excellent superintendant of the Calcutta Botanic Garden, who has sent several able collectors, at the expence of the East India Company, to explore its vegetable treasure.

Without further notice, I shall now venture to give specific characters and detailed descriptions of several new Nepaul plants.

1. Rhododendron *setosum*, ramulis undique setosis; foliis ovalibus obtusissimis subtus marginibusque setosis; pedicellis glanduloso-setosis laciniis calycinis brevissimis nudis.

Habitat in Alpe immensa nivosa, Gossaignsthan Nepalensium dicta. D. Wallich. ♄.

Frutex Δ parvus ramosissimus, rami flexuosi subfastigiati (cortice tuberculato-rugoso deciduo) ramuli setis patentibus densè suppediti; folia ovalia obtusissima brevissimè petiolata, punctis nitidis resinosis utrinque instructa, subtus marginibusque densè setosa; flores capitati; pedicelli brevissimi, setis et glandulis intermixtis densè suppediti: laciniæ calycinæ brevissimæ nudæ: corolla purpurea tubo brevissimo, fauce nudo, laciniis ovatis obtusis crenulatis; genitalia exserta, filamenta basi barbata; pistillum filiforme longissimum, stigmate capitato. Folia turionesque contrita aromam gratissimam spirant, qua de causa dominæ in India Orientali iis in suffimentis utuntur.

Rhododendron *hirsutum* ab eo differt, ramulis junioribus pilosiusculis; foliis ovatis mucronulatis ciliatis supra glabris; pedunculis plus elongatis; laciniis calycinis linearibus aristatis ciliatis; corollæ laciniis ovatis acutiusculis; stylo villoso, stigmate excavato.

2. RHODODENDRON *anthopogon*, ramulis densè pubigeris; foliis ovalibus subtus dense tomentosis: floribus capitatis; corolla subhypocrateriformi fauci barbato, genitalibus inclusis.

Habitat in Alpe immensa nivosa, Gossaignsthan Nepaliensium dicta. D. Wallich. ♄.

Frutex Δ pedalis fasciculatim ramosissimus, ramis fastigiatis; cortex rugosus, rimosus, deciduus, ramulis pube brevissimo ferrugineo densè instructis; folia ovalia petiolata subretusa coriacea supra nuda anastomosanti venosa, subtus densè ferrugineo-tomentosa: Flores capitati; pedunculi brevissimi resinosi; laciniæ calycinæ breves rotundatæ margine villosæ; corolla subhypocrateriformis roseo-purpurea, tubo cylindrico, laciniis rotundatis crispato-crenulatis, fauce villo tortuoso candido barbato; genitalibus tubo inclusis; filamenta plana glabra; stylus superne crassior staminibus duplo brevior; stigma depressum.

Rhododendron *Dauricum,* ab supera primo discriminatur foliis tenuioribus deciduis nudis utrinque punctis resinosis crebrè instructis; floribus paucis lateralibus, corollis subrotatis tubo vix ullo fauce nudo; genitalibus longè exsertis; stigmatè capitato.

3. Rhododendron *campanulatum,* ramulis glabris: foliis ellipticis mucronulatis supra glabris subtus tomentosis, petiolis pedunculisque glabris; corolla campanulata, laciniis planis integerrimis; germinibus glabris.

Habitat Alpes Gossaingsthan. D. Wallich. ♄.

Frutex △, magnitudine R. Cataubiensis; cortex rugosa decidua; ramuli juniores glabri, folia late elliptica mucronulata coriacea supra nuda nitida subtus tomento brevissimo fusco instructa, basi rotundata, petiolis glabris; flores corymbosi terminales; pedunculi alterni glabri; laciniæ calycinæ brevissimæ rotundatæ glabræ; corollæ campanulatæ magnitudine illorum R. Ponticæ roseæ impunctatæ latæ, laciniis latè rotundatis planis margine integerrimis; filamenta plana basi villosa pistillo longiora; stylus angulatus, stigmate excavato; germinibus glabris.

Ab præcedente differt R. *Cataubiense* ramulis petiolisque densissimè tomentosis; foliis subtus niveis; laciniis corollæ crenulatis.

R. *arboreum* etiam differt foliis lanceolatis acutis subtus niveis basi subacutis; floribus glomeratis; pedunculis calycibusque densè tomentosis; corollis majoribus intus maculatis: laciniis emarginatis crispato-crenulatis; pistillo staminibus longiore, stigmate depresso subcapitato; germinibus densè tomentosis.

4. ANDROMEDA *cupressiformis*, procumbens; foliis quadrifario-imbricatis ovatis trigonis margine scarioso-membranaceo, apice diaphano-aristatis; pedunculis villosis, segmentis calycinis oblongis aristatis.

A. *cupressiformis* Wallich in literis.

Habitat in Alpibus Nepalensibus. D. Wallich. ♄.

Frutex △ procumbens ramosissimus; ramis ascendentibus, apicibus acutis: folia quadrifario-imbricata ovata trigona glabra nitida; margine scarioso-membranacea, apicibus mucrone tenui diaphano instructis: pedunculi solitares axillares uniflori villo longo tortuoso tecti; segmenta calycina oblonga diaphano-aristata extus nervosa corollas campanulatas æquantia.

A. *tetragona* ab eo discrepat, ramis brevioribus obtusis; foliis obtusis marginibus apicibusque nudis; pedunculis longioribus glabris; laciniis calycinis brevibus ovatis acutis muticis corolla duplo brevioribus.

A. *ericoides* etiam discrepat, ramis confertis gracilioribus attenuatis; foliis lineari-oblongis trigonis marginibus apicibusque ciliis setosis instructis; pedunculis glabris, laciniis calycinis muticis.

5 Lilium *Nepalense*, caule simplicissimo 1-floro scabriusculo; foliis lanceolatis sparsis acuminatis floralibus verticillatis; flore campanulato cernuo, petalis subunguiculatis.

Topho ab indigenis dicta.

Habitat in Nepalia. D. Wallich.

Caulis erectus simplicissimus teres uniflorus scabriusculus; folia sparsa lanceolata acuminata nervosa utrinque glabra, floralia verticillata; flos campanulatus cernuus pedunculatus pedunculo nudo; petala lanceolata acuta subunguiculata rosea? nervosa, apicibus patentibus.

Lilium *Japonicum* ad quem proxime affine, ab eo differt, caule glabro; foliis omnibus sparsis linearibus acutis longioribus; floribus erectis, petalis sessilibus.

6. Delphinium *scabriflorum*, petiolis longissimis basi non dilatatis; foliis basi cordatis 5-lobo palmatis segmentis cuneatis inciso-lobatis hirsutis; bracteolis pedicellis calycibusque scabri pilosis; calcaribus curvatis obtusis, pedicellis longioribus; capsulis glabris.

Habitat in Alpibus Nepaliæ. D. Wallich. ♃.

Radix perennis; caules subgraciles 4-pedales subsimplices teretes erecti basi læves, supernè pilosi; folia radicalia longissimè petiolata, (petiolis subteretibus pilosis,) 5-lobo palmata, segmentis cuneatis inciso-lobatis utrinque præcipuè nervis pilosis, lobulis mucronatis ; caulina pauca remota 5-partita, segmentis lanceolatis inciso-lobatis mucronatis utrinque pilosis ; racemi stricti pauciflori ; bracteoli lineares obtusiusculi pedicellique et calyces valdè scabrè pilosi; calcaribus curvulatis obtusis pedicellis longioribus ; foliola perianthii ovata obtusa multinervosa, margine crispato-undulata, extus virescentia, intus marginesque obscurè cœruleæ ; petala exteriora calcarata, apice glabra bifida lobulis obtusis, interiora lamina patente barbata profundi bifida, lobulis obtusis crenulatis; filamenta basi membranaceo-dilatata ; ovarii tres glabri, styli recti; flores obscurè virescente-cœrulei ; faciem Aconiti ochroleuci refert.

7. Leontodon *eriopodum*, foliis linearibus runcinatè glabris intra folia densè lanigeris ; scapo foliis breviore undique lanigero ; pappo tenuissimo serrulato, brevissime stipitato.

Habitat in Nepaliæ Alpibus. D. Wallich. ♃.

Radix crassa fusiformis. Planta cæspitosa intra folia lana tortuosa fulva densè instructa ; folia pluria patentia linearia runcinata utrinque glabra, lobulis obtusis ; scapi plures foliis breviores 1-flori teretes inanes lana candida undique tecti; anthodium magnitudine ejus Apargiæ autumnalis, squamæ exteriores patentes ovato-oblongæ, interiores erectæ lineari-lanceolatæ obtusiusculæ basi membranaceo-dilatatæ; semina ovata lævia; pappo tenuissimo serrulato æquali albo stipite brevi.

8. TRAGOPOGON *gracile*, caule erecto flexuoso, 1-floro; foliis superne angustè linearibus carinatis, basi dilatatis; anthodiis 6-phyllis; pappo inæquali breve stipitato.

Habitat in Nepaliæ Alpibus. D. Wallich. ♃.

Radix fusiformis, caules plures graciles flexuosi 1-flori foliosi læves vix foliis longiores; folia radicalia erecta angustè linearia obtusiuscula nervosa subtus carinata glabra intus præcipuè ad basin lanigera, caulina superne angustè linearia basi dilatata amplexicaulia intus lanigera; anthodium magnitudine eorum Lactucæ perennis, 6-phyllum, squamis lanceolatis cuspidatis glabris; flosculi pauci lineares lutei; semina lævia; pappus inæqualis brevè stipitatus.

9. SAUSSUREA* *gossipiphora*, caule simplici lanigero foliis lineari-lanceolatis acutis, dentatis lana occultis; floribus aggregato-capitatis sessilibus involucratis lana longissima velatis.

Cnicus gossipinus Wallich in literis.

* Pro charactere hujus generis, confer *Annales du Muscum*, tom. 16.

Habitat in Alpe excelsa Gossaingsthan Nepalensium dicta. D. Wallich. ♃.

Planta ob formam singularem mirifica est, molem parvam lanæ referens; radix fibris longis simplicibus crassis composita; caules palmares solitarii simplices lana longissima gossipina densissimè obtecti; folia lineari-lanceolata acuta coriacea reticulatim nervosa dentata in lana longissima occulta; flores in caput densum convexum obsiti, involucrati bracteis exterior linearibus, interior ovatis acuminatis quadruplo-brevioribus lana velatis; anthodiis ovatis sessilibus imbricatis, squamis inermibus omnibus acutis, receptaculum setosum, setæ breves scariosæ; semina parva angulata papposa, pappo ingente plumoso sessili.

London, }
September 1820. }

XXIX.—*Description of a New Species of Potentilla, from the West Coast of Greenland; with some Account of the Arctic Flora.*

By Robert Kaye Greville, Esq. M. W. S.

(*Read* 18*th November* 1820.)

In submitting the following paper to the notice of the Society, I have not merely been actuated by the pleasure common to all lovers of Natural History, that of delineating and describing a new object; nor have I confined myself to the additional and pleasing task, of rendering that public homage to a brother-labourer in the same field, that every liberal mind delights to acknowledge. The state of botanical knowledge, as confined to the Arctic Regions, is yet very limited; and, above all, the general as well as particular geographical distribution of plants, is a subject that has only been noticed by a few individuals. Whatever contributions, then,

POTENTILLA JAMESONIANA

R. K. Greville. ad nat. & delin. E. Mitchell, sculpt.

that can be added to our stock of information on these subjects, it is presumed will not be unworthy of public attention : and it is under this impression that I have drawn up the following short paper, which, I am well aware, derives a value it would not otherwise possess, from the figure and description of the interesting little plant, so recently discovered by Mr Jameson.

POTENTILLA foliis ternatis, apice incisis, utrinque sericeis; caule simplici, erectiusculo, sub-bifloro; calycis segmentis inæqualibus.

POTENTILLA *Jamesoniana*. Leaves ternate, gashed at the apices, silky on each side. Stem simple, nearly erect, scarcely two-flowered; segments of the calyx unequal.

Class and Order, Icosandria Polygynia.

Nat. ord. ROSACEÆ, Juss. Decand.

See Plate XX.

Description.

Root. I have not seen.

Stem about four inches, simple, rough at the bottom, with the remains of old stipules, which form a series of hard reddish scales, that increase in number with the age of the plant; and, together with the radical leaves, form a thick turf. They probably assist in protecting it from the rigour of winter. The upper or herbaceous part, is hairy and tomentose, becoming silky beneath the calyx.

Leaves ternate, silky, particularly the upper surface, less so underneath, and of a paler colour; leaflets ob-ovate, the two outer trifid, the centre one irregularly quinquefid. The radical leaves are on short footstalks, scarcely longer than the leaves themselves. The footstalks are covered with fine silky hairs. Stem-leaf (for there is seldom more than one) sessile, three-lobed, middle lobe trifid.

Stipules broad, embracing the stem.

Calyx hairy and tomentose; the segments unequal.

Flowers terminal, solitary, large, rarely two on the same stem.

Petals emarginate, inversely kidney-shaped, of a deep yellow colour, slightly tinged with buff.

Anthers on very short filaments, and few in number.

Seeds. I have not seen.

Duration perennial. *Hab.* West Coast of Greenland. *Altitude* 300 feet. *Time of flowering*, June and July.

This elegant little plant was discovered on Hare Island, (or as it is sometimes called, Waygat Island), in lat. 70° 30′, on the 22d of June 1818, by William Jameson, Esq. surgeon, who kindly communicated it to me, with a request that I would give a figure and description of it to the world. In so doing, I have, at the same time, conferred upon this delicate arctic stranger, the name of its finder;—a name, that I trust will be continued by future botanists, as a reward for that love of science and general observation, which enabled Mr Jameson to add to the already extensive genus Potentilla, another and so beautiful a species. It would be well, if other individuals, possessing similar opportunities, were actuated by an equally praiseworthy curiosity, to explore the half-untrodden shores of Greenland and Spitzbergen.

Wahlenberg, by his Flora Lapponica, has contributed more than any other individual, to illustrate the Arctic Flora; and his work deservedly ranks among the first of its class. But there is a great mass of information still to be obtained, from the more inaccessible parts of the arctic circle, which becomes interesting, in proportion to the difficulty of procuring it. Were this subject better understood, the Physiology of Botany would receive a considerable addition of interest. We should, then, be enabled to show, in a more general manner, the change of habit in such plants as are common to many degrees of latitude,—to illustrate the geographical distribution of vegetation, and to trace in a more beautiful point of view, the gradual descent of many plants from the mountains to the plains, as they approach the pole; and the effects of climate upon such as are common to the plains both here and in higher latitudes.

Salix *herbacea* is with us an Alpine plant; and in Lapland, (lat. 67½°–70°), placing the limits of perpetual snow at 3300 feet, in which Humboldt and Wahlenberg agree, Salix herbacea is found to grow at from 2100 to 2400 feet of elevation. On the west coast of Greenland, (lat. 70° 40′–71°), Mr Jameson gathered the same plant at an elevation of only 300 feet. In latitude 74°, he again met with it; but it had then entirely lost its character, as an alpine plant, and was growing upon a small low island. It was also brought to Mr Jameson by a sailor, from the level coast of Labrador, (lat. 76°) adhering to a specimen of Papaver *nudicaule*. This little salix, with one or two others, the largest of which do not exceed three or four inches, are the only trees to be seen in these dreary regions.

According to Humboldt*, the most common plants "in montibus nivosis zonæ frigidæ," are CARYOPHYLLEÆ (Stellaria, Cerastium,) ERICINÆ (Andromeda,) and RANUNCULACEÆ. In Spitzbergen, however, (lat. 79° 10′,) Captain Scoresby found SAXIFRAGÆ not uncommon; and Mr Jameson obtained several CRUCIFERÆ and ROSACEÆ, with a few GRAMINEÆ, from Greenland.

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* Vid. HUMBOLDT, de Distributione Geographica Plantarum.

The following account of the plants Mr Jameson gathered in Greenland, with the altitudes at which they occur, I cannot do better than give in his own words.

"On the sea-shore we found Cochlearia *officinalis*, Statice *armeria*; and in one or two places, where the soil is sandy, Arundo *arenaria*. Immediately above this, Lychnis *dioica*, Alopecurus *alpinus*, Potentilla *sericea*, Empetrum *nigrum*; and among the large stones detached from the higher ground, Stellaria *humifusa*. The banks of those periodical streams which run down the sides of the mountains, produce Eriophorum *angustifolum*, Saxifraga *stellaris*, S. *cernua*, Stellaria *graminea*, Rumex *digynus*, Arabis *alpina*, Draba *alpina*, *var.* flore albo, and Ranunculus *nivalis*. These occur at a very moderate elevation.

"Higher up, or about the altitude of 300 feet, and growing among debris, Papaver *nudicaule*, Cerastium *latifolium*, Silene *acaulis*, Potentilla *sp. nov.*, Saxifraga *Grœnlandica*, S. *tricuspidata*, S. *oppositifolia*, Pedicularis *hirsuta*, P. *flammea*, P. *recutita?* Draba *alpina*, D. *stellata*, Stellaria *biflora*, Azalea *Lapponica*, and Salix *herbacea*. Three plants remain to be mentioned, which, taken together, constitute the greater proportion of the vegetation of the country. These are Vaccinium *uliginosum*, Andromeda *tetragona*, and Dryas *integrifolia*. The two former, in particular, cover extensive tracts of land, and occupy the same situations there, as the common heath does in Scotland. They occur from a little above the sea-mark, to an elevation of about 800 feet, when they become very much stunted, and rarely produce flowers. Above this point we found a profusion of Lichens, chiefly Cetraria *nivalis*, and various species of Gyrophora incrusting the rocks. The only phænogamous plant observed here, was Saxifraga *tricuspidata*, its succulent habit adapting it to situations where scarcely any other plant will grow.

"On one of the Duck Islands *, which is perfectly flat, and situated in lat. 74°, I only noticed the following plants: Potentilla *frigida?* Andromeda *tetragona*, Cerastium *latifolium*, Silene *acaulis*, Stellaria *humifusa*, Papaver *nudicaule*, Salix ? S. *herbacea*, a Festuca, probably *vivipara*, and a Carex, probably *rigida*."

An arranged catalogue of the plants recently brought by Captain Scoresby from Spitzbergen, and by Mr Jameson from Greenland, will not, it is hoped, be uninteresting to those who are curious respecting the economy of Nature in so dreary and inhospitable a country, where the whole process of vegetation is often completed within the short space of a month or six weeks.

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* They are three in number.

A catalogue of the plants found in Spitzbergen, lat. 79° 10′ by Captain Scoresby, and named by Robert Brown, Esq. to which I have added as many habitats as I have been able to obtain, in order to give a general idea of their geographical distribution.

Hexandria.

Luzula *campestris.* Juncus campestris, *L.* *Hab.* in pascuis siccioribus totius fere Europæ. Lapponia (Wahl.) Islandia (Hook.)

Decandria.

Andromeda *tetragona.* *Linné.* *Hab.* in Lapponia, (Wahl.) Siberia, (Pers.) Grœnlandia, (Jam.

Saxifraga *oppositifolia, L.* *Hab.* in Helvetia, (Schleich.) Britannia, (Smith.) Montibus Carpaticis, (Wahl). Islandia, (Hook.) Lapponia, (Wahl.) Grœnlandia, (Jam.)

S. *cernua, L.* *Hab.* in Helvetia, (Schleich). Britannia, (Smith). Islandia, (Hook.) Lapponia, (Wahl.) Grœnlandia, (Jam.)

S. *var. nivalis, L.* *Hab.* in Britanniæ summis alpibus, (Smith). Lapponia, (Wahl.) Islandia, (Hook).

S. *cæspitosa β Grœnlandica.* *Wahlen. lapp.* 119. In Grœnlandia, (Jam.)

Cerastium *alpinum, α hirsutum.* *Wahlen. lapp.* 136. *Hab.* in alpibus totius fere Europæ.

ICOSANDRIA.

Dryas *octopetala, L.* *Hab.* in Helvetia, (Schleich.) Britannia, (Smith.) Montibus Carpaticis, (Wahl.) Islandia, (Hook.) Lapponia, (Wahl.)

POLYANDRIA.

Papaver *radicatum. Rottb.* vix diversum e P. *nudicaule, L.*

Ranunculus *sulphureus. Soland. in Phipp's voyage.* *Hab.* in montibus excelsis Europæ, Asiæque borealis et frigidissimæ. Finmarkia, (Wahl.) Siberia, (Laxan. patrin.)

DIDYNAMIA.

Pedicularis *hirsuta, L.* *Hab.* in Lapponia, (Wahl.) Siberia, (Pallas.) Grœnlandia, (Jam.)

TETRADYNAMIA.

Cochlearia *Grœnlandica?* vel C. *Anglica, Wahl. lapp.*

Cardamine *bellidifolia, L.* *Hab.* in alpibus Scoticis, (Smith.) Lapponia, (Wahl.) Siberia, (Pallas.) Islandia, (Hook.)

Draba *alpina, L.* *Hab.* in alpibus Europæ borealis, (Pers) Lapponia, (Wahl.) Grœnlandia, (Jam.)

Diœcia.

Salix *polaris, Wahlenb. lapp.* 261. tab. 13. fig. 1. *Hab.* in Finmarkia et ad lacum Tornensem inter Sphagnum Cel. *Liljeblad.*

Cryptogamia.

Trichostomum *lanuginosum.*
Hypnum *dendroides.*
rufescens ?
Bryum *ventricosum.* *Smith brit.*
ligulatum ?
Dicrani species ?
Andræa *alpina.*
Ulva ?
Fucus forsan nov. sp. prope *alatum* sed absque fructificatione.
plumosus.
sinuatus *.
Conferva ?
nigra ?
Conomyce *furcata, Achar. syn.* 276.
pocillum. *Id.* 253.
Solorina *crocea.* *Id.* 8.
Alectoria *jubata,* β *chalybeiformis.* *Id.* 291.
Lecanora *murorum,* var. *Id.* 181.

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* I presume *sinuosus* is here intended.

Lecidea *atrovirens*. *Id.* 24.
Gyrophora *hirsuta*. *Id.* 69.
erosa. *Id.* 65.
proboscidea. *Id.* 64.
Endocarpum *sinopicum*. *Id.* 98.
Sphærophoron *coralloides*. *Id.* 287.
Parmelia *stygia*. *Id.*
recurva. *Id.* 206?
sp. nov.? sed absque fructific.
Peltidea *canina?*
Cetraria *nivalis*. *Id.* 228.
Cornicularia *aculeata*, β *spadicea*. *Id.* 300.
Usnea? prope U. *melaxantham*. *Id.* 303.
Stereocaulon *paschale*. *Id.* 284 *.

A Catalogue of the Plants collected by William Jameson, Esq. surgeon, on the West Coast of Greenland, betwixt latitudes 70° and 71°, in 1818 and 1820.

TRIANDRIA.

Eriophorum *polystachion*. Wahl. Fl. lapp. 18. E. angustifolium, (Smith.) *Hab.* in Helvetia, (Schleich.) Britannia, (Smith.) Montibus Carpaticis, (Wahl.) Lapponia, (Wahl.) Islandia, (Hook.)

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* *Vide* Scoresby's Account of the Arctic Regions, vol. i. Append. No. 5. p. 75.

Alopecurus *alpinus*. *Smith*. *Hab*. in alpibus Scoticis.

Arundo *arenaria*, *L*. *Hab*. in America, (Michaux.) Britannia, (Smith.) Lapponia, (Wahl.) Islandia, (Hook.)

Festuca *vivipara ?* *Hab*. in alpibus Britannicis, (Smith.)

Pentandria.

Statice *Armeria*, *L*. *Hab*. in Britannia, (Smith) Siberia, (Pallas.) Swedia, (Linn.) Lapponia, *var*. β (Wahl.) Islandia, (Hook.)

Rhododendron *lapponicum*, *Wahl*. Fl. lapp. 104. Azalea lapponica, *L*. *Hab*. in Swedia, (Linn.) Russia, (Pallas.) Lapponia, (Wahl.)

Hexandria.

Rheum *digynum*. Wahl. Fl. lapp. 101. tab. 9. fig. 2. Rumex digynus, *L*. *Hab*. in Helvetia, (Schleich.) Britannia, (Smith) Montibus Carpaticis, (Wahl.) Swedia, (Linn.) Siberia, (Pallas.) Islandia, (Hook.)

Tofieldia *palustris*. *Huds*. Tofieldia borealis, *Wahl*. *Fl*. *lapp*. *Hab*. in Helvetia, *(Hall*. Anthericum filamentis glabris ?) In America, *(Mich*. Narthecium alpinum.) Swedia, (Linn.) Britannia, (Smith). Islandia, (Hook.) Lapponia, (Wahl.) Siberia, (Pallas.) Non est *T*. *pusilla* Nutt. et Pursh ? Vid. Hooker in Fl. Lond.

OCTANDRIA.

Vaccinium *uliginosum, L.* *Hab.* in Helvetia, (Schleich.) Britannia, (Smith.) Montibus Carpaticis ad 6600 pedum elevationem, (Wahl.) America, (Mich.) Swedia, (Linn.) Siberia, (Pallas.) Kamtschatka, (Arct. Zool.) Islandia, (Hook.) Lapponia, (Wahl.)

DECANDRIA.

Andromeda *tetragona, L.* *Hab.* in Spitzbergia, (Scoresby.) Vid. supra.

Pyrola *secunda, L.* *Hab.* in Helvetia, (Schleich.) Montibus Carpaticis in sylvis fere omnibus usque ad terminum abietis ubique, (Wahl.) Britannia, (Smith.) America, (Mich.) Islandia, (Hook.) Siberia, (Pallas.) Lapponia, (Wahl.)

Saxifraga *stellaris, L.* *Hab.* in alpibus Europæ ad latera rivulorum. Siberia, (Gmel.) Swedia, (Linn.) Islandia, (Hook.) Lapponia, (Wahl.)

S. *tricuspidata.* *Retz. scand.* *Hab.* in Grœnlandia, (Pers.)

S. *cernua, L.* *Hab.* in Spitzbergia, (Scoresby.) Vid. supra.

S. *Grœnlandica, L.* *Hab.* in Spitzbergia, (Scoresby.) Vid. supra.

S. *oppositifolia, L.* *Hab.* in Spitzbergia, (Scoresby.) Vid. supra.

Stellaria *humifusa* *. *Swartz. Hab.* in alpibus Sueciæ et Norvegiæ, (Pers.)

S. *graminea*, *L. Hab.* in dumosis totius fere Europæ. Lapponia, (Wahl.) Siberia, (Gmel.)

Alsine *biflora*, (Wahl.) Fl. lapp. 128. Stellaria biflora, *L. Hab.* in Swedia, (Linn.) Siberia, (Pallas.) Islandia, (Hook.)

Silene *acaulis*, *L. Hab.* in Helvetia, (Schleich.) Britannia, (Smith). Montibus Carpaticis, (Wahl.) Swedia, (Linn.) Lapponia, (Wahl.) Islandia, (Hook.)

Lychnis *dioica*, *L. Hab.* in Britannia, (Smith.) Montibus Carpaticis, (Wahl.) Swedia, (Linn.) Lapponia, (Wahl.)

Cerastium *latifolium*, *L. Hab.* in Helvetia, (Schleich.) Var. β in Montibus Carpaticis ad latera abscondita alpium altissimarum, (Wahl.) Britannia, (Smith) Islandia, (Hook.)

ICOSANDRIA.

Dryas *integrifolia* †. Pers. Syn. pars secund. p. 57. *Hab.* in Norvegia, (herb. Juss.)

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* There appears to be much confusion respecting this plant. *Vide* Wahlenberg's Fl. lap. p. 124.-5., at Stellaria *crassifolia*; and p. 129.-130., at Arenaria *humifusa*. Mr Jameson's plant agrees, in every respect, with the character given in Pers. Syn. p. 501. I have not seen the N. Act. Holm. in which Swartz published it.

† At Dryas *octopetala*, in Fl. lapp. Wahlenberg has the following observation: " Dr. *integrifoliam* a cl. Per-

Potentilla frigida* ? Vill. delph. 3. p. 563. Pers. Syn. p. 56.

P. *Jamesoniana,* sp. nov. *Hab.* in Groenlandia, (Jam.)

P. *sericea* † ? *Willd.* *Hab.* in Siberia, (Pers.)

POLYANDRIA.

Papaver *nudicaule. Hab.* in Siberia, (Pers.) Islandia, (Hook.) Spitzbergia ? (Scoresby).

Ranunculus *nivalis, L. Hab.* in Lapponia, (Wahl.) Swedia, (Linn.) Norvegia, (Gunn.) Spitzbergia, (Mart.) Islandia, (Hook).

DIDYNAMIA.

Pedicularis *flammea, L. Hab.* in Alpibus Helvetiæ, (Hall.) Islandia, (Hook.) Lapponia (Wahl).

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soon, in Synops. p. 57. pro Norwegica planta perperam exhibitam, nonnisi e Groenlandia habuit, cel. Vahl. secundum. Act. Hist. Nat. Hafn."

* P. foliis omnibus ternatis, inciso-serratis hirsutis. This, surely, cannot be Schleicher's P. *frigida,* which Wahlenberg says belongs to his P. *verna?* Persoon's P. *frigida,* in Synops. p. 56., answers to our Greenland plant, even to the *radix crassa.* Vid. Wahlenb. in Flora Carpatorum Principal. p. 156. Brown's P. *Groenlandica,* in Ross's Voyage, vol. ii. p. 193. marked *nov. sp.? nimis affinis P. frigidæ et Brownianæ,* is probably our plant.

† This, if not *sericea,* will be Brown's P. *pulchella,* nov. sp. Vide Brown, in Ross's Voyage to Baffin's Bay, vol. ii. p. 193.

P. *hirsuta, L.* *Hab.* in Swedia, (Linn.) Spitzbergia, (Scoresby) vid. supra.

P. *recutita ? L.* *Hab.* in Helvetia, (Schleich.) in summis Alpibus.

TETRADYNAMIA.

Draba *alpina, L.* *Hab.* in Spitzbergia, (Scoresby), vid. supra.

D. *hirta* var. β *alpicola,* Wahl. lapp. 175, tab. 11. fig. 1. D. stellata, *Jacq.* *Hab.* in Britannia, (Smith), Lapponia, (Wahl).

D. *muricella, Wahl. Fl. lapp.* 174. tab. 11. fig. 2. D. nivalis, *Liljebl.* *Hab.* in Helvetia, (Schleich.) Lapponia, (Wahl).

Arabis *alpina, L.* *Hab.* in Helvetia, (Schleich.) in Alpibus Europæ; et in Barbaria, (Pers.) Islandia, (Hook.) Lapponia, (Wahl.).

Cochlearia *officinalis, L.* *Hab.* in Helvetia, (Schleich.) Britannia, (Smith), Montibus Carpaticis, (Wahl.) Swedia, (Linn.) Siberia, (Gmel.) Islandia, (Hook.) Lapponia, (Wahl.).

SYNGENESIA.

Gnaphalium *alpinum, L.* *Hab.* in Alpibus Europæ. Swedia, (Linn.) Siberia, (Pallas.) Islandia, (Hook.) Lapponia, (Wahl.).

Diœcia.

Salix *? *Hab.* Duck Islands, lat. 74°.

S. *herbacea*, *L.* *Hab.* in summis Alpibus Europæ. In Russia et Siberia, (Pallas). Swedia, (Lin.) Lapponia, (Wahl.) Duck Island, lat. 74°. (Jam.).

Empetrum *nigrum*, *L.* *Hab.* in locis montosis totius Europæ. America, (Mich.) Siberia, (Pallas). Kamtschatka, (Arct. Zool.) Islandia, (Hook.) Lapponia, (Wahl.).

Cryptogamia.

Splachnum *mnioides*, var. α *minus*, *Hook. Musc. Brit.*

Hypnum *cupressiforme*, *Hook. Musc. Brit.*

Dicrani species.

Cetraria *Islandica*. Achar. Syn. 229. Physcia Islandica. *Decand*,

C. *nivalis*, Achar. Syn. 228.

Lecanora *tartarea* γ frigida. Achar. Syn. 172. Lichen tartareus β frigidus. *Wahl. Fl. lapp. p.* 403. Patellaria tartarea, *De Cand.*

L. *murorum* var.?

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* It is probable that this may turn out to be the "Salix arctica, *nov. sp.*" of Brown. Vide Voyage to Baffin's Bay, by Ross, vol. ii. p. 194.

There are living specimens brought from Duck Islands by Mr Jameson, in the Botanic Garden at Edinburgh, and also in the collection of Mr Neill at Canonmills, near that city; so that, in another year, we may be able to ascertain the characters of the species.

Cenomyce *rangiferina,* var. Achar. Syn.
Cenomyce ?
Gyrophora *erosa,* Achar. Syn. 65.
Cornicularia ? prope C. *aculeata.*
Usnea ? nov. sp. ?
Stereocaulon *paschale,* Ach. Syn. 284.
Sphærophoron *coralloides.* *Id.* 287.

Besides the above catalogues, there is another that remains to be noticed, containing several very interesting discoveries. This consists of those plants which were collected by various gentlemen who accompanied Captain Ross in his Voyage of Discovery to Baffin's Bay; from latitude 70° 30′ to 76° 12′, on the east side, and in lat. 73° on the west side. This collection, like that of Captain Scoresby, was arranged by Robert Brown, Esq.—a circumstance, of itself, sufficient to stamp a value upon it.

From this list, I shall only extract such plants as have not enriched the two former; not omitting, however, to make similar additions to illustrate their geographical distribution.

Triandria.

Agrostis *algida, Phipps's Voyage,* p. 200. Wahl, Lapp. p. 25, t. 1. Gramen sui generis, ***Brown.*** *Hab.* in stillicidio aquæ nivalis ad latus septentrionale alpis Raste-kaisse Finmarchiæ orientalis; ubi adeo ab aqua inundata fuit ut spica tantum eminuit. Lecta florens, d. 27 Julii 1802, Wahl.

A. *paradoxa,* Brown, *nov. sp.* vix hujus, forsan proprii generis, *Brown.*

Poa *laxa,* Willd. sp. pl. 1. p. 386. *Hab.* in Helvetia (Schleich.), Montibus Carpaticis (Wahl). —P. laxa, Wahl. Fl. Lapp., est P. flexuosa, Smith, Fl. Brit. et Fl. principal. Carpat. Wahl.

DECANDRIA.

Pyrola *rotundifolia, L.?* absque floribus haud determinanda.

Saxifraga *propinqua,* Brown, *nov. sp.* S. hirculo, cui proxima, minor, et diversa præsertim calycibus nudis et petalis inappendiculatis. *Brown.*

S. *flagellaris,* Sternberg, saxifr. p. 25. t. 6. S. setigera, *Pursh. Amer.* 1. p. 312.

S. *petiolaris,* Brown, *nov. sp.* proxima S. rivulari.

Lychnis *apetala, L. Hab.* in Swedia, (Linn.) Lapponia, (Wahl.) Siberia, (Gmel. Pers.).

L. *triflora,* Brown, *nov. sp.*

ICOSANDRIA.

Potentilla *pulchella,* Brown, *nov. sp.* P. sericeæ affinis.

P. *Groenlandica,* Brown, *nov. sp.?* nimis affinis. P. *frigidæ* et *Brownianæ.*

TETRADYNAMIA.

Draba *oblongata,* Brown, *nov. sp.*

D. *corymbosa,* Brown, *nov. sp.?* præcedenti valde affinis, et ambæ D. *rupestri,* (Hort. Kew. 4. p. 91.) proximæ. *Brown.*

Cochlearia *fenestrata,* Brown, *nov. sp.* A C. *Anglica* et *Danica,* quibus valde propinqua, differt valvulis subaveniis et dissepimento elliptico-lanceolati axi dehiscente. *Brown.*

SYNGENESIA.

Leontodon *taraxacum, L.?* varietatis nana? vix species distincta. *Brown.*

MONŒCIA.

Carex *compacta,* Brown, *nov. sp.* C. pullæ affinis.

DIŒCIA.

Salix *arctica,* Brown, *nov. sp.*

S. ? specimen mancum dubiæ speciei præcedenti proximæ. Brown.

POLYGAMIA.

Hierochloe *alpina* Br. Holcus alpinus, *Wahl. Lapp.* p. 31 *.

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* A curious plant, first discovered by Liljeblad, (sv. flor. ed. 2. p. 41.) *ad Tornea-träsk in alpe Kärpile,* and made by him an Aira. Vide an excellent description of it by Wahlenberg, Fl. Lapp. p. 32.

Cryptogamia.

Lycopodium *selago, L.*

Polytrichum *juniperinum.* Musc. Brit. p. 25.

Orthotricum *cupulatum.* Id. 72.

Dicranum *scoparium.* Id. 57.

Mnium *turgidum.* Wahl. Lapp. p. 351.

Bryum ———, absque capsulis.

Hypnum *aduncum, L.*

Jungermannia ——— fructificatione nulla.

Cenomyce *fimbriata.* Achar. Syn. p. 254.?

Dufurea ? *rugosa,* Brown, *nov. sp.*

Cornicularia *bicolor.* Achar. Syn. p. 301.

Usnea ?———, *nov. sp.?* absque scutellis.

Ulva *crispa.* Lightf. Scot. 972 ?

Algarum genus ? ? Confervis simplicissimis et Tremellæ cruentæ (*Eng. Bot.* 1800.) quodammodo affine ? ? Minute globules, the colouring matter of the red snow, of which extensive patches were seen in lat. 76° 25′ N. and long. 65° W. *Brown* *.

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* Vid. Ross's Voyage to Baffin's Bay, vol. ii. p. 191. et seq.

Edinburgh, 25. *Buccleuch-Place,*
October 23. 1820.

XXX.—*Account of the Lutra vittata, and of the Viverra poliocephalus.*

By Thos. Stewart Traill, M. D. F. R. S. E. & M. W. S.

(*Read 27th November* 1819.)

The animal to which I apply the name of *Lutra vittata,* appears to me to be that described by Buffon under the name of Le Fouine de la Guiane, or Martin of Guyana; which, if not the same, is nearly allied to the Viverra vittata of systematic writers.

Mr Pennant, and some other naturalists, have judiciously separated the Otters from the Mustelæ of Linnæus, and united the rest of this genus to the Viverræ of the Linnean system: but this animal, I presume from careless examination, has been hitherto permitted to remain among the Weesels; though the structure of its feet, which are all perfectly webbed, shews that it must be classed among the Otters. The name Lutra vittata is proposed, as characteristic of the conspicuous white band or vitta, which passes across its forehead, to the sides of its neck. I am disposed to consider Viverra vittata of Gmelin's edition of the Systema Naturæ and of Shaw, the Grison of Allamand and Buffon, as a young specimen of this animal. The only marked differences seem to be in the proportions of the limbs and tail. The general habits of the two animals do not materially differ.

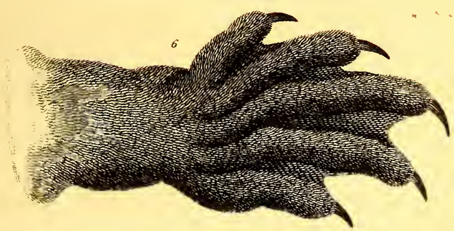
The specimen from which this description and figure are taken, was killed in Demerara by Charles Edmondston, Esq. and brought to this country by him in 1817.

Lutra vittata.

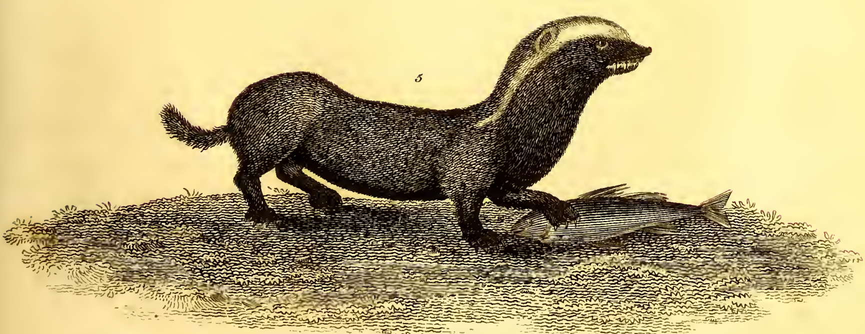
Character. L. nigricans, vitta alba per frontem et aures, ad humeros producta.

Blackish Otter, with a white band passing through the forehead and ears, to the shoulders. Pl. XIX. fig. 5.

The upper part of the body, and the whole tail, have a dark dingy grey hue, produced by the yellowish white tips of its blackish hairs. The vitta passes just above the eyes; is about $\frac{3}{4}$ths of an inch broad on the forehead; includes the ears, which are round and small; dilates a little at the lower part of the neck, and ends in a point on the shoulders. The



Lutra vittata.



Figs 1.2.3.4. Drawn by R. K. Greville — *Engraved by W. H. Lizars*

head below the vitta; the throat, breast, and limbs, appear of a glossy black, in a direct light, but of a very dark chocolate brown, when seen obliquely. The belly is of a darker grey colour than the back. The limbs are short and strongly formed; the toes of all the feet are perfectly webbed, (Pl. XIX. fig. 6.); the claws are long and sharp; the tail appears flattened, from the hair dividing on its upper surface, and passing off sidewise, leaving a narrow space in the centre rather bare. The teeth are strong and large; the eyes are said to be of a reddish hue. The dimensions of this specimen (which seemed to be very well stuffed), are as follows:

	FEET.	INCH.
Extreme length, ...	2	11
Length of head, ...	0	6½
——— of body, ...	1	7½
——— of tail, ...	0	9
——— from nose to eye, ...	0	1⅝
——— from eye to ear, ...	0	1½
Circumference of body, ...	1	0
——————— of head, ...	0	10
Height at shoulder, ...	0	5½
——— at hip, ...	0	6

The Weesel described shortly by Buffon under the name La Grande Marte de Guiane, is mentioned as a doubful species by Shaw. A well stuffed specimen of this animal having been brought by Mr Edmondston to England, I have described and figured it. Pl. XXIII. fiig. 1.

VIVERA POLIOCEPHALUS.

Grey-headed Weesel.

Character.—V. corpore nigro; capite colloque griseis jugulo macula flavescenti angulari nigro, margine circumscripta notato.

Weesel with a black body; head and neck dark grey; the throat marked with a yellowish angular spot, edged with black.

The habit of this animal is slender; its limbs longer than in most of the genus; its claws and teeth are uncommonly large. The canine teeth project much from the upper jaw, and give the animal a fierce appearance. The ears are prominent; the eyes large. The hair of the whole trunk, the limbs and the tail, is of a glossy black. That on the tail is very full and long; but the hair which covers the head and neck, is dull, and of a dark iron-grey colour. The disposition of the hair on the neck is rather peculiar. From behind the ears

Fig. 1.

M^r. ADIE'S INSTRUMENT FOR SPECIFIC GRAVITIES.

Fig. 2.

GREY HEADED WEESEL.

W.H. Lizars Sculp^t.

to the nape of the neck, the hairs point upwards, forming a slight ridge. At the nape, the hair is partly deflected downward, as in the figures. The jugular spot is of considerable size, of an ochry-yellow colour, and an irregular hexangular form, surrounded by a border of jet-black. The hair is short on the whole fore-part of the body, and gradually lengthens on the hind-parts.

The dimensions are as follows:

	FT.	IN.
Extreme length of the animal,............	3	8
Length of the body (along the back),...	2	3
Length of tail,..................................	1	5

The specimen here described, was brought to England from Demerara, by Charles Edmonston, Esq.

XXXI.—*On the Leaves, Capsule and Root of Buxbaumia aphylla.*

By Robert Kaye Greville, Esq. M. W. S. &c.

(Read 2d December 1820.*)*

Though so much has been written respecting this highly curious moss, and many excellent figures of it published, there are several peculiarities in its structure that have escaped the observation of muscologists, not even excepting the accurate Hooker;—a circumstance that can be owing to nothing but its rarity.

This singular plant is named after its discoverer, the "modest Buxbaum," as Haller calls him. It was found by him about the year 1712, on the banks of the Wolga, near Astracan, and published in his *Centuriæ*, 2. *p*. 8. *t*. 4. *f*. 2. Since which time, the "Regina Muscorum" has been figured and described, either as a moss or a fungus, by a great number of authors, but particularly by Schmiedel, who " Buxbaumiam in Dissertatione Academica pulchre et egregie explicavit."

In the fourth number of the Flora Londinensis (new series), the reader will find the best and most recent account of *Buxbaumia aphylla.* It is there minutely described, and its history admirably detailed by Dr Hooker, who had first the good fortune to detect it in Great Britain, at Sprowston, near Norwich.

In 1818, Mr Stewart, lecturer on Botany in Edinburgh, was so fortunate as to find a habitat for this very rare plant, on the hills in the neighbourhood of Peebles; from whence he procured a considerable number of specimens, on some of which he detected leaves, and described them as being very minute, reticulate, laciniate, or deeply cleft into four or five segments, and situated on the sides and summit of the bulb. Mr Stewart also stated, in a paper read before the Wernerian Society *, that he had observed more than one fruit-stalk to arise occasionally from the same bulb; and in one instance so many as three: of which one was decayed, another still retaining the calyptra, and a third intermediate. This circumstance naturally induced Mr Stewart to consider the plant as perennial. I have not yet been so fortunate as to find a completely satisfactory instance of this; for though I have received specimens with the fruit-stalks in

* 11th December 1819.

apparent contact, I have not been able to trace the connection on dissecting the bulb; but from the nature of the root, it is extremely probable that the plant *is* perennial; and what greatly contributes to confirm me in this opinion is, that the greater part of the tomentose or hairy appearance of the bulb, seems to be produced by the remains of old leaves; not indeed such as Mr Stewart noticed, but similar to some that I have recently discovered, and shewn to that gentleman *.

The leaves that I observed appeared to me to be of two kinds.

The first (Pl. XXI. fig. 3.) is formed, as far as I could ascertain, entirely of conferva-like filaments, closely united from the base, to somewhat less than half the length of the leaf; they then separate from each other; are continued sometimes singly, and sometimes collected into small bundles converging

* Since this paper was written, the scientific world has suffered a serious loss in the death (3d November 1820) of this very intelligent and indefatigable botanist, who, from the natural energy of his mind, promised to hold a conspicuous place in the pursuit not only of natural history but of general literature. A few days previous to his death, he completed the laborious office he had undertaken, of editing the Lectures of the late Dr Brown, Professor of Moral Philosophy in the University of Edinburgh. He had also just finished the article *Musci* in Dr Brewster's Encyclopœdia, but did not live to complete the correction of the last sheet.

at the summit. Before the filaments separate, they appear to be frequently jointed; more rarely so afterwards.

The second kind of leaf (fig. 4.) is more common than the first, as far as I have hitherto experienced; but the structure is no less singular. The lower part is strongly reticulated,—the reticulations very irregular, and the bars or cellular divisions remarkable,—being uniform in their diameter, which is considerable, smooth, semitransparent, and of a peculiar inflated appearance, difficult to describe or represent. Before the leaf begins to contract, the reticulations cease, and a number of conferva-like filaments are produced, which seem to be seldom, if ever, jointed, but are long, and generally much entangled; so that it is difficult to obtain a leaf for examination, free from a mass of filaments, belonging either to old or adjoining leaves. In consequence of this entanglement, added to their minuteness, I have not yet been able to discover the true form of the leaves of Buxbaumia; all that I have examined having been more or less damaged.

The colour of all the leaves is a light green, tinged with a brown that increases in age; but the filaments are even then generally diaphanous, and exactly resemble the dark-coloured filaments that are to be met with on every specimen, towards the upper part of the bulb. I regret exceedingly, that I was not able to show the first kind of leaf to Mr Stewart, having lost the one I made the drawing from, and never succeeded in finding another: of the kind last described he saw several. These little objects are so minute, that they may be easily overlooked, even when under the microscope, from the well-known difficulty of managing that instrument when high powers are used.

In Hedwig's * highly magnified section of the capsule of *Buxbaumia*, the little pillar or duct between the small globe and seminal bag, is represented as curved. This was also the case in the capsule of which I have given a section, (fig. 6.). In the young capsule, (fig. 7.) this duct is straight, as is also the seminal bag; but as the latter enlarges, and in some degree follows the oblique direction of the capsule, the duct necessarily becomes curved in the direction of the gibbous portion of the capsule. In making the dissection given at fig. 6., I was so fortunate as to divide the little globe, the cervix or little column which supports it, and a part of the duct; these are evidently hollow, and communicate with each other. The cervix above mentioned is connected with the sides of the apophysis, by numerous fibrillæ, which, towards the little globe, graduate into a spongy or cellulose texture, forming a sort of delicate septum, between the capsule and apophysis. This is much too strongly marked in the figure borrowed from

* Fundament. Hist. Nat. Musc. Frond. Pars II. t. 3. f. 10.

Schmiedel, in the Amœnitates Academicæ of Linnæus, (fig. *f.*).

In examining a very young plant, only just emerged from the bulb, with the pistil on its summit, I found the bulb evidently hollow to a certain degree, as well as the pistil itself. This hollow perichætium terminated in a fleshy root, and might belong to an old plant. I could not, however, detect any thing like an internal bulb in any of the specimens which I dissected; and what Schmiedel has figured as the *Bulbus ex villo exemptus,* which is copied into the Amœn. Acad. (fig. *k.*), I cannot but conceive to exist more in imagination than in reality. The cavity is gradually filled up; and this seems to take place by the mere thickening of the *seta,* as the plant advances to maturity.

The character of the *root* of *Buxbaumia,* I have found to be uniform in every individual I have examined. Its length is from a line, to a line and quarter. Its thickness considerable, to where it branches off, into three or four divisions. Its substance is fleshy and brittle. The bulb of this moss exists, therefore, in appearance, rather than in fact, and chiefly receives its external character from what I take to be the remains of old leaves, which produce the same effect as the accumulation of old stipules in many phænogamous plants. The root itself, being very brittle, is easily lost; and being, besides, often tortuous, and generally passing off obliquely from the bulb, it is more liable to injury, By carefully removing the soil and fibres, it is not difficult to make a longitudinal section; which, if it be well done, will shew the *seta* passing through what was once the perichætial cavity, and losing itself in the fleshy substance of the root, which is considerably thicker than the *seta*. Towards the upper part, the root is generally solid, but towards the extremity, hollow, (fig. 8.)

In order to avoid the disadvantages that result from changing the trivial names of plants it will be scarcely necessary to change that of Buxbaumia; although, to some, it may appear absurd to call a plant *aphyllous*, when leaves have been actually detected upon it. At the same time, these leaves are so completely inconspicuous to the naked eye, that the absurdity almost vanishes. Should another trivial name, however, be considered essential, *Buxbaumia acaulis*, would be as appropriate as was *B. aphylla* originally.

EDINBURGH, 25. BUCCLEUCH PLACE,
October 30. 1820.

PLATE XXI.
BUXBAUMIA APHYLLA

R.K. Greville delin.

Eng.d by W.H. Lizars

Explanation of Plate XXI.

Fig. 1. A leaf about double the natural size.

2. The first kind of leaf magnified.

3. A leaf of the same kind more highly magnified.

4. The second kind of leaf highly magnified.

5. The reticulations of the same very highly magnified.

6. A section of a full sized, but not mature capsule, shewing the hollow communication between the cervix, the globe, and the duct supporting the seminal bag.

7. Section of a young capsule just beginning to assume the gibbous character. When under the microscope, the duct appeared to be continued in the form of something like a columella, to nearly the summit of the seminal bag, which seemed to be enclosing it. It was also more transparent than the rest.

8. Section of the root, shewing the *seta* passing down and losing itself in the substance of the root; also the hollowness of the root towards its extremity, and its division into a few large branches.

9. View of a pistil growing by the side of an old seta, natural size.

10. The same magnified.

11. Plants of Buxbaumia, in different stages of growth, natural size.

XXXII.—*Account of a Singular Fossil Skeleton, discovered at Whitby, in February* 1819.

By the Rev. George Young, A. M. Whitby, Yorkshire.

(*Read* 24*th April* 1819.)

Of the extraneous fossils occurring in the vast bed of aluminous schistus on the Yorkshire coast, none are more interesting, than those petrified bones which have been supposed to belong to an animal of the crocodile family. A skeleton of this kind, about twelve feet long, was found in the year 1758, an account of which was given in the 50th volume of the Philosophical Transactions, and the 30th volume of the Gentleman's Magazine. Another, measuring fifteen feet, was discovered in 1791; but no correct drawing of it was obtained *. A very curious fossil

* The drawing mentioned in the History of Whitby, p. 780, is inaccurate in several particulars, especially as to the appearance of the ribs.

Fig. 1.

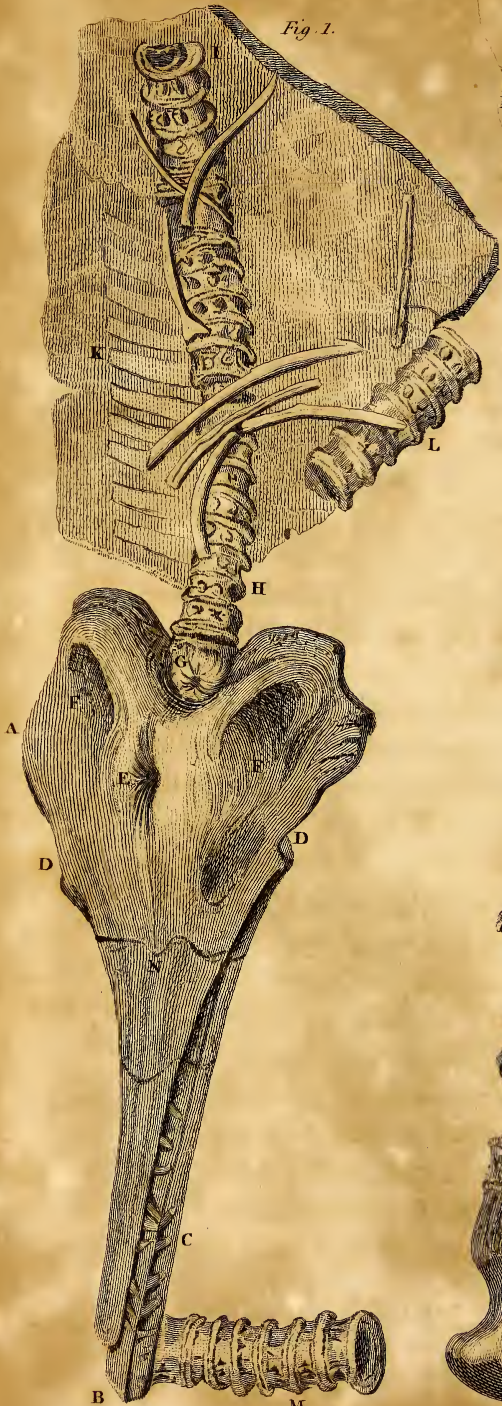


Fig. 3.

Fig. 2.

remain of the same kind, was found in February last, and is now in the possession of Mr George Watson of Whitby. The object of this paper, is to communicate to the Society an account of that specimen; which the faithful drawing by Mr John Bird, will serve to illustrate. Plate XXII.

The skeleton was imbedded in the alum-rock, where it is washed by the tide, and covered at high-water, about half a mile east from the entrance of Whitby harbour, and ten yards from the face of the steep cliff, which there fronts the German ocean. The cliff at that place, is about sixty yards in height; which, of course, was the depth of this skeleton from the surface, before that part of the cliff, which formerly covered it, was washed away. The skeleton lay in the upper part of the great aluminous bed, which here descends below high-water mark. Its position was nearly horizontal; the top of the cranium having first made its appearance. This must have been exposed for some years, as it is considerably water-worn; an accumulation of loose stones, over that part of the rock, having both concealed the skeleton, and contributed by their rolling to wear its surface.

The skeleton, as may be seen in the drawing, is not only in a mutilated state, but dislocated and rent into pieces, indicating some terrible convulsion at the period when it was imbedded. The most entire part is the cranium, (Fig. 1. A,) though even this has been much compressed, and shattered; the sockets for the eyes (D D,) being flattened, and the jaws distorted; so that the upper jaw projects over the under, on the right side; leaving part of the inner surface of the under jaw exposed on the left side, at C. The teeth, which are nearly conical, but swell a little in the middle, and have a gentle bend inwards, have been almost all broken or displaced; so that they are lying in various positions, and a few of them are even found beneath the cranium, in the cavity between the two diverging sides of the lower jaw, immediately under that part of the upper jaw marked N. The head is three feet long, and tapers towards the anterior extremity in the form of a bird's beak, being near fourteen inches broad at the thickest part; while the snout, for a considerable space, would measure only about three inches in breadth, were the one jaw laid directly over the other.

The rest of the skeleton consists of portions of the spine, with a few broken and mutilated ribs. One portion, H, K, I, consisting of twenty-one vertebræ, and extending two feet in length, was found behind the cranium, nearly in the natural position, but twisted to one side; so that the spinal processes K, instead of rising perpendicularly, appear in a horizontal position on the right side. Some of the vertebræ at H, were separated in taking up the skeleton; and as the head was removed before any other part was discovered, it is uncertain whether the curious bone marked G, which is fixed in the cranium, and seems to be the atlas, was in contact with the vertebræ H; or whether some thinner cervical vertebræ, that are now lost, might intervene. At any rate, it was obvious, from inspecting the bed where the skeleton was found, that the interval between the bone G and the vertebræ H, if any, must have been very small.

Another portion of the spine, (L), consisting of six vertebræ, was found diverging from the portion H, K, I, on the left side. These two fragments of the spine are represented in the drawing as attached to a portion of their aluminous matrix, with some broken ribs lying across them. The ribs seem to be slender for an animal of such size.

A third fragment of the spine (M), consisting of nine vertebræ, has been thrown much more out of place, being immediately before the cranium, extending from the point of the snout on the left at right angles. The end of the snout at B, is not only in contact with part of these vertebræ, but has been crushed into their substance; both being much compressed at the point of contact.

The place where this skeleton was embedded, has been carefully examined all around, but nothing more belonging to it has been found, except a few more broken ribs, and two vertebræ. The latter were found in the direction of the fragment L, at the distance of three feet, and, like the vertebræ M, are longer than those found behind the cranium, and may therefore have belonged to the middle of the spine.

To what class of animals this skeleton, and others found at Whitby, should be assigned, it is difficult to determine. They appear, however, to have little or no alliance with the crocodile family. No portion of any crustaceous covering has been found with them, nor any part of the bones of the feet. The teeth, indeed, resemble those of the crocodile, but differ from them materially in the regularity of their size and their arrangement. The cranium is totally unlike that of the crocodile, as the writer found by comparing the drawing with a specimen of the latter in Dr Barclay's Museum. Besides, the vertebræ are evidently those of a fish, each being in the form of a concave lens, hollow on both sides. It further appears, that the animal has had a pectoral fin, similar to that in the drawing, fig. 2., which is a correct representation of a fossil fin in the possession of Mr Bird, found about two years ago, not far from the spot where the large skeleton has since been discovered. In the general search, occasioned by the discovery of the latter, some vertebræ of an animal of the same description, but much smaller, were found; and, along with these, some fragments of a pectoral fin, the same with fig. 2., but also much smaller. Hence it may be inferred, that the larger animal must also have had pectoral fins; and it is by no means unlikely, that the fin represented in the drawing was one of them. It is somewhat imperfect, especially on the upper side; but is, on the whole, an interesting animal remain. Some portions of pyrites adhere to it, particularly three pyritous bivalves of the genus Tellina. It may be remarked, that some parts of the large skeleton are also pyritous.

From the exact correspondence between this pectoral fin and that figured in the Philosophical Transactions for 1816, at p. 320., and from the general resemblance which this Whitby petrifaction bears to that in Bullock's Museum, described by Sir Everard Home in the Philosophical Transactions for 1814 and 1816, there can be no doubt that the animals of which these are the remains, have belonged to the same genus, though they appear to be of different species.

Sir Everard Home considers the Charmouth animal as allied to the shark family; particularly in regard to the conformation of its pectoral fin, which he compares with that of the Squalus acanthus; but the animal of Whitby, and even that which he describes, may be viewed as more nearly connected with the cetacea, especially those of the genus Delphinus. On comparing the cranium of the Delphinus vulgaris, (fig. 3.) with the fossil cranium, (fig. 1.) it will be seen, that, notwithstanding the compressed and distorted state of the latter, there is a considerable resemblance between them. They are similar in the elongated form of the snout, and in the number and shape of the teeth. The depressions in the upper part of the cranium (F F) are nearly alike. The aperture at E, in the fossil skeleton, corresponds, in some respects, with the blow-hole E, though it has not its semilunar form; and the groove running from the blow-hole to the point of the snout, which, in the recent animal, is filled with cartilaginous matter, is distinctly observed in the fossil. animal. Perhaps if the fossil cranium were compared with that of the dolphin, which La Cepede has denominated *Le Danphin Nesarnack,* a more striking conformity might be perceived *.

No opportunity has occurred of comparing the fossil pectoral fin, (fig. 2.) with that of the dolphin; but the descriptions of the latter, by Cuvier and La Cepede, furnish sufficient ground for regarding them as analogous †.

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* La Cepede, Hist. Nat. de Cétacées, p. 307.—Fossil heads have been found at Whitby, bearing a stronger resemblance to that of the Charmouth animal, and perhaps to that of the Dolphin, than the present fossil cranium. An interesting specimen of this kind, found near Whitby, about two years ago, is now in the possession of Thomas Hinderwell, Esq. Scarborough. In that fossil animal, the top of the cranium is elevated, and the sockets for the eyes are remarkably distinct. An engraving of that fossil animal, and of other interesting specimens, will be given in the *Geology of the Yorkshire Coast,* about to be published by the writer of this paper, in conjunction with Mr Bird.

† "The bones of the carpus in the *Dolphins,* and other cetacea, are very much flattened; almost all of a hexagonal

After all, it must be acknowledged, that, in the conformation of the pectoral fin, and other particulars, this fossil animal differs from all living creatures hitherto described. It is not unlikely, however, that as the science of Natural History enlarges its bounds, some animal of the same genus may be discovered in some parts of the world. Brown, in his late Travels in Egypt, could not, among all the fishes of the Nile, identify more than one or two, as corresponding exactly with any of the European fishes; and when the seas and large rivers of our globe shall have been more fully explored, many animals may be brought to the knowledge of the naturalist, which at present are known only in the state of fossils.

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figure, and form, by their union, a compact surface, resembling a pavement."—Cuvier's Comparative Anatomy, vol. i. p. 319.—See also his Descriptions of the Metacarpus and Phalanges, pp. 320.–327.

"D'ailleurs, cet humérus, les deux os de l'avant-bras qui sont très-comprimés, ceux du carpe dont l'aplatissement est très-grand, les os du métacarpe très-déprimés et soudés ensemble, les deux phalanges très-aplaties du pouce et du dernier doigt, les huit phalanges semblables du second doigt, les six du troisième et les trois du quatrième, paroissent unis de maniere à ne former qu'un seul tout, dont les parties sont presque immobiles les unes relativement aux autres."—La Cepede, Hist. Nat. de Cétacées, p. 265.

XXXIII.—*Physiological Notice concerning the Early State of the Common Frog.*

By James Wilson, Esq. M. W. S.

(Read 24th January 1818.)

On procuring the spawn of the frogs last spring, (1817), I was struck with a peculiarity which I had never heard mentioned by any one, or read of in the writings of naturalists. It is well known, that the young tadpoles are enclosed in pellucid globular bodies for some days. These bodies are deposited by the frog in one connected string, to the number of many hundreds; but, in the water, they have the appearance of a compact gelatinous mass. This gelatinous substance nourishes the young, and upon it they have been supposed to feed even after their exclusion from the egg, as they are observed to rest upon it, never quitting it for some days, during which their size is considerably augmented.

In the course of my observations on these animals, having occasion, a few days after their exclusion, to remove a mass of the gelatinous matter in which they had been contained, from one vessel to another, I was surprised at perceiving that the tadpole still adhered to it, at the same time appearing to make frequent struggles to effect its liberty, and in which, in the course of a short time, it succeeded. On examining another, under like circumstances, with the assistance of a lens, I perceived that this was caused by a transparent filament or cord, proceeding from the centre of the globule, and attached to the belly or under-side of the animal.

The idea of the umbilical cord, by means of which the fœtuses of mammiferous animals are nourished in the placenta of the mother, immediately occurred to me, and I was curious to know, whether, in the case of the tadpole, this apparently similar structure might not be subservient to the same end.

As this might be ascertained by cutting the connecting cord immediately after the exclusion of the tadpole from the centre of the gelatinous body, and observing the rapidity or the slowness of its increase, compared with the growth of such as remain attached to it, I resolved to institute a course of experiments to that effect. In consequence, however, of one of those unfortunate mishaps which occasionally interrupt the investigations of the naturalist, I was deprived, for that season, of the power of drawing any conclusion regarding this supposed analogy. (The vessel in which my young brood were contained, was overturned and broken, and its inhabitants were destroyed.) The observation itself, however, in so far as I know, has not been previously made; and it may possibly lead to some curious results connected with the physiology of the lower classes of animals.

I find that the fact of frogs and insects deriving their nourishment from the mouth, and never by means of any umbilical vein, is insisted upon by the older naturalists, as forming a physiological distinction between these animals and such as strictly belong to the viviparous classes. In proof of this, I may adduce the following passage from the writings of Swammerdam, in which he treats of the changes of the frog.

"De plus on doit observer que de même que les insectes, qu'on trouve renfermez dans les fruits, dans le fromage, et dans la chair qui se gâte, prennent leur aliment par la bouche, *et jamais par quelque veine umbilicale:* de même aussi les petits de grenoüilles ne sont point joints ni unis à leur aliments par aucune sorte de veine; mais ils prennent de même leur nourriture par la bouche: et à la maniere des autres insectes, ils ne commencent à manger, qu'apres qu'ils se sont depoüillez de la membrane, dont ils etoient revetus."—*Histoire generale des Insectes, p.* 199.

Though ignorant of the cause, Swammerdam seems, however, to have been aware of the circumstance of the tadpole reposing on this gelatinous substance for some time after its exclusion from it. This he attributes, not to any necessity resulting from its present organization, but to the desire of rest. Thus, in the passage immediately preceding that which I have just quoted, he expresses himself as follows:

" Et il faut bien remarquer ici que les petits de grenoüilles ne consument jamais tout leur aliment, (by which last word he means the gelatinous bodies formerly mentioned), mais lorsque les parties sont separées les unes des autres par le moien de l'eau, qui s'y est insinuée, et que cet aliment n'a plus que la forme d'un nuage, qui flotte sur l'eau, il ne s'en sert plus que pour se reposer. Aussi nous voyons que lorsqu'il est las de nager, il se renferme incontinent dans ce nuage pour se reposer doucement."

I have troubled the Society with this inconclusive notice on the subject at this time, lest any of its members, more able than myself to form an opinion, should feel inclined to make the experiments alluded to, during the ensuing spring.

The time of their appearance is regulated by the state of the season, and the nature of the situation in which the spawn has been deposited. The greater number are excluded by the end of the first week in May. I have found, that the favourite food of tadpoles, as soon as they are entirely detached from the transparent globules, is the common duckweed, (Lemna gibbosa and minor) so frequent in most ponds. They do not, however, refuse other kinds of food. On one occasion, in particular, I observed that several of their own species having been wounded by the fierce larva of a large dystiscus, were immediately attacked and devoured by their more vigorous companions. The enormous crowds of these creatures which may be seen in spring, has often been a subject of wonder, more particularly when they are considered in relation to the greatly diminished numbers of the perfect animal. Few out of the millions produced, ever attain maturity, most of them serving as food to the different species of aquatic insects. I once observed an aquatic larva transfix and devour thirteen in the course of a few hours.

The tadpole state generally continues about two months; but I have found, that the period of transformation is hastened by their confinement within doors. The hinder legs are the first of the external members which are perfected. In those whose progress I attended to, they appeared about the 8th of June. They are at first small and pendant, and of no benefit to the animal in assisting its locomotion. From that day to the 23d of the same month, they continued to increase in size, and upon the 24th, they were employed as organs of motion. After the 20th, the animals themselves rarely remained under water above a few minutes without coming to the surface, and carrying down a small globule of air, and from this time they swam with less rapidity and ease than formerly, from the motion of the legs interfering with and counteracting the action of the tail. On the 25th of the same month, the fore-legs of several made their appearance. With regard to these, I may remark, that although the growth of the hinder extremities is exceedingly gradual, yet the fore-legs make their appearance at once, nearly in a state of perfection. Of this I discovered the reason, on a more close examination. The growth of the anterior limbs is in fact internal, that is, they are concealed in a hollow, under the lower jaw, near its posterior angle; and when the tadpole swims with one side a little elevated, their motion, if carefully observed, may be distinctly seen through the filmy integument by which they are covered, some days previous to their appearance externally. This I had an opportunity of ascertaining, by means of such as remained in a less advanced state. About the 25th, also, the progress of ossification became very visible, through the transparent skin of the back.

The body of the tadpole decreases in size, and assumes the appearance of being emaciated before the completion of all its limbs, at which time the bony parts are easily discernible, from the acuteness of their angles. The tail, likewise, when compared with the other parts, is of a more gelatinous appearance, and the difference of its texture and colour is then very visible at its junction with the body.

Upon the 28th of June, being a few days within two months from the time of their first appearance, several quitted their native element, and were found upon the dry ground. On being replaced in the water, they dived once or twice, but seemed, during their short stay on land, to have nearly lost their former power of swimming;—their specific gravity, too, was changed, as it now required some little exertion to prevent their rising to the surface of the water, when unassisted by weeds or otherwise from below. The tail still adhered, though somewhat altered in its appearance. The filmy upper and under border was wanting, and had either fallen off or contributed to increase the growth of the central part, which, although considerably shorter, was now thicker and rounder in its form than it had hitherto been. On the 30th of June, the tail had contracted into a small rounded protuberance, a few lines in length, and the animals themselves then exercised the faculty of leaping with agility. On the 1st of July, this protuberance was scarcely discernible, and the only apparent difference, exclusive of size, between the young frog and the adult individual, consisted in the body of the former being terminated by a salient instead of a re-entering angle.

I may add, that the singular faculty of reproduction of members of the body, is well exemplified in these animals. If, during their existence in the tadpole state, the tail be separated from the body by a pair of scissars, it is reproduced in the course of a week or two. I have observed, however, that this experiment prevents the appearance of the hinder extremities at the usual period, and I presume that the exertion of the reproductive power may probably exhaust those fluids of the body which are required for the increment of the limbs.

January 1818.

XXXIV.—*On the Luminosity of the Sea.*

By John Murray, Esq. Lecturer on Chemistry, &c.

(*Read 29th December* 1819.)

At an early period, the phenomenon of luminous animals arrested the attention of naturalists; and among these observers, we find Linnæus and Pliny. Not confined to the *Lampyris*, it is clearly ascertained, that the property of emitting light obtains in other animals, as the *Scolopendra electrica*, *Fulgora lanternaria*, and others.

The phosphorescence exhibited by vegetable and animal matter in their decomposition, and that of some gems and minerals, by exposure to light and heat, should be ever carefully discriminated from the luminous vestiture of living beings; and which appears to me to have but a slight analogy with the former.

Whether the luminous phenomenon is to be ascribed to electric energies, or an effect connected with nervous influence, or dependent on something peculiar and insulated from these, is a question which has not yet been determined, nor perhaps can be, in the present state of human knowledge. Experiment seems, however, to decide, that glow-worms are not more luminous in oxygen than in atmospheric air; neither is the luminosity extinguished in carbonic acid gas. This would appear to countenance the belief, that it is not connected with any thing like combustion. When Mr Maccartney applied electrical stimuli, he succeeded in inducing light in the case of the *Lampyris;* but the concomitant circumstances clearly proved, that its action was entirely mechanical.

The light of the sea has been ascribed to various causes. To phosphorescence,—the effect of animal decomposition,—to the imbibing of solar light, analogous to the diamond,—and to an electric effect induced by friction. While others have more plausibly assigned it to the presence of luminous animals; and of these, the *Cancer fulgens, Medusa pellucens, hemispherica,* &c. *Limulus noctilucus, Salpæ,* &c. have been described.

I remember to have taken up a luminous *medusa* on the coast of Norfolk, where the river New disembogues itself into the sea.

On my voyage from Leghorn to Civita Vecchia, I remarked, that the Mediterranean was particularly refulgent, prior to a storm which we encountered; and this circumstance led me to investigate the phenomenon on our own shores.

I was struck with the luminosity which the sea presented a few evenings ago. It was succeeded by a gale; and may be, perhaps, considered its presage. The sea sparkled with great brilliancy; and seemed to reflect from its bosom the celestial scene. A more attentive survey appeared to present at least two distinct phenomena of this description. One seemed to scintillate, and was minute; while the other exhibited an undulatory movement of the phosphoric kind, apparently commencing at the centre, and diverging in concentric circles to the edge of the discs, which seemed sometimes an inch in diameter. Immediately before the gale, I saw a solitary occasional gleam; but during its continuance could discover none.

From the edge of the pier now constructing here, I took up a small portion of sea-water, including some luminous substance. It was some time, indeed, before I could recognise the existence of any foreign body, to which I could attribute the luminous effect; however, I clearly perceived, that there was no phosphorized oleaginous matter on the surface of the water. I saw, at length, the shadow of an animal in rapid movement, depicted on the bottom of the basin; and itself was transparent as the medium in which it floated. It seemed to be a *Beroe*, and identical with the species called *fulgens*, by Mr Maccartney, (Philosoph. Trans. p. 260, for 1810.) The animal when at rest, exhibited a somewhat crescent form. The ciliary processes of the ribs, which in swimming described a kind of tortuous motion, seemed to be those parts from whence the light was derived, but of which the whole body occasionally partook. The *Beroe* died a few minutes after I had received it, which I attributed to the *light* of the candle, rather than to increment of temperature in the medium. When taken up on the point of a probe, it had the appearance, and nearly the consistency, of jelly; it was diaphanous, and presented a spherical figure of about one-sixth of an inch in diameter.

The late Professor Smith of Christiana considers that the luminous appearance which diffuses itself over the whole surface of the sea in the Atlantic, arises from a dissolved slimy matter; and that the most minute glittering particles, when highly magnified, had the appearance of solid spherical bodies. I cannot doubt, but that these luminous particles originated with some of the mollusca and crustacea adverted to; and that they had been detached by the action of the waves, or friction, the consequence of other causes, as may appear in the sequel.

Another quantity of sea-water presented me the *Medusa*, perhaps the species called *scintillans*. I could discover no other kinds. The medusa was about three-fourths of an inch diameter. It died very shortly after I brought it home; and perhaps the light, as in the former case, was the cause. It is supposed, that the *Scolopendra electrica*, is destroyed by exposure to solar light; and Mr Maccartney observes, that the medusæ always retreated from the surface as soon as the moon rose; and he also states, that exposure to day-light deprived them of the power of shining.

By stirring the salt-water containing the medusa, occasional gleams were exhibited. I then transferred it to a basin of *fresh* water, when it sunk to the bottom like a falling star. The effect here, was of the most beautiful description. There appeared strings of minute beads of fire, like a chain illuminated by electricity. By stirring the fluid, these luminous points were disentangled, and exhibited a pretty hemisphere of stars. These floating fires soon ceased to lighten the fluid mass; agitation could not restore the effect, though a few drops of acid caused a solitary gem to twinkle. The medusa was transparent and gelatinous like the other. There can be no doubt, but that it was the tendrils or feelers which were vested with this brilliant and beautiful ornament; and I presume, that these living fires originated here as in the ciliary processes of the beroe; and that they were, subsequently, by some peculiar mechanical impulse, transfused over the transparent membranous sac or disc.

We dare scarcely speculate, touching the design of the primary distinction. This much we know, that Almighty Goodness has made nothing superfluous or in vain. For aught we know, it may be to allure its prey, or to subserve the purposes of coition. The visitation of luminous animals, would seem connected with meteorological phenomena; and it would be interesting to ascertain, from different parts of the coasts, whether they or others generally contribute to the effect. Meantime, I shall anxiously watch their return, for some experiments I have in prospect.

Stranraer, 30*th November* 1819.

XXXV.—*Explanation of an Apparatus, suggested by Colonel* Yule, *for Discharging Ordnance upon Mr* Forsyth's *Plan; and an Account of some Experiments performed with it.*

By Mr John Deuchar, Lecturer on Chemistry.

(*Read* 16*th December* 1820.)

It is proposed, in the present paper, first to explain an apparatus some time ago suggested by Colonel Yule, for applying Mr Forsyth's plan to the discharging ordnance, without either the use of a light, or the usual prime; and, secondly, to give a very brief account of several experiments which I have performed with it.

I. The apparatus has first to be noticed.—This is very simple. It consists of a thick brass tube, (Plate XXIV, fig. 1. A B), fifteen inches long, which is meant to represent the touch-hole of the gun. The diameter of the bore of this tube, (as is shewn in fig. 6.) is about the 18th or 20th part of an inch.

It terminates at the top (A), in a cup (fig. 3. *d*); at the bottom of which, the bore of the tube is divided into three very small holes, (see fig. 4.), to prevent the powder falling into the tube. Into this cup, about one grain of the new composition, afterwards alluded to, is put, when the apparatus is to be used. At the top of the apparatus, is a bar of brass (C D), which, at the one end (D), turns upon a joint; and, at the other (C), is supplied with a cap, in the centre of which is a steel projection, or hammer, (fig. 2. *e*). The cap covers the whole of the raised part (A), at the top of the tube (A B); and the hammer nearly fits the cup (fig. 3. *d*), and is made to strike flat upon the bottom of it (fig. 4. *d*). Between the joint of the bar (D), and the top of the tube (A), is placed a piece of cork (I), or any elastic substance, to prevent the steel hammer (*e*) coming too close upon the composition, before firing, and to make it spring up again after the discharge. The apparatus is united at the top by a frame of brass (G H), which, to prevent its being injured by the firing, is screwed upon another frame of wood (E F). The tube screws into four pieces; and it was into the hollows left at the joinings of these (*a b* and *c*), by only half screwing them, that the different substances were put, which are noticed in the experiments.

Explanation of Plate XXIV.

Fig. 1. represents the whole apparatus on a scale of four-tenths to one inch.

Fig. 2. gives a section of the cap C, and steel hammer *e*, which strikes upon the powder at the top of the tube A B.

Fig. 3. gives a section of the top A of the tube, and the cup *d* for holding the powder.

Fig. 4. shews the bottom of the cup, which screws into A, from below, as shewn in fig. 3. The hole through the tube from B to A, divides into three smaller openings.

Fig. 5. shews the end of one of the divisions of the tube A B, and the size of the screw which unites them at *a*, *b*, and *c*.

Fig. 6. shews the bore of the tube at *a*, *b*, *c*, and B.

Fig. 2, 3, 4, 5, and 6, shew the parts of the apparatus of the full size; and for fig. 1. there is a scale given.

I may mention a few advantages of this mode of firing ordnance of every description. These are principally extracted from a communication on the subject, with which Colonel Yule has favoured me.

"1*st*, The instantaneous inflammation of the whole of the powder contained in the cartridge."

The expansion of the aëriform fluids produced, must act with more force than in the old method; of course, less powder will be required for any proposed result; and, as none of the charge is forced out uninflamed, any given quantity of gunpowder will afford its fullest possible effect.

"*2d,* The removal of all danger of explosions arising from the cartridges and loose powder coming in contact with lighted matches in the gun-decks of men of war in time of action." The whole process is performed without the necessity of using a match-light of any description; nor is there any inflamed substance forced from the touch-hole during the discharge.

"*3d,* The removal, in a great degree, of the inconvenience arising from the accumulation of smoke in the gun-decks of men of war, or in casement batteries in time of action." In the proposed method, there is not the slightest production of smoke at the touch-hole; and as neither prime nor prime-tube is required, it is also free from any risk of accident by the discharge of these, and this, at sea, is a considerable advantage.

"*4th,* The removal of all inconvenience arising from the priming being blown away by high winds, or washed off by heavy rains, or the shipping of a sea." The cap at the top of the new apparatus covers the touch-hole, and prevents any of these inconveniences of the old mode.

"*5th*, A saving of the whole amount at present applied to the manufacture or purchase of quick matches, priming-tubes, flints, and various other articles now in use both in the navy and in the field."

Another advantage of this mode deserves particularly to be noticed; namely, the rapidity with which the whole is performed. This facilitates the execution of a charge, by the effect being almost instantaneous with the pointing of the gun. It also saves much of the time at present spent in applying priming-tubes, or trains of powder; for, with Colonel Yule's apparatus, the time that is required is very trifling.

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II. Having now stated all that is necessary with regard to the apparatus itself, it remains for me, in the concluding part of this paper, to direct the attention of the Society to several experiments performed with it, which present rather extraordinary results.

At the request of Colonel Yule, I commenced, about the beginning of July last, a number of experiments, with the view of discovering a powder which should never miss inflaming the cartridge; and I was fortunate enough to hit upon one. All the usual fulminating powders were first tried, without success. The fulminating mercury, when the fifth part of a grain only was used, rent asunder the steel plate at the top, (marked D), and yet did not reach as far as the gunpowder (placed at B). Some of the antimonial preparations were found
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sometimes to fire the gunpowder; but they left a cake of crocus behind, which stopped up the holes, and could not easily be removed. The following substances, and a variety of other inflammables, were used, mixed with an equal weight of super-oxymuriate of potassa:

Golden sulphuret of antimony;
Black sulphuret of antimony;
Red precipitate of mercury;
Chinese vermilion;
Muriate of mercury;
Red oxide of mercury;
Æthiops mineral;
Red oxide of lead;
Flowers of sulphur;
Rosin;
Gum Arabic;
Gum gamboge.

None of these, however, produced any regular effect; and several of them gave no inflammation at all. I shall now add a list of powders, all of which occasionally pierced the flannel, and inflamed the gunpowder below it. Very few of them, however, did so twice successively.

1.	Super-oxymuriate of potassa, -	5
	Sublimed sulphur, - -	2
	Charcoal powder, - - -	1

This and No. 3. are the worst on the list.

2.	Super-oxymuriate of potassa, -	12
	Flowers of sulphur, - - -	4
	Charcoal powder, - - -	2
	Gum Arabic powder, - -	1

This and No. 9. are fourth best.

3.	Super-oxymuriate of potassa, -	18
	Flowers of sulphur, - -	3
	Gum Arabic, - - - -	1
4.	Super-oxymuriate of potassa, -	4.5
	Flowers of sulphur, - -	1.5
	Charcoal powder, - - -	1.5
	Nitre, - - - -	2.5

This and Nos. 5. and 8. are the third best.

5.	Super-oxymuriate of potassa, -	4.0
	Flowers of sulphur, - -	1.0
	Charcoal powder,	1.0
6.	Super-oxymuriate of potassa, -	1.0
	Sulphuret of antimony, - -	1.0

This and No. 7. are fifth best; but they leave a hard cake of crocus of antimony, which adheres very strongly to the apparatus.

7.	Super-oxymuriate of potassa, -	1.0
	Sulphuret of antimony, - -	1.0

The proportions of this powder were taken by volume.

8.	Super-oxymuriate of potassa, -	2.0
	Dried charcoal powder, -	1.0
9.	Super-oxymuriate of potassa, -	1.0
	Dried charcoal powder, -	1.0

10.	Super-oxymuriate of potassa, -	3.0
	Dried gunpowder, - - -	2.0
	This is the best.	
11.	Super-oxymuriate of potassa, -	1.0
	Gunpowder in fine powder, -	1.0
	This is the second best.	

After numerous trials with these, their comparative regularity in producing the desired effect was calculated to be nearly as has been noted in the above list; but I found that even No. 10. was not so uniform as was necessary for Colonel Yule's object. I had now, however, almost doubted of success, when it occurred to me to try the composition which has since been found to succeed for more than an hundred successive times, without leaving any residuum to stop the firing. Of the composition of this powder, and some cautions necessary to be attended to in its preparation, an account will be given in a future paper.

It was with this powder that I performed the experiments which presented those striking results, of which I have now to give a brief account.

I was led to these, with the hope of elucidating, still farther than I had previously done, a particular view of caloric, of which I have, for six years past, given an account in my chemical classes. I availed myself of the use of Colonel Yule's apparatus, to commence the investigation; and I am still occupied with it. At present, therefore, it is only in my power to notice a few of the experiments, in a detached form.

The first experiments were performed by firing the new composition (using about one grain, or rather less, at each trial,) through a piece of cartridge flannel tied over the hole at the bottom (B) of the apparatus, when it inflamed a quantity of gunpowder fixed in a tin-case below the flannel. This was repeated successively, for many times, without cleaning the apparatus, and the flame never failed to pierce the flannel and fire the gunpowder.

Should this succeed as regularly when applied to the gun itself, there could remain no doubt but that it would possess all the proposed advantages. There was therefore fixed to a six-pounder an apparatus similar to the one described, excepting that it wanted the long tube (A B), for which the priming hole of the gun became a substitute. It was charged with cartridge, and, in several of the trials, with ball and cartridge; and upon the same experiments being repeated with it, it gave the same uniform results.

The next experiments were with the view of ascertaining how the results stood related to Sir Humphry Davy's theory regarding the impervious nature of wire-gauze to flame. Wire-gauze, of different degrees of fineness, was, in successive trials, put in the interior of the joinings of the tube, (*a*, *b* or *c*) so as to cover the hole completely. When the coarser wire-gauze was employed, the flame was found to pass through and set off the gunpowder; but the same result never took place with wire-gauze as fine as that used in Sir Humphry Davy's safety-lamp, unless when the flame seemed to have burst a passage through the gauze. But when these experiments were performed without the powder and flannel at the bottom (B), it was found that the flame went through even three pieces of the wire-gauze at once.

The next experiments, and probably the most surprising of the whole, were with gunpowder placed in one of the divisions of the apparatus *(a, b,* or *c)*. In some of the trials, I found that the flame had passed through the gunpowder, (at *a, b,* or *c)*, without inflaming it; although, in other trials, I found it did not do so.

This, at first, appeared to be an objection to the proposed application of the apparatus. But after repeated trials, I found that the above curious result only took place when the stroke with the hammer was slight; for, when a smart blow was given, inflammation always took place.

In a few of the experiments, I put gunpowder at two divisions of the apparatus *(a* and *b)*, and found, that the flame sometimes went through both without firing either portion; at other times, one portion was inflamed, and one left unaltered.

In performing these experiments, I first put a small piece of flannel upon the hole of the joining of the tube, and upon this I poured the gunpowder, using, 2, 3, 4, and sometimes even 5 grains at once. After all of the trials, I found a brownish scorched mark in the centre of the flannel, about the size of the hole of the tube.

A variety of experiments were also performed, with flannel, paper, and other substances, placed between the joinings; in all which cases it was found, that the flame had been forced through, generally leaving a hole in the substance used, and a pale-coloured flame was observed to dart to a considerable distance below the bottom (B) of the tube.

In a future paper, I hope to have the honour of laying before the Society a fuller account of these curious experiments. In that paper, I propose to enter upon the cause of the results which present themselves; and to notice more fully the nature of the flame whilst in rapid motion, the alteration of effect upon substances, by retarding its movement, and the canse of its apparent inaction upon the gunpowder.

XXXVI.—*Description of two New Philosophical Instruments.*

By Alexander Adie, F. R. S. E. & M. W. S.

(Read 3d April 1819.*)*

In the following paper I propose to describe, *first*, A new instrument under the name of Sympiesometer, for ascertaining the changes in the pressure of the atmosphere; and, *2dly*, A Hygrometer, in which the smallest variation of moisture and dryness are indicated.

I.—*Sympiesometer.*

My attention was first directed to the improvement of the Barometer, with the view of rendering it susceptible of indicating any of those minute changes in the weight of the atmosphere, which might be supposed to arise from the action of the Sun and Moon. A very sensible instrument was obviously necessary for such a purpose; and I was therefore led to the idea of measuring the pressure of the atmosphere by its effects in compressing a column of common air, Upon constructing an instrument of this kind *, however, I found that the air was absorbed by the fluid with which it was inclosed, and that a good and permanent barometer could not be made upon such a principle till this radical defect was removed. I therefore directed my attention particularly to this object, and succeeded beyond my most sanguine expectation, in freeing the Air Barometer from this great source of inaccuracy.

The name of *Sympiesometer* which I have given to this improved instrument, is derived from the Greek words συμπιεζω to compress, and μετρον a measure, denoting the property it possesses of measuring the weight of the atmosphere by the compression of a gaseous column.

The principle of the Sympiesometer, which is represented in one of its forms, in Plate II. Fig. 2.,

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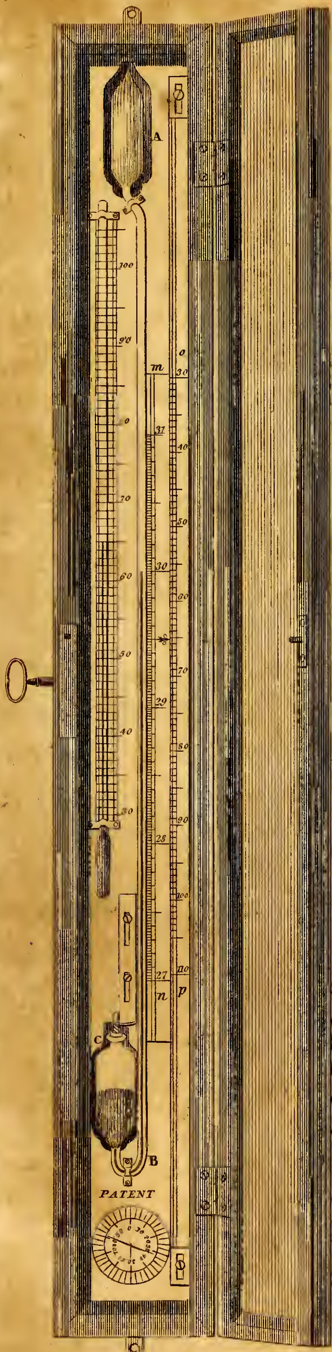
* When I constructed this instrument, I was not aware that Dr Hooke had employed the compression of a column of air to measure the weight of the Atmosphere. The Sympiesometer, however, will be found to have no resemblance to his instrument but in this particular.

MR. ADIE'S SYMPIESOMETER



Lizars Sculpt.

consists in employing an elastic fluid or gas, different from air, and any liquid, excepting quicksilver, which neither acts upon the gas which it confines, nor is perceptibly acted upon by the air, to the contact of which it is in some measure exposed. Hydrogen gas, azotic gas, or any of the gases not liable to be absorbed by the inclosing fluid, may be used; but I prefer hydrogen gas as superior to any other that I have tried. The liquid which answers best is an unctuous oil, or a mixture of unctuous and volatile oils. I consider almond oil, coloured with anchusa root, as the most eligible.

The Sympiesometer consists of a tube of glass A B C, of about 18 inches long, and 0.7 of an inch diameter inside, terminated above by a bulb A, about two inches long inside, and half an inch diameter, (but this will vary, as the instrument is required to have a greater or lesser range); and having the lower extremity B bent upward, and expanding into an oval cistern C, open at top.

The bulb A at the upper end of the tube is drawn to a slender thread, and is at first left open. In order to introduce the gas and oil, I fill the bulb and tube with quicksilver: Then holding the tube horizontal, a communication is formed between a gasometer, containing the gas to be used, and the slender pipe at the end of the bulb A, by means of a flexible tube. As the tube is brought to a vertical position, the quicksilver flows out till it descends in the tube to the level of the top of the cistern, and the gas enters to supply its place. The slender pipe is then to be sealed hermetically close to the bulb A, by a touch of the flame of a blowpipe.

The tube A B C is now to be inverted, and the mercury poured out of the cistern C, allowing the column which occupies the tube to run towards the bulb, to prevent the escape of the gas. The tube being again turned into a vertical position, the portion of quicksilver which remains is removed, by pouring some of the oil over it, and heating the gas until, by its expansion, it forces the columu of quicksilver which is left at the lower end of the tube, into the cistern; then, holding the tube nearly horizontal, the oil will enter as the gas cools, and the remaining quicksilver may be poured out of the cistern C.

The inclosed gas which has thus been introduced, changes its bulk, or occupies more or less space, according to the pressure of the atmosphere upon the surface of the oil in the cistern C. The scale *m n* for measuring the change in the bulk of the gas occasioned by a change of pressure, is formed experimentally, by placing the instrument in an air-tight glass-case, along with an accurate barometer and thermometer.

The glass-case is furnished with a condensing and exhausting syringe, by which any density may be given to the inclosed gas, so as to support a column of quicksilver in the barometer of 28, 29, 30, or any other required number of inches. The height of the oil in the tube of the Sympiesometer corresponding to these points being marked on its scale, and the spaces between being divided into an hundred parts, these parts correspond with hundredths of an inch, on the scale of the mercurial barometer.

As the bulk of the gas is altered by any change that takes place in the temperature of the atmosphere, it is necessary to apply a correction on this account. For this purpose the principal or barometric scale *m n*, is made to slide upon another scale *o p*, placed either below it or on one side of it, which is divided into degrees and parts, so as to represent the change of bulk in the gas produced by a change of temperature under the same pressure, and corresponding to the degrees of a common Thermometer attached to the instrument.

This scale is constructed in the same manner as the scale of a common thermometer, by changing the temperature of the bulb while the pressure is the same, and noting the range of the oil occasioned by it.

In using the instrument, observe the temperature by the thermometer, and set the index which is upon the sliding Sympiesometer scale, opposite to the degree of temperature upon the fixed scale; and then the height of the oil, as indicated on the sliding scale, will be the pressure of the air required.

When the height of one place above another is to be measured by the diminution of the pressure of the atmosphere, another correction is necessary to insure perfect accuracy in all instruments indicating this change, because the pressure of a column of air of a given altitude varies according to its humidity or moisture. I have therefore added to the Sympiesometer a new Hygrometer, which is afterwards described in p. 492.

In some of the Sympiesometers which I have made, the scale is divided into parts corresponding to the increase in bulk which takes place in the gas, by the diminished pressure of the atmosphere on ascending a given height, the temperature being 32° of Fahrenheit. This scale is also formed by experiment, as follows: The instrument being placed in the glass-case as before described, increase the density of the inclosed air, until it support a column of quicksilver of 31 inches, the temperature being 32°. Mark this point zero; then, from the logarithm of 31 substract .0100, and find the corresponding number, which is 30.294; regulate the density of the air to support a column of quicksilver of this length; number this point on the scale 100, and divide the space into 100 parts; each part will equal the increase of bulk or fall of the oil in the tube by ascending one fathom. In the above manner proceed, by subtracting .0100 from the logarithm last found, and marking the points corresponding to these densities, until the scale is complete.

By the above scale, the approximate height will be given without the aid of a table of logarithms, by subtracting the number of fathoms indicated by the Sympiesometer, at the under station from that indicated at the upper station, the difference being the number of fathoms which the one station is above the other.

Previous to laying this instrument before the public, I wished to have it submitted to a fair trial, by comparing it with observations made in the same ship with the Marine Barometer. For this purpose Quintin Leitch, Esq. of Greenock, the proprietor of the ship Buckinghamshire, obligingly sent one of the first which I had made with this ship on her voyage from the Clyde to the East Indies, in the year 1816; and the following is the report given of the instrument by the late Captain Christian, the commander, on his return.

"I am glad to say that I consider your Barometer a valuable instrument at sea, having given it a fair trial on the outward passage to India, by keeping a correct register of it, as well as of the common Marine Barometer, taken every third hour, night and day, during the passage; and I not only found that it was fully as sensible of the changes of the atmosphere as the other barometer, but that it had a great advantage over all barometers I have ever seen used at sea, namely, that of not being in the smallest degree affected by the motion of the ship, which will often make the quicksilver in the common tube plunge, or rise and fall, in such a degree as to make it very difficult to come within at least one or two tenths of an inch of the truth, even in the largest ships. On the passage home I also found it very correct in the indication of the winds and weather."

An opportunity of trying the Sympiesometer in a very different climate ocurred last year, when the Expedition under Captain Ross sailed to the Arctic Regions. Lieutenant Robertson of the Isabella kindly undertook the charge of this instrument, and regular observations were made every four hours with the Sympiesometer and Marine Barometer, the results of which were highly satisfactory. The observation scommenced on the 24th of April, in North latitude 51° 39′ and longitude 1° 7′ E.; and were continued to the latitude of 76° 50′ N., and during the return of the Expedition to Deptford till the 13th of November. These observations, in the form of a graphical representation of the progress of the Sympiesometer and Marine Barometer, have been published in Captain Ross's Account of the expedition, and will enable navigators to form a correct estimate of the relative value of the two instruments.

The following is Captain Ross's official report upon the Sympiesometer:

"This instrument acts as a marine barometer, and is certainly not inferior in its powers. It has also the advantages of not being affected by the ship's motion, and of taking up very little room in the cabin. I am of opinion, that the instrument will supersede the Marine Barometer, when it is better known."

Lieutenant Robertson, in a letter to the Honnourable Captain Napier of Merchistoun, has spoken of it in the following manner:

"The Sympiesometer is a most excellent instrument, and shews the weather far better than the Marine Barometer. In short, the barometer is of no use compared to it. If it has any fault, it is that of being too sensible of small changes, which might frighten a reef in when there was no occasion for it; but, take it altogether, in my opinion it surpasses the mercurial barometer as much as the barometer is superior to having none at all."

I have also had it in my power to make trial of the Sympiesometer on coasting voyages, through the favour of my friend Mr Stevenson, engineer to the Scots Lighthouse board, who placed one of them in the cabin of the Lighthouse Yacht beside a good marine barometer. Along with a register of both instruments, extracted from the ship's log-book, he has favoured me with a communication, which states, that, "after an experience of two years, the Sympiesometer affords the most delicate and correct indications of the weather;" and that "it is a great favourite on board, being commodious even for the smallest cabin, and at the same time easily read off."

"The master, mate, and steward of the Lighthouse Yacht, (Mr Stevenson adds,) give such accounts of the utility and conveniency of the Sympiesometer, as are well calculated to recommend it to the attention of those sailing in vessels of the smallest burden. It is now in use in the service of the Commissioners of the Northern Lights, on board the Light-house Yacht, of 80 tons register, and the Pharos, or Bell Rock Tender, of 45 tons."

II.—*New Hygrometer.*

In the winter of 1816, I made many trials of different substances, for the purpose of ascertaining their hygrometric powers, in order, if possible, to find one which should possess sufficient sensibility, and, at the same time, not to be liable to change the extent of its contraction between the extremes of dryness and humidity. Among the various substances which I tried, those that changed their bulk in a considerable degree by a change of humidity, were Rottenstone, Chalk, unbaked Clay made very thin, and Mountain Cork. Though, from the friable nature of the three first, it was found difficult to use them, yet I am of opinion, that they may be advantageously employed in the construction of hygrometers, and there is reason to think that they will not be subject to any alteration in their scales.

Charcoal, from its known durability, likewise presented itself as a proper substance for the above purpose; and it was found, upon trial, to be sensibly hygrometric, although its range was very limited.

Most of the above substances were formed into hollow cylinders, and cemented to the end of thermometer tubes; and their expansibility was tried by filling the cylinder and tube with mercury, in the usual manner.

But the substance which was found to possess by far the most delicate sensibility, and extensive range, was the internal membrane of the *Arundo Phragmites*. A small bag, made of this membrane, is attached to the lower end of a thermometer tube, so as to form, as it were, its bulb. It is then nearly filled with quicksilver, which rises and falls, in consequence of the contraction and dilatation of the membrane, by any change of moisture; and these changes are indicated upon a scale attached to the tube, the zero of this scale marking absolute humidity, and the other extremity of the scale absolute dryness. The lower end of the glass tube, instead of being merely inserted into the top of the bag, may pass through it, the quicksilver in the bag communicating with that in the tube by one or more openings made through the sides of the tube. By this means, the bag is supported by the glass, and prevented from being injured by any slight accident; and the instrument is also less affected by any change of temperature.

A convenient portable hygrometer may be made, by employing aslip of this membrane, and attaching its extremities to the end of a lever, somewhat like the small pocket metallic thermometers. The external appearance of one of these instruments is shewn at the bottom of the Patent Sympiesometer, represented in Plate XXV. Fig. 1.

Although this membrane is not entirely free from the change to which all animal and vegetable substances are liable, yet hygrometers made of it possess a considerable degree of uniformity amongst themselves; and, in point of sensibility, this membrane exceeds every other substance that I have met with.

XXXVII.—*Description of an Instrument for ascertaining the Specific Gravity of Bodies, without the Use of Weights or Calculation.*

By Alexander Adie, F. R. S. E. & M. W. S.

(Read 16th December 1820.)

This instrument is a simple lever of a square form, balanced on a centre. One arm of the lever is made considerably longer than the other, to allow a greater range of division. On the long arm, a slider and hook, A, (as represented in Plate XXIII. Figure 1.,) moves freely; the upper part of the slider is opened, to show the divisions on the upper surface of the lever; and there is an index-line in the centre of the opening. The divisions are numbered from 1.1 up to 22; and each prime division as far as 4, which is the useful part of the scale, is subdivided into 10, and numbered 1.1, 1.2, &c. The fixed cylindrical weight at the extremity of the short arm is merely to counterterpoise the long arm. Each division of the scale denotes the portion of the arm which lies between it and the extremity marked by the line S. G. (specific gravity); and their place is found by dividing the whole length of the arm from the centre to the line S. G. by their numbers, so that the divison marked 4 will be one-fourth from the extremity, 3 will be one-third, &c. When the specific gravity of a body is to be ascertained, it is to be suspended by a horse-hair from the short arm, and moved along until it is balanced; the index on the slider having been previously set to the line S. G.; the body is now to be immersed in water, and the equilibrium restored by moving the slider towards the centre; the number of the division on the scale opposite to the index on the slider, will be the specific gravity of the body required. Supposing the index to be betwixt the third and fourth small division from 2|5, the specific gravity of the body will be 2.57, each small division being equal to two hundredths.

Thus far the above instrument corresponds with that already described by Dr B. H. Coates, in the Journal of the Academy of Natural Sciences at Philadelphia. But the scale of this instrument becomes very minute, when the specific gravity exceeds 4, and almost useless in higher numbers. In addition, therefore, to the scale already described, there is another scale on the side of the beam, numbered from 0 to 1000, and divided into 500 equal parts:

these parts are again subdivided into 10, by a Verneer scale on the slider, which divides the whole length of the arm into 5000 parts. Near to the extremity of the short arm, there is an additional centre and steel-hook, which convert the lever into the common steelyard. To the hook a small weight is suspended, to balance the beam when the index of the verneer is at 0, the beginning of the scale; and the slider is so regulated, that when it is moved to the outer end of the scale marked 1000 grains, it exactly balances 1000 grains weight, hung at the hook of the short arm. From this arrangement, it is evident, that the value of every division of the verneer, will be equal to two-tenths of a grain; and each division of the scale itself, will be equal to two grains. The substance of which the specific gravity is to be found, must not exceed 1000 grains in weight. It is to be suspended by a hair from the hook at the short arm, and balanced by moving the slider along the beam. Note the number on the scale, as shown by the verneer: suppose it to be 475, which is its weight in grains; the body is now to be immersed in water in the usual way; move the slider towards the center, until it again equiponderate: suppose the weight now indicated by the verneer to be 290.8 grains, the first weight divided by the difference of the two weights already found, gives the S. G. being in this case 2.578. This differs in nothing from the common method of finding specific gravities, except in its not requiring the use of weights; and the advantage it possesses over the former scale is, that it will give the specific gravity of platinum with as much accuracy as that of the lightest mineral.

Canaan Lodge,
14th Dec. 1820.

XXXVIII.—*Continuation of an Account of some Experiments performed with an Apparatus for Discharging Ordnance, without the Use of a Light or Match-lock; in which several Inferences are drawn with regard to the Nature and Source of the Flame.*

By John Deuchar, M. W. S., P. A. R. P. S.;
Lecturer on Chemistry in Edinburgh.

(Read 10th February 1821.)

I have now to lay before the Society, a continuation of the account of my experiments with Colonel Yule's apparatus for discharging ordnance.

Since last hazarding a few observations on this curious subject, I have not been able to allot to it that time which the investigation deserves; yet still the facts at which I have arrived, may probably justify the consumption of the Society's time for a little longer. From these facts I have endeavoured to draw several conclusions with regard to the source of the flame, and the nature of caloric in general.

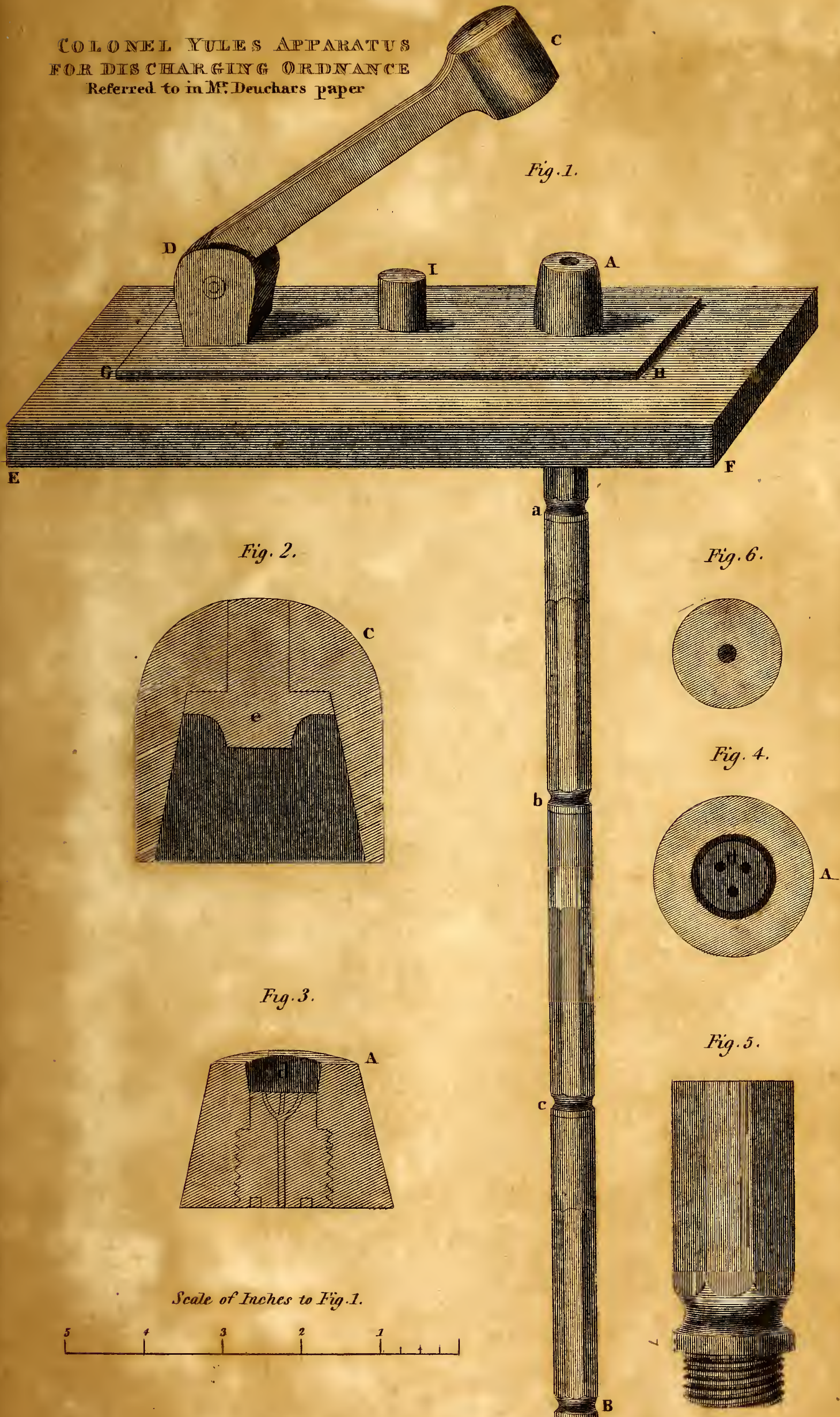
I. I first directed my attention to such experiments as I thought most satisfactory in proving the application of the apparatus to the firing of ordnance of every description; and for this purpose the first seven experiments have been selected.

Experiment 1.—A piece of flannel was put over the bottom of a tube 15 inches long (see Pl. XXIV. fig. 1. B.), and immediately below, and close to it, was tied two folds of paper, with a quantity of gunpowder. Upon exploding a grain of the new fulminating powder at the top (A), the flame was forced down the whole tube, and the gunpowder was fired. When the gunpowder is wrapped in a single piece of thin paper, it generally happens that the flame forces through without firing it. When this takes place, the whole or a part of the gunpowder is scattered about, and the paper is rent asunder, without any appearance of combustion.

Experiment 2.—A piece of flannel, as in the first experiment, was put at the bottom of a tube 15 inches long, and below this was tied another piece of flannel, containing gunpowder. Upon exploding the fulminating powder at the top, the flame pierced the flannel, and inflamed the gunpowder.

Both these experiments prove, that the flame of the new fulminating powder can descend through

COLONEL YULES APPARATUS
FOR DISCHARGING ORDNANCE
Referred to in Mr. Deuchars paper



Engd. by W.H.Lizars

a tube 15 inches deep, pierce a piece of flannel, and fire gunpowder. And supposing the tube to represent the touch-hole of a gun, and the flannel and gunpowder to be a substitute for the cartridge, then we may conclude that the gun would be discharged, although the cartridge were 15 inches distant from the fulminating powder, which will never occur, even in the largest pieces of ordnance. An objection, however, arises to the above conclusion; that it may be owing to the tying being very close, and the flame having no room to spread, that the gunpowder was inflamed in experiments first and second, and that when applied to the gun the flame may be lost over the surface of the cartridge. It becomes necessary to answer this objection, and this is done by the two following experiments.

Experiment 3.—A quantity of gunpowder was scattered over the bottom of a circular tin canister. The canister was 8 inches deep, and nearly 3 in diameter. Over the powder was laid a piece of cartridge flannel. The tube (A B) was made to descend into the canister, to within 2 inches of the flannel; and then a grain of the fulminating powder was exploded at the top. The result was quite satisfactory, the flame pierced the loose flannel, and fired the gunpowder.

Experiment 4.—A tube 14 inches long, was bent at the 10th inch from the top, so as to present 4 inches out of the straight line in which the flame formerly proceeded, and through which it must now pass before it could issue from the under end. Upon exploding the powder as before, the flame issued from the bent end of the tube. When this experiment was tried with flannel, gunpowder, paper, &c. at the bottom, several peculiar circumstances presented themselves, which may induce me afterwards to investigate more particularly the phenomena.

Experiment 5.—In order to ascertain whether the apparatus were apt to clog up, or miss firing from repeated use, it was discharged for 130 successive times, and never failed to produce the proper effect; and still the apparatus did not require to be cleaned for future use.

Experiment 6.—As it appeared of importance to know the temperature at which the new fulminating powder would spontaneously explode, a number of experiments were made with it for that purpose. In one of these there were placed upon a circular tin plate, at three situations, with 2 inches intervening, forming, as it were, the points of an equilatural triangle, sulphur, gunpowder, and the fulminating mixture, one grain of each; below the centre of this triangle, there was a taper, the flame of which was so near as to spread a little upon the tin-plate. In one minute the sulphur began to melt, and in 25 seconds more it was all melted; at the end of 10 minutes, neither of the powders appeared to be altered, but nearly one-half of the sulphur was converted into vapour; at this time the plate was too hot to be touched by the hand.

Experimeut 7.—A grain of the fulminating powder, and the same quantity of gunpowder, were put upon a tin-plate, at 2 inches distance; and at the centre below was put a spirit-lamp. The following is the result of the time of explosion in several trials.

Fulminating Powder.	*Gunpowder.*
in 32 seconds.	in 46 seconds.
28 ——	44 ——
25 ——	60 ——
29 ——	62 ——
40 ——	70 ——
45 ——	85 ——
30 ——	60 ——
40 ——	60 ——
41 ——	60 ——
60 ——	92 ——

In obtaining these results, the distance at which the spirit-lamp was put below the tin-plate sometimes varied considerably, but it was always so near as to spread a little upon its surface. This, however, so far accounts for the great difference between the periods of explosion in the same powder.

Experiment 8.—A piece of cartridge flannel was tied over the under part (B) of the tube, and about one grain of the new powder was exploded at the top (A). The flame was seen to dart through the flannel. The flannel, when examined after the discharge, had not the slightest appearance of having been scorched; it was, however, blackened a little at the spot through which the flame had passed.

Experiment 9.—The 8th experiment was repeated with several pieces of flannel at once. After each discharge with the flannel doubled, the interior piece was a very little scorched, but the exterior one appeared as formerly. When three pieces of the flannel were put at the bottom of the tube, the flame seemed with difficulty to pierce them; the interior flannel was more scorched than took place with the two pieces only, and part was entirely gone; the middle flannel was also slightly scorched. When four pieces of flannel were used, the interior two were much burnt, and the third a little; but the flame did not pierce through the fourth piece. When this last was several times repeated in a very dark situation, there could not be discovered the slightest appearance of the flame at the bottom of the tube.

Experiment 10.—When two pieces of thin coarse paper were put at the bottom of the tube (B), and the powder was exploded as before, the flame passed through, making a rent in the paper, without burning it in the least. When the paper was examined, it presented, on each side of the hole, the separated threads, as if it had been torn with the hand. When four pieces of paper were used, the flame did not pass through them. When paper and flannel were used at the same time, it was found that the interior one was always a little scorched.

From several of these results it would appear, that when the flame proceeds with great velocity, its power of acting upon inflammables or other substances is so prevented; but wherever we, by any means, retard that motion, we facilitate its action. In the eighth experiment noticed, when one piece only of flannel was used, the flame passed through without scorching it; but we find, in the ninth experiment, that as we add to the resistance by additional pieces of flannel, we have the more of the scorched effect. The same was illustrated in the tenth experiment, when a piece of paper was put below one piece of flannel, and when the flannel was put below the paper. This was also proved by the phenomena of the four first experiments.

Experiment 11.—Independent of the proposed application of the apparatus, it appeared of considerable importance to ascertain the distance to which flame could thus be propelled. On this account I affixed to the apparatus a tube 26 inches long; after numerous trials with this, and with tubes of decreasing lengths, I found that no flame appeared at the bottom, till the tube was shortened to 23½ inches, and then it appeared very feeble, and of a pale blue colour.

Experiment 12.—The next circumstance which seemed to claim inquiry, was the distance at which the flame could explode the gunpowder. When the gunpowder was put immediately in contact with the lower aperture of a tube 23½ inches long, it was fired; but when a piece of flannel intervened it was not acted upon. Thus it appeared, that although the flame, at 23 inches distance from the source of its production, could inflame a quantity of powder, yet it had not force enough to pierce even one piece of flannel. The tube was now gradually shortened, and trials made at each change, till it was reduced to between 19 and 20 inches, when it fired the gunpowder through the flannel.

I have repeated more extensively the experiments with wire-gauze, which I noticed at a former meeting; and although it often happens that a part of the finest kind is forced away or rent asunder by the flame, I find I was mistaken in my last paper, when I imagined that the flame could not pass through without injuring the texture of the gauze.

The first trials with wire-gauze were made very hurridly; but the chief mistake arose from using the gauze upon the assurance of the manufacturer, that it was the same as used in the safety lamp, without myself counting the number of meshes which it contained.

The five following experiments are meant to remove any misconception on this part of the investigation. I have confined my notices to two kinds of gauze; the one considerably coarser than the other. A square inch of the coarser gauze contained 1296 meshes, being 36 wires in the length; and the same quantity of the finer gauze contained 4900 meshes in the square, being 70 wires in the length. Now, upon examining two of Sir Humphry Davy's lamps, one for magnetic purposes with copper gauze, and another for common work with iron gauze, I find, that an inch of the gauze of the former contains only 26 meshes in the length, and 676 in the square; and that the gauze of the latter contains 28 meshes in the length, and 784 in the square; shewing, that even the coarsest wire-cloth which I have used, is finer than what is employed in the safety lamp; and that my results acquire additional strength in proving, that the wire-gauze is not impervious to the flame extricated by the explosion of the fulminating powder.

Experiment 13.—A tube, which could be separated into six pieces of nearly the same length, was screwed to the apparatus, making the distance from the top (A) to the bottom, fully 23 inches. A piece of the coarser wire-gauze already described, was put upon the hole at the joining *a*, when the fulminating powder was exploded at A, the flame passed through the gauze, and appeared at the bottom of the tube. The same kind of wire-gauze was next placed at *a* and *b*, and then at *a*, *b* and *c*, at the same time; and the flame passed through all the pieces. This effect was also obtained, when similar pieces of wire-gauze were put at all the five joinings of the tube at once. In this last result, the first piece of wire-gauze was $4\frac{1}{2}$ inches from the top (A); the second $8\frac{1}{4}$; the third 12; the fourth 16; and the fifth 20; and the flame appeared at the bottom, after a passage of $23\frac{1}{2}$ inches through five pieces of the wire-cloth.

Experiment 14.—As I could not get the flame to pass through the whole of the tube, when I encreased the joinings beyond $23\frac{1}{2}$ inches, it was impossible to try an additional number of pieces of wire-gauze, by adding them in the same way. I therefore increased the number, by putting more than one at the same joining. I found, upon repeated trials in this way, using the tube 15 inches long, as shewn on Plate XXIV. Fig. 1. that the flame could pass through 3, 6, 9 and 12 pieces at once; these being placed 1, 2, 3 and 4 pieces at each of the joinings *a*, *b*, and *c*.

Experiment 15.—Although, by the two last experiments, it was proved that the flame could pass through the coarser wire-gauze when increased even to 12 pieces, yet it did not follow that it was not thereby altered somewhat in its nature. A probable change was, that it might become innert with regard to inflammables, as takes place in the several safety lamps, and particularly that of Sir Humphry Davy. Several experiments were tried, to ascertain if this suggestion were correct; first, the wire-gauze was put at *a* ; then at *a* and *b* ; and lastly, at *a*, *b* and *c* ; placing at the same time, during each trial, a quantity of gunpowder in a piece of flannel at the bottom of the tube ; and in all of these I found the gunpowder to be inflamed, and the wire-gauze not to be in the least injured.

Experiment 16.—I next tried the result of firing the fulminating powder, with the finest wire-gauze placed first at *a*, then at *a* and *b*, and then at *a*, *b* and *c*, and found that the flame still appeared at the bottom (B) ; shewing that the gauze, although much finer than that used in Sir Humphry Davy's safety lamp, was not impervious to this flame. In some of the experiments I found a hole had been made in the centre of the wire-gauze, and sometimes the parallel wires were forced wider. This was very often the case, when a piece of wire-gauze was put at all the joinings, *a*, *b* and *c*, and then it was the gauze at *a* which was torn, or otherwise injured.

Experiment 17.—In order to ascertain if the flame still remained unaltered, notwithstanding its having passed through the finest gauze, a quantity of gunpowder in flannel was affixed to the bottom of the apparatus, and it was inflamed through one, two, and even three pieces of the gauze. Here the same occasional appearance, noticed in the last experiment, occurred, with regard to the upper piece of wire-gauze.

II. When we look for the cause of these phenomena there are two explanations which at once suggest themselves. The one, ascribing the whole to electricity; and the other, to condensed caloric.

The circumstances which lead to the electrical explanation of the phenomena, are,

1*st*, The rapidity of the result. This takes place before the least vibration is conveyed to the under end, as is proved by the following experiment.

Experiment 18.—A tin cup, loosely fitted to the bottom of the tube, was filled with gunpowder, and a quantity of the fulminating powder was exploded in the usual way at the top; in this case, the motion of the flame was so instantaneous with the percussion, that the gunpowder was fired before the vibration from the blow could act upon the tin-cup. This was tried in various other ways with the same result.

2*dly*, The colour of the flame much resembling electric light. It is slightly bluish.

3*dly*, There being some similarity in the darting of the light from the bottom of the tube, and the passing of an electric spark from a discharge.

4*thly*, The odour resembling some of those which arise from actions which have often been called electrical. And, *5thly*, The fulminating powder employed, containing an electric, which we were entitled to suspect had been brought into rapid excitation by the percussion.

Such, then, being the corresponding appearances of the electric fluid and the flame in question, a number of experiments were tried, with the view of either establishing or overturning this apparent identity. As the results were all unfavourable to the electric theory, I shall content myself with stating only three of them.

Experiment 19.—A brass chain was fixed, so as to unite the tube with the ground; under this arrangement, were the flame electric, it must have been conveyed silently by means of the chain to the ground; but this did not take place: the flame still continued to dart forward as formerly at each discharge.

Experiment 20.—When, again, a tube, 30 inches in length, was attached to the apparatus, I found, that the discharges of the fulminating powder did not force the flame to the bottom of that tube. Now, had this been the electric fluid, it should have passed along any length of tube with equal facility.

Experiment 21.—A chain was attached to the tube of the apparatus when its length was varied; and this chain was made to communicate with a Leyden phial. After several trials, during each of which repeated discharges of the fulminating powder were made to pass into the tube, it was found, that there was not the slightest indication of the presence of electric fluid in the Leyden phial.

Having found that the first hypothesis does not hold true, we are led to adopt the second, which ascribes the phenomena to condensed caloric.

Under this view of the subject, we have a more complicated agent to trace. In the electric theory, we had only one source of the fluid, in an ingredient of the fulminating powder, and we had ready tests for its nature and presence: but we have various sources from which the caloric may arise; and our means for ascertaining its nature and presence are sometimes rather inconclusive. In the present case the caloric may arise from one or more of five different sources.

1. It may be disengaged from the fulminating powder, by a change of capacity induced by the blow of the hammer; or probably from a partial decomposition of the union of the substances with their natural caloric.

2. It may arise from the combustion of the ingredients of the powder, in contact with the compressed air.

3. The air of the tube may give out caloric, being condensed by the gasseous bodies liberated at the top.

4. The air in the cap at the top of the tube, may give out caloric, when compressed between the cap

in the one direction, and the gaseous ingredients of the powder in the other direction. And,

5. The caloric may arise from the rapid movement of the gaseous substances along the brass tube.

Such are the probable sources from which the caloric may be derived; and we may admit that they all so far unite to disengage it.

But, again, when we consider the nature of the caloric, the simplicity of the electric fluid is also lost. The condensed caloric may be attached to some disengaged gaseous fluid; it may proceed by vibrations; or it may exist by itself, quite distinct for the momentary period of its being visible, as it were in an insulated form, somewhat analogous to radiation.

From the various results I have obtained in my experiments, and particularly in those undertaken for the express purpose, I am rather inclined to adopt the last of these conjectures regarding the state in which the caloric exists during its rapid movement. It would be encroaching too much on the time of the Society, to detail the whole of the experiments which seem to prove this. I shall therefore content myself with one which, of itself, seems conclusive.

Experiment 22.—When we put a piece of tinder into a condensing syringe, and force down the piston, the tinder is inflamed; from this fact I concluded, that in the case of Colonel Yule's apparatus, were the flame accompanied by moving air, or were it the result or quality of compressed air, it would inflame a piece of tinder put in any of the joinings of the tube: I therefore repeatedly tried the experiment, using the finest German tinder, but no inflammation took place. To render the experiment more complete, I tried if the flame would act upon the tinder when in contact with the air at the bottom of the tube, and found that it did so.

From this conclusion, if allowed to be correct, we have an additional argument, did the state of the question require it, for the materiality of caloric.

Experiment 23.—I tried to collect some of the air at the bottom of the tube, both in a water and a mercurial trough, but found that not above two or three bubbles of it could be obtained at each discharge,—too small a quantity to arise from the fulminating powder. I have not yet collected enough to ascertain its nature; it is very likely that it may be a little of the air of the tube forced out by the rapid movement of the flame, and the pressure of the expansion which occurs at the top.

Edinburgh, 9th February 1821.

Conclusion of the Experiments upon the Nature of Flame; to which are added several suggestions for future Inquiry.

When first I offered a few remarks upon the experiments performed with the new fulminating powder, I promised to examine the cause of the various phenomena which I then stated had occurred, with the view of laying the whole before the Society. I have already done so with regard to all the experiments, except those which exhibited the very unexpected result of the flame occasionally passing through some gunpowder without firing it. I have now, therefore, to notice more fully this circumstance.

Experiment 24.—I have repeated the experiments mentioned in my former paper, which presented this curious result of the flame passing through a quantity of gunpowder placed at *a*, *b*, or *c*, without inflaming it. The result, however, is by no means regular in its occurrence; sometimes I found it to succeed in three successive trials; at other times I have failed four or five times before I have produced the effect. In all these cases I was careful to make the powder cover the whole surface of the piece of flannel upon which it was poured. This variety of effect seems to take place from some accidental circumstances, which have as yet escaped my notice. At some times I have apparently succeeded best when I used gunpowder, the grains of which were large, and at other times again the small-grained gunpowder was most uniform.

The principal cause we may adduce for the powder remaining uninflamed, under the above circumstances, is the rapid motion of the flame. We are entitled to draw this conclusion from the phenomena which occurred in the 1st, 8th, and 10th experiments; in these we found that the flame did not act upon the substances through which it passed, when the resistance was feeble. But in the 9th and 10th experiments, when the resistance to which it was opposed was increased, then its effect upon the substances was more apparent. The same change of effect seems also to take place with regard to the gunpowder; when the resistance is increased, the powder is always inflamed, and the apparent inertness only takes place when the motion of the flame is left almost wholly free. The failure of effect alluded to in several of the trials in the 24th experiment, may have occurred from the flannel having been too thick and compact, or from too large a body of flame having passed down the tube at one discharge.

Another cause may be assigned for the gunpowder at the joinings *a, b* or *c,* remaining uninflamed. There is scarcely any air contained in the space *a, b* or *c;* the flannel and gunpowder nearly fill the whole, so far as the tube is unscrewed, and the tube itself contains little air. Now, a certain quantity of air may be necessary to enable the caloric, in the insulated and condensed form in which we may assume it to exist during this rapid motion, to display fully its usual effects upon substances. When this supply of air is not present, then the caloric passes through the gunpowder and other substances, without inflaming, or otherwise affecting them; but when we put resistance at the bottom B, we facilitate the concentration of the air contained in the tube, and therefore promote the action; or when we leave a quantity of air at *a, b,* or *c,* we in like manner assist the inflammation.

The above explanation will appear in a still clearer point of view, when we consider the nature of those affinities which often take place between bodies, when in a nascent state, although every attempt has failed to unite them, after they have assumed their separate forms. The same may occur with regard to flame. When propelled in an insulated form, it may not act upon inflammables placed at a distance from the point of its disengagement; but, when it meets with resistance, in contact with such substances, or when it is presented to them in its nascent state, then its full energy may be displayed, Its effects, therefore, would be more strikingly displayed, were it to carry along with it, a quantity of air, than they would be, were it to force its way through the tube and air in a separate form.

But, upon the whole, we must allow it to be a subject of considerable obscurity, and further trials may be necessary properly to elucidate the cause.

In concluding this subject, I may add a few experiments, the result of which I have not yet been able to examine with sufficient care. I state them, therefore, as suggestions for future examination.

It has been found in experiments 11 and 14, that the flame does not pass through a tube above $23\frac{1}{2}$ inches long. Now, this may be explained, either upon the supposition that the caloric is merely a property of a quantity of air or gas, which is forced along the tube by the explosion; or upon the hypothesis I have suggested, that the flame exists so far independent of the air, and is rather, for the short period of its motion, in an insulated form. If we hold the first of these to be correct, then we will be inclined to maintain, that the flame ceased to appear at the bottom of a longer tube, because the velocity of the air was exhausted before it could reach that point, and that, therefore, its excess of caloric was given out to the interior of the tube. If, again, we adopt the second hypothesis, presuming the materiality of caloric, then we will maintain that the flame, though capable of insulation to a certain extent, yet has a strong attraction for all kinds of matter, and has a tendency to extend itself from particle to particle of such bodies as come in contact with it. Its particles, too, have a strong repulsion for each other, and facilitate the diffusion. Hence as we lengthen the tube, we increase the surface of attraction, till we entirely diffuse the flame. It is so far favourable to this supposition, that air does not become luminous, when united with a great quantity of caloric; and it has even been observed, that air has remained invisible, although heated to such a degree as to inflame substances upon which it was allowed to act. The following experiments seem calculated to elucidate one or other of these theories with regard to caloric.

Experiment 25.—Let a tube be affixed to the apparatus, of such a length only as just admits of the flame passing out at the bottom. Let the interior be made quite resplendent, by wiping away the smoke, moisture, &c. from its surface. Let a given weight of the fulminating powder, say exactly one grain, be used at each trial, and regulate the blow as well as possible, that it may be nearly of the same force each time. Examine, in several discharges, cleaning the interior of the tube each time, if the flame passes through the whole length, and appears at the bottom. Then try the following:

Experiment 26.—Take the same tube used in the last experiment, and let the inner surface of it be blackened by means of smoke, or any other substance. Let the same quantity, one grain, of the fulminating powder, be discharged by a similar stroke to that given in the previous trials; and observe if the flame still issues from the bottom of the whole of the tube. If it does not appear, gradually shorten the tube, till the flame is seen to dart from the bottom. This will shew if the difference be great. The tube must be cleaned, and again blackened for each trial.

Experiment 27.—Take a tube, the interior resplendent, of the greatest length that will allow the flame to force its way through a piece of paper, tied tight upon the bottom. Try the effect repeatedly with one grain of the fulminating powder, observing if the flame dart through the paper.

Experiment 28.—Let the tube used in the 27th experiment be blackened in the interior, and then discharge one grain of the powder, as before, with a piece of paper at the bottom. In this case we are to observe if the same result still takes place, or if the paper now remains whole.

Now, should the result of these experiments shew that the flame uniformly passes through a longer resplendent tube, than it does through a blackened one, and that the paper at the bottom is not torn when the interior of the long tube is blackened, then we have a strong argument in favour of the materiality of the flame, independent of the air. The clear surface reflects the flame, and, therefore, does not retard its motion; the blackened surface absorbs the flame, and therefore retards its motion: but the air is affected nearly in the same degree by both surfaces; therefore, it should produce the same mechanical effects upon the paper at the bottom, whether the interior be resplendent or blackened. If the flame passes through the same length of the tube, without any regard to the colour of the surface, then we may maintain that it is the power of the combination that prevents the flame leaving the air, to display its natural character of absorption by a black surface; at the same time also, the velocity of the flame itself may have a tendency to retain it in an insulated form. But if we find, that, by blackening the inner surface, we stop the progress of the flame, we are entitled to assume, even although the air still pass from the bottom of the tube and tear the paper, that there has here been a quantity of free caloric passing along, quite independent of the quantity retaining in the constitution of the air. But, again, if we find, upon trying Experiments 27, and 28, that the paper at the bottom is torn, at a greater distance from the top, when the interior is resplendent than takes place when it is blackened, then we have it clearly shewn that the flame has been producing these effects in an insulated form; for had the tearing of the paper been the effect of the motion of a quantity of air, then we should have expected no change of result to take place, whether the surface were black or resplendent.

Experiment 29.—Let a tube be taken of the greatest length that will admit the flame to pass entirely through it. Add to this as much more tube as will prevent the flame appearing at the bottom: try if, by discharging a grain of the powder, a piece of paper tied over the under part will be torn; if it be not torn, then heat as much of the tube as can be conveniently done, and discharge as before the same quantity of powder; and observe if the flame be now forced through a longer tube than it was before, when the tube was cold.

Should this last experiment prove to us, "that the flame will pass through a longer hot tube than it will through a cold one," then we have the possibility of the caloric existing in a free independent state, still more strikingly shewn. We have here taken a tube so long that the air cannot pass to the bottom of it; the air stops merely because the power of its motion is exhausted, by the opposition of the air in the tube; there is no attraction of absorption or any other nature exerted, which could be weakened by applying heat. But, on the other hand, all matter has a tendency to receive caloric, and the lower the temperature is the more is this tendency encreased; therefore, when a tube which, at a low temperature, does not admit the flame to pass through, is heated, the surrounding powers of attraction are weakened, and the flame is enabled to proceed to a greater distance.

Although I have thus for the present brought this curious investigation to a close, yet should any other important circumstances connected with the apparatus, occur at a future period, I shall not hesitate to fulfil my duty to the Society, by laying the whole before them.

24th February 1821.

APPENDIX.

HISTORY

OF THE

SOCIETY.

(Continued from Vol. II. p. 662.)

THE Secretary read a communication from Mr Alexander Hood, surgeon in Kilmarnock, giving a more particular description of the Fossil Tusks, &c. found in tirring a sandstone quarry in the parish of Kilmaurs, Ayrshire, mentioned at the meeting of 7th June last, accompanied with a part of one of the tusks, which he presented to the Society.

1817. Dec. 20. Mr Hood's Account of the Fossil Elephant of Ayrshire.

Professor Jameson read a paper on the Geognostical Characters of Simple Minerals, and on the Vegetable Origin of the Diamond, in particular cases. The Secretary read a communication from Mr Butter, surgeon, shewing that the Change of Plumage in the Females of some Gallinaceous Birds, to that which resembles the Males, depends on age only.

1818. Jan. 10. Professor Jameson on the Geognostic Characters of Gems, &c. Mr Butter on Female Gallinæ assuming Male Plumage.

1818. Jan. 24. Mr James Wilson on the Early State of the Tadpole. Mr Adie's newly contrived Instrument named Sympiesometer, described.

The Secretary read a communication from James Wilson, Esq. on the Early State of the Tadpole, shewing its connection with the globular egg, by means of a filament, analogous to an umbilical cord. Mr Adie afterwards exhibited and explained his new instrument called the Sympiesometer, or Measurer of Compression; in which the moveable column consists of oil, enclosing, in a glass tube, a portion of azote, which changes its bulk according to the density of the atmosphere. A sliding scale is attached, to ascertain the temperature.

1818. Feb. 7. Dr Traill's Account of the Orang Outang of Africa.

The Secretary read a communication from Dr Traill of Liverpool, giving an account of the Dissection of a specimen of the Orang Outang of Africa, which died lately at Liverpool, illustrated with drawings, and containing also some notices concerning its manners and habits during the voyage.

1818. Feb. 21. Conclusion of Dr Traill's Account of the Orang Outang.

The Secretary read the remainder of Dr Traill's account of the Orang Outang. Mr Bullock of London being present, exhibited a specimen of the Anser ruficollis, shot near Berwick; being the first known instance of the occurrence of that bird in Britain, during the last thirty years. At the same meeting, a valuable collection of the Ferns of Tristan d'Acunha was presented by Captain Carmichael, who had himself collected them on that remote island.

The Secretary read a notice concerning a new animal, allied to the Goat and Sheep, which inhabits the Stony Mountains to the south-west of Hudson's Bay, two skins of which were some time ago presented to Professor Jameson by Mr Auld of Churchhill Fort, Hudson's Bay; together with a letter from Mr Laurie, on the quality of the wool which covers a great part of the animal. Professor Jameson then communicated to the Society a series of new views concerning the formation of Mountains and Valleys on the surface of the earth, on the general principles of Crystallization.

1818. March 7. Secretary's Report on the Stony Mountain Sheep; and Professor Jameson on the Formation of Mountains and Valleys by Crystallization.

The Secretary read a report from Mr Thomas Laurie, relative to the fleece of the Rocky Mountain Sheep, sent from Hudson's Bay by Mr Auld. Also a communication from Captain Carmichael, of notices connected with the Natural History of Birds and Fishes, observed in warm latitudes, and a Register of the Temperature of the Sea and Atmosphere, kept in a voyage from the Cape of Good Hope to Bengal, and back again. Professor Jameson then communicated to the Society, some remarks on the probable state of the Polar Ice, founded on the observations of Captain Scoresby, and on the paramount pretensions of that scientific navigator to the consideration of the Government of the country in the projected voyage of discovery to the North Pole. Mr Bullock exhibited to the Society, a specimen of the Rose-coloured Thrush,

1818. March 21. Mr Laurie's Report on Rocky Mountain Sheep.

Captain Carmichael, Natural History Notices, and Journal of Temperature of Sea and Air.

Professor Jameson on the Polar Ice.

Specimen of the Rose-coloured

Thrush, caught at Hoy in Orkney.

Turdus roseus, (the female,) taken by Mr Hamilton of Hoy, in Orkney, in his garden, among a flock of starlings.

1818. April 4. Captain Scoresby's Account of a New Magnetical Instrument; and Dr Fleming on the Transpiration of Dew-like Drops on leaves of Corn.

The Secretary read an abstract of a letter from Captain Scoresby to Professor Jameson, giving an account of an instrument for shewing the Longitude, founded on a hitherto unknown principle in Magnetism. Also a notice from Dr Fleming of Flisk, relative to the Drops of Moisture observed on the tops of the leaves of young shoots of Corn, which have generally been considered as Dew, but which Dr Fleming shewed to be a liquid transpired by the plant.

1818. April 18. Mr Stevenson on Filling up of Fresh-water Lakes.

The Secretary read a communication from Mr Stevenson, civil engineer, on the Encroachment of the Water of Loch Lomond, and other fresh water Lakes, on their banks, and the tendency to fill up in the middle. Likewise an extract of a letter from Mr Bald, now at Newcastle, describing some of the Collieries there, and illustrating the importance and efficacy of the Wire-gauze Safety-Lamp.

A Committee appointed to meet with the Directors of the Highland Society, in regard to the introduction of the Rocky Mountain Sheep into Scotland.

A report by Mr Laurie on the Rocky Mountain Sheep having been presented, the following gentlemen were appointed a committee to communicate with the Directors of the Highland Society of Scotland, and to request their attention to the importance of endeavouring to introduce a breed of the animal into this country, and their assistance in effecting this object, viz. Robert Stevenson, Esq.; Dr Barclay; C. S. Monteith, Esq. of Closeburn; and David Falconar, Esq. of Carlowrie.

Professor Jameson read a communication from Dr Fleming, describing the Rocks in the vicinity of Cork.

1818. May 2. Dr Fleming on the Rocks of Cork.

Professor Jameson read a communication from Dr Grierson of Cockpen, on the Casts or Petrifactions of Trees found in the Sandstone of the Coal Formation in Mid-Lothian, illustrated with specimens and sketches.

1818. May 16. Dr Grierson on Petrifaction in Sandstone of Coal Formation.

Professor Jameson communicated to the Society an account of the Series of Rocks which occur on the south-east coast of Fife, between Macduff's Cave and the Ely; with notices of particular appearances in their disposition and arrangement.

1818. May 30. Professor Jameson on the Rocks of the Ely in Fifeshire.

Professor Jameson communicated to the Society an account, illustrated by specimens, of the Geognostic Structure of the chain of hills stretching between Table Bay and False Bay, at the Cape of Good Hope, by Dr Adams.

1818. Nov. 21. Dr Adams on the Geology of the Cape of Good Hope

Captain Scoresby read a paper on the size of the Mysticetus or Greenland Whale, shewing that this animal is found in the present day of equal dimensions as in former times. Mr Sivright communi-

1818. Dec. 19. Captain Scoresby on the Size of the Greenland Whale;

and Mr Sivright on Globules of Air and Water in Topaz, &c.

cated to the Society a notice respecting the frequent occurrence of Globules of Air and Water in Scotch Topaz, Heavy-spar, &c.

1819. Jan. 9. Professor Jameson on the Geognosy of the Grampians.

Professor Jameson read the first part of an account of the Geognostic Structure of the Grampians.

Jan. 23. Dr Hibbert on the Rocks of Shetland.

Dr Hibbert read to the Society his Observations on the Stratification of the Shetland Islands.

Feb. 6. Continuation of Professor Jameson's Geognosy of the Grampians.

Professor Jameson continued his Mineralogical Account of the range of the Grampian Mountains, illustrating his descriptions by numerous sections of the country.

Feb. 20. Continuation of Dr Hibbert's Geognosy of Shetland.

Dr Hibbert read the second part of his account of the Geognosy of the Shetland Islands, consisting chiefly of observations on the Relations of the Quartz and Sandstone of the Western part of the country.

March 6. Mr Campbell on the Living Principle; and contin. of Dr Hibbert on the Geog. of Shetand.

Mr Campbell of Carbrook read a paper on the Gradations in the Scale of Being, and particularly on the Living Principle. Dr Hibbert read a paper on the Serpentine District of Shetland.

March 20. Dr Brewster on the Optic. Prop. of Minerals; and Dr Hibbert's contin. of the Geognosy of Shetland.

Professor Jameson read a communication by Dr Brewster, on the Optical Properties of Minerals. Dr Hibbert read the continuation of his Account of the Geognosy of Shetland.

1819. April 3. Captain Scoresby on Overcoming Difficulties to Discoveries in the Arctic Seas; and Dr Hibbert's contin. of his Acount of Shetland.

The Secretary read a communication from Captain Scoresby, on the Means of overcoming some of the Difficulties to Discoveries in the Arctic Seas: and Dr Hibbert gave a description of the Sienite District of Shetland, in continuation of his general account of the Geognosy of these Islands.

April 10. Conclusion of Dr Hibbert's Geognosy of Shetland.

Dr Hibbert gave an account of the Granite and Sandstone Districts of Shetland; and completed his view of the Geognosy of these Islands, by some remarks on Papa Stour.

April 24. Mr Stewart on the Germination of Cryptogamous Plants; and Rev. Mr Young on a Fossil Animal found at Whitby.

The Secretary read a communication from Mr Stewart, containing remarks on the Germination of some kinds of Cryptogamous Plants, and a list of some of the rarer Cryptogamous Plants which have been lately found in the neighbourhood of Edinburgh. Likewise a description, illustrated by drawings, of the Fossil Remains of a Cetaceous Animal found in slate-clay near Whitby, by the Reverend George Young.

May 1. Mr Neill on the former existence of the Beaver in Scotland; and Mr Bald on the Coal Formation.

The Secretary read a memoir regarding the Evidence of the Existence of the Beaver as a native Quadruped of Scotland in former ages: and Mr Bald read a paper on the Form of the Coal Formation in Great Britain, illustrated by numerous sections and specimens.

Dec. 11. Mr Stewart on Buxbaumia aphyl.

The Secretary read a communication from Mr Stewart, Lecturer on Botany, giving an account of la; and M Stevenson on the Formation of Holland.

his having found and examined many specimens of the rare moss Buxbaumia aphylla, and giving reasons for believing it to be a plant of longer duration than botanists have hitherto thought. Likewise a paper by Mr Stevenson, on the Original Formation of the Land now constituting the territory of the United Dutch Provinces.

Dec. 29. Professor Jameson on the Rocks of Sandside; and Mr J. Murray on the Luminosity of the Sea.

Professor Jameson read an account of the Rocks of Sandside in Sutherland, and illustrated the description by sections and specimens: and a paper on the Luminosity of the Sea, by Mr John Murray, Lecturer on Chemistry, was read.

1820. Jan. 15. Mr Trevelyan on the Rocks of Bamborough. Mr Butter on the Change of Plumage of Female Birds. Prof. Jameson on Change of Plumage on the approach of Winter.

Professor Jameson laid before the Society, a notice of some of the Mineralogical appearances at Bamborough Castle, communicated by Mr Trevelyan of Wallington. Mr Butter read a communication on the Change of Plumage which is sometimes observed in aged Female Birds, to that of the Male, being a supplement to the paper formerly read by him on the same subject. Professor Jameson read a short paper on the Mode in which the Change of Colour in some Birds is accomplished on the approach of winter.

Jan. 29. Professor Jameson on Whin-dikes; and on the Spines on the Wings of Birds.

Professor Jameson communicated to the Society, his observations on the Similarity frequently existing between what are called Whin-dikes, and Veins and Beds of Quartz and Sandstone, illustrating them by sketches. He likewise communicated a short notice regarding the Spines to be observed on the fifth bone of the wings of the Water-rail, Coot, Water-hen, and some other water birds; the notice being accompanied by an exhibition of specimens.

1820. Feb. 12. Dr Yule on a Collection of Plants from India; and Professor Jameson on Mud Volcanoes, &c.

Dr Yule laid before the Society, a notice regarding a collection of rare Plants, in a living state, received from Dr Wallich of Calcutta; and on the means of Transporting Plants and Seeds safely from distant tropical countries. Professor Jameson read a paper on Rocks formed by mud-volcanoes, hot springs, &c.

Feb. 26. Dr Dewar on the Mode of Nutrition of Hair, Feathers, and Nails: and Dr Boué on the Rocks of Auvergne.

Dr Dewar read a paper on the Mode of Nutrition of the Hair, Feathers, and Nails of Animals. Professor Jameson read a letter from Dr Boué, containing an account of the Resemblance of the Rocks of Auvergne and the Vivarais, to some of those in this country.

March 11. Professor Jameson on Formation of Trap-rocks.

Mr Stewart read a paper describing a collection of Cryptogamous Plants chiefly received from North America. Professor Jameson communicated his reason for differing from the Volcanists in their views in regard to the formation of Trap-rocks.

March 25. Mr Stevenson on the Bottom of the North

The Secretary read the first part of a paper by Mr Stevenson, on the bottom of the German Ocean or North Sea, illustrated by beautiful plans and sec-

Sea; Mr Swainson on a New Species of Picus; and Mr Stewart on the Germination of Ferns.

tions. Likewise a communication from Mr Swainson of Liverpool, describing Two New Species of Picus. Mr Stewart then read a paper on the Germination of some of the Fern tribe.

April 8. Conclusion of Mr Stevenson on the Bottom of the German Ocean; and Mr David Don on New Scotch Plants.

The Secretary read the remainder of Mr Stevenson's paper on the Bed of the German Ocean, or North Sea. He then read a communication from Mr David Don, London, describing several rare Plants found in Scotland, and which are new to the Scottish Flora.

August 3. Mr Sivright on Silica in Teak-wood; and Mr Greville on rare Devonshire Fuci.

Professor Jameson communicated to the Society, a notice by Mr Sivright, regarding the existence of a very considerable quantity of Pure Silica in the Teak-wood of the East Indies. And the Secretary read a communication from Mr Greville on some rare Fuci found on the shores of Devonshire.

Nov. 18. Dr Barne's Biography of an Old Gentleman who has completed his 115 year; Professor Jameson on the Arctic Expedition; Mr Greville on the Aretic Flora; and Mr Don on the Plants of Nepaul.

The Reverend Mr Russel read a communication from Dr Barnes, to Professor Jameson, giving an account of an old gentleman, now alive, who had completed his 115th year. The Professor then gave a general account of the progress of the Discovery Ships through Barrow's Straits; their wintering in a bay in Melville Island; the animals met with, &c. derived from conversations with the Officers of the Hecla, lately in Leith Roads. He likewise read extracts from two botanical communications; one by Mr Greville, on the Plants of the

Arctic Regions, and describing a New Species of Potentilla, brought home by Mr Jameson, surgeon; and the other by Mr David Don, describing several new Plants from the Nepaul Mountains.

1820. Dec. 2. Professor Jameson's Account of the Arctic Overland Expedition; and Mr W. Jameson's Voyage to Baffin's Bay.

Professor Jameson read an account of the Overland Arctic Expedition: and he, at the same time, laid before the Society, a Map of the Country, on the west and north sides of Hudson's Bay, drawn by a Native Esquimaux. He then read the first part of a Voyage to Baffin's Bay, by Mr William Jameson.

Dec. 16. Conclusion of Mr Jameson's Voyage to Baffin's Bay. Description of Mr Adie's Instrument for determining the Specific Gravity of Minerals; and account of Colonel Yule's Improved Mode for Discharging Ordnance.

The Secretary read the concluding part of Mr W. Jameson's narrative of his Voyage into Baffin's Bay. Mr Adie then laid before the Society, his Improved Instrument, or Beam, for facilitating the determining of Specific Gravities of Minerals, &c. the principal advantages of which are, that no weights or calculations are necessary; that the whole operations may be performed in a few minutes; and that the instrument is easily portable, and is not expensive. Mr Deuchar, Lecturer on Chemistry, communicated to the Society, an account of Colonel Yule's improved Apparatus for Discharging of Ordnance; and mentioned some results that have occurred as to the nature and properties of Flame.

1821. Jan. 13. Dr Colladon's Notice

The Secretary read two notices from Dr Colladon; one relative to Cinchonin and Quinin, or the

1821. of Cinchonin and Quinin; and of Spix's Expedition: and Professor Jameson on the use of Iodine in the Cure of Goitre, and of its existence in Peat.

Alkaline Substances existing in Cinchona; the other relative to the Travels in Brazil, of Messrs Spix and Martins, sent thither by the king of Bavaria. Professor Jameson also read a notice in regard to the use of Iodine in the cure of Goître, and of the existence of Iodine in the Peat of this country, and in cryptogamous land plants. The Professor then exhibited, 1. A preserved head of a New Zealand Chief, having the skin and tattooing of the face in a very perfect condition. 2. A section of a log of Elm, containing the nest of a titmouse, completely encircled by the solid wood of the tree, the specimen having occurred in one of the Royal Dockyards, and been sent by Lord Melville to Professor Jameson, for the Regius Museum of the University.

OFFICE-BEARERS, 1821.

Office-Bearers elected at the Meeting on the 2d December 1820.

President.

Robert Jameson, Esq. Prof. Nat. Hist. Edin. &c.

Vice-Presidents.

Sir Patrick Walker,
Tho. Mackenzie, Esq. M. P.
Robert Stevenson, Esq.
David Falconar, Esq.

Secretary, Pat. Neill, Esq.
Treasurer, William Ellis, Esq.
Librarian, James Wilson, Esq.
Painter, P. Syme, Esq.

Council.

Thomas Sivright, Esq.
Dr James Gregory *jun.*,
Capt. Thomas Brown.
Patrick Small Keir, Esq.
Col. David Williamson.
William Newbigging, Esq.
Dr Samuel Hibbert.
Robert Bald, Esq.

List of Members of the Wernerian Natural History Society of Edinburgh,—continued from Volume Second.

HONORARY.

1819.

Nov. 27. His Royal Highness PRINCE LEOPOLD of SAXE COBOURG.

1820.

Aug. 5. The Count ITTERBURG of Sweden.

RESIDENT.

1817.

Dec. 20. Captain THOMAS BROWN, (formerly Non-Resident, January 8. 1814.)

SAMUEL HIBBERT, M. D.

1818.

April 15. GEORGE BERRY, Esq. Edinburgh,

JOHN INNES CRAWFORD, Esq. Edinburgh.

ROBERT LISTON, Esq. Surgeon, Edinburgh.

PATRICK SMALL KEIR, Esq. of Kinmonth.

The Rev. THOMAS NELSON, Edinburgh.

Dec. 5. Colonel DAVID STEWART of Garth.

JOHN AITKEN, M. D. Edinburgh.

1818.
The Rev. Michael Russell, D. D. Leith.
Dr William Macdonald of Ballishare.

1819.
April 15. Andrew Smith, Esq. Staff Surgeon.
John Gillies, M. D. Edinburgh.
Capt. John Wilson Carmichael Edinburgh.
Henry Dewar, M. D. Edinburgh.
James Robinson Scott, Esq. Lecturer on Botany.
Sir James Stuart, Bart. of Allanbank.
Andrew Waddell, Esq. Leith.
Professor George Dunbar, Edinburgh.
Dr Walter Oudney, Surgeon. R. N.
The Rev. Edward Craig, Edinburgh.
John Stewart, Esq. Lecturer on Botany.
Robert Kaye Greville, Esq. Edinburgh.
Andrew Clason, Esq. Edinburgh.
John Crawford, Esq. Edinburgh.
Dr James Fisher, Edinburgh.

1819.
Dec. 29. William Graham, M. D. Edinburgh.
John Deuchar, Esq. Lecturer on Chemistry, Edinburgh.

1820.
Dec. 2. William Jardine, Esq. younger of Applegirth.

1821.
Mar. 10. Matthew Miller, Esq. Glenlee.
Gilbert Innes, Esq. of Stow.
James Hay, Esq. Leith.
William Drysdale, Esq. Edinbnrgh.
William Marshall, Esq. Edinburgh.
James Maitland Hog, Esq. Newliston.

NON-RESIDENT.

1818.

April 15. William Clelland, Esq. Glasgow.
James Muttlebury, M. D. Bath.

Dec. 5. Dr Samuel Sproull, Bombay.
Edward Seymour, Esq. A. B.

1819.

April 15. Sir James Macgregor, Bart.
Prideaux John Selby, Esq. of Twizell-House.
Samuel Parkes, Esq. London.
Robert Fraser, Esq. Civil Engineer.
Captain Webb, Nepaul.
Dr William Gordon, Jamaica.
Alexander Laidlaw, Esq. Nepaul.
Henry Heuland, Esq. London.
Captain Carmichael, formerly of Tristan d'Acunha.

Dec. 29. William Swainson, Esq. Liverpool.
Walter Calverley Trevelyan, Esq. B. A. M. G. S. Wallington.
Joseph Harrison Fryer, Esq. of Lyzick-Hall.
John Murray, Esq. Lecturer on Chemistry, Aberdeen.

1820.

Aug. 5. Dr Robert Willis.

Dec. 2. Andrew G. C. Tucker, Esq. Ashburton.

1821.

Mar. 10. Dr George Magrath, Plymouth.

FOREIGN.

1818.

April 15. Dr James Mease, Philadelphia.
Professor Lallement, Paris.

1819.

April 15. Dr Thomas Horsfield, Java,
Professor Griscom, New-York.
Dr G. F. W. Meyer of Göttingen.
Mr A. Risso of Nice.
Dr Amie Boue, Hamburgh.
Dr August Verdeil, Lausanne.
Count Breunner, Hereditary High Chamberlain of Lower Austria, &c.
Professor De Wolfe, Nürnberg.
Dr Meyer, Counsellor of State, Offenbach.
Mr Konrad Jakob Temminick, Haarlem.

Dec. 29. Mr John Menge of Hanau.
M. Louis Dufresne, Jardin du Roi, Paris.
M. Le Chevalier Geoffroy St Hilaire, Paris.

1820.

Aug. 5. Baron Porlier of Switzerland.

Dec. 2. Dr Louis Theodore Frederick Colladon of Geneva.
M. Justizcommissar Keferstein, Halle.

1821.

Mar. 10. M. Auguste Pyramus Decandolle, Geneva.
M. Herberski, Professor of Medicine, Wilna.
Dr L. H. Bojanus of Wilna.
Dr Blasius Merrem, Professor of Natural History, Marburg.
Professor H. F. Link, Director of the Botanic Garden, Berlin.
Dr Daniel Drake, Cincinnati, Ohio.
M. K. Am. Kühn, Professor of Geognosy and Mining, Freyberg.
M. Haidinger of Vienna, now at Freyberg, Saxony.

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