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FACULTIES OF BIRDS.

CHAPTER I.

VISION OF BIRDS.

THE animals most celebrated for piercing sight are the eagle and the lynx; but if the acute vision of the eagle rested on no better authority than that of the lynx, we should not be disposed to rely on its accuracy, though old Aldrovand says that "nobody of sound mind will deny the lynx to be the clearest sighted of all quadrupeds, since all naturalists are agreed upon the point*." There can be little doubt, however, that the agreement thus quoted as an authority sprung from reading and copying rather than from observation; or perhaps, as Gesner seems to think, from the similarity of the name to Lynceus, whom the poets fable to have been able to look through trees, walls, and rocks, and even, if we credit Apollonius, to see into the very bowels of the earth. "The truth is," says Gesner, "that Lynceus, of whom so many fables are told, was the first that found out the mines of gold, silver, and copper in the earth, and therefore simple people seeing him bring gold and silver out of the earth, and coming

* De Quadrupedibus Viv. p. 94.

now and again upon him when he was digging deep for it, using the light of candles which he never brought out of the pits, they foolishly imagined that by the sight of his eyes he was first of all led to seek those treasures, and hence the proverb 'more quick-sighted than Lynceus,' and from these came the opinion of the singular perspicacity in the lynx*." Observation indeed proves that the sight of the lynx (*Felis cervaria*, TEMMINCK, and *F. Lynx*, LINN.) is similar, and little if at all superior, to that of the cat or the tiger; and as it pursues its prey in the night, its eyes, though in appearance "brilliant," as Buffon correctly says, are ill fitted for vision except during twilight. Cuvier, Temminck, Ranzani †, and other recent writers take no notice whatever of the vision of the lynx.

The proverbial piercing sight of the eagle rests upon very different evidence to that of the fables we have just endeavoured to account for. Systematic writers afford little information on the subject; but we have abundant proof of this intensity of vision from other sources. We may, however, reasonably doubt the fact of its fixing its gaze upon the sun, the "naked sun" (*il sol pur*), as Petrarch gives it ‡, even though the authority of Scaliger tells us that having "repeatedly placed an eagle in the sun, it gazed on its rays for a long time intensely and pertinaciously §." It does not appear what motive can induce the bird to gaze on the sun, even if it have the power. Larks indeed and some other small birds are attracted by bright objects, as is proved by what bird-catchers call *daring*, that is, fixing a piece of looking-glass on a moveable pivot and whirling it round; but in this case it is probable the larks are allured by the principle of curiosity so very lively in birds, as we have else-

* Hist. Anim. Linx.

† Elem. di Zoologia, ii. 309.

‡ Sonet. 18.

§ Exerc. 228.

where copiously exemplified. On the general physiological principle, also, that the more stimulus an organ can bear the less sensible it must be, we may conclude that the two circumstances of piercing sight and capability to gaze on the sun are incompatible. Accordingly we find that animals which prey in the night, and white animals with red eyes (*albinos*), while they can see with a faint glimmer of light on account of their extreme sensibility of vision, are so overpowered by the glare of the sun's light that they can scarcely see at all.

There is indeed a peculiarity in the eyes not only of the eagle but of all birds, tending to defend them from too strong light, to which it may be interesting to advert. In the eye of man and many other animals, including birds, a beautiful provision is made for supplying it with the moisture which is indispensable to render its restless motions easy. For this purpose a fountain or gland, situated in man within the upper and outer part of the bony socket, affords a constant supply of tears, about three or four ounces of which it has been computed are discharged upon the human eyeball every twenty-four hours. Besides this there is an ointment prepared in the beautiful little glands, about thirty in number, interspersed within the fine skin of the inner eyelid near to the roots of the eyelashes, appearing when magnified like studs of minute pearls. This ointment, which, according to M. Majendie, is of a glairy consistence, like white of egg, is dissolved and diluted by the tears, and the whole is constantly spread over the eyeball by the sweep of the eyelids, which act like valves, and are composed of semi-transparent muscular substance, attached to a ring of gristle or cartilage, which is hinged on the adjacent bone, and gives the eyelids firmness and preserves their shape. Our eyes are besides elegantly fringed with short hairs, either to defend the eye with a grate-work from any thing falling into it, or to perform some unknown operation on light. The use of the eyelids is strikingly demonstrated from what takes place when they are cut off—a savage punishment sometimes practised in barbarous countries. This prevents sleep, and from the constant irritation of the light, the eyes inflame, the inflammation spreads to the brain, and the victim of torture expires in the most dreadful agony.

Birds differ considerably from other animals with respect to the eyelids, which are indeed formed horizontally and very distinct; but the under lid is in most birds much larger and more moveable than the upper, as was observed by Aristotle, in many cases forming on the inner surface a smooth, polished plate (*lamina*).

The part, however, which we have more particularly alluded to, we may with some propriety call the eye-brush (*membrana nictitans; troisième paupière*, BLAINVILLE). In our own eye we may examine this eye-brush at a looking-glass by turning the eye away as far as possible from the nose. It is a little red fleshy membrane, in form of a crescent, which in such a position of the eye is spread over its inner angle, and when any dust has fallen upon the ball, it sticks to this and is carried into the corner of the eye by the membrane folding back. In birds, again, this eye-brush is much more extended, and is spread over the whole eye by means of two muscles*, one forming a tendinous cylindrical canal, the other passing through this and working like a cord in a pulley. The membrane being translucent, when it is drawn over the eye like a curtain, it is well calculated to prevent it from being dazzled by too much light.

* Petit, Mém. de l'Acad. des Sciences, 1735-6.

It is evidently, however, a mere conjecture that it is by means of this membrane the eagle can look at the sun*, for we do not see how it could be proved by experiment, as it would be impossible to perceive through it the direction of the pupil. Aristotle was of opinion it was for the purpose of moistening the eye; but Aldrovand thinks we cannot well draw such an inference, as our own eye is kept sufficiently moist without such a provision †.

Willughby describes the eye of the golden eagle as having "a certain thick tunicle stretched forth from below upwards, covering the globe in nictation. Two eyelids, one above, the other beneath, although the lower alone extending upwards is sufficient to cover the whole eye. The region of the eyebrows is very eminent, like that prominent part of houses called the eaves, under which the eyes lie hid as it were in a deep cavity. The eyes are of a green colour (*chlorops*) of a fiery splendour, shining forth in a pale blue. The pupil is of a deep black. It is very admirable to observe what care nature hath taken, and what provision she hath made for the conservation of the eyes, than which there is no part in this animal more excellent; for not being content with one tegument, as is usual in other animals, she seemeth to have framed four several lids or covers for them. The membrane for nictation is the same thing, and affords the same use to them that the eyelids do to man. Besides which nature hath superadded two other eyelids, and of these the lower so large that they alone suffice to cover and preserve the eye ‡."

It was another remark of Aristotle, that the vision of the osprey (*Pandion haliaëtus*, SAVIGNY) is weak on account of the shade which covers the eyes,

* Blumenbach, by Lawrence and Coulson, p. 298.
† Ornithologia, i. 64. ‡ Ornithology, by Ray, p. 58.

and it might be for this reason, perhaps, that he was induced to separate it from the eagles and class it with the owls. There can be no doubt Aristotle was in error in making this remark, as the distance from which it is observed to dart upon its prey proves its sight to be very acute rather than deficient. Aldrovand examined the eye of this bird with minute attention, in order to verify or disprove Aristotle's observations. He accordingly discovered, what Aristotle probably meant by a *shade* or *cloud*, that the opening of the pupil, commonly covered only by the transparent cornea, is in the osprey lined with a very delicate membrane, having the appearance of a small spot. Any apparent inconvenience of structure that might arise from this circumstance is compensated by the great transparency of the circle round the pupil, which in most other birds is dull and opaque. It does not therefore follow that its sight is fainter than that of other birds, because the light can pass easily and largely through the small circle which bounds the pupil, though it is probable the middle of the image will be marked with a small obscure spot, and that the lateral vision ought to be more distinct than the direct. It does not however appear that it sees worse than other birds. It may not perhaps soar quite so high as the golden eagle (*Aquila chrysaëtas*, ALDROVAND), nor descry and pursue its prey from such remote distances, nor have quite so acute vision; but it is not, like the owls, blinded by dazzling light, and it searches for victims as well by day as by night.

Willughby thinks it "partly false or uncertain," that the golden eagle "doth so excel in quick-sightedness, soaring so high in the air that she can very hardly be discerned by us in all that light, yet she can espy a hare lying under a bush, or a little fish swimming in the water; though I grant," he adds, "that both the eagle and other rapacious birds are very sharp-sighted, yet do I not think that their eyes can reach the object at such distances*."

We may remark, however, with all deference to the high authority of Willughby, that his scepticism is here carried too far, as the accounts he objects to are supported by undoubted facts. For though we should reject the authority of Homer, who, as Pope renders it, says—

> Endued with sharpest eye,
> The sacred eagle, from his walks above,
> Looks down and sees the distant thicket move,
> Then stoops, and sousing on the quivering hare,
> Snatches his life †;

and though we should doubt the testimony of Aurelius Augustine, who says that "the eagle, when so high in the air as to be invisible to us, can perceive a hare lurking in an orchard, or a small fish swimming in the water ‡;" yet we cannot refuse to admit as unquestionable facts the observations of such men as Wilson and Vaillant. Speaking of the white-headed eagle (*Haliaëtus leucocephalus*, Savigny), Wilson says, "from the ethereal heights to which he soars, looking abroad, at one glance, on an immeasurable expanse of forests, fields, lakes, and ocean, deep below him;" and of the osprey (*Pandion haliaëtus*, Savigny) he says, "down rapid as an arrow from heaven he descends, the roar of his wings reaching the ear as he disappears in the deep §." M. Vaillant again says of his vociferous eagle (*Haliaëtus vocifer*, Savigny), that, "like the osprey and the white-tailed eagle (*Haliaëtus albicilla*, Savigny), it dives rapidly from a great height in the air upon a fish which it

* Ornithology, by Ray, p. 57.
† Iliad, xvii.
‡ Apud Aldrovand, Ornith. i. 15.
§ Amer. Ornith. v.

descries*." We have ourselves more than once seen the osprey dash down from a height of two or three hundred feet upon a fish of no considerable size, and which a man could with difficulty have perceived at the same distance†; but, in an instance elsewhere mentioned‡, we observed the golden eagle (*Aquila chrysaëtas*, ALDROVAND), at Mehlem on the Rhine, beating about among the orchards, as if it were on the look out for a hare or a rabbit; and if it were allowed to make a single instance like this overturn a general conclusion, we might oppose it to the testimonies already adduced.

Ross, in his voyage to Baffin's Bay, proved that a man under favourable circumstances could see over the surface of the ocean to the extent of one hundred and fifty English miles. It is not probable that any animal exceeds this power of vision, though birds perhaps excel men and most quadrupeds in sharpness of sight. M. Schmidt threw, at a considerable distance from a thrush (*Turdus musicus*), a few small beetles, of a pale grey colour, which the unassisted human eye could not discover, yet the thrush observed them immediately and devoured them. The bottle-tit (*Parus caudatus*) flits with great quickness among the branches of trees, and finds on the very smooth bark its particular food, where nothing is perceptible to the naked eye, though insects can be detected there by the microscope. A very tame redbreast (*Rhondella rubecula*) discovered crumbs from the height of the branch where it usually sat, at the distance of eighteen feet from the ground, the instant they were thrown down, and this by bending its head to one side, and using, of course, only one eye. At the same distance a quail (*Coturnix major*, BRISSON) dis-

* Oiseaux d'Afrique, i. 18. † J. R.
‡ Architecture of Birds, p. 174.

covered, with one eye, some poppy seeds, which are very small and inconspicuous*.

In looking at objects which differ in their distances, the eye has been supposed to undergo some change of its parts or relations. It is supposed, in a word, to do for itself what spectacles or glasses do for those who are very long-sighted, or who are very near-sighted. What this change is, has been the subject of minute investigation and of learned discussion; but still there is little with regard to it certainly known.

Sir Charles Bell is somewhat doubtful of the fact of the alleged change in the eye, or, at least, he thinks it much less than has been conjectured. He is therefore inclined to ascribe what takes place, in looking at near and distant objects, in a great measure to attention. We can attend at pleasure to a letter of a word, to the whole word, or to the page of a book, in the same way as we can attend to a distant object, while we overlook those which are nearly on a line with it but nearer†. The mechanical effect produced by thus directing the attention, Sir Charles Bell does not attempt to trace. In a note, however, on the iris, he states a fact of which he might have taken advantage. When a cat is roused to *attention*, as by the scratching of a mouse, the *pupils* of her eyes *dilate;* and the same thing occurs when she struggles to get loose from your hands‡.

Several ingenious experiments were made by Dr. T. Young to discover the alleged changes in the eyeball. He forced upon the ball of the eye the ring of a key, so as to cause by its pressure a luminous spot, and, looking at objects of different distance, he

* Blicken en den Haushalt der Natur, p. 26, 1826.

† Bell's Anat. Pt. ii. B. i. 11. vol iii. p. 334.

‡ See also Fontana, Dei noti dell' Iride, ii. 17.

expected the spot would become greatly larger; but, on the contrary, it remained the same. In another experiment, he placed two candles, corresponding to the extent of nerve of the eye, and then made the highest change of its focus, expecting that, in consequence, the outer candle would appear to move away from him; but in this also he was disappointed *.

On the assumption of a change in the eye, several suppositions have been made concerning the nature of that change, most, if not all, of which are liable to objections not easily repelled. We shall briefly advert to the chief of these opinions. They refer to a change in the globe of the eye,—in the cornea,—in the iris,—in the ciliary ring,—and in the crystalline. According to the first of these, the globe of the eye is compressed or relaxed by the surrounding muscles of the eyeball, in order to render the axis of the globe longer or shorter. But were this so the retina would be puckered up into folds; and, besides, we should be more conscious of the change, inasmuch as the muscles of the eye are voluntary †.

It was the opinion of Monro, that the change partly arose from the varied pressure of the eyelids upon the ball, and he made several experiments to prove this. He kept his eyelids wide asunder, and attempted to read a book while he held it so near that the letters were indistinct. He could not read it, in these circumstances; but, without moving his head or the book, and bringing his eyelids within a fourth of an inch from each other, he found he could read distinctly ‡. Sir Charles Bell, however, on keeping the eyelids open, and using flat camel-hair pencils, as a substitute for the eyelashes, found the same effect;

* Phil. Trans. 1793—1801; Medical Liter. p. 98-9.
† Hosack, Phil. Trans. 1794, p. 196; Knox, Edinb. Trans. x. 50.
‡ Three Treatises on the Eye.

and concluded, that it was the modification of the light by the eyelashes and not the compression of the eye which took place.

M. Jurine's theory is, that the cornea is compressed and rendered more convex by the contraction of the iris. To render this plausible, he supposes that there is a muscular ring round the iris, which contracts on looking at near objects, but that, when looking at more distant ones, it relaxes, and the cornea springs back, by its elasticity, to its primary place. But, not to mention that this muscular ring of the iris cannot be demonstrated, we *know that the iris is not fixed in the cornea at all,* but in the inflexible white of the eye. That the cornea, however, is affected in some degree, seems to have been proved by Mr. Ramsden. He invented an apparatus, by which the head was accurately fixed, and a miscroscope adapted to observe the changes in the eye whilst observing near and distant objects. From very nice experiments, made with this apparatus, it was found that the cornea moved the eight-hundredth part of an inch from the nearest point of distinct vision, to a distance of ninety feet*.

Sir Everard Home has attempted to explain this from the connection of the cornea with the muscles. He found that they are inserted into the white coat, about an eighth of an inch from the cornea; and that therefore their compression of the eyeball will force the humours outwards, and thus push out the cornea. Not content with this, he detached the outer layer of the cornea along with the muscles, and even conceived that the muscles spread over the cornea. This, as Dr. Monro remarks, must destroy the supposition of the cornea's being moved outwards by the muscles, as their contraction would draw it inwards.

It is another opinion, that the iris produces the

* Nicholson's Journ. 4to. i. 303, &c.

adaptation of the eye to distance by its muscularity or extension, its vessels being injected to extend it, and emptied to contract it. This is also mere supposition. *The muscular power of the fringes of the ciliary ring in drawing the crystalline forwards or backwards* is another supposition, as is proved by the want of contractile power in these fringes, the very point on which the opinion is founded.

We have not a doubt it is by the eye alone that the carrier pigeon (*Columba tabellaria*, RAY) performs those extraordinary aërial journeys which have from the earliest ages excited astonishment. We have frequently witnessed the experiment made with other pigeons of taking them to a distance from the dove-cot, expressly to observe their manner of finding their way back, and we feel satisfied that their proceedings are uniformly the same. On being let go from the bag, in which they have been carried in order to conceal from their notice the objects on the road, they dart off on an irregular excursion, as if it were more to ascertain the reality of their freedom than to make an effort to return. When they find themselves at full liberty, they direct their flight in circles round the spot whence they have been liberated, not only increasing the diameter of the circle at every round, but rising at the same time gradually higher. This is continued as long as the eye can discern the birds, and hence we conclude that it is also continued after we lose sight of them, a constantly increasing circle being made, till they ascertain some known object enabling them to shape a direct course*.

It is not a little interesting to contrast the proceedings just described with those of a pigeon let off from a balloon elevated above the clouds. Instead of rising in circles like the former, the balloon pigeon drops perpendicularly down like a plummet, till it is able to

* J. R.

The Carrier Pigeon (*Columba tabellaria*).

recognise some indications of the earth below, when it begins to wheel round in a descending spiral, increasing in diameter for the evident purpose of surveying its locality and discovering some object previously known by which to direct its flight.

The rapidity with which the carrier pigeon performs long journeys, may perhaps be adduced as an objection to this explanation. M. Antoine, for example, tells us that a gentleman of Cologne, having business to transact at Paris, laid a wager of fifty Napoleons (£40) that he would let his friends know of his arrival within three hours, and as the distance is a hundred leagues the bet was eagerly taken. He accordingly took with him two carrier pigeons which had young at the time, and on arriving at Paris at ten o'clock in the morning, he tied a letter to each of his pigeons, and despatched them at eleven precisely. One of them arrived at Cologne at five minutes past one o'clock, and the other nine minutes later*, and consequently they had performed nearly a hundred and fifty miles an hour, reckoning their flight to have been in a direct line. But their rapidity was probably much greater if they took a circular flight, as we have concluded from the observation of facts. Audubon proves that the American passenger pigeon (*Columba migratoria*) can fly at least a mile in a minute†, and this is a heavier bird than the carrier pigeon. The flight of the carrier pigeon however is, if we may trust to the facts recorded, very various. Lithgow, the traveller, tells us that one of them will carry a letter from Babylon to Aleppo (which is thirty days' journey) in forty-eight hours. In order to measure the speed of the bird, a gentleman some years ago sent one from London by the coach to a friend at Bury St. Edmunds, and along with it a

* Antoine, Animaux Célèbres, ii. 121.
† Ornith. Biogr. p. 320.

note desiring that the pigeon two days after its arrival there might be thrown up precisely when the town-clock struck nine in the morning. This was accordingly done, and the pigeon arrived in London, and flew into the Bull Inn, Bishopsgate-street, at half-past eleven, having flown seventy-two miles in two hours and a half*, not half the speed, it may be remarked, of the Cologne pigeons above recorded.

The observations of Audubon on the passenger pigeon tend to confirm the view which we have taken. "Their great power of flight," he says, "enables *them to survey and pass over an astonishing extent of country in a very short time. This is proved by* facts well known in America. Thus, pigeons have been killed, in the neighbourhood of New York, with their crops full of rice, which they must have collected in the fields of Georgia and Carolina, these districts being the nearest in which they could have procured a supply of that kind of food. As their power of digestion is so great that they will decompose food entirely in twelve hours, they must, in that case, have travelled between three and four hundred miles in six hours, which shows their speed to be, at an average, about one mile in a minute. A velocity such as this would enable one of these birds, were it so inclined, to visit the European continent in less than three days.

"This great power of flight is seconded by as great a power of vision, which enables them, as they travel at that swift rate, to inspect the country below, discover their food with facility, and thus attain the object for which their journey has been undertaken. This I have also proved to be the case, by having observed them, when passing over a sterile part of the country, or one scantily furnished with food suited to them, keep high in the air, flying with an

* Bingley, Anim. Biogr. ii. 361.

extended front, so as to enable them to survey hundreds of acres at once. On the contrary, when the land is richly covered with food, or the trees abundantly hung with mast, they fly low in order to discover the part most plentifully supplied. Their body is of an elongated oval form, steered by a long well-plumed tail, and propelled by well-set wings, the muscles of which are very large and powerful for the size of the bird. When an individual is seen gliding through the woods, and close to the observer, it passes like a thought, and on trying to see it again, the eye searches in vain; the bird is gone." "As soon," he adds, "as the pigeons discover a sufficiency of food to entice them to alight, they fly round in circles reviewing the country below. During their evolutions on such occasions, the dense mass which they form exhibits a beautiful appearance as it changes its direction, now displaying a glistening sheet of azure, when the backs of the birds come simultaneously into view, and anon suddenly presenting a mass of rich deep purple. They then pass lower over the woods, and for a moment are lost among the foliage, but again emerge and are seen gliding aloft*."

The return of the carrier pigeon from such distances to its home is, we think, most plausibly accounted for by its flying in circles; but that there may be some other manner in which it is directed, is not improbable from what takes place among quadrupeds. Instances, for example, are not uncommon of cats having returned of their own accord to the place from which they have been carried, though at the distance of many miles, and even across rivers, where they could not possibly have had any knowledge either of the road or of the direction that would lead them to it. "The nature of this beast," says Gesner, "is to love the place of her breeding; neither will she tarry in any strange place,

* Ornith. Biogr. p. 323.

although carried far, being never willing to forsake the house for the love of any man, and most contrary to the nature of a dog, who will travel abroad with his master; but although their masters forsake their houses, yet will not these beasts (cats) bear them company, and being carried forth in close baskets or sacks they will return again*." We have thus known a cat travel from London to Chatham in Kent, a distance of thirty miles †; and most persons can relate similar incidents. Gesner, however, is not correct in confining this propensity to the cat, for dogs frequently do the same. D'Obsonville, in his curious work, mentions a remarkable instance in a mastiff. This dog, which he had brought up in India from two months old, accompanied him and a friend from Pondicherry to Benglour, a distance of more than three hundred leagues. "Our journey," he goes on to say, "occupied nearly three weeks; and we had to traverse numerous plains and mountains, and to ford rivers and go along several by-paths. The animal, which had certainly never been in that country before, lost us at Benglour, and imme diately returned to Pondicherry. He went directly to the house of M. Beylier, then commandant of artillery, my friend, and with whom I had generally lived. Now the difficulty is not so much to know how the dog subsisted on the road (for he was very strong and able to procure himself food), but how he could so well have found his way after an interval of more than a month ‡."

A still more extraordinary instance of returning is recorded on the authority of Lieutenant Alderson of the Royal Engineers, who was personally acquainted with the facts. In March, 1816, an ass, the property of Captain Dundas, R.N., then at Malta, was shipped

* History of four-footed Beasts, by Topsel, p. 82.

† J. R.

‡ D'Obsonville's Phil. Essays, Lond. 1784.

on board the Ister frigate, Captain Forrest, bound from Gibraltar for that island. The vessel having struck on some sands off the Point de Gat, at some distance from the shore, the ass was thrown overboard to give it a chance of swimming to land—a poor one, for the sea was running so high that a boat which left the ship was lost. A few days afterwards, however, when the gates of Gibraltar were opened in the morning, the ass presented himself for admittance, and proceeded to the stable of Mr. Weeks, a merchant, which he had formerly occupied, to the no small surprise of this gentleman, who imagined that from some accident the animal had never been shipped on board the Ister. On the return of the vessel to repair, the mystery was explained; and it turned out that Valiante (so the ass was called) had not only swam safely to shore, but, without guide, compass, or travelling map, had found his way from Point de Gat to Gibraltar, a distance of more than two hundred miles, through a mountainous and intricate country, intersected by streams which he had never traversed before, and in so short a period that he could not have made one false turn. His not having been stopped on the road was attributed to the circumstance of his having been formerly used to whip criminals upon, which was indicated to the peasants (who have a superstitious horror of such asses) by the holes in his ears, to which the persons flogged were tied *.

It would appear, from an observation of Professor Lichenstein, that birds which feed on carrion may probably resort to making circular flights, similar to the pigeon, in order to discover a carcass. He remarked, when travelling in Southern Africa, that if an animal chanced to die, in the very midst of the most desert wilderness, in less than half an hour

* Intr. to Entom. ii. 502, note.

there was seen high in the zenith a number of minute objects descending in spiral circles, and increasing in visible magnitude at every revolution. These were soon discovered to be a flight of vultures, which must have observed from a height, viewless to the human eye, the dropping of the animal immediately marked out for prey *.

Dr. James Johnson mentions a fact illustrative of the same view. During the north-east monsoon, when the wind blew steadily in one point for months in succession, he observed a concourse of birds of prey from every point of the horizon hastening to a corpse that was floating down the river Ganges; and he accounts for their thus congregating, and appearing *suddenly from immense distances, to their soaring high in the air for the purpose of looking out for food* †.

It is said in St. Matthew, as the received translation gives it, that "where the carcass is, there will the *eagles* be gathered together ‡;" and in Job it is said, "where the slain is, there is she." Now it is well known that the eagle does not feed on carrion, and it has been proved by experiment that it will not touch it unless pressed by hunger §. Yet Professor Paxton contends with St. Jerome that the eagle is certainly meant in the text, and quotes after Bochart || the Arabian historian Damir, who asserts that the eagle can discover a carcass at the distance of four hundred parasangs, with this singularity that if he find part of it have been previously eaten by the osprey he will not touch the leavings of his inferior ¶. This circumstance, as it appears to us, makes rather against than for Dr. Paxton's opinion, supposing the authority of Damir to be good. In consequence of

* Travels in Africa. † Med. Chir. Review, Dec. 1828.
‡ Matth. xxiv. 28, and Luke xvii. 37. § Selby, Illustr. i.
|| Hieroz. ii. 175. ¶ Illustr. ii. 9.

this apparent discrepancy between facts and the text, St. Chrysostom proposed to read "vultures" for "eagles," in the passages both in Matthew and Job *. Aldrovand, we think, has given the only judicious solution of the difficulty † by referring to a very common oriental species (*Gypaëtus barbatus*, Storr), which was remarked by Aristotle to be similar in form to the eagle, but had more the habits of the vulture ‡.

Besides the nictitating membrane in the eye of birds already described, which is not altogether peculiar to them, there is another singular part of the organ whose use has not hitherto been clearly ascertained. It is called by the French Academicians the purse (*marsupium*), and the comb (*pecten plicatum*). It arises in the back of the eye, and proceeding apparently through a slit in the retina, it passes obliquely into the vitreous humour, where it terminates, reaching in some species to the capsule of the lens. Numerous blood-vessels run in the folds of the membranes which compose it, and the black pigment by which it is covered suggests the idea that it is chiefly destined to absorb the rays of light when they are too strong or dazzling: if this be the fact, it may serve the eagle in good stead when gazing, if he ever do so, on the sun. It is the opinion of others, that it serves to assist in producing the internal changes of the eye §; but this has been opposed by Crampton, who has shown that the changes in question, at least in the ostrich and several large birds, are produced by a peculiar circular muscle in the eyeball ||.

* Chrysost. Hom. xlix. † Ornithologia, i. 20.
‡ Hist. Anim. ix. 32.
§ Blumenbach, Comp. Anat. §. 290.
|| Thomson's Annals, March, 1813.

This singular membrane has been long known, and is well described by the French Academicians, who remark that, in the eyes of the turkey, the optic nerve, which is situated very near the side, spreads into a round space, from the circumference of which a number of black filaments are sent off to form, by their union, a membrane peculiar to the eye of birds. In the eyes of the ostrich they describe the optic nerve as dilated into a sort of funnel of a similar substance. From this funnel a folded membrane takes its origin, forming a sort of purse drawn to a point. This is covered with a black pigment, easily rubbed off *.

Buffon is of opinion that, on account of this expansion of the optic nerve, birds must have a vastly more perfect sight than other animals, embracing also a much wider range. Hence it is that a sparrow-hawk, while he hovers in the air, espies a lark sitting on a clod, though at twenty times the distance at which it could be perceived by a man or dog. The kite, which soars to so amazing a height as totally to vanish from our sight, can yet distinguish small lizards, field-mice, and birds, and from this lofty station he selects his prey. This prodigious extent of vision is moreover conjoined with equal accuracy and clearness, inasmuch as the eye can dilate and contract, can be shaded or uncovered, depressed or protruded, readily assuming the precise condition adapted to the distance of an object and the quantity of light †.

In consequence of the rapidity with which birds traverse the air, extent and acuteness of vision appear to be indispensable, in order to direct them in their flight. Had they indeed been formed with eyes like the mole (*Talpa lucida*, C. Bonaparte), incapable of seeing more than a few inches' dis-

* Mém. l'Hist. des Animaux

† Montbeillard, Oiseaux, Prelim.

tance, they would have been in constant danger of dashing against every intervening obstacle. "Indeed," says Buffon, "we may consider the celerity with which an animal moves as a just indication of the perfection of its vision. A bird, for instance, that shoots swiftly through the air, must undoubtedly see better than one which slowly describes a tortuous tract. Among quadrupeds, again, the sloths have a very limited sight." It may accordingly be inferred, that birds have more precise ideas than slow-moving caterpillars, of motion and its accompanying circumstances, such as those of relative velocity, extent of country, the proportional height of eminences, and the various inequalities of hill and dale, mountain and valley. Our bird's-eye views, of which the accurate execution is so tedious and difficult, give but a very imperfect picture of the relative inequality of the surfaces which they represent; but birds can choose the proper stations, can successively traverse a field in all directions, and with one glance comprehend the whole. On the other hand, the quadruped knows only the spot where it feeds,—its valley, its mountain, or its plain; but it has no conception of expanse of surface,—no idea of immense distances, and no desire to push forward its excursions *.

The eye of birds, it is worthy of remark, besides being peculiar in structure, is also greatly larger than in most other animals in proportion to the bulk of the head. According to M. Petit, the ball of the eye in a female eagle was, at its greatest width, an inch and a half in diameter; that of the male was three lines less; that of an ibis, six lines; of a stork, four times larger; that of the cassowary was four times larger than its cornea, being an inch and a half in diameter, while the cornea was only three lines †.

* Montbeillard, Oiseaux, Prelim.

† Mém. l'Hist. des Animaux, 1726-36.

Eyes of the Eagle, showing their great size in proportion to the head.

The mere bulk of the eye, however, is rather a fallacious test to trust to; for several birds, in which the globe of the eye is large, have very weak sight, particularly in the daytime, such as the woodcock and the owls. The woodcock (*Scolopax Gallinago*, Ray) has very large, prominent eyes, but it cannot support a strong light, and sees best during twilight; and, as Colonel Montagu remarks, its eyes seem to be peculiarly calculated for collecting the faint rays of light in the darkened vales and sequestered woodlands, during nocturnal excursions, thus enabling it to avoid trees and other obstacles*. It is probable, indeed, that the proverbial stupidity of the bird arises from this weakness of sight. Like the owl, indeed, its motions are much more agile and lively at nightfall and dawn than at any other time; and so strong is this propensity to action at the rise or descent of the sun, that woodcocks when kept in a room are observed to flutter about regularly every morning and evening, while during the day they only trip on the floor without attempting to fly.

The stone-curlew (*Œdicnemus crepitans*, TEMMINCK) differs from the woodcock particularly in this, that though its eyes are similarly prominent, yet, if we may believe M. Montbeillard, its sight is very acute in the daytime, though he admits it can see best in the twilight. The prominence of its eyes enables it to see behind as well as before, and it is with difficulty therefore that it can be approached†. Paley justly remarks that "what is gained by the largeness or prominence of the globe of the eye is width in the field of vision."

With respect to owls, as well as most night-prowling animals, the eye is unquestionably very sensible. Of the barred owl (*Strix nebulosa*, GMELIN) Audubon says, its "power of sight during the day seems to be rather of an equivocal character, as I once saw one alight on the back of a cow, which it left so suddenly afterwards, when the cow moved, as to prove to me that it had mistaken the object on which it had perched for something else. At other times I have observed that the approach of the grey squirrel intimidated them, if one of these animals accidentally jumped on a branch close to them, although the owl destroys a number of them during twilight‡."

* Ornith. Dict. p. 562, 2d edit.
† Oiseaux, Art. Le grand Pluvier.
‡ Ornith. Biography, p. 244.

M. Vaillant mentions a similar circumstance which he more than once observed in different species of owls, if they chanced to be roused from their lurking places by day, when instead of pursuing small birds, which are their natural prey, they fled from them in fear*.

Wilson says of the snowy owl (*Stryx nyctea*) that "the conformation of the eye forms a curious and interesting subject to the young anatomist. The globe of the eye is immoveably fixed in its socket by a strong, elastic, hard, cartilaginous case, in form of a truncated cone: this case being closely covered with a skin appears at first to be of one continued piece; but on removing the exterior membrane it is found to be formed of fifteen pieces, placed like the staves of a cask, overlapping a little at the base or narrow end, and seem as if capable of being enlarged or contracted, perhaps by the muscular membrane in which they are encased." "In five other different species of owls," adds Wilson, "which I have since examined, I found nearly the same conformation of this organ, and exactly the same number of staves. The eye being thus fixed, these birds, as they view different objects, are always obliged to turn the head; and nature has so excellently adapted their neck to this purpose, that they can with ease turn it round, without moving the body, in almost a complete circle†."

In nocturnal birds, M. de Blainville remarks that the eye, besides being comparatively very large, is flat (*comprimé*) both before and behind, while the transparent cornea is placed at the end of a sort of tube formed by the bony portion of the sclerotic. The retina is consequently comparatively very large and extended, and the iris also; while the mem-

* Oiseaux d'Afrique, tom. i.
† Amer. Ornith. iv. 56, 1st edit.

branes, being probably more soft and delicate, are more susceptible of impressions from a small quantity of light. The nictitating membrane is also very large, and the upper eyelid, unlike other birds, is moveable*.

We have adverted to the method of catching larks by means of a looking-glass, referring to the remarkable curiosity of birds as the probable cause of their being attracted to the bright glass. Whether it is on a similar principle that ravens, jays, and magpies (*Corvidæ*, LEACH) are fond of bright objects we have no means of deciding. In accordance with this view, a writer on Natural History says, "A looking-glass is a matter of great wonder to magpies. We once saw one placed on the ground where two were hopping about. One of them came up to it, stared at it in apparent wonder, hopped off to the other, and then both returned and spent at least ten minutes in nodding, chattering, and hopping about the glass†." Colonel Montagu tells us he was "assured by a gentleman of veracity, that his butler having missed a great many silver spoons and other articles, without being able to detect the thief for some time, at last observed a tame raven with one in his mouth, and watched him to his hiding-place, where he found more than a dozen‡."

A similar story is told by Mrs. S. C. Hall of a raven kept a few years ago at Newhaven, an inn on the road between Buxton and Ashbourne. This bird had been taught to call the poultry when they fed, and could do it very well too. One day the table was set out for the coach-passengers; the cloth was laid with the knives and forks, spoons, mats, and bread, and in that state was left some time, the room-door being shut, but the window open. The

* Principes d'Anatomie Comparée.

† Brit. Naturalist, ii. 216.

‡ Dict. p. 400.

raven had watched the operation very quietly, and, we may suppose, felt a strong ambition to do the like. When the coach was about arriving, and the *dinner carried in, behold, the whole paraphernalia of the dinner-table had vanished! It was a moment of consternation*,—silver spoons, knives, forks, all gone. But what was the surprise and amusement to see, through the open window, upon a heap of rubbish in the yard, the whole array carefully set out, and the raven performing the honours of the table to a numerous party of poultry which he had summoned about him, and was very consequentially regaling with bread*.

M. Antoine tells us that there is an annual mass, called the magpie mass, said in the church of St. John en Grève, which arose from the following circumstance. A magpie, indulging its propensity to carry off and conceal glittering objects, took a fancy to make free with the church plate, and in consequence thereof a maid servant was accused of the theft and delivered over to the hands of justice. The accused, according to the barbarous custom of that period, was put to the torture, and a confession of the crime being thus extorted, the poor girl was condemned to die. Six months after the lost plate was discovered behind a mass of tiles on an old house, where a tame magpie had concealed them and continued to add to the hoard. The mass was founded on account of the innocent girl who had fallen a victim to an execrable law†. This story was no doubt the origin of the well-known melo-drama, the Maid and the Magpie. The author of the British Naturalist tells us that he once saw "taken out of a magpie's nest, a crooked sixpence of which some village fair one had haply been despoiled, a tailor's thimble, two metal buttons, a small plated

* Hort. Register, Jan. 1832, p. 332.

† Animaux Célèbres, ii. 118; and Mercier, Tabl. de Paris.

buckle, and three or four bits of broken crockery*." At the same time he exculpates the jackdaw (*Corvus monedula*), for want of proof of a similar charge made against him. "At country churches," he says, "where *it frequents the steeple, a situation to which it is very* partial, we have heard it accused of a very profane theft:—at those places in the north, a collection is made in a salver outside the door, and if a sixpence or a shilling finds its way among the copper donations, the jackdaw is accused of pouncing down and purloining it, but we have no proof against it †."

The Bengal sparrow (*Passer Bengalensis*, Klein) seems to be equally fond of bright objects. We have elsewhere detailed its habit of studding its nest with fire-flies ‡; and it is no doubt on the same principle that it is taught to perform certain feats. If a ring, for example, be dropped into a deep well, and a signal given to one of these birds, he will fly down with amazing celerity, catch the ring before it touches the water, and bring it to his master. Sir William Jones tells us that these birds are also, by way of frolic, taught to pluck off the gold ornaments from the head-dresses of ladies and bring them to their lovers.

The celerity of the Bengal sparrow in catching the ring evidently depends as much upon quickness of vision as on rapidity of flight; and to this quickness we must attribute the difficulty often experienced by marksmen in shooting at certain species. "The divers (*Colymbi*) of Louisiana," says M. Dupratz, "when they see the fire of the touch-pan, dive so nimbly that the lead cannot hit them, for which reason they are called lead-eaters §." We have repeatedly seen the same quickness of eye exemplified in the cormorant (*Carbo cormoranus*, Meyer) of our own

* Brit. Naturalist, p. 216.

† Ibid. p. 229.

‡ Architecture of Birds, p. 249-50.

§ Hist. de la Louisiane, ii. 115.

seas; for though approached with the greatest caution, and when the bird has not manifested any fear but was skimming about on the water, the instant the powder flashed in the pan, it would dive down and escape the danger*.

It may be worth mentioning that animals born with perfect eyes can use them the instant they enter the world. Sir James Hall, when making experiments on hatching, observed a chicken in the act of breaking through the shell, and just as it got out a spider began to run along the box, when the chicken darted forward, seized and swallowed it as adroitly as if it had been instructed by its mother.

* *J. R.*

Chapter II.

HEARING OF BIRDS.

The effect of an accidental occurrence in giving undue importance to things not otherwise extraordinary, is strikingly exemplified in the instance of the geese which are reported to have saved the capitol of Rome. "*The Gauls,*" says *Livy,* "*having discovered that the rock Carmentalis was accessible, one night when it was pretty clear, sent a man to examine the way, without his arms which were afterwards handed to him. Others followed, lifting and assisting each other, according to the difficulties they encountered in the ascent, till they reached the summit. They proceeded with so much silence, that neither the sentinels nor even the dogs, animals usually so vigilant as to be roused by the slightest noise, took any alarm. They did not however escape the notice of the geese, which, being sacred to Juno, had been fed by the Romans, notwithstanding the famine caused by the siege. This saved the capitol; for, by their cackling and beating their wings, they roused Marcus Manlius, a brave soldier and formerly consul, who, snatching up his arms and giving the alarm, flew to the ramparts, set upon the Gauls, and by precipitating one of them over the rocks terrified the rest so much that they threw down their arms*." Pliny accordingly infers from this circumstance (probably a mere legend) that "the goose is very vigilant and watchfull: witnesse the capitol of Rome, which

* Hist. v. 47.

by the meanes of geese was defended and saved; whereas at the same time, through the default of dogs (which should have given warning) all had like to have bin lost*." Ælian again tells us that the Gauls bribed the dogs of the capitol to silence with food, which the geese refused and screamed out†; and hence it was inferred by Columella that geese are preferable to dogs for watching a farm ‡, while Vegetius does not hesitate to assert that they are the most vigilant sentinels that can be planted in a besieged city§. In this opinion most naturalists, from Albertus Magnus and Aldrovand down to Buffon and Bewick, concur. "It is certain," says the last, "that nothing can stir in the night, nor the least or most distant noise be made, but the geese are roused, and immediately begin to hold their cackling converse; and, on the nearer approach of apprehended danger, they set up their more shrill and clamorous cries‖."

From the incident in the Roman history alone, the goose has been rendered as famous for its quickness of hearing as the eagle for acuteness of vision¶, though Cælius Rhodiginus thinks the wild boar may dispute the palm with it**. Other authors attribute the supposed vigilance of the goose to its acute smell; and Lucretius adopting this opinion says, "The white goose, the preserver of the citadel of Romulus, scents the odour of man at a great distance††; and Isidore echoes the same opinion ‡‡.

But, whatever truth may be in the narratives given by Livy and Ælian, we are quite certain that, so far from possessing any superiority either in hearing or smelling, the goose is much inferior to many other

* Hist. Nat. x. 22, by Holland. † De Animal, xii. 33.
‡ De Re Rustica. § De Re Militar. iv. 26.
‖ Birds, 293, ed. 1826. ¶ Gelli, Circe.
** Lect. Antiq. xx.¹ †† De Rerum Natura, iv.
‡‡ Etymol. xii. 7.

birds in these respects. This is easily proved by the simple experiment of trying the effect of various sounds upon the birds, taking care to have the cause thereof concealed from their view. We have, for example, caused a dog to bark behind a wall on the other side of which geese were feeding, without their appearing to take any notice of it, no more than they did when we shouted aloud on purpose to alarm them. When the dog, however, was brought into view, they took immediate alarm *. We should therefore be inclined to infer that the hearing of the goose is by no means so very quick. The structure of the ear again would lead to the same conclusion; although it does indicate quicker hearing than that of the duck, the cavity of the drum as well as other parts of the organ being much more capacious in the goose. Its smell also, though undoubtedly acute, as might at once be concluded from the capacity of the nostrils, is more adapted for ascertaining the quality of its food than for giving intimation of distant danger. Accordingly we never see a goose elevating its head and snuffing the air as dogs, deer, and other animals are observed to do, for the apparent purpose of discovering distant friends or enemies. We should therefore reject the explanation given by Lucretius and Isidore.

The correct view of the matter, as it appears to us, was first hinted at by Albertus Magnus, who says the goose sleeps so lightly, that it is awakened by the least noise †. The profoundness of sleep indeed is found to be in proportion to the quantity of brain and the rapidity of circulation, and both these being in birds unfavourable to sleep, renders them very easily awakened ‡. The hearing also, according to M. Cabani, though it is not so soon overpowered by

* J. R. † Apud Aldrovandi Ornith. iii. 46.
‡ Macnish, Philosophy of Sleep, p. 40.

sleep as sight, smell, and taste, is much more easily awakened, for a slight noise will often rouse a sleep-walker, who had borne an intense light on his unshut eyes, without seeming in the least to feel its influence *.

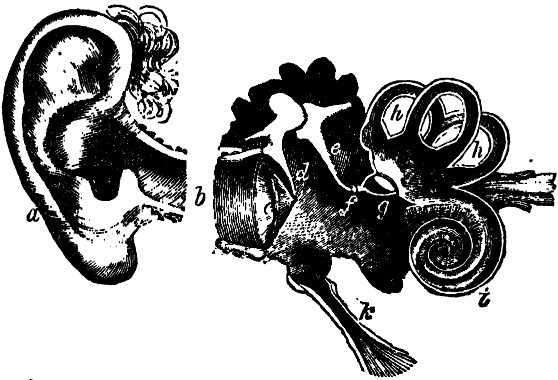
The structure of the ear in birds would lead us to conclude that they could not hear so quickly as other animals. It may be interesting to illustrate this by comparing the ear of birds with that of man. The outer shell, as we may term it, of our own ear projects a little forward, presenting five eminences and three cavities, the whole spread out into a sort of funnel, well adapted, from its windings, to collect the waves or pulses of sound afloat in the air around †. The substance also is carefully fitted for its office, being very sensible, and composed of a firm though elastic texture of gristle or cartilage, and not of unyielding bone, nor of soft fleshy muscle, though there are small muscles which stretch or relax it, as occasion may require. The skin which covers it is thin and dry, and is attached to the gristle below by a strong tissue that contains but a very small quantity of fat. Here is seen a great number of pellicles, which prepare and furnish the shining matter that gives to the skin its polish, and perhaps part of its flexibility. As many nerves and blood-vessels run through this part of the ear, it is thence rendered very sensible, and easily becomes red.

The lap of the ear, possessed by no animal but man, is very different from the part which we have just described, being soft and flabby, and full of fat; but this is perhaps intended to prevent the escape of the sound collected in the upper windings of the shell, when it has reached the entrance of the passage. We make this supposition on the principle that soft

* Rapports du Phys. et Morale.

† Himly, Biblioth. für Ophthalmalogie, i. 6.

substances, like the lap of the ear, are well known to be bad conductors of sound.

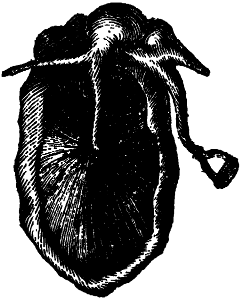


Man, in section, showing the general structure of the Ear:—*a*, the external ear; *b*, the auditory passage; *c*, the drum; *d*, the malleus, or mallet bone; *e*, the incus, or anvil bone; *f*, the os orbiculare, or small round bone; *g*, the stapes, or stirrup bone; *h*, the semicircular canals; *i*, the cochlea, or labyrinth; *k*, the Eustachian tube, which opens into the back of the mouth.

The utility of the external ear in making sound distinctly heard, may be demonstrated by a very simple experiment. Place the palms of the hands closely on the ears, so as to press the windings of the funnel flat to the temples, and the sounds which you hear, instead of being distinct, will be confused and humming, like the sound of running waters, or the distant murmur of a forest. A similar effect will be produced by interrupting the communication in any other way, as in the amusement well known to children of putting a univalve sea-shell to their ear to produce, as they imagine, the sound of the sea-waves breaking on the shore. It is worthy of remark, that the external ears of Europeans are much more flat, and lie closer to the temples, than in savage nations; a circumstance evidently caused by the dress worn in infancy, which cramps the outer ears of our children, and consequently injures the distinctness of hearing in after-life. M. Majendie, however, affirms, from experiment, that the removing of the external ear altogether does not injure hearing more than a few days, till the sufferer becomes accustomed to the new condition of the organ; though we should think that this must depend on the age of the person. Some individuals have the power of moving the external ear, similar to what we observe in the lower animals, but this does not appear to improve or increase the hearing.

Inside of the temporal bone, showing the position of the drum and bones of the Ear, surrounded by the mastoid cells.

The windings and other inequalities of the outer ear meet in the narrowest part of the entrance, and the windings thus united take the form of a tube, which enters the bone of the temple, and is continued through it, till it reach the part called the drum (*tympanum*). "Infants," says Smellie, "hear bluntly, because the bones of their ears are soft and cartilaginous; and, of course, the tremulations excited in them, by the motions of the air, are comparatively weak. Young children, accordingly, are extremely fond of noise: it rouses their attention, and conveys to them the agreeable sensation of sound; but feeble sounds are not perceived, which gives infants, like deaf persons, the appearance of inattention, or rather of stupidity*."



The Tympanum and Bones of the Ear.

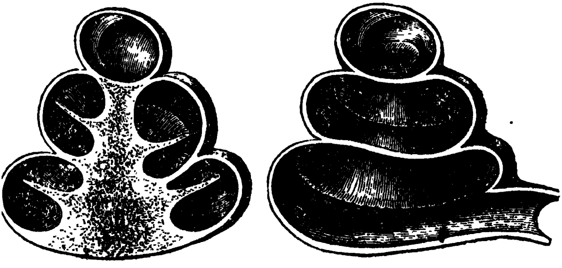
The skin which lines the entrance tube of the ear (*meatus externus*) is extremely thin and delicate, and is reflected over the drum so as to cover it. This tube is oblique and winding, to prevent (it may be) the sound from being reflected from the drum into the air again without producing the sensation of hearing, which would, to a certain extent, be the consequence were the tube straight.

* Philosophy of Natural History, i. 268, 8vo.

At the bottom of this passage there is a thin parchment-like skin, stretched obliquely across for the reception and reverberation of the sounds propagated thither from the air: this is the drum, which is covered, as we have seen, in the same way as the tube. The middle layer under the drum is quite transparent. It is remarkable that the whole membrane is braced like the head of a drum; but, in place of the strings of the drum, the membrane of the ear is stretched and kept tight by the threads of a muscle. So, at least, it is conjectured by Sir Everard Home, from analogy; for it is only in large animals, such as the elephant, that these threads have been discovered.

Bones of the Ear.

There is placed behind the drum a chain of small bones or springs, so arranged as to hinge upon one another; and when one moves all the others follow, in consequence of their connection with appropriate muscles. The first of these bones (*malleus*), which is shaped like a hammer, is in contact with the middle of the drum, and when a sound strikes upon the drum, it is supposed to cause the muscles attached to the bone to contract and pull it, while this movement consequently reacts upon the drum. When the motion has been thus originated, it is plausibly conjectured to be communicated in succession to the other three bones of the chain, the last of which (*stapes*) has the form of a stirrup with a solid base, and plays like the key of a flute upon a hole or opening (*fenestra ovalis*) that leads to several channels or passages farther inward. The internal ear has several of these passages, which are much in the form of wind instruments of the convoluted kind, being full of turns and windings like a French horn. From their intricacy they are called the labyrinth.

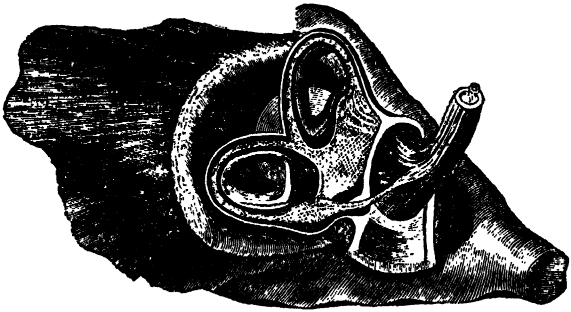


Sections of the Cochlea.

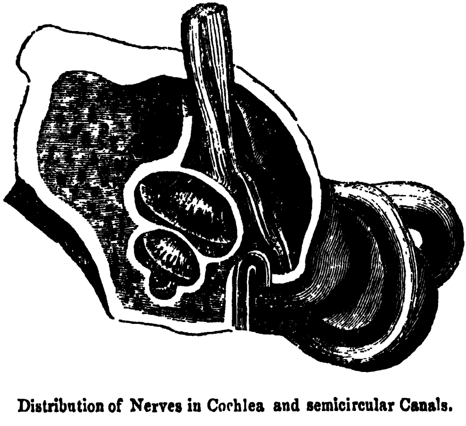
External view of the Cochlea and semicircular Canal.

Section of Cochlea and semicircular Canals.

The labyrinth is filled with a fluid of a watery consistence, which being in contact with the nerve, which is spread in numberless branches over its inner surface, is conceived to act a similar part in the conveyance of sounds, as the fluid in the mouth and the nose in conveying tastes and smells. The whole labyrinth may be said to consist of three parts—the vestibule or oval gallery, on the door of which the stirrup bone, as we have said, plays,—the canals in form of a half circle leading from the vestibule,—and the cochlea or snail-shell, so called from its shape, with which also the vestibule communicates.



Distribution of Nerves in semicircular Canals.



Distribution of Nerves in Cochlea and semicircular Canals.

It is well known to musicians, that a violin or common drum will not sound well without a hole in it, to cause the sound produced to come with more force by a communication with the air without. The sound indeed would otherwise be imprisoned in the instrument, and would be heard muffled and confined by the surrounding wood. The same would be the case in the ear. The sound transmitted from the drum to the bony springs, and by them to the parts of the labyrinth, would be smothered in its passage almost as soon as it had passed the drum. To prevent this, there is a contrivance exactly like the hole in the common drum and in the violin.

For this purpose, behind the drum of the ear, a tube opens, and runs by the side of the labyrinth, widening as it goes, till it ends in a trumpet-like opening behind the curtain (*velum pendulum palati*), which separates the nostrils from the mouth. It is named from its describer, Eustachius, the Eustachian tube *. It is so indispensable to perfect hearing, that when it is in any way obstructed there always follows some degree of deafness. When it is opened also by opening the mouth, we hear better than when the mouth is shut, the orifice of the tube being thereby enlarged,—an observation which did not escape Shakspeare:

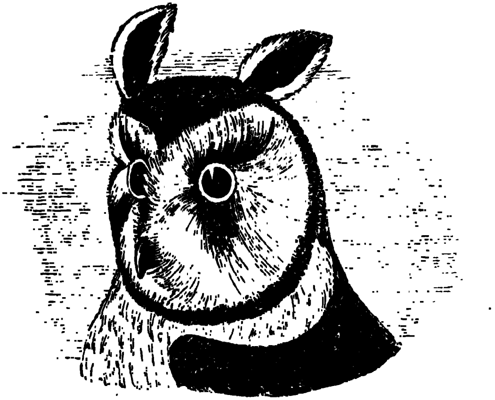
> I saw a smith stand with his hammer thus,
> The whilst his iron did on the anvil cool,
> With *open mouth* swallowing a tailor's news †.

Such is the ear of man: but in birds it differs in many particulars. Instead, for instance, of the external shell (*concha*), with its windings terminating in a funnel, there is only a circular tuft of feathers in some species, which is besides not found in many others. "Night birds alone," says Baron Cuvier,

* Eustachius de Auditus Organ.

† King John.

" have a large external ear, which, nevertheless, is not so prominent as that of quadrupeds; this opening is generally covered with barbed feathers, more fringed than the others*." With respect to the external opening of the ear " in the owl," says Grew, " that perches on a tree, and hearkens after the prey beneath her, it is produced farther out above than it is below, for the better reception of the least sound‡." It appears to us, however, that the large circle of feathers, remarkable in many of the owls, is more fitted for producing a convergence of the rays of light than the pulses of sound, inasmuch as the very soft feathers of which they are composed are among the very worst conductors of sound. The same thing may be said of the smaller tuft of feathers immediately around the ear itself.

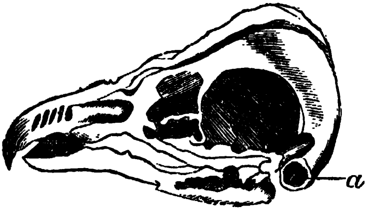


Head of the Horned Owl (*Strix Otus*).

Be this as it may, there can be no doubt about the peculiar conformation of the bones of the external

* Règne Animal, i. 305, edit. 1829.
† Cosmologia Sacra, i. 5.

ear in owls. Speaking of the owl, Dr. Farrar says, " He never hunts or goes abroad for food except in twilight; and even then, when in an old building, where his prey abounds, he will be seen perched majestically and silently upon any projecting substance whatever. Thus elevated above the ground, sounds indicating his prey must ascend, and are received by the arched, overhanging, and concave external bony structure of his ear. This function being roused, his head is naturally turned into the direction whence the sounds emanate; and he is thus enabled to discover, if not always to seize his prey*."

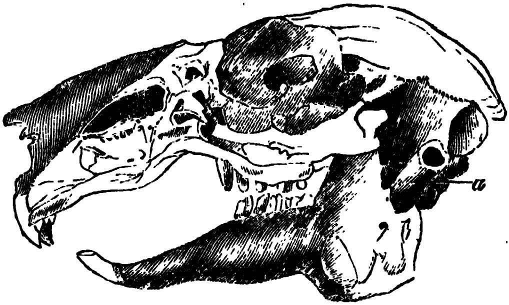


Skull of the Horned Owl; *a*, the auditory canal.

"In a fox," says Grew, "that scouteth underneath the prey at roost, it (the ear) is for the same reason produced farther out below. In the polecat, which hearkens straight forward, it is produced behind, for the taking of a forward sound. Whereas in a hare, which is very quick of hearing, and thinks of nothing but being pursued, it is supplied with a bony tube, which, as a natural acoustic (*ear-trumpet*), is so directed backwards as to receive the smallest and most distant sound that comes behind her†." Dr. Farrar has investigated these circumstances with still more minuteness than Grew, from whom he probably took the hint. In the skull of the hare, he tells us,

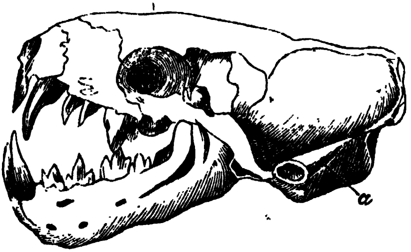
* Mag. of Nat. Hist. iv. 12. † Cosmologia Sacra, i. 5.

when it "is placed horizontally before you, the tubulated bony portion of the external ear is seen nearly half an inch in length, and a quarter of an inch in diameter, pointing backwards and upwards at an angle of 45° or thereabouts. To this tube in the living animal is attached the external ear, which is moved in various directions to suit the purposes of the animal. This animal is a pursued one; and, as such, is indebted for its safety to a quick perception of danger by means of its external senses. The least remarkable of these is certainly not that of hearing: viewed externally, we find long open ears, for the most part inclining backwards; but also occasionally forward, as well as laterally. These are moved in various attitudes by muscles placed for that purpose; and thus serve as excellent media for collecting sounds, and transmitting them through the bony portion of the canal to the internal ear. That these organs are valuable adjuvants to another sense (that of sight) no one will doubt, especially when he recollects that animals of this class, although possessing a very wide expanse of sight, yet do not enjoy an equally distant one, which is not to be wondered at when we look at the diminutive stature they exhibit; yet for this loss they are compensated by having the sense of hearing very acute from a number of points, though much more from behind than in any other direction. Many persons contend that the hare cannot distinguish sounds immediately before her, which is not unlikely when we consider the bony structure of the external ear; however, this is not absolutely necessary, as her prominent eyes scarcely allow any object to approach her without some part of its shadow being depicted upon the retina, and thus communicating the alarm to the timid animal.



Skull of the Hare; *a*, the auditory canal.

"As a contrast to the situation of the auditory tube in the hare, I shall now mention that of the polecat, which animal is, as is well known, a pursuing one; consequently requiring its external senses, or rather the communications for conveying impressions to them, as forward as possible. This animal has its external auditory tube similar in length and diameter to the hare's—placed at an angle of 45°, but pointing from behind, in a direction downwards and forwards; in fact, the very opposite to the position described in the hare. When we consider the habits of this animal, and behold the structure containing one sense, acting in concert with and supporting another still more valuable to the animal's



Skull of the Polecat; *a*, the auditory tube.

existence, we cannot but wonder at the excellence of arrangements that provides for wants which mere *human ingenuity can only comprehend, but could* never supply.

"From this tube being placed very forward, we should naturally conclude that this animal's sense of hearing is necessarily much less acute from behind than before. This supposition I am inclined strongly to support from the following circumstance: A farmer in the neighbourhood had his poultry disturbed on several successive nights, but could not make out the case till one day he discovered near his residence a couple of these vermin gamboling in a very frolicsome manner. Without disturbing them, he returned hastily to his house, got his gun loaded, and then went back to look for his visitors. Approaching them cautiously from behind, he was enabled to come within a very few yards of them He levelled his gun, but it missed fire. This occurred five or six times without a single spark being elicited from his flint; and notwithstanding all this hammering in their rear, the animals never were in the least alarmed. Fortune, however, at last favoured him, and he was enabled to obtain one of them; but the other made its escape.

"I was much puzzled with his recital of the circumstance; and could not in any manner satisfactorily account for it, till I examined its skull minutely (having obtained it for a skeleton), and then discovered its auditory canal situated in the position before mentioned.

"This investigation satisfied my mind that though this animal may hear sounds behind it, yet they are only heard imperfectly; otherwise it must have taken alarm at the many attempts to fire the gun. Applying this analogy to the hare, we may suppose that this animal, whose external tube is placed backward, would not distinguish sounds very distinctly in front of her. Many facts in the Natural History of the hare might be produced to support this idea; but one will suffice:—a hare, pursued by greyhounds along a turnpike road, was seen by a woman approaching her immediately in front; she knelt down, and the hare ran fairly into her apron, which was stretched out to receive him. This circumstance clearly proves that poor puss was much more occupied from dangers behind, than those which so unfortunately were placed before her.

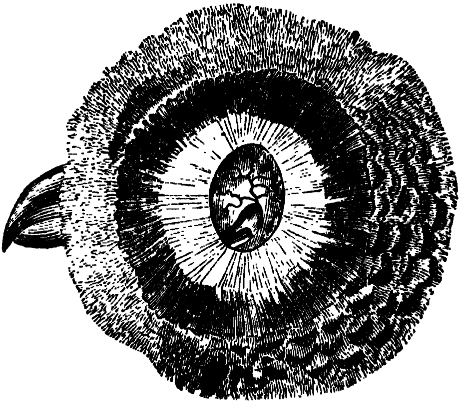
" The next animal is one which, although predatory in its habits, does not obtain its prey by pursuit, but steals upon it unawares; and, as such, is much indebted to the excellence of its outward perceptions for the ease with which it seizes its victims.

" This animal is the fox. On examination we find the external portion of his auditory structure is not tubulated in a similar manner to the two former instances; but, on the contrary, is expanded principally from behind, in a forward direction, into nearly a circular aperture. This opening is very well adapted, when the head is thrown laterally and upwards, for receiving sounds from above. His prey is usually met with in hen-roosts, or perched on trees; and his mode of taking them by surprise induces him to approach them stealthily. Hence arises the necessity of sounds indicating their immediate presence being transmitted to the sensorium as soon as possible. The moment his ear indicates his prey above him, his eye is immediately turned in that direction; and thus, if within his reach, is very speedily captured. What more beautiful provision for this animal's necessities could be met with than those with which he appears to be provided? His ears first give the indication of the presence of his prey, and his eye instantly contemplates the object of his pursuit*."

* Mag. of Nat. Hist. iv. 12.

Skull of the Fox; *a*, the auditory hole.

It has been well remarked by the earliest authors, that birds are not provided like other animals with an external ear, because their passage through the air* would have been obstructed by long ears like those of the hare or the ass. In owls there is a peculiar valve placed at the opening, partly of a membranous, and partly of a muscular structure, which has by some authors been deemed analogous to the human ear, and it is around this that



Structure of the Ear of the Owl.

* Derham, Phys. Theol. b. iv. c. 3, 1; Savart, Ann. de Chim. xxvi. 5.

the tuft of feathers already mentioned is arranged*, so as to form a large funnel, which is brought into view when the two folds or lips are separated. The outer opening is very large, parted into two chambers by a square bone, and forming a considerable upright slit in form of an S, extending as high as the head itself†.

The drum of the ear in birds bulges outwards in a somewhat convex form, and consists of two membranes. In order to support, distend, or relax the exterior membrane, there is a cartilaginous organ stretching from the side of the passage almost to the middle of the membrane; while there is another cartilage divided into three branches, the middle one of which, being the longest, is joined to the top of the cartilaginous organ before mentioned, and assists in bearing up the exterior membrane. The cartilage joins the top of the columella (*ossiculum auditus*), which is a very fine, thin, light, bony tube, the bottom of which expands into a plate (*sperculum*) corresponding to the base of the stirrup-bone in the

Drum of the Ear in Birds. (Enlarged from Derham's figure.)

* Blumenbach, Comp. Anat. § 263. † Blainville, p. 532.

human ear, and like it fitting the oval hole, to which it is braced all round by a very slender membrane*.

M. De Blainville, in opposition to most other comparative anatomists, and in conformity to the doctrine of minute analogies now pursued on the Continent, endeavours to show that the chain of bones found in the human ear is equally to be found in birds, though in order to make out this, he is under the necessity of confessing that, while "the chain of small bones is complete," these bones consist not of bony substance, but of cartilage, subcartilage, and even of muscles †.

With reference to this speculative theory upon the subject of the ear of birds, Sir Charles Bell, justly remarks, that "the only effect of this hypothesis is to make us lose sight of the principle which ought to direct us in the observation of such curious structures, as well as of the conclusions to which an unbiassed mind would come. The matter to be explained is simply this:—the chain of bones in the ear, which is so curiously adapted in the mammalia, to convey the vibrations of the membrane of the tympanum to the nerve of hearing, is not found in the organ of hearing of birds; but there is substituted a mechanism entirely different. They choose to say that the incus, one of the bones of the chain, is wanting in the bird. Where shall we find it? they ask. Here it is in the apparatus of the jaw or mandible; in that bone which is called *os quadratum*. I believe that the slight and accidental resemblance which this bone in the bird has to the incus is the real origin of this fancy. Let us follow a juster mode of reasoning, and see how this hypothesis obscures the beauty of the subject. The first step of the investigation ought to be to inquire into the fact,

* Cuvier, Leçons d'Anat. Comp. Blumenb.; Derham, Phys. Theol. vii. 2, note *d.*

† Principes, p. 527.

if there be any imperfection in the hearing of birds. That is easily answered:—*the hearing of birds is most acute*; the slightest noise alarms; and the nightingale, or other bird of song, in a summer evening, will answer to the note of his rival when he is out of hearing. We have next to observe the imperfection in the organ—the want of an external ear; which, were it present, would be at variance with all that we have most to admire in the shape of the bird and the direction of the feathers, as conducing to its rapid passage through the air. With this obvious defect of the external ear, can we admit that the internal ear is also imperfect, notwithstanding the very remarkable acuteness of hearing, which we know to result from this internal structure, and from it alone? Now we we do, in fact, find a different structure in the ear of birds, but yet nothing is wanting. The columella is a shaft of bone of exquisite delicacy, which is extended from the outward membrane of the ear to the labyrinth, or proper seat of the nerve of hearing. It occupies the place and office of the chain of four bones which belong to the ear of mammalia. We have no authority, however, for affirming that the incus is here wanting, more than any other bone of the chain;—and if it be said that the os quadratum is the missing incus, why should not we find in the oviparous reptiles, where there is a columella in the ear, an os quadratum in the jaw?

"From this mode of inquiry we find that the sense of hearing is enjoyed in an exquisite degree in birds; that the organ of the sense is not imperfect, but is adapted to a new construction, and a varied apparatus, suited to the condition of the bird; and that there is no accidental dislocation, or substitution of something less perfect than what we find in other classes of animals*."

* Bridgewater Treatise on the Hand, p. 139.

The internal parts of the ear in birds are much less complicated than in man and quadrupeds; but, without going into the minute particulars of difference, we shall only mention one peculiarity, which is, that while the chamber of the drum communicates with three large cavities in the adjacent bony plates, these again communicate by an equal number of openings with the drum in the same side, one of them extending over the skull to its fellow on the other side. Sir Everard Home has observed a similar kind of communication by means of the cells of the skull in the elephant*. We have little doubt that the provision made for rendering birds more buoyant, consisting of air-vessels extended from the lungs throughout the body, and even to the bones themselves, contributes to render the vibrations of the air more distinct, muffled as they must always partially be by the feathers of the bird.

The faculty of imitating sounds possessed by certain birds, proves that their hearing must be exceedingly delicate; and though we suspend our belief of the great musical talents which some birds are said to have derived from education, we find many well-attested instances of a delicate ear in species by no means remarkable for vocal execution. Madame Piozzi gives an account of a tame pigeon, which answered by gesticulation to every note of a harpsichord. As often as she began to play, the pigeon hurried to the concert with every indication of rapturous delight. A false note produced in the bird evident tokens of displeasure, and if frequently repeated, it lost all temper and tore her hands†.

A no less remarkable instance of the effect of music on a pigeon is related by Lockman in his reflections upon operas, prefixed to his musical drama

* Comp. Anat. † Letters from France and Italy.

of Rosalinda. Being at the house of a Cheshire gentleman, whose daughter was a fine performer on the harpsichord, he observed a pigeon, which, whenever the young lady played the song of "*Speri si*" in Handell's opera of Admetus, would descend from an adjacent dove-cot to the room window where she sat, and listen with every indication of pleasure till the song was finished, when it uniformly returned to the dove-cot.

M. Le Cat, holding the theory that the cochlea or snail-shell of the ear is the organ which perceives harmony and which is wanting in birds, yet admits birds to be the most musical of all animals, and to have an exquisite hearing, "because," he says, "their heads are almost entirely sonorous like a bell, owing to their not being involved in complicated muscles, as are the heads of other animals. Hence must they necessarily be agitated by the sounds which present themselves. The labyrinth of their ear, being very sonorous, is sufficient for this end. The most simple grot will echo back a musical air; but if to this excellent disposition of hearing in birds nature had added the cochlea, they would have been much more sensible of harmonious modulations. They would have had a passion for harmony, as almost all animals have for gormandizing; which is not the case. For one ought to recollect that the musical quality peculiar to birds, proceeds less from the delicacy and taste of their ear, than from the disposition of their throat. They, furthermore, in this particular, resemble musicians, who give pleasure to others, without partaking of any themselves. We hear a dog howl, we see him weep, as it were, at a tune played upon a flute; when, on the contrary, this animal is all alive in the field at the sound of a French horn. The horse takes fire at the sound of a trumpet, in spite of the thick muscular texture his auditory organ is encompassed with.

Without the cochlea these animals are provided with, one would by no means discover in them this sensibility for harmony. We should rather find them, in this respect, as stupid as fish, which are destitute of the cochlea, as well as birds; but without the advantages which birds have of a head sufficiently disengaged, sufficiently sonorous, to supply this defect*."

For the sake of illustration we may remark, that many other animals, besides birds, are observed to be singularly affected with certain sounds. Amongst these the elephant is not a little remarkable, though Sir Everard Home is disposed to think it does not possess a musical ear. Suetonius, for example, tells us, that the Emperor Domitian had a troop of elephants disciplined to dance to the sound of music, and that one of them who had been beaten for not having his lesson perfect, was observed, the night afterwards, practising by himself in a meadow†. Outrageous bulls have likewise, in several instances, been calmed into gentleness by music. Of this musical feeling in oxen Dr. Southey mentions a very singular instance. "The carts," he says, "of Corunna make so loud and disagreeable a creaking with their wheels for want of oil, that the governor once issued an order to have them greased; but it was revoked on the petition of the carters, who stated that the oxen liked the sound, and would not draw without its music‡." Even fish, upon better authority than the old story of Amphion and the dolphin, are said to have shown signs of being affected by music; and seals, we are told, have crowded to hear a violin §. "Seals," says Valerius Flaccus, "delight in song||," which Sir Walter Scott has rendered,—

* Le Cat, on the Senses, Eng. Trans.

† Hist. Cæs. xii. See also Menageries, ii. 70-1.

‡ Letters from Spain. § Laing's Voyage to Spitzbergen.

|| Gaudebant carmine Phocæ.

Rude Heiskar's seals, through surges dark,
Will long pursue the minstrel's bark.

In Germany they take the shad (*Alosa clupea*, MERRET) by means of nets, to which bows of wood, hung with a number of little bells, are attached in such a manner as to chime in harmony when the nets are moved. The shad, when once attracted by the sound, will not attempt to escape while the bells continue to ring. Ælian says the shad is allured by castanets: and so delicate is the ear of this fish reported to be, that the sound of thunder terrifies them to death, and numbers are annually found thus killed on the Rhine and the Moselle*.

Numerous other instances of a similar kind are recorded, upon authority far from being destitute of respectability, though they may somewhat startle the faith of the incredulous. An officer, confined in the Bastile at Paris, begged the governor to permit him the use of his lute, to soften his confinement by the harmonies of his instrument. At the end of a few days this modern Orpheus, playing on his lute, was greatly astonished to see frisking out of their holes great numbers of mice, and descending from their woven habitations crowds of spiders, which formed a circle about him while he continued playing upon his instrument. At first, he was petrified with astonishment, when, having ceased to play, the assembly of animals immediately broke up. Having a great dislike to vermin, it was two days before he ventured to touch the instrument; but having mustered courage to conquer his dislike, he recommenced his concert, when the assembly was by far more numerous than at first; and, in the course of farther time, he found himself surrounded by a hundred of these animal amateurs.

* Physicæ Curiosæ, p. 1261.

M. Marville has given the following curious details on this subject. Doubting, he tells us, the truth of those who say it is natural for us to love music, especially the sound of instruments, and that beasts themselves are touched with it, being one day in the country he made his observations, while a man was playing on a conch shell (*trompe marine*), upon a cat, a dog, a horse, an ass, a hind, cows, small birds, and some barn-door fowls in a yard under the window on which he was leaning. He did not perceive that the cat was in the least affected, and he even judged by her air that she would have given all the musical instruments in the world for a mouse, for she slept all the while unmoved in the sun; the horse stopped short from time to time before the window, raising his head up now and then, as he was feeding on the grass; the dog continued for above an hour seated on his hind legs, looking steadfastly at the player; and the ass did not discover the least indication of his being touched, eating his thistles very peaceably; the hind lifted up her large wide ears, and seemed very attentive; the cows slept a little, and after gazing awhile, went forward; some little birds which were in an aviary, and others on trees and bushes, almost tore their little throats with singing; but the cock, minding his hens, and the hens, solely employed in scraping in a neighbouring dunghill, did not show in any manner that they took the least pleasure in hearing the music.

Sir William Jones, in his curious dissertation on the musical modes of the Hindoos, says, " I have been assured by a credible eye-witness that two wild antelopes used often to come from their woods to the place where a more savage beast—Sirajuddaulah—entertained himself with concerts, and that they listened to the strains with an appearance of pleasure, till the monster, in whose soul there was no music, shot one of them to display his skill in archery*."

The anatomical structure and conformation which constitutes what is called a musical ear, remains hitherto unknown; but if we may judge from the songs of birds, it must differ considerably in them from what it does in man, as their musical scale cannot be adapted to any of ours; though Mrs. Piozzi's account of the musical pigeon, as well as the fact of bulfinches and other birds learning to pipe waltzes and other airs, proves that they can accommodate their ear to scales differing from the one in which they naturally sing.

Independently of structure and conformation, no very satisfactory explanation has, so far as we know, been given of what is called a musical ear. M. Le Cat says the ear of a good musician is a sort of prism, which separates and distinguishes the tones combined in harmony, as the glass prism separates the colours of light. But this, we think, is no less fanciful, than a comparison between sound and colours; scarlet, for example, being compared to the sound of a trumpet, as was done by a blind man because he had no other means of comparison. One of the most singular and ingenious accounts which we have met with of the peculiarity of a musical ear, is given by Dr. Thomas Brown of Edinburgh, in his Lectures on the Philosophy of the Human Mind. He thinks, because people who are not musical can distinguish grave and acute, low and loud sounds, as well as a musician, that the peculiarity must lie in the comparison of successive sounds. It may prove interesting to quote his own words.

"If the want of a musical ear," says Dr. Brown, "had involved either a general defect of hearing, or a general slowness of discrimination in other cases

* Asiatic Researches.

of nice diversity, the wonder would not have been great. But those who are without ear for music perceive as readily as others the faintest whisper; they distinguish like them the faintest shades of difference in mere articulations of sound, which constitute the varieties of language, not the articulation only, but the differences also of the mere tones of affection or displeasure, grief or gaiety, which are so strikingly analogous to the varied expressions of musical feeling; and their power of discrimination in every other case in which the judgment can be exercised is not less perfect. Nay, to increase still more the difficulty, they are often as sensible as others of the beauty of series of tones of a different kind; and some of our best poets and declaimers, who, of course, must have had a quick discernment of metrical rhythm, and of the melody of execution, have yet been incapable of distinguishing the musical relations of sounds, as reciprocally high or low, the melody that results from them in certain succession, and the harmony or the discord of their union.

"That it depends chiefly, or perhaps entirely, on the structure or state of the mere corporeal organ of hearing, which is of a kind, it must be remembered, peculiarly complicated, and therefore susceptible of great original diversity in the parts, and the relations of parts that form it, is very probable; though the difference of the separate parts themselves, or of their relations to each other, may, to the mere eye, be so minute as never to be discovered by dissection, thus leaving to every future race of inquirers the same difficulty which has perplexed ourselves, and the same difficulty of overcoming it.

"In the sense of vision, we may remark, there is a species of defect very analogous to the want of musical ear;—a defect which consists in the difficulty, or rather the incapacity, of distinguishing some colours from each other, and colours which, to general observers, seem of a very opposite kind. As the want of musical ear implies no general defect, in like manner it is to be found in persons who are yet capable of distinguishing with perfect accuracy the form and the greater and less brilliancy of the coloured object; and we may remark too, in confirmation of the opinion, that the want of musical ear depends on causes not mental but organic; that, in this analogous case, some attempts, not absolutely unsuccessful, have been made, to explain the apparent confusion of colours, by certain peculiarities of the external organ of sight. Though the one case, however, were to throw no light upon the other, it is still gratifying to philosophers to have a case at all analogous, to which, when they are weary of considering what has baffled all their endeavours to explain it, they may have the comfort of turning away their attention without the mortification of seeming absolutely to fly from the subject. Such is the strange constitution of our nature, that merely to have another difficulty presented to us, though it may be yet absolutely insurmountable in itself, if only it have some slight resemblance to a former difficulty, seems to us almost as if we had succeeded in explaining the first; and each difficulty, by a very convenient transposition which our pride knows well how to make, snpplies, according as we have been considering the one rather than the other, the place of explanation to that which is afterwards to explain it no less clearly in its turn.

"Proceeding on the analogy of these phenomena to those of tickling, an analogy which, striking as it is in many circumstances, does not justify more than conjecture in this application, it may be conceived to be at least not absolutely impossible, since a diversity of some kind there must be, that in those who receive no pleasure from music, as in those who are not ticklish, there is a rapid return of the nervous organ after each separate touch or pressure in the one case; and each separate tone in the other case produces its particular effect,—that effect which it would have produced in all if unaccompanied by any other tone in music, or slight pressure in tickling, but that a succession of these produces no effect different from that which each would have produced singly. A certain interval is necessary for distinct hearing in every case; and before this interval has passed, the auditory nerves in this case may be imagined to be quiescent, or nearly quiescent.

"In an inquiry of this sort all which is necessary is to account for the mere original defect of pleasure; since if the relations of notes, as reciprocally high or low, never gave any delight, the ear having no object of interest in these successions, would soon habitually neglect them, and at length cease altogether to distinguish them, attending only to the verbal meaning of sounds, and not to their tone; in the same manner as we pay little attention to another relative difference of voices, as more or less loud, unless when the difference is very considerable, and not in those common differences of intensity which distinguish every voice in conversation from every other voice; or as after living long in a province, the dialect of which is distinguished by any accentual peculiarities, we at last become unconscious of these, and hear the words, as it were, stripped of their peculiarity of tone. In what is termed the cultivation of a musical ear, however, we have not an analogy merely, but a direct proof of this influence of habit.

"That the ear may be improved by cultivation, or, in other words, by nice attention to the differences of musical sounds, every one knows; and if this attention can enable us, even in mature life, to distinguish as different in themselves, sounds which, but for the habitual attention, we should have regarded as the same, it may well be supposed that continued inattention from earliest infancy may render us insensible to musical relations still more obvious and precise than those which we have thus only learned to distinguish; or, which is the same thing, that continued attention from infancy to slight musical differences of sound—an attention which may be regarded as the natural effect of pleasure received—may render us capable of distinguishing tones as very dissimilar, the difference of which, however obvious at present, we should scarcely, but for such original attentive discrimination, have been able to detect. What, in comparison, the refined ear of a performer, almost every moment of whose life has been spent amidst sounds

> 'Untwisting all the chains that tie
> The hidden soul of harmony,'

is to a common musical ear, that common musical ear may be to those in whom this discriminating skill seems to be wholly, or nearly defective. The refined musician, who, but for the long practice of his art, would have shared that incapacity which now excites his wonder, is astonished that persons of a common ear do not distinguish the nice differences which appear to him almost as remarkable as those differences which they are capable of perceiving; and the person of common musical ear only does the same thing, when he is astonished that the less refined differences remarked by himself are not obviously distinguishable to all mankind, or, at least, by all who have no deafness to incapacitate them from hearing the separate sounds. The discrimination in both has depended on previous attention, which has necessarily been greater in the one case than in the other; and what attention can we suppose to have been originally given if, from the cause which I have ventured to state as a possible one in persons without musical ear, no pleasure had originally been felt by them in any sequence of notes as successive, and the whole value of sound been to them, the meaning of which it was symbolically representative, which, accordingly, they have learned to discriminate in every other case as accurately as others*?"

* Brown's Lectures, ii. 318.

CHAPTER III.

SMELL IN BIRDS.

As the sensation of smell, so far as we can judge, seems to depend upon the diffusion in the air of very subtile effluvia, or a principle called *aroma*, hitherto but little understood, it is obvious that objects cannot be perceived at so great a distance by smell as by hearing or vision, which do not depend on materials derived from the objects themselves. The discovery of distant water by the camel, however, seems to depend on the sense of smell*; and, if we are to credit the authorities given by Bryant, the ass has a similar faculty of discovering distant water by the smell, whence he thinks, in conformity to his singular views of mythology, the ass came to be the object of worship in the East. He takes occasion from this circumstance to explain a passage in Genesis†, which has long puzzled the best Hebrew critics. Instead of "Anah that found the mules in the wilderness," Bryant renders it the ass "which found waters in the wilderness, when Anah fed the mules of his father, Zibeon." The term (ימם, *Imim*), which Bryant renders "waters," occurs in no other part of the Bible, and while some have rendered it "mules," others, "giants‡," the Vulgate gives in "hot springs" (*aquas calidas*). Bochart, Aquila, and Symmachus retain the original word, and, proceeding upon this

* See Menageries, vol. i. p. 295, &c.; and Edin. Phil. Journ. 1820.

† Ch. xxxvi. v. 24.

‡ Targum in Genes.

view, Houbigant reads "Anah who attacked the Emims in the wilderness." We pretend not to decide which is the most correct, though Bryant's rendering seems the most rational.

These two instances of the camel and the ass, however, seem to be solitary, for we have no good evidence to prove that other animals can discover very distant objects by the smell, though the fact has been commonly asserted of vultures, and also, as we have already remarked, of the goose. In a case of this sort observation is always better than the most *ingenious and plausible theoretical reasoning; and fortunately we possess, with respect to the vulture and* some other birds, the remarks of Dr. James Johnson, which we have already partially referred to, but shall now give entire. "It has always," says the Doctor, "appeared to us most extraordinary, indeed unaccountable, that birds of prey could scent carcasses at such a distance as they are said to do. We were led to scepticism on this subject some twenty years ago, while observing the concourse of birds of prey from every point of the horizon to a corpse floating down the river Ganges, and that during the north-east monsoon when the wind blew steadily from one point of the compass for months in succession. It was extremely difficult to imagine that the effluvia from a putrifying body in the water could emanate in direct opposition to the current of air and impinge on the olfactories of birds many miles distant. Such, however, were the *dicta* of natural history, and we could only submit to the general opinion. We have no doubt, now that we know the general opinion to be something wrong, that it was by means of the optic rather than the olfactory nerve, that these birds found out their quarry.

"The toucan ranks next to the vulture in discerning, whether by smell or by sight, the carrion on which it feeds. The immense size of its bill, which is many times larger than its head, was supposed to present, in its honey-comb texture, an extensive prolongation of the olfactory nerve, and thus to account for its power of smelling at great distances; but, on accurate observation, the texture above-mentioned in the bill is found to be mere diploe to give strength to the bill. Now the eye of this bird is somewhat larger than the whole brain; and it has been ascertained by direct experiments, that where any putrid carrion was enclosed in a basket, from which effluvia could freely emanate, but which concealed the offal from sight, it attracted no attention from vultures and other birds of prey till it was exposed to their view, when they immediately recognized their object, and others came rapidly from different quarters of the horizon, where they were invisible a few minutes before. This sudden appearance of birds of prey, from immense distances, and in every direction, however the wind may blow, can only be accounted for by their soaring to an altitude. In this situation their prey on the ground is seen by them, however minute it may be, and their appearance is merely their descent from high regions of the atmosphere to within the scope of our optics. How far these remarks apply to the raven, the only bird of the vulture genus that comes within our review, we leave for more experienced naturalists*."

Dr. Johnson here represents the toucan as preying on carrion, a statement different from what is given in books of natural history, and his remarks on the nerves of smell are equally opposed to the recent observations of Dr. Stewart Traill, of Liverpool†.

"All systematic authors," says Dr. Traill, "have described the bill of the genus *Ramphastos* as hollow. The Linnæan character even begins 'Rostrum

* Medico-Chir. Review. † Linn. Trans. xi. 288.

maximum inane,' &c.; and Buffon has eloquently enlarged on the supposed error, or oversight of nature, in furnishing so small a bird with a bill so monstrous and useless. *My friend Charles Waterton, Esq., who has lately returned from the interior of Guyana, had observed, that when a portion of the bill of a* toucan is shot away, the remainder bleeds profusely; and on immersing the bill of a recently-killed bird in hot water, he was enabled to detach from the exterior covering of the bill a horny substance, which filled its whole cavity, consisting of a delicate net-work of bony matter in the interior, surrounded by thin plates of the same material. On these bony partitions a great number of blood-vessels are distinctly ramified in the living animal. This gentleman favoured me with a specimen thus prepared; in carefully examining which, I found that the nostrils conducted to the internal cells of the substance within the upper mandible.

"From this observation, and the great vascularity of the part, I concluded that the bill is not a useless incumbrance, as Buffon rashly conjectured; but that it is an admirable contrivance of nature to increase the delicacy of the organ of smell in a species whose residence and habits require great nicety in that sense. As the animal is incapable of either tearing or bruising its food, it necessarily must feed on small substances. Its aliment is said chiefly to consist of small fruits or seeds; and for readily attaining these in the wilds of almost impenetrable forests, an acute organ of smell is no doubt requisite. Instead, then, of regarding the bill of the toucan as a useless load, I am disposed to consider it as an instance of that wisdom and contrivance which attentive observation every where discovers in the works of nature."

According to Azara, toucans destroy a great number of living birds, attacking them, chasing them from their nests, and devouring the eggs or young,

The Toucan—(*Ramphastos Toco*).

which they can with their long bill draw from the recess of a hole, and even from the deep basket woven by the orioles, or from the solid masonry of the baker-bird (*Merops rufus*). This account is corroborated by the interesting observations made by Mr. Broderip upon a toucan (*Ramphastos erythrorhynchus*), which was kept alive in London. The predacious habits of this bird were first observed by the proprietor on the occasion of a young canary-bird having escaped and gone near to the toucan's cage. The toucan appeared more than usually excited, and when the door was opened it instantly seized and devoured the canary-bird. Mr. Broderip being desirous of witnessing a similar circumstance, the proprietor selected a goldfinch for the experiment.

"The instant he introduced his hand with the goldfinch into the cage of the toucan, the latter, which was on a perch, snatched it with his bill. The poor little bird had only time to utter a short weak cry; for, within a second it was dead, killed by compression on the sternum and abdomen, and that so powerful, that the bowels were protruded after a very few squeezes of the toucan's bill. As soon as the goldfinch was dead, the toucan hopped with it still in his bill to another perch, and, placing it between his right foot and the perch, began to strip off the feathers with his bill. When he had plucked away most of them, he broke the bones of the wings and legs (still holding the little bird in the same position) with his bill, taking the limbs therein, and giving at the same time a strong lateral wrench. He continued this work with great dexterity, till he had almost reduced the bird to a shapeless mass; and ever and anon, he would take his prey from the perch in his bill, and hop from perch to perch, making at the same time a peculiar hollow clattering noise, at which times I observed that his bill and wings were affected with a vibratory or shivering motion, though the latter were not expanded. He would then return the bird to the perch with his bill and set his foot on it. He first ate the viscera, and continued pulling off and swallowing piece after piece, till the head, neck, and part of the back and sternum with their soft parts were alone left: these, after a little more wrenching while they were held on the perch, and mastication, as it were, while they were held in the bill, he at last swallowed, not even leaving the beak or legs of his prey. The last part gave him the most trouble; but it was clear to me, that he felt great enjoyment; for, whenever he raised his prey from the perch, he appeared to exult, now masticating the morsel with his toothed bill, and applying his tongue to it, now attempting to gorge it, and now making the peculiar clattering noise, accompanied by the shivering motion above-mentioned. The whole operation, from the time of seizing his prey to that of devouring the last morsel, lasted about a quarter of an hour. He then cleaned his bill from the feathers, by rubbing it against the perches and bars of his cage. While on this part of the subject, it may be as well to mention another fact, which appears to me not unworthy of notice. I have more than once seen him return his food after he had taken it from his crop, and, after masticating the morsel a while in his bill, again swallow it: the whole operation, particularly the return of the food to the bill, bearing a strong resemblance to the analogous action in the ruminating animals. The food on which I saw him so employed was a piece of beef, which had evidently been macerated some time in the crop. While masticating it, he made the same hollow clattering noise as he made over the remains of the goldfinch. Previous to this operation, he had examined his feeding-trough, in which there was nothing but bread, which I saw him take up and reject; and it appeared to me that *he was thus reduced from necessity to the above mode of solacing his palate with animal food.* His food consists of bread, boiled vegetables, eggs, and flesh; to which a little bird is now added, about every second or third day. He shows a decided preference for animal food, picking out all morsels of that description, and not resorting to the vegetable diet till all of the former is exhausted*."

It will appear from these observations, that Baron Cuvier is in error, when he says of the toucans, "the structure of their bill obliges them to swallow their food without mastication; when they have seized it, they throw it in the air, the more easily to swallow it†." It is always hazardous to venture upon general observations of this kind without personal observation to support them, for, how plausible soever they may appear on paper, they seldom accord with facts.

With respect to the smell of vultures, Willughby says, "they have an excellent sagacity of smelling above all other birds, so that they can perceive the savour of dead carcasses from far," to which Ray adds, "many miles off they say‡." Some of the old authors indeed, such as Thomas Aquinas, specify the distance at which a vulture can scent out a dead body to be five hundred miles §, and Isidore alleges it is no matter even if the sea itself intervene‖; both of which statements are intended, we presume, as a comment on the passage in Pliny, where it is affirmed that the vulture has a more sagacious scent, as the eagle has a clearer sight, than man; or on that of Lucretius, in which he compares the scent of the vulture for carrion to the scent of bees for honey.

* Zool. Journ. i. 487. † Règne Animal, i. 460, edit. 1829.
‡ Ornith. by Ray, p. 66. § De Anim. Comment. ii. 97.
‖ Origin. xii. 7.

Apuleius compares a glutton smelling out a good dinner as superior in such sagacity to the dog or the vulture.

It may well be disputed, however, that the smell of the vulture or any other bird extends to the distances alleged by these writers, for, as was long ago remarked by Cælius Rhodiginus, odorous effluvia cannot be distinguished at any considerable distance, as they are not only diluted by being diffused in the air, but may even be thereby wholly changed in their qualities*. The observations of Avicenna are still more to the point. "Odours," he says, "arise from most animals as well as from man; and in a similar way *things are rendered visible at a considerable* distance, even beyond high mountains. I have myself indeed observed vultures wheeling about in the air, and of course their vision must be extensive, to enable them to see from a higher elevation than the highest mountains, since they can in such circumstances discern a piece of carrion in the plains below them. But if it is denied, that colours can be perceived at such distances, much more ought the same to be affirmed of odours, whose power is weaker than that of colours; and since it is not indispensable for every animal to move the eyelids or the eyes in order to see, neither is it indispensable for every animal to smell to a thing in order to perceive the scent thereof†.

From all these various facts we think Dr. Johnson's remarks are decidedly the most plausible; and even those authors who speak in the most unhesitating manner of the powers of smell, furnish from their own accounts circumstances to prove their opinions doubtful. Wilson, for example, speaking of the turkey-vulture (*Cathartes aura*, ILLIGER), says,

* Lect. Antiq. viii. 18.

† Apud Aldrovandi Ornithol. i. 126.

"These birds, unless when rising from the earth, seldom flap their wings, but sweep along in ogees, and dipping and rising lines, and move with great rapidity. They are often seen in companies, soaring at an immense height, particularly previous to a thunder storm. Their wings are not spread horizontally, but form a slight angle with the body upwards, the tips having an upward curve. Their sense of smelling is astonishingly exquisite, and they never fail to discover carrion, even when at the distance from it of several miles *." Their soaring in the air, whether during a thunderstorm or at any other time, must evidently be not for the purpose of smelling out, but for discovering by the eye some piece of carrion. The Abbé Clavigero's account of the black vulture (*Catharte urubu*, VIEILLOT) is precisely similar. "They fly so high," he says, "that although they are pretty large, they are lost to the sight; and, especially before a hailstorm, they will be seen wheeling in vast numbers under the loftiest clouds, till they entirely disappear. They feed upon carrion, which they discover by the acuteness of their sight and smell, from the greatest height, and descend upon it with a majestic flight in a great spiral course †."

When the turkey-vultures roost, they usually sit in companies on the branches of a large tree, and "they may be seen," says Wilson, "on a summer's morning, spreading out their wings to the rising sun and remaining in that posture for a considerable time. Pennant conjectures that this is to purify their bodies, which are most offensively fetid. But is it reasonable to suppose that *that* effluvia can be offensive to them, which arises from food perfectly adapted to their nature and which is constantly the object of their desires ‡?" This is corroborated by the remark of

* Amer. Orinth. ix. 98, 1st edit. † Hist. Mexico.
‡ Amer. Ornith. ix. 97.

Dr. Latham that vultures, "when left to themselves, rather prefer flesh already tainted than fresh meat. In this circumstance of their disposition," he adds, "I am clear, in respect of the carrion vulture of Jamaica, two of which I kept alive for some time in my garden. They would indeed eat raw flesh, but expressed particular pleasure when any tainted food was offered them, fluttering with expanded wings and falling on with double appearance of appetite, as well as devouring twice the quantity as at other times*."

The raven is another of those birds which have been celebrated for discovering distant objects by the smell, which Bingley thinks "must be very acute; for in the coldest winter days, at Hudson's Bay, when every kind of effluvia is almost instantaneously destroyed by the frost, buffaloes and other beasts have been killed where not one of these birds was to be seen, *but in a few hours scores of them have been* found collected about the spot to pick up the blood and offal†." Mr. Knapp is also disposed either to refer this circumstance to smell, or to some mysterious sense inscrutable to human penetration. "Should an animal die," he says, "or a limb of fresh carrion be on the hooks in the tree, the hoarse croak of the raven is sure immediately to be heard calling his congeners to the banquet. We see it daily in its progress of inspection, or high in the air on a transit to other regions, hastening, we conjecture, to some distant prey. With the exception of the snipe, no bird seems more universally spread over the surface of our globe than the raven, inhabiting every zone, the hot, the temperate, the severe; feeding upon and removing noxious substances from the earth, of which it obtains intimation by means of a faculty we have little conception of. Sight it cannot be; and we know not of any fetor escaping from an animal pre-

* Gen. Hist. of Birds, i. 2. † Animal Biog. ii. 242.

vious to putrescence so subtile as to call these scavengers of nature from the extremity of one county to that of another: for it is manifest from the height which they preserve in their flight, and the haste they are making, that their departure has been from some far distant station, having a remote and urgent object in contemplation*."

The following anecdote told by M. Antoine, if it may be credited, illustrates this view of the case in a striking manner. A gentleman who had been robbed by his servant, forgave him on condition that he would promise to abandon his bad habits: this promise he so far kept, and conducted himself so steadily, as to accumulate enough of money to enable him to marry and to keep an inn on a much frequented road. About twenty years after, the gentleman travelling that way came to lodge with his old servant, whom he did not recollect till the man came forward, made himself known, and expressed how gratified and happy he was in again waiting upon him. He gave him the handsomest room, and the best fare; but the night had no sooner set in, than this perfidious wretch, after so much show of attachment, stabbed his old master with a dagger, threw his body into a cart, and carried it to a river at the back of his house. In order to avoid discovery, and to prevent the corpse from rising to the surface of the water, he pierced the body through with a long stake sharpened at the end, which he pushed so far into the mud, that only a very small portion of the end of the stake was visible. A few days afterwards some ravens arrived from all directions, and crowded to the spot. Their increasing croaking, altogether unusual at the place, led the inhabitants to fancy a thousand foolish stories. The pertinacity of the birds was such, also, that it was useless to attempt driving

* Journ. of a Naturalist, p. 172, 3d edit.

them away. This increased the excited curiosity so much, that the stake was at length, with difficulty, drawn out, which was no sooner done than the body rose to the surface of the water. Inquiries were accordingly made to discover the murderer; and the wheel-marks of the cart having been traced to the back of the inn, the master was taken up upon suspicion and confessed his crime*.

A similar faculty of acute smelling is popularly ascribed to the rook (*Corvus prædatorius*), not for the purpose of procuring food, but for descrying danger. Dr. Darwin has remarked, that a consciousness of danger from mankind is much more apparent in rooks than in most other birds. "Any one," adds Bingley, "who has in the least attended to them, will see that they evidently distinguish that the danger is greater when a man is armed with a gun than when he has no weapon with him. In the spring of the year, if a person happen to walk under a rookery, with a gun in his hand, the inhabitants of the trees rise on their wings, and scream to the unfledged young to shrink into their nests from the sight of the enemy. The country people, observing this circumstance so uniformly to occur, assert that rooks can smell gunpowder †." We have no doubt, however, that had the writer tried the experiment, as we have done, of presenting his umbrella or his walking-stick at the rooks, they would have been equally alarmed as at the levelling of a double-barrelled fowling-piece.‡ Their ability to smell gunpowder is evidently a fancy. That rooks, however, have some acute faculty of this kind appears from their remarkable dexterity in discovering their food. "I have often," says Mr. Knapp, "observed them alight on a pasture of uniform verdure, and exhibiting no sensible appearance of withering

* Animaux Célèbres, i. 192.

† Anim. Biogr. ii. 250.

‡ J. R.

or decay, and immediately commence stocking up the ground. Upon investigating the object of their operations, I have found many heads of plantains, the little autumnal dandelions, and other plants, drawn out of the ground and scattered about, their roots having been eaten off by a grub, leaving only a crown of leaves upon the surface. This grub, beneath, in the earth, the rooks had detected in their flight, and descended to feed on it, first pulling up the plant which concealed it, and then drawing the larvæ from their holes. By what intimation this bird had discovered its hidden food, we are at a loss to conjecture; but the rook has always been supposed to scent matters with great discrimination *."

Water-birds (*Natatores*, ILLIGER) might be supposed, from the considerable development of their nerves of smell, to have this sense very acute; and accordingly we have already seen that Lucretius attributes to the quick smelling of the geese, their discovery of the Gauls when they attempted to take the capitol by surprise. The organs of smell in the goose, however, are considerably less developed than those of the duck †. The petrels, we might infer, ought to possess an acute smell, as their nostrils are not only large, but different from other birds; they project distinctly from the beak, forming a singular-looking sort of nose, in some species, such as the pintado petrel (*Procellaria capensis*), nearly an inch long ‡; in the giant petrel (*P. gigantea*, GMELIN) it is much more. As these birds do not fly so high in the air as vultures and ravens, and live upon dead fish and similar garbage, these prominent nostrils are probably intended to render them

"Sagacious of their quarry from afar."

* Journ. of a Naturalist, p. 179, 3d edit.

† De Blainville, Principes, p. 322.

‡ Lesson, Man. d'Ornith. ii. 397.

This opinion is rendered more probable from the very different structure of the nostrils in birds which feed on live fish. The pelicans, for example, have the cavity of the nostrils in general very small, and the marginal cartilage, as well as the opening in the bone, scarcely perceptible, even in the skeleton. The cormorant (*Carbo cormoranus*, MEYER), again, which is ranked in the same group (*Pelecanidæ*, LEACH), has the nostrils so small that De Blainville says it is with difficulty a very small slit can be distinguished at the base of the bill in the living birds, hence he designates them by the term *Cryptorhinia*. The same author describes in several species a sort of scale covering the nostrils like a lid*, which must, we should imagine, diminish their power of smell by admitting only a minute portion of the air containing odoriferous particles. It is worthy of remark, that the kingfisher (*Alcedo*), though not a swimming bird like the pelicans and cormorants, has very small nostrils, with a cartilaginous lid†; smell being, so far as we can judge, of inferior moment to them, inasmuch as they feed almost exclusively on live fish ‡, which they must discover and pursue by the eye.

In ducks (*Anatidæ*, LEACH), many of whom seek their food amongst the mud at the bottom of standing water, the nerves of smell are greatly expanded, a fact which has been long known. "Flat-billed birds," says Mr. Clayton, "that grope for their meat, have three pair of nerves that come into their bills, whereby they have that accuracy to distinguish what is proper for food and what to be rejected, by their taste, when they do not see it. This was most evident in a duck's bill and head; ducks having larger nerves that come into their bills than geese or any other bird that I have seen; and therefore quaffer and grope

* Principes d'Anat. Comp. 323-4. † Ibid. 319.
‡ See Paxton in Hort. Regist, Jan. 1832.

out their meat the most. But then I discovered none of these nerves in round-billed birds. But since, in my anatomies in the country, in a rook, I first observed two nerves that came down betwixt the eyes into the upper bill, but considerably smaller than any of the three pair of nerves in the bills of ducks, but larger than the nerves of any other round-billed birds. And it is remarkable that those birds, more than any other round-billed birds, seem to grope for their meat in cow-dung*." "I observed," says Dr. Moulin, "three pair of nerves in all the broad-billed birds that I could meet with, and in all such as feel for their food out of sight, as snipes, woodcocks, curlews, geese, ducks, teals, widgeons, &c. These nerves are very large, equalling almost the optic nerve in thickness. Two are distributed nigh the end of the upper bill, and are there very much expanded, passing through the bone into the membrane, lining the roof of the mouth †."

The facts thus proved by the structure of the organ are corroborated by the actions of the birds themselves. There can be little doubt indeed that animals may sometimes be deceived into eating what is unwholesome, or even poisonous ‡. But this, it is probable, happens much more rarely in those endowed with acute smell than in others; for according to the beautiful remark of Cicero, borrowed, it is highly probable, from the Greek philosophers, "the nostrils are providentially placed high because odours have a tendency to rise, and are also near the mouth for the purpose of discriminating food and drink §." Even very young ducks, accordingly, as we have more than once observed, will reject from the mud in which

* Phil. Trans. No. 206.
† Ibid. No. 199, or Lowthorp's Abridg. ii. 861-2.
‡ See Insect Trans. p. 76-8 ; Ins. Miscell. p. 30.
§ De Natura Deorum, ii. 56.

they may be fishing such substances as they judge by smell to be unfit for food, while they will eagerly swallow a bit of biscuit which for the sake of experiment may be concealed amongst the mud; and they will as eagerly seize and swallow any animal garbage which they find in the same place, and which has just been rejected by their fellow-swimmers the swans, whose food is wholly vegetable*. Dr. Darwin was therefore in some degree right in the following remarks, though he evidently carries his principle to extremes which facts will not altogether justify. "The senses of smell and taste," says the Doctor, "in many other animals greatly excel those of mankind; for in civilized society, as our victuals are generally prepared by others, and are adulterated with salt, spice, oil, and empyreuma, we do not hesitate about eating whatever is set before us, and neglect to cultivate these senses; whereas other animals try every morsel by the smell before they take it into their mouths, and by the taste before they swallow it; and are led each to his proper nourishment by this organ of sense†."

We have already mentioned the instance of a chicken, which, the instant it was excluded from the shell, picked up a spider, evidently guided thereto by the eye. The celebrated Greek physician, Galen, made an experiment which proves a similar early development of smell, and will furnish an interesting illustration of our subject.

"On dissecting," he says, "a goat great with young, I found a brisk embryon, and having detached it from the matrix, and snatching it away before it saw its dam, I brought it into a certain room, where there were many vessels, some filled with wine, others with oil, some with honey, others with milk or some other liquor, and in others were grains and fruits: we first observed the young animal get upon its

* J. R. † Zoonomia, i. 195.

feet and walk; then it shook itself, and afterwards scratched its side with one of its feet; then we saw it smelling to every one of these things that were set in the room; and when it had smelt to them all, it drank up the milk*."

In the instance of Galen's kid, as well as of the young ducks, the nose was brought near to the object whose smell was to be ascertained; but, in some very singular instances, this appears to be perceived in a manner not a little puzzling. We can easily understand indeed that swine, when ploughing up the ground in search of roots, may distinguish, by smelling such as they chance to turn up, what is suited to them for food, for this is nothing more than was done by Galen's kid; but when we are told they are employed on the Continent to hunt for truffles (*Tuber cibarium*, Sibthorp), we must infer that their sense of smell is rather beyond what we can well conceive by comparison with our own perceptions. The truffle-gatherer, we are told, ties a cord round the animal's leg, drives him into the pastures, and wherever he begins to root with his nose, truffles are found at the depth of several inches, though the truffle before it is cooked has by no means a strong or remarkable smell. Dogs, however, are employed in a similar manner for the discovery of truffles, and with a success which is astonishing to those who witness this exercise of instinct for the first time†.

We have observed a still more remarkable instance of the same kind in the mole (*Talpa cæca*, Savi.). As this singular creature feeds chiefly upon earthworms, it is well fitted for hunting after them under ground, from being able to burrow with great rapidity by means of its snout and claws; but what is more worthy of notice still, is its faculty of discovering their haunts. Worms, it may be remarked, are not

* De Locis, vi. 6. † Loudon's Encycl. of Plants, p. 1024.

found indiscriminately in a field, but in such places only as afford a supply of decayed vegetable matter upon which they feed. In pastures, accordingly, they always crowd to the droppings of cattle, under which the herbage is smothered, and more or less in a state of decomposition. Now to these haunts of the earth-worms, we have observed the mole generally finds its way, not by searching for them on the surface, and then burrowing under them, a process we could easily understand, but by a direct route under ground. The droppings of cows, it is true, have a rather strong and penetrating musky odour; but it is very questionable, we think, whether it is possible for this to become diffused under ground at the depth of several inches, and to the extent of several yards. Yet we have seen as many as three mole-tracks, each from an opposite direction, terminating in the same cow's dropping, like radii to a centre. But even if the odour were proved to be diffused under ground, that would not serve to account for the moles directing their courses in the same way to the under surface of stones, another favourite resort of the worms*.

The woodcock (*Scolopax rusticola*, CHARLET), which feeds upon earth-worms, exhibits equal dexterity with the mole in discovering them. "These birds," as Colonel Montagu says, "rambling through the dark, are directed by an exquisite sense of smelling to those places most likely to produce their natural sustenance, and by a still more exquisite sense of feeling in their long bill collecting their food. The eye is not called into use, for, like the mole, they actually feed below the surface; and, by the sensibility of the instrument which is thrust into the soft earth, not a worm can escape that is within reach. A woodcock in our menagerie," he adds, "very soon discovered and drew forth every worm in the ground,

* J. R.

which was dug up to enable it to bore; and worms put into a large garden-pot, covered with earth five or six inches deep, are always cleared by the next morning, without one being left. The enormous quantity of worms that these birds eat is scarcely credible; indeed it would be the constant labour of one person to procure such food for two or three woodcocks *."

The same opinion respecting the acute smell of the woodcock was held by the older authors, among whom we may name Nemesian, Gesner, and Aldrovand †. M. Montbeillard also says it seems to discover its food by smell rather than by sight ‡, which is supposed to be corroborated by what is related by Bowles of certain tame woodcocks at San Ildefonso in Spain, belonging to the Infant, Don Louis. "Here," says Bowles, "there was a fountain which flowed perpetually to keep the ground moist, and in the middle a pine-tree and shrubs for the same purpose. Fresh sod was brought to them, the richest in worms that could be found; in vain did the worms seek concealment when the woodcock was hungry; it discovered them by the smell, stuck its bill into the ground, but never higher than the nostrils; drew them out singly, and raising its bill into the air, it extended upon it the entire length of the worm, and in this way swallowed it smoothly, without any action of the jaws. This whole operation was performed in an instant, and the motion of the woodcock was so equal and imperceptible that it seemed doing nothing. I did not once see it miss its aim: for this reason, and because it never plunged its bill up to the orifice of the nostrils, I concluded that smell is what directs it in search of its food §."

* Ornith. Dict. p. 562, 2d edit.

† Aldrovandi Ornithologia, iii. 126.

‡ Oiseaux, Art. La Becasse.

§ Bowles's Nat. Hist. of Spain, p. 484.

In some instances it may be that the worm-casts point out to the woodcock where to dig for the worms, but such an explanation will not apply to all the facts just quoted from Montagu and Bowles. A recent author seems inclined, however, to doubt that the woodcock is guided by smell, and remarks that "the bill being inserted only as far as the nostrils proves nothing but the necessity of preserving respiration; and the bill once fixed in the earth the position of the nostrils must be a matter of total indifference. We cannot conclude that, anteriorly to the insertion of the bill, smell had any thing more to do with the precision of the action than sight. The organ of this sense is in general so obtuse among birds, that it is contrary to analogy to suppose the woodcock peculiarly privileged in its enjoyment, more especially as, in consequence of the fleshy substance which terminates its upper mandible, it is already endued with a species of tact calculated to enable it to discover suitable aliment in wet and muddy ground*." We may remark, however, that if touch or taste be meant by tact, neither of these would enable the bird to discover worms deep in the earth, any more than it would enable swine or dogs to find truffles, or the mole to drive a burrow in a straight line from its nest to a stone at several yards distance.

* Cuvier's Anim. Kingdom, by Griffith, viii. 524.

Chapter IV.

TASTE IN BIRDS.

We have tried numerous experiments upon soft-billed song-birds (*Sylvicolæ*, Vieillot), which are in some measure omnivorous, in order to discover whether or not they were guided by taste in their preference or rejection of certain articles. The black-cap (*Philomela atricapilla*), for instance, which is very fond of berries, will greedily devour those of the elder, the privet, the honeysuckle, and the ivy, as well as currants and grapes; but it will not touch the berries of the bitter-sweet (*Solanum dulcamara*) which a red-breast in the adjacent cage seemed to relish, while he rejected the privet berries. What appeared to be the most remarkable circumstance in these experiments was, that the berries are for the most part swallowed entire without the bird breaking or bruising them with its bill. Now it is difficult for us to conceive that the berry could be tasted while it remains unbroken; at least our organs are too obtuse to distinguish tastes under such circumstances *.

The observations of Mr. Knapp upon these birds agree exactly with our own. "Our gardens," he says, "shrubberies, and orchards become their resort, seeking for the fruits usually produced in those places. And, first, the fauvette (*Philomela hortensis*), with all her matured brood, is certain to be found feeding voraciously upon our cultivated berries,

* J. R.

or mining a hole in the fig or jargonel pear; and so intent are they upon this occupation, that they will permit a reasonable examination of their form and actions, but at other periods it is difficult to approach them. The black-cap discontentedly flits about our inclosures and thickets all the summer through, building her nest or tending her young; the fine clear harmony of the male bird resounding in the morning from the brake, yet, timid and alarmed, he ceases and hides himself if we approach; but now he introduces all his progeny to our banquet; cautious still, we can yet observe his actions, and easily distinguish the black or brown heads of the sexes, as they are occupied beneath the foliage of an Antwerp raspberry. The white-throats now, too, leave their hedges, and all their insect food, which for months had been their only supply, and in the thick covert of the gooseberry extract with great dexterity the pulp of the fruit, or strip the currant of its berry. The elegant, slender form of the female, her snowy throat and silvery stomach *, render her very conspicuous, as she scuttles away to hide herself in the bush; her plain brown-backed mate seems rather less timid, but yet carefully avoids all symptoms of familiarity. Other doubtful little birds likewise appear, and are gone; several of which, however, are probably the young of ascertained species.

"All these fruit-eating birds seem to have a very discriminating taste and a decided preference for the richest sorts; the sweetest variety of the gooseberry or the currant always being selected; and when they are consumed, less saccharine dainties are submitted to: but the hedge-berry of the season our little foreign connoisseurs disdain to feed on, leaving it for the

* We think our author has in this instance described the male babillard (*Curruca garrula*, BRISSON) for the female white-throat. J. R.

humbler-appetited natives; they are away to sunnier regions and more grateful food *."

With respect to insects and other small animals upon which the same birds also feed, they are equally nice in their preferences and rejections. We had a fauvette (*Philomela hortensis*), for example, which was exceedingly fond of spiders (*Phalangium opilio, Epeira diadema, &c.*), the largest of which it would contrive to swallow; but the black-cap, though it will devour flies of every sort, will not touch a spider, and while it will eat almost any smooth caterpillar (*Phlogophora meticulosa, Mamestra brassicæ, &c.*), it will not touch those of the cabbage butterfly (*Pontia brassicæ*), which the fauvette devoured with avidity. Neither of these birds again, nor the nightingale, will touch an earth-worm, of which the red-breast is very fond †. No bird will touch the caterpillar of the magpie moth.

These facts and many more of a similar kind, which we could easily enumerate, fully authorize us, we think, to conclude, that some birds at least are endowed with the faculty of taste; though this is expressly or partially denied by certain authors distinguished for accuracy of observation, such as Colonel Montagu and M. Blumenbach, because in several species "the tongue is horny, stiff, not supplied with nerves, and consequently unfit for an organ of taste.‡" But it does not follow, because the tongue in most other animals is the chief organ of taste, that birds with a horny tongue destitute of nerves cannot discriminate their food by taste, since other parts of the mouth may perform this office; an inference rendered more probable, from the structure and texture of the mouth, and from what takes place in man and quadrupeds.

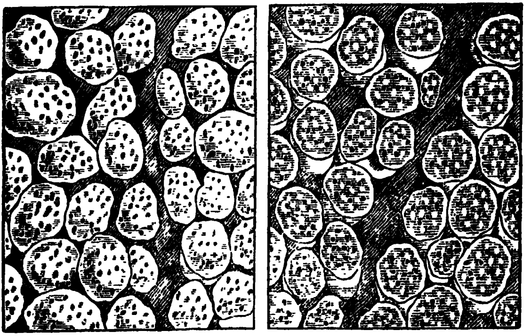
It is obvious to the most casual observer, that the upper surface of the tongue in man does not appear

* Journ. of a Naturalist, p. 232, 3d edit.

† J. R.

‡ Blumenbach, Comp. Anat. § 233.

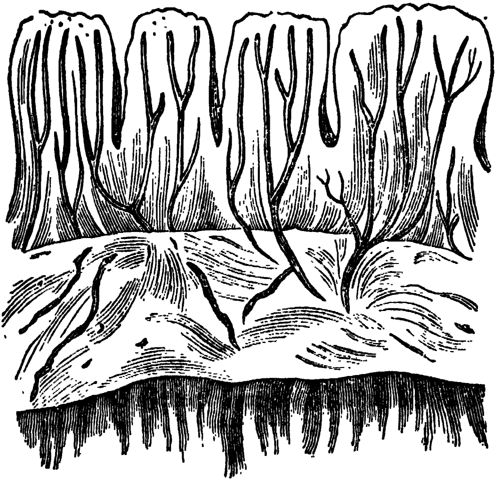
so smooth as the lips, at least to the eye; the rough-like appearance being occasioned by what we may not inappropriately call the *tasters* (*papillæ*), which are of different sorts according to the purpose they are intended to serve. One sort, situated on the



a, Portion of the upper surface of the Human Tongue, showing the nervous Papillæ; magnified 100 times.—*b*. The same in transverse section, showing that each papilla is composed of nerves (white) and arteries (black); magnified 100 times.

upper surface of the tongue, are formed like a cone or sugar-loaf, and very close set like the bristles of a brush. Towards the tip they are more elevated and sharp, and many of them are divided at the summit into bristle-like points; while towards the sides they become gradually less elevated, till they are reduced to little blunt buttons. The latter are not perhaps so much designed for the purpose of tasting as of forcing the juices out of the substance which is tasted, and of breaking it down against the roof of the mouth to fit it the better for solution. Among those of this class are distributed others of a larger size, but much less numerous, somewhat in form of a small mushroom placed on a very short footstalk, and easily distinguishable to the eye by their redness and brilliancy.

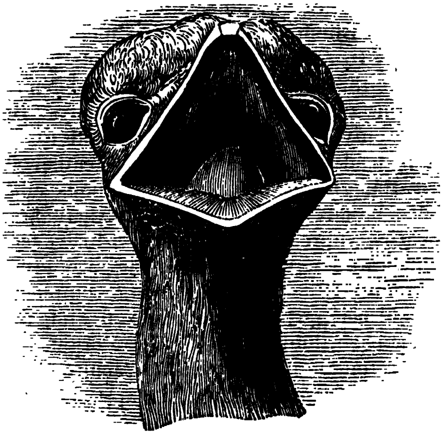
The greatest number of this sort are towards the tip and edges of the tongue, where the taste is most acute, and where they are less exposed to injury than they would have been on the surface or middle of the tongue. All of these are covered with a very thin scarf-skin—a light, delicate, gauzy membrane, red with blood-vessels.



An upright section of the nervous Papillæ; magnified 400 times.

These tasters are not, however, confined to the tongue, but may be seen in the inner skin of the lips and cheeks, as well as on the palate or roof of the mouth. It has farther been proved that these are useful in tasting, by the case of a boy whose tongue sloughed off in confluent small pox, and who retained the sense of taste, though not so vividly as before his calamity.

Now all birds possess a tongue, though in some species, such as the pelican (*Onocrotalus pelecanus*, ALDROVAND), it is so very small *, that its very existence has been denied by several good observers; among whom Willughby says, "I could not see any tongue; but where the root of the tongue was fixed, I observed certain perforate bodies:" and Ray adds, "neither could Faber, who saw this same bird afterwards at Rome, find the tongue, though he searched diligently for it †." The gulls (*Laridæ*, LEACH), and the cormorant (*Carbo cormoranus*, MEYER), have, according to M. De Blainville, an exceedingly small tongue, smooth, slippery (*lisse*), without horny texture and with no trace of papillæ ‡." These birds however feed chiefly, if not exclusively, on live fish, the species of which require little discrimination, as no species, we believe, comes amiss to them. The



Tongue and Head of the Ostrich (*Struthio Camelus*).

* Blumenbach, Comp. Anat. § 233; Cuvier, Règne Animal in voce.

† Ray's Willughby, Ornith. p. 327

‡ Anat. Comp. p. 261.

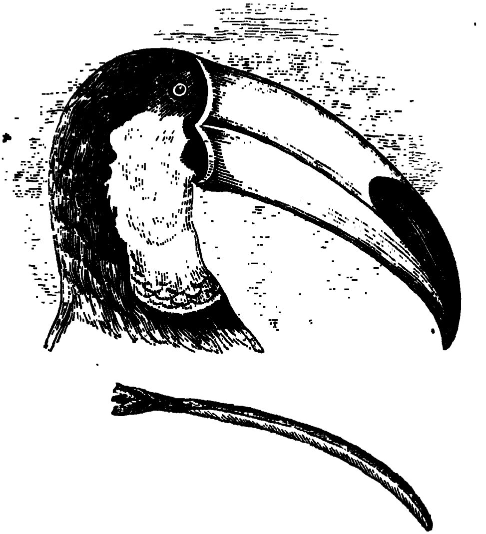
tongue in the ostrich (*Struthio Camelus*, ARISTOTLE), however, which is an omnivorous bird, is also small. Baron Cuvier describes it as "short and rounded like a crescent *," and Vallisnieri, the celebrated Italian naturalist, says it is "very short, similar to that of fishes, smooth, slippery (*lubrica*), and without any appearance of papillæ, which, according to Malpighi, are the chief organs of taste; and indeed it heedlessly swallows pieces of wood, stones, ropes, bits of cloth, iron, glass, and the like, not seeming to feel any taste, but foolishly gulping them down †."

We think, on the contrary, the *lubrica* of his own description would lead to the conclusion that the ostrich did possess taste, and that the shortness of the tongue corresponds with the short bill.

The toucan (*Ramphastos*) possesses the most singular tongue of any other bird, being sometimes, according to Blumenbach, "several inches in length, yet scarcely two lines broad at its root, having the appearance throughout of a piece of whalebone, with its margins fibrous ‡." "These," says Buffon, "are the only birds which may be said to have a feather instead of a tongue; and a feather it certainly is, though the shaft is a cartilaginous substance two lines broad; for on both sides there are very close barbs, entirely like those of ordinary feathers, and which are longer the nearer they are inserted to the extremity §." This not being supplied with nerves, and, being withal horny and stiff, quite unfits it, as Blumenbach thinks, from being an organ of taste; but if the tongue possess not this faculty, it is evidently a very useful organ, as appears from the account given by M. Pozzo of one of the red-bellied species (*Ramphastos picatus*), bred up by him, and

* Règne Animal, i. 495, ed. 1829.
† Notomia dello Struzzo, Esperienze, p. 180, 4to. Padova, 1726.
‡ Comp. Anat. §. 234. § Oiseaux, Art. Le Toucan.

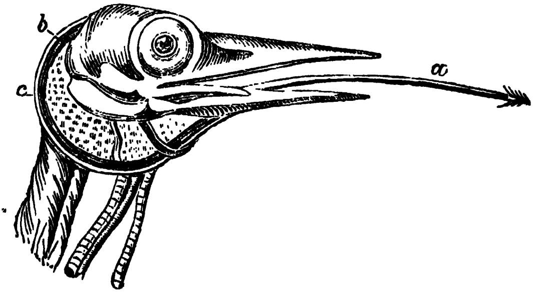
perfectly domesticated. "It fed upon the same things as parrots; but was most greedy of grapes. These being plucked off one by one, and thrown to it, it would with great dexterity catch in the air before they fell to the ground. Its bill," he adds, "was hollow, and on that account very light, so that the bird had but little strength in this apparently formidable weapon; nor could it peck or strike smartly with it. But its tongue seemed to assist the efforts of this unwieldy machine: it was long, thin, and flat, not much unlike one of the feathers on the neck of a dunghill-cock; this the bird moved up and down, and often extended five or six inches from the bill. It was of a flesh-colour, and remarkably fringed on each side with small filaments. It



Tongue and Head of the Toucan (*Ramphastos tucô*).

is probable, that this long tongue has greater strength than the thin hollow beak that contains it; and that the beak is only a kind of sheath for this peculiar instrument, used by the toucan in obtaining its provision *."

The tongue of the woodpecker is usually said to be extremely long; but this, according to Blumenbach, is not quite correct, the part which corresponds to the tongue in other birds being remarkably short, and merely a sharp-pointed horny portion, with its sides barbed. "Behind this," he adds, "there is a very singular hyoid bone, of a very slender aspect, with very long pillars (*crura*), consisting of five gristly portions composed of a single piece and two pairs. In the quiescent state of the organ, the former lies in a fleshy and very extensile sheath of the bill. The first pair of cartilages is articulated with this, and



Apparatus for protruding and withdrawing the Woodpecker's tongue.—*a*, The barbed tongue, protruded to its natural length.—*b*, One of a pair of riband-shaped muscles, which arise together from the base of the upper mandible, and, separating on the forehead, diverge, and pass backward, over and round the head, and returning forwards, beneath it, are inserted into the lower mandible.—*c*, One of a pair of stiff cartilaginous straps, which are enclosed in a sheath with the muscles, *b*, and accompanying them in their whole course, are inserted by a small bone into the root of the tongue.—From this structure it is evident, that when the muscles, *b*, contract, the cartilaginous straps being confined with them, and not being able to shorten their length, must push the tongue forwards, and when the muscles relax, draw it back again.

* Bingley, Anim. Biogr. ii. 234.

they are placed at the sides of the neck. The second pair, commencing from these, run completely over the skull, under the skin, and advancing, from behind, forwards, their converging extremities are placed together in a kind of groove, and commonly terminate anteriorly, by an attachment to the right side of the upper jaw. This posterior pair of cartilages may therefore be compared to steel springs, which actuate the whole organ. This is an elegant example of the great share which mere elasticity possesses in the performance of some functions of the animal economy. When the tongue is to be darted out, the anterior pieces are drawn together, and enter the sheath of the single portion extended for their reception. The tongue is thus lengthened, and admits of being thrust out some inches*."

The barbs at the tip, like the beard of an arrow, or the witter of a fish-hook, are not the least remarkable part of this curious organ, and unequivocally point out its use. "The bird," according to the excellent description of Paley, "having exposed the retreats of the insects by the assistance of its bill, with a motion inconceivably quick, launches out at them this long tongue; transfixes them upon the barbed needle at the end of it; and thus draws its prey within its mouth." "If this be not mechanism," he adds, "what is? Should it be said that, by continual endeavours to shoot out the tongue to the stretch, the woodpecker species may by degrees have lengthened the organ itself beyond that of other birds, what account can be given of its form, of its tip? How, in particular, did it get its barb, its dentation? These barbs, in my opinion, wherever they occur, are decisive proofs of mechanical contrivance†."

* Comp. Anat. § 237. See also Huber de Lingua Picis Stuttgard, 1821; Phil. Trans. xix. 509.

† Nat. Theol. p. 251.

Another ingenious contrivance connected with the woodpecker's tongue, appears to have been first described by Mr. Bowman, of Wrexham. "In the back part of the palate," he says, "is inserted a longitudinal groove, which tapers to a point outwards, and is fringed with stiff hairs pointing towards the throat. Without this provision it would be difficult to conceive how the bird could so easily and speedily detach its food from the barbs of the tongue, as it is known to do, particularly as the groove in the palate is placed much too backward for the tip of the former, in the natural position, ever to reach it; and even if it could draw it in so far, the peculiar direction of the hairs would prevent their action. We must therefore infer (though the motion is performed with such celerity that we can never expect to observe it), that the tongue is taken into the mouth in a reflected position, like that of the frog, and that the tip of it is drawn through the groove, the sharp hairs of which scrape off the insects from the barbs, while the deglutition is assisted by the tubercles on the surface of the tongue during the first part of the operation of drawing it into the mouth*."

During the summer of 1831 we had brought to us a young wryneck (*Yunx torquilla*), whose singular manner of feeding attracted our notice. Though it was so old as to be able to fly, it made no attempt to escape, and manifested no fear. We placed it in a cage in which was the empty nest of a white-throat (*Curruca cinerea*, Brisson), and threw in a quantity of ants with their pupæ that it might fare abundantly. Those who are not acquainted with this bird may be told that it has a very long tongue, which it has the power of pushing out far beyond the point of its bill, an organ similar to that of woodpeckers and

* Bewick's Birds, i. Intr. xxiv. note, ed. 1826.

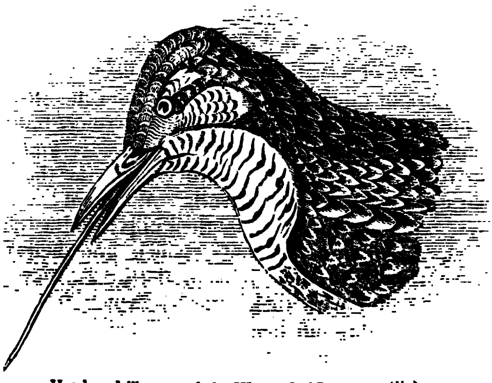
the quadrupeds called ant-eaters (*Myrmecophagæ*, LINN.). It is said of the latter that they station themselves near an ant-hill, extend their long tongue across a frequented track of the insects, who, crowding upon the tongue to examine what it may be, are *suddenly drawn along with it into the animal's mouth, and devoured. At other times it is said to plunge its tongue into an ant-hill, and drag up with it* incredible numbers of the inhabitants. The accuracy of these accounts we have no right to question: but it does not appear that the wryneck uses its extensile tongue in this way; at least, our young bird uniformly thrust its tongue between the grass stems of the white-throat's nest, to rout out the ants which had taken shelter there, and as soon as they were thus forced within its reach it pecked them up in the usual way with its beak. It is probable, therefore, that actual observation may discover all the ant-eaters to proceed in the same manner; and that woodpeckers which prey on insects feeding under the bark of trees, may only use their tongues to drive their prey within reach of their beaks, and not, as is usually believed, for catching it, by means of its glutinous covering*.

As these observations, however, differ widely from the views of other naturalists, we shall not presume to affirm that we are right and they wrong, but shall quote one or two facts on the other side, and leave our readers to verify or disprove them, as they may find most accordant with truth. White, of Selborne, says, "The wrynecks thrust their bills into the turf, in quest, I conclude, of ants, which are their food. While they hold their bills in the grass, they draw out their prey with their tongues, which are so long as to be coiled round their heads†." Colonel Montagu says, "We were enabled to examine the manners

* J. R.

† White's Selborne, ii. 246, ed. 1825.

of this bird minutely, by taking a female from her nest, and confining her in a cage for some days. A quantity of mould, with emmets and their eggs, were given it; and it was curious to observe the tongue darted forward and retracted with such velocity, and *with such unerring aim, that it never returned without an ant or an egg adhering to it; not transfixed by the horny point, as some have imagined, but* retained by a peculiar tenacious moisture, by nature provided for that purpose. While it is feeding the body is motionless, the head only is turned to every side, and the motion of the tongue is so rapid that an ant's egg, which is of a light colour, and more conspicuous than the tongue, has somewhat the appearance of moving towards the mouth by attraction, as a needle flies to a magnet. The bill is rarely used except to remove the mould, in order to get more readily at these insects: where the earth is hollow, the tongue is thrust into all the cavities to rouse the ants; for this purpose the horny appendage is extremely serviceable, as a guide to the tongue. We



Head and Tongue of the Wryneck (*Junx torquilla*).

have seen the popinjay (*Picus viridis*, RAY) take its food in a similar manner; and most probably every species of that genus does the same*."

Mr. Knapp thus describes the habits of the wryneck: "Shy and unusually timid," says he, "as if all its life were spent in the deepest retirement away from man, it remains through the day on some ditch-bank, or basks with seeming enjoyment, in any sunny hour, on the ant-hills nearest to its retreat; and these it depopulates for food by means of its long glutinous tongue, which, with the insects, collects much of the soil of the heaps, as we find a much larger portion of grit in its stomach than is usually met with in that of other birds†."

The rapidity and variety in the movements of the tongue in these birds will not, however, appear to be so very extraordinary to the person who may have attended minutely to those of his own tongue; for independently of the endless positions it assumes in speaking, it is no less varied in the processes of eating and drinking. Now there can be no motion without a mover; and in animals every mover is a muscle or fleshy riband, which is fixed into the thing to be moved for the purpose of pulling it in the direction required. In the numerous motions of the human tongue there are only three pairs of these fleshy ribands employed; and the threads or fibres of these are so interwoven near its tip, that the nicest art cannot trace them to their terminations, though it is probable every fibre has an action of its own. It is very remarkable, however, that none of the fibres cross the furrow which may be observed to divide the tongue into two equal portions. The muscles—four on each side—which thus compose the fleshy portion of the tongue, run backwards and are attached to a

* Ornith. Dict.

† Journ. of a Naturalist, p. 191, 3d ed.

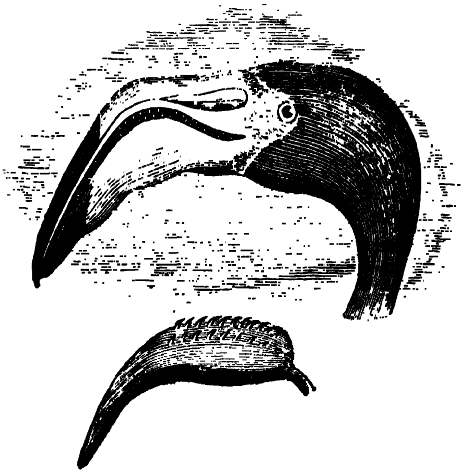
bone (*Os hyoides*) in shape of a horse-shoe, very moveable in consequence of its not being joined with any other bone, but hanging among the muscles employed in speaking and swallowing. The motions of the lingual fibres are facilitated by fat or oil beautifully spread over them and around them. They play indeed in a mesh-work of fat which is poured out on their surface by countless pipes, many of them too small for the most powerful microscope to discover. This mechanism, so carefully and minutely adapted to its end, affords a clear explanation of the rapid and various motions of the tongue; for though we admire and wonder at the contrivance, we are no longer astonished at these motions, when we examine this minute and beautiful mechanism of innumerable fibres washed by an oily fluid, constantly renewed every moment of our lives.

The bird which is perhaps the most celebrated for its tongue is the flamingo (*Phœnicopterus ruber*), so much so that if Belon be right * Aristotle named the bird from its tongue (γλοττις)†. This was esteemed by the luxurious Romans one of the greatest delicacies that could be brought to table; "Apicius," according to Pliny, "the most riotous glutton and belly-god of his time, being the first who taught men that the tongue of the phœnicopterus was a most sweet and delicate piece of meat ‡." Lampridius reckons among the extravagances of Heliogabalus, his ordering for his table dishes filled with flamingoes' tongues §. The Roman epicure, Vitellius, also bringing together the delicacies of all parts of the world, caused to be served up at his entertainments, at once, the livers of scari, the roes of murænæ, the brains of pheasants and peacocks, and the tongues of flamin-

* Oyseaux, p. 199, fol. Paris, 1555. † Hist. Anim. viii. 12.
‡ Holland's Plinie, 296. i.
§ Hist. August, Script. 8vo. Leyden, 1671.

goes *. Macrobius and other emperors are said to have been fond of these tongues, though Galen, as quoted by Belon, ridicules the matter †.

Whether it might be only on account of their rarity that such dishes were prized, we find the same opinion of the delicacy of the flamingo's tongue echoed by modern voyagers, such as Dutertre, Roberts, and Dampier, who describe the tongue as very large, with a lump of fat near the root furnishing a morsel fit for the king's table. Dampier might well ascertain the fact, as he and two others by secreting themselves killed fourteen of these birds at once ‡.



Head and tongue of the Flamingo (*Phænicopterus ruber*).

The French Academicians describe the tongue of the flamingo as edged with fleshy papillæ turned backward, the whole being large enough to fill the

* Suetonius. † Oyseaux, p. 199.
‡ Davies, Hist. Barb, p. 88.

cavity of the under mandible of the bill. M. De Blainville's description nearly accords with this, as he represents it to be "large, soft, and studded with very fine papillæ *."

The same author gives a minute description of the tongue in ducks (*Anatidæ*, LEACH), which he says possesses "a lingual membrane, large, expanded, and divided into two, by a deep longitudinal furrow. It is besides tolerably soft, but it differs in the several species in the disposition of the papillæ which cover it. In the common duck (*Anas Boschus*) the middle furrow is furnished with a single row of small corneous hooks, of which the posterior is much larger than the others, and unites with a small oval disk, more elevated than the rest of the tongue, having its edge finely divided. The edge of the tongue itself is provided with a sort of scales, largest in front, formed by rather coarse hairs, disposed like the teeth of a comb. The rest of the membrane of taste is covered with soft papillæ, very fine in front,—larger and more tuberculated backwards. Before the opening of the windpipe are several rows of long papillæ, somewhat horny, inclining backwards: the tip is rounded, thin, and finely papillated. In swans (*Cygni*) the tip and part of the posterior end of the tongue is, on the contrary, covered by stiff and close set hair; the middle and the rest of the posterior portion are armed with a sort of bony plates, disposed in longitudinal lines, one on each side of the middle furrow, and the other more on the outside and backwards. The long soft papillæ, in fine, are seen behind a large rough tubercle †."

In the parrots (*Psittacidæ*), again, the tongue is thick, fleshy, and the lingual membrane soft, and provided with papillæ, disposed lengthwise upon a sort of anterior disk, supported by a corneous semicircle,

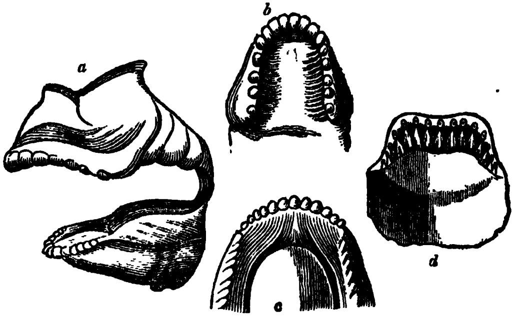
* Anat. Comparée, p. 260. * Ibid. p. 261.

which forms the under part of the tongue. The whole is covered by a very thin scarf-skin (*epidermis*), *with a black pigment beneath it, the whole structure being evidently well fitted for an organ of taste**. *We may remark in passing, that it is an erroneous* notion to suppose it is the thick tongue of parrots which enables them to speak; for starlings and magpies speak as well, and they have slender tongues †.

In considering the organs of taste, it would be wrong to overlook the teeth, though they appear to be chiefly affected by acids, and by things which are very cold or very hot. M. Majendie mentions the experiments of a French dentist, which appear to prove that the teeth imbibe liquids; but except in the case of acids, which act upon them by combining with the lime in the enamel or the bone, we do not see that the fact could be maintained. In another point of view, which we have not met with in authors, we may consider the teeth as exercising a function intermediate, if we may say so, between taste and touch, by ascertaining the hardness, softness, tenacity, elasticity and similar qualities of food, and we think it highly probable that it is in this way the little birds we have just mentioned ascertain the qualities of the berries which they fed upon or rejected ‡. The horny portion of a bird's bill, indeed, is a good deal similar in function to the teeth of other animals; and upon this similarity M. Geoffroy St. Hilaire has published some curious facts in support of what he denominates his 'Theory of Analogues.' Though he says it may be considered a piece of pleasantry to assert that fowls have teeth, yet he finds he can not only keep his ground upon the point, but discovers every day fresh confirmatory facts, though as high an authority as he—Blumenbach—says "the jaws of birds are wholly destitute of teeth§." He was led to the

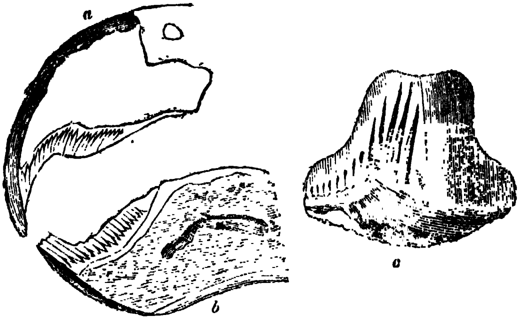
* Anat. Comparée, p. 259. † J. R. ‡ J. R.
§ Comp. Anat. §. 49.

investigation by examining the beaks of two chicks of the ring paroquet (*Psittacus torquatus*, ALDROVAND), *full grown, but which had not been able to break through the egg-shell. In these he observed a regular set of teeth of which he has published the figures.*



Teeth of the Ring Paroquet [chick] (*Psittacus tonguatus*).—*a*, The upper and lower mandibles, showing the teeth on their anterior margins.—*b*, *c*, The same, viewed from beneath, and from above.——*d*, Portion of the beak of the Blue Macaw (*Ara ararauna*), showing the teeth worn down by use.

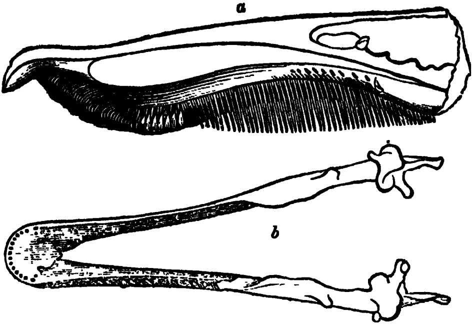
Upon finding teeth thus distinctly perceptible in the chick, the professor was naturally led to examine adult birds. Accordingly, on examining the beak of the blue macaw (*Ara ararauna*, LESSON), he found a similar arrangement of the horny substance of the beak to the dental organization in the chick of the paroquet, not indeed so rounded into distinct teeth, but little splinter-like pieces standing almost at right angles to the mandibles and closely compacted. In the instance of the paroquet chicks, he could trace nerves and blood-vessels running towards each toothlet; but in the adult macaw, the tube in which these had apparently lain in the embryo chick was filled with a cartilaginous substance. It will be interesting to compare his figures of the structure in the macaw with those we have already given of the chick paroquet.



Teeth of the Blue Macaw (*Ara ararauna*).—*a*, Upper mandible; *b*, Lower mandible: in section, to show the teeth; *c*, Portion of ditto, showing the teeth worn down by use.

According to M. Geoffroy St. Hilaire, then, the bill of a bird represents that sort of teeth which he terms composite, of which the teeth of the elephant furnish another example, and which consists of a series of plates or dentary cones, each covered with a pulpy plate or cone, and all re-united into one mass by enamel or a cortical envelope. The only difference of these consists in the nature of the substance oozing from the nucleus, and in the constant absence of sockets and fangs. These interior cones or plates are also distinguishable in the substance of the bills of ducks, and are terminated in a more distinct manner in little plates or denticulations, all around the edges of the bill. The latter differ from those of the paroquet in being permanent in adult birds. The divisions on the edges of the bill are much deeper and more numerous in the shoveller duck (*Rhynchaspis clypeata*, LEACH). These indeed very much resemble the whalebone, or *baleen*, as it has been called, of the whale*, and is intended, it would appear, for a similar purpose, namely, to

* Geoffroy St. Hilaire, Syst. Dentaire des Mamm. et des Oiseaux, 8vo. Paris, 1824.



a, The upper mandible of the Shoveller (*Rhynchaspis clypeata*), in section.—*b*, The lower jaw of the Common Duck.

assist in separating the peculiar food of the animal from what is extraneous, by a process analogous to filtration. It may be interesting to give some details of this singular organ in the whale. We must first premise that the principal food of the whale consists of small shrimps, crabs (*Cancer pedatus*, *C. oculatus*, *&c.*), medusæ, and the like, which it separates from the sea-water by means of the apparatus of whalebone plates, six or seven hundred in number, placed across the jaws, whose whole surface they cover. These are all joined firmly by their upper edge to the palate; for there are none attached to the lower jaw. Their broad ends are planted in the gum, and their narrow ends point to the upper part of the mouth. In a full-grown whale, the central blades are fifteen feet long; but they gradually diminish towards the anterior and posterior ends of the cavity. Their greatest breadth is at the gum, and is there ten or twelve inches; and they are placed at such a distance from each other, that a hand could be slipped in edgewise between every pair. "They resemble," Mr. Scoresby says, "a frame of saws in a saw-mill." The weight of these blades in a large whale amounts in all to a ton and a half; they form the framework, as it were, of *the filter; but something more is necessary to complete it before it would answer the intended purpose.* This, *however*, is accomplished in the most perfect manner by the free edges of the laminæ being split into innumerable bristles, which make the whole ceiling of the mouth look like one continued brush or cushion of hairs. This then is the admirable organ by whose means the vast bulk of the whale is nourished; and here is another example of the Divine Wisdom, combined with unlimited power, in which the works of creation everywhere abound. Mr. Scoresby observes that "when the whale feeds, it swims with considerable velocity below the surface of the sea, with its jaws widely extended. A stream of water consequently enters its capacious mouth, and along with it large quantities of water-insects; the water escapes again at the sides, but the food is entangled and sifted, as it were, by the whalebone, which, from its compact arrangement and the thick internal covering of hair, does not allow a particle the size of the smallest grain to escape*."

The whale, however, does not proceed in the same manner as the shoveller, inasmuch as it does not suck in, but takes a mouthful of the water containing its prey, and as its mouth, according to Mr. Scoresby's description, "presents a cavity as large as a room, and capable of containing a merchant-ship's jolly-boat full of men, being six or eight feet wide, ten or twelve feet high (in front), and fifteen or sixteen feet long†," it can consequently gulp up an enormous quantity of water.

The duck, again, employs suction to filter the mud, examining, with great care, the puddle, the brake, and every mixture likely to contain eligible food. The operation is excellently described by Paley. "The

* Account of the Arctic Regions, vol. i. p. 469.

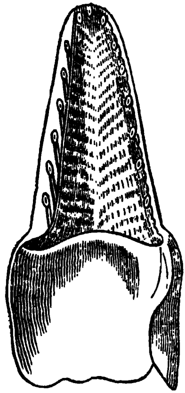
† Ibid. p. 455.

liquid," he says, "or semi-liquid substances, in which *the animal has plunged her bill, she draws, by the action of her lungs, through the narrow interstices which lie between these teeth; catching*, as the stream passes across her beak, whatever it may happen to bring along with it that proves agreeable to her choice, and easily dismissing all the rest. Now, suppose the purpose to have been, out of a mass of confused and heterogeneous substances, to separate for the use of the animal, or rather to enable the animal to separate for its own, those few particles which suited its taste and digestion; what more artificial, or more commodious, instrument of selection could have been given to it than this natural filter? It has been observed also (what must enable the bird to choose and distinguish with greater acuteness, as well probably as what greatly increases its luxury) that the bills of this species are furnished with large nerves,—that they are covered with a skin,—and that the nerves run down to the very extremity*."

M. Geoffroy St. Hilaire, pursuing his Theory of Analogues, of which we have already given a characteristic specimen, proceeds to compare the filtering apparatus in the mouths of the whale and the shoveller (*Rhynchaspis clypeata*, Leach) with the palates of other animals which he finds to be lined with similar wrinkles, the difference of one species from another consisting in little more than the greater or less degree of thickness in the cartilaginous plate, forming the tranchant wrinkles. In the macaw this forms a single mass, only marked with a few streaks†.

The various forms, indeed, which we meet among the bills of birds, are wonderfully adapted to their wants. Instead, as Paley remarks, of the fleshy lips and teeth of enamelled bone, there is "to perform the

* Nat. Theology, p. 225. † Système Dentaire, p. 15.



Palate of the Blue Macaw.

office of both, a hard substance (of the same nature with that which composes the nails, claws, and hoofs of quadrupeds) cut out into proper shapes and mechanically suited to the actions which are wanted. The sharp edge and tempered point of the sparrow's bill picks almost every kind of seed from its concealment in the plant; and not only so, but hulls the grain, breaks and shatters the coats of the seed, in order to get at the kernel. The hooked beak of the hawk tribe separates the flesh from the bones of the animals which it feeds upon, almost with the cleanness and precision of a dissector's knife. The butcher-bird transfixes its prey upon the spike of a thorn whilst it picks its bones. In some birds of this class we have the cross-bill, i. e. both the upper and lower bill hooked, and their tips crossing. The spoon-bill enables the goose to graze, to collect its food from the bottom of pools, or to seek it amidst the soft and liquid substances with which it is mixed. The long tapering bill of the snipe and woodcock penetrates still deeper into moist earth, which is the bed in which the food of that species is lodged. This is exactly the instrument which the animal wanted. It did not want strength in its bill, which was inconsistent with the slender form of the animal's neck, as well as unnecessary for the kind of aliment upon which it subsists; but it wanted length to reach its object*." In the curlew (*Numenius arquata*, LATHAM), besides, in the woodcock, and the snipe, there are, as in ducks, three large pairs of nerves almost equal to the optic nerve in thickness, which pass along the palate and then along the upper mandible to the very point of the bill.

"If we look," says Sir Charles Bell, "to the mandible of a bird, we shall find that it is withal a fly-trap—hence, its motions must be rapid; and the velocity is increased by the most obvious means imaginable, that is, by giving motion to both mandibles, instead of to one. When a dog snaps, he throws back his head, and thereby raises the upper jaw, at the same time that the lower jaw is dropped; but these are slow and clumsy motions, pertaining to the muscles of the neck as well as of the jaws; and the poor hound makes many attempts before he catches the fly that teazes him. But a swallow or fly-catcher makes no second effort, so admirably suited is the apparatus of prehension to the liveliness of the eye and the instinct. The adaptation of the instrument consists in this, that the muscles which open the lower mandible, by the same effort, open the upper one. A process of the lower mandible, projecting much behind the centre of motion, and the muscle which is attached to it, opens the bill; but, at the same time, the lower mandible presses upon the bone, the os quadratum. Now, there is attached to this bone, projecting forwards, with its anterior extremity fixed

* Nat. Theology, p. 223.

against the upper mandible, a shaft or process of bone, and this receives the pressure of the os quadratum when the muscle acts; so that, being thrust forwards like a bolt, it opens the upper mandible, which moves upon the skull. Here, then, is a piece of mechanism as distinct as the lock of a gun, which is for the purpose, as we have said, of giving rapidity to the motions of the bill. Is it nearer the truth to consider this as a new apparatus, suiting the necessities of the creature, or an accidental result of the introduction of a bone, which, in its proper office, has nothing to do with the jaw*?"

The most singular form of the bill in birds of this group (*Grallatores*, ILLIGER) is that of the avoset (*Recurvirostra avocetta*, GESNER), which is flexible like whalebone, and, contrary to the usual direction of the bills of birds, is curved upwards, which led Buffon, in his usual style of theorizing, to suppose it to be "incapable of defence and of effort,—an example of one of those errors or essays of nature, which, if carried a little farther, would destroy itself; for if the curvature of the bill were a degree increased, the bird could not procure any sort of food, and the organ destined for the support of life would infallibly occasion its destruction. The bill of the avoset may therefore be regarded as the extreme model which nature could trace, or at least preserve, and for that reason it is the most distant from the forms exhibited in other birds. It is even difficult, he adds, to conceive how this bird feeds by help of an instrument that can neither peck nor seize its prey, being only fit to rake in the softest mud. It seems to employ itself in searching the froth of the waves for fish-spawn, which appears to be its chief support †."

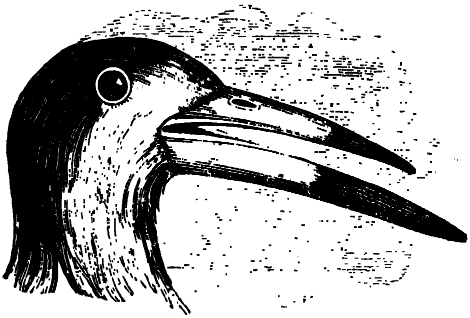
* Bridgewater Treatise on the Hand, p. 141.
† Oiseaux, Art. L'Avocette.

Nothing could have been farther from fact than these hypothetical statements. Dr. Buchanan informs us that two avosets, which were wounded on an island in the Hoogly, near Calcutta, lived for some time afterwards, being fed with small fish, and these they readily scooped up from a pan of water*; while Wilson says of the American avoset (*Recurvirostra Americana*, PENNANT), that "it almost constantly frequents the shallow pools in the salt marshes; wading about, often to the belly, in search of marine worms, snails, and various insects that abound among the soft muddy bottoms of the pools†."

In the same mistaken spirit, Buffon libels the contrivance of the bill in the skimmer or cutwater (*Rhynchops nigra*), which is well described by Ray as consisting of two pieces extremely unequal, the lower mandible, being long and extended disproportionately, and projecting far beyond the upper into which it falls like a razor into its haft‡. From this Buffon concludes that "it can neither eat sidewise nor gather food, nor peck forwards." But though he here asserts in so many words that it cannot "gather food," he adds, that "to catch its prey with this awkward and defective instrument, the bird is obliged to fly skimming the surface, with its lower mandible cutting the water." He further quotes M. De la Borde, who says these birds "feed on small fish which they catch on the wing where the water is shallow, keeping their lower mandible almost always in the water, and when they feel a fish they close both mandibles §," and of course secure the prey. So far, then, from the bill of the shearwater being "an awkward and defective instrument," it appears, even from Buffon's own showing, to be as admirably adapted to

* Montagu, Ornith. Dict. p. 14, 2d ed.
† Amer. Orn. vii. 133. ‡ P. 104-5.
§ Oiseaux, Art. Le Bec-en-Ciseaux.

the bird's mode of life as the bill of the avoset already described.



Head of the Shearwater (*Rhyncops nigra*).

Another genus of birds whose bill is defective, according to Buffon, may be found in the creepers (*Certhia*), which, though "living upon the same insects as the woodpeckers, the nuthatches, and the tits, cannot, from the defect of the bill, extract the insects lodged under the bark, and which therefore follow those birds, making them their providers and dexterously snatching the little prey *." On the contrary, whoever looks at the bill of our common creeper (*Certhia familiaris*) must at once perceive that its form is admirably adapted for searching for insects in the crevices of trees, being in fact curved in the same way as the beetle forceps used by insect collectors on the Continent for the same purpose †. It is more so indeed than the bill of the tits, which however is employed in a different way, being strong enough to enable the bird to chisel out a hole in bark or soft wood, though the creeper is no doubt equally suc-

* Oiseaux, Art. Les Grimpereaux.
† See Insect Miscell. p. 373, fig. *a*.

The Creeper (*Certhia familiaris*), male and female, and nest.

cessful in finding insects with its curved bill, as the tit that has to dig before they can be reached. It is moreover paying a bad compliment, unauthorized by facts, to the quickness of the carpenter-birds, to suppose they catch so few of the insects which they have been at the trouble to dislodge, as to leave enough for the creepers to subsist upon. The tits are besides so very voracious as to be unlikely to leave the least particle of any thing eatable behind them. A pair of the oxeye (*Parus major*, RAY), provincially named the willow-biter, or Joe Bent, "will," says Mr. Knapp, "attach themselves to a crop of peas in our gardens, and unremittingly persevere in the business of consuming them, from morning until night, without any abatement of appetite or lassitude from employ *." We have at present (1832) one of those birds which will, in the course of one day, devour more than half his own weight (ten drams) of hemp-seed, German paste, biscuit, or any other food whatever; his incessant exercise in climbing about the cage, tumbling and throwing somersets, in every possible variety of attitude, enabling him no doubt to digest quantities comparatively so enormous †.

* Journ. of a Naturalist, p. 207, 3d edit. † J. R.

Chapter V.

TASTE OF GRANIVOROUS BIRDS.

When horses or rabbits are fed with oats, though their teeth can readily crush the grain, yet they accidentally swallow many grains uncrushed, which they cannot in consequence digest, their stomachs not being endowed with the power of acting on the solid grain. In order, indeed, as it should seem, to ensure the continuance of species, Providence has furnished the seeds of vegetables with a power of resisting destruction greatly superior to that of the plants produced from them, and hence it is probable the great difficulty of digesting unbroken seeds, as well as of destroying their vegetative life by great degrees of cold or heat*.

But the circumstance of a horse or a rabbit swallowing uncrushed grain is only accidental, the greater portion of what they swallow being fitted for digestion; whereas in fowls which feed on grain it is all swallowed whole, their bills not being adapted for bruising it. Upon comparing these fowls, therefore, with the horse and the rabbit, it becomes an obvious inquiry in what manner the unbruised grain is digested,—an inquiry which was started in very early times, but not satisfactorily decided till Spallanzani and other modern physiologists instituted a series of experiments upon the subject.

The most absurd fables indeed were current respecting the stones found in the stomachs of fowls, and the illustrious Redi was persuaded by his friend Morera to apply one of them he had brought from India to his forehead as a certain cure for a violent megrim (*hemicrania*) to which he was subject. The experiment, as might have been anticipated,

* See Insect Transformations, p. 95-9.

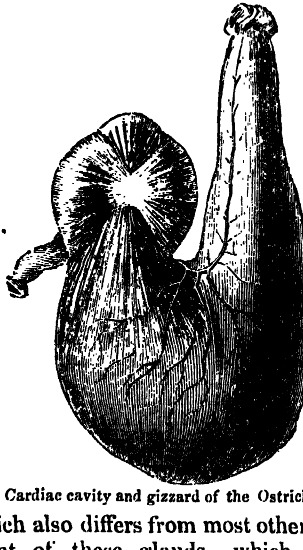
failed, to the great astonishment of Morera, who could only solve the difficulty by supposing Redi's headach to be different from those of Asia; for, said he, "unless these stones be endowed with miraculous virtues, Nature, who makes nothing in vain, nor without a particular end, would not have produced them in the stomachs of fowls." So also thought Redi; but not being able to see any connection between their production and the cure of headachs, though Morera fortified his opinion by the authority of Pliny, Galen*, and Solinus, he set himself to discover some more rational explanation of the circumstance, and went through a number of ingenious experiments with this view†. These we shall not however stop to detail, for though his conclusions were perhaps near the truth, those of subsequent observers are more adapted to our present purpose. It will be useful before detailing these experiments, to give some description of the organs of digestion in birds.

The crop or craw (*ingluvies*) is a large membranous cavity, analogous, as many think, to the first stomach in ruminating animals, placed at the lower end of the gullet, in front of the chest, the gullet opening into its upper part, and recommencing about the middle of the bag, so that the crop is in some measure out of the course of the regular communication between the two openings of the gullet. It receives the food when first swallowed, and by softening it by means of certain secretions, fits it for transmission into the organ called the gizzard. In birds which have no distinct crop, the lower part of the gullet expands into the form of a reservoir.

To the crop succeeds another cavity in shape of a funnel (*infundibulum*), which may not improperly be called the second stomach, smaller than the crop, but varying considerably in different species. It is larger

* De Incantatione. † Degli Anim. Viventi.

and much thicker than other parts of the tube, and is very distinctly marked in poultry, &c. (*Rasores*, ILLIGER). This cavity is furnished with an immense number of glands, called *solvent* or *gastric* glands, of a cylindrical form and placed close to each other. All of these glands are hollow, and secrete a digestive fluid, which is discharged from each through a small opening into the cavity. In the ostrich these glands are as large as garden peas, and their openings are easily recognised ; the cavity itself is moreover in this bird much larger than the proper stomach, so much so as to induce the celebrated Italian naturalist Valisnieri to term it the first stomach (*primo ventricolo*) *.



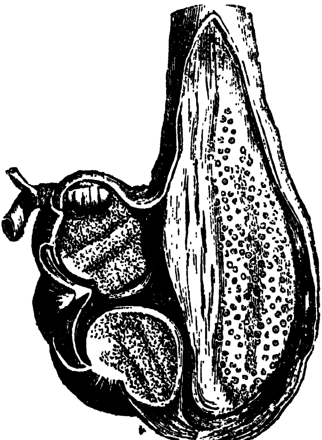
Cardiac cavity and gizzard of the Ostrich.

The ostrich also differs from most other birds in the arrangement of these glands, which, instead of forming a belt or zone around the cavity, are placed lengthwise in a long narrow stripe, commencing at

* Notomia della Struzzo, p. 159, 4to. Pavia, 1726.

the termination of the gullet, and running along the front towards the gizzard. This band measures about twelve inches in length, and is about three inches at its greatest breadth. It is remarkable that this organ with its glands is largest in such birds as feed upon substances hardest of digestion. In some other birds it is, as we shall afterwards see, very small, and in others (*Alcedo*) wanting altogether*.

The gizzard (*ventriculus callosus*) is a cavity of moderate size and of a flat spherical form, composed, according to Grew†, of six, and according to others of four, distinct muscles; but the discrepancy is explained by considering two of the six as conductors of the food, rather than as forming a portion of the organ, the greater part of which is composed of only two muscles, of a peculiarly dense and firm texture, hemispherical in shape, and lined with a thick membrane of



Cardiac cavity and gizzard of the Ostrich, opened to show its internal structure.

* Blumenbach, Comp. Anat. § 97.

† Comp. Anat. of the Stomach, p. 34.

the nature of gristle. This lining resembles the scarf-skin of the human body in becoming gradually thicker by pressure and rubbing. Towards the cavity of the stomach it forms folds and depressions, which on the opposite surfaces are adapted to each other. The cavity of the gizzard is comparatively small and narrow, and its outlet is very near its entrance*.

In many birds the outlet of the gizzard has no valve or other mechanism to prevent a portion of the contents from escaping before being duly digested, and consequently a waste of the food swallowed ensues, particularly when the bird has a very liberal supply. Sir Everard Home is disposed to consider these circumstances as intended by Providence to aid in the dissemination of plants; and Sir Joseph Banks remarked to him that "the seeds which pass through the gizzards of birds, without having been acted on by the organs of digestion, are not only fit for vegetation, but have the period of their vegetating much accelerated. The haws or berries of white-thorn require being buried in the earth for a year before they are fit to be sown; but if turkeys are fed with them in autumn, and the dung is sown, the plants begin to vegetate in the following spring. So ready are the seeds that have passed through the intestines of a bird to grow, that it is sufficient for them to be enveloped in the dung of the bird without being covered with earth.

"At a country-house of Sir Joseph Banks, when the family are from home, the blackbirds are in the habit of perching on the iron rails of a stone staircase leading up to the house, and a currant-tree, a way-faring-tree, and a yew-tree, grew up from the place where they dropped their dung, and were evidently disseminated by them. The various plants found in our hedges, as the dog-rose, the briars, the bramble, the common and water-elder, and a great variety of other

* Blumenbach, Comp. Anat. § 100.

plants, have the same origin, particularly cherry-trees*." With all deference, however, to our author, we have no doubt that the plum, cherry, and gooseberry trees, which we so frequently meet with in hedges and by road-sides, as frequently originate from fruit accidentally dropped by passengers as from birds in the manner suggested. One instance, however, of the dissemination of seeds by birds has long attracted attention in the singular parasitic shrub called the misseltoe (*Viscum album*). The berries of this shrub are eaten early in spring by the missel-thrush (*Turdus viscivorus*) and other birds, and the seeds passing undigested, adhere to the branches of trees, where they vegetate. This method of propagation is indeed denied by some authors from the circumstance of the roots being always inserted on the underside of the branches; but they surely forget that the rains must soon wash the seeds down from the upper part of the branch where they are first deposited. It was not till after many experiments were tried, that the misseltoe could be propagated artificially, and success, if we mistake not, was first obtained in the garden of Mr. Collins of Knaresborough, where many thriving plants were produced on the dwarf apple-tree, by rubbing the berries when ripe upon the smooth bark, so as to cause the seeds to adhere closely†. Mr. Loudon directs the berries to be inserted into slits in the bark of a tree early in spring, and a bit of matting to be tied over them to protect them from birds‡.

To return to the structure of the gizzard; it is obvious that every part of it is calculated for producing very powerful trituration, and apparently to compensate for the absence of grinding teeth in the animals. It results from the hard gristly structure of the gizzard in granivorous birds that it is possessed of small sensibility, and hence, as Sir Everard

* Comp. Anat. i. 287. † Hunter's Evelyn.

‡ Encycl. of Plants, No. 2054.

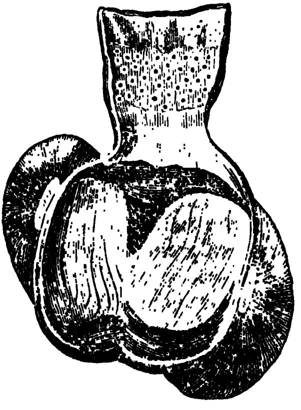
Home remarks, these birds never refuse food even when dying, and when none of the functions of digestion are going on; a circumstance which gives the by-standers hopes of recovery, for the bird will go on feeding till it drop down dead. If examined after death the gizzard is generally quite full; whereas other animals would not eat any thing in such a case, though they might perhaps drink, water being amongst the last things which the dying desire and rarely ever loathe.

In order to ascertain the peculiar powers of the gizzard in grinding and in digesting, Spallanzani, repeating and extending the experiments of Réaumur, procured small glass and metal balls and tubes, perforated with numerous holes, and filling them with different kinds of food, he caused them to be swallowed by barn-door fowls, turkeys, and other birds. The balls having been filled with barley and other grain, in their entire unbruised state, he allowed them to remain from twenty-four to forty-eight hours in the gizzard, when they were taken out and examined. In all such cases, he could not, after the most attentive examination, discover that the digestive fluid had effected the least change on the grains, though from the numerous holes in the balls they were fully exposed to its action. The grains indeed had suffered no diminution of size and exhibited no marks of dissolution. Similar experiments were repeatedly tried upon birds furnished with strong muscular gizzards, and the result was uniformly the same,—no effect, in any instance, being produced by the digestive fluid upon the grain contained in the balls.

From these experiments proving unsuccessful, Spallanzani was led to suspect that, though the digestive fluid was incapable of dissolving the grains in their entire state, it might probably act upon them when sufficiently bruised or comminuted. To ascertain this point, accordingly, he filled his balls with bruised grains, introducing them as before into the gizzards of various fowls; and his conjecture was partly verified, for in all the numerous trials which he made he invariably found that the grains were more or less dissolved in proportion to the time the balls were permitted to remain in the gizzard.

Before the process of digestion can commence, therefore, the grains must be bruised, and such as are not bruised before passing into the gizzard are there subject to the action of the two gristly surfaces already described, which in granivorous birds seem to produce a rotatory motion upon the food in consequence of one side of the cavity not corresponding exactly to the other, a conformation that has been well explained by Sir Everard Home.

"In the turkey," he says, "when the external surface of the gizzard is first attentively examined, viewing that side which is anterior in the living bird, and on which the two bellies of the muscle and middle are more distinct, there being no other part to



The gizzard of a Turkey, opened to show its grinding surfaces.

obstruct the view, the belly of the muscle on the left side is seen to be larger than on the right, as may be observed in the annexed engraving.

"This appears on reflection to be of great advantage in producing the necessary motion; for if the two muscles were of equal strength they must keep up a greater degree of exertion than is necessary; while, in the present case, the principal effect is produced by that of the left side, and a smaller force is used by that of the right to bring the parts back again.

"The two bellies of the muscle by their alternate action produce two effects; the one, a constant friction on the contents of the cavity; the other, a pressure on them. This last arises from the swelling of the muscle inwards; which readily explains all the instances which have been given by Spallanzani and others, of the force of the gizzard upon substances introduced into it, a force which is found by their experiments always to act in an oblique direction. The internal cavity, when opened in this distended state, is found to be of an oval form, the long diameter being in the line of the body: its capacity nearly equal to the size of the pullet's egg; and on the sides there are ridges in the horny coat, in the long direction of the oval.

"When the horny coat is examined in its internal structure, the fibres of which it is formed are not found in a direction perpendicular to the ligamentous substance behind it; but in the upper portion of the cavity they have a direction obliquely upwards.

"From this form of cavity it is evident that no part of the sides are ever intended to be brought in contact; and that the food is triturated by being mixed with hard bodies and acted on by the powerful muscles which form the gizzard*."

Grew had long before most correctly investigated the action of the gizzard, so far as it is mechanical,

* Comp. Anat. i. 316.

and aptly describes it as an organ "wherein the meat, as in a mill, is ground to pieces, and then pressed by degrees into the guts in the form of a pulp; for which purpose the deductor serves to deliver the meat from the echinus to the laboratory, as a hopper to a mill; the four grinders, or chief operators, are the millstones*."

Agreeably to these views, it has been recorded that Felix Plater found an onyx, a precious stone of peculiar hardness, which had been swallowed by a hen, diminished no less than one-fourth of its bulk in four days; and a French gold piece of money lost in the same way sixteen grains of its weight†. Réaumur and Spallanzani, again, found that when tin tubes full of grain were introduced into the stomachs of turkeys, and allowed to continue there a considerable time, they were broken, crushed, or distorted in a most singular manner. "I have seen," says Spallanzani, "instances without number of such contusions, one of which I cannot forbear here relating. Having found that the tin tubes which I used for common fowls were incapable of resisting the stomach of turkeys, and not happening at that time to be provided with any tin plate of greater thickness, I tried to strengthen them by soldering to the ends two circular plates of the same metal, perforated only with a few holes for the admission of the gastric fluid. But this contrivance was ineffectual; for after the tubes had been twenty hours in the stomach of a turkey, the circular plates were driven in, and some of the tubes were broken, some compressed, and some distorted in the most irregular manner.

"I then tried the following means of preventing this inconvenience. Having perforated the circular plates in the centres, I passed a wire through the

* Comp. Anat. of the Stomach, ix. 40-1.
† Swammerdam, Biblia Naturæ, p. 168.

holes, and bound it tight round outside of the tubes; when the two ends met, they were twisted together; consequently, though the soldering should be destroyed, yet this contrivance would prevent the circular plates from receding from the ends of the tube, unless the wire passing through them should be broken. I prepared four tubes in this manner, and gave them to a turkey six months old. After they had remained a whole day in the stomach, I killed the animal; and my astonishment was extreme at finding that the tubes, in spite of my expedient, were very much damaged. All the iron wires were broken, two where they were twisted, and the two others at their entrance into the tubes: the plates, so far from remaining soldered to the tubes, were found amongst the food; they were not flat as at first, but some were bent so as to form an angle, some curved, and in others one part was pressed close to the other. The tubes had sustained equal injury; two of them were flattened as if they had been struck by a hammer, the third was moulded into the shape of a gutter, the soldering of the fourth was destroyed, and it was expanded like a wafer.

"These phenomena will less surprise those who have learned from Redi * and Magalotti † how ducks, fowls, and pigeons pulverize hollow globules of glass in a very short space, and even solid ones in a few weeks. I have already observed, that I repeated these experiments with the greatest success. Some spherules of glass blown by the lamp, and so thick that they would seldom break when thrown on the ground, were generally reduced to small fragments, after remaining three hours in the stomachs of hens or capons; the fragments were not sharp as when they are broken by the efforts of the hand, but

* Esperienze intorno a Cose naturali.

† Saggio di naturali Esperienzi.

as obtuse as if their edges and points had been abraded by a grinding-stone. The longer the spherules continued in the stomach, the more minutely were they triturated; so that in a few hours they were reduced to a mass of particles, not larger than grains of sand. The rapidity also of this process appears in some measure proportional to the size of the animal. A wood-pigeon generally breaks them less speedily than a chicken, a chicken than a capon, but a goose the soonest of all. The reason is plain, since the larger species have thicker and more powerful stomachs*."

It appeared from these experiments that smooth and blunt substances, though thus violently acted upon, did not injure the texture of the stomach. Spallanzani hence bethought him of trying what effects would be produced by sharp and angular substances, and upon introducing into the gizzard of a cock a piece of rough jagged glass, he found that in the space of twenty-four hours, the angles were all broken off, without having wounded or even scratched any part of the stomach. When we take this into account, therefore, we ought not to consider the subsequent experiments of the Abbé so very cruel and revolting as at first sight they must appear. For the purpose, accordingly, of discovering the extent of this singular power of the gizzard to break sharp points without sustaining injury, "twelve strong tin needles," says Spallanzani, "were firmly fixed in a ball of lead, the points projecting about a quarter of an inch from the surface. Thus armed, it was covered with a case of paper and forced down the throat of a turkey. The bird retained it for a day and a half without showing the least symptoms of uneasiness. Why the stomach should have received no injury from so horrid an instrument I cannot explain:

* Dissertations, i. 14.

the points of the twelve needles were broken off close to the surface of the ball, except two or three of which the stumps projected a little higher. Two of the points of the needles were found among the food; the other ten I could not discover, either in the stomach or the long track of the intestines; and therefore concluded that they had passed out *."

In another experiment, which without knowing the previous facts we might justly have deemed still more cruel, Spallanzani tells us he fixed "twelve small lancets, very sharp both at the point and edges, in a similar ball of lead. They were such as I use for the dissection of small animals. The ball was given to a turkey-cock, and left eighteen hours in the stomach; at the expiration of which time that organ was opened, but nothing appeared except the naked ball, the twelve lancets having been broken to pieces: I discovered three in the large intestines, pointless and mixed with the other contents; the other nine were missing and had probably been voided. The stomach was as sound and entire as that which had received the needles.

"Two capons, of which one was subjected to the experiment with the needles, and the other with the lancets, sustained them equally well. My next wish was to know how much time elapsed before the beginning of the fractures; and by repeated experiments on turkeys, I found that these sharp bodies begin to be broken and lose their shape in two hours. This at least happened in two individuals of the species: in one four of the lancets, and in the other three of the needles were broken within that space; the others were blunted, but continued fixed in the balls †."

An acquaintance with these singular experiments is calculated in part to diminish our surprise at finding stones in the gizzards of fowls, a fact which,

* Dissertations, i. 18. † Ibid. i. 19.

as we have already mentioned, has been very differently explained by naturalists. These stones were considered by the Italian naturalist Cæsalpinus, rather as medicinal, than as a common auxiliary to digestion; while Boerhaave supposed them to act as absorbents for any superabundant acid in the stomach; and Whytt of Edinburgh supposed the irritation, which he inferred them to produce, useful as a stimulant to the obtuse, almost insensible, coats of the gizzard *. Borelli again formed the very extravagant idea that the stones in question contributed directly to nutrition, an opinion which is refuted by the experiments of Redi, who, having shut up two capons with nothing but water and little pebbles for food, found that they drank much water, but died, one in twenty, the other in twenty-four days, neither of them having swallowed a single stone †.

An opinion little less fanciful adopted by Blumenbach ascribes to the stones the especial purpose of killing the grains of corn, which, while capable of germinating, would resist the action of the digestive fluid ‡. This requires no refutation; but it has been supposed to be partially corroborated from the similar circumstance of pebbles being swallowed by the pangolin (*Manis pentadactyla*); for as the food of this animal consists of insects swallowed entire, the pebbles have been thought necessary for the purpose of crushing the insects and depriving them of life, so as to render them capable of being digested §.

Others have supposed these pebbles intended to sheath the gizzard in order to enable it to digest, or at least to break down into small fragments, the hard

* Phys. Essays, 8vo. Edinb. 1766.
† Esperienze, p. 84; Osserv. p. 91-2.
‡ Comp. Anat. § 100.
§ Bostock, Physiol. iii. 408, note.

angular substances which may be swallowed*; but Spallanzani has shown by his experiments that the muscular action of the gizzard is equally powerful, whether the small stones are present or absent. To ascertain this point, he took wood-pigeons the moment they escaped from the egg, and fed and nursed them himself till they were able to peck. "They were then," he continues, "confined in a cage and supplied at first with vetches soaked in warm water, and afterwards in a dry and hard state. In a month after they had begun to peck, hard bodies, such as tin tubes, glass globules, and fragments of broken glass, were introduced with the food. Care was taken that each pigeon should swallow only one of these substances. In two days afterwards they were killed. Not one of the stomachs contained a single pebble; and yet the tubes were bruised and flattened, and the spherules and bits of glass blunted and broken. This happened alike to each body, nor did the smallest laceration appear on the coats of the stomach.

"I did not confine my observations to this one species. With the same view, I set under a turkey-hen several eggs, partly her own, and partly of a common hen. When the chickens were hatched I took charge of them myself, and employed the same precautions as with the wood-pigeons. They were confined for fifty-five days in separate cages, and their food consisted of various sorts of grain. The last days they had to live I introduced into their gizzards hard indigestible substances. Upon examination the stomachs appeared to be free from stones, yet the fragments and spherules of glass, and the tin tubes, were not on this account either the less or the more bruised or broken. Hence then," he adds, "we have at length a decision of the famous question

* See Smellie, Philosophy of Natural History, vol. i. ch. 8.

concerning the use of these pebbles, so long agitated by authors. It appears that they are not at all necessary to the trituration of the firmest food, or the hardest foreign substances, contrary to the opinion of many anatomists and physiologists, as well ancient as modern; I will not however deny, that when put in motion by the gastric muscles, they are capable of producing some effects on the contents of the stomach*." Blumenbach, however, denies both these facts and Spallanzani's conclusion, of the stones being swallowed without design, from mere stupidity; and asserts that "these stones are so essential to due digestion that birds grow lean without them, although they may be most copiously supplied with food†;" a fact attested also by Dr. Bostock‡.

Without deciding this contested point, we shall add the remarks of our distinguished physiologist, John Hunter, upon the opinion of Spallanzani. "In considering," says he, "the strength of the gizzard, and its probable effects when compared with the human stomach, it must appear that the gizzard is in itself very fit for trituration. We are not, however, to conclude that stones are entirely useless; for if we compare the strength of the muscles of the jaws of animals who masticate their food, with those of birds who do not, we shall say that the parts are well calculated for the purpose of mastication; yet we are not from thence to infer that the teeth in such jaws are useless, even although we have proof that the gums do the business when the teeth are gone. If stones are of use, which we may reasonably conclude they are, birds have an advantage over animals having teeth, so far as stones are always to be found, while the teeth are not renewed. If we constantly find in

* Dissertations, i. 26. † Comp. Anat. § 100.
‡ Physiology, iii. 458, note.

an organ substances which can only be subservient to the functions of that organ, should we deny them that use, although the part can do its office without them? The stones assist in grinding down the grain, and by separating its parts allow the gastric juice to come more readily in contact with it*."

"Very few of the soft-billed birds," says the Hon. and Rev. W. Herbert, "eat gravel: the nightingale never, nor does the redstart. The whinchat in confinement will sometimes swallow stones as large as swan-shot, which pass through very soon; but he seems to eat them like a fool, taking them for victuals, in the same manner as I have seen tame redstarts, which do not naturally choose vegetable food, swallow green peas, after passing several minutes in trying to kill them. But these birds have the power of expectorating the shells and hard parts of insects which they cannot digest, throwing them off in little oval balls. Young birds before they feed themselves appear to be endowed with powers of digestion which they do not afterwards retain. There is no difficulty in rearing any young *Sylviæ* till they are full grown; but after this period the difficulty of preserving them by artificial food commences. The redstart gives to its young such beetles as the aged bird is afraid of swallowing. It feeds its young entirely with flies and coleopterous insects. The brown wren does the same, often giving them the large lambda moth. The yellow wren gives aphides and small green caterpillars. Full grown white-throats, which have been reared in a cage, at the sight of a green caterpillar immediately perk up their heads, and cry *etchat, etchat*. Tame *Sylviæ* are such fools that if the floor of their cage is cleaned by a flannel rubber or woollen mop, they eat the woollen hairs which form an indi-

* On the Animal Economy, p. 196-8.

gestible ball in their stomach, which they cannot expectorate, and which is sure to kill them *."

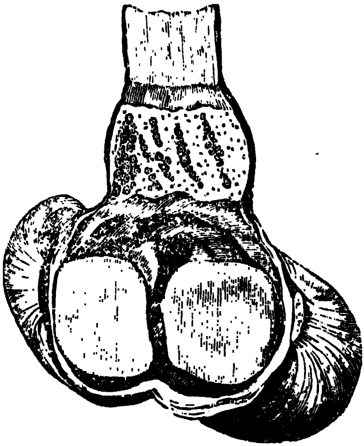
According to Colonel Montagu, granivorous birds have some power of retaining the small stones taken into the gizzard, or evacuating them when they become polished and less useful, though they cannot disgorge them as birds of prey do the pellets of bones and feathers which they are unable to digest. He thinks that in a state of nature birds swallow only a wholesome portion of these stones, whereas domesticated birds frequently devour too many. He has known instances in which the whole cavity of the gizzard was filled with gravel; and in particular he mentions part of a brood of ducks, half grown, which swallowed so great a quantity of gravel as not only to fill the gizzard, but the crop and even the gullet: they soon after died †.

In the swan and the goose, whose food is similar, but different from that of the turkey, there is no distinct crop, but the lower part of the gullet is expanded so as to form a reservoir to store up the food. This structure is perhaps peculiarly adapted to act upon grass, which, according to Sir Everard Home, " appears more difficult of digestion than any other vegetable used for food; and no preparation hitherto employed has rendered the human stomach capable of converting it into nourishment ‡." The goose has the digestive glands more complex than the swan, a peculiarity which may be probably accounted for, as Sir Everard thinks, from the swan's feeding on the weeds and coarse grass growing by the sides of rivers; whereas the goose, from feeding on the common grass of the fields, is the only exclusively grazing bird in this country §.

* Notes to White's Selborne, 8vo. edit. 1833.

† Ornith. Dict. p. 498, 2d edit.

‡ Phil. Trans. 1810. § Ibid.



The gizzard of a Swan, opened to show its grinding surfaces.

Our author, however, seems to have overlooked another native bird, the little bustard (*Otis minor*, Ray), which, according to Montagu, has an enormous stomach, and in one he examined, this was crammed with herbage*. In another examined by Selby, " the stomach was distended by various grasses and the stems of clover†." The structure of the stomach in this bird leads to the conclusion that the leaves and tenderer parts of plants are readily macerated and prepared in the stomach by the united action of the digestive fluid and animal heat, rather than by the friction of its sides. From the stomach of the little bustard not being furnished with that strong gristly substance, found in birds which feed on grain and other hard substances that require great muscular power to break or bruise them, it may be fairly in-

* Orn. Dict. p. 299. † Illustrations, p. 281.

ferred that, under certain circumstances, grass and other herbs are rendered easy of digestion and yield their utmost possible nutriment without trituration. It certainly is not a little singular that the stomachs of carnivorous animals, which can digest even the hardest bones, cannot act upon grass,—a fact exemplified in the dog; for when he eats grass, as he sometimes does by way it is supposed of a medicine, he either ejects it again or it passes through his intestines altogether unaltered.

The interesting facts furnished by comparative anatomy seem to authorize the inference that the varieties of structure, more particularly of the solvent glands, are for adapting the bird to the supply of provisions afforded by the country it inhabits. Every one of these glands, accordingly, produces a secretion fitted for the digestion of all the different kinds of food, and whatever complexity is found in the organs is chiefly for the purpose of economizing the food, by preventing it from escaping till it is thoroughly digested. In addition to the instances which we have already mentioned, Sir E. Home gives the following illustrations.

"The cassowary of Java (*Casuarius Emeu*, Lesson), as it lives in the most luxuriant country in the world, has its digestive organs adapted to such abundance. The gullet is unusually large: it dilates into the cardiac cavity, which is a direct continuation of it, and is everywhere studded over with small gastric glands of a simple structure: these are placed on each side in oblique rows, which terminate in a middle row, extending the whole length of the cavity. The termination is marked on the lower part by the commencement of the lining, which covers the whole internal surface, being very thin for a little way, as well as upon the anterior part, becoming thicker and thicker posteriorly, where the cavity of the gizzard is situated. There is an oblique valvular constriction, formed by muscular fibres, between the cardiac cavity and that of the gizzard; there is also a canal leading from the cardiac cavity, the gizzard forming a pouch projecting from the posterior side; so that the food does not necessarily go into the gizzard, but may either do so, or pass on into the duodenum, and this most probably at the will of the bird. The cuticular lining extends a little way below the cavity of the gizzard, and terminates upon the edge of a broad valve, which may be considered as its boundary, separating it from a large oval cavity about four inches long. The oblique valve between the cardiac cavity and the gizzard retains the food, and allows the liquor of the solvent glands to mix with it before it enters the gizzard, and probably a great part of it never enters this cavity at all. The passage from the digestive organs is so free, that the stones swallowed for the use of the gizzard readily pass into the intestines, which is not the case in others; and these intestines are wider and shorter than in any other bird. The fact of the stones passing along the intestines I learnt from Sir Joseph Banks, who, while he was visiting the menagerie at the Cape of Good Hope, was much astonished to see a cassowary, which was feeding very voraciously on fruits, void a large quantity of stones, some of them of considerable size.

"The cassowary of New South Wales (*Dromiceius Novæ Hollandiæ*, VIEILLOT), as it lives in a country naturally fertile, but less luxuriant than Java, has its digestive organs formed on the same principle; but differs in this particular, that the solvent glands are larger in size, although similar in structure. They are placed in regular transverse rows; the gizzard is thicker, has a stronger lining, and is rather more in the direct line of receiving food from the cardiac cavity," while "the passage from the stomach to the intestine is less open.

The Cassowary (*Casuarius Emeu*).

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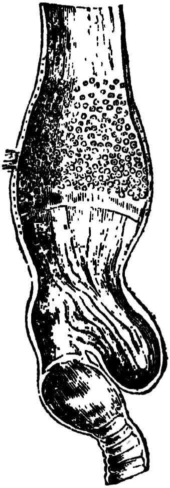
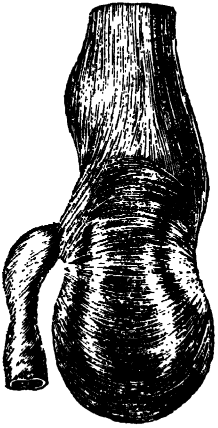
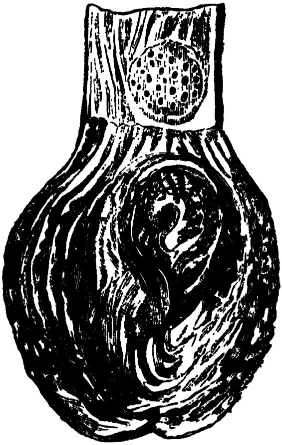


The stomach of the Emeu, opened to show the gastric glands.



Cardiac cavity and gizzard of the Nandu.



The same, opened to show the gastric glands.

"In the American ostrich (*Rhea Nandu*, VIEILLOT), a native of a less productive soil, the gastric glands are fewer in number, when compared with its size, than in other birds. They only occupy a small space of a circular form, on the posterior side of the cardiac cavity; the smallness of their number is, however, compensated by the complexity of their structure, similar to that of the gastric glands in the beaver. The cardiac cavity is dilated to a large size, as in the cassowary, and there is a similar oblique muscular valve by which it is separated from the gizzard. The digastric muscle is stronger in its power, and the tendons between the two bellies of the muscle are beautifully distinct. The orifice leading from the gizzard is so very narrow, that nothing can pass out of it that has not been reduced to a small size." But "the stones and other hard bodies which those birds swallow must, from their weight, force their way into the gizzard.

"The African ostrich (*Struthio camelus*), an inhabitant of the desert, where there are very few plants, has means of economizing its food much beyond the others. The gastric glands are not only more complex, but more numerous; their secretion is applied to the food in the cardiac cavity, in which it is retained by its gravity, is triturated by the extraneous hard bodies that are swallowed, and it is then forced up into the gizzard to undergo a second trituration. All such substances must remain in the cardiac cavity, both from its being the most depending part, and from the cavity of the gizzard being too small to admit their entering it. The cardiac cavity, in the instance which I examined, contained stones of various sizes, pieces of iron and half-pence; but between the grinding surfaces of the gizzard were only broken glass, beads of different colours, and hard gravel mixed with the food*."

* Home, Comp. Anat. i. 295.

M. Montbeillard thinks the ostrich swallows stones and metallic substances with the view of ballasting its body for running, as bees and storks have been fabulously asserted to carry stones for a similar purpose*. The alligator of South America is another anomalous instance of a similar kind. The Indians on the banks of the Oroonoko assert that, previously to an alligator going in search of prey, it always swallows a large stone, that it may acquire additional weight to aid it in diving and dragging its victims under water. An officer in the Colombian Navy who mentions this, tells us, that being somewhat incredulous upon the point, (how could he be otherwise?) he was satisfied of the fact by Bolivar, who, in order to convince him, shot several alligators with his rifle, and in the stomachs of all of them were found stones varying in weight according to the size of the animal. The largest killed, he says, was about seventeen feet in length, and had within him a stone weighing from sixty to seventy pounds †!

Whatever may be the object of the ostrich, there can be no doubt of the fact of its swallowing stones and metal,—even red hot iron ‡, it has been asserted, though Albertus Magnus upon trying the experiment could not prevail on one to swallow bits of iron §. M. Perrault found in the stomach of an ostrich seventy doubloons, most of them worn down and reduced to three-fourths of their size, the corrosion being confined to the convex side which was most exposed to the attrition of the gizzard. Those which swallowed copper were evidently poisoned by it, for they soon died ||.

Vallisnieri, in his admirable account of the ostrich, informs us that bits of wood, iron, or glass, which

* See Insect Architecture, p. 42.

† Recollections of Venezuela.

‡ Marmal, Description d'Afrique. § Hist. Anim.

|| Mem. Acad. des Sciences, 1705, &c.

have remained some time in the stomach, are not smooth or shining, as they would be if worn by the friction of the coats; but are rough, furrowed, or perforated, presenting precisely such an appearance as would be produced by the corrosion of a solvent.

This solvent reduces the hardest and the softest bodies alike to impalpable molecules, which may be observed by the microscope, and even by the naked eye. Vallisnieri found in the stomach of the ostrich a nail fixed in one of the sides, in such a manner as to prevent its meeting the opposite side, and consequently the compression of the contents; yet the food was as completely dissolved in this ventricle as in another in which the usual action took place, and this at least proves that the digestion is not performed solely by trituration. He observed a copper thimble in the stomach of a capon, which was corroded only where it touched the gizzard, and consequently where it was least exposed to the attrition of the hard substances; whence the solution of metals in the gallinaceous tribe must be ascribed rather to the action of some menstruum, than to the pressure and resistance of the coats, and the analogy naturally extends to the ostrich. He discovered in the stomach of an ostrich a piece of money, which had been so completely corroded that its weight was reduced to three grains*.

We have remarked, that the fruit-eating birds seem indifferent to the comminution of their food before it is swallowed. The black-cap and the fauvette (*Philomela hortensis*) will accordingly swallow berries of so large a size, that it might previously appear impossible for their little gullets to admit them. In the case of very ripe grapes or cherries, we can better comprehend this from the ready compressibility of the fruit; but the hard, incompressible berries of the ivy are apparently swallowed with equal ease and

* Notomia dello Struzzo, 4to. Padova, 1626.

no less relish, than a bit picked out of an Orleans plum or a ripe pear. The seed-eating birds, on the other hand, always endeavour when they can to break the husk, and caged canaries or goldfinches may thus be observed to spend more than half their time in shelling off the husks of the larger seeds, though rape, millet, or poppy seed is too small to get the edges of the bill to act upon it, and has therefore to be swallowed unbroken*. Whether the gravel or sand which is always given to cage-birds, and without which it is said they will not thrive, contributes to the trituration of these seeds in the stomach, has not been ascertained, and has indeed been less attended to than the analogous circumstance in the case of poultry.

*J. R.

CHAPTER VI.

TASTE OF CARNIVOROUS BIRDS.

IT was remarked by Plato, that when animals were created, peculiar species of food were assigned to each,—"to one herbs, to another the fruits of trees; to some roots, and to a distinct race, it was permitted to feed upon the flesh of other creatures*." The Grecian philosopher, however, does not seem to have had so clear a notion of the order in which this assignment was made as our modern inquirers, inasmuch as he appears to consider it subsequent to the provisions of strength, swiftness, natural weapons of defence, and means of protection from the inclemencies of the weather. Were we to follow out Plato's views according to the interpretation which they will justly bear, we must conclude that the peculiar species of food was appointed to each animal without reference to its organization, whereas there cannot be a shadow of doubt of this being the very reverse of the fact. A beautiful passage in Buffon appears to us to place the matter in its true light.

"The mode of life," he says, "the habits, and economy of animals, are not so free as might be supposed. Their actions result not from inclination and choice, but are the necessary effects of their peculiar organization and structure. Nor do they seek ever to infringe or evade the law of their constitution; the eagle never abandons his rocks, nor the heron her shores: the one shoots down from the

* Protagoras, § 57.

aërial regions to plunder or murder the lamb, founding his prescriptive right on his strength, his weapons, and his habitual rapine; the other, standing in the mire, patiently expects the glimpse of its fugitive prey. The woodpecker never forsakes the trees round which he is appointed to creep. The snipe must for ever remain in the marshes, the lark in its furrows, and the warbler in its groves. All the granivorous birds seek the inhabited countries, and attend on the progress of cultivation: while those which prefer wild fruits and berries perpetually fly before us, and cherish the wilds, and forests, and mountains; there, remote from the dwellings of man, they obey the injunctions of Nature. She retains the hazel-grous under the thick shade of pines; the solitary blackbird under his rock; the oriole in the forests, which resound with its notes; while the bustard seeks its subsistence on the dry commons, and the rail in wet meadows. Such are the eternal, immutable decrees of Nature, as permanent as their forms; these great possessions she never resigns, and on these we vainly hope to encroach. And are we not continually reminded of the weakness of our empire? She obliges us even to receive troublesome and noxious species; the rats make a lodgement in our houses, the martins in our windows, the sparrows in our roofs; and when she conducts the stork to the top of our old ruinous towers, already the habitation of the mournful family of nocturnal birds, does she not hasten to resume the possessions which we have usurped for a time, but which the silent lapse of ages will infallibly restore to her?

"Thus the numerous and diversified species of birds, led by instinct and confined by their wants, to the different districts of Nature, have apportioned among themselves the air, the earth, and the water. Each holds its place and enjoys its little domain, and the means of subsistence, which the peculiarity of its faculties will augment or abridge. Thus the spoonbill seems formed for gathering shell-fish; the small flexible strap and the reflected arch of the avoset's bill reduce it to live on fish-spawn; the oyster-catcher has an axe-shaped bill, calculated for opening the shells; and the crossbill could not subsist were it not dexterous in plucking the scales from the fir-cones. Lastly, the shearbill could neither eat sidewise, nor gather food, nor peck forwards; its bill consisting of two pieces extremely unequal, the lower mandible being long and extended disproportionately, projects far beyond the upper, into which it falls like a razor into its haft*."

Even leaving the peculiar form of the bills out of consideration, the organization of the stomach, and of other internal parts, is so different in birds which feed on animal food from what it is in those that feed on vegetables, as to lead to a similar conclusion. It is well known that ruminating animals, such as the cow and sheep, have a quadruple stomach, or rather a series of four stomachs; while those which feed on animal substances, as the cat and swine, have only a single stomach, which is besides more simple in structure. A similar difference of organization occurs among birds, as we shall now detail, beginning with carnivorous birds which have the most simple stomachs.

The first peculiarity which strikes an observer in the organs of carnivorous birds is the great width of the gullet, for the purpose, it would appear, of facilitating the deglutition of large pieces of food, and also the regurgitation of feathers and other substances which cannot be readily digested. In the golden eagle (*Aquila chrysaëtas*, ALDROVAND), for example, the gullet is dilated near its termination, and there is a

* Oiseaux, Art. Le Bec-en-Ciseaux.

regularly formed single crop of large dimensions rather on the right side, resting in the hollow of the bone, which corresponds to the collar-bones (*claviculæ*) in quadrupeds. Below this is the cavity into which the pipes open from the gastric or solvent glands, these forming a broad compact belt. These glands are each very distinct, of a cylindrical form; with very small canals, or villous internal surfaces, and thick coats open at one end, and closed and rounded off at the other. They lie parallel to one another, and nearly at right angles to the membrane through which they open; the closed end being slightly turned upwards, so as to make the orifice the most depending part. At the lower end of the belt there is a second contraction, separating it from the gizzard immediately below, which is surrounded by a digastric muscle of weak power, and has a soft internal membrane, as have all birds that live on animal food*.

M. Réaumur tried several curious experiments on the digestive powers of the kite, for which purpose he employed tin tubes filled with different substances, particularly flesh, and this being after a time ejected, according to the custom of the bird, enabled him to examine the effects produced. As the flesh thus enclosed was, when retained long enough in the stomach, completely digested (not merely macerated as M. Batigne insinuates†), he concluded that the digestion was caused without any trituration by the gastric fluid alone. The Abbé Spallanzani made similar experiments upon various birds, some of which, it may be interesting to mention, particularly those with the eagle, which he says was the common eagle of Buffon, and the black eagle of Linnæus,

* Sir E. Home, Comp. Anat. i. 273; Blumenbach, by Coulson, p. 100.

† Reflect. sur les Exper. de M. de Réaumur.

both synonymous with the golden eagle (*Aquila chrysaëtas*).

"The ordinary food of my eagle," says the Abbé, "consisted of live cats and dogs, when I could procure them. It easily killed dogs much larger than itself. When I forced one of these animals into the apartment where I kept the eagle, it immediately ruffled the feathers on the head and neck, cast a dreadful look at the dog, and taking a short flight, immediately alighted on his back. It held the neck firm with one foot, by which the dog was prevented from turning his head to bite; and with the other grasped one of the flanks, at the same time driving the talons into the body; and in this attitude it continued till the dog expired, in the midst of fruitless outcries and efforts. The beak had been hitherto unemployed, but it was now used for making a small hole in the skin, which was gradually enlarged; from this the bird began to tear away and devour the flesh, and went on till it was satisfied. I must not omit observing that it never ate any skin, nor intestine, nor bone, except very small ones, such as the ribs of cats and small dogs. Notwithstanding this ferocity, and violent impetuosity in attacking animals, it never gave any molestation to man. I, who was the feeder, could safely enter the apartment where the bird was kept, without any means of confining its movements, and beheld these assaults without dread or apprehension; nor was the eagle at all hindered from attacking the living prey I offered it, or rendered shy by my presence. As it was not always in my power, or at least in my will, to give it living food (for I had not always dogs and cats at hand; and fowls, which are equally acceptible, were too expensive), I substituted flesh, which, though it was not so well relished, was not disagreeable. In general, when it had flesh at will, it only made one meal a day. I found by weighing what it ate, that thirty ounces of flesh served it one day with another. This species of eagle is provided with a very large craw, which of course is the first receptacle of food, and when it was at liberty to eat its fill, this was generally distended to a larger size than that of a turkey-cock full of grain; it gradually contracts in proportion as the flesh passes into the stomach, just as it happens in common fowls.

"It is said by several celebrated naturalists and physiologists, that the eagle when unable to procure flesh will feed upon bread. To ascertain this point I made various experiments. I first set before the bird both flesh and wheaten bread; and finding that it ran towards the flesh without even casting a look upon the bread, I set only the latter before it, and this after a day's fast, when it must have been pressed by hunger. When I had prolonged the fast to the fourth day, the bird ran towards me as I opened the door of the apartment, but with no other view than to ask food. I offered it a piece of bread, but in vain; for, without even touching it, it returned to the place where it stood before my coming in. I might have carried the trial still further, but was afraid of the animal sinking under it. I therefore abandoned this mode of experiment, and concealed the bread in some flesh, as I had done in my experiment with the falcon, and had recourse to the same expedient, whenever I was desirous that my eagle should take tubes and other substances. For though this ferocious bird was exceedingly gentle towards me, who was his feeder, yet it might have been hazardous to irritate him, and that would have been unavoidable if I had opened the beak and thrust bread down the throat by force. The first portion of bread which the eagle swallowed concealed by flesh, amounted to half an ounce. Indigestible bodies, such as feathers, used to be thrown up eighteen, twenty, or at most twenty-four hours after they were received into the stomach. But the bread was not, and the same thing took place when the quantity of bread was increased to six ounces. My last experiment upon bread was to substitute the crust instead of the crumb; but the result was just the same; and notwithstanding the eagle had shown so little appetite for this kind of food, its health did not appear to suffer. I was obliged to conclude, that this species of vegetable is digested, and converted into real nutriment, as well as animal matters. I could not therefore refuse to accede to the opinion of those who affirm that eagles, when much pressed by hunger, will feed upon bread, though mine would not touch it.

"I had before observed that the eagle devours the smaller bones of dogs and cats along with the flesh. When I gave that in my possession a bird, it would also swallow all the bones, except those of the extremities; and as they were not thrown up, there was good reason for believing that they were digested; a circumstance that exactly agrees with my observations on falcons and various other birds. But greater certainty being desirable, two pieces of the rib of a small dog, each about two inches long, were tied together, and two thigh-bones of a cock; this packet was retained twenty-three hours, but the bones were very much altered during that time. The two pieces of rib were reduced to the thinness of a membrane; the least violence was sufficient to break them; they were totally inelastic, and had lost all their marrow. The two thigh-bones now resembled tubes of parchment; they were easily compressible, and when left to themselves recovered their shape, and after being bent they would become straight again. Upon one of the bones thus wasted and altered, there was a very singular appearance: about one-fifth was still bony, but tender, yielding to the touch, and much attenuated. It is therefore apparent that the juices of the stomach are capable of dissolving bone, and that in a short space. I was unwilling to throw aside these bones thus reduced almost to nothing, and therefore, tying them up in a bundle, I gave them again to the eagle, in order to see whether they would be entirely dissolved, or, like a caput mortuum, retain their membranous appearance ; but, being apprehensive that this could not be so well ascertained if they were naked in the stomach, I enclosed them in a tube. It was retained thirteen hours, and upon examination was entirely empty ; it was therefore reasonable to infer that the gastric fluid had now completed the solution. The readiness with which these bones, of a texture by no means tender, were digested, led me to suppose that the hardest would not resist the action of the gastric liquor. To determine this, I began by giving the eagle a sphere of bone, worked at the lathe out of an ox's thigh-bone, of the same diameter as that which had been used for the falcon, and taken from the same individual. Upon that occasion I observed that the falcon did not dissolve it during the long space of thirty-five days and seven hours. In the present case it was every day cast up and immediately returned, and in twenty-five days and nine hours it was completely digested. The eagle is then capable not only of digesting the hardest bones, but of digesting them in a shorter space than some other birds of prey*."

In a wild state, as in confinement, it is probable that eagles always prefer living prey to carrion, though they may, when pressed by hunger, frequently have recourse to such fare. It is in this way we must account for what is related of these birds by eastern travellers, supposing them to be correct in the species;

* Dissertations, i. 187.

for it is not unusual for travellers, unacquainted with natural history, to confound vultures and other large birds with eagles.

From eagles being observed to feed chiefly on animals killed by themselves, while other carnivorous birds were content with carrion, the ancient naturalists drew distinctions between the species, founded on this circumstance. According to Aristotle, some of these rapacious birds will not attack a pigeon while it is sitting, and the pigeon is so well aware of this, that it will not leave its perch on the appearance of a bird of this sort, but will take wing when another species comes in sight*. Pliny takes the same view with more minuteness; when speaking of birds of prey he says, they "are divided into sundry and distinct kinds, by their greedinesse, more or lesse, and their manner in chase and preying; for some there be that never seise on a fowle but upon the ground: others againe never assaile any birds, but when they spy them flying about some tree. There be also, that take a bird perching and sitting on high; and ye shall have them that overtake them as they fly in the wide and open aire. The doves therefore and pigeons, knowing the danger of flying aloft, so soon as they espy them, either light upon the ground and settle, or else fly neere the earth, and thus help themselves by taking a contrary course to the hawks' nature, to avoid their talons †." Proceeding still upon the same view, Albertus Magnus divides rapacious birds into noble, ignoble, and mixed ‡; a division which has been partially adhered to by most subsequent authors, even down to the most recently proposed classifications §.

"Birds," says Mr. Knapp, "which we denominate rapacious, such as falcons, hawks, owls, live upon

* De Anim. ix. 24. † Holland's Plinie, i. 274.
‡ De Anim. xxiii. 5, de Falcone. § Zool. Journ. i. 313.

animal food, which they capture, kill, and devour; abstaining, unless stimulated by necessity, from creatures they may find dead." "The raven and the crow likewise eat ànimal food, but it is generally such as has been killed by violence or ceased to exist, only in cases of want killing it for themselves. The crow, in the spring, when food is difficult of attainment, will kill young pigeons; and the magpie, having young ones, captures the new hatches of our domestic poultry *."

Now although both the structure of the birds, and their more usual habits, certainly accord in some measure with the original remark of Aristotle, we must take the whole with considerable limitation, if we keep to facts proved by observation. The circumstance of eagles, while in confinement, preferring living prey to carrion, proved by every one who has kept the birds, seems to us of much less force than the facts derived from observing the birds in a wild state. "Notwithstanding," says M. Vaillant, "all which poets and historians and the authors who have copied them have written, I have verified the observation so frequently, as authorizes me to maintain and repeat it to be false, that eagles, even when pressed by hunger, never pounce upon carrion †." Wilson is no less explicit.

"Were we disposed," he says, "after the manner of some, to substitute for plain matter of fact all the narratives, conjectures, and fanciful theories of travellers, voyagers, compilers, &c. relative to the history of the eagle, the volumes of these writers, from Aristotle down to his admirer the Count de Buffon, would furnish abundant materials for this purpose. But the author of the present work feels no ambition

* Journ. of a Naturalist, p. 244, 3d edit.

† Oiseaux d'Afrique, i. 8.

to excite surprise and astonishment at the expense of truth, or to attempt to elevate and embellish his subject beyond the plain realities of nature. On this account, he cannot assent to the assertion, however eloquently made, in the celebrated parallel drawn by the French naturalists between the lion and the eagle, namely, that the eagle like the lion 'disdains the possession of that property which is not the fruit of his own industry, and rejects with contempt the prey which is not procured by his own exertions;' since the very reverse of this is the case in the conduct of the bald and the sea-eagle, who, during the summer months, are the constant robbers or plunderers of the osprey or fish-hawk, by whose industry alone both are usually fed. Nor that, 'though famished for want of prey, he disdains to feed on carrion,' since we have ourselves seen the bald eagle, while seated on the dead carcass of a horse, keep a whole flock of vultures at a respectful distance, until he had fully sated his own appetite *."

There can be no question, moreover, respecting the general accuracy of Aristotle's remark, that some birds of prey prefer striking their prey on the wing, others to pounce upon birds at roost or other animals on the ground, circumstances which give some colour to the distinctions of noble and ignoble. M. Belon tells us that it is a common amusement with the Turks at Constantinople to toss from the tops of the houses pieces of bullock's lungs, which were pounced upon with such velocity and unerring aim by kites that they rarely fell to the ground †.

The hen harrier, or ring-tail hawk (*Circus pygargus*, Fleming), appears to have similar manners to the falcons observed by M. Belon. Bingley tells us

* Amer. Ornithol. vii. 17.

† Observ. dans ses Voy. en Orient. 4to. 1553.

that a gentleman, who was shooting in Hampshire, sprung a pheasant, shot at it, and notwithstanding the report of his fowling-piece, it was pursued by a hen harrier, but escaped into a covert. He afterwards sprung and missed several more, the hawk continuing to hover round all the while he was beating the field, as if well aware of the game which lurked in the stubble. It might be, that the bird had been rendered daring and bold by hunger, or perhaps it might not be able to strike the game nor pounce on it when on the ground where a pheasant might make a stout resistance. At all events, it is not likely so large a bird could escape the piercing eye of the hawk, which was apparently on express look out for prey. "Hence," adds the author, "that propensity in game to cowering and squatting till they are almost trodden on, which doubtless was intended by Providence as a mode of security, though it has long been rendered destructive by the invention of nets and guns *."

The fearless courage of birds of prey, however, impels them to attack game of considerable size. From the stomach of an American sparrow-hawk (*Falco sparverius*) Wilson took a considerable part of the carcass of a migratory thrush (*Turdus migratorius*), including the unbroken feet and claws, though this thrush is within half an inch as long as the hawk †. But this is nothing to the smaller falcons even attacking eagles. The falcon gentil, as it was formerly termed, the gos-hawk (*Astur palumbarius*, BECHSTEIN) of modern writers, was reputed one of the most courageous, in the days of falconry, when it was flown at the largest game.

"Were there not," says Dr. Russell, "several gentlemen now in England to bear witness to the fact, I should hardly venture to assert that with this

* Anim. Biogr. ii. 207. † Amer. Ornith. iv. 58

bird, which is about the size of a pigeon, the inhabitants sometimes take large eagles. This hawk, in former times, was taught to seize the eagle under the pinion, and thus depriving him of the use of one wing, both birds fell to the ground together; but I am informed that the present mode is to teach the hawk to fix on the back, between the wings, which has the same effect, only that the bird tumbling down more slowly, the falconer has more time to come to his hawk's assistance. But in either case, if he be not very expeditious, the falcon is inevitably destroyed. I never saw the shaheen fly at eagles, that sport having been disused before my time, but I have often seen him take herons and storks. The hawk, when thrown off, flies for some time in a horizontal line, not six feet from the ground, then mounting perpendicularly, with astonishing swiftness, he seizes his prey under the wing, and both together come tumbling to the ground. If the falconer, however, be not expeditious, the game soon disengages itself and escapes*."

The common buzzard (*Buteo vulgaris*, FLEMING), which is certainly not the bravest of the rapacious birds, and never, according to Montagu, pursues its prey on the wing, has been known to exhibit no little daring. One which M. Fontaine kept tame, when hovering early in the morning over the skirts of the forest of Belesme, dared to attack a fox, and the keeper seeing him on the shoulders of the fox, fired two shots at him: the fox was killed, and the buzzard had his wing broken†.

Even eagles are not always so courageous as this, as appears from the following anecdote by M. Vaillant. "I was once," he says, "witness to a combat which took place in the environs of Paris,

* Nat. Hist of Aleppo.

† Buffon, Oiseaux, Art. La Buse.

Buzzard (*Buteo vulgaris*).

between ten missel-thrushes and a white-tailed eagle (*Haliætus albicilla*, SAVIGNY), in which the latter was completely beaten, and had squatted down in a shed, where he had sought refuge. Attracted by the reiterated cries and continued agitation of the thrushes, whose manœuvring announced something extraordinary, I went to the spot, and was surprised to discover them engaged with an eagle. Being in what were called the royal preserves, I was not provided with arms, but unwilling to resist so fine an opportunity of procuring a bird which would be a valuable acquisition to my collection, I ran to my house at Asnières, a village not far from the spot, and returned with a pistol loaded with a large ball, as my fowling-piece would have too much exposed me. I regained the plain; I saw the eagle still fighting with the missel-thrushes, who had not at all given way; and, in defiance of watchful and inflexible keepers, and the atrocious game-laws, with a heart palpitating between joy and apprehension, I approached within ten paces of the dastardly bird, and nicely adjusting my pistol, killed him in a moment. Immediately burying my weapon, and concealing the eagle among some brambles, I quitted the place, looking eagerly around me with no little apprehension, as every man whom I saw moving about the plain seemed to me to wear a keeper's uniform; but this time the vigilance of the keepers was at fault; there was no cause for alarm. I bore off my prize, and gained my dwelling without detection, where, proud of my acquisition, I invited all my friends to be witnesses of my triumph*."

In owls the gullet is larger than in eagles, but the gizzard is similar in form, and the digastric muscle is weak. The Abbé Spallanzani tried similar experiments upon owls to those upon eagles, which we

* Oiseaux d'Afrique, vol. iii.

have already given. "Observing," he says, "that when they were hungry and opened their beaks very wide, if I dropped a pea, French bean, or cherry into it, they swallowed it with as much avidity as if it had been the pleasantest kind of food, I was desirous of seeing whether the stomach would digest vegetable substances. With this view I enclosed several of the seeds just enumerated in some tubes, and forced the bird to swallow them, but to no purpose; for though the liquor swelled the seeds, and perhaps altered the colour, they underwent no diminution of bulk. They were cast up undigested in a day or two; a circumstance which sufficiently shows that such kind of food, notwithstanding they appear to relish it, is ill adapted to their gastric juices. The greediness with which they swallow such substances can arise only from that blind appetite in consequence of which many birds take whatever is offered them.

"Being satisfied with these experiments on nocturnal birds of prey, I turned my attention to some of the diurnal ones. My first subject was a falcon, given me by my illustrious friend the Abbé Corti. I soon found that I could not handle this bird so familiarly as those which I have had occasion to mention hitherto. The strong beak and long sharp talons would not easily permit me to open the mouth by force, but I contrived a method of introducing tubes into the stomach without the bird being aware, by cutting some flesh in pieces, making holes in them, and in these concealing the tubes. When the falcon was hungry he ran eagerly to the pieces of flesh, and swallowed them whole. For the fraud to succeed it was necessary that the tubes should be quite covered with flesh, for if any part of them was bare, the falcon would put them under his talons, and tear the flesh away with his beak, and swallow it, leaving the tube.

"My first experiment was made with a view to ascertain whether it was capable of digesting bone, independently of the action of the stomach. This result was successful; but I have before said so much on the subject of the digestion of bone, that I should omit relating the present instance particularly, but for a new and important phenomenon, which renders the detail necessary. The bone consisted of little splinters of an ox's thigh-bone; they were very hard and compact, and of various sizes, from a grain of wheat to a bean; they weighed together sixty-seven grains. I put them into two close tubes, in which they were rather closely crammed. To prevent their falling out of the tubes when they began to be dissolved, and consequently to get loose from each other, I put the tubes in a linen bag, a precaution which I had before employed, and continued to employ occasionally in future. In twenty-four hours the bones had shifted their respective places, and rattled in the tubes, a circumstance that showed the bulk to be diminished. I examined them again after they had been two days in the stomach. The pieces of the size of grains of wheat were all destroyed, which were now no larger than millet. Three of the splinters were at first as big as beans, but now reduced to the size of maize. Those of an intermediate size were diminished in proportion. During the whole time they all continued hard. At the third examination, after fifty-seven hours' longer continuance in the stomach, the three large pieces only were left, and they were now no larger than millet; when I struck them with a hammer, I found that they retained their original hardness. The gastric liquor, therefore, of the falcon does not, like that of owls and many other animals, insinuate itself into the substance of the bone, but acts on the surface only. The phenomenon, I think, may be thus explained:—

conceive a bone to be composed like wood, or, taking a more familiar instance, like an onion, of a great number of strata. The strata of the onion are of considerable thickness, but we must imagine that in bone they are exceedingly thin. The gastric fluid of owls or other animals will first dissolve the upper stratum, but while it is doing this it will penetrate and soften the contiguous strata, without dissolving them. Hence the tenderness of bone that has lain in the stomachs of animals. On the contrary, we must suppose that the gastric liquor of the falcon has no power of penetrating the internal strata, but that its action is limited to the surface. According to this supposition the bone will be digested without having the internal parts softened; and thus stratum after stratum will be taken away, just as it would happen if we had a menstruum capable of dissolving only the superficial layer of an onion without acting upon the others*."

According to Sir Everard Home, the carrion crow (*Corvus Corone*) has the cavity of the gizzard of an oval form, with a thick wrinkled lining and a weak digastric muscle. From living chiefly upon carrion, its sagacity appears to be rendered acute in discovering not only a dead carcass, but animals which are weak and sickly. When a crow therefore is seen lingering about alone in any unusual place, it may be suspected that a sheep or other animal is somewhere near, and likely to die. When the animal becomes worse, the crow approaches nearer, and as soon as it is unable to move, pecks out its eyes, and sheep are often found still alive with their eyes thus pecked out†. "The crow," says Colonel Montagu, "will also pursue birds on the wing, when pressed by hunger. We once saw this bird in pursuit of a pigeon, at which it made several pounces like a hawk; but the pigeon escaped

* Dissertations, i. 162.

† Comp. Anat. i. 275.

by flying in at the door of a house. We have also seen it strike a pigeon dead from the top of a barn. It is a great destroyer of young game and poultry*."

The crow feeds, however, occasionally on grain: "I have," says Sir Everard Home, "found grain in its gizzard, but it is not the kind of food of which it is most fond. The crow is by many accused of destroying the grass, by pulling it up by the roots. This is an error arising out of the following very curious circumstance. In searching for grubs which are concealed in the earth, and supported by eating the roots of the grass, the crow pulls at the blade of grass with its bill, and when the grass comes up, the bird knows that there are under it insects which have destroyed its roots, and in this way detects them; but if the blade of grass is firm, it goes to another part of the ground. In a field where grubs are very abundant, the crows scatter the grass every where, so as to give the appearance of having rooted it up, while they have only exposed the depredations of the insects by which the roots had been destroyed. As the rook lives occasionally upon grain, it was natural to suppose there would be some characteristic distinction between the digestive organs of that bird and those of the crow, whose food is chiefly animal, but upon the most accurate examination no difference whatever can be detected except the cuticular lining being thinner. This leads me to conclude that although the rook does eat vegetable substances, the principle upon which the gizzard is formed is such as to fit it more particularly for the digestion of insects. The gizzard of the raven is like that of the crow.

"There are many other birds under similar circumstances; they eat and digest vegetable food very readily, but when the choice is given them prefer that of the animal kind; and from the weakness of the

* Ornith. Dict. p. 113, 2d edit.

digastric muscle, the gizzard is evidently not to be classed with those of the granivorous birds. The bustard is of this kind; its gizzard is not unlike that of the raven. It has a thick cuticular lining, and a weak digastric muscle, but the gastric glands are uncommonly large; so as to have attracted the attention of M. Perrault, who has given an account of their structure, saying, that they are conical tubes terminating in a point at one end, and open at the other, and are larger than in any other bird except the ostrich, whose solvent glands he appears not to have examined.

"As I have not had an opportunity of examining these glands in the bustard, I must rest this account upon the structure of the glands upon M. Perrault's authority, as stated in the work on Comparative Anatomy, published under the patronage of Louis XIV. in 1676.

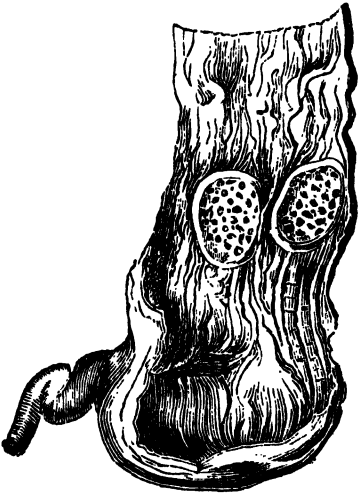
"Understanding that the bustard in India is a favourite bird for the table, and that all bustards are there considered to be granivorous birds, I was unable to reconcile this circumstance with the structure of its digestive organs; but this difficulty is solved by the following account of the mode of feeding of this bird, which is taken from Mr. Hunter's notes upon this subject, who kept a cock-bustard a whole summer in his garden. It died in November apparently from the cold of the winter. He killed mice and sparrows with his bill by pinching their heads, and then swallowed them whole, even when of considerable size. It was easy to observe a large mouse going down his throat making a moving tumour till it came to the turn of the neck: it then moved backwards, and although out of sight, yet its progress was traced by the feathers between the shoulders separating, and closing again as soon as it passed into the gizzard. It was fond of worms, and while the gardener was

The Bustard (*Otis tarda*).

The Adjutant (*Ciconia argala*).

digging, stood by him and looked out for them. It ate the buds of flowers, and particularly of roses; also the substance of cucumbers, but not the outside. From these observations the bustard is evidently fitted more particularly to live on animal food*."

One of the most voracious of carnivorous birds is the gigantic crane, or, as it is called in India, the adjutant (*Ciconia argala*, TEMMINCK). It does not, however, rank in systematic arrangements as a bird of prey any more than the bustard, though we have just seen that the latter lives chiefly on animal food. The structure of the stomach in the adjutant corresponds with this similarity in habit, though the solvent glands are differently formed from those of



The stomach of the Adjutant, opened to show its internal surface, and the gastric glands arranged in two oval groups

* Comparative Anatomy, i. 277.

any other bird. These glands are not placed round the upper portion of stomach, but form two circular figures, about one inch and a half in diameter on the fore and back part of it, each gland being composed of five or six cells, and these opening into one common pipe. The gizzard and digastric muscle are nearly of the same strength with that of the craw, and the former is lined with a similar horny cuticle*.

These birds are not only capable of digesting bones, as Spallanzani proved eagles and owls to be, but they seem to be fond of them, swallowing every bone which they can get down their gullet, whence they are denominated bone-eaters. It has been stated by Sir Everard Home that there was found in the craw and stomach of one of these birds a land tortoise, ten inches long, and a large male black cat, entire†. Mr. Smeathman, to whom we are indebted for several very interesting details in natural history, has given an account of this bird, which we think will furnish a good illustration of our subject. The adjutants, he tells us, "are met with in companies; and when seen at a distance, near the mouths of rivers, coming towards an observer, which they often do with their wings extended, may well be taken for canoes upon the surface of a smooth sea; when on the sand-banks, for men and women picking up shell-fish or other things on the beach. One of these, a young bird about five feet high, was brought up tame, and presented to the chief of the Bananas, where Mr. Smeathman lived; and being accustomed to be fed in the great hall, soon became familiar, duly attending that place at dinner-time, placing itself behind its master's chair frequently before the guests entered. The servants were obliged to watch

* Sir E. Home, Comp. Anat. i. 278.

† Phil. Trans. for 1813, p. 77.

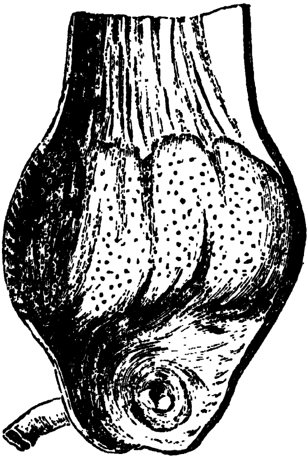
narrowly, and to defend the provisions with switches; but, notwithstanding, it would frequently seize something or other, and once purloined a whole boiled fowl, which it swallowed in an instant. Its courage is not equal to its voracity, for a child of eight or ten years old soon puts it to flight with a switch, though at first it seems to stand on its defence, by threatening, with its enormous bill widely extended, and roaring with a loud voice like a bear or tiger. It is an enemy to small quadrupeds, as well as birds and reptiles, and slily destroys fowls or chickens, though it dares not attack a hen openly with her young. Every thing is swallowed whole; and so accommodating is its throat, that not only an animal as big as a cat is gulped down, but a shin of beef broken asunder serves it but for two morsels. It is known to swallow a leg of mutton of five or six pounds, a hare, a small fox, &c. After a time the bones are rejected from the stomach, which seems to be voluntary, for it has been known that an ounce or two of emetic tartar given to one of these birds produced no effect*."

* Latham, Gen. Hist. of Birds, ix. 40-1.

CHAPTER VII.

TASTE OF PISCIVOROUS BIRDS.

THE digestible properties of fish are not greatly different from those of flesh, and accordingly we find that the digestive organs of birds which feed upon fish are very similar to those of birds purely carnivorous. In the gannet or solan-goose (*Sula alba*, MEYER), for example, the solvent glands are very numerous, and placed round the cavity of the gizzard in the form of a very broad belt, extending nearly as low as the outlet of the stomach, and forming, as in the hawk, four distinct portions, though the interstices are less distinct. The digastric muscle is feeble, and the cavity is of an oval form, the outlet going off



The gizzard of the Solan Goose, opened to show the gastric glands.

about the middle of the right side*. The inner surface of the gizzard also is soft, smooth, and spongy, particularly that portion of it which covers the gastric glands, secreting a mucus not found elsewhere. This was ascertained upon examining the organs of a cormorant (*Carbo cormoranus*, Meyer) suspected of having been poisoned. In this bird, it is worth remarking, the solvent glands being in close contact form a compact mass, and are placed within the dilated portion of the gizzard; though they do not extend all round, but form two circular portions, one on the fore and another on the hind part of the surface, for about half the length of the cavity.

In the cormorant just mentioned, supposed to have been poisoned, it was found that the bird had died in consequence of a newt (*Triton palustris*, Laurenti) having been put into its mouth with the hind feet foremost, by the person who fed it; the newt spreading its legs, could neither be forced down into the gizzard, nor thrown up by the mouth: the irritated gullet (*œsophagus*) became inflamed, and the inflammation extended along the inner membrane of the gizzard, the contents of which were enveloped in a thick mucus: the inner membrane was generally very vascular; but the two circular portions, where the gastric glands are situated, were coated over with a thick and almost solid mucus, which could not be completely removed, so firmly did it adhere. This appearance was so very extraordinary, and the orifices of the gastric glands were so completely choked with mucus, that it was difficult to believe the mucus had not been secreted by the gastric glands and poured out by their excretory ducts. This, however, was ascertained not to be the case, by cutting off the orifices and the membrane through which they open, and finding the ducts themselves empty. These cir-

* Sir E. Home, Comp. Anat. i. 279.

cumstances explain a disease to which that bird is liable, and which is not uncommon to other birds; this is, having ascarides in the gizzard; and these are confined to those particular spots. The worms irritate the membrane, and then feed upon the secretion produced by such irritation. This is analogous to the disease in sheep called the rot; the flukes in the biliary ducts which constitute that disease irritate those ducts, and feed upon the bile which is secreted in increased quantity, in consequence of the disturbed state in which the ducts are constantly kept*.

The cormorant is a great destroyer of fish, and so keenly does it engage in the sport, that advantage has been taken of the circumstance to train it for fishing, in the manner hawks are trained for fowling, a tight collar being put round the throat to prevent the swallowing of the prey. A bird of this species, kept by Colonel Montagu, was extremely docile, of a grateful disposition, and by no means of a savage or vindictive spirit. He received it by coach after it had been four and twenty hours on the road; yet though it must have been hungry, it rejected every sort of food he could offer to it, even raw flesh; but as he could not procure fish at the time, he was compelled to cram it with raw flesh, which it swallowed with evident reluctance, though it did not attempt to strike him with its formidable beak. After seeing it fed he withdrew to the library, but was surprised in a few minutes to see the stranger walk boldly into the room, and join him at the fireside with the utmost familiarity, where it continued dressing its feathers till it was removed to the aquatic menagerie. It became restless and agitated at the sight of water, and when set at liberty plunged and dived without intermission for a considerable time, without capturing or even discovering a single fish; and apparently

* Sir E. Home, Comp. Anat. i. 282.

convinced that there were none to be found, it made no farther attempt for three days.

"The dexterity," continues Colonel Montagu, "with which this bird seizes its prey is incredible. Knowing its own powers, if a fish is thrown into the water at a distance, it will dive immediately, pursuing its course under water, in a direct line towards the spot, never failing to take the fish, and that frequently before it falls to the bottom. The quantity it will swallow at a meal is astonishing; three or four pounds twice a day are readily devoured, the digestion being excessively rapid. If by accident a large fish sticks in the gullet, it has the power of inflating that part to its utmost, and while in that state the head and neck are violently shaken, in order to promote its passage. This is a property we never observed in any other bird, but it is probably common to the rest of the tribe, or such as are destitute of nasal apertures. That all birds have a communication between their lungs and the cavity of their body surrounding the viscera, more or less, is well known; but as there is no passage into the gullet (*œsophagus*) but by the mouth, to effect this inflation a violent compression of the body becomes necessary, at the same time the bill is closed, and the air is forced back into the mouth and pressed into the gullet. It is observable that, in the act of fishing, this bird always carries its head under water, in order that it may discover its prey at a greater distance, and with more certainty than could be effected by keeping its eyes above the surface, which are agitated by the air, and rendered unfit for visional purposes. If the fish is of the flat kind it will turn it in the bill, so as to reverse its natural position, and by this means only could such be got within the bill; if it succeeds in capturing an eel, which is its favourite food, in an unfavourable position for gorging, it will throw the fish up to a distance, dexterously catching it in a more favourable one as it descends. In thus turning the fish, the delatable skin under the bill is of great use, but is by no means deserving of the appellation of a pouch, not being capable of more distension than any other part of the gullet (*œsophagus*) ; nor can it be used as a reservoir for provisions, either for its own use or for the use of its young, as asserted by some authors. It lives in perfect harmony with the wild swan, goose, various sort of ducks and other birds, but to a gull with a piece of fish it will instantly give chase: in this it seemed actuated by a desire to possess the fish, for if the gull has time to swallow it, no resentment was offered. Apparently the sight of the fish created a desire of possession, which ceased when it had disappeared *."

We find the following story given by the Dutch naturalist, Jonston, from Odoric. "In a certaine city," says he, "scituate by the great river in the East, we went to see our host fish. I saw in his little ships, cormorants tied upon a perch, and he had tied their throat with a string, that they should not swallow the fish they took. In every bark they set three great panniers, one in the middle, and at each end one; then they let loose their cormorants, who presently caught abundance of fish, which they put into the panniers, so that in a short time they filled them all. Then mine host took off the straps from their necks, and let them fish for themselves: when they were full, they came back to their pearches and were tied up again †." Scaliger says that a similar mode of fishing was practised at Venice ‡.

In consequence of the pelican (*Pelecanus onocrotalus*, Aldrovand) being furnished with a peculiar organ for storing up its prey, it would seem to be still better adapted than the cormorant for being

* Ornith. Dict. p. 102, 2d edit.

† History of Wonderful Things, p. 185, fol. London, 1657.

‡ Exercitat. xxxviii. 3.

The Pelican (*Pelecanus onocrotalus*).

trained to fish, and we are accordingly informed by M. Pirard that it has been actually employed in this manner by the Chinese*. Labat also tells us that the Indians trained a pelican, which they despatched in the morning after having stained it red, and that it returned in the evening with its bag full of fish which it was made to disgorge †.

The sac or bag of the pelican is an elastic flesh-coloured membrane, which hangs from the lower edges of the under mandible, reaching the whole length of the bill to the neck, said to be capacious enough to hold about four gallons of water. The bird has the power of contracting the bag by wrinkling it up under the mandible, so that it is scarcely visible; but after a successful fishing, it is incredible to what extent it is frequently distended. It preys chiefly upon the larger fish, with which it fills its capacious pouch in order to digest them at leisure; and Sir Joseph Banks remarked, that one which he observed showed considerable dexterity in tossing about the fish stored up in its bag till it lay in the proper position to be swallowed ‡.

Dr. Paley has made this singular bag in the pelican the basis of some excellent remarks on the theory that the organs of animals have been formed not by the Creator, but by their own efforts and habits,—which we think it may be useful to quote. The bag of the pelican, say the theorists, is the result, "not of the habit or effort of a single pelican, or of a single race of pelicans, but of a habit perpetuated through a long series of generations. The pelican soon found the conveniency of reserving in its mouth, when its appetite was glutted, the remainder of its prey, which is fish. The fulness produced by this attempt, of

* Voyage de Pirard, i. 376.

† Quoted by Buffon, Oiseaux, Art. Le Pelecan.

‡ Sir E. Home, Comp. Anat. i. 306.

course, stretched the skin which lies between the under chops, as being the most yielding part of the mouth. Every distension increased the cavity. The original bird, and many generations which succeeded him, might find difficulty enough in making the pouch answer this purpose; but future pelicans, entering upon life with a pouch derived from their progenitors, of considerable capacity, would more readily accelerate its advance to perfection, by frequently pressing down the sac with the weight of fish which it might now be made to contain.

"These, or of this kind, are the analogies relied upon. Now, in the first place, the instances themselves are unauthenticated by testimony, and, in theory, to say the least of them, open to great objections. The instance of the pelican, which appears to me as plausible as any that can be produced, has this against it, that it is a singularity restricted to the species; whereas, if it had its commencement in the cause and manner which have been assigned, the like comportation might be expected to take place in other birds which fed upon fish. How comes it to pass that the pelican alone was the inventress, and her descendants the only inheritors of this curious resource?

"Upon the whole, after all the schemes and struggles of a reluctant philosophy, the necessary resort is to a Deity. The marks of *design* are too strong to be gotten over. Design must have had a designer. That designer must have been a person. That person is GOD *."

The great stretch of wing in the pelican, extending to eleven or twelve feet, and consequently double that of the swan or the eagle, enables it to support itself for a length of time in the air, where it balances itself with great steadiness, and only changes its place to dart directly downwards on its prey, which rarely

* Natural Theology, p. 441, 14th edit.

escapes; for the violence of the dash, and its wide-spread wings, by striking and covering the surface of the water, make it boil and whirl, and at the same time stun the fish, and deprive it of the power of escape*. According to Nieremberg these birds spend in fishing the hours of the morning and evening, when the finny tribe are most in motion, and choose the places where they are most plentiful; and it is not a little amusing, he adds, to behold them sweeping the water, rising a few fathoms above it, falling with their neck extended and their sac half full, then ascending with effort to drop again, and continuing this exertion till the sac is quite filled†.

The white-headed eagle (*Haliaëtus leucocephalus*, Savigny), as described by Wilson, seems to be the prince of fishing birds. "Elevated," he says, "on the high dead limb of some gigantic tree that commands a wide view of the neighbouring shore and ocean, he seems calmly to contemplate the motions of the various feathered tribes that pursue their busy avocations below; the snow-white gulls slowly winnowing the air; the busy sandpipers (*Tringæ*) coursing along the sands; trains of ducks streaming over the surface; silent and watchful cranes, intent and wading; clamorous crows, and all the winged multitudes that subsist by the bounty of this vast liquid magazine of nature. High over all these hovers one whose actions instantly arrests all his attention. By his wide curvature of wing, and sudden suspension in air, he knows him to be the fish-hawk (*Pandion haliaëtus*, Savigny), settling over some devoted victim of the deep. His eye kindles at the sight, and balancing himself with half opened wings on the branch, he watches the result.

* Petr. Martyr, Nov. Orb. Decad. i. 6; apud Montbeillard, Oiseaux.

† Hist. Nat. x. 223.

Down, rapid as an arrow from heaven, descends the distant object of his attention, the roar of its wings reaching the ear as it disappears in the deep, making the surges foam around. At this moment the eager looks of the eagle are all ardour; and, levelling his neck for flight, he sees the fish-hawk once more emerge, struggling with his prey, and mounting in the air with screams of exultation. These are the signal for our hero, who, launching into the air, instantly gives chase, soon gains on the fish-hawk, each exerts his utmost to mount above the other, displaying in the rencontres the most elegant and sublime aërial evolutions. The unencumbered eagle rapidly advances, and is just on the point of reaching his opponent, when, with a sudden scream, probably of despair and honest execration, the latter drops his fish; the eagle, poising himself for a moment, as if to take a more certain aim, descends like a whirlwind, snatches it in his grasp ere it reaches the water, and bears his ill-gotten booty silently away to the woods."

Those birds of the eagle kind which fish on their own account (all of them rob when they can) pursue nearly the same method of dashing from a height upon their prey in the water;—the blagre (*Haliaëtus blagrus*, Savigny), for example, of Africa, and the vociferous eagle (*Haliaëtus vocifer*) called the bald buzzard in M. Vaillant's Travels. The latter usually establishes what may be justly called a fishery at the mouth of some considerable river, over which it hovers high in the air till it perceives a fish, when it dashes down striking the water and plunging its whole body beneath the surface in order to secure its prey, usually a fish of considerable size, which it carries to some neighbouring rock or the trunk of some branchless tree*. So constantly does it keep to the same eating station, that M. Vaillant procured a

* Oiseaux d'Afrique, i. 18.

pair of these birds from discovering such a station. "While walking," he says, "along the bank opposite to that on which my camp stood, I perceived a number of heads, fragments of large fishes, and the bones and remains of small antelopes, strewed on the ground, near the rotten trunk of an old tree. I immediately concluded that this must be the place where a pair of bald buzzards had established their fishery, and it was not long before I saw them sailing in the air at a great height." He found, however, they were too quick-sighted to come to their station while he remained concealed only in the bushes, and it was not till he had a hole dug in the ground, over night, where he concealed himself for two days successively, that he succeeded in shooting the birds*.

The osprey (*Pandion haliaëtus*, SAVIGNY) cannot, according to Montagu, either dive or swim, and consequently can only take such fish as swim near the surface. On one occasion he observed an osprey looking out for prey on the river Avon. At last, he saw its attention arrested, and like the kestril (*Falco tinnunculus*), in search of mice, it became stationary, as if examining what had attracted its notice. After a pause of some time, it descended to within about fifty yards of the surface of the water, and there continued hovering for another short interval, when it precipitated itself into the water with such great celerity as to be nearly immersed. In three or four seconds the bird rose without any apparent difficulty, carried off a trout of moderate size, and, instead of alighting to regale upon its prey, soared to a prodigious height and did not descend within his view†. Pliny gives a similar description, evidently applicable to the same bird, which he says "hath the quickest and clearest eye of all others, soaring and mounting on high: when she spieth a

* Travels, i. 196, 2d edit. † Linnæan Trans.

fish in the sea, downe she comes with a power, plungeth into the water, and, breaking the force thereof with her brest, quickly she catcheth up the fish and is gone*,"—a circumstance which we have frequently witnessed at the kyles of Bute and elsewhere, when we have seen the osprey shoot down like a thunderbolt from the air into the sea upon a fish she had marked for her prey †.

The description, however, which Wilson has given of the fishing of the osprey, excels even Pliny's in eloquence, while it equals Montagu's in accuracy. "On leaving his nest," he says, "he usually flies direct till he comes to the sea, then sails round in easy curving lines, turning sometimes in the air as on a pivot, apparently without the least exertion, rarely moving his wings; his legs extended in a straight line behind, and his remarkable strength and curvature of wing distinguishing him from all other hawks. Suddenly he is seen to check his course, as if struck by a particular object, which he seems to survey for a few moments with such steadiness that he appears fixed in the air flapping his wings. This object, however, he abandons and is again seen sailing round as before. Now his attention is again arrested, and he descends with great rapidity; but ere he reaches the surface, shoots off another course as if ashamed that a second victim had escaped him. He now sails at a short distance above the surface, and by a zigzag descent, and without seeming to dip his feet in the water, seizes a fish, which, after carrying a short distance, he drops it or probably yields up his prey to the bald eagle, and again ascends, by easy spiral circles, to the higher regions, where he glides about with all the ease and majesty of his species. At once, from the sublime aërial height, he descends like a perpendicular torrent, plunging

* Holland's Plinnie, i. 272. † J. R.

into the sea with a loud rushing sound, and with the certainty of a rifle. In a few moments he emerges, bearing in his claws his struggling prey, which he always carries head-foremost, and, having risen a few feet above the surface, shakes himself as a water spaniel would do, and directs his heavy and laborious course direct for the land. If the wind blows hard, and his nest be in a quarter from whence he comes, it is amusing to observe with what judgment he beats up to windward; not in a direct line, but making several successive tacks to gain his purpose*."

It would appear from these accounts that the circumstance mentioned by the ancient naturalists of the osprey being sometimes dragged under water and drowned is not improbable. The polypus (*Medusa* or *Sepia*) is the animal to which, though "unwarlike and timid," as Scaliger† calls it, this is ascribed. Ælian says the polypus holds fast by a rock while it drags the eagle under water‡.

The heron pursues a very different mode of fishing, and we have often admired the patience with which it will stand knee-deep on the edge of a lake, for hours together, as immoveable as if it were inanimate, watching for the chance appearance of a fish or a frog within reach of its formidable bill. Like the spider ambushed in its web, or the ant-lion (*Myrmeleon*) in its pitfall, the heron might be judged by a bystander to be indolent and sluggish; but no sooner does a fish come into view, than its every fibre seems buoyant with animation, and it strikes its victim with electric celerity, rarely missing its aim. We have most commonly seen the heron fishing very early in the morning, but once we observed one on a bright moonlight summer night standing, as we have described, on the edge of Loch Brown in Ayrshire. As

* Amer. Ornith. v. 13.

† Exercitat. 231. ‡ Hist. Animal, vii. 11.

the day advances, it usually quits the water to return to its nest, or to pass to some other fishing station, as we have never seen an instance of its fishing when the day was advanced*.

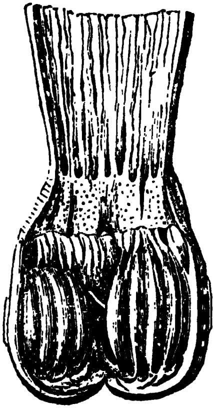
M. Buffon has given a singularly distorted view of the facts we have just stated, erroneously inferring, as it would appear, the degree of misery which he ascribes to the heron, from the supposition of what he himself would feel in similar circumstances. "It is peculiarly unfortunate," as Dr. Drummond well remarks, "that this sort of comparison is not adopted in the only instances where it could be attended with good,—that is, when the animals around us are undergoing pain and deprivation from our own tyranny and oppression. If in these cases we would imagine ourselves in their place, and think of the misery we should experience by such change of situation, it might be a powerful motive for our attempting to mitigate their sufferings. In a state of nature no race of animals is unhappy†."

The dexterity with which fishing birds strike their prey, is well exemplified in the common king-fisher (*Alcedo Ispida*), which, from living on small quick-moving river fish, would starve if it did not far exceed them in acuteness of sight, and rapidity of motion.

In several species which feed upon fish and marine insects, the gizzard has the solvent glands placed either within itself, or similarly to those of carnivorous birds. It is probable, in the first case, that the digestive fluid requires to be applied to the whole surface of the food, which usually consists of fish or reptiles, swallowed entire. The observations of Mr. Bullock accord with this view. When at the Bass Rock, he saw the gannet (*Sula alba*, MEYER) fish for herrings, and frequently watched an individual

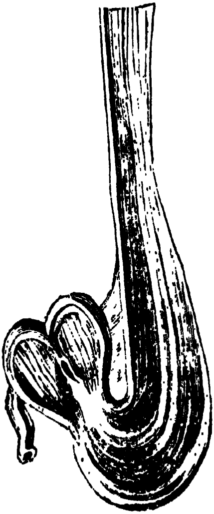
* J. R. † Letters, p. 214.

bird swallow a fish, go to its nest, and regurgitate it into the mouth of its young, and in that short time the skin of the fish had quite disappeared. In the second case, as in the sea-mew (*Larus canus*), and the flamingo, the gizzard has not only a thick lining, but there is a strong digastric muscle, evidently for the purpose of enabling the birds to feed on shell-fish.



The gizzard and cardiac cavity of the Sea-mew, opened to show its internal structure.

A still more striking construction of the digestive organs is found in the rotch (*Mergulus melanoleucus*, RAY). The gullet may be said to form almost a continuous tube descending below the portion where the solvent glands are situated, and then rebending upwards again towards the right, and entering a small gizzard furnished with a strong digastric muscle. The extent of the cavity containing the solvent glands, and turn which it takes almost directly upwards, the gizzard being at the highest instead of the lowest part, appear to be peculiar to this species. "This mechanism," says Sir Everard Home,



Stomach of the Rotch, opened to show its internal structure.

" makes the obstacles to the food in its passage to the intestines unusually great, and enables the bird to digest both fishes and sea-worms with crustaceous shells. It appears to be given for the purpose of economising the food in two different ways; one, retaining it longer in the cardiac cavity; the other, supplying that cavity with a greater quantity of gastric liquor than in other birds. This opinion is further confirmed by the habits of life of this particular species of bird, which spends a portion of the year in the frozen regions of Nova Zembla, where the supplies of nourishment must be both scanty and precarious*."

* Comp. Anat. i. 284.

Chapter VIII.

TASTE OF INSECTIVOROUS BIRDS.

From the circumstance of humming-birds frequenting flowers and thrusting their needle-formed bills into the blossoms, as bees do their tongues and butterflies their suckers, it has been hastily concluded by naturalists, that, like these insects, they feed on honey. But if such naturalists had paused for a moment to consider the structure of the organs in the humming-birds (*Trochilidæ*), their conclusions would not perhaps have been so hasty. Wilson found on repeated dissection, that the ruby-throat humming-bird (*Trochilus colubris*) had always a quantity of insects in its stomach, either whole or in fragments *; and other observers of respectability have confirmed the statement †. The most circumstantial account of this point is given by Audubon in his biography of the same bird.

"The nectar or honey," he says, "which the humming-birds sip from different flowers, being of itself insufficient to support them, is used more as if to allay their thirst. I have seen many kept in partial confinement, when they were supplied with artificial flowers made for the purpose, in the corollas of which water with honey or sugar dissolved in it was placed. The birds were fed on these substances exclusively, but seldom lived many months, and on being examined after death were found to be extremely emaciated. Others, on the contrary, which were supplied

* Amer. Ornith. ii. 26. † See Waterton's Wanderings, &c

twice a day with fresh flowers from the woods or garden, placed in a room with windows merely closed with mosquito gauze-netting, through which minute insects were able to enter, lived twelve months, at the expiration of which their liberty was granted them, the person who kept them having a long voyage to perform."

"This species," continues Audubon, "has a particular liking for such flowers as are greatly tubular in their form. The common jimpson weed or thorn-apple (*Datura stramonium*), and the trumpet-flower (*Bignonia radicans*), are among the most favoured by their visits, and after these, honey-suckle, the balsam of the gardens, and the wild species which grows on the borders of ponds, rivulets, and deep ravines; but every flower, down to the wild violet, affords them a certain portion of sustenance. Their food consists principally of insects, generally of beetles (*Coleoptera*); these, together with some equally diminutive flies, being commonly found in their stomach. The first are procured within the flowers, but many of the latter on wing. The humming-bird might therefore be looked upon as an expert fly-catcher."

Again, says the same delightful author, "no sooner has the sun introduced the vernal season and caused millions of plants to expand their leaves and blossoms to his genial beams, than the little humming-bird is seen advancing on fairy wings, carefully visiting every opening flower-cup, and, like a curious florist, removing from each the injurious insects that otherwise would ere long cause their beauteous petals to droop and decay. Poised in the air, it is observed peeping cautiously, and with sparkling eye, into their innermost recesses; whilst the ethereal motions of its pinions, so rapid and so light, appear to fan and cool the flower without injuring its fragile texture, and produce a delightful murmuring sound well adapted

Humming-birds, engaged in extracting the nectar, and catching insects, in the flowers of *Bignonia radicans* and *Solandra grandiflora*.

for lulling the insects to repose. Then is the moment for the humming-bird to secure them. Its long delicate bill enters the cup of the flower, and the protruded double-tubed tongue, delicately sensible, and imbued with a glutinous saliva, touches each insect in succession, and draws it from its lurking-place, to be instantly swallowed. All this is done in a moment, and the bird, as it leaves the flower, sips a small portion of its liquid honey *." From this description we may perhaps infer that the humming-bird swallows insects alive, as those birds which prey solely on the wing must partly do, their bills not appearing sufficient to crush them.

The greater number of birds are careful to kill their insect prey before swallowing it, as if aware of its being indigestible so long as it remains alive. We had a caged fauvette (*Philomela hortensis*) which in this way would seize large spiders or full-grown caterpillars of the cabbage butterfly, and beat them about the perches and wires of the cage till they were quite dead before it attempted to swallow them. A redbreast, in the same way, will shake and beat an earthworm about, and sometimes break it into several pieces before eating it; and rooks will treat in a similar manner the dew-worms and the grubs of the cockchafer which seem to be their principal food †, though systematic naturalists, from Gesner down to Linnæus and his followers, appear to consider this species as feeding only upon corn, which is contrary to the fact, for they will not touch grain unless compelled by want of their natural food.

Speaking of the rook, Mr. Knapp says, "It has at times great difficulty to support its life, for in a dry spring or summer most of these are hidden in the earth beyond its reach, except at those uncertain

* Ornith. Biography, p. 248-52. † J. R.

periods when the grub of the chafer is to be found; and in a hot day we see the poor birds perambulating the fields, and wandering by the sides of the highways, seeking for and feeding upon grasshoppers, or any casual nourishment that may be found. At those times, was it not for its breakfast of dew-worms, which it catches in the gray of the morning, as it is appointed the earliest of risers, it would be famished. In the hot summer of 1825 many of the young brood of the season perished from want; the mornings were without dew, and consequently few or no worms were to be obtained; and we found them dead under the trees, having expired on their roostings. It was particularly distressing, for no relief could be given, to hear the constant clamour and importunity of the young for food. The old birds seemed to suffer without complaint; but the wants of their offspring were expressed by the unceasing cry of hunger and pursuit of their parents for supply, and our fields were scenes of daily restlessness and lament. Yet amid all this distress, it was pleasing to observe the perseverance of the old birds in the endeavour to relieve their famishing families, as many of them remained out searching for food quite in the dusk, and returned to their roosts long after the usual period of retiring. In this extremity it becomes a plunderer, to which by inclination it is not much addicted, and resorts to our newly-set potato fields, digging out the cuttings. Ranks are seen sadly defective, the result of its labours, I fear; and the request of my neighbours now and then for a bird from my rookery, to hang up *in terrorem* in their fields, is confirmatory of its bad name. In autumn a ripe pear or walnut becomes an irresistible temptation, and it will occasionally obtain a good share of these fruits. In hard frost it is pinched again, visits for food the banks of streams, and in conjunction with its congener the 'villain crow,' becomes a wayfaring bird, and 'seeks a dole from every passing steed.' During the unusually severe winter of 1829-30 our rooks became certainly 'corn-eaters:' the ground was bound down by the frost, and their favourite food hidden by the snow. They fixed themselves by dozens on the oat-ricks out in the fields; and the late-sown, just germinating wheat was dug up from the soil, to a very injurious extent, by our half-famished birds; but they appeared to return to their common food upon the relenting of the frost. Its life is not always dark and sombre; it has its periods of festivity also. When the waters retire from meadows and low lands, where they have remained any time, a luxurious banquet is provided for this corvus, in the multitude of worms which it finds drowned on them. But its jubilee is the season of the cockchafer (*Melolontha vulgaris*), when every little copse, every oak, becomes animated with it, and all its noisy, joyful family feeding and scrambling for the insect food *."

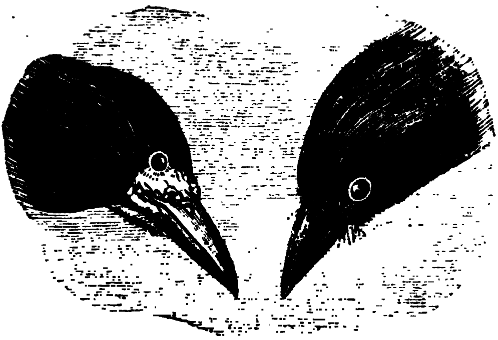
A singular circumstance relating to the rook has given rise to some discussion among naturalists. Instead of the projecting feathers which in other species of crows extend from the eyes and the base of the bill as far as the opening of the nostrils, the rook has a bare, almost white, rough, scaly skin. This peculiarity, according to M. Montbeillard, who is followed by Colonel Montagu †, Dr. Latham ‡, Cuvier §, Temminck ||, and other naturalists, results from its mode of life; for in scratching deep into the ground with its bill, this in time becomes rough from the feathers being worn off by continual rubbing. This opinion is supposed to be strengthened by an

* Journal of a Naturalist, p. 179, 3d edit.

† Orn. Dict. p. 429, 2d edit. ‡ Gen. Hist. iii. 12.

§ Règne Animale, i. 421, edit. 1829.

|| Manuel d'Ornith. i. 111.



Heads of Rook and Crow.

observation made by M. Daubenton, who saw six of these birds in an uncultivated field very busy lifting and turning over the scattered stones in order to get at the worms and insects underneath, and so briskly did they work that they made the smaller stones spring two or three feet. M. Montbeillard adds, that "straggling feathers are perceived at the base of the rook's bill, a sufficient proof that the bird is not naturally bald *."

A bird found at the Cape of Good Hope by M. Vaillant, so closely resembled the rook in size and colour, that he was disposed to consider it the same species, the only observable difference being in having the base of the bill covered with feathers. "Probably," says the author, "because it finds in this part of the world more abundant provision, and is not therefore forced to thrust its beak into the ground in search thereof. I am myself," he adds, "very much disposed to believe that it is friction alone which produces the callosity on the head of the rook; for I have in

* Oiseaux, Art. Le Freux.

Europe, in September and October, killed crows altogether like rooks, with the fore part of the head quite covered with feathers, most probably the young rooks of the year. I have also seen in the beginning of winter very considerable flocks pass into Lorraine, of these same crows, having their faces clothed with feathers. Besides, it would be very easy to ascertain whether this bird naturally loses the feathers on its face, or whether this loss is caused by continual rubbing on the ground while in search of food. It would be quite sufficient to rear a young rook in a cage for one year, and then if the same effect were produced, it ought to be considered characteristic of the species, as it is of some other birds. In this case the crow of the Cape in question would, in spite of its close resemblance to the rook of Europe, be a distinct species. Then the crows I have mentioned, which I saw and killed in Lorraine, would be nothing else than young rooks; for, as I have remarked with respect to vultures having naked heads, they might have this part feathered when young. I propose to ascertain this point on the first opportunity*."

It does not appear that M. Vaillant ever made, or at least published his proposed observations, and it is not usual to tame rooks: M. Bechstein says he never saw one tamed†; but the compiler of Bewick (well known not to have been the admirable artist himself) vaguely says, "the same appearance" of the base of the bill "has been observed in such as have been brought up tame," and therefore "we are inclined to consider it an original peculiarity‡."

Mr. Waterton, in a recent paper, very satisfactorily disproves the opinion, that the feathers are removed by the process of the bird thrusting its bill into the ground.

* Oiseaux d'Afrique, ii. 12.

† Taschenbuch Deutch, i. 97.

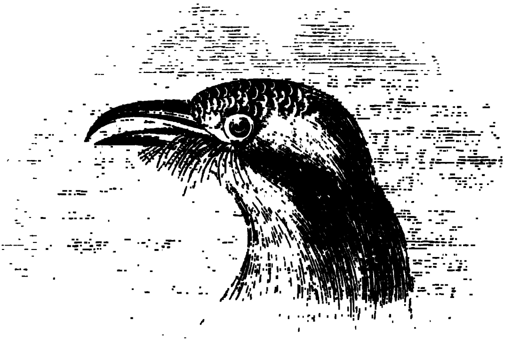
‡ Birds, i. 86, edit. 1826.

The rook indeed, though so common a bird, and so frequently written about by naturalists, has been the subject of no little misrepresentation, from the time Gesner termed it a corn-eater (*Frugivora*), and Linnæus a corn-gatherer (*Frugilegus*), up to the present time. It has been well remarked by the Rev. W. Bree, that "when any mischief is done in the garden, the orchard, the plantation, or on the farm, we are very apt, too hastily, to lay the blame on such animals as may happen, in pursuance of their usual habits, to be occupied in or near the spot where the mischief takes place. Frogs and toads have, before now, been accused of eating the strawberries, because they are often met with among the strawberry-beds. We have been told of a gentleman who charged the rooks with having stripped his oak-trees of their leaves. That the oaks were nearly bare was beyond dispute; and he had himself seen the rooks settling upon them by thousands, and pecking away right and left with their bills. War was therefore declared by the owner against the rooks, and good store of ammunition laid in for the occasion. But, fortunately for the 'black population,' before hostilities actually commenced, the gentleman was convinced by some one who stepped in, and knew more of natural history than he did himself, that the rooks were not in fault; quite the contrary; they had only flocked to the trees for the sake of devouring the myriads of cockchafers, and of the larvæ of moths, which were the real depredators. Every country gentleman, every gardener, every farmer, every person, in short, who owns or is occupied about any portion of the earth's surface, ought to learn something of natural history; for otherwise he runs the risk of persecuting and destroying his best friends *."

Most birds which feed on insects are distinguished

* Mag. Nat. Hist. v. 66, note.

by bristles (*vibrissæ*) at the root of the bill, not unlike the whiskers of a cat, and probably intended to aid them in capturing their prey. These bristles are larger in the night-jars than in most other birds, but are very distinct in most of our small birds, such as the nightingale, the redbreast, the flusher (*Lanius collurio*), the beautiful bird called the roller (*Coracias garrula*), which on rare occasions pays us a transitory visit, and the fly-catchers (*Muscicapidæ*).



Head of the Roller, showing the vibrissæ.

The latter differ considerably in their mode of hunting from several other species which take insects chiefly on the wing. Instead of keeping up a continuous flight like the swallow or the bat, the fly-catcher chooses a station where he can take good observation of all the insects which may venture within his boundaries—generally the dead leafless branch of a tree, or the top of a gate-post; whence, in Kent, the common fly-catcher (*Muscicapa grisola*) is expressively called the post-bird. "This fly-catcher," says Mr. Knapp, "delights in eminences. The naked spray of a tree, or projecting stone in a building, or even a tall stick in the very middle of a grass plot, is sure to attract attention, and from this it will be in constant activity a whole summer's day, capturing its food and returning to swallow it," seeming "to require a proportion of food equal to any bird, capturing one moment and resting the next *."

It is worthy of remark that this is the mode of hunting pursued by some predacious insects, such as the dragon-flies (*Libellulidæ*), with this difference, that the dragon-fly does not so rigidly confine itself to one station as the fly-catcher, probably in consequence of its much greater power of wing, enabling it to range in an instant from one end of a lane to the other. Yet we have remarked that one of these insects will remain for days together in the same beat, returning at intervals to two or three chosen stations, such as a withered bramble-branch, the bend of a projecting rush, or the cross-bar of a paling, ready to dart after any luckless butterfly that might come in sight. The chaffinch (*Fringilla spiza*), though not exactly an insectivorous bird, follows the same practice, though we do not find that this has been remarked by naturalists †.

Mr. Main, an excellent observer, must, we think, be mistaken in saying that the chaffinch is "during summer entirely insectivorous ‡;" for though we believe it feeds its young almost wholly on insects, the old birds uniformly prefer vegetable food. In the early summer they accordingly look out for the seeds which are first ripe, such as those of nailwort (*Draba verna*), groundsel, chickweed, and the speedwells (*Veronicæ*), and even eat the leaves and young shoots when they cannot procure seeds. Their being prolific breeders, and requiring, of course, an extensive supply of insects for their young, may have led to the mistake.

* Journ. of a Naturalist, p. 207, 3d edit.

† J. R.

‡ Mag. Nat. Hist. iv. 417.

We once reared a young chaffinch from the nest, and, previous to its first moult, it eagerly devoured flies and other insects; but afterwards, though it retained the habit of snapping at every fly that came near it, and even of killing them, it always dropped them in the cage, and we never observed it after this period to swallow any insect*.

"In the early part of last summer" (1831), says the Rev. W. Bree, "our attention was attracted by a chaffinch, which, as we sat in our room, we observed to pay repeated visits to a broom-bush (*Spartium scoparium*) immediately in front of our windows. The bird remained a considerable time in the bush at each visit, and appeared exceedingly busy about something, hopping from spray to spray, searching and rumaging among the branches, and evidently using his bill. We suspected that the object of plunder was the young soft seed of the broom, which at the same time was much in the same state as peas are in when fit to gather. Upon examination, however, we found every pod whole and untouched; but the bush was smothered with aphides; and these, we ascertained, (not the soft seeds, as we had supposed,) were what attracted the chaffinch. Whether the bird devoured the aphides itself when in the bush, or (as we rather suspect) carried them off for the purpose of feeding a young brood, we cannot say; but an immense number of aphides must have been destroyed during its repeated visits †." It is probable, however, that during winter, the chaffinch is compelled to become omnivorous, and to put up with whatever it can procure. We have thus frequently observed numbers of them crowding about compost heaps in the fields where little could be found except the maggots of flies or an occasional beetle; and it may be in pursuit of similar prey that

* J. R. † Mag. Nat. Hist. v. 65, note.

they may be seen resorting to the tops of moss-grown walls, since even during cold frosty weather, particularly when the sun shines out, we may occasionally in such places see a ladybird (*Coccinella*) peep out from its mossy retreat to ascertain whether the spring has yet set in, and roused the aphides from their torpidity*. This we deem to be highly plausible; but, as Mr. Knapp has explained the circumstance differently, we shall give our readers an opportunity of comparing his views with our own.

"I have often," he says, "thought that this bird, the chaffinch and some others, obtain much of their support in the winter and spring seasons, especially when the ground is covered with snow, by feeding upon the capsules or fertile heads of various mosses, having frequently noticed them pecking and masticating something upon the walls, and in such places where these plants abound, and nothing besides that could afford subsistence to any animated creature, particularly the awl-screw moss (*Tortula subulata*), and these races perfect their capsules principally during those periods in which other matters which could afford them sustenance is [*are*] sparingly found. The object of the existence of many of these lowly plants has been considered as obscure, and their profusion a general subject of admiration. Of these the hygrometer moss (*Kœlreuteria hygrometica*, Hedwig) presents a very prominent example of unvarying annual exuberance. If this conjecture be correct, that they afford nutriment to these poor little creatures in a season of destitution, it affords us another instance of the benevolence of the Creator, extending, as far as we can perceive, through every department of creation: we cannot trace this chain because we are ignorant of consequences, nor perceive the termination because it is of infinite duration; but to

* J. R.

attest any perception of wisdom and of goodness is a laudable and just homage of the creature who observes it *."

The compiler of Bewick says that the bullfinch (*Pyrrhula vulgaris*, TEMMINCK) "in the spring frequents gardens, where it is usefully busy in destroying the worms which are lodged in the tender buds †." This has been repeated by others ‡, and we were disposed from casual observation to consider it a correct statement, reasoning in part from the analogy of the tom-tit (*Parus cœruleus*, RAY) and birds of similar habit, which do not, we believe, destroy any buds. But we have positive fact, always better than the most plausible analogy, to prove that seed-eating birds do eat buds. We observed, for instance, in the winter of 1831–2, though unusually mild, that the buds of our currant bushes were extensively destroyed by the house-sparrow (*Passer domesticus*). We find also that tame green birds and canaries will feed upon buds or almost any vegetable substance which they can manducate, but refuse all insects §.

In February, 1799, Dr. Townson opened the stomachs of two bullfinches that had been shot in a cherry-tree, and, exclusively of a few grains of sand and some small pebbles, he found nothing but embryo flowers. "I could discover," he says, "with the assistance of my lens, all the parts of the flowers. The mischief these two little epicures had done, and probably at one breakfast, is incredible. From the quantity of buds I found in their stomachs, each of which was composed of four or five flowers, I think they had not eaten less than a thousand a-piece ||."

The testimony of Mr. Knapp, to the same circum-

* Journal of a Naturalist, p. 150, 3d edit.

† Birds, i. 166, edit. 1826.

‡ See Townson's Tracts, p. 157.

§ J. R.

|| Tracts on Nat. Hist. p. 158.

stance, is no less explicit. "The idea," he says, "that this bird selects only such buds as contain the embryo of an insect to feed on it, and thus free us of a latent colony of caterpillars, is certainly not correct. It may confer this benefit accidentally, but not with intention. The mischief effected by bullfinches is greater than commonly imagined, and the ground beneath the bush or tree on which they have been feeding is commonly strewed with shattered buds, the rejectments of their banquet; and we are thus deprived of a large portion of our best fruits by this assiduous pillager, this 'pick-a-bud,' as the gardeners call it, without any redeeming virtues to compensate our loss. A snowy, severe winter makes great havoc with this bird. It feeds much in this season upon the fruit of the dog-rose 'hips,' as we call them. When they are gone, it seems to pine for food, and is starved, or perhaps frozen on its roost, as few are observed to survive a long inclement winter*."

* Journal of a Naturalist, p. 157, 3d edit.

Chapter IX.

TOUCH IN BIRDS.

Two very ingenious theorists, Count Buffon and Dr. Darwin, maintain that the sagacity of animals is in all or most instances dependent on the peculiar structure and delicacy of the organs of touch. The arguguments which they have advanced in support of these views are not a little plausible; and though many of them may be more of the nature of coincidences than related as cause and effect, we think it will prove interesting to introduce a few as illustrations.

The elephant, for example, which surpasses perhaps every other animal in intelligence, possesses a very delicate organ of touch in its trunk or proboscis, with which, as with a hand, it can lift the most minute things; and from its flexibility, it can bend around and feel whatever it wishes to examine. Similar examples occur, though not so strikingly, in other animals, such as the dog, which examines every thing with his nose; and the theory appears to be corroborated by reference to the greyhound, which is well known to be the most stupid of the species, and which, from its possessing a less exquisite smell, does not, like other dogs, examine objects in this manner. It is certain also that the armadillo, which is covered with hard scales, manifests only the lowest degree of wisdom.

" The muzzle," says Buffon, " is divided into two parts by the mouth, because the tongue serves both for touching bodies, and for turning them over, which they often do before they seize them with their teeth. It is likewise probable that animals which are furnished with many instruments of feeling, as the cuttle-fish, the polypus, and others, have a superior faculty of distinguishing, and of choosing what is agreeable or convenient for them. Hence fishes, whose bodies are covered with scales, ought to be the most stupid of animals, because they can have no knowledge of the form of objects, and a very obtuse sense of feeling must be conveyed through the scales. Hence, also, all animals which have not divided extremities, as arms, legs, paws, &c. must have a more obtuse sense of feeling than those that are furnished with these instruments of sensation. Serpents, however, are less stupid than fishes; because, though their skin is hard and scaly, they have the faculty of twisting round bodies, and of obtaining by this means more accurate conceptions of the forms and qualities of these bodies *".

It follows from this theory, that the hand should be the principal organ for procuring intelligence, and consequently that man is furnished with organs of touch superior to any other order of animals. It requires explanation, however, to render this plausible; for many of the four-handed animals (*Quadrumana*, BLUMENBACH), as monkeys and lemurs, have hands as soft and delicate as ours. "The monkey," says Dr. Darwin, "has a hand well enough adapted for the sense of touch, which contributes to his great facility of imitation; but in taking objects with his hands, as a stick or an apple, he puts his thumb on the same side of them with his finger, instead of counteracting the pressure of his fingers with it: from this neglect he is much slower in acquiring the figures of objects, as he is less able to determine the distances or diameters of their parts, or to distinguish

* Oiseaux, vol. i. Intr.

their vis inertiæ from their hardness. Helvetius adds, that the shortness of his life, his being fugitive before mankind, and his not inhabiting all climates, combine to prevent his improvement*. There is, however, at this time, an old monkey shown in Exeter Change, London, who, having lost his teeth, when nuts are given him, takes a stone into his hand, and cracks them with it one by one; thus using tools to effect his purpose like mankind.

"The beaver is another animal that makes much use of his hands; and, if we may credit the reports of travellers, is possessed of amazing ingenuity. This, however, M. Buffon affirms, is only where they exist in large numbers, and in countries thinly peopled with men; while in France, in their solitary state, they show no uncommon ingenuity.

"Indeed all the quadrupeds that have collar-bones (*claviculæ*) use their fore limbs in some measure as we use our hands—as the cat, squirrel, tiger, bear, and lion; and as they exercise the sense of touch more universally than other animals, so are they more sagacious in watching and surprising their prey. All those birds that use their claws for hands, as the hawk, parrot, and cuckoo, appear to be more docile and intelligent; though the gregarious tribes of birds have more acquired knowledge†."

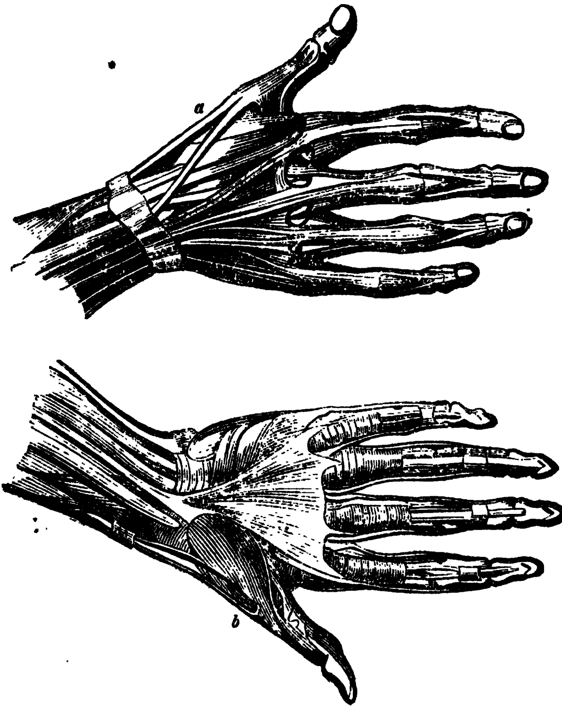
The hand of man, again, considered in this point of view, is most exquisitely contrived. The fingers, though composed of bones and strong ligaments to give them vigour, are, at the same time, finely adapted for bending round objects, and ascertaining their shape and their inequalities or their smoothness. The mechanism, also, by which these several parts are moved, furnishes a striking illustration of the wisdom of Providence. To give the fingers

* De l'Esprit, tom. i.

† Zoonomia, i. 199.

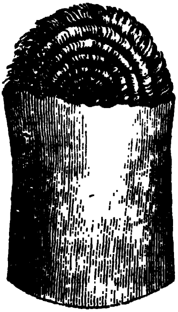
strength in grasping and in sustaining weights, powerful muscles were indispensable; and muscles, to be strong, must be large, or of considerable length. Now, had muscles of the necessary magnitude to move the fingers with power been situated in the palm, or on the back of the hand, they would have rendered it thick and clumsy, and its lightness, mobility, and beauty would have been destroyed. To prevent this unsightly clumsiness, and also to give them a more powerful purchase from their length, the muscles which move the fingers are disposed of in the arm, some of them as high as the elbow-joint. They act on the fingers by means of long narrow tendons, like ribands, which are firmly strapped down at the wrist by a cross band of muscle, to prevent their rising out from the arm, as the tendons called the hamstrings do at the back part of the knee-joint, in consequence of not being thus bound down. This, however, is only part of the mechanism. The tendon or cord which draws the ends of the fingers inwards to the palm, and which is inserted a little short of the nail, would have also started out inconveniently from the finger, like the string of a bow, had it not been bound down in the same way. On the inside of the fingers, however, a strap like the one at the wrist would have been too clumsy. Instead of this, the tendon or cord of the tip or end joint passes through a slit in the tendon of the second joint, which prevents it from starting out from the bone. Nothing could have been better provided for uniting lightness, mobility, and strength.

The thumb is a very important part of the hand, and is, at least so far as strength is concerned, almost peculiar to man; for, in the hands of apes and lemurs, the thumb is small and feeble (Eustachius says it is altogether *ridiculous*), and cannot act, as in man, in opposition to the combined force of the



Muscles of the hand.—*a*, back view. *b*, front view.

fingers. The mechanism for moving the thumb is somewhat different from that of the fingers. The most important muscles of the thumb—those which bend it in opposition to the fingers—could not have been fixed in the arm, as the required motion is across the palm. These muscles are accordingly placed around the inner ball of the thumb, forming



Nerves of the finger.

a firm and vigorous assemblage of cords, ready to move the thumb in every useful direction.

The wild fancy which was maintained by Lord Monboddo, that man originated from a race of orang-outangs, which had learned by accident to bend the thumb in opposition to the fingers, is refuted by the structure of the thumb in these animals*. " It must be observed," says Mr. Coulson, " that the fingers of their hands are opposed with difficulty to the thumb, which is sometimes altogether wanting; besides, both the toes and fingers are with difficulty separated from each other †." Though Dr. Darwin, as we have already seen, attributes superior sagacity to such birds as use their claws for hands, facts do not by any means bear him out in the example he adduces of the cuckoo, which certainly exhibits no superiority of intelligence over the goose or the buzzard, both proverbial for stupidity. Birds indeed appear to be stupid rather in proportion to their bulk, whatever may be the cause,

* Meckel, Anat. Comp. vi. § 210.
† Blumenbach, Comp. Anat. § 224, note.

than with respect to the peculiar structure of their feet; at least, there can be little doubt that the peacock, the bustard, and the ostrich, are more stupid than the sparrow, the tom-tit, and the humming-bird.

It may certainly improve the tact of such birds as possess the power of turning one of the toes either backwards or forwards at pleasure. The osprey (*Pandion halieætus*, SAVIGNY), for example, like the eagles, has one back and three front toes, but it differs both in having the outer toe larger than the inner ones, and in this toe being moveable, so that the bird can turn it back at pleasure,—a disposition better adapted for grasping the slippery fish on which it feeds, than were it constructed like the feet of other birds. We find a similar structure in the foot of the cuckoo, and Dr. Drummond conjectures "that the cuckoo lays her egg on the ground, and then conveys it in her foot to the nest of its future foster parent *," though M. Vaillant, as we have elsewhere seen, almost proves that the egg is carried in the bill †. Dr. Drummond is also disposed to consider the very large foot of the nuthatch (*Sitta Europæa*) peculiarly adapted for carrying nuts, and holding them firm till it opens them with its bill.

In man, the hand is without doubt the principal organ of touch; but we frequently also use the lips, the tongue, and the teeth, for ascertaining the tactual qualities of things. The teeth indeed, as we have already remarked, have a very delicate perception of some of the properties of substances, particularly their cold, heat, and resistance, and are often employed to discover these properties. The lips, again, form a very important organ of touch, as their muscularity fits them so well for taking hold of whatever

* Letters to a Young Naturalist, p. 207.

† Architecture of Birds, p. 376.

is submitted to them for examination. Their touch is also perhaps rendered more nice and delicate by there being no fat lining the skin, as is the case in most other parts of the body. The tongue also, in its movements of speaking, eating, and swallowing, so far as it is not affected with taste, is plainly a muscular organ of touch. Dr. Haslam, however, is disposed to consider it obtuse in its tactual feeling, as any person, he says, may easily prove to his satisfaction by the experiment of applying his tongue to the wrist to discover the state of his pulse *. But he surely forgets that the tongue can readily detect the finest hair amongst food, and that Mitchell, the blind and deaf boy, made great use of his tongue as an organ of touch. Its supposed imperfection, when applied to the pulse, arises from its flexibility and deficient strength.

In the horse the lips seem to be peculiarly adapted to be an organ of touch, being large, very moveable, and well supplied with nerves †; though Blumenbach says he is not so clear in considering, as has been done by Derham and Darwin, the snout of the mole and the swine as genuine organs of touch, much less the whiskers of the cat and many other quadrupeds, though he thinks these serviceable, when they come in contact with any object, in warning and making the animal attentive.

Cats, according to Darwin, "seem to possess something like an additional sense by means of their whiskers; which have perhaps some analogy to the antennæ of moths and butterflies. The whiskers of cats consist not only of the long hairs on their upper lips, but they have also four or five long hairs standing up from each eye-brow, and also two or three on each cheek; all which, when the animal erects them,

* On Sound Mind, p. 56.

† De Blainville, Anat. Comp. p. 221.

make with their points so many parts of the periphery of a circle, of an extent at least equal to the circumference of any part of their own bodies. With this instrument, I conceive, by a little experience, they can at once determine whether any aperture amongst hedges or shrubs, in which animals of this genus live in their wild state, is large enough to admit their bodies; which to them is a matter of the greatest consequence, whether pursuing or pursued. They have likewise a power of erecting and bringing forward *the whiskers on their lips, which probably is for* the purpose of feeling whether a dark hole be further permeable *."

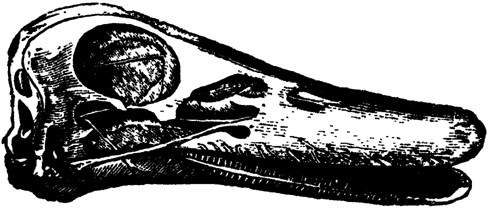
"The seal," says Blumenbach, "has a very long nerve below the orbit of the eye, consisting of about forty branches, which are distributed to the projecting lip. I have traced many of their terminations to that part of the integuments in which the bulbous roots of their strong whiskers are inserted. I think, however, that the ornithorynchus clearly possesses an organ of touch. In this curious animal, the sense in question resides in the integuments which cover the expanded portion of its jaws, particularly the upper one; this part is most copiously supplied with nerves from the fifth pair, and chiefly from its second branch, distributed just in the same manner as they are on the corresponding parts of swimming birds †."

Sir Everard Home describes the mouth of this animal to be "regularly formed like that of a quadruped, but projecting beyond it a bill so like that of a duck, that it might almost be taken for it, though it is still more like that of a spoonbill, the middle part being composed of bone, and the whole having a very strong cuticular covering. In the upper mandible of the bill the lip extends for half an inch everywhere beyond the bony part, and is thick and fleshy; the

* Zoonomia, i. § 16. † Comp. Anat. § 224.

upper surface is smooth, and where it joins the head there is a circular flap which lies loose upon the hair; the under surface of this portion is also smooth, but has two hard ridges of a horny nature, situated longitudinally on each side of the middle line of the bill. The lower mandible of the bill is much smaller than the upper, and when opposed to it, the upper lip extends beyond it for the whole of its breadth *."

The structure which has just been described is exactly similar to that of geese and ducks, whose bills are covered with an extremely sensible skin, supplied with an abundance of nerves from all the three branches of the fifth pair,—an apparatus that enables them to feel about for their food in mud, where Blumenbach (mistakingly as it seems to us) supposes they can neither see nor smell it †.



Skull of the Duck, showing the distribution of the fifth pair of nerves to the upper mandible, and the serratures on the edge of the lower jaw.

M. Majendie is disposed to restrict the term *tact*, amongst other things, to the perceptions of heat and cold; but though we do not consider the restriction happy, there can be no doubt of the sensation being considerably different from others peculiarly ascribed to touch, though we may not, with Darwin and Fleming, refer them to a distinct sense. Dr. Fleming distinguishes what he terms the sense of heat from

* Home's Lectures, i. 304.

† Comp. Anat. § 224.

Ornithorynchus paradoxus—The Duck-bill.

touch, by its not requiring, like the latter, any muscular effort for its exercise *. That there are peculiar nerves, in various parts of the skin, appropriated to the perception of heat, Dr. Darwin thinks is proved by the heat of a furnace giving no pain to the nerve of the eye, while it scorches and pains the parts adjacent. Warm water, again, or warm oil, when poured into the ear, gives no pain to the nerves of hearing, and its warmth is not even perceived by them, though it may be hot enough to scald the external orifice. He evidently does not, in this, make any account of these nerves being deep-seated. Whether these facts and others of a similar kind are sufficient to authorize us to consider the sense of heat distinct from that of touch, we shall not here stop to determine, but content ourselves with mentioning a few circumstances illustrative of the subject, in addition to those we have mentioned elsewhere †.

Amongst birds, fewer instances perhaps are commonly observed of the peculiar influence of cold and heat than in other animals, in consequence, no doubt, of their warm covering of feathers. We have remarked also, that the non-conducting power of the feathers is peculiarly increased in some of the smaller species during the night by changing the position. We have at present, for example, an ox-eye (*Parus major*, Ray), which, when going to sleep, rolls itself into a round ball, erecting every feather so far as not to separate its point from the adjoining ones. The quantity of the non-conducting surface is by this means increased to the depth of nearly half an inch more than it is when the feathers are laid flat and smooth, while the bird is skipping about the cage in the day time; and as the feathers of the belly are at

* Philosophy of Zoology, i. 171.

† Insect Miscel. p. 16, &c.; and Habits of Birds, chap. iii.

the same time spread over the feet, the little creature is admirably protected from the cold. Amongst the birds we have observed in confinement, the black-cap, which perches in roosting, is very particular in spreading a bundle of feathers over its feet, though it is not possible to cover them so completely on a perch as the little ox-eye can do in sitting on the floor of the cage. We were the more struck with this circumstance in the black-cap, from the non-migratory birds in the contiguous cages usually roosting with their legs exposed, as is the case with the goldfinch, the green-bird, the redbreast, and even the dunnock (*Accentor modularis*), whose red legs might indicate greater delicacy of skin than either the ox-eye or the black-cap, whose lead-coloured legs might induce us to imagine them less sensitive *.

There can be no doubt that several of our smaller birds which migrate to a warmer climate in winter, are more susceptible to impressions of cold than species apparently more tender that winter here, such as the gold-crested wren, whose bustling activity appears to keep it warm during frosty weather; and it no doubt erects its feathers during the night in a similar manner to the ox-eye. Mr. Sweet remarked, that some of the migratory birds are so tender that the slightest frost is often sufficient to kill them, and they are consequently fond of huddling into the warmest corners. From the chinchilla (*Chinchilla lanigera*) being a native of Chili, it was inferred that it might be pleased to lie warm, and a piece of flannel was accordingly given to one in the collection of the Zoological Society; but instead of lying upon it, as a cat would have done, it always pulled it about, and dragged it to the outer division of its cage. It is to be recollected, however, that both its fur and skin are thick, while the skin of the cat is tender, which

* J. R.

makes it both susceptible of cold, and, as Pennant observed, terribly afraid of being beat.

The cat also, as is well known, prefers the hearth-rug to any other situation in a room, and though she cannot be said to exhibit much contrivance in keeping herself warm, compared at least with her insidious cunning in taking her prey, she certainly shows most surprising knowledge and tact in discovering the best non-conductors of heat. Darwin would have considered this as an unequivocal proof of knowledge derived from experience*; but as we cannot bring ourselves to give cats the credit of discovering, and then acting upon, the philosophic principles of the distribution of caloric, we shall venture upon the inference from the fact that they are not indigenous (contrary to the received opinion) to so cold a climate as Britain, and are impelled to search after warm places in consequence of their great impatience of cold.

The feet of the cat, though they are thickly clothed with hair above, and padded with a soft cushion of thickened epidermis, intermediate between cartilage and tendon, on the soles, may be always observed to be cold to the touch when the animal has been exposed to a low temperature, as are the ears likewise, and in such circumstances it manifests its uncomfortable feelings by restlessly wandering about till it can find a warm corner. This very appetite (if it may be so called) for warmth appears to us to be the chief cause which prevents our domestic cats from ever becoming wild; for in every part of the country where there are woods, they might find abundant prey; and it is well known that when cats once take to bird-catching in the woods, they never afterwards eat any thing dead but with reluctance. We have had many opportunities of observing cats in this half-wild state; but though they depended for food wholly upon the

* Zoonomia, i. § 16; and Brown's Observ. p. 263.

birds and mice they could catch, and were so wild as scarcely to permit themselves to be seen, much less approached, yet no instance ever came to our knowledge of their having made their domicile in the woods; but they uniformly slept and littered in the least frequented barns and other out-houses of farms. This we are inclined to attribute to their finding such places warmer than any they could discover in the woods, and to the supply of mice they might find there when birds were less plentiful; for it could not well be traced to their attachment to man, whom they always fled from as fearfully as a fox would do.

A very particular instance of this once came under our observation. A cat, which had been long remarked as one of the wildest of those which frequented a barn on the borders of a wood in Ayrshire—so wild indeed as to be seldom seen—was several times during a sharp frost observed, with no little surprise, to pass and repass into the adjacent farm-house, which it had not for some years been known either to enter or approach. It might have been inferred that it was compelled by hunger, had not this been the best season for catching birds; but, in one of its stealthy visits, it was seen snugly coiled up beside a baby in the cradle, to the no small horror of the mother, who imagined, in accordance with the popular prejudice, that it had come to suck away the baby's breath. All we could say to persuade her of the impossibility of the cat doing this was of no avail, and orders were immediately given to every servant on the farm to kill the poor cat wherever she could be found. Her caution and agility, however, were long successful in saving her, and though the persecution she thus experienced rendered her, if possible, much wilder than before, yet she was not thereby deterred—not even after being wounded by a pitch-fork, and her leg lamed by throwing a hatchet at her—from paying a daily visit to the baby in the cradle, because it was the warmest place within her knowledge, and next to food she considered warmth as indispensable to life. She persisted thus in venturing to the cradle till she was at length intercepted and killed *.

It is worth remarking, that this cat was a pale tabby of small size, with a long slender tail tapering to a point, none of which circumstances agree with the common wild cat (*Felis catus*, LINN.) found in our mountain woods. The latter has a short tail, which, when bent over the back, only reaches to the shoulder; while it is thick, or rather broad, and does not taper, but ends bluntly as if a portion had been cut off.

Tails of the wild and domestic Cat.

M. Temminck, looking at these distinctions, and also at the great difference of size, the wild being a third larger than the domestic cat, is of opinion that they are decidedly different species, and he is disposed to consider a new species (*Felis maniculata*) recently sent from Nubia by M. Rüppel as the original of the domestic cat †, which opinion would accord

* J. R.

† Temminck, Mammalogie, No. iv. sp. 17. We have, since

with the above remarks respecting its impatience of cold. Linnæus and Buffon seem to have been among the first to confound these two species, though the latter was aware of the remarkable difference in the length of their intestines,—those of the wild cat being only thrice the length of the body, proving it to be purely carnivorous, while those of the domestic cat are much longer, being nine times the length of the body, proving it to be able to subsist on a portion of vegetable food; and accordingly we find that our cats are very fond of boiled greens, &c. which it is probable no wild cat would touch. That these changes are not caused by domestication is proved by no such difference appearing in the intestines of the wild boar and the pig, and by domestic animals being always increased rather than diminished in size, when compared with their known wild originals. To enter more minutely into this, however, would lead us too far from our immediate subject; but it may be worth mentioning that the domestic cat is only of recent introduction in the higher northern latitudes, as in Sweden * and Norway †, while it is not yet introduced into Lapland ‡.

The demoiselle heron (*Anthropoides Virgo*, VIEILLOT), which Buffon had from the coast of Guinea, took similar care of its comfort to the cats above mentioned, for he tells us "it had chosen for itself a room with a fire to shelter it during the night, and in winter (1778) it repaired every evening to the door sounding for admission." A similar anecdote is related by M. Antoine of a lapwing

writing this, seen Rüppel's specimens at Frankfort, and cannot agree with Temminck. J. R.

* Linnæus, Fauna Suecica.

† Pontoppidan, Nat. Hist. Norw. ii. 18.

‡ Zimmerman, Spec. Zool. Geograph. p. 172.

Anthropoides Virgo—Demoiselle Heron.

(*Vanellus cristatus*, MEYER), "which a clergyman kept in his garden; it lived chiefly on insects; but as the winter drew on these failed, and necessity compelled the poor bird to approach the house, from which it had previously remained at a wary distance; and a servant hearing its feeble cry, as if it were asking charity, opened for it the door of the back kitchen. It did not venture far at first, but it became daily more familiar and emboldened as the cold increased, till at length it actually entered the kitchen, though already occupied by a dog and a cat. By degrees it at length came to so good an understanding with these animals, that it entered regularly at night-fall, and established itself at the chimney corner, where it remained snugly beside them for the night. But as soon as the warmth of spring returned, it preferred roosting in the garden; though it resumed its place at the chimney corner the ensuing winter. Instead of being afraid of its two old acquaintances, the dog and the cat, it now treated them as inferiors, and arrogated to itself the place which it had previously obtained by humble solicitation. This interesting pet was at last choked by a bone which it had incautiously swallowed *."

These birds, we think, manifested more intelligence, instinct, or whatever it may be called, than occurs in an animal much wiser in appearance, the Barbary ape (*Macacus sylvanus*, LACEPEDE), which, though a native of Africa, has established a colony on the rock of Gibraltar. Here it is occasionally so cold in winter, that these poor apes are fain to huddle about any chance fire that may be lighted; but though they are seen sitting close to the dying embers, they have never been known to add a single chip of fuel to continue the fire †, a circumstance not a little singular.

* Antoine, Animaux Célèbres, i. 70.

† Scott, Intellectual Philosophy, iv. 1.

Those animals which lie torpid during winter are usually careful to provide a warm and well sheltered domicile for their long sleep, and it is not a little interesting to observe the proceedings of different species. The edible snail (*Helix pomatia*, LINN.), for example, found in the middle districts of England, but supposed to have been introduced from the Continent in the sixteenth century, forms at the end of autumn a very curious winter cell. When at liberty, it constructs this cell of earth, moss, and withered grass, by means of its muscular foot, enlarging the cavity by turning itself round, and forming the roof by carrying up portions of earth and moss *. But, according to Mr. Bell, " it is not by the pressure of the foot and the turning round of the shell that this is principally effected. A large quantity of very viscid mucus is secreted on the under surface of the foot, to which a layer of earth or dead leaves adheres; this is turned on one side, and a fresh secretion being thrown out, the layer of earth mixed with mucus is left. The animal then takes another layer of earth on the bottom of the foot, turns it also to the part where he intends to form the wall of his habitation, and leaves it in the same manner, repeating the process until the cavity is sufficiently large, and thus making the sides smooth, even, and compact. In forming the dome or arch of the form, a similar method is used, the foot collecting on its under surface a quantity of earth, and the animal turning it upwards, leaves it by throwing out fresh mucus, and this is repeated until a perfect roof is formed †."

We brought a pair of these animals from the woods of Godesberg on the Rhine in 1829; and as they were kept under an inverted glass with only a few

* M. Gaspard in Majendie's Journ. de Physiologie, ii. 295.

† Zoological Journal, i. 94, note.

leaves, it was amusing to see how solicitous they appeared to be to make the most of these in forming their cells. One of them made the side of the glass a part of the wall of its cell, against which it formed a sort of arch with such leaves as chanced to be within its reach ; but as it seemed to have no idea of bringing materials from a distance, the covering was thin and imperfect. The other attempted to establish itself in the middle of the area, apart from the sides of the glass ; but it was less successful than its fellow, as it always deranged the portion of wall it had constructed by turning about in search of materials. It was curious to remark the different habits of two other species of the family (*Helix aspersa*, and *Helix nemoralis*, MÜLLER), confined under the same glass. The latter, giving themselves no trouble about a covering, crept quietly up as high as they could get, and formed their calcareous lid (*operculum*) upon the bare glass. The second of the edible snails was at length reluctantly compelled to follow their example, after being foiled in all attempts to cover itself with a dome of leaves.

Our common hedge-hog (*Erinaceus Europæus*) makes a similar preparation to the preceding for his winter's sleep, being frequently found so bewrapped in leaves, as to have little resemblance to an animal. The hedge-hog however has not, so far as we are aware, been ever observed in the act of forming this covering of leaves, though it is supposed to roll itself about till its spines take up a sufficient number, in the same way as it is popularly believed (without proof) to do with apples. That it collects leaves for this purpose, and carries them to its den, has been repeatedly witnessed ; and when domesticated it will construct a barricade of leaves at the mouth of its den*. It

* Gent. Mag. for June 1782.

would hence appear that the ancient Greeks erroneously undervalued the skill of the hedge-hog, when, comparing it with the *polysophia* of the fox, they said it only knew the important art of defence*.

The hare, which remains active all winter, is somewhat less provident against cold, its close fur, particularly upon the feet, furnishing it with good protection; and yet the winter *form*, as it is called, or den of the hare, is a very snug little place. We had once occasion to cross the wild mountainous tract on the north-east boundary of Ayrshire, after a heavy fall of snow, which a subsequent frost had hardened on the surface into a crust sufficient to bear the foot without sinking. For several miles we did not see a living creature, and even the hardy raven, that might have fared sumptuously on the hapless sheep, many of which had fallen victims to the weather, seemed to have abandoned its summer haunts for the warmer vicinity, perhaps, of the sea-coast. On crossing a small holm by the side of a brook, the water of which we could hear running, though it was mantled over with snow and invisible, we were not a little startled—alarmed indeed—by a hare dashing through between our legs and almost upsetting us, and we found we had actually stepped over her *form* before she was roused †. The ancients had a notion that the hare sleeps with its eyes open ‡, and hence, Horus Apollo says, the Egyptians pictured a sleeping hare as the hieroglyphic of what was obvious. "The Greeks," says Gesner, "had a common proverb (Λαγος καθευδον), 'a sleeping hare,' for a dissembler or counterfeit, because the hare sees when she sleeps; for this is an admirable and rare work of nature, that all the residue of her bodily parts take their rest, but the eye standeth continually

* Πολλ' οἶδ' ἀλωπηξ ἀλλ' ἐχῖνος ἓν μεγα. Zenodotus ex Archiloch.

† J. R.

‡ Gesner, Hist. Anim. by Toplis, p. 208.

sentinel*." The hare in question, however, must have been in a profounder sleep than usual, tempted perhaps by the supposed security of its retreat in this almost untrodden wilderness. Upon examining the form, we found it as neatly rounded as a bird's nest, and of considerable depth, the foundation being a thick tussock of withered rush (*Juncus maximus*) well lined with bent, not carried thither, it would appear, but grown upon the spot, and only beat down and arranged into a snug, circular, basket-like cavity, just sufficient to contain the little animal when coiled up to sleep. We could not ascertain whether it had been quite open above, or partly covered with bent and rushes, and curtained with snow; but we think the latter most probable, for had there been a speck of darker colour than the uniform white surface around us, before we came to the spot, we could scarcely have failed to observe it. If such a covering, however, had existed, it must have been destroyed at the exit of the hare.

White of Selborne, in describing the severe season of 1776, still remembered in popular chronology as the *Frosty Harvest*, says, "The hares lay sullenly in their seats, and would not move till compelled by hunger; being conscious, poor animals, that the drifts and heaps treacherously betray their footsteps and prove fatal†." It is by no means unlikely that this was the case with the hare which we started; for we could perceive no footprints to or from her little nest; but if she did move out to forage, she must have gone at least a couple of miles to the nearest farm-yard, at Whitehaugh, where she had every chance to be shot while tasting the rip of corn usually hung out about the hedges for this purpose; in which way, indeed, we had seen one killed the previous night at Waterhead farm. It may be true, as the older authors affirm, that hares never

* Ibid. p. 209. † Nat. Hist. of Selborne, Let. 10.

feed near home, "either," says Gesner, "because they are delighted with foreign food, or else because they would exercise their legs in going; or else, by secret instinct of nature, to keep their forms and lodging-places unknown*." Albertus Magnus, on the other hand, says that hares feed only in the night, because their heart and blood is cold,—evidently, in this case, speaking, as was heretofore the custom, upon mere conjecture.

Several animals, among those which do not become torpid, provide no hay-lined cell as a snug retreat from the cold, but contrive to prevent the dissipation of their animal heat by retreating under the snow itself, taking advantage of the covering furnished by Providence for the protection of vegetables. The latter is beautifully illustrated, as it appears to us, by what occurs in the cultivation of Alpine plants in our gardens, many of which, such as auriculas, some saxifrages, &c., are not unfrequently destroyed or rendered unhealthy by our winters, whilst they flourish amidst their native snow; probably because in the Alps, where they are growing wild, they are throughout the winter covered with a complete coating of snow, which, from not being a rapid conductor of heat, is instrumental in the earth's not parting quickly with its warmth, in the same manner as woollen garments prevent the escape of heat from the body;—this protects them through the cold season: whereas, in our climate, these plants are exposed alternately to the severe influence of frost (unprotected by the covering of snow), and to long-continued rains. Even during the winter months our plants frequently commence growing before the spring arrives, and thus are rendered more obnoxious to the succeeding frosts, and, besides this, the chief strength of the plants (which should be reserved for

* Gesner, by Toplis, p. 209.

the great effort to be made in the spring) is exhausted before its due season; whilst, in the Alps, they lie entirely dormant until the sun at once melts the snow, and calls them into life and blossom. Gardeners, accordingly, in the cultivation of the finer sorts of auriculas, &c., have to imitate, as far as possible, their native climate, by protecting them in a frame or shed both from the severe frosts and wet.

Amongst the animals which take advantage of the non-conducting property of snow, the white grous or ptarmigan (*Lagopus vulgaris*, FLEM.) may be mentioned, which will burrow under the drifted wreaths, picking up a scanty subsistence among the herbage and seeds of heath for many weeks. This indeed may be considered one of its destined and regular habits*, and it no doubt feels as comfortable while it is protected from the keen frosty gales of the mountain by its snowy canopy, as does the partridge of the low country when skulking for a similar purpose under the lee side of a hedge; but there are two other native species of grous, the black-cock (*Tetrao tetrix*), and the moor fowl (*Lagopus Scoticus*, FLEMING), the latter peculiar to Britain, which only resort to the same expedient when forced by accident. The common shelter of both of these is the higher and more bushy clumps of heath (*Calluna vulgaris*, HOOKER); but when these, as occasionally happens in most winters, become covered with snow, the grous find it convenient to remain under cover, rather than venture abroad, where they have less chance of meeting with food and shelter.

The care taken by insects to protect themselves from cold we have elsewhere adverted to†, but may here mention one or two facts by way of illustration,

* See Olaus Magnus, Hist. Septentrion, xix. 33, for an interesting account of the mode of hunting these birds.

† Insect Transformations, chap. xvii.

nothing, we conceive, being more interesting than comparisons between animals of different species, with reference to similar circumstances. One of the most remarkable circumstances, then, with regard to this in insects, is the early appearance of some species. Although few insects are seen during cold weather, yet on fine days some are always stirring; but it is much less wonderful to see the larger butterflies (*Vanessa Urticæ, Gonepteryx Rhamni, &c.*) braving the cold, inasmuch as their bodies and wings are warmly clothed with down and feathers, than some of the more delicate moths (*Tortricidæ; Tineadæ*), which appear to be less comfortably clothed. The common hive-bees, when tempted by a glimpse of sunshine to leave their hive, frequently perish of cold before they can effect their return; though they also have a tolerably thick coat of hair for their defence. This early appearance of bees, however, as well as of some butterflies, may be considered as accidental, rather than according to the usual order of things; but there are several insects whose regular time of appearance is fixed by nature in the first months of the year, probably for the purpose of supplying a scanty meal to such of the soft-billed birds as are permanent residents, the berries on which they have in part subsisted being now useless or exhausted. Amongst these we may reckon the small egger-moth (*Eriogaster lanestris*), which is disclosed towards the end of February, having lain from the preceding July in a pupa case, similar to plaster of Paris in consistence and appearance. The moth itself is but of middle size, and is pretty closely covered, particularly on the body, with hair. Its inconspicuous chocolate brown colour might furnish the advocates for concealment in respect of colour with a very good illustration.

The little gnat (*Trichocera hiemalis*, MEIGEN), which may be seen in troops during winter weaving eccentric dances in the air, even when the ground is covered with snow, flies for shelter, as we have frequently found, to the hollow stems of umbelliferous plants, and similar places, near its usual haunts. A much smaller and more delicate fly, which has not a little puzzled systematic naturalists to class (*Aleyrodes Cheledonii*, LATREILLE), preserves itself from the cold in a similar manner. This species is so small that it would not cover the area of a pin's head, and its snow-white wings, as well as its elegant form, might entitle it to the appellation of the mite-butterfly; yet so well does this tiny creature know how to avoid cold, that after the severe winter of 1829-30, we found three of them sporting about in March, in Shooter's Hill Wood, as lively as if no frost had occurred.

During the previous frost in that season, we opened two nests of the yellow ant (*Formica flava*), in which the inhabitants were by no means torpid or inactive, although not so lively as in summer; but these nests had been carefully constructed in a peculiarly warm situation, being both in the trunks of old willows, rendered quite spongy by dry rot, and facing the south-west, where they had the benefit of every glimpse of sunshine.

Chapter X.

LOCOMOTIVE FACULTIES OF BIRDS.

Birds, particularly small birds, appear to be the most restless of all animals,—a circumstance which might lead us to conclude, that animals are restless in proportion to their diminutive size, were this not in opposition to many other facts. The bee, for example, is equally noted for industry and bustling activity with the ant, which is not one-fourth of its size; nay, the large wood ant (*Formica rufa*) is greatly more active than the very small black ant (*Ponera contracta*, Latreille). The gnat (*Culex*), again, a comparatively small insect, seems to repose during the greater part of its existence, remaining fixed in one spot for whole days together, and only moving about for an hour or two in the evening; while we may observe on the same wall a still smaller insect (*Neiedes elegans?* Curtis) seldom moving quicker than the minute-hand of a clock, the motion of which, by interrupted jerks, much resembles that of the insect.

There cannot, however, be a doubt that the wren and the tom-tit are more active and restless than the bustard, the ostrich, or even than the eagle; and the activity moreover of such small birds is not, like that of the gnat, confined to an hour or two, but continues almost uninterruptedly during sun-light, sleep being, it would appear, less necessary than it is to larger animals to restore vigour after exertions so long continued. Motion of some kind indeed seems as indispensable to life as food and air; and even the motions of animals, which may be primarily accounted for by referring to their exertions to procure subsistence, and shelter, and the like, must always, in a secondary point of view, give them beneficial exercise.

WALKING OF BIRDS.

"All living creatures," says Pliny, "have one certaine manner of marching and going, according to their several kinds, unto which they keep, and alter not. Birds only vary their course, whether they go upon the ground or flie in the aire. Some walke their stations, as crowes and choughs; others hop and skip, as sparrows and ousels: some run, as partridges, woodcocks, and snipes; others again cast out their feet before them, staulk and jet as they go, as storks and cranes *."

Aristotle has remarked that there is no animal known to fly always as fish are known to swim, and hence he shrewdly concludes that all birds can walk, though such as have small feet are sometimes called footless (*Apoda*)†,—a conclusion which, considering the former weight of Aristotle's authority, ought, we think, to have prevented the older naturalists from inventing so many fables respecting the bird of paradise;—fables which continue to be partly kept afloat by the specific name (*Apóda*) still given to this bird in systematic works, though the authors of these works know well that, so far from the bird of paradise being destitute of feet, it has actually very large ones in proportion to its size; so difficult it is to eradicate any error once diffused through the medium of books or of popular opinion. It may not be uninstructive, however, to advert to some of the singu-

* Holland's Plinie, x. 38. † Hist. Anim. i.

lar fancies formerly maintained respecting the circumstance in question.

It was evident, according to these authors, that the bird of paradise was without feet; for none had them of the great numbers imported to Europe*. It was even alleged that the inhabitants of Aron believed the bird to be hatched with legs, but apt to lose them, either from disease or old age, which, if true, would both explain and excuse the error†. M. Barere, again, who speaks of course from pure conjecture, asserts, that they have legs so short and so thickly clothed with feathers to the toes, that they may readily be overlooked; thus, as Buffon remarks, falling into as great a mistake as the one he was endeavouring to correct‡. It is no less anomalous and improbable, that each of the toes has three joints; for in almost all birds, the number of joints is different in each toe, the hind one having two, including that of the nail and of the fore toes, the inner having three, the mid one four, and the outer five §.

Trusting to Nieremberg ||, who had heard from a person that found a bird of paradise dead, of its having no feet, and fortifying this with his own observation of specimens, he boldly pronounces upon the mendacity of Pigafetta, who had sailed with the circumnavigator Magellan in the ship Victoria, and having seen the birds of paradise alive, asserted that their legs were slender, and about a palm in length ¶. Clusius, anxious to investigate the point, made diligent inquiry among the Dutch navigators who had sailed in the Oriental seas, and though he

* Scaliger, Exercit. ccxxviii. 2.
† Helbigius, Collect. Acad. Etraug. iii. 295.
‡ Oiseaux, Art. l'Ois. de Paradis. § Ibid. note.
|| Hist. Nat. x. 13.
¶ Physicæ Curiosæ, p. 1203.

Paradisea—Bird of Paradise.

had at first adopted the common opinion, was induced, from the information he received, to change it, as the navigators all agreed that the birds had legs, rather more weak and slender than those of the magpie, and that they could walk (*incedere*) and fly like other birds; but the Indians, upon taking them, cut off the legs, and taking out the entrails, dried them in the sun to fit them the better for ornamental head-dresses. The practice of disembowelling them, in conjunction with their being deprived of feet, led to another singular fancy, that having no need of food, they lived wholly upon dew and vapours.

There is a British bird—the swift (*Cypselus murarius*, TEMMINCK), which has, at least in name (*Apus*, BELON; *Hirundo Apus*, LINNÆUS), been represented as destitute of feet; but though its legs are exceedingly short, the structure of its feet is admirably adapted to its economy. The shortness of the legs and the great length of the wings render it very difficult, if not impossible, for it to rise from an even surface, and, as if conscious of this inability, it is never seen to light on the ground; "but," as Dr. Drummond well remarks, "there is no imperfection in this, for the air and not the ground is the bird's place of abode*." The peculiar conformation of the foot distinguishes the swift from the swallows, and indeed from all other known birds; for though some species have the power of turning one of their toes either before or behind, none but the swift can turn all the four toes of the foot forwards. The least toe also, which, following the analogy of other birds, should be the back one, consists only of a single bone, while the other three toes have only two bones each,—a structure adapted to the habit of the bird of clinging with ease to the perpendicular face of walls and rocks and eaves of houses, aided by its

* Letters to a Young Naturalist, p. 218.

strong, sharp, hooked claws. Even when the swift is placed upon the ground it cannot walk, according to White, but can only crawl*.

The feet in swallows, though not quite so short as in the swift, are very small, because its prescribed habits do not require them to be large. In the capture of its prey, for example, it does not employ its feet, and, to use the words of Dr. Drummond, it does not require them to be in any particular position, "as in water birds, since it neither dives nor swims; it does not want long legs like the heron, for it has not to obtain its food by wading and patiently watching for it; neither has it occasion for the strong and powerful feet and claws of the bird of prey, because it needs no instruments for grasping. In fact, the great requisite in the foot of the swallow is, that it shall be formed without those qualifications which are such wise provisions in the feet of most other birds, for what is a perfection in them, would be an imperfection in it. Its legs are extremely short, and the whole foot disproportionately small and delicate: this forms the perfection of the swallow's foot; and in it we may recognise another of those admirable examples of Divine ordinance, which are every where before our eyes, without our taking the trouble of employing a thought on the subject†."

The kingfisher (*Alcedo ispida*) is another British bird whose legs are exceedingly small and not well adapted for walking, which, familiar as we are with the species, we never saw it attempt. In this it is singularly different from its fellow fisher, the dipper (*Cinclus aquaticus*, Bechstein), which can not only trip along the edge of a rock, but can walk, as we have repeatedly witnessed, directly under water in shallow pools and slow-running streams, emerging to

* Selborne, Lett. 61. † Letters, p. 217.

the surface at a considerable distance from the place where it had entered*. Willughby, who had observed it go under water, but had no notion of its walking there, supposes it to have a portion of membrane between the toes like swimming birds; but this is not the fact, for the toes are distinctly parted without any membrane. The leg besides is feathered to the knee and the claws are very strong and curved, the claws of the back toe being the strongest. Its curious habit of walking under water appears to have been first observed by M. Hebert, whose interesting narrative we shall give.

"On the verge of the lake Nantua," says he, "I lay ambushed in a hut formed of pine-branches and snow, where I patiently waited till a boat, which was rowing on the lake, should drive some wild ducks to the water's edge. I observed without being perceived; before me was a small inlet, the bottom of which gently shelved, and might be about two or three feet deep in the middle. A dipper stopped here more than an hour, and I had full leisure to view its proceedings. It entered into the water, disappeared, and again emerged on the other side of the inlet which it thus repeatedly forded. It traversed the whole of the bottom, and seemed not to have changed its element, and discovered no hesitation or reluctance in the immersion. I perceived several times, however, that as often as it waded deeper than the knee, it displayed its wings, and allowed them to hang to the ground. I remarked, too, that when I could discern it at the bottom of the water, it appeared enveloped with air, which gave it a brilliant surface; like some sorts of beetles, which are always in water, enclosed with a bubble of air. Its view in dropping its wings on entering the water might be to confine this air; it was certainly never without some, and it seemed to quiver. These

* J. R.

singular habits of the dipper were unknown to all the sportsmen whom I have talked with; and perhaps without the accident of the snow-hut, I should ever have been ignorant of them: but I can aver that the bird came to my very feet, and, that I might observe it, I did not kill it *."

M. Montbeillard also distinctly states that the dipper walks quite into the flood, following the declivity of the ground, entering by degrees till the water reaches its neck, and as it advances, holding its head not higher than usual but completely submersed, and descending to the very bottom, where it walks as if it were on dry ground †.

These details seem to be authenticated by the personal observations of the two distinguished naturalists; but the facts are disputed by Montagu and Selby. "I have repeatedly," says the latter, "seen them dive below the surface and remain submerged for a considerable time, occupied in pursuing the fry, or young fish, or in search of the larvæ of aquatic insects. At other times they walk slowly into the water from the shallow part of a pool, till it becomes of sufficient depth for diving; but I have not been able, even from close observation, to certify the fact of their walking with apparent ease at the bottom, an error of opinion which might arise from the manner of their occasionally entering the water. On the contrary, the same exertion seems to be used by them as by other diving birds ‡."

"We have seen it," says Montagu, "walk into the water, and, as it were, sink beneath the surface, as if its specific gravity was actually greater than that of the element; but doubtless some exertion must be used to keep itself at the bottom besides that of simple walking, or it would instantly rise and float on

* Buffon, Oiseaux, Art. Le Merle d'Eau. † Ibid.
‡ Illustrations, p. 62.

the surface; for, like all other birds, its specific gravity is greatly inferior to that of water. In one or two instances, where we have been able to perceive it under water, it appeared to tumble about in a very extraordinary manner, with its head downwards, as if pecking something; and at the same time great exertion was used both by the wings and legs. The idea of any bird being capable of walking beneath a fluid so infinitely more dense than itself, does not require any depth of philosophical reasoning to refute. Birds, of all animals, have the least specific gravity, and consequently require great exertion to keep themselves under water. The dipper has been seen to float on the surface, and from thence to dive. The young birds showed no inclination to dive in a tub of water, but showed great uneasiness by struggling on the surface*."

Without pretending to decide the point, though our own repeated observations incline us to differ from Montagu and Selby, we may remark that the structure and position of the legs in the dipper are so different from those of diving birds, as to indicate a very different habit. M. Montbeillard, for example, says of one species (*Cat-marin*), that it can only walk on the surface of the waves, and his intelligent correspondent M. Baillon, of Montreuil, says he one day found two of these divers cast ashore by the tide, lying on the sand, working their feet and wings, and crawling with difficulty, so that he gathered them like stones, though they were not hurt nor weakly, for upon throwing up one of them it flew away and dived and played on the water as if rejoiced at regaining its proper element †.

The Laplanders call the loon (*Colymbus glacialis*) the *lame* bird, because the bird walks awkwardly ‡,

* Ornith. Dict. p. 135. † Oiseaux, Art. Le Cat-marin.
‡ Hearne's Journ. p. 429, 4to.

the legs indeed being so placed as to render it difficult to use them in walking. When one, which Colonel Montagu had, quitted the water, it shoved its body along upon the ground like a seal, by jerks, rubbing the breast against the ground, and returned again to the water in a similar manner *.

The coot (*Fulica atra*), like the divers, has an aversion to take wing, and can seldom be sprung in its retreat at low water; yet though it walks rather awkwardly, it contrives to skulk through the grass and reeds with considerable quickness, the compressed form of its body being peculiarly fitted for this purpose; and we have often marked its progress by the top of the herbage, on the edge of a lake, moving as if it had been swept by a narrow current of wind †. The same aversion to run rather than to take wing may also be remarked in the rails (*Rallidæ*, Leach), some of which are land birds, and amongst these we may mention the land-rail or corn-crake (*Ortygometra crex*, Fleming), a bird that has been said never to take the water, and keeps regularly upon the ground, taking flight but rarely, and never except when compelled thereto. Its leg and shank (*tarsus*) are both of considerable length—a circumstance that enables it, as Dr. Drummond remarks, to put one foot far forward while the other is far backward, whence it can take long strides, and these being repeated in quick succession, the speed of the bird is very great, which renders it very often able to elude both sportsmen and dogs, without having recourse to its wings ‡.

"We may know," says M. Montbeillard, "when a dog lights on the scent of the corn-crake from his keen search, his number of false tracks, and the obstinacy with which the bird persists in keeping the ground, insomuch that it may be sometimes caught by the

* Ornith. Dict. p. 309. † J. R.
‡ Letters, p. 219.

hand: it often stops short and squats down; the dog pushing eagerly forward overshoots the spot and loses the trace; the bird, it is said, profits by its blunder, and runs back on its path; nor does it spring till driven to the last extremity, and then it rises to a good height before it stretches onwards. It flies heavily, and never to a great distance. It is usually seen to alight, but in vain should we search for it; before the fowler has reached the spot the bird has tripped off more than a hundred paces. The fleetness of its feet compensates for the tardiness of its wings: all its little excursions, its windings, and its doublings, in the fields and meadows, are performed by running *."

A young corn-crake kept by Mr. Jewis, contrary to the usual statement in books, "always seemed highly delighted when water was placed for it. It would swim, dive to the bottom, and play about with the greatest apparent satisfaction, and with as much activity as if it had never been used to any other element. Its manners were peculiarly pleasing and interesting, and its motions elegant. It ran with great swiftness, with its head nearly to the ground. The form of the corn-crake," he adds, "seems admirably calculated for the life it is intended to lead; its sharp compressed bill and narrow head are well adapted for separating the grass, and opening a way for its slender and gently swelling body; by this means the movement of the blades of grass is so small, that it is enabled to make its way rapidly through the meadows without being perceived, so that one moment it may be close at hand, and in the next be at the far side of the field, without its being able to discover in what manner it has changed its situation †."

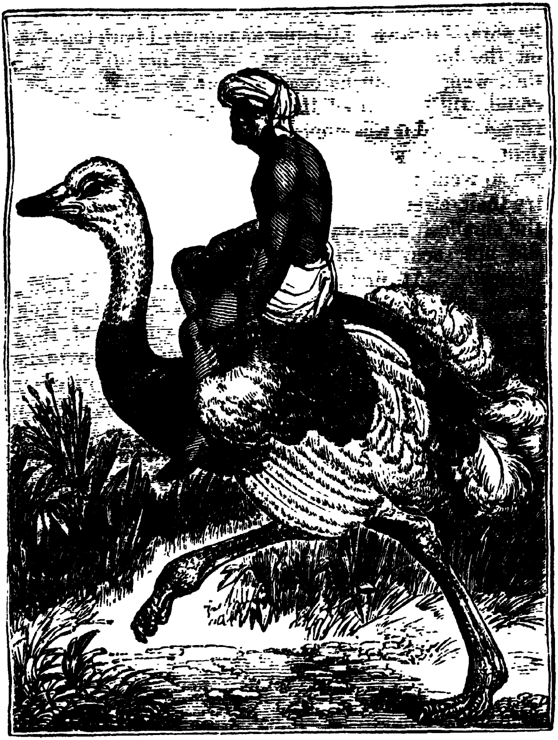
The bird, however, most celebrated for fleetness of

* Oiseaux, Art. Le Rale de Genet.

† Hort. Register, Nov. 1831, p. 218.

running is the ostrich, or bird camel (*Struthio Camelus*), as it may well be named. "What time she lifteth up herself on high," says Job, "she scorneth the horse and his rider *." According to Dr. Shaw, the wings serve her both for sails and oars, whilst her feet, which have only two toes, and are not unlike the camel's, can bear great fatigue. M. Montbeillard, however, is of opinion that it does not spread its wings and tail-feathers with the view of assisting its motion, but from the common effect of the corresponding muscles, as a man in swimming throws out his arms. Though the ostrich is universally admitted to run faster than the fleetest horse, yet the Arabs contrive to run these birds down on horseback, their feathers being valuable, and their flesh not to be despised. The best and fleetest horses are trained for this chase. When the hunter has started his game, he puts his horse upon a gentle gallop, so as to keep the ostrich in sight without coming too near to alarm it and put it to its full speed. Upon observing itself pursued, therefore, it begins to run at first but gently, its wings like two arms keeping alternate motion with its feet. It seldom runs in a direct line; but, like the hare, doubles, or rather courses in a circular manner, while the hunters, taking the diameter or tracing a smaller circle, meet the bird at unexpected turns, and with less fatigue to the horses. This chase is often continued for a day or two, when the poor ostrich is starved out and exhausted, and finding all power of escape impossible, it endeavours to hide itself from the enemies it cannot avoid, running into some thicket, or burying its head in the sand: the hunters then rush in at full speed, leading as much as possible against the wind, and kill the bird with clubs, lest the feathers should be soiled with blood.

* Job xxxix. 18.



Ostrich carrying a Negro.

M. Adanson saw two tame ostriches which had been kept two years at the factory of Podor, on the south bank of the Niger. "They were so tame," he says, "that two little blacks mounted both together on the back of the largest: no sooner did he feel their weight, than he began to run as fast as ever he could, till he carried them several times round the village; and it was impossible to stop him, otherwise than by obstructing the passage. This sight pleased me so well, *that I would have it repeated: and to try their strength, I made a full-grown negro mount* the smallest, and two others the largest. This burden did not seem to me at all disproportioned to their strength. At first they went a moderate gallop; when they were heated a little they expanded their wings as if it were to catch the wind, and they moved with such fleetness that they seemed to be off the ground. Everybody must some time or other have seen a partridge run, consequently must know there is no man whatever able to keep up with it; and it is easy to imagine that if this bird had a longer step its speed would be considerably augmented. The ostrich moves like the partridge, with both these advantages; and I am satisfied that those I am speaking of would have distanced the fleetest race-horses that were ever bred in England. It is true they would not hold out so long as a horse; but without all doubt they would be able to perform the race in less time. I have frequently beheld this sight, which is capable of giving one an idea of the prodigious strength of an ostrich, and of showing what use it might be of, had we but the method of breaking it and managing it as we do a horse*."

The traveller, Moore, mentions that he saw a man journeying mounted upon an ostrich†; though

* Voyage to Senegal, Pinkerton's Collection, xvi. 69.

† Quoted by M. Antoine, Anim. Célèbres, i. xix. 1.

both this and the instance given by M. Adanson show the circumstance to be of unusual occurrence.

A British bird, the bustard (*Otis tarda*, Ray), now rarely seen, if not extinct, is very similar to the ostrich in its faculty of running, being so fleet as to be hunted with greyhounds, a sport followed even by the ancient Greeks, as we learn from Xenophon and Ælian. The male of this species is furnished with a singular bag or pouch, opening under the tongue, and hanging down on the fore part of the gullet, as low as the middle of the neck. This seems to have been first observed by Aristotle*, but was particularly described by Dr. Douglas, who imagined it was intended as a reservoir for water, indispensable in the extensive arid plains which it inhabits. He found it capacious enough to hold several quarts of water. Colonel Montagu, however, seems to be somewhat sceptical upon this point. "We think it impossible," he says, "that the bird could fly with such an addition of weight before its wings, which would throw it out of the centre of gravity. We see the heron, and many other birds, obliged to extend their legs behind, and contract their necks when flying, in order to balance themselves on the wing. Seven quarts of water (the quantity mentioned by Dr. Douglas) are nearly equal to fourteen pounds weight, and certainly more than the bird could carry in that situation†." It would appear indeed from the observations of Sir Everard Home that Montagu's objections are valid; for in the adjutant (*Ciconia argala*, Temminck), which has a bag precisely similar, he found that it contained "nothing but air, which the bird has a power of expelling and filling the bag again at pleasure." In the adjutant

* Hist. Anim. lib. ii. sub. fin.

† Ornith. Dict. p. 63.

Himantopus melanopterus—The Stilt. (A duck has been introduced to show by comparison the great length of the stilt's legs.)

the bag communicates with the large air cells on the back of the neck*, and therefore we may fairly conclude it is intended to render the birds light and buoyant for running, since they are too heavy to fly without considerable difficulty.

These birds are remarkable for the length of their legs, which must be very advantageous for swiftness of running; but it would be wrong to infer as a general principle that all birds with long legs are swift-footed. On the contrary, the wading birds (*Grallatores*, Illiger), which have proportionably much longer legs than the ostrich or the bustard, are not well adapted for walking on land. Amongst these the flamingo (*Phœnicopterus ruber*) is one of the longest-legged birds, yet it is in this respect far exceeded by the stilt (*Himantopus melanopterus*, Meyer), and the legs in the latter are besides slender, and even "so flexible," as Wilson says of the American stilt, "that they may be bent considerably without danger of breaking†," as if, in accordance with Pliny's name (*Himantopus*), they had been cut out of a thong of leather‡. Aldrovand mentions its pace as slow and laborious; and White of Selborne says, "it must be matter of great curiosity to see it move; to observe how it can wield such a length of lever with such feeble muscles as the thighs seem to be furnished with. At best one should expect it to be but a bad walker: but what adds to the wonder is, that it has no back toe. Now without that steady prop to support its steps, it must be liable in speculation to perpetual vacillations, and seldom able to preserve the true centre of gravity§." The truth is that the legs are not formed for walking, but for wading; and we have the testimony of Wilson that

* Comp. Anat. i. 278.

† Amer. Ornith. vii. 55.

‡ Oppian, de Aucup. ii.

§ Letter 91.

the American species wades "with expedition and without fatigue*."

The reasoning of naturalists, indeed, respecting the conformation of the feet of birds, is, when not derived from living specimens, as frequently wrong as right. It has been usual, for example, since the time, if we mistake not, of Gesner and Aldrovand, to consider the peculiar structure of the foot in parrots and woodpeckers, with two toes before and two behind, as so peculiarly characteristic of climbing birds, that in systematic classifications the birds which have their toes so placed are denominated climbing birds (*Scansores*, ILLIGER; *Grimpeurs*, LACEPEDE). But unfortunately for this division, many species which have the feet so constructed have never been observed to climb, such as the cuckoo and the wryneck; while many species which do climb, such as the nuthatch (*Sitta*) and the creeper (*Certhia*), have their toes placed in the usual manner.

White's remarks on the walk of birds are well worth quoting. "Most small birds," he says, "hop; but wagtails and larks walk, moving their legs alternately: all the duck kind waddle; divers and auks walk as if fettered, and stand erect on their tails: crows and daws swagger in their walk; woodpeckers use their tails, which incline downward, as a support when they run up trees: parrots, like all other hook-clawed birds, walk awkwardly, and make use of their bill as a third foot, climbing and descending with ridiculous caution. All the poultry (*Gallinæ*) parade and walk gracefully and run nimbly †."

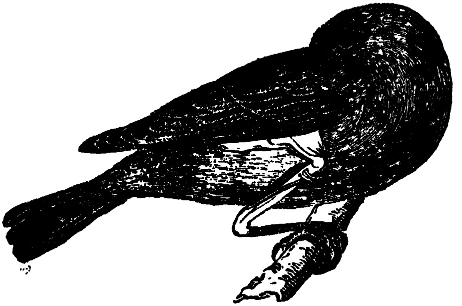
It is worthy of remark that as the bones commonly considered as belonging to the leg in birds correspond to the heel of the human foot, all birds must

* Amer. Ornith. vii. 55. † Selborne, Letter 84.

walk as we may say on tiptoe. As they have their centre of gravity, however, not directly over their legs, but more forward, it requires peculiar contrivances in their formation to enable them to balance themselves on their toes. Accordingly birds have their toes for the most part proportionally much longer than other animals, while the great flexion of the leg upon the thigh brings the toes more under the centre of gravity.

Feet of Water Birds in the act of making the back-stroke in swimming.—*a*, The Diver.—*b*, The Cormorant.—*c*, The Gribe.—*d*, The Phalarope.

Birds have this further peculiarity, that the standing posture is their state of most perfect rest, arising from the structure of their legs, as first explained by the old Italian naturalist, Borelli. The tendons of the muscles which bend the claws pass over the joints of the heel, and are joined there by another muscle



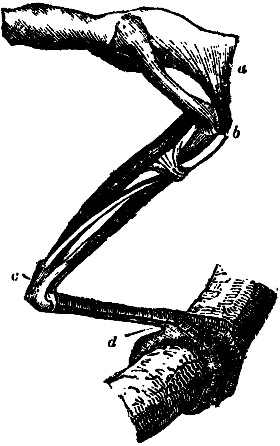
Bird at rest: after Borelli.

which passes over the knee, so that the bending of the heel is necessarily followed by a bending of the toes. When a bird therefore alights on the branch of a tree, the weight of its body bends those joints, and thus puts the tendons on the stretch, which draws in the claws to lay hold of the branch without any effort on the part of the bird, and hence it sits as secure when asleep as when awake*.

"This explication," says M. Barthez, "has been repeated by Monro, but has been well refuted by M. Vicq d'Azyr†." "It is true indeed," says Dr. Barclay of Edinburgh, "that in these propositions the late Vicq d'Azyr, after showing more than usual anxiety to point out some myographical errors, and after asserting just what Borelli had asserted before, that one flexor only passes over the convexity at the knee, has, by artfully concealing what Borelli has said of the joint of the heel, and by insinuating what he has not said of the joint of the knee, completely succeeded in convincing Barthez that his cavilling criticism is an able refutation. But the leg of a bird that perches

* De Motu Animalium, Prop. 149 and 150.

† Nouvelle Mecanique des Animaux.



Anatomy of the Leg of a Bird at rest: after Borelli.—*a*, a muscle which arises from the haunch-bone, and, becoming suddenly tendinous, passes the *outer* angle of the thigh-joint at *b*; then, winding round the leg-bone, it slips over the *outer* angle of the leg-joint at *c*, proceeds forwards to the palm of the foot, divides, and is inserted into the bones of the toes. From this arrangement it is evident that, when the bones of the leg and thigh are *bent together* by the weight of the sleeping bird, the tendon will be stretched over the angles *b* and *c*, and the bones of the foot become strongly clasped.

in its sleep is easily procured, and children, who in general are fond of the experiment, can demonstrate the fact that Borelli has explained, and which he has explained by descriptions of the muscles sufficiently minute and sufficiently accurate to support his conclusions*."

It is owing to the same ingenious mechanism that birds can rest on one leg as easily, perhaps more so, than upon both; at least the fact is certain, however it may be accounted for by Vicq d'Azyr and Barthez, that a great proportion of birds sleep standing on one

* On Muscular Motion, p. 439.

leg ; while the flexibility of the neck allows it to be brought back upon the body, and the head placed under the wing, so as to bring the centre of gravity more over the feet, and thence to increase the stability. It is stated by the older naturalists, and repeated by several modern authors, that storks and other wading birds, when resting on the banks of a river, and standing on one foot, " hold a stone or other heavy body in the claws of the other to give them weight." We much suspect, however, that this contrivance is imaginary ; at least we never witnessed it, and could not credit it without more positive testimony than a general remark.

One of the most singular circumstances which we have met with respecting the walk of birds occurs in the Chinese jacana (*Parra sinensis*, LATHAM), whose enormously long toes enable it to walk with agility from leaf to leaf of the great water-lily.

The Jacana (*Parra sinensis*) walking on the floating leaves of the water-lily.

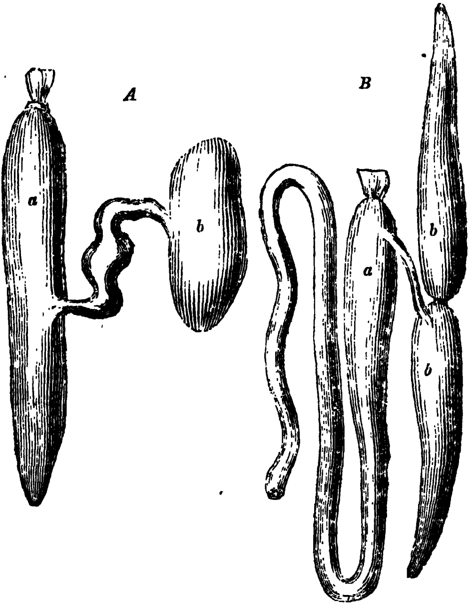
Chapter XI.

FLIGHT OF BIRDS.

In the beautiful apologue given by Plato in his Protagoras, in which Epimetheus is represented as distributing to all animals the qualities best adapted to their several modes of life, we find it said that "to some he gave wings to show them that their safety is in the air."

The flying of a bird in the air is performed on similar principles to that of a fish swimming in the water, with this difference, that the bird is more heavy in comparison with the air, than the fish in comparison with the water. At first view, it might be thought impossible for so huge an animal as the Ostend whale (*Balænoptera boops?*), weighing four hundred and eighty thousand pounds, to swim in the sea, considering that its body, so far as the bones and muscles were concerned, must have been considerably heavier than water. Yet by a singular contrivance it is at once buoyed up in the sea, and rendered so much lighter than water, that it floats on the surface when dead. This consists in an enormous layer of an oily substance called blubber, immediately under the skin. We are well justified in using the epithet "enormous," from the fact that in the Ostend whale the blubber measured four thousand gallons, and weighed a twelfth of the whole body. With a large proportion, therefore, of a light body like this to buoy it up, so far from finding it difficult to swim, it would require a great effort in order to dive deep into the water.

In fishes (for the whale, being a warm-blooded animal and breathing the air, is not considered a fish), the buoyancy indispensable for swimming is effected by a very different contrivance. A bladder, varying in form in different species, is filled with air (azote in fresh water, and carbonic acid gas in marine, fishes), over which the animal appears to possess a voluntary power, either to empty it by compression or fill it by distension. Now it is obvious that, by the effort to compress the swimming-bladder, the body of the fish must be contracted, and consequently, as the absolute



Swimming-Bladders.—*A*, In the Dace:—*a*, the stomach;—*b*, the swimming-bladder.—*B*, In the Conger Eel:—*a*, the stomach;—*b b*, the swimming-bladder.

weight may be considered the same, or, as mathematicians say, a constant quantity, the specific gravity, upon which the buoyancy depends, must increase, and the fish must accordingly sink. On the other hand, by the effort to distend the swimming-bladder, the muscles are relaxed, and the whole body not only becomes specifically lighter, but the included air expands, and buoys up the fish. The truth of this explanation has been tried by the experiment of pricking the bladder and allowing the air to escape, when the fish sinks and cannot rise above the bottom of the water *; but when a fish dies it floats to the surface, because it would appear, from the want of voluntary compression, the swimming-bladder then expands to its utmost dimensions; at least we have always in dead fishes observed it to be much distended †.

The contrivance for rendering birds buoyant in the air is considerably different from either of these, and was first discovered by the celebrated Harvey; at least, he says, he does "not remember it to have been previously observed by anybody ‡." Air in considerable volume is introduced into the body, though it is not, as in fishes, contained in one cavity, but is distributed into numerous cells in various parts of the body. The lungs, compared with those of quadrupeds, are rather small, but the air-cells with which they communicate § occupy a considerable extent of the chest and belly. These cells are much divided by partitions, furnished, as has been observed in large birds, with muscular fibres, supposed to be employed in sending the air back to the lungs, as is done by the diaphragm in other animals, and which is wanting in birds. This is no doubt the reason why birds appear to pant, so much in breathing, a much greater portion of the

* Ray in Phil. Trans. No. 114–15. † J. R.

‡ De Generatione Animal. p. 4, 4to. London, 1651.

§ Willis, de Anim. Brutorum, i. 3.

body being always put in motion than in quadrupeds *.

Besides these air-cells, which fill the whole cavity of the body from the neck downwards, and serve the double purpose of assisting in the assimilation of nutriment, by the supply of oxygen and the removal of carbon, and of diminishing the weight of the body,—there are others situated in the bones themselves, particularly the larger bones, both those which are cylindrical and those which are broad and angular. It is not a little remarkable that all these bones in birds are (at least in the middle) destitute of marrow †; and, as Camper has shown, are furnished with openings for the purpose of communicating with the lungs ‡. Experienced observers can tell from inspecting the bone of a full-grown bird, whether or not it contains air-cells, without even seeing any of the openings through which the air enters, for such bones are for the most part of a purer white, and sometimes the bone is so thin that the cells may be seen through it; yet such appearances are not always to be trusted. The openings ought, therefore, in these investigations, to be sought for, though they are sometimes not a little difficult to discover. In the long bones, we may mention, they are generally situated close to one of the extremities, while in bones in pairs there is for the most part only one common opening.

"The air-bones in young birds" are described to be "filled with marrow, which becomes gradually absorbed to make room for the admission of air. This gradual expansion of the air-cells, and absorption of the marrow, can nowhere be observed so well as in the young tame geese, when killed in different periods of the autumn and winter. The limits to the air-cells may be clearly seen from without by the

* J. R. † Fred. II. De Arte Venandi, p. 39.
‡ Kleine Schriften, i. 1, tab. 1 & 4.

transparency of the bony walls. From week to week the air-cells increase in size, till, towards the close of the season, the air-bones become transparent. In all these bones the marrow first disappears from the vicinity of the opening which admits the air, and continues longest at the points further removed from this opening. Towards the close of the summer and beginning of autumn, although in external appearance the young goose resembles the parent, no trace of air-cells can be discovered in its bones, the interior of the bones being then filled with marrow. About the fifth or sixth month the marrow begins to disappear. This circumstance, which applies also to other birds, shows with what caution one should form an opinion, from young birds only, on the size of the air-cells. In many kinds of birds the air-cells of some bones are nearly fully developed, although they have the openings of the bones which lead to the air-cells *."

Not only the bones, but the quills of the feathers also make a part of this contrivance. These while growing are filled with an organized pulp; but as soon as they arrive at their full growth, this pulp being absorbed renders them light, and the lightness is increased by air from the atmosphere being introduced into their cavity through a small opening at the termination of the furrow where the quill or barrel ends and the plumelets of the feather begin. Air is also introduced in a similar manner into the plumelets themselves.

The existence of these cells can be shown upon any bird by simply blowing with a little force into the windpipe, by which means the belly may be blown up to a considerable size, a circumstance which would not occur in other animals. Experiments of this kind were performed by Colonel Montagu on the

* Blumenbach, Comp. Anat. § 182.

gannet (*Sula alba*, MEYER), and are so interesting that we shall give them in his own words.

"A pipe," he says, "was first introduced into the windpipe (*trachea*), and when air was propelled through it, the whole internal cavity of the body was inflated, but no air passed into the external cells between the skin and the body; an incision was then made in the lower part of the abdomen into the body, very near the vent, it readily found its way through the *larynx*, producing a noise similar to the sound emitted by the living bird. A small opening was then made in the skin on the left side, about midway between the wing and the thigh, and a pipe introduced, having first stopped those directly communicating with the internal parts. It was now obvious that when air was forced through this orifice, the skin on that side, as far as the middle line of the body, was greatly inflated, extending into the lower part of the neck, along the larger joints of the wing, down the thigh, and also into the cavity of the body; but the right side was not in the least affected. The pipe at the *trachea* being now removed, the air produced a similar effect upon the *larynx*, as before mentioned, but not so loud. Still suspecting that there was a communication between the sides, by means of some valvular apparatus, the right side was subjected to the same experiment; the result, however, negatived our expectation, the effect produced being similar in every respect.

"From a repetition of these experiments upon several subjects, it became evident that there was a communication between the lungs and the cellular membrane that covers the greater part of the body, as well as with the whole cavity of the body, but that, by reason of some valvular contrivance, the skin could not be artificially inflated through the lungs, although air would readily pass in a contrary direction. It is also clear that there is no direct communication between the two sides *."

In the pelican, a similar contrivance has been described by several French naturalists, and M. Lory, in particular, has demonstrated a communication from the atmosphere to the pipes of the quill-feathers; as Colonel Montagu also did in the gannet above-mentioned. According to M. Montbeillard, the air in the pelican passes from the breast into the arm-pits, or rather wing-pits, from which it insinuates itself into numerous vesicles, covering the muscles, and indeed the whole body immediately under the skin. These vesicles are so much inflated, that, upon pressing the skin with the fingers, the air is observed to move about as if enclosed in a bladder. Upon the expiration of the air in breathing, the air compressed in the breast passes into the wing-pits, and thence spreads to the subcutaneous vesicles. By blowing into the windpipe, the course of the air may even be made sensible to the eye; and hence it may be well conceived how the pelican can enlarge its bulk without increasing its absolute weight.

"In a journey," says M. Tachard, "which we made to the load-stone mine, M. de la Marre wounded one of these large birds which our people call *Grand Gosier*, and the Siamese *Noktho* .... Its spread wings measured seven feet and a half. On dissection we found, under the fleshy panicles, very delicate membranes, which enveloped the whole body, which, folding differently, formed many considerable pouches, particularly between the thighs and the belly; between the wings and the ribs, and under the craw, some were so wide as to admit the two fingers; these great pouches divided into many little ducts, which, by perpetual subdivision, ran into an endless multitude of ramifications, which were perceptible only by the

* Ornith. Dict. p. 195, 2d edit.

bubbles of air which inflated them; insomuch that, pressing the body of this bird, one heard a little noise like that produced by pressing the membranous parts of an animal which has been inflated. By the assistance of the probe and blowing, we discovered the communication of these membranes with the lungs *."

Besides the air-cells filled from the lungs, it appears from several of the preceding details that there are others directly filled from the mouth and nostrils through the windpipe. The latter, particularly in birds of prey and high-flying birds (*Alauda*, *Ciconia*, *&c.*), are very large, ascending beneath the skin of the neck and shoulders and around the skull. "In the stork," says Dr. Macartney, "we find these cells large enough to admit the finger to pass a considerable way down upon the inside and back of the wing: they are also large in the owl †."

It is evident that all this extraordinary number and volume of air-cells, as well as the very great strength observable in the bones of birds, is for the express purpose of rendering them light and buoyant, so that they may support themselves in the air with less effort.

It is but right to add, that the opinion of John Hunter, who has so well elucidated the anatomical structure and extent of the air-cells of birds, is not altogether in accordance with the conclusions which we have been led to draw.

The following excellent remarks on the structure, which is so admirably adapted for rendering birds light and buoyant, are by Sir Charles Bell:—

"First," he says, "it is necessary that birds, as they are buoyed in the air, be specifically lighter; secondly, the circumference of their thorax must be extended, and the motions of their ribs limited, that

* Hist. Géner. des Voyages, ix. 311.

† Rees's Cyclopædia, Art. Birds.

the muscles of the wings may have sufficient space and firmness for their attachment. Both these objects are attained by a modification of the apparatus of breathing. The lungs are highly vascular and spongy, but they are not distended with air. The air is drawn through their substance into the large cavity, common to the chest and abdomen; whilst the great office of decarbonization of the blood is securely performed, advantage is taken to let the air into all the cavities, even into those of the bones.

" The weight of the body being a necessary concomitant of muscular strength, we see why birds, by reason of their lightness, as well as by the conformation of their skeleton, walk badly. And, on the other hand, in observing how this lightness is adapted for flight, it is remarkable how small an addition to their body will prevent them rising on the wing. If the griffon-vulture be frightened after his repast, he must disgorge before he flies; and the condor, in the same circumstances, is taken by the Indians, like a quadruped, by throwing the lasso over it. It is interesting to notice the relations of great functions in the animal economy: birds are oviparous, because they never could have risen on the wing had they been viviparous; if the full stomach of a carnivorous bird retard its flight, we perceive that it could not have carried its young. The light body, the quill-feathers, the bill, and the laying of eggs, are all necessarily connected.

" As every one must have observed, the breastbone of birds extends the whole length of the body; and owing to this extension, a lesser degree of motion suffices to respiration; so that a greater surface, necessary for the lodgement and attachment of the muscles of the wings, is obtained, whilst that surface is less disturbed by the action of breathing, and is more steady. Another peculiarity of the skeleton of the bird, is the consolidation of the vertebræ of the back; a proof, if any were now necessary, that the whole system of bones conforms to that of the extremities, the firmer texture of the bones of the trunk being a part of the provision for the attachment of the muscles of the wings. The ostrich and cassowary, which are rather runners than fliers, have the spine loose.

"The vertebræ of the back being fixed in birds, and the pelvis reaching high, there is no motion in the body; indeed, if there were, it would be interrupted by the sternum. We cannot but admire, therefore, the composition of the neck and head, and how the extension of the vertebræ, and the length and pliability of the neck, whilst they give to the bill the office of a hand, become a substitution for the loss of motion in the body, by balancing the whole, as in standing, running, or flying. Is it not curious to observe how the whole skeleton is adapted to this one object, the power of the wings?

"Whilst the ostrich has no keel in its breast-bone, birds of passage are, on dissection, recognizable by the depth of this ridge of the sternum. The reason is, that the angle formed by this process, and the body of the bone, affords lodgement for the pectoral muscle, the powerful muscle of the wing. In this sketch of the dissection of the swallow, there is a curious resemblance to the human arm; and we cannot fail to observe, that the pectoral muscle constitutes the greater part of the bulk of the body. Borelli makes the pectoral muscles of a bird exceed in weight all the other muscles taken together, whilst the pectoral muscles of man are but a seventieth part of the whole mass of the muscles. And here we see the correspondence between the strength of this muscle and the rate of flying of the swallow, which is a mile in a minute, for ten hours every day, or six hundred miles a day. Mr. White says truly, that the swift lives on the wing; it eats, drinks, and collects materials for its nest in flying, and never rests but during darkness. If it be true that birds, when migrating, require a wind that blows against them, it implies an extraordinary power as well as continuance of muscular exertion.

" We see how Nature completes her work, when the intention is that the animal shall rise buoyant and powerful in the air: the whole texture of the frame is altered and made light, in a manner consistent with strength. We see also how the mechanism of the anterior extremity is changed, and the muscles of the trunk differently directed *."

We deemed it the more necessary to enter with some minuteness into the conformation and use of the air-cells, from their not being so obvious to a common observer, in reference to the flying of a bird, as are the wings and the tail, to which we shall now direct attention.

Though it is obvious that birds could not fly without wings, yet the peculiar mechanism of the process is not, we believe, generally understood. It is no uncommon thing to see a goose, while walking on a common, spread out its wings to their full extent, and begin to flap them about with great violence, and yet the bird is not thereby moved an inch from the ground; a circumstance that, without inquiry into the cause, seems contrary to what might have been anticipated. By observing the difference between this ground-flying (if we may call it so) of the goose, and the actual rising of a pheasant, for example, into the air, we may arrive at the reason why the goose does not, while the pheasant does, ascend. The goose, it may be remarked, keeps her wings spread both in the upward and the downward motion, and consequently the resistance of the air in

* Bridgewater Treatise on the Hand, p. 77.

the first case will press her body downwards rather than upwards; while, as her evident intention is not to rise above the ground, she forcibly expels the air from her air-cells, as may be inferred from the screaming always uttered on those occasions, and caused, we have reason to believe, by the forcible expulsion of the air. Her body is thus rendered specifically heavier, and consequently resists the upward impulse given by the downward motion of the wings. The pheasant, on the other hand, instead of expelling the air, takes a deep inspiration, increasing the size of the body as much as possible, inflating at the same time the wing-feathers, and bulging them outwards without separating their tips from the sides. While taking deep inspirations, he may be observed also several times rising on tiptoe and puffing out and balancing his body, to feel whether he has thrown enough of air into the bones and feathers to float him along. He then crouches back in order to give additional force to his spring, and forthwith leaps up into the air, at the same time rapidly raising his wings from the sides, but keeping the individual feathers close together like a folded fan, which he takes care not to open till he begins to bring them down. For this purpose he spreads them out to their utmost extent, and then striking the air with all his force, its resistance pushes him upwards, and he bounds aloft towards his tree-perch, or wherever else he wishes to go. The same series of motions, first raising the folded wings, and then forcibly bringing down the spread wings, must be incessantly repeated during the flight of every bird; in the same way as a swimmer, by pressing the water downwards with his spread hands keeps himself afloat, and, by directing the motion obliquely backwards, is thereby pushed forwards. It may also be remarked, that the swimmer raises his hands before renewing the stroke with the fingers closed, slanting, in a similar way to the bird raising its folded wings, so as to diminish the surface opposed to the resisting medium *. The direction in which a bird can fly depends greatly on the form of its wings; and hence Sir Everard Home justly infers, that a motion directly upwards can only be performed by birds whose wings are nearly horizontal, as the lark and the quail. "In general," he says, "the wings are placed oblique: this is principally owing to the length of their feathers, the fixed point of which is at the root. When birds fly horizontally, their motion is not in a straight line, but obliquely upwards, and they allow the body to come down to a lower level before a second stroke is made by the wings, so that they move in a succession of curves. To ascend obliquely, the wings must repeat their strokes upon the air in quick succession; and in descending obliquely, these actions are proportionally slower.

"In birds of prey the form of the wings is very oblique, so that they cannot rise in the air perpendicularly unless they fly against the wind; they have, however, a greater power of horizontal motion than other birds, because the extreme parts of the wings are long, and the ends of the feathers lap over each other, which opposes a uniform resistance to the air; while in other birds the air passes through between the feathers, which lessens the power of keeping the wing oblique. To enable themselves to turn to the right or left, they move one wing more rapidly than the other. This is attended with difficulty when the flight is rapid; they therefore make a large sweep before they can turn round †."

In the ingenious attempts which have been made to devise wings to enable men to fly in the air, it has rarely been taken into account, that the muscles of

* J. R. † Home, Comp. Anat. i. 109.

the most powerful arm are proportionably slender and weak when compared with the wing-muscles of birds; and therefore even if wings sufficiently efficient could be contrived, the arms would be too feeble to wield them, considering also that there are no air-cells distributed through the human body as in birds, to diminish its specific gravity by inflation. It may prove interesting to many of our readers to give a few details respecting these muscles of flight in birds; and we cannot follow a better guide than M. Chabrier, who has made the flight both of birds and insects his particular study for nearly half a century, and has published the result of his earlier observations in a considerable volume *.

"If each muscle of flight," says M. Chabrier, "were to contract individually and independently of the rest, it would only put in motion the most moveable parts of the body with which it is especially connected; there would be no reaction. This assertion is true in all respects; as, for example, in the depression of the wings during flight, the resistance or the contraction of the middle pectorals and their congeners is absolutely necessary, since, without it, the wings would fall by their own weight, and the action of the great pectorals would be useless. Besides, in the depression of the wings, the fixed point of the middle pectorals where the respective tendons attach themselves to the humerus being removed, the sudden contraction of these pectorals must necessarily facilitate the ascension of the trunk, until the humerus is stopped by the cessation of action in the great pectorals. It may easily be conceived why the projecting muscles of the trunk and the depressors of the wings are stronger than the elevators; it is because the former cause the trunk to start, and by this means depress the wings, notwithstanding the

* Essai sur le Vol, 4to. Paris, 1801.

resistance of the latter; these, being unable to prevent the humerus from descending, become fixed there, and draw up the trunk, thus assisting the action of the great pectorals, and also participating in projecting the trunk both forwards and above.

"Thus, that the bird may raise and direct itself in the air, all the muscles must contract themselves in the following manner: the clavicle and the omoplate being fixed by the trapezium, the rhomboid, the upper part of the great dorsal, the costo-scapular and the short clavicular, and the wing being partly unfolded, brought forward and raised by the action of the middle pectoral of the internal subclavian, the elevators of the humerus, of the coraco-brachial, and of the extensors of the anterior membrane of the wing, the bird springs into the air, completely expanding his wings. At the same time the great pectorals, the primary agents of the wings, of which the point is fixed in the humerus by the insertion of their respective tendon, contract suddenly; and, in consequence of the resistance which the air opposes to the movement of the wings, carry all their power to the sternum; by this intervention they cause the trunk to rise, and the wings, whose immediate depression is resisted by the atmospheric air, as we have just said, are nevertheless depressed by these indirect means.

"While all this is performed with extreme quickness several muscles of the wing, besides, among others, the extensors of the tail, strive to extend the wing; but as the resistance of the air on the extremities of the plumage is very great, and this fluid opposing all rapid movement on their part, these muscles then direct their power against the sides of the trunk. Taking then their position on the bone of the wing, on the external side of the wing, and acting by their upper extremity, they extend the main wing-bone over the fore wing-bone; and as this action and that of the great pectorals occur at the same instant and in concert on each side of the trunk, the latter is forced up in a middle direction.

"Thus the combination of these various efforts impart to the trunk a force of projecting forward and ascending, by which it is propelled with the wings. This projection is evidently similar to the leap of other animals. The great pectorals then relax, and the wings immediately reascend, partly by the reaction of the air on their lower surface, and the descent of trunk, and partly by the action of the middle pectorals and their congeners, whose contraction, so to speak, continues during the flight.

"After having darted forwards, the bird remains for an instant unsupported by the air; this fluid then, by its reaction, repels and tends to raise it still higher than the leap alone could have done; and afterwards prevents it again falling as low as the point of departure.

"The ascension of the trunk is doubtless favoured by the internal air, which insinuates itself into every part of the animal, and which the latter has the faculty of retaining. This air, which is perhaps a light gas, being dilated and rarefied by great heat, not only is its specific gravity probably diminished, but it must also contribute to diminish that of the bird, by inflating it and supplying all vacancies during the flight.

"If the bird which descends precipitately fears to hurt itself on approaching the earth, it opens its wings and its tail, and takes several little leaps, which, diminishing the rapidity of the descent, permit it to alight gently on the earth.

"It is by the assistance of the tail that certain birds are enabled to descend with precipitation from a great height: by spreading the tail and closing the wings they cause the action of the air to predominate on the hind part of the body, which directs the fore part downwards, and leaves it entirely to the influence of gravitation.

"The tail may strengthen the action of the wing by moving towards the same side *."

* Annales des Sciences for 1829, p. 502.

Chapter XII.

MIGRATION OF BIRDS.

Few subjects connected with natural history are more interesting, or have more attracted the attention of ordinary observers, than the periodical appearance and disappearance of certain species of birds. These curious phenomena have been noticed in all ages and countries; the sages of old, as well as the scientific of our own days, have looked upon them with interest; and to the agriculturist, the shepherd, and all whose occupations lead them to the fields, the woods, or the hills, they are in some measure familiar. Even the inspired seer has found in them an illustration suited to his purpose:—"The stork in the heaven," says the prophet Jeremiah, "knoweth her appointed times; and the turtle, and the crane, and the swallow observe the time of their coming."

In our latitudes the migration of birds is two-fold; in other words, there is a passage northwards and a passage southwards. Or, we may divide the birds that occur in any of the temperate climates of the northern hemisphere into permanent residents; birds that breed and remain all summer to retire southwards in autumn; birds that visit us in winter and return in spring to breed in more northern regions; and, lastly, birds that sojourn with us only for a short period on their passage northward in spring, and again on their return in autumn.

Among the permanent residents, there are species which perform a limited migration, shifting from one part of the country to another, according to local circumstances. Of these may be mentioned, in our country, the curlew and golden plover, which in winter reside chiefly along the shores, while in summer they betake themselves to the inland lakes and moors; the lapwing, which seems to move northward in winter; the linnet, which in that season deserts the hilly regions and approaches the habitations of man; and the dipper, which in summer ascends the streams towards their sources. These partial migrations seem to be determined partly by the state of the weather, and partly by the necessity of retiring to less frequented places for the purpose of incubation.

When the primrose, the daisy, the violet, and other early flowers make their appearance, we begin to look for the return from southern climes of those birds which we are accustomed to observe during the summer months. The wheat-ear is seen on the wall tops and sandy downs, the whin-chat among the thickets of furze, and the ring-ouzel in the hilly districts. As the season advances, when the hawthorn displays its fresh young leaflets, and the sloe is covered with a profusion of sweet white flowers, the different species of swallows enliven the air, seen at at first one by one, or in small numbers in sheltered places, but soon swarming over the meadows and the groves. The shrill scream of the swift, as it wheels its rapid flight over the houses, next informs us that summer is about to commence. Then is heard from the wood or the hill-side the well-known cry of the cuckoo, and in the quiet evening the singular crake of the land-rail issues from among the long grass of the dank meadows. By this time numerous warblers have arrived—the nightingale, the redstart, the black-cap, the willow-wren, and other species which nestle in the gardens, hedges, and groves. These birds remain with us during the fine season, rear their young, pursue their various avocations, and when the cold nights of autumn apprise them of the approach of winter, when food would fail them in our climate, they take their departure, and travel towards warmer regions.

While the inland districts are thus gladdened with the return of these interesting birds, the shores of the ocean swarm in many places with summer visitants. The gannet, the different species of tern, the auk, the guillemot, the puffin, the eider duck, and many other birds, betake themselves to the rocky headlands, or the remote islets, where they find a retreat, not always secure from the violence of men, in which they deposit their eggs and rear their young.

To every one who derives pleasure from the contemplation of Nature, few sights can be more interesting than that of one of the great breeding places which occur here and there along our coasts. The description of one of these which we lately visited, may afford some idea of the vast multitudes of birds that resort to such stations.

The island of Berneray, at the southern extremity of the outer Hebrides, is of an elliptical form, about a mile in length, and upwards of half a mile in breadth. It presents the appearance of a mass of rock considerably inclined, the northern part dipping into the water, and the southern exhibiting an abrupt section, rising to the height of several hundred feet. The rocks, viewed from the sea, present a grand and very interesting spectacle, exhibiting masses of inclined, perpendicular, and projecting cliffs, smooth, largely fissured, or minutely intersected. Their whole face, along an extent of half a mile, was covered with birds, of which, notwithstanding their immense numbers, there were only four species: the guillemot, the auk, the puffin, and the kittiwake. These birds inhabit the cliff, not promiscuously, but with a degree of regularity and distinction which strikes the beholder with wonder. On the summits of the rocks breeds the puffin, burrowing among the grassy tufts; from thence to half-way down is the space selected by the auks; while in the remaining division are placed the guillemots and gulls, the latter coming almost to high-water mark. Of the auks and guillemots, which lay only a single egg, placed on the bare rock, one may often see, on a shelf not more than three yards in length and as many feet in breadth, fifty or sixty individuals, jammed together like a solid mass, and each sitting upon its egg. Such masses are of frequent occurrence, the shelves being larger or smaller; but in general, two or three or four are seen together, and sometimes an individual is observed sitting solitary, if one may say so, when it is surrounded by others at no greater distance than three or four feet. The gull, on the other hand, has a regularly constructed nest, made of grass and sea-weeds, fixed to the face of the rock with clay or mud, and usually containing three eggs. This appeared to be the most numerous species, and in many places the rock was white with it; but the numbers of the auk and guillemot were not less astonishing. When a shot was fired, most of the birds in the neighbourhood left their stations and flew about, while some fell into the sea, and on emerging raised with their wings a continuous sheet of spray which extended several hundred yards from the rocks. After a succession of shots, almost the whole body seemed to be on wing, presenting the appearance of a cloud, which occupied a quarter of a mile square, and through which one could scarcely distinguish the blue sky from the flakes of clouds. In their flight the birds did not cross much, but generally moved in the same direction, wheeling in a large circle, a disposition which probably arose from their number being so great that they could not conveniently fly at random. Their mingled screams were blended into one harsh mass of sound, in which the cry of individuals could not be distinguished. The noise and bustle reminded us of some great city, and the prodigious number could be compared to nothing but the shoals of some species of fish. Some were fishing on the smooth sea around the island, some flying from the rocks, some resting along the margin of the water, upon shelves or projecting crags, while by far the greater number were sitting upon their eggs. Such was the appearance of the place when the birds were not disturbed, and they were by no means very excitable, for unless after a shot, none stirred on our account, however close the boat came. It was not uncommon to see them ranged in a line extending several yards along a fissure, and this formed a very interesting spectacle, especially when their white breasts appeared; for, excepting the gulls, these birds stand nearly erect.

Towards the end of summer the species which occur in these breeding-places begin to disperse, their numbers becoming perceptibly diminished immediately after the young have begun to fly; and by the middle of September they have entirely deserted their summer residence, leaving it to its ordinary inhabitants, the cormorants, and a few straggling gulls.

About the same period, the numerous species of Sylviæ, Saxicolæ, and other small birds, the swallows, martins, land-rails, and all those whose appearance in spring afforded us delight as indicating the approach of the sunny season, disappear from the groves and fields. The robin has already arrived in the gardens, the yellow-bunting, the linnet, and other small birds congregate in large flocks, frequenting the neighbourhood of the farm-houses, and the snipes and the plovers are occasionally met with in the low grounds. Now we begin to see birds which had disappeared at the beginning of summer. Flocks of fieldfares and red-wings cover the fields; the woodc- ' 's found in the marshes and by the sides of rills; snow-buntings are spread along the sandy shores, on which also we perceive the purre, the sanderling, and turnstone; while the bays and arms of the sea are sprinkled over with divers, gulls, and ducks that have escaped from the rigours of the arctic winter.

Of those species which appear in our country at the periods of their passage northwards in spring, and southwards in autumn, may be mentioned several kinds of geese, the northern diver, and the red-breasted merganser. But besides those which, although they pass over the country, neither remain to breed in summer, nor take up their residence with us in winter, numberless individuals of our summer and winter species merely appear with us for a few days on their transit. Thus, the common tern, which breeds abundantly in Scotland, extends to the arctic regions, and the woodcock and fieldfare, which winter in the same country, proceed much farther south.

The regular appearance and disappearance of some species of birds excited the curiosity of observers in all ages, and led to many conjectures respecting its causes. It was long alleged and believed that swallows, instead of removing to warmer climates, lie concealed in fissures of rocks, in sand-banks, in the holes of decayed trees, and even at the bottom of the water in ponds, remaining during the winter in a torpid state. "It is certain," says the Dutch naturalist, Jonston, "that in hollow trees, lying many close together, they preserve themselves by mutual heat *." "In certain woods of Upper Germany," says the author of the Physicæ Curiosæ, "upon cutting up a rotten oak tree, it has been found full of swallows †." He does not quote his authority, but we find the same circumstance reported by Albertus Magnus, Gaspar Heldelin, Augustine Niphus, and others ‡.

Unfortunately for the credibility of such accounts, however, they all wear the aspect of fanciful conjecture, rather than of a fact actually observed; and though we have accounts of similar circumstances purporting to be from actual observation, they all appear suspicious when strictly investigated. The Hon. Daines Barrington, for instance, told Mr. Pennant, on the authority of Lord Belhaven, "that numbers of swallows have been found in old dry walls and in sandhills near his lordship's seat in East Lothian; not once only, but from year to year, and that when they were exposed to the warmth of a fire they revived. We have also," he adds, "heard of the same annual discoveries near Morpeth in Northumberland, but cannot speak of them with the same assurance as the two former; neither in these two instances are we certain of the particular species §." "In many other places," he elsewhere says, "they have been found, but I will not vouch for the truth of it; as, first, in a decayed hollow tree, that was cut down near Dolgelly in Merionethshire; secondly, in a cliff near Whitby in Yorkshire, where, in digging out a fox, whole bushels of swallows were found in a torpid condition; thirdly, the Rev. Mr. Conway, of Lychton, Flintshire, a few years ago, between All Saints and Christmas, on looking down an old lead

* Hist. vi. 20. † Mirab. Anim. ix. 46.
‡ Apud Aldrovandi Ornithol. ii. 17.
§ Brit. Zool. 97.

mine in that country, observed numbers of swallows clinging to the timbers of the shaft, seemingly asleep, and on flinging some gravel on them, they just moved, but never attempted to fly or to change their place *."

The following narrative by M. Achard was communicated to the Royal Society by Mr. Peter Collinson. "In the latter end of March," says he, "I took my passage down the Rhine, to Rotterdam. A little below Basil, the south bank of the river was very high and steep, of a sandy soil, sixty or eighty feet above the water.

"I was surprised at seeing near the top of the cliff, some boys tied to ropes, hanging down doing something. The singularity of these adventurous boys, and the business they so daringly attempted, made us stop our navigation, to inquire into the meaning of it. The waterman told us they were reaching the holes in the cliffs for swallows or martins, which took refuge in them, and remained there all the winter, until warm weather, and then they came abroad. The boys being let down by their comrades to the holes, put in a long rammer, with a screw at the end, such as is used to unload guns, and, twisting it about, drew out the birds. For a trifle I procured some of them. When I first had them, they seemed stiff and lifeless; I put one of them in my bosom, between my skin and shirt, and laid another on a board, the sun shining full and warm upon it; and one or two of my companions did the like. That in my bosom revived in about a quarter of an hour; feeling it move, I took it out to look at it; but perceiving it not sufficiently come to itself, I put it in again: in about another quarter, feeling it flutter pretty briskly, I took it out, and admired it. Being now perfectly recovered, before I was aware, it took flight; the covering of the boat prevented me

* Brit. Zool. App.

seeing where it went. The bird on the board, though exposed to a full sun, yet I presume, from a chilness of the air, did not revive so as to be able to fly *."

White of Selborne was so much convinced of the probability of swallows remaining hid or torpid during winter, that he attempted to watch them to their retreat, and actually saw them dart down above some low shrubs, for several evenings together. "This spot," he goes on to say, "in many respects seems to be well adapted for their winter residence, for, in many parts, it is as steep as the roof of any house, and therefore secure from the annoyances of water; and it is, moreover, clothed with beechen shrubs, which, being stunted and bitten by sheep, make the thickest covert imaginable, and are so entangled as to be impervious to the smallest spaniel; besides, it is the nature of underwood beech never to cast its leaf all the winter, so that, with the leaves on the ground and those on the twigs, no shelter can be more complete. From all these circumstances put together, it is more than probable that this lingering flight at so late a season of the year (Oct. 22d) never departed from the island. I have only to add, that were the bushes, which cover some acres, and are not my property, to be grubbed up and carefully examined, probably those late broods, and perhaps the whole aggregate body of the window-swallows of this district, might be found there in different secret dormitories; and that, so far from withdrawing into warmer climes, it would appear that they never depart three hundred yards from the village †."

Pursuing this idea, our ingenious naturalist carried the investigation thus suggested into actual trial, which he thus elsewhere records: "I therefore determined to make some search about the south-east end of the hill, where I imagined they might slumber

* Phil. Trans. for 1763. † P. 293, Sir W. J.'s edit.

out the uncomfortable months of winter. But supposing that the examination would be made to the best advantage in the spring, and observing that no swallows had appeared by the 11th of April last, on that day I employed some men to explore the shrubs and cavities of the suspected spot. The persons took pains, but without any success; however, a remarkable instance occurred in the midst of our pursuit; while the labourers were at work, a window-swallow, the first that had been seen this year, came down the village in the sight of several people, and went at once to a nest, where it staid a short time, and then flew over the houses; for some days after, no swallows were observed, not till the 16th of April, and then only a pair *."

The Rev. W. T. Bree, an excellent observer, who has for many years attended to the arrival and departure of swallows, seems to incline to a similar opinion with that of White. There can be no question indeed about the fact of some few swallows appearing early in April, and even in March, before the general flight arrive—a fact which is recorded in the proverb, that "one swallow does not make summer," common to most languages †. This is a circumstance, according to these naturalists, "much more in favour of hiding than migration, since it is more probable that a bird should retire to its hybernaculum, just at hand, than return for a week or two only to warmer latitudes." After a review of all the facts bearing on the case, Mr. Bree concludes that, "however far they

* Letter 95.

† The Greeks have Μία χελιδὼν ἔαρ οὐ ποιεῖ; the Latins, "Una hirundo non facit ver;" the French, "Une hirondelle ne fait pas le printems;" the Germans, "Eine schwalbe macht kéinen frühling;" the Dutch, "Een swaluw maakt geen zomer;" the Swedes, "En svala gör ingen sommar;" the Spanish, "Una golondrina no hace verano;" the Italians, "Una rondine non fa primavera." *Foster on Swallows*, p. 10, note.

may fall short of positive proof, they undoubtedly afford much probability to White's opinion, that the *hirundines* do not all leave this island in winter *."

Spallanzani saw swallows in October, on the island of Lipari, and he was told that when a warm southerly breeze blows in winter, they are frequently seen skimming along the streets. He thence comes to the same conclusion as the preceding, that they do not pass into Africa at the approach of winter, but remain in the island, and issue from their retreat in warm days in quest of food †.

As the dormouse, the bat, and other hybernating animals do not appear to have any peculiarity of anatomical structure from which we might account for the circumstance, besides certain depositions of fat ‡, and a valvular conformation of the veins §, the use of which is not well known, we cannot, consequently, make any inference upon this point from the anatomical structure of swallows and other migratory birds ||. But experiment is no less valuable a test than structure, and experiments respecting the conjectured torpidity of the swallow were tried by Spallanzani, who found that swallows do not appear to suffer by cold at the freezing point; while at eight or nine degrees below it they manifest uneasiness, and at thirteen or fourteen degrees below it they speedily perish. In order to discover the effect of a continued low temperature, Spallanzani confined some swallows in wicker cases covered with waxed silk to keep them dry, burying them in snow with only a hole to admit air. After having been immersed for thirty-five hours, some of them were dead, and others exhibited signs of great weakness, but without any

* Mag. Nat. Hist. ii. 17.

† Travels in the Two Sicilies, iv. 115.

‡ Cuvier, Anat. Comp. iv. 92.

§ Phil. Trans. 1805. || Bostock, Physiol. ii. 195.

appearance of torpidity or even lethargy; in ten hours more, they were all found dead. That they had not died in consequence of want of food he further proved by keeping other swallows without food in his study, when he found they could support life from three to five days without any thing to eat *.

A still more convincing proof that swallows do not become torpid in winter, may be derived from those which have been successfully kept in cages. Dr. Reeve says he has known several attempts made to keep swallows in a warm room during winter without success †; but M. Natterer, a celebrated continental naturalist, kept a number of swallows in cages for eight or nine years together ‡; and in this country they have been successfully reared by Mr. Pearson.

"Five or six of these birds," says Bewick, "were taken about the latter end of August, 1784, in a bat fowling-net at night; they were put separately into small cages, and fed with nightingale's food; in about a week or ten days they took food of themselves, and seemed much strengthened by it; they were then put all together into a deep cage, four feet long, with gravel at the bottom; a broad shallow pan was placed in it, in which they sometimes washed themselves. One day Mr. Pearson observed that they went into the water with unusual eagerness, hurrying in and out again repeatedly with such swiftness as if they had been suddenly seized with a frenzy. Being anxious to see the result, he left them to themselves about half an hour, and going to the cage, found them all huddled together in a corner apparently dead; the cage was then placed at a proper distance from the fire, when only two of them recovered, and were as healthy as before; the rest died. The two remaining were allowed to wash themselves occasionally for

* Dissertations.

† On Torpidity, p. 47. ‡ Temminck, Man. i. 426, 2d edit.

a short time only, but their feet soon after became swelled and inflamed, which Mr. Pearson attributed to their perching, and they died about Christmas; thus the first year's experiment was in some measure lost. Not discouraged by the failure of this, Mr. Pearson determined to make a second trial the succeeding year, from a strong desire of being convinced of the truth respecting their going into a state of torpidity. Accordingly, the next season, having taken some birds, he put them into the cage, and in every respect pursued the same method as with the last; but to guard their feet from the bad effects of the damp and cold, he covered the perches with flannel, and had the pleasure to observe that the birds throve extremely well; they sung their song through the winter, and soon after Christmas began to moult, which they got through without any difficulty, and lived three or four years, regularly moulting every year at the usual time. On the renewal of their feathers, it appeared that their tails were forked exactly the same as in those birds which return hither in the spring, and in every respect their appearance was the same*."

The story of bank-swallows having been drawn from their holes on the Rhine, it may be observed, is dated in April, which is about the usual time of the appearance of those birds, and is no more extraordinary than it would be to find a sparrow under a house-eave, or a tom-tit in the hole of a tree. Did the bank-swallows really remain torpid in those holes during the winter, nothing would be easier than to find them there,—a circumstance which we believe has never been recorded even in the annals of credulity. In a numerous colony of this species, established in the bank of a stone-quarry at Catrine, in Ayrshire, we have in numerous instances witnessed

* British Birds, i. 328.

the opening of the nest-holes in the operations of quarrying, and never knew or heard of a swallow being found there either torpid or otherwise*. "In October 1810," says Forster, "I opened several sand-martins' holes near Dorking in Surry, and found in one of them a variety of very small bony substances which might be part of large insects mixed with dirt †."

"A gentleman," says White, "who was this week (March 23) on a visit at Waverly, took the opportunity of examining some of the holes in the sand-banks, with which that district abounds. As these are undoubtedly bored by bank-martins, and are the places where they avowedly breed, he was in hopes they might have slept there also, and that he might have surprised them just as they were awaking from their winter slumbers. When he had dug for some time, he found the holes were horizontal and serpentine, as I had observed before; and that the nests were deposited at the inner end, and had been occupied by broods in former summers; but no torpid birds were to be found. He opened and examined about a dozen holes. Another gentleman made the same search many years ago, with as little success. These holes were in depth about two feet ‡."

Similar legends to those we have quoted respecting torpid swallows have been related respecting other migratory birds, such as the cuckoo. Some affirm that the cuckoo hides itself and remains dormant during winter, and it has accordingly been reported that cuckoos have been discovered in the midst of winter not only in holes of trees, but under ground, in sandy soils, or in caverns of rocks, antique buildings, and old walls. Others pretend that they have been found in wheat and hay-stacks, and after car-

* J. R. † Brumal Retreat, p. 24, note, 6th edit.
‡ Selborne, p. 347.

rying them to the fire, they have revived and sung with as much vigour as in spring. "I have heard it affirmed," says an intelligent author, "that an old hollow tree being cut down in a certain village in Wiltshire, and laid on the fire, a cuckoo revived by the warmth, jumped out of it, and began repeating its usual note with great energy, to the admiration of the beholders: but I think this relation is too extravagant to deserve our credit *."

But however untenable the opinion may be that swallows and cuckoos become torpid in winter, it appears rational when compared with the notion that has been gravely supported of their going under water to undergo their winter's sleep;—a notion which we should not have brought under review were it not that it still seems to linger in the fancies of some, from the authority of the names of those by whom it has been adopted. The earliest statement of this notion which we have been able to trace is given by Olaus Magnus, archbishop of Upsal in Sweden, published in 1555.

"From the northern waters," says the archbishop, "swallows are often dragged up by fishermen in the form of clustered masses, mouth to mouth, wing to wing, and foot to foot, these having at the beginning of autumn collected amongst the reeds previous to submersion (*descensuræ*). It is also to be noted, that the most sweet season being now over and gone, they plunge into the water with a song, from which at the beginning of spring they quietly emerge to revisit their old nests, or from natural solicitude to fabricate new ones. When young and inexperienced fishermen find such clusters of swallows, they will, by thawing the birds at the fire, bring them indeed to the use of their wings, which will continue but a very short time, as it is a premature and forced revival;

* Discourse on Emigration, p. 35, 8vo. Lond. 1795.

but the old, being wiser, throw them away *." Pennant shrewdly remarks that "the good archbishop did not want credulity," for "after having stocked the bottoms of lakes with birds, he stores the clouds with mice, which sometimes fall in plentiful showers in Norway and the neighbouring countries †."

Etmuller, professor of Botany and Anatomy at Leipsic, a century after Olaus, gives his personal testimony to the circumstance. "I remember," he says, "to have found more than a bushel measure (*medimnus*) would hold of swallows closely clustered among the reeds of a fish-pond under the ice, all of them to appearance dead, but the heart still pulsating ‡." Our own excellent naturalist, Derham, who quotes this, adds, "We had, at a meeting of the Royal Society, Feb. 12th, 1713, a farther confirmation of swallows retiring under water in the winter, from Dr. Colas, a person very curious in these matters, who, speaking of their way of fishing in the northern parts by breaking holes and drawing their nets under the ice, saith, that he saw sixteen swallows so drawn out of the lake of Lamrodt, and about thirty out of the king's great pond in Rosneilen; and that at Schlehitten, near a house of the Earl of Dohna, he saw two swallows just come out of the waters that could scarce stand, being very wet and weak, with their wings hanging on the ground; and that he observed the swallows to be often weak for some days after their appearance §."

Linnæus, taking the matter as proved, expressly says that "the chimney-swallow (*Hirundo rustica*), together with the window-swallow (*H. urbica*), demerges, and in spring emerges ‖;" and we find from the dissertations read before the Academy of

* Gent. Sept. Hist. xix. 20, 12mo. Lugduni, 1652.
† Brit. Zool. ii. 352.
‡ Dissert. ii. 10, § 5.
§ Physico-Theol. vii. note d,
‖ Syst. Naturæ.

Upsal, that the submersion of swallows was received in Sweden as an acknowledged fact. The late Peter Collinson, in his correspondence with Linnæus, "repeatedly urged him to bring the matter to a decisive issue by proposing some questions, and pointing out an easy method of having them answered. As Linnæus did not take any notice of these questions for a long while, although he was strongly called upon at different times by his acute correspondent, we may fairly infer that he was unable to give any satisfactory answer; and his constant evasion of the experimental proofs is an indication of his being unprepared to support what he had asserted by any thing more than the common authorities *."

Klein, the rival of Linnæus, also supports the doctrine, and tells us that the mother of the Countess of Lehndorf saw a bundle of swallows brought from out of the lake Fische Haff, near Pilaw, which when brought to the fire flew about. Klein examined a considerable number of other cases of swallows found in lakes and often under ice by fishermen, who swore positively to the facts; but he always failed in procuring recent, much less ocular, testimony †.

Of a somewhat older date, Aldrovand tells us, "P. A. Talentini, a nobleman of Cremona, highly worthy of credit, informed me upon the testimony of a Jesuit presbyter, that the swallows in Silesia, Bohemia, Poland, Moravia, and the neighbouring countries, every where precipitated themselves into cisterns and wells ‡;" but if this were so common every where, all dispute could be readily settled by examining the bottom of any given well or cistern during winter.

The most recent authority which we have met with upon the subject is that of Baron Cuvier, who asserts of the bank-swallow (*Hirundo riparia*, PLINY), as

* Reeves on Torpidity, p. 47.

† Hist. Avium, p. 200-5. ‡ Ornithol. ii. 297.

"well authenticated, that it falls into a lethargic state during winter, and even that it passes that season at the bottom of marshy waters*." It would have been well if he had at least referred us to some of these authenticated accounts; for we have been unable to trace any thing more satisfactory than what we have already mentioned.

We deem it unnecessary to enter at much length upon a refutation of these opinions, as it must be obvious that it is physiologically impossible for a swallow or any other bird to live many minutes, much less for months, under water. The frog and other amphibious animals which do hybernate under water have a peculiar formation of the heart which enables them to do so, and which is not thus formed in swallows. "Though entirely satisfied," says Pennant, "in our own mind of the impossibility of these relations, yet desirous of strengthening our opinion with some better authority, we applied to that able anatomist, Mr. John Hunter; who was so obliging to inform us that he had dissected many swallows, but found nothing in them different from other birds as to the organs of respiration. That all those animals which he had dissected of the class that sleep during winter, such as lizards, frogs, &c. had a very different conformation as to these organs. That all these animals, he believes, do breathe in their torpid state; and, as far as his experience reaches, he knows they do; and that therefore he esteems it a very wild opinion that terrestrial animals can remain any long time under water without drowning†."

Independently of the established principles of physiology, the matter has been experimentally tried, and

* Griffith's Transl. vii. 61. "Il parait constant qu'elle s'engourdit pendant l'hiver, et même qu'elle passe cette saison au fond de l'eau des marais." *Regne Anim.* i. 396, edit. 1829.

† Brit. Zool. ii, 253.

it has been found that swallows kept under water, with all due precautions, die in a few minutes *. A window-swallow, which M. Montbeillard had in his study, escaped from the cage and fell into a pan of water, and it was only by the greatest care that he succeeded in restoring it to life: a few minutes' longer immersion would probably have rendered his efforts hopeless †.

It may be added, that in Germany a reward of an equal weight in silver was publicly offered to any one who should produce swallows found under water; but, as Frisch informs us, nobody every claimed the money ‡.

A no less fanciful, but, as it appears to us, a more defensible opinion, was published in a scarce tract purporting to be written by 'A Person of Learning and Piety,' who maintained, with no little ingenuity, that our migratory birds retire to the moon. He thinks that they are about two months in passing thither, and that after they are arrived above the lower regions of the air into the thin æther, they will have no occasion for food, as it will not be so apt to prey upon the spirits as our lower air. Even on our earth, he argues, bears will live upon their fat all the winter; and hence these birds, being very succulent and sanguine, may have their provisions laid up in their bodies for the voyage; or perhaps they are thrown into a state of somnolency by the motion arising from the mutual attraction of the earth and moon.

"Concerning the great distance," he adds, "between the moon and the earth, if any shall still remain unsatisfied, I leave only this to his consideration, Whether there may not be some concrete bodies at much less distance than the moon, which may be the

* Ornith. Ital. iii. 6, quoted by M. Montbeillard.

† Oiseaux, xiii. 303, edit. 12mo.

‡ Vorstellung der Vögel in Deutschland, i.

recess of these creatures, and serve for little else but their entertainment.

"Thus we see many rocky islands in the sea that are of no other manifest use than for sea-fowls to rest and breed upon, and these are therefore commonly called Gulrocks. Now if there be such globules (or etherial islands) they must be supposed of such magnitude only, and set off at such distance as their reflective light may not reach home to our earth (though perhaps they may serve to illuminate our atmosphere), else they would ere now have been discovered, and yet no farther off than these birds may conveniently arrive unto them in such time as may be most convenient to allow them. This I do suggest, because it is as hard for me to persuade myself that they come from any other part of this earth as it is to persuade another that they come from the moon, and therefore if the moon will not be allowed, some other place must be found out for them *."

This notion, extravagant as it appears to be, was discussed by the celebrated Ray and his correspondents; but, as might have been expected, it was decided by them that the moon is too far off to be reached by our migratory birds.

* An Essay towards the probable Solution of this Question, Whence come the Stork, &c.; or where those Birds do probably make their Recess, &c. 12mo. Crouch, London, 1703.

Chapter XIII.

MIGRATION—*continued.*

Dismissing the untenable conjectures which were exhibited in the last chapter, we shall now state a few facts proving the migration of birds to other countries. In the first place let us observe the flights of some of our more common species of birds.

The only breeding place of the gannet, on the east coast of Scotland, is the Bass Rock, at the mouth of the Frith of Forth. Individuals of the species may frequently be seen fishing as far up as Queensferry, a distance of upwards of thirty miles, as well as along all parts of the coast. In like manner the gannets of Ailsa Craig may be seen along all parts of the coast of Ayrshire. In the outer Hebrides, they may be observed every morning about sunrise, flying in strings eastward along the coast; and in the evening, proceeding outward over the ocean, in the direction of St. Kilda, their only roosting place in that district. Here then we have a daily migration extending to sixty or more miles, the object of which is to procure a supply of food. This kind of migration is necessarily performed by all birds, although it may be less extensive in most species.

The next kind of migration is that performed by birds which are permanent residents in a district or country of greater or less extent, but which shift from one place to another in search of food. The purre or dunlin, for we believe they are identical, breeds on the moors of Dumfriesshire, and other parts of

Scotland, confining itself entirely to the interior during the summer; but towards the end of August, or in September, when the young are fully fledged, it descends to the sandy shores; and at a later period moves southward, and disperses over all the coasts of the island. This is also the case with the golden plover, although in a less remarkable degree, as well as with the curlew, which do not leave the kingdom at any period of the year. The partial migration of the crow is also well exemplified in Dumfriesshire; they breed in great numbers at Dalswinton and Carruchan, but forsake these places as soon as their young are fully able to fly; during the autumn and winter they frequently return to these localities, as if to view the scenes of their incubatory labours.

In the Philosophical Transactions*, Catesby, who gave much attention to this subject, remarks that, besides the migratory birds which remain and breed throughout the summer, there are others which arrive periodically at certain places, for the sake of some sort of grain or other food of which their own country may be supposed destitute. These birds, after a short stay, depart, and are not again seen until that time twelvemonth, at which time they return, and continue repeating their annual visits. Pursuing the subject, the same sensible naturalist, whose remarks on the general subject of migration subsequent writers have done little more than repeat, says, " though the secret ways by which instinct guides birds and other irrational creatures are little known to us, yet the causes of some of their actions are apparent. Analogous to the lucrative searches of man through distant regions, birds take distant flights in quest of food, or what else is agreeable to their nature; and when they discover some new grain or pleasing food they return,

* Vol. xliv. part i. for the year 1746.

and acquaint their community therewith, and, joining in numerous flights, make annual excursions to solace in this their exotic food. Since the discovery of America there have been introduced from Europe several sorts of grain, which were never before known in that part of the world, and which, not before some length of time, were found out and coveted by these migratory birds. No wonder this grain should not be immediately known to birds of distant regions; for above half a century passed from the time of cultivating wheat, rice, and barley in Virginia and Carolina, before those grains were found out and frequented by those foreign birds, of which one has but lately made its appearance in Virginia, as my ingenious friend, Dr. Mitchel, informs me that he, being in his garden, a bird flew over his head, which appeared with uncommon lustre, and surprised him the more, not having seen the like kind before. Mentioning this to some of his neighbours, he was told by them, what afterwards was confirmed to him by his own observation, that these exotic birds had but within these few years appeared in Virginia, and had never been observed there before. They arrive annually, at the time that wheat (the fields of which they most frequent) is at a certain degree of maturity, and have constantly, every year, from their first appearance, arrived about the same time in numerous flights. They have attained the name of wheat-birds." Catesby further mentions that, in September 1725, he was lying upon the deck of a sloop in a bay at Andros island, where he and the company with him distinctly heard, for three successive nights, the flight of these birds, whose note is plainly distinguishable from others, passing over head northerly, which is their direct way from Cuba to Carolina. This led him to conclude that, after partaking of the earlier crop of rice in Cuba, they proceed over the sea to Carolina with the same object, the rice being there ready for them.

The same writer speaks of the blue-wing teal, a bird which, in the month of August, comes in great numbers to Carolina, and remains until the rice, on which they feed, is gathered in, in the month of October. In Virginia, where no rice grew, they fed on a kind of wild oat, growing in the marshes, and in both instances became extremely fat.

The same observant naturalist, in his fine work on the natural history of Carolina, Florida, and the Bahama Islands, gives an account of a migratory bird, which he calls the rice-bird. The following is an abridgment of his account:—In the beginning of September, while the grain of rice is yet soft and milky, innumerable flights of these birds arrive from some remote parts, to the great detriment of the inhabitants. In the year 1740, an inhabitant, near Ashley river, had forty acres of rice so devoured by them that he was in doubt whether the quantity they had left was worth the expense of gathering in. They are in Carolina esteemed more delicate eating than any other bird. When they first arrive they are lean, but become in a few days so excessively fat, that they fly sluggishly and with difficulty, and when shot frequently break with the fall: they continue three weeks, and retire by the time that the rice begins to harden. He mentions it as a very singular circumstance, that the hen-bird alone comes in the September visit. Seeing them to be all feathered alike, he at first imagined that they were the young of both sexes not perfected in their colours; but, by opening several scores, as they were prepared for the spit, he found them to be all females; and, after repeated searches, he was never able to find one cock-bird at that time of the year. But in the spring of the year another transient visit was paid, and then the different sexes were plainly distinguishable.

A remarkable example of this kind of migration is afforded by the passenger-pigeon of America, the history of which is given by Audubon, in his Ornithological Biography. "The most important facts," he says, "connected with its habits, relate to its migrations. These are entirely owing to the necessity of procuring food, and are not performed with the view of escaping the severity of a northern latitude, or of seeking a southern one for the purpose of breeding. They consequently do not take place at any fixed period or season of the year; indeed it sometimes happens, that a continuance of a sufficient supply of food in one district will keep these birds absent from another for years. I know, at least, to a certainty, that in Kentucky they remained for several years constantly, and were nowhere else to be found. They all suddenly disappeared one season when the maize was exhausted, and did not return for a long period. Similar facts have been observed in other states.

"In the autumn of 1813, I left my house at Henderson, on the banks of the Ohio, on my way to Louisville. In passing over the Barrens, a few miles beyond Hardensburgh, I observed the pigeons flying from north-east to south-west, in greater numbers than I thought I had ever seen them before; and feeling an inclination to count the flocks that might pass within the reach of my eye in one hour, I dismounted, seated myself on an eminence, and began to mark with my pencil, making a dot for every flock that passed. In a short time, finding the task which I had undertaken impracticable, as the birds poured on in countless multitudes, I rose, and counting the dots then put down, found that one hundred and sixty-three had been made in twenty-one minutes. I travelled on, and still met more the farther I proceeded. The air was literally filled with pigeons; the light of noon-day was obscured as by an eclipse; the dung fell in spots, not unlike melting flakes of snow; and the continued buzz of wings had a tendency to lull my senses to repose.

"Whilst waiting for dinner at Young's inn, at the confluence of the Salt-river with the Ohio, I saw, at my leisure, immense legions still going by, with a front reaching far beyond the Ohio on the west and the beech-wood forests directly on the east of me. Not a single bird alighted; for not a nut or acorn was that year to be seen in the neighbourhood. They consequently flew so high, that different trials to reach them with a capital rifle proved ineffectual; nor did the reports disturb them in the least. I cannot describe to you the extreme beauty of their aërial evolutions, when a hawk chanced to press upon the rear of a flock. At once, like a torrent, and with a noise like thunder, they rushed into a compact mass, pressing upon each other towards the centre. In these almost solid masses, they darted forward in undulating and angular lines, descended and swept close over the earth with inconceivable velocity, mounted perpendicularly so as to resemble a vast column, and when high, were seen wheeling and twisting within their continued lines, which then resembled the coils of a gigantic serpent.

"Before sunset I reached Louisville, distant from Hardensburgh fifty-five miles. The pigeons were still passing in undiminished numbers, and continued to do so for three days in succession. The people were all in arms. The banks of the Ohio were crowded with men and boys, incessantly shooting at the pilgrims, which there flew lower as they passed the river. Multitudes were thus destroyed. For a week or more, the population fed on no other flesh than that of pigeons, and talked of nothing but pigeons. The atmosphere, during this time, was strongly impregnated with the peculiar odour which emanates from the species."

Captain Flinders relates a somewhat parallel instance; he says that while on his voyage he saw "a stream of stormy petrels, which was from fifty to eighty yards deep and three hundred yards, or more, broad. The birds were not scattered, but flying as compactly as the full movement of their wings seemed to allow; and this stream of petrels for a full hour and a half continued to pass without intermission, at a rate little inferior to the swiftness of a pigeon. Now taking the stratum at fifty yards deep by three hundred in breadth, and that it moved at thirty miles an hour, and allowing nine cubic inches of space to each bird, the number would amount to one hundred and fifty-one millions and a half."

Among these irregularly migratory birds, one of the most remarkable is the wild turkey, which shifts about from one district to another, according to the comparative abundance of the natural fruits. The continent of North America, on account of its great extent from north to south, and the comparative facility of making observations in the different states and provinces, affords an excellent field for studying the partial migrations of birds, some of which have been detailed by Wilson and Audubon.

The blue-bird of America seems to have a power of continuous flight almost equal to that of the swallow, and among the most interesting of *established* facts on the subject of migration is that which makes it necessary that this small bird should pass at least six hundred miles over the sea. Wilson says, "Nothing is more common in Pennsylvania than to see large flocks of these birds, in spring and fall, passing at considerable heights in the air, from the south in the former, and from the north in the latter season. The Bermudas are said to lie six hundred miles from the nearest part of the continent. This seems an extraordinary flight for so small a bird; but it is a fact that it is performed. If we suppose the blue-bird to fly only at the rate of a mile a minute, which is less than I have actually ascertained them to do overland, ten or twelve hours would be sufficient to accomplish the journey." Such facts as this seems to render quite unnecessary the admission of Catesby, who, while he believed, for himself, that birds were capable of very long flights over the sea, allowed that they might be guided, by the same sagacity which instructs them to change climates, "to the narrowest part of our channel, to evade the danger of passing a wide sea." We doubt not that even the short-winged quails, of which he is particularly speaking, would scorn to be confined to the passage between Dover and Calais.

The periodical migration of the gannet affords an instance of a mixed nature. That bird arrives early in spring, and is located in four or five spots along the British coasts, of which may be mentioned the Bass Rock, Ailsa Craig, and St. Kilda. In autumn the gannets leave their breeding places, and are seen along the coasts of England, and in the channel. In mild winters some individuals often remain, and even the whole flock has been known to winter in their summer residence. Even when they all leave the breeding places, many individuals do not extend their migration beyond the southern coasts of England, but where the extreme point of the range may be has not yet been ascertained.

In all these cases, the distribution of food seems to be the principal cause of the movements of the birds; but in other cases it is clear that the rigour of the winter also acts as an exciting cause; yet it is doubtful whether cold alone be sufficient to drive birds from their northern haunts. Fieldfares and red-wings, no doubt, leave the northern parts of Europe at the end of autumn, because at that period the ground begins to be covered with snow, so that they are unable any longer to procure food; but they merely shift, so as to place themselves on the limits of the storm, their object being apparently more to obtain the necessary supplies, than to evade the cold. In mild and open winters they remain in our country until late in spring; whereas, after snow has continued several weeks on the ground, it is seldom that any are to be seen. As to swallows, it is evident that the same cause operates most powerfully on them, because, as we have seen, they are capable of bearing as much cold as other small birds.

How far the migrations of our summer visitants may extend, has not, we believe, been yet settled in any one instance with a satisfactory degree of precision. In the beginning of April the stork arrives in small flocks in Holland, where it is sure to meet with an hospitable reception, and where it returns year after year to the same chimney-top. In the beginning of August, when the young are fully fledged, it prepares for its departure, multitudes assembling from the surrounding districts, and chattering with their bills, as if in mutual congratulation. At length, on the appointed night, the whole band mount into the higher regions of the air, and pursue their southward course, until they alight among the marshes of northern Africa, and especially Egypt, where they have been seen in the winter.

On the subject of the migration of storks we may quote the following anecdote, which appeared lately in several public journals:—

"Last year (1833) a Polish gentleman having caught a stork upon his estate near Lemburg, put round its neck an iron collar with this inscription, 'Hæc ciconia ex Polonia' (this stork comes from Poland), and set it at liberty. This year the bird returned to the same spot, and was again caught by the same person. It had acquired a new collar of gold, with the inscription, 'India cum donis remittit ciconiam Polonis' (India sends back the stork to the Poles with gifts). The gentleman, after having shown the inscription to his neighbours, again set the bird at liberty*." It is worthy of remark that the stork emigrates on the approach of winter, even when circumstance of climate or food cannot operate, or can operate but faintly in inducing it to do so. Thus, at Bagdad, which enjoys an extremely mild winter, and where even a slight degree of frost is not usual, the stork regularly leaves the place against the approach of that season.

In like manner the quail, which in spring is diffused over all the temperate regions of Europe, is known to betake itself, in autumn, to the coasts of Africa, and to penetrate into Arabia and Persia. Notwithstanding the smallness of their wings they cross the Mediterranean: they wait whole weeks for a favourable wind, reposing on every small isle: hence they are taken by thousands on the Ionian isles and the coast of Asia. Should the wind change rapidly, great numbers of them perish in the sea. Swallows have been seen crossing the Mediterranean in autumn towards the African shores, but where their voyage terminates is yet unknown.

It is remarkable that all migratory birds, when detained in captivity, manifest great agitation when the period of their migration arrives, insomuch that some of them, the quail in particular, occasionally kill themselves through their efforts to escape. This

* 'Atlas,' December 21, 1834.

agitation is always greatest at night, proving, together with observation, that birds generally commence their flight at that time. The cause of this pervading inquietude cannot be attributed either to the want of food or the increase of cold, it being experienced by individuals removed from the influence of either, and therefore must reside in some as yet mysterious warning, no doubt produced by natural causes, which the Creator and Preserver of the universe has found necessary to the safety of his creatures.

It may seem strange that birds, such as the quail and land-rail, remarkable for their limited powers of flight, should be able to perform so extensive a journey as that from England to Egypt; but doubtless these, and many species of small birds, instead of flying continuously, proceed at intervals only, journeying by night and resting by day. The celerity with which swallows fly renders any exploit by them ón the wing credible enough; and the steady flight of gannets, geese, and ducks, is obviously capable of carrying them over a very large space in a short time. The flight of birds generally may be estimated at from fifty to one hundred and twenty miles an hour; and if we take the mean of this, we shall find it sufficient to enable the migratory birds to perform the most extended journeys. The wonder is not in the flight itself, but in the impulse and instinct by which it is commenced and carried on.

Pennant finds no difficulty in accounting for the motive of migrations: a defect of food at certain seasons, or the want of a secure asylum from the persecutions of man during the time of courtship, incubation, and nutrition. He considers that most of the birds which leave us in spring to spend the summer elsewhere have been traced to Lapland, a country of lakes, rivers, swamps, and alps covered with thick and gloomy forests that afford shelter during summer to these fowls, which in winter disperse over the greater part of Europe. In these arctic regions, in consequence of the thickness of the woods, the ground remains soft and penetrable to the woodcocks, and other slender-billed fowls; and for the web-footed birds the water affords innumerable larvæ of the gnat. The days are there long, and the beautiful meteorous nights indulge them with every opportunity of collecting so minute a food; whilst mankind is very sparingly scattered over those vast northern wastes.

The migration of winter birds of passage doubtless proceeds on the same general law as that which regulates the movements of those birds which spend the summer with us and leave us in winter. Birds which find the temperature and circumstances of our summer most congenial to their wants and habits retire on the approach of severe weather to find something similar in the south; while others which remain among us in winter, to avoid the extreme rigour of that season in the most northerly regions, return to their own country when that rigour has abated. Nevertheless, there are difficulties in accounting for the migration of the winter birds of passage, which are not so apparent in the case of the others. The following are some of those difficulties, which we give nearly as stated by Mr. Collinson, in vol. 44, for 1747, of the Philosophical Transactions.

There appears no necessity, either on the score of food or climate, for their departure from us. They probably come here in winter for the sake of food and a more genial climate than that which they have left; but in some very severe seasons, when there is a great scarcity of berries, they find their subsistence here with difficulty, and often perish from the want of sufficient food. It is, therefore, unaccountable that after they have remained through the hardships of a severe winter with us, and might be expected to rejoice at the approaching spring, and build their nests and couple, they, on the contrary, then take their departure, as if that mild and pleasant temperature which delights and cherishes most other creatures were disagreeable to them. The place of their summer retirement is Sweden and other countries in that latitude; but as they would find those countries too cold for their reception, and probably destitute of provision, if they went thither immediately on leaving this country, they travel gradually, and prolong their passage through the more moderate countries of Germany and Poland, so that by the time they reach the northern regions the severity of the cold has much abated, and some sorts of food may be there found. The winter food of these birds being berries, and particularly haws, and as these grow more abundantly here than in northern regions, this may be one of the circumstances which attract them to this country; but, no doubt, their principal motive is to exchange for a more temperate climate the rigour of the frozen countries of the north. Their coming may thus be accounted for; but the cause of their departure at the season they leave us presents a considerable difficulty. If it be said that they do not go till the haws and berries are all gone, and they are necessitated to seek for food elsewhere, this would not account for it unless we supposed that the north could afford them a fresh and better supply, which it certainly could not. It is, therefore, likely that they change their diet; but even then, one would imagine that it would be easier for them to find their subsistence here than in the northern regions to which they then proceed.

Among the most remarkable of this class of birds who find the severe weather from which others retire most congenial to their wants or constitutions, may be mentioned the snow-bunting and the snow-bird. The former, although a bird of song, withdraws to the frozen zone to breed and nurture its young. It inhabits not only Greenland, but even the dreadful climate of Spitzbergen, where vegetation is almost extinct, and where scarcely any but cryptogamous plants are found. Yet these buntings are found in great flocks both on the land and ice of Spitzbergen; it is probable that they breed there, and it is certain that they do so in Greenland, where they arrive in April, and make their nests in the fissures of the rocks in May. The snow-bird, in America, retires northward in April, when the weather begins to be warm, arrives about the Hudson-bay factory in June, and proceeds further north to breed. This species is so numerous that Mr. Wilson, in the 'American Ornithology,' says, "In the circuitous route I travelled, of more than one thousand eight hundred miles, I never passed a day, and scarcely a mile, without seeing numbers of these birds, and frequently large flocks of several thousands."

With reference to the subject of migration in general, and that of the distribution of birds in Europe in particular, the best observations that we have met with are those of M. Temminck, which we therefore present here, as translated from his highly accurate and useful Manuel d'Ornithologie.

"The yearlings and the old birds," he says, "rarely travel together in these journeys, which are longer or shorter as the necessity of seeking a fresh supply of food in other climates obliges them to quit those places which fail at certain seasons to furnish them with the means of subsistence. I think I have traced the reason of this separation of families, and the collection into flocks of birds nearly of the same age, to a very natural cause, produced by the difference of the periods at which the moult takes place in the old and young birds; and this also appears to be the cause that the flocks composed of adult individuals migrate to a much greater distance, whether in autumn or at their return in spring, than the bands composed of young ones, which do not in either season extend their journey so far. The plumage of these birds being still incomplete, and the colours not fixed, they generally take one or two years before they are in a state for breeding. They then choose those places where adults of their own species do not build their nests, the latter always expelling them from the districts which are to give birth to a new progeny. When the old ones extend their journey to the arctic regions, those of one or two years old are found in the middle countries of Europe; and when the old ones choose the temperate climates, the young ones remain in the south, or at farthest do not pass the seas which separate Europe from the northern parts of Africa—countries in which the greater part of the larger species of our migratory birds, that do not perfect their growth within the first year, choose to reside in winter. It is from these countries, or the numerous islands of the Archipelago, and those of the Mediterranean and the Gulf of Venice, that they set off on their return in spring. Numerous flocks are then seen on all our southern coasts, especially where the sea forms gulfs, such as the Archipelago, the Adriatic Gulf, and those of Genoa and Lyons. These meetings continue eight, ten, or at most fifteen days; in which time the passage of those countries is completed. The routes taken by our marsh and water birds depend entirely on the course of the rivers and the direction of the great lakes. As the waters are to supply each species with its proper food, they seem to be impelled by a wonderful instinct, to choose for a rallying point and place of departure those spots whence the passage from the sea to the lakes and rivers is shortest and less occupied by the land. Thus the flocks that assemble in the environs of Genoa and Savona repair first to the banks of the Po; then following the passes of the great valley of the Alps, which descend into Piedmont, they rise above the mountains, where different species of the birds in question are annually killed. From these points they appear to direct their flight to the great lakes of Switzerland, particularly that of Geneva, which all the water and marsh birds of Europe resort to for a short period, or pass more or less regularly. From thence they seem to continue their journey by the lakes of Morat, Neufchatel, and Bienne, and repair to the Rhine, by following the course of which they arrive at the Baltic, the great inland seas, and the North Sea. These companies, already less numerous when they arrive in the north, disperse soon after, and make preparations for rearing their progeny.

"The route most frequented by all the water birds is along the borders of the sea. Those which come from the Gulf of Gascony, from Spain, and the coast of Barbary, appear to follow that only. Several species of waders uniformly follow it, and the same route is taken by all those birds which are unprovided with powerful means of flight. The divers, the grebes, and other fresh-water fowl, which seldom fly when occupied in the north with the cares of pairing and breeding, are however endowed with great powers for this action; their flight is vigorous and long sustained; they even rise above the high mountains, for it is not rare to find individuals of these species on the lakes of the Alps, where the waders and web-footed species are often killed.

"It appears that the great flocks which assemble in the Ionian Isles, and the vast marshes between Venice and Trieste, follow in their travels the course of the Tagliamento, to arrive at the lakes in the environs of Villach and Klagenfort. They visit the immense marshes which are formed by the lakes Balaton and Neuzidel, where several species remain, while others reascend the Danube, and continue their journey to the Baltic Sea. On the lakes of Hungary and the Danube several species are found which also visit the shores of the ocean.

"It appears to me that the species most peculiar to the western countries assemble in the Archipelago, and on the borders of the Black Sea. They ascend the Danube, and, following the course of that river, arrive in Hungary and Austria, countries that abound with various species of birds in great numbers. I have not travelled over the whole extent of country crossed by the birds in the latter migration, nor that which takes place from the Gulf of Lyons, by the mouths of the Rhone, along that river, and by the Douts, the way by which their companions reach the Rhine. The banks of this great river are peopled in spring and autumn by a large number of birds. We find in the part which forms a limit to the western countries of Germany all the species that live by the shores of the ocean and the Baltic Sea. It is, however, very rarely that we see companies composed of old ones, these seeming to come more frequently by chance, and separately. The yearlings of almost every species pass pretty regularly along these parts; and the individuals that are killed on the great lakes of Switzerland and Italy are either young birds, or such as are one or two years old. It is to be understood that the species which do not continue their periodical journey as far as the North Sea and the Baltic are exceptions; the old ones of these species are the only individuals that stray to the northern climates, and it is exceedingly rare to find the young ones there."

To this we may subjoin such observations of other continental writers on the general subject as have not already been anticipated.

M. Ul. Ekstroem, in his Observations upon the Birds of Passage in Sudermania in Sweden, states the following, among other interesting facts, which were the results of long and careful observation. Birds of passage generally migrate with a contrary wind. Several species do not follow the same meridian in arriving and departing, and they are, therefore, only seen once a year in the same districts. In Sudermania several species which were formerly very rare are now very common, and *vice versâ*. He gives an opinion upon the causes which engage or compel birds to change of country. Without disputing that difference of temperature and nourishment have much to do with it, he is inclined to consider that habit is quite as much concerned; according to him the recollection of the old ones that they have made the journey, carrying the young with them, and the "instinct of travel," which, at certain periods, affects them with a real nostalgia, must be considered, especially the last, as the principal and immediately exciting cause of these migrations. He shows, by examples, that the failure of food alone cannot be the cause, as some birds leave at the period when their proper food is the most abundant; and generally the birds of passage arrive and depart at the usual periods, whatever be the state or prospects of the season *.

M. Brehm, who has given much attention to the subject of the migration of birds, considers the fol-

* Review in 'Bulletin Universel,' of M. Ul. Ekstroem's 'Observations sur les Oiseaux de Passage dans la Sudermanie, en Suede.'

lowing facts as established:—Every bird has its native country, where it freely reproduces, and remains part of the year, travelling in the remainder. Most birds spend half the year at their home, and pass the other half in travelling. Some, particularly birds of prey, travel by day; but by far the greater part travel by night; and some perform their migrations indifferently either by day or night. They seem to pass the whole of their migration without sleep, for they employ the day in seeking their food, stopping in the places where they are most likely to find it. They commonly keep very high in the air, and always at nearly the same distance from the earth, so that they rise very high over mountains, and fly lower along valleys. They require a wind that blows *against* them, as a contrary wind assists and raises them. This last statement must, however, we imagine, be subject to some very large exceptions.

The same writer thus answers the rather difficult question, "What decides birds to emigrate?" It is not want of nourishment, for most of them commence their migration while there is still abundance in the country they are leaving. Atmospherical currents are not the cause, nor do the changes of season explain it, as the greatest number set off while the weather is yet fine; and others, as the larks and starlings, arrive while the season is bad. Atmospherical influences can only hasten the migration in autumn, but must rather retard or derange it in spring. It is the *presentiment* of what is to happen which determines birds to begin their journey. It is an instinct which urges them, and which initiates them into the meteoric alterations that are preparing. They have a particular faculty of foreseeing the rigours of the coming season; an exquisite sensibility for the perception of atmospherical changes that are not yet arrived, but are approaching.

According to the statements of M. Schlegel, European birds of passage generally pass the winter in Africa and in the south-west of Asia. Forskål enumerates a great number of birds which, according to the report of an Arab hunter, spend the winter in the north of Africa; but as we are not furnished with the systematic names of these birds, the information is of little use at present. MM. Hemprich and Ehrenberg met with many birds of Europe in the valley of the Nile; many of these are also found in Upper Egypt, in Nubia, and even in Abyssinia. The interior of Africa is at present too imperfectly known to furnish us with any certain information concerning the birds which arrive and make a temporary stay there; but we find our birds of passage upon the western shores of that part of the world during the severities of our winter season.

Nothing is, upon the whole, more probable than that the largest number of our birds of passage inhabit the interior of Africa during the winter. M. Schlegel thinks that after having passed the Mediterranean they distribute themselves in the north of Africa; that the greater part of the aquatic birds hasten to the banks of the Nile, where they find suitable nourishment, and where they pass the winter, while the innumerable flocks of insectivorous birds of passage penetrate a great deal further to the south. Some of the birds of the southern point of Africa are in the habit of migrating on the approach of winter; it does not appear where they can direct their course unless to the north, but on this point there is a great dearth of positive information.

M. J. Konijnenburg, in his Memoir upon the Birds of Passage that frequent the Netherlands, states the following as the results of his investigations:—The greater part of the spring, autumn, and winter birds of passage come from the borders and forests of Germany, and return thither. The birds of song and the summer birds come from the Greek Archipelago, and return thither when the temperature ceases to be mild in the Low Countries. A small number of birds, drawn by the company of others, chased by birds of prey, or driven by famine, depart from their usual practice and make two migrations in the same year. A small number of other birds are often seduced by the mildness of the temperature, and by the abundance of food which they find, to prolong their stay beyond the usual time, and even to spend the winter in the Netherlands. The same circumstances doubtless occur in other countries.

In conclusion, the migration of birds is a subject on which comparatively few observations have yet been made. Even the precise periods of their appearance and disappearance in different parts of Europe have not been noted with the necessary degree of attention; and until persons properly qualified shall undertake the task, we must remain contented with vague notices and unfounded conjectures. The migration of fishes, which is an equally wonderful if not equally interesting phenomenon, is in a great measure placed beyond our investigation; but that of birds, being observable by any individual residing in the country or making daily excursions to it, and sufficiently acquainted with the species, might be illustrated by simultaneous exertions made at different stations along the coasts and in the interior.

Chapter XIV.

INSTINCT.

By far the greater number of the details both in this and the two preceding volumes, on the Architecture and the Domestic Habits of Birds, are referable to what is very commonly, both in popular and scientific language, termed *instinct*;—a term, however, whose precise signification has never been settled. The most usual meaning of the word is the converse of that of reason; for while *reason* is understood to be a faculty by which animal movements are directed in consequence of some inferred effect being anticipated, *instinct* is supposed to direct blindly without any process of inference, or of anticipation derived from experience. A hungry infant, for instance, will suck with eagerness the breast of its mother, not in consequence of inferring that milk will nourish it, but blindly from the faculty termed instinct. On the same principle, a hungry man will eat eagerly without ever thinking about the nourishing qualities of the food; but if he be told that the food is poisoned, he immediately acts upon inference, and reason steps in to correct the instinct which might lead him to destruction, though the fear of death that influences his inference is equally instinctive with the instinct that impels him to eat when he is hungry. These familiar illustrations will enable the reader to form some notion of the distinctions commonly made between reason and instinct, and give him a key to many of the opinions that have been promulgated on this difficult subject by philosophers of eminence. To some of these we shall now briefly advert, beginning with the hypothesis which endeavours to prove the close similarity, if not the identity, of instinct and reason.

I. The hypothesis in question, under various modifications, was maintained among the ancients by Pythagoras and Plato, and among the moderns by Helvetius*, Condillac, Smellie, Hill, Hume, and Darwin. Smellie says, "The great source of error on this subject is the uniform attempt to distinguish instinctive from rational motives. I shall, however, endeavour to show that no such distinction exists, and that the reasoning faculty is itself the result of instinct." He considers instinct to be "every original quality of mind which produces feelings or actions when the proper objects are presented to it. It seems then to be apparent, that instincts are original qualities of mind; that every animal is possessed of some of these qualities; that the intelligence and resources of animals are proportioned to the number of instincts with which their minds are endowed; that all animals are, in some measure, *rational beings*; and that the dignity and superiority of the human intellect are necessary results, not of the conformation of our bodies, but of the great variety of instincts which Nature has been pleased to confer on the species †."

"Though animals," says Hume, "learn many parts of their knowledge from observation, there are also many parts of it which they derive from the original hand of Nature, which much exceed the share of capacity they possess on ordinary occasions, and in which they improve little or nothing by the longest practice and experience. These we denominate instincts, and are so apt to admire as something very extraordinary and inexplicable by

* De l'Esprit, i. 2, &c.

† Phil. of Nat. History, i. 252, 8vo. Dublin, 1790.

all the disquisitions of human understanding: but our wonder will perhaps cease or diminish, when we consider, that the experimental reasoning itself, which we possess in common with beasts, and on which the whole conduct of life depends, is nothing but a species of instinct or mechanical power, that acts in us unknown to ourselves; and in its chief operations is not directed by any such relations or comparisons of ideas as are the proper objects of our intellectual faculties *."

To prove a similar position, Dr. Darwin traces the experience of animals up to their earliest embryo state. "The chick in the shell," he tells us, "begins to move its feet and legs on the sixth day of incubation, or on the seventh day; afterwards it is seen to move itself gently in the liquid that surrounds it, and to open and shut its mouth. The white of the egg is found in the mouth and gizzard of the chick, and is nearly or quite consumed before it is hatched. The chick, yet in the shell, therefore, has learned to drink by swallowing a part of the white of the egg for its food; but not having experienced how to take up and swallow solid seeds or grains, is either taught by the solicitous industry of its mother, or by repeated attempts is enabled at length to distinguish and to swallow this kind of nourishment.

"It has been deemed," he adds, "a surprising instance of instinct, that chickens should be able to walk, by a few efforts, almost immediately after their nativity; whilst the human infant, in those countries where he is not incumbered with clothes, as in India, is five or sixth months, and in our climate almost a twelvemonth, before he can safely stand upon his feet. The swimming of chickens in the egg resembles their manner of walking, which they have thus

* Essays, ii. 72, edit. 8vo. Edinb. 1800.

in part acquired before their nativity, and hence accomplish it afterwards with very few efforts; whilst the swimming of the human creature resembles that of the frog, and totally differs from his mode of walking*."

"By a due attention to such circumstances," Darwin elsewhere says, "many of the actions which at first sight seemed only referable to an inexplicable instinct, will appear to have been acquired, like all other animal actions that are attended with consciousness, by the repeated efforts of our muscles under the conduct of our sensations or desires †."

Dr. Darwin in another work goes even further than this, and would have us believe that the migrations of birds are not instinctive, but accidental improvements, like the arts among mankind, taught by their contemporaries, and delivered by tradition; and thinks it "not unreasonable to conclude, that some of the actions, both of large animals and of insects, may have been acquired in a state preceding the present one, and have been derived from the parents to their offspring by imitation or other kind of tradition ‡."

This doctrine must appear to most readers to be groundless and fanciful. But lest it may, by its novelty, fascinate any young and inexperienced inquirer, we shall borrow from Dr. Mason Good a familiar instance, which nobody can possibly explain upon Darwin's principles.

"In various cases of the instinctive faculty," he remarks, "the most excursive theorist cannot picture to his imagination any thing like a chain of thought, or previous reasoning; any thing like habit or imitation, by which the means and the end are joined together. Let us take as an example, the very com-

* Zoonomia, xvi. 3. † Ibid. xvi. 2, 4.
‡ Temple of Nature, note 40.

mon instance of a brood of young ducks brought up under a hen, and, contrary to all the instincts and feelings of the foster-mother, plunging suddenly into the water; while she herself trembles piteously on the brink of the pond, not daring to pursue them, and expecting every moment to see them drowned. By what kind of experience or observation, by what train of thought or reasoning, has the scarcely-fledged brood been able to discern that a web-foot fits them for swimming, and that a fissured foot would render them incapable?—a knowledge that mankind have only acquired by long and repeated contemplation, and which has never been fully explained to this hour. Habit, imitation, and instruction, would all concur in teaching them to flee from the water, as a source of inevitable destruction; and yet, in opposition to all these influences and premonitions, we see them obeying an irresistible impulse, which directs them to what is fitting, stamped in the interior of their little frames, and which is equally remote from the laws of mind and of mechanism *."

II. Directly opposed to the writers who seem inclined to make little or no distinction between reason and instinct, are those who, with Des Cartes, Cardinal Polignac, Buffon, Winckler, Steffens, Robinet, Lamarck, and the more modern authors of the Lamarckian school, maintain, some more distinctly than others, that animals are mere machines, acting in consequence of the effects of necessary external causes.

Winckler, in illustration of his doctrine, alleges that the brain of a bee or a spider is impressed at birth with certain geometrical figures, according to which models its works are constructed †. No doubt the form of a bird's nest would be maintained, on the same principle, to originate in a hemisphere

* Book of Nature, ii. 119. † Kirby and Spence, ii. 466.

impressed on the brain. The statements of Buffon are equally fanciful.

"Bees," he says, "are associated without design or motive; for whatever may be the effects of their association, it is clear that they have neither been foreseen nor conceived by the creatures that produced them, and that they result solely from universal laws of mechanism established by the Almighty. Suppose ten thousand automatons assembled in the same place, all endowed with the same force, and determined by a perfect resemblance in their external and internal structure, and by a uniformity in their movement, to perform the same operation, a regular work would be the necessary result. They would exhibit the relations of regularity, of resemblance, and of position; because these depend upon the relations of motion, which we have supposed to be equal and uniform. The relations of juxta-position, of extension, and of figure, would also appear, because we have supposed a given and circumscribed place; and, if we bestow on these automatons the smallest degree of sensation, just as much as is necessary to make them feel their existence, to have a tendency to self-preservation, to avoid what is hurtful, to desire what is agreeable, &c., their operations will be not only regular, proportioned, similar, and equal, but they will have the air of the highest symmetry, solidity, convenience, &c.; because, in the process of their labours, each of the ten thousand individuals has assumed that arrangement which was most commodious to itself, and has, at the same time, been obliged to act and to arrange itself in the manner least incommodious to the rest.

"Shall I enforce this argument still further. The hexagonal cells of the bee, which have been the subject of so much admiration, furnish an additional proof of the stupidity of these insects. This figure, though extremely regular, is nothing but a mechanical result, which is often exhibited in some of the most rude productions of nature. Crystals, and several other stones, as well as particular salts, &c., constantly assume this figure. In the same manner, each bee endeavouring to occupy as much space as possible in the limited dimensions of the hive, and the bodies of the bees being cylindrical, they must necessarily make their cells hexagonal, from the reciprocal obstruction they give to each other.

"The genius of bees has been estimated according to the regularity of their works. Bees are said to be more ingenious than wasps, hornets, &c.; for, though the latter are acquainted with architecture, their fabrics are more rude and irregular. But it was not considered by the abettors of this opinion, that the greater or less regularity depends solely on the number and figure and not on the intelligence of these creatures. In proportion to the greatness of the number, there are more equal and opposite forces in action, and, of course, more mechanical restraint, and more regularity and apparent perfection in their works *."

What Steffens says of instincts, namely, that they are nothing but "the shootings out of inorganic animal masses †," may be the same, for aught we can understand of such transcendental doctrines, with the following very extraordinary statement from Lamarck. "It is not the organs," he says, "or, in other words, the nature and form of the parts of the body of an animal, which have given rise to its habits and its particular faculties, but on the contrary, its habits, its manner of living, and those of its progenitors, have, in the course of time, determined the form of

* Wood's Buffon, iii. 599.

† See his 'Beiträge zur innern Naturgeschichte der Erde,' page 298.

its body, the number and condition of its organs, in short, the faculties which it enjoys. Thus, otters, beavers, water-fowl, turtles, and frogs were not made web-footed in order that they might swim; but their wants having attracted them to the water in search of prey, they stretched out the toes of their feet to strike the water, and move rapidly along its surface. By the repeated stretching of the toes, the skin which united them at the base acquired a habit of extension, until in the course of time the broad membranes which now connect their extremities were formed.

"In like manner, the antelope and the gazelle were not endowed with light agile forms, in order that they might escape by flight from carnivorous animals; but having been exposed to the danger of being devoured by lions, tigers, and other beasts of prey, they were compelled to exert themselves in running with great celerity, a habit which, in the course of many generations, gave rise to the peculiar slenderness of their legs, and the agility and elegance of their forms.

"The camelopard was not gifted with a long flexible neck, because it was destined to live in the interior of Africa, where the soil was arid and devoid of herbage; but being reduced, by the nature of that country, to support itself on the foliage of lofty trees, it contracted a habit of stretching itself up to reach the high boughs, until its fore legs became longer than the hinder, and its neck so elongated, that it could raise its head to the height of twenty feet above the ground *."

We deem it quite unnecessary to attempt any refutation of such extravagance. Those who wish to see an able discussion on the subject will find it in Lyell's Geology †.

We shall now advert to two other classes of

* Philosophie Zoologique. † Vol. ii. chap. 1.

opinions, which have been and are maintained by philosophers who do not speculate quite so fancifully as those we have just quoted from, though the subject is confessedly beset with difficulties on every side.

III. The erudite Cudworth, in his desire to support the Platonic theory of the creation of the world, endeavoured to maintain that the whole creation is animated by an active *plastic* nature, besides pure mind and pure matter. He accordingly referred all instincts to this plastic nature, without adverting to the circumstance that, according to his own showing, inorganic matter ought to give evidence of the plastic nature, and exhibit instincts as well as animals and plants, which is contrary to the fact. The doctrine, however, though apparently so ill-founded, is not very far from that which ascribes instincts to a principle similar to attraction, or to an immediate emanation from the Deity.

Sir Isaac Newton says, "The instinct of brutes and insects can be the effect of nothing else than the wisdom and skill of a powerful ever-living Agent, who, being in all places, is more able by his will to move the bodies within his boundless uniform sensorium, and thereby to form and reform the parts of the universe, than we are by our will to move the parts of our own bodies*."

Addison has supported a similar opinion with considerable ingenuity. He says that there is not, in his opinion, "any thing more mysterious in nature than this instinct in animals, which rises above reason, and falls infinitely short of it. For my own part," he adds, "I look upon instinct as upon the principle of gravitation in bodies, which is not to be explained by any known qualities inherent in the bodies themselves, nor from any laws of mechanism; but, according to the best notions of the greatest philosophers,

* Optics, page 379.

is an immediate impression from the first Mover, and the divine energy acting in the creatures;—such an operation of the Supreme Being, as that which determines all the portions of matter to their proper centre."

As illustrations of this doctrine, to show the difference between instinct and reason, he says, "Animals 'in their generation are wiser than the sons of men;' but their wisdom is confined to a few particulars, and lies in a very narrow compass. Take a brute out of his instinct, and you find him wholly deprived of understanding. To use an instance that comes often under observation:—

"With what caution does the hen provide herself a nest in places unfrequented, and free from noise and disturbance? When she has laid her eggs in such a manner as she can cover them, what care does she take in turning them frequently, that all parts may partake of the vital warmth? When she leaves them to provide for her necessary sustenance, how punctually does she return before they have time to cool, and become incapable of producing an animal? In the summer you see her giving herself freedom, and quitting her care for above two hours together; but in winter, when the rigour of the season would chill the principles of life, and destroy the young one, she grows more assiduous in her attendance, and stays away about half the time. When the birth approaches, with how much nicety and attention does she help the chick to break its prison*? not to take notice of her covering it from the injuries of the weather, providing it proper nourishment, and teaching it to help itself; nor to mention her forsaking the nest, if, after the usual time of reckoning, the young one does not make its appearance. A chemical operation could not be followed with greater

* This is erroneous. See Habits of Birds. chap. ix.

art or diligence, than is seen in the hatching of a chick, though there are many other birds that show an infinitely greater sagacity in all the fore-mentioned particulars.

"But at the same time the hen, that has all this seeming ingenuity, which is indeed absolutely necessary for the propagation of the species, considered in other respects, is without the least glimmering of thought or common sense. She mistakes a piece of chalk for an egg, and sits upon it in the same manner; she is insensible of any increase or diminution in the number of those she lays; she does not distinguish between her own and those of another species; and when the birth appears of never so different a bird, will cherish it for her own. In all those circumstances which do not carry an immediate regard to the subsistence of herself or species she is a very idiot *."

Dr. Mason Good, without seeming to be aware of this passage, or of the opinion of Newton and Addison, announces views which coincide very nearly, as may be seen from his own statement:—"In every organized system," says Dr. Good, "whether animal or vegetable, and in every part of such system, whether solid or fluid, we trace an evident proof of that controlling and identifying Power, which physiologists have denominated, and with much propriety, the PRINCIPLE OF LIFE. Of its cause and nature we know no more than we do of the cause and nature of gravitation or magnetism. It is neither essential mind nor essential matter; it is neither passion nor sensation; but, though unquestionably distinct from all these, is capable of combining with any of them; it is possessed of its own book of laws, to which, under the same circumstances, it adheres without the smallest deviation; and its sole and uniform aim, whether act-

* Spectator, vol. ii.

ing generally or locally, is that of health, preservation, or reproduction. The agency by which it operates is that which we denominate, or should denominate, INSTINCT, and the actions by which its sole and uniform aim is accomplished are what we mean, or should mean, by INSTINCTIVE ACTIONS; or, to speak somewhat more precisely, instinct is the operation of the living principle, whenever manifestly directing its operations to the health, preservation, or reproduction of a living frame, or any part of such frame.

"The law of instinct, then, is the law of the living principle; instinctive actions are the actions of the living principle; and either is that power which characteristically distinguishes organized from unorganized matter, and pervades and regulates the former, as gravitation pervades and regulates the latter, uniformly operating by definite means, in definite circumstances, to the general welfare of the individual system or of its separate organs; advancing them to perfection, preserving them in it, or laying a foundation for their reproduction, as the nature of the case may require. It applies equally to plants and to animals, and to every part of the plant as well as to every part of the animal, so long as such part continues alive. It is this which maintains from age to age, with so much nicety and precision, the distinctive characters of different kinds and species; which, as is noticed in a preceding study, carries off the waste or worn-out matter, supplies it with new, and in a thousand instances suggests the mode of cure, or even effects the cure itself, in cases of injury or disease. It is 'the Divinity that stirs within us' of Stahl, the *vis medicatrix naturæ* of Hoffman and Cullen and the physicians of our own day. It is hence the strawberry travels from spot to spot, and the cod or the cuckoo, with a wider range, from shore to shore, or from climate to climate*."

* Book of Nature, ii.

Hartley, the celebrated author of the Theory of Cerebral Vibrations, says, "The direction in brutes to provide for themselves and their offspring would be a kind of inspiration, mixing itself with and helping out that part of their faculties which corresponds to reason in us, and which is extremely imperfect in them; only this inspiration might be natural, as proceeding from the same stated laws of matter and motion as the other phenomena of nature; whereas the inspiration of the Sacred Writer appears to be of a much higher source, so as to be termed supernatural, properly, in contra-distinction to all knowledge resulting from the common laws of nature. And yet it may result from some higher laws in nature; for sacred inspiration would lose nothing of its authority, though it should appear to be within such laws as by their fixedness might be termed nature *."

Two living authors have, with some modifications, advocated similar opinions. "It becomes necessary," says Mr. Oliver French, "to establish a test, whereby the operation of the moral, intellectual, and scientific powers here alluded to may be ascertained; and whereby the line of demarcation may be distinctly drawn between man and brute. This test, I believe, is included in the following propositions, viz.:— 1st. That moral qualities do not become objective in the minds of brutes; or, that the moral actions which they perform are not reflected upon or contrived by them as such; *thus that they possess no moral consciousness*, and consequently that no moral design can be attributed to them; and therefore that so much of moral design as appears conspicuous in their actions must be the effect of moral powers or energies, *acting upon them in a region of their* minds above the sphere of their proper consciousness.

* On Man, Dr. Priestley's edit.

2d. That intellectual and scientific qualities do not become objective in the minds of brutes; or, that the intellectual and scientific actions which they perform are not reflected upon or contrived by them as such; thus, that they possess no intellectual or scientific consciousness, and consequently that no intellectual or scientific design can be attributed to them; and, therefore, that so much of intellectual or scientific design as appears conspicuous in their actions must be the effect of intellectual and scientific powers or energies, acting upon them in a region of their minds above the sphere of their proper consciousness.

"Admiring and respecting as I do the endeavours of all who are engaged in the promotion of philosophic inquiries, I cannot but think that in the particular subject before us too much has been done to confound the natures of man and brute, and to separate both from the fountain of their existence. Man is what he is, and derives his superiority over the brute creation from the circumstance that all things whatever become morally and scientifically objective to him; and the brute is what he is, and derives his inferiority from the total absence of this distinguished and ennobling faculty. It is true that many specious arguments may be and have been advanced to prove that brutes participate in human rationality, in kind, if not in degree; but the ends which their natures are evidently destined to fulfil would be, one might imagine, alone sufficient to refute the supposition. For it is but reasonable to conclude that the conscious powers of the creature will be according to the ends of its existence; and as these ends are in the brute creation neither moral nor scientific, but purely natural, and as regards themselves only subservient to what is moral and scientific, it thence would follow that they are not possessed in themselves of any moral, intellectual, or scientific conscious powers, and are therefore merely natural agents of a secondary class in which such powers are exhibited*."

Dr. Hancock, who, about ten years ago, published a volume on Instinct, takes nearly the same view as Mr. O. French. "On surveying," he says, "the actions of men and brutes, there seem to be sufficient logical grounds for making two grand distinctions; the one comprising those actions which appear to be done blindly or without premeditation and without experience; and the other, those which are done with forethought, by combining means to accomplish ends, which are often the result of individual or social experience and instruction.

"These general facts seem to be so obvious, that they lead us at once to call them by different names, and to conclude that they arise from different propensities or faculties; and the words Instinct and Reason come up as nearly to the view of the case as any others we could employ. Hence, while reason acts with intelligence and design (variably, indeed, and inconstantly), profiting by experience, comparing motives, balancing probabilities, looking forward to the future, and adapting itself to every change of circumstance, instinct operates with uniformity in all individuals of the same species, and performs its office with unerring certainty, prior to all experience.

"It is proper for me here to remark that the word reason is used in senses which are extremely different; sometimes to express the whole of these powers which elevate man above the brutes, and constitute what is called his rational nature, more especially perhaps his intellectual powers, and sometimes to express the power of deduction or argumentation. The former is the sense in which the word is used in common discourse. It is in the latter restricted sense, as indeed

* Zoolog. Journ. i. 12.

is implied a little above, that I wish the word reason to be understood, wherever it occurs in this Essay, viz. the discursive faculties, wholly depending on outward evidence for its conclusions. Hence, if there be any actions which are performed with every indication of design, forethought, and wisdom, which are not the result of instructions nor of individual experience, but of a power operating above the consciousness of the creatures, and directing it with unerring certainty to some specific ends by means far beyond its comprehension, whether in man or in the brute, these actions are instinctive; and, on the other hand, if there be any actions, which evidently result from observation and instruction, indicating an intelligent power of combining means and adapting them to ends of which the creature is conscious, these actions come within the province of reason *."

Dr. Hancock elsewhere says, "In the lowest order of animals the divine energy seems to act with the most unimpeded power. It is less concentrated in the successive links of the living chain upward to man. The lowest animal has this divine power, not of free choice, nor consciously; the holiest of men has it also consciously and willingly, and it then becomes his ruling principle; his divine counsellor; his never-failing help; a light to his feet, and a lantern to his path †."

IV. The late Baron Cuvier, in his description of an orang-outang, distinctly states his opinion that instinct depends on ideas not originating from sensation, but flowing immediately from the brain. "The understanding," he says, "may have ideas without the aid of the senses; two-thirds of the brute creation are moved by ideas which they do not owe to their sensations, but which flow immediately from their brain. Instinct constitutes this order of phenomena:

* Essay on Instinct, p. 16. † Ibid. p. 513.

it is composed of ideas truly innate, in which the senses have never had the smallest share*." Dr. Mason Good justly remarks that Cuvier appears in this to confound instincts with ideas, as others have confounded them with feelings.

Dr. Virey has taken rather a different, and, so far as anatomy is concerned, a very ingenious view of the differences between reason and instinct. His opinions on the subject perhaps amount to no more than a plausible theory; but some of his illustrations are interesting and lead the mind on to think for itself on this curious subject;—

"The mover of instinct is only the love of self, or the preservation of the individual and its kind;—a sentiment implanted in all organized beings, and among animals regulated by pleasure and pain, which inspires in them inclinations, aversions, and affections. Hence the individual brings into action the admirable mechanism of the organs with which it is endowed: it associates their different acts; led on continually by the pleasure of following nature, it works spontaneously, and always well, without knowing it does well, and without trial or repetitions. We shall even see that by contradicting this instinctive direction, the animal endeavours to attain its object by all the means at its disposal, but without evincing that it acts from judgment.

"The difference, indeed, between instinct and reason is very marked. Pure instinct works always without deliberation; but maturely driven on by want or desire, by sentiments, passions, and every species of interior excitement, involuntarily. It pursues but one route; it aspires at what is useful and profitable in life, which it always recognizes by secret affinity. Among insects there is no apprenticeship, no improvement, no variation in the practice, no super-

* Annales du Museum d'Hist. Nat. xvi. 46.

added invention; but all is wisely disposed beforehand for an act which is necessary, perfect, and natural. A child, or a dull peasant who instructs himself, and studies by the aid of experience, though acting ill at first, afterwards improves. The insect needs none of these imperfect essays: Supreme Wisdom has rendered it unnecessary.

"Reason, on the contrary, receiving impressions and images from without, or by the external senses, transforms them into ideas in the brain, compares and coolly judges of them; arranges its actions by them; determines voluntarily in consequence, by what appears true, or just, or best, according to occurrences, climates, &c. This is the peculiar faculty of reasoning man; he acts by his free will in several ways.

"Instinct never acts more completely than among those animals which are the least endowed with acquired knowledge. It is clear that those little creatures, such as insects, each of which scarcely lives more than a few weeks in the world, could not have time or means to acquire, like a child, any information by education or habit to accomplish the destinies which nature has designed them. We must therefore attribute to them a mind ready formed and enlightened, and even incapable of acting otherwise. But man and the larger species of animals, who exist longer, and who possess organs and senses more developed, a remarkable brain, and therefore functions less limited, and which can vary their actions according to circumstances, must participate more or less of liberty, of acquired knowledge, and of understanding. Instinct becomes secondary with the latter, in proportion as the intellectual functions are greater and able to replace it. Therefore man, when endowed with reason so highly cultivated as to become sometimes sublime, is almost totally devoid of instinct, particularly in a state of civilization; his taste and his sense of smelling, for example, being weaned from natural aliments, are no longer able to discern, in the forests of America, a wholesome fruit from the poisonous manchineel, which has a sweet smell; he must take the savage as a guide, whose instinct is less depraved by the arts of the kitchen, by which we disguise all nature; this savage would be again surpassed by the instinct of the ape."

We have thus given an account of the chief opinions which have been promulgated on the subject of instinct, and, to avoid misrepresentation, in the very words of the authors. The points of difference are not very easy to be reconciled.

CHAPTER XV.

CONCLUSION.

"ILLUSTRATIONS of the power, wisdom, and goodness of the Creator," says a late author, "might be produced from the works of nature without end; they meet us at every turn; and to whatever department our inquiries are directed, they flow in upon us in overwhelming abundance. It is well worthy of remark, indeed, as showing the depth and solidity of the foundation on which rests the existence of a supreme, intelligent, and beneficent First Cause, that the further we push our discoveries, the more clearly are the divine perfections exhibited. It is not merely true, that on a superficial view we perceive the necessity of believing that a limited and changing world, such as that in which we dwell, could neither exist without being produced, nor be the author of its own existence; and that there must therefore be, beyond the range of our senses, an independent and uncreated Essence, without beginning, without bounds, incapable of change, intelligent, ever active, all pervading; but it is also certain that these *primâ facie* views, as they may be called, are not only uncontradicted, but fully established by the most minute survey of the objects within the sphere of our vision; so that he who penetrates the deepest into the secrets of nature, only multiplies proofs of that most sublime and most animating truth, that 'Verily there is a God, who made and rules the universe*.'"

* Bushman's Introduction to the Study of Nature, London, 1834.

The study of ornithology, in all its aspects, affords numerous illustrations of the truth of these observations. Whether we consider the external form and anatomical structure of birds, or examine their faculties and habits, or compare them among themselves or with each other, or turn our attention to the admirable adaptation of their whole frame and constitution to the circumstances of external nature in the particular locality which they are destined to inhabit; or regard them with reference to other animals; either in their bodily powers, or their instinctive impulses, or their mental qualities—in every light in which it is possible to view the subject, the conclusion which irresistibly forces itself on the mind is always the same. Contrivance inexhaustible, intelligence vast and comprehensive, still infinitely beyond the grasp of the human intellect, combined with a power which never fails to effect its object, and a goodness which makes life in all its forms a blessing, are the characters which in this, as well as in every other department of nature, are conspicuous and undeniable. It is not absolute perfection indeed which in this search we discover. We are ourselves imperfect, and the world around us is imperfect; but it is a relative perfection which suits every thing to its present condition, and which leaves nothing for man to feel in contemplating it, but a mingled sentiment of mysterious awe, profound admiration, and overflowing gratitude.

Throughout the works on subjects of Natural History, which form portions of the 'Library of Entertaining Knowledge,' attention has constantly been paid to the proofs which have presented themselves so abundantly of a supreme designing hand; but in bringing this series of volumes on 'Birds' to a close, it seems useful to collect the proofs which belong to this division of nature into one point of view, by a rapid glance over the road that has been travelled.

In considering the external form of a bird, the first thing that strikes the philosophical inquirer is the wisdom with which Providence has adapted it to the element in which it is destined to move. In its smooth pointed bill, and gradually enlarging head and neck, he perceives an instrument admirably calculated to penetrate the yielding air. The rounded prow-like shape of its breast, too, is adapted with mathematical exactness to the same useful purpose; while its flexible tail is made with surprising skill to perform the part of a rudder; and its wings equally poised, and furnished with quills and feathers modelled by numerous wonderful contrivances, at once for lightness, for strength, and for tenacity, and altogether exhibiting a machine of the most perfect kind for aërial navigation. The very varieties in the nature of this machinery, adapted as they are to the faculties and instincts of each species, impress the mind with a deep sense of the minute and skilful care of a beneficent Creator, and give a peculiar interest to the investigation.

When we proceed from the external form to the consideration of the internal structure of birds, as adapted to their peculiar function of moving through the air, we perceive a system of contrivances evidently intended to promote the same end. In the mechanical art exhibited in the formation of the bones and muscles, by which power and motion is given to the wings,—in the conformation of all the bones, uniting strength with lightness,—in the air so singularly distributed through the bones and in other parts of the body,—in the modification of the intestines,—in the whole comparative anatomy, in short, of the winged tribes, we trace, with an astonishment increasing in proportion to the diligence of the re-search, the same unceasing solicitude to adapt every thing to their nature.

If again we compare the different species of birds among themselves, whether as to the climate they are formed to inhabit, or the localities they are destined to frequent, or the food on which they are intended to subsist, we still meet with obvious indications of wise and beneficent design. Contrast the legs and feet of the swift, which never alights on the ground, but clings to the perpendicular face of walls and rocks, with those of the heron, which wades in search of food on the margin of the marshy pool, or compare the broad-billed and web-footed duck, whose proper element is the water, with the sharp talons and strong hooked beak of the eagle and other birds of prey; and with certainty we must infer the wide difference of their habits and instincts, from the simple inspection of the instruments with which their Creator has furnished them.

In the mutual adaptations, indeed, of the structure of the various races of birds to their faculties and propensities, we perceive a world of wonders, calculated to make a lively impression on a reflecting mind, and to fill it with the most interesting views of the great Author of Nature. In examining the vast variety of these faculties and propensities, we have uniformly found that a corresponding variety exists in the conformation of the species, which irresistibly confirms what every department of nature unites in proclaiming, that nothing is formed without an intelligent, consistent, and infinitely comprehensive plan. We do not know if there be any other class of animals, from the microscopic insect whose world is a blade of grass, up to the quadruped that ranges the woods and the forests, which in this respect teaches lessons of more varied and edifying instruction. The earth, the air, and the waters teem with feathered inhabitants, and in reference to all these elements, the peculiarities with which the Creator has distinguished the various tribes is amazing, whether we consider the wisdom and beneficence of the contrivances in themselves, or the consummate skill with which they are suited to the respective situation in which these tribes are intended to exist. Consider, for example, the productive powers and the corresponding instincts by which Providence has secured the preservation of the respective species. The egg is itself an admirable production; and how mysteriously is the chick developed, till it bursts its own shell at the appointed and appropriate moment, rejoicing in its new existence! The nest too, sometimes so artificially formed by the mother-bird, and her tedious and self-denying period of incubation, as well as her maternal care of the callow brood when hatched, are instances so full of intelligence and forethought, that it seems as if the hand of the Deity himself were visibly displayed tenderly guiding her unconscious path.

Nor is it possible to overlook the means and adaptations by which the life thus mysteriously bestowed continues to be preserved. To all the species, however diversified, food of some kind is necessary; and therefore all are furnished with organs of swallowing and digesting suited to their respective wants. But these organs would be altogether useless were not two considerations superadded—an instinct to desire and select the proper food, and a locality in which that food is to be obtained. It is curious and edifying to observe with what discrimination the young of these animals, without experience and without instruction, instinctively seize on the particular kind of food adapted to their digestive organs, rejecting all other kinds, however palatable and nutritive to creatures of a different species. Nor is it less worthy of remark that there is scarcely a vegetable or animal production which some species of bird does not seem created to feed upon; and that, speaking generally, wherever that peculiar production is to be found, there is also to be found the particular kind of bird to which it furnishes wholesome food. With some striking examples of this kind the sportsman of our own country is well acquainted. He finds the partridge in the plains, the woodcock in the forests, the grouse on the moors, and the ptarmigan on the loftiest peak of the mountains. He knows too that other species migrate from country to country, seeking their food in distant regions, over trackless oceans, and through an extended atmosphere, when it fails in their native haunts. The ornithologist is aware that instances of this kind are not confined to the birds of game alone, but form a rule so universal as to deserve a place among the wonderful adaptations which exist between the animal and vegetable worlds. We have already remarked the astonishing celerity with which, in tropical countries, vultures and other birds of prey congregate from all quarters of the heavens around a dead carcase to devour it, indicating at once the acuteness of their sight, and the remarkable provision which has been thus made for the destruction of what might otherwise injuriously infect the atmosphere; and we may now rank this fact among those that establish, or at least illustrate, the wise arrangements to which we have been adverting.

We are reminded, by what has been just said, of the peculiar intensity of some of the senses in certain species of birds, which opens another view of the wise and beneficent provisions of Providence. It is by the remarkable strength of their vision that birds of prey are enabled to mark their quarry at a height where, to the human eye, they themselves are almost invisible, and from whence, with incredible velocity, they pounce on their unsuspecting victims; and it is doubtless the same extraordinary faculty which, if it does not enable, at least powerfully assists the migratory tribes to shape their course through the trackless atmosphere and over unbeaconed seas. When the carrier-pigeon is let loose in a strange region, he darts suddenly aloft in spiral circles, increasing the diameter at every turn, till at last, having, from his airy height, descried some known familiar spot in the remote distance, he shoots directly forward to his home, like an arrow from a bow.

The hearing of birds, so necessary for escape from dangers as well as indicating the neighbourhood of their prey, is scarcely less perfect in many species than their sight; yet the external ear, which is essential for producing distinctness of sound as the organ is formed in quadrupeds and man, would obstruct their rapid progress through the air, and be inconvenient in other respects. This appendage is therefore withheld, but it is amply compensated by a peculiarity in the internal structure—a circumstance which indicates the never-failing resources of the Creator. This may be considered as a slight and perhaps a trifling change; but it acquires importance as being one of an infinite variety of beneficent contrivances for the comfort and happiness of the different tribes of animals, wisely adapted to the peculiarities of their condition.

We do not know, indeed, that there is any thing among the wonders of creation which strikes the inquiring mind more forcibly than instances of departure from an ordinary rule, for the obvious purpose of accommodation to circumstances. In comparative anatomy such accommodations incessantly occur, and it is this which gives so peculiar a charm to that interesting department of science. Were all animals to be formed precisely on the same external model, or were deviations from a common form to bear no distinct reference to their localities and instincts, it would be less easy to refute the comfortless theory of the infidel, who refers all the operations of nature to material causes and excludes from the universe the designing hand of an intelligent Creator. There might then be less absurdity in the monstrous hypothesis which teaches that all things have been the result of a mere brute mechanism, and that the same active but blind and insensible powers which produce a crystal have, under happier combinations, called into existence more perfect organizations, and resulted in the formation of living beings. Such an argument would still indeed have been quite untenable, but the demonstration by which it is disproved would have been less perfect and satisfactory had we been unable to show with what extreme and anxious solicitude the most minute particulars in the organic structure of each species of animal are made to harmonize with each other, and with what surpassing skill they are suited to their individual nature and offices.

Such a mode of reasoning presents itself to the mind with peculiar force when any one organ is selected, and its peculiarities are distinctly traced in different races of living creatures. A recent author has employed an argument of this kind with much felicity in reference to the human hand*. He has traced the rudiments and frame-work of this most perfect mechanical contrivance through all the various species of mammalia, beginning at the monkey and ending with the whale, and his demonstrations show that the very same instrument is employed in them all, but that it is with the most astonishing wisdom adapted to the peculiar faculties and functions of each distinct tribe, being moulded in one class into a paw, in another into a solid hoof, in a third into a tool for

* Sir Charles Bell's Bridgewater Treatise.

digging, in a fourth into a fin for dividing the water. The examination of this one contrivance in such various forms—not to mention the innumerable others which, were we so inclined, we might adduce—all of them curiously adapted by some slight variation to the special use of the animal in whose possession it is found, affords a proof of design too palpable and striking to be resisted. It is as if one were to go into the premises of a mill-wright and observe the various mechanics engaged each in his respective department with saws of different kinds and dimensions, from that coarse and strong instrument which divides the forest-tree into planks to the tiny tool employed in the more delicate labours of the workshop. He would say with unhesitating certainty, here is a most useful invention beautifully adapted to the various purposes of the artificer. The existence of one saw would be a proof of contrivance, but that proof is multiplied a hundred fold by the skill with which the contrivance is modified to suit it for such numerous and nice operations.

An evidence of a similar kind, but on a far more extensive scale, is derivable from the innumerable adaptations which exist between the bodily development of the various tribes of animals and their instincts and mental capacities. In our chapter on reason and instinct, we have entered very fully into this most interesting subject; and the preceding history of the faculties of the feathered race will afford abundant illustrations of the truths there contained, and we scarcely know what stronger proof could be required of a supreme creative Intelligence.

In conclusion, we would observe, that there is something exceedingly delightful in the view which nature exhibits of the multiplicity and diversity of animated beings, each adapted to its own peculiar sphere, and all at the same time so abundant as to leave no large portion of the terraqueous globe without inhabitants. If there are differences in climates, there are also differences of constitutions and instincts suiting living creatures to exist and to enjoy existence in them all. From the glowing equator to the vicinity of the frozen poles all nature is instinct with life and buoyant with happiness. On the dry land, the fields and the deserts, the woods and the forests, the valleys and the mountains, all teem with animation and are vocal with joy. The waters, the lakes, the rivers, and the mighty ocean from shore to shore, bring forth and nourish their myriads of living creatures, different in kind, but united by a wonderful analogy into one grand and mighty chain of existence, all fitted with superlative wisdom to their respective habitations. Even the viewless air is not void of life and indications of enjoyment:—the feathered tribes there soar with the wings which all-bountiful nature has provided, traversing fearlessly the blue expanse, and singing as they mount towards the clouds.

Nor is it to be forgotten, that of all sublunary creatures, man alone is endowed with faculties capable of discerning the Creator's hand in his works. Had not the human race been called into existence, all these magnificent provisions would have been unappreciated and unknown. The glories of the divine perfections would still indeed have been inscribed on nature, but among earthly existences there would have been no eye to read and no heart to feel them. Man has justly been called the priest of nature; and while from the seen he rises to the unseen—from the temporal to the eternal—he ought never to forget that the high rank which has been assigned him implies a high responsibility; and that, in proportion, as his vision is enlarged and his faculties are exalted, his duties and obligations are, to an equal extent, increased.

GENERAL INDEX

TO

THE THREE VOLUMES

COMPLETING THE SUBJECT OF ORNITHOLOGY.

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