The senses : with numerous illustrations.

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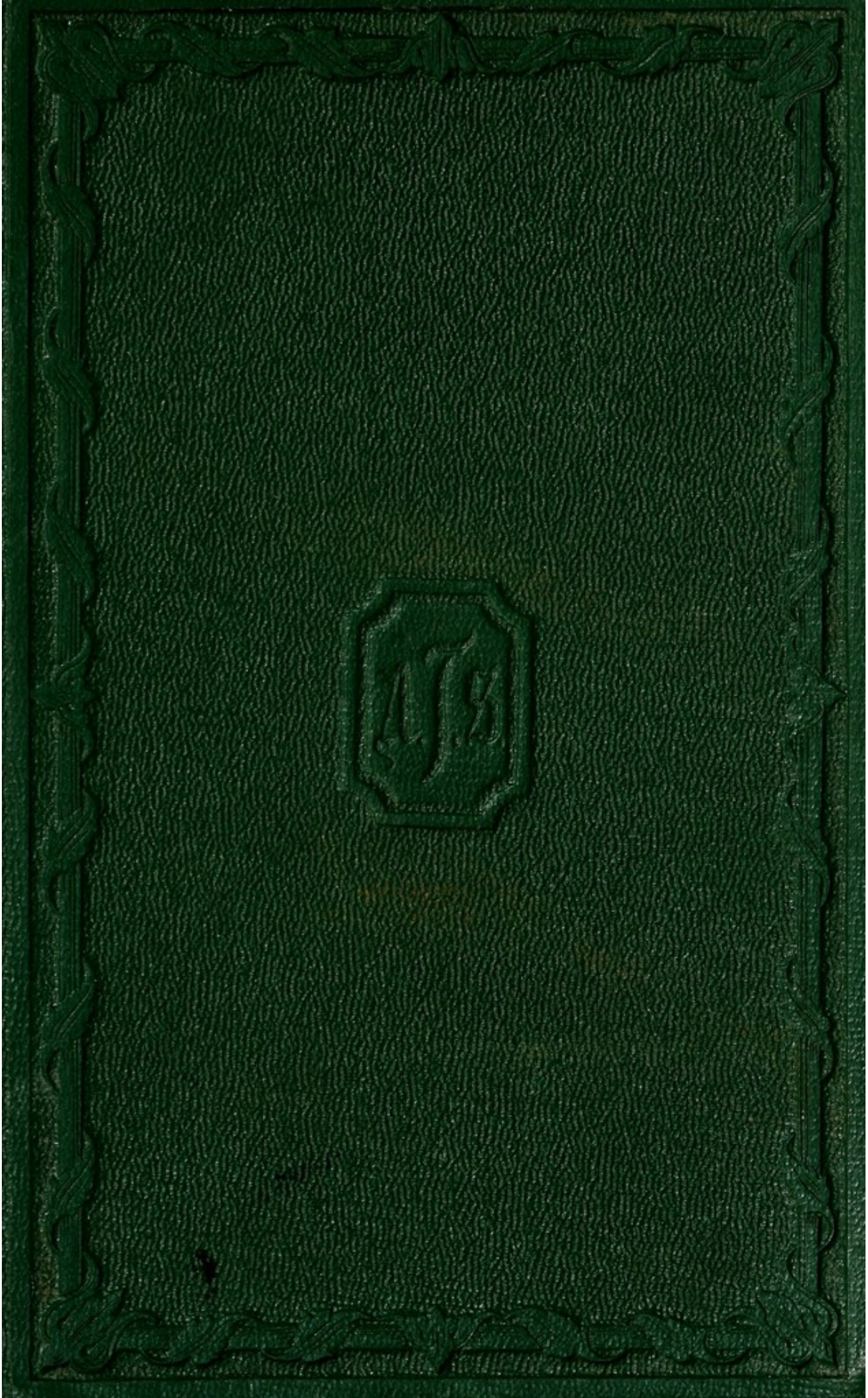

E. M. Hartwell
from Grandma
Massey

THE SENSES.

WITH NUMEROUS ILLUSTRATIONS.

"Christ exalted our whole conception of nature by habitually associating it with the spiritual instruction of man." — BAYNE.

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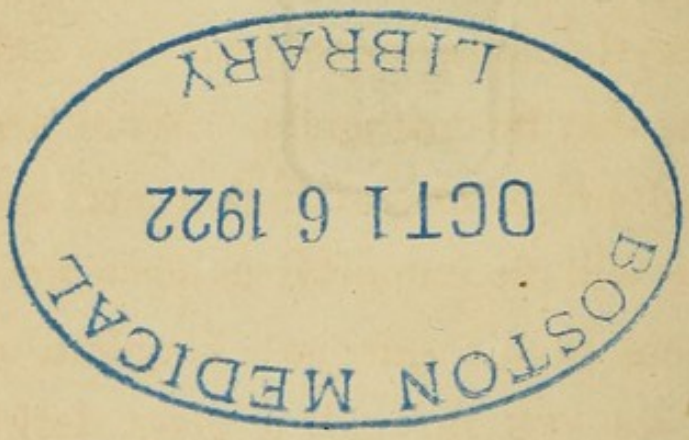

RIVERSIDE, CAMBRIDGE:

STEREOTYPED AND PRINTED BY H. O. HOUGHTON.

PREFACE.

"CONSIDER the lilies," said our Lord to his disciples when teaching them some of the simplest yet sublimest truths of the gospel. God has spread open the wondrous book of his works, filled with his own great thoughts, illustrated by pictures which only his divine hand could draw, and ever speaking to us of his goodness, and our duty of gratitude, of love, and of obedience to him.

It is to this source of instruction and never-failing interest that we would attract the young. In the study of THE SENSES, we see how God has provided for the enjoyments and the safety of the creatures that he has made. What are these but hints and prophecies of higher arrangements by which he will fit immortal natures for homes and happiness in his spiritual kingdom above? "For now we SEE through a glass darkly, but then face to face; now I KNOW in part, but then shall I know *even as also I am known.*

W.

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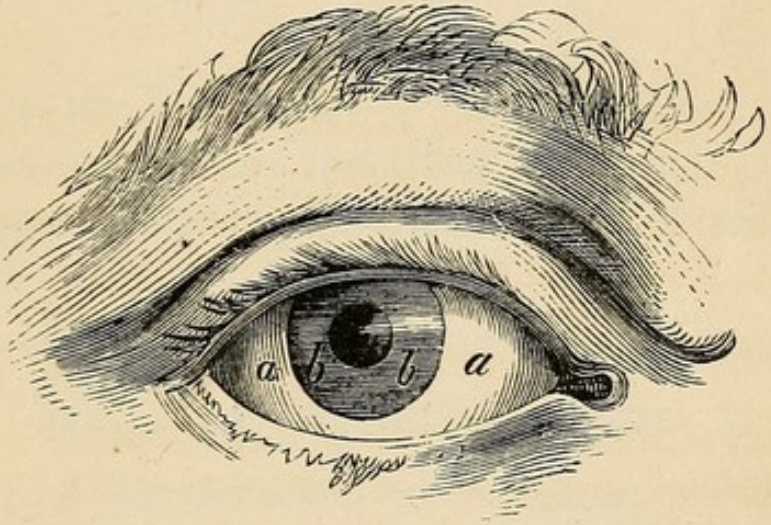
SIGHT.



THE HUMAN EYE

SIGHT.

CHAPTER I.

Structure of the Human Eye.— The Pupil.— Red Eyes.— Humors.— Muscles.— Lachrymal Gland and Ducts.— Protection of the Eye.— Omnipresence of God.

It would be an interesting task to trace the sense of sight, from the little creatures in which it may first be detected to its most perfect development. At every step of our progress, it would become us to adore the attributes of the great Creator, which are displayed in the humblest as well as the noblest of his works. But for this there would be required space far beyond our present limits, and a minuteness of detail which would not be deemed popular. The attention must, therefore, be directed to a simple description of the structure of the eye, some

of the varieties which appear in different creatures, and a few of the most striking facts relating to the function of sight.

Speaking generally, the eye is a globe, or ball, admirably adapted to the purposes intended. Its first, or outer coat, is called the sclerotic.[1] The whole of the back part of the eye-ball, which is sunk within the socket to the edge of the transparent portion, has this covering. It is composed of fibers, interwoven in every direction. In man, it is flexible, and endowed with great tenacity. Its use is to protect the important parts within, to preserve the globular figure of the eye, and to afford sufficient support to the muscles by which it is moved. In all vertebrate animals, however, the figure of the eye is not globular; and, where this is the case, the sclerotic coat has more or less of a bony character. In birds, of which the owl is an example, it is surrounded by a bony belt, not unlike the frame of a watch-maker's eye-glass. This is to prevent that tendency to the form of a globe, which fluids, on compression, naturally assume.

[1] See *a a*, page 7.

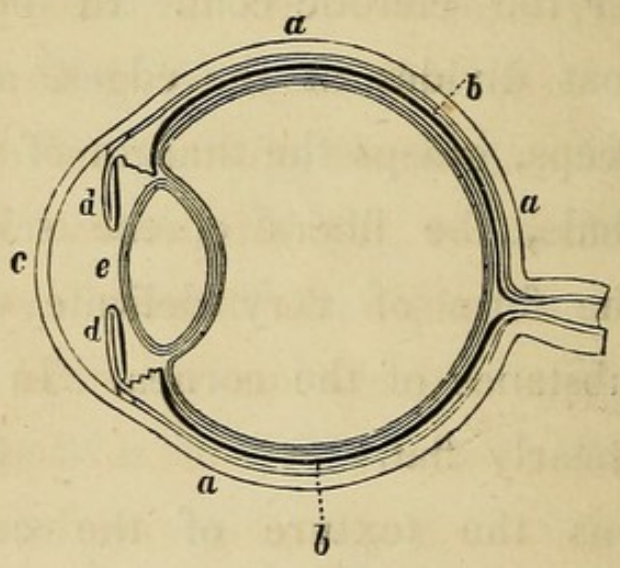
The transparent covering in front of the eye is called the cornea,[1] which may be compared in shape to a common watch-glass. It is somewhat cup-shaped, and thin at its rim, where it joins the sclerotic coat. It appears to be composed of concentric plates, or coats, one within another, like those of the onion, united by a compact cellular substance. It possesses few blood-vessels and nerves. The union of the cornea with the sclerotic coat exhibits some diversity in different animals. In man, the cornea slides under the sclerotic coat. In the hare, the sclerotic coat divides at the edges, and, like a pair of forceps, grasps the margin of the cornea. In the whale, the fibers of the sclerotic coat pass, in the form of very delicate white lines, into the substance of the cornea. In fishes, the cornea is nearly flat.

Dense as the texture of the cornea may seem, it is porous, and suffers the escape of the fluid behind it, after death. In its healthy state, no vessels admitting the red particles or globules of the blood are to be observed in this

[1] See *b b*, page 7.

transparen coat, but vessels receiving the uncolored portion exist in abundance. When inflamed, they become so enlarged as to admit the colored globules. Disease, if suffered to continue, always destroys its transparency, thus effectually intercepting the rays of light, and causing blindness.

Immediately within the sclerotic coat is the choroid membrane; at its anterior, or front part, it gives off a sort of fringe-like structure; and where the cornea joins the sclerotic coat it



Section of the Eye. *a a a*, the Sclerotic Coat; *b b*, the Choroid Membrane, showing the Black Pigment; *c*, the Cornea; *d d*, the Iris; *e*, the Pupil.

gives off the iris. The iris is a circular membrane, having a central aperture, termed the pu-

pil. Its color varies from gray and bluish-gray to hazel, dark hazel, and black. It is the seat of what is commonly called the color of the eye. The cut shows these different portions of the eye in a vertical section; or, the reader can look at his own eye in a mirror, and easily understand the outer structure. A modern traveler states, that he could never understand the declaration in the Song of Solomon, "Thine eyes are like the fish-pools in Heshbon," (vii. 4,) till he had visited the East. But there, as he observed reservoirs for the purpose of containing fish, which, arrayed in their most brilliant colors, darted hither and thither, beneath the brightest rays of the sun, he felt that the changes of which the human eye is susceptible had here a lively and beautiful illustration. The iris is peculiarly sensible to light. It acts, therefore, as a self-adjusting curtain, moderating the rays of light, and preventing too large a quantity being admitted. The shape of the pupil varies in different quadrupeds, though, for the most part, it is round as it is in man. In the cats, that hunt in the gloom, and therefore

require all the light that can be made available, it is long and vertical and becomes round at night. In larger creatures, such as the leopard, the lion, and the tiger, the pupil assumes a round form.

The surface of the choroid coat is covered by a black mucous coloring matter, to absorb, instead of reflecting, the superfluous rays of light, and thus to secure distinctness of vision. For the same reason, and in imitation of nature, the insides of the tubes of telescopes and other optical instruments have a coating of black. In some quadrupeds, a small space is free from this pigment, so that the surface of the choroid, or, as some rather consider it, a thin, distinct membrane over the choroid, is seen to glisten at the bottom of the eye. The eyes of cats glare in the light of a candle; an effect produced by the shining of this space without the coloring matter.

Some rabbits, and other animals, have what are called red eyes. In this case, the hair is white, and the creatures are called albinos. Some of the human race have these peculiar-

ities. The redness of the eyes in these cases is to be traced to the absence of the black pigment, or rather to the mucous being uncolored. Thus the vascular structure, by which we mean the arteries, veins, and other vessels of the choroid, is seen. It is a curious fact, that there appears to be some connection between the coloring matter of this mucous coat and that of the hair. Where there is a deficiency in the one, there is a deficiency also in the other, as if the secretion were one and the same. Red eyes are always weak, and incapable of enduring strong light.

The inner membrane of all is called the retina. The optic nerve, at its entrance into the eye, divides itself into numerous small bundles of fibrils, and these spread themselves out, and so unite with each other as to form a net-work, which is the outer layer of the retina. From this substance a very large number of little fibers arise, all directed toward the center of the eye. These pass through a delicate layer of tissue, containing a minute net-work of blood-vessels, and from this every fiber receives a

sheath, which covers its extremity. The surface of the retina is entirely composed of these little tubercles, which are closely set together. In the retina of a frog, the diameter of these nervous fibers is stated at about $\frac{1}{5800}$th of an inch; while that of the tubercles is about $\frac{1}{3840}$th of an inch. In man, they are stated at from the $\frac{1}{8000}$th to the $\frac{1}{8400}$th of an inch.

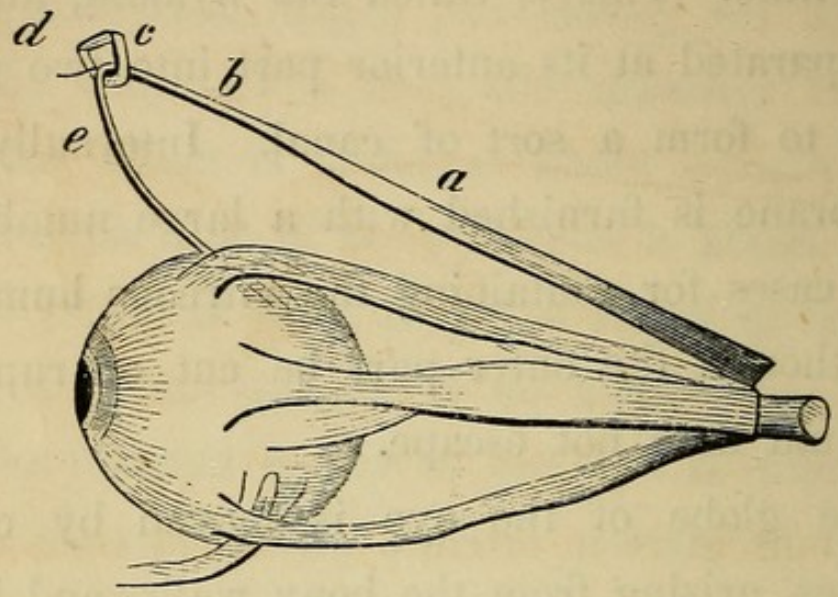
The internal cavity of the eye is filled with three humors. The anterior portion of the eye contains the one called aqueous, or watery; it surrounds the iris, which divides the cavity into two chambers, the pupil being the door of communication. Immediately behind the pupil is the crystalline humor, or lens. In man, the lens is like a convex magnifying glass; its texture is like hardened jelly; and it is enveloped with a membraneous sac, quite transparent, but not adhering to its surface. If immersed in boiling water, it becomes dark and hard, and is found to consist of concentric plates, formed by the combination of delicate fibers. The greatest portion of the eye, and the whole of its back part, is occupied by the vitreous, or glassy hu-

mor. It is of a gelatinous or sticky quality, quite transparent, and contained in a very fine membrane. This is called the hyaloid, and can be separated at its anterior part into two plates, so as to form a sort of canal. Internally, this membrane is furnished with a large number of little cases for containing the vitreous humor, so that though the outer part be cut or ruptured, the fluid does not escape.

The globe of the eye is moved by certain muscles, arising from the bony walls, and inserted into the sclerotic coat. One around the eye, for raising the globe; another, for moving it downward; a third, for drawing the orbit inward, toward the inner angle of the eyelids, or the nose; a fourth, parallel on the opposite side of the orbit to the former muscle, for moving the eyeball outward; and three others, which demand a particular notice.

One of them, called the oblique superior, or upper muscle, passes through a little pulley attached to the bone of the forehead, and runs in a slanting manner downward until it is fastened to the outer coat of the eye. By this

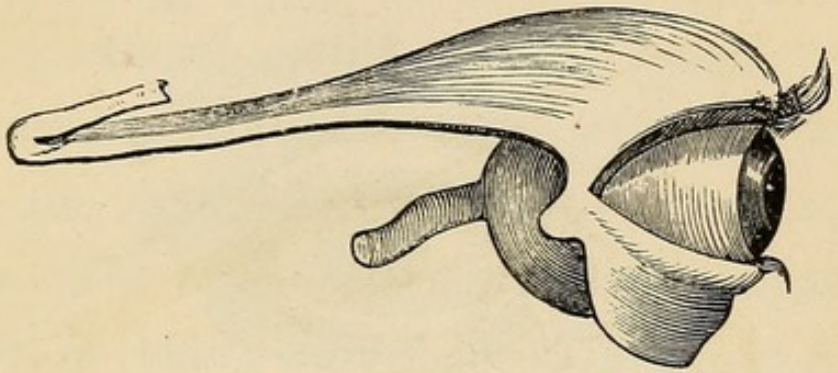
simple and beautiful arrangement, which is easily understood by looking at the cut, the globe



Muscles of the Eye. At the upper part of the globe is the levator oculi, or the muscle for lifting the eye; at the lower, the depressor, for moving it downward; and in the middle the abductor. The upper oblique muscle, *a*, is extended over the upper part of the globe, and gradually assumes the form of the tendon, *b*, which passes through the pulley, *c*, fixed to the inner edge of the orbit, *d*, then returning backward and downward, *e*, is inserted in the sclerotic coat.

of the eye is rolled by the muscle outward and sometimes downward. The other is the oblique inferior, or lower muscle, arising from the lower edge of the bony orbit, and running obliquely backward, to be inserted into the sclerotic or outer coat. Another muscle opens wide the eyelids, depressing the lower at the

same time that it elevates the upper. The engraving gives a profile of it in its natural position.



Muscle of the Eyelids.

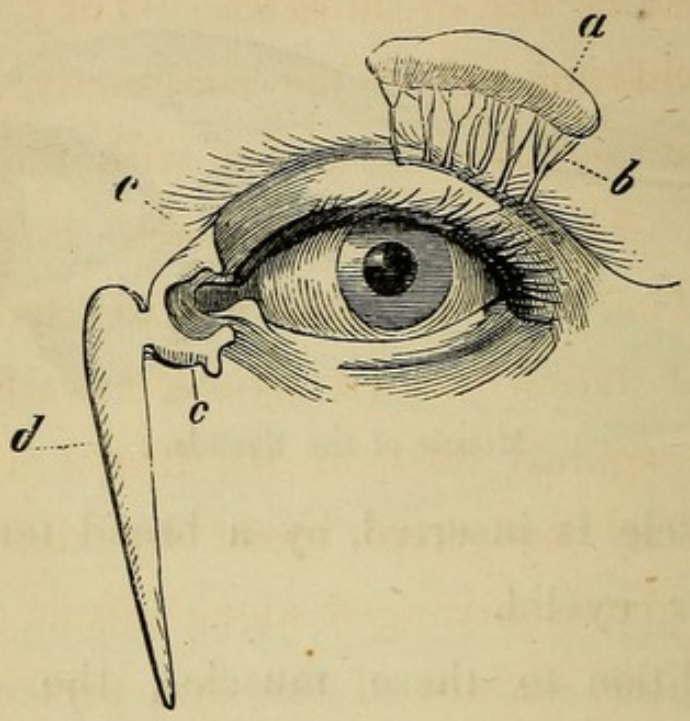
This muscle is inserted, by a broad tendon, into the upper eyelid.

In addition to these muscles, the orbit, or cavity under the forehead, in which the eye is placed, contains the lachrymal or tear gland.

This is situated near the temple, and sends out the fluid secreted, forming the tears, so as to allow them to trickle over the cornea, by several minute tubes. This fluid passes over the eye, in order to keep it moist and clean. It also washes off any small irritating particles which may adhere accidentally to the cornea.

Most wisely and benevolently is it ordered, that the irritation should excite an unusual flow, so as to wash the eye more effectually. The

fluid is absorbed by two small openings, situated at the internal angle of the eye. These lead



a, Lachrymal Gland; *b*, its Ducts; *c c*, the small Orifices; *d*, Lachrymal Duct terminating in the Nostrils.

into a membraneous sac, whence a tube conveys it into the nostrils. What a perfect little contrivance is this! a wash-basin and towel, and a spout to carry off all the waste water!

Abundant provision is made for the protection of the eye. Sunk within the socket, it is overhung by the brows, which not only give expression to the countenance, but also defend the eye from violence or accidents. The fringes of the hair interrupt the trickling down of the

perspiration. The globe of the eye has, also, a special defense in the eyelids, which are moved by a peculiar set of muscles. They are lined by a membrane called the conjunctiva, or joining membrane, which unites with the sclerotic coat, the blood-vessels of each intermingling freely. The edges of these lids are fringed with a row of hairs, termed eyelashes, which form a screen against dust, or too bright a glare of light. They are kept moist by the secretion of small glands arranged along them. The eyelids wipe the surface of the eye, protect it from injury, and close together during sleep. They are natural curtains, involuntarily open during the hours of toil, and as involuntarily drawn during the repose of exhausted nature. Though capable of being closed voluntarily, they close involuntarily, by an instinctive energy, when the eye is threatened, as if to afford it special protection. How carefully has God protected the eye from injury! And shall we not pray with the Psalmist, "*Keep me as the apple of the eye*, hide me under the shadow of thy wings."

And now, having thus hastily sketched an

outline of the eye, shall He be forgotten who constructed this wondrous and admirable organ, who adapted it to the material world around, and who made it one of the inlets of knowledge to the mind? So let it not be. Most impressively does it tell us of the perfections of God, and remind us that he is about our path and our bed, and is acquainted with all our ways. "He that formed the eye, shall he not see?" Well may we adopt the language of the Psalmist: —

"Such knowledge is too wonderful for me;
It is high, I can not attain unto it.
Whither shall I go from thy Spirit?
Or whither shall I flee from thy presence?
If I ascend up into heaven, thou art there:
If I make my bed in hell, behold, thou art there.
If I take the wings of the morning,
And dwell in the uttermost parts of the sea;
Even there shall thy hand lead me,
And thy right hand shall hold me.
If I say, Surely the darkness shall cover me;
Even the night shall be light about me.
Yea, the darkness hideth not from thee;
But the night shineth as the day:
The darkness and the light are both alike to thee."

And to these inspired words we may add:

"Then let this thought possess my breast,
Where'er I rove, where'er I rest;
Nor let my weaker passions dare
Consent to sin, for God is there."

CHAPTER II.

Eyes of Fishes and Birds.— Lens with its Fibers.— Eye of the Secretary Bird.— Eyes of the Chameleon.— Eyes of Insects.— Prismatic Facets.— Eyes of Crustaceous Animals.— Eyes of the Giraffe.

No organ of the senses is so important to fishes as the eye. It is generally unprovided with eyelids, but is capable of being slightly turned in various directions. Living as these creatures do in a fluid medium, with which the eye is always washed, they have no tear glands; but the cornea, which is slightly convex, is protected by a delicate continuation of the skin of the head, which passes over it. The sclerotic coat is very thick and firm, and generally contains cartilaginous plates in its tissue; and in some fishes it is converted into a cap of bone.

That the eye in fishes may bring the light to a focus or point on the retina in a denser medium than the air, the power of the crystalline lens is increased to the utmost. The aqueous humor,

which, being nearly of the same density as the surrounding element, would have but a feeble power in concentrating the light to a focus, is just sufficient in quantity to allow of the free suspension and movement of the iris. The vitreous humor, too, though the rays of light are more refracted or bent than while passing through the aqueous humor, would still be insufficient; and hence, the crystalline lens is the chief means of bringing the rays to a focus, or point of conveyance, on the retina.

For this a distinct provision is made. Instead of being simply convex, as in many other creatures, it is globular, and though perfectly transparent, at the same time is very dense. But as the focus of this lens is short, in proportion to the increase of its refractive power, it is placed much closer to the retina than in most animals, and the vitreous humor is therefore diminished. Both the vitreous and the crystalline lens are, in many fishes, kept in their place by a very delicate, slender membrane, derived from the retina, which traverses the vitreous humor, and is inserted in the covering of the lens.

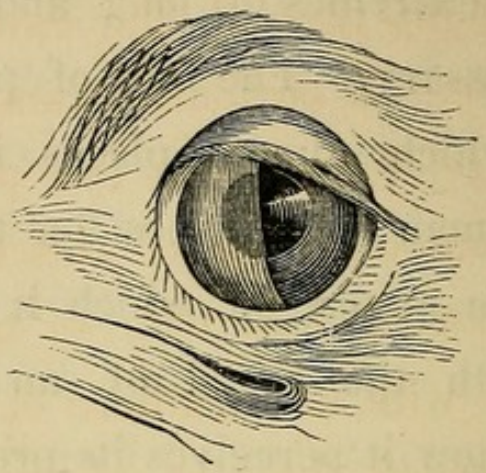
The structure of the lens of fishes is very curious. It has been found that the hard central portion is composed of a succession of concentric, transparent plates, the surfaces of which, though apparently smooth, have a luster like that of mother-of-pearl. The cause is the same in both cases—the occurrence of regularly arranged lines. These lines, which mark the edges of the separate fibers composing each plate, converge from what may be called the meridian of this little globe, to its two poles. These fibers are flat, tapering as they approach these poles. The breadth of the fibers of the outer layer is about the 5,500th part of an inch, and they are locked together by tooth-like projections. The number of teeth in each fiber has been computed, by Sir David Brewster, to whom we owe these interesting discoveries, to amount to 12,500. The whole lens contains about 5,000,000 of fibers; and, consequently, the total number of these minute teeth amounts to 62,500,000,000.

Very different from the eye of a fish is that of a bird: in the former, the sphere of vision is very limited; in the latter, it is remarkably extensive.

The rapid movements of the feathered tribes require also a special provision. A variation between the extremes of long and short sighted vision is necessary. The bird of prey, at a hight in the air which almost places it beyond the reach of human sight, sees on the surface of the earth the mouse on which it determines to pounce. With the speed of an arrow it descends; and now it perceives its prey as distinctly as it did when far remote; and to the long and short sight there is a complete and all-wise adaptation. As we draw out or press in the tube of a telescope, according to the distance or nearness of the object on which we are looking, so is there on the part of the bird an instinctive adjustment of the organ of vision. It contains what has been aptly called "a living sponge," filling and separating the parts between which it is placed, when this is desirable; contracting and allowing them to approach, when this is required.

Birds are provided with a special eyelid, or, as it is called, a nictitating or winking membrane; when at rest, it is neatly folded up in the inner angle of the eye. By a peculiar muscle, it can

be brought instantly over the pupil, be retained there at will, or be allowed to fold up again.



Eye of the Secretary Bird, showing the passage of the Nictitating Membrane across the Cornea.

One of its uses, while sweeping over the eye, is doubtless to clear the cornea; but the most important is, to interrupt the light of day. It is very observable indeed in the owl, which, when exposed to the light, defends its large eyeballs from the glare, by drawing this delicate and beautifully contrived curtain over them. When the bird is on the chase, during the dusk of evening or night, it is folded up, the pupil at the same time enlarging, and the eyelids being opened widely apart.

The eyes of animals living both upon the land and in the water are generally intermediate in

form and structure between those of fishes and those of the air-breathing classes, which receive the rays of light through the rare medium of the atmosphere. A curious circumstance may be mentioned in reference to the eye of the chameleon. A recent observer of this creature says, that nothing struck him with so much surprise, in connection with its variations of color, as the difference between the tint on one side of the body and that of the other. He attributes this to involuntary galvanic or nervous currents, distinct from and independent of each other, and occupying separate halves of the body. The remote cause of the difference in color in the two halves of the creature is referred to the manner in which the light acts on the animal; and the different effects are traced to two different centers, from which the nervous currents radiate.

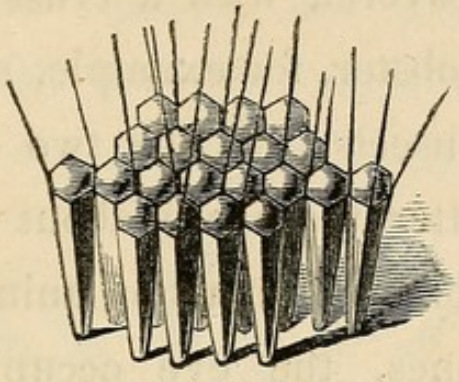
Over these centers, it is said, the organ of vision immediately presides, and that we ought not to wonder that the action of light has such powerful effects on the irritable structure of the chameleon, considering that the eye is most highly developed. The eyes move independently of

each other, and convey different impressions to their respective centers. The consequence is, that when the animal is agitated, its movements appear like those of two creatures glued together; each half wishes to have its own way, and there is no accordance of action. But when the creature is undisturbed, the eye which receives the strongest impression conveys it to the common center, and prevails on the other eye to follow that impression, and direct itself to the same object. The chameleon, moreover, may be asleep on one side, and on the other awake. Thus says Dr. Weissenborn, who came to these conclusions: —"When cautiously approaching my specimen at night with a candle, so as not to awaken the whole animal by the shaking of the room, the eye turned towards the flame would open and begin to move, and the corresponding side to change color; whereas the other side would remain for several seconds longer in its torpid and unchangeable state, with its eye shut."

The simple eyes of insects resemble those of higher animals, but the compound eyes may well fill us with amazement. These organs are

The Chameleon

two in number. When examined with a microscope, their surface appears divided into a



Group of Prismatic Facets, from the Eye of a Bee. The hairs between them tend to protect the surface from injury.

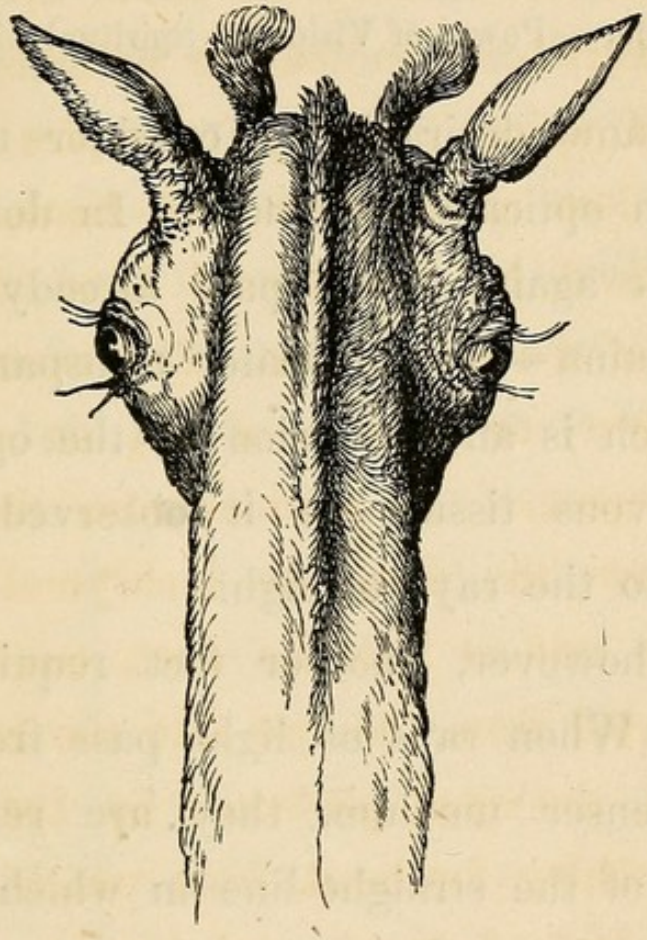
multitude of six-sided facets, between which minute hairs are generally seen. The number of facets is various. Thus, in the ant, there are 50; in the common house-fly 4,000; in some dragon-flies, upwards of 12,000; and more than double this number has been counted in other insects. As the eyes of insects can not be moved, the number of facets appears to compensate for this want. Here, however, it may be asked, do they see distinctly with every one of these, or with only one? To this it may be replied, that the probability is, that only one acts perfectly at a time, the insect seeing imperfectly with the rest. Thus, we perceive in all its distinctness

a part of a landscape, while we see confusedly the whole. The eyes of crustaceous animals, or those animals covered with a crust or shell, like the crab and lobster, for example, are compound, like those of insects. In the two compound organs of the latter there are about 5,000 eyes.

In all vertebrate animals or animals possessed of jointed spines, the eye occupies a cavity, more or less surrounded with bone, its walls being formed by the frontal bone above, and by those of the face below. This cavity is lined with a layer, or cushion of fat, on which the eyeball reposes. It contains also the muscles which move the eye, the lachrymal or tear gland, the orifices into the duct, conveying the fluid secreted from the eye into the nostrils.

In man, the eyes, protected by the edge of the overarching forehead, from which arise the eyebrows, look forward, and have a comparatively bounded sphere of vision. In the lower animals, especially the timid and gentle, as the deer or hare, each eye is situated laterally, looking from opposite sides of the head, and is large and projecting. The sphere of vision is

thus extended, so that the approach of enemies, numerous as they are, may be more readily discerned. In the giraffe, this projection of the eye is so great, that, in connection with its lateral position, the animal is really as capable of



Eyes of the Giraffe.

seeing behind it as before, as the engraving will clearly show. Hence arises one of the great difficulties which the hunter experiences of getting within gunshot.

CHAPTER III.

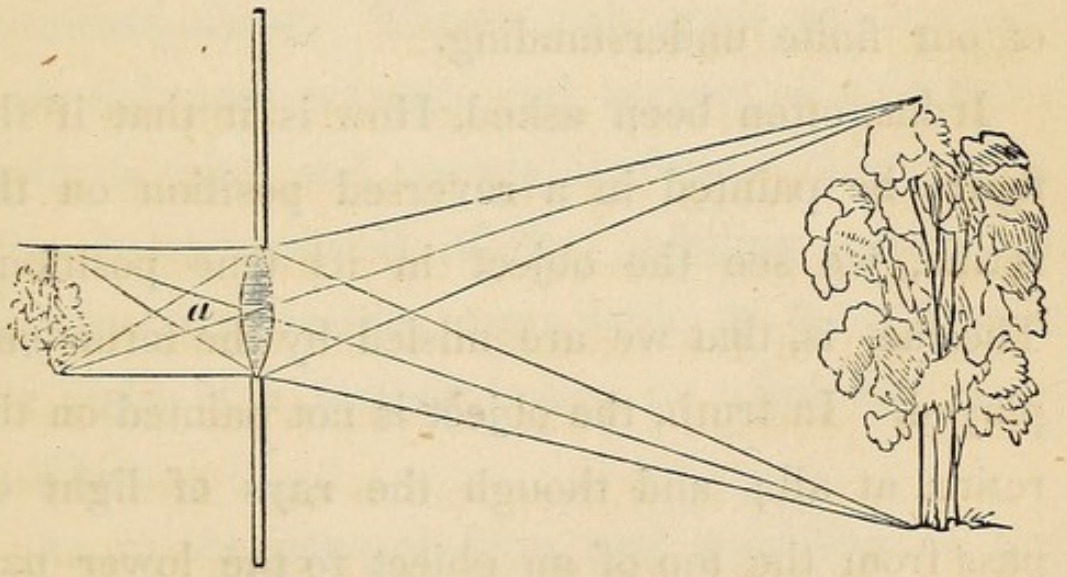
Function of Vision. — Refraction of Light. — Color. — Magnitude. — Power of Vision. — Spiritual Light.

It is now desirable to consider the human eye as an optical instrument. In doing so, we must look again at the part already described as the retina — the delicate, transparent, filmy web, which is an expansion of the optic nerve. This nervous tissue, be it observed, is alone sensible to the rays of light.

Here, however, another fact requires to be noticed. When rays of light pass from a rare into a denser medium, they are refracted or bent out of the straight line in which they naturally proceed. Thus if you place a stick in clear water, it will appear bent. The rays of light, therefore, emanating in a straight line from a given object, on touching the cornea pass through the aqueous humor, which being denser than air causes them to be thus refracted. After

passing through this humor they proceed through the lens, suffering still further refraction, next through the vitreous humor; and all is so exquisitely arranged, that they meet at a point, termed the focus, on the retina.

To illustrate this by a simple experiment: let a lens be placed in an opening in the window-shutter of a darkened room; then from any object, a tree, for instance, all the light which each point sends forth towards the lens will be concentrated in a focal point behind it; and if a sheet of paper be held there, it will have on it an image of the tree.



Lens in the Shutter of a Window. *a*, the Lens.

In the same way the retina receives images of the various objects placed before the eye. But

if it be asked, How does it take knowledge of the rays of light which these objects send forth? How is it that it should then convey to the mind, not an impression of the rays of light, but of the objects themselves? How does the mind, having contemplated these objects, associate them with others? the only reply is, We are aware of the fact, but this is all. We know that the exile looks at the sea, and thinks of his native land; and that the wayworn traveler who sees a flower blossoming in the wilderness may adore God's power and wisdom and goodness; but the manner in which these results arise defies the grasp of our finite understanding.

It has often been asked, How is it that if the figure be painted in a reversed position on the retina, we see the object in its true position? The fact is, that we are misled by the terms employed. In truth, the object is not painted on the retina at all; and though the rays of light do pass from the top of an object to the lower part of the retina, and those from the right of an object to the left, it is not of these rays nor of the place where they strike, that the mind takes

knowledge. We see no picture but the object itself; and as we see the parts of an object in the direction of the rays proceeding from them, it follows that the eye truly sees objects in their natural and relative situation.

All the hues and tones of color with which we are familiar, however varying in their minutest tints, or on the same object, are seized upon by the eye with exquisite discrimination. Here it is aided by none of the other senses; while, on the contrary, its information aids that of touch, whence, after due experience, a knowledge of bodies is obtained, which neither would communicate alone. Thus touch gives us the softness, lightness, warmth, and texture of a feather; sight its color, and, mainly, its form. And hence, after being assured of the unfailing connection between the qualities appreciable by these senses, the sight of a feather brings to mind its other qualities.

As to the general form and condition of the surface of bodies, the eye relies on experience. It is true, it judges of the roughness or smoothness of any object by the different degrees of the

illumination or light and shade of the various parts composing it. But then, touch was long needed to assure the mind of the connection between different degrees of illumination and the corresponding elevations or depressions of such bodies. Thus, after a series of experiments, at length relying on the sight alone, the mind becomes capable of accurately judging from the impressions received through that medium.

Having determined the fact as to form and surface, the eye is naturally led to an estimate of magnitude. The magnitude of an object (or the idea thus denominated) is communicated to the mind by the size of the angle produced by a line drawn from each of the extreme points of that object, and meeting in the eye. But as the size of the angle thus drawn depends no less on the real magnitude of objects than on their distance, it must be obvious that the true information is only to be acquired by the assistance of touch, and that only after a long series of experiments. It is easy to see, that if an elephant and a sparrow are at the same distance from the eye, the angle formed by imaginary lines, from

the extreme points of the dimensions of the former, converging toward the eye, would be much greater than the angle formed by similar lines from the latter. But remove the elephant to a certain distance, and let the sparrow remain, and the angle formed in either case will be the same. This is one of the laws of perspective, without attending to which, the artist could never imitate nature. For, were he to draw an elephant miles off, of its natural relative magnitude to a sparrow close by, he would outrage truth. The object in each case falling on the retina, under the same degree of angle, distance in the one case produces an angle as acute as proceeds from a minute object near at hand. This, then, shows how necessary experience is to our information on this subject.

The knowledge of distance, in all its degrees, is solely the result of experience. Infants stretch their hands to grasp distant objects, as well as those within reach. And why? The sense of touch has not yet corrected that of sight, and they have yet to learn, by practice, what are the relations of size and distance. After all, the

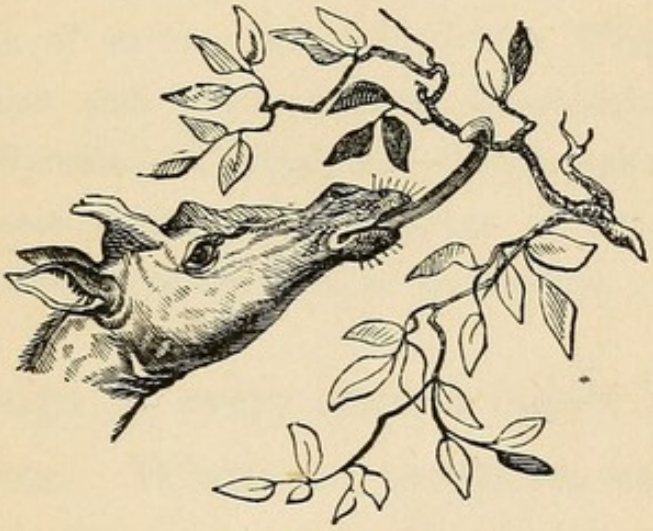
ideas of distance and of size are more or less imperfect, and while sight continues good, we are all our life learners. Let a man accustomed to land, and habituated to judge of objects in fields and woods and vales, where from the eye to any fixed point there is a succession of objects, be placed on board a vessel out at sea. Land appears; and if a sailor is asked the distance, he tells you with tolerable correctness how many miles yet intervene; to the landsman's eye, it appears just close beside the vessel. The expanse of sea, without any succession of objects to graduate the distance, is to an inexperienced eye extremely deceptive. The distinctness and illumination of objects assist us in judging of distance; but it often happens, as these characters are variable, and depend on atmospheric conditions, that error, and not accuracy, results from the impression.

How precious is the power of vision! The loveliest scenery of the earth, the most wonderful works of art, are lost to him whose sight "the drop serene hath quenched." Well might Milton sing in plaintive strains, —

"Thus with the year
Seasons return; but not to me returns
Day, or the sweet approach of eve or morn,
Or sight of vernal bloom or summer's rose,
Or flocks or herds, or human face Divine;
But cloud instead, and ever-during dark
Surrounds me: from the cheerful ways of men
Cut off; and for the book of knowledge fair,
Presented with a universal blank
Of nature's works, to me expunged and rased,
And wisdom, at one entrance, quite shut out."

There is, however, a more fearful privation still; it is spiritual blindness, an ignorance of the things that belong to our peace. Is this the state of the reader? Then, while it should be seriously lamented, because of its guilt, and may well excite apprehension, because of its danger, it should be remembered that there is still hope concerning this thing. The means of cure are found in the Word of God, the agency by which it can be rendered effectual is the power of the Holy Spirit. May He "who commanded the light to shine out of darkness," shine into the heart, "to give the light of the knowledge of the glory of God in the face of Jesus Christ!" 2 Cor. iv. 6.

TASTE.



TONGUE OF THE GIRAFFE.

TASTE.

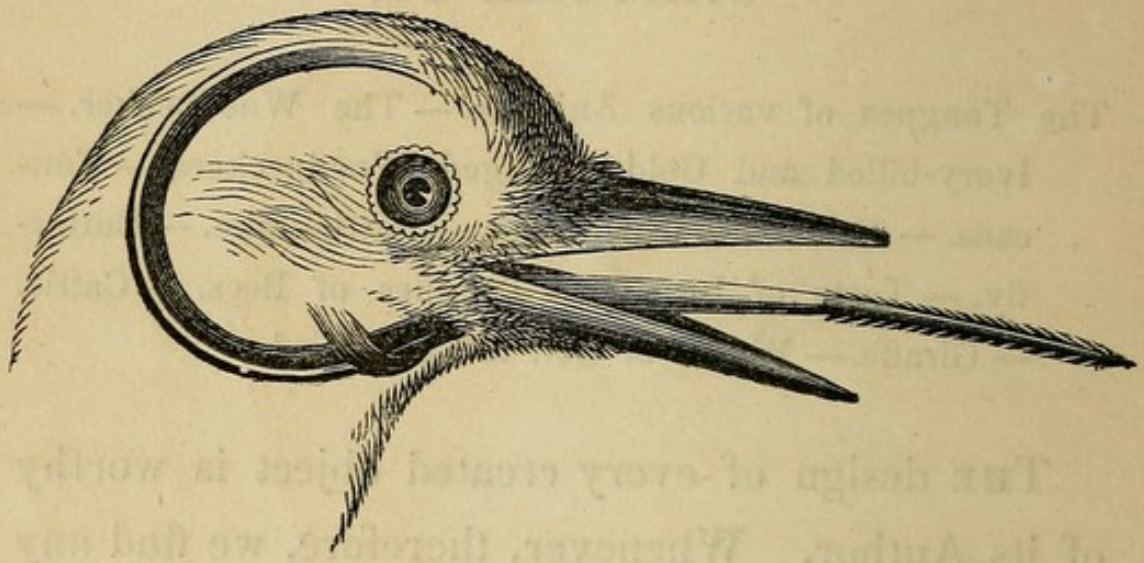
CHAPTER IV.

The Tongues of various Animals. — The Woodpecker. — Ivory-billed and Golden-winged Woodpeckers. — Toucans. — Parrots. — Chameleon. — Rattlesnake. — Butterfly. — Taste of Insects. — Tongues of Bees. — Cattle. — Giraffe. — Works of God to be studied.

THE design of every created object is worthy of its Author. Whenever, therefore, we find any thing required to be accomplished for the welfare of his creatures, then we trace his operation. But he ceases to work when he would continue to do so without an adequate reason. Of this fact we are reminded in connection with the sense of taste: in certain instances, it accords with the Divine wisdom and benevolence to endow it with great delicacy, and here it is found; in others, this grant would have been needless,

and here it is withheld. The various modifications of the tongue are also exceedingly curious.

Taste in birds must be feeble, if it exists at all. The skin of their tongue has no tasters, found on those of other creatures; and frequently this part is enveloped in a horny sheath; yet among them we shall discover facts well deserv-



Tongue of Woodpecker — showing also the elastic, hooped muscle which moves it.

ing attention. Thus, the tongue of the woodpecker is, as Paley long since remarked, "a particular instrument for a particular use;" and "what," he asks, "except design, ever produces such?" This bird lives chiefly on insects, lodged in the bodies of decayed or decaying trees. It is, therefore, furnished with a hard, angular, and

sharp bill for boring into the wood. When, by this means, it has reached the cells of the insects, its tongue comes into play. No other species of

Golden-winged Woodpecker.

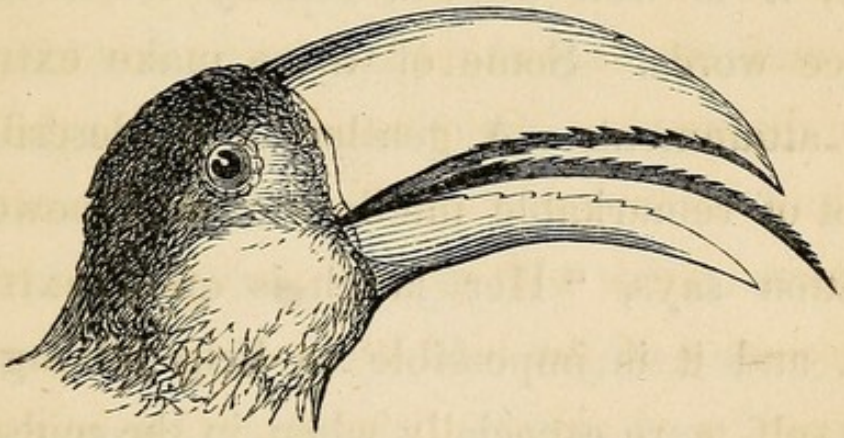
bird has such an instrument. The tongue is so long, that it can be darted out three or four inches from the bill. It is tipped with a stiff, sharp, bony

thorn, and, moreover, this tip is toothed on both sides, like the beard of an arrow, or the barb of a hook. Its use will at once be seen. The bird, having opened the retreats of the insects, darts forth its long tongue, transfixes them with its spear, and draws its prey within its mouth. At every point of this process we behold exquisite adaptation. That the beak may be sufficiently sensible, a nerve perforates the bone by innumerable small canals, so that the horny covering may feel in the crevices of the wood and under the bark; and thus the tongue receives its direction, after being darted forth with great celerity. To prevent the necessity of the bird sticking each insect with its arrow, a viscid or sticky secretion bedews the tongue, which is poured out from a very large gland. The golden-winged woodpecker is abundant throughout the whole of the United States, and is celebrated for its liveliness and activity.

The ivory-billed woodpecker prefers the top of the tallest trees, whence it seldom descends to the ground. So great is its strength, that it has been seen to detach pieces of bark seven or eight inches in length, with a single blow

of its bill. Beginning at the top branch, it has torn off the bark to an extent of twenty or thirty feet in the course of a few hours, and then looked out for the precise spot where the grubs were concealed, immediately renewing its blows with great vigor, and giving forth its loud notes as if highly delighted.

The tongue of the toucan, a bird of the Amer-



Tongue of a Toucan

ican tropics, is composed of a long, firm, narrow cartilage, fringed along each side with a continued barb of fine slender projections. These are directed forward, and become longer toward the tip. The tongue, from its structure and inflexibility, can not be used to turn the food, or guide it into the gullet; and hence, when the bird seizes any morsel, it is thrown

with a jerk into the widely-opened throat, and then swallowed.

The powers of speech with which some birds are gifted are truly surprising. The writer heard, a few years ago, a canary, able distinctly to articulate several words, which it was accustomed to introduce in the midst of its very animated, varied, and melodious song. Parrots of both sexes, it is well known, readily learn to pronounce words. Some of these make extraordinary attainments. A gentleman in describing a parrot of remarkable intelligence and powers of imitation says, "Her laugh is quite extraordinary, and it is impossible to help joining in it one's self, more especially when, in the midst of it, she cries out, 'Don't make me laugh so; I shall die, I shall die.' Her crying and sobbing are curious; and if any one says, 'Poor Poll, what is the matter?' she replies, 'So bad, so bad; got such a cold;' and, after crying for some time, will gradually cease, and, making a noise like drawing a long breath, says, 'Better now,' and begins to laugh." What a resemblance is here to the marked insincerity of many rational beings!

"The first time," says the writer, "I ever heard her speak, was one day when I was talking to the servant at the bottom of the stairs, and heard what I then considered to be a child's voice call out, 'Payne,' (the maid's name,) 'I am not well; I am not well;' and on my saying, 'What is the matter with that child?' she replied, 'It is only the parrot; she always does so when I leave her alone, to make me come back;' and so it proved, for on her going into the room the parrot stopped, and then began laughing, quite in a jeering way.

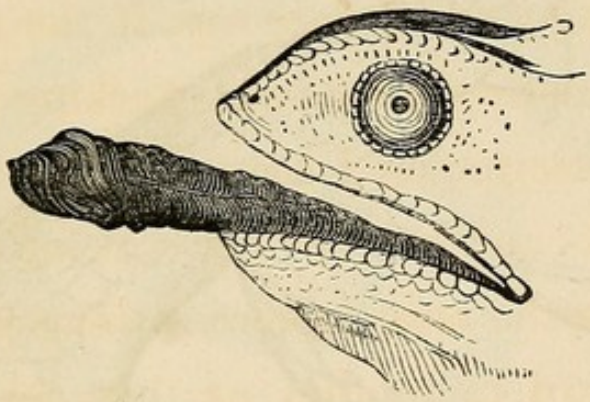
"It is singular enough that whenever she is affronted in any way, she begins to cry; and when pleased, to laugh. If any one happens to cough or sneeze, she says, 'What a bad cold!' One day, when the children were playing with her, the servant came into the room, and on their repeating to her several things that the parrot had said, Poll looked up and added, quite plainly, 'I didn't!' Sometimes, when she is inclined to be mischievous, the servant threatens to beat her, and she often says, 'No, you won't.' She calls the cat very plainly, saying, 'Puss, puss,' and

then answers, 'Mew;' but the most amusing part is, that whenever I want to make her call it, and for that purpose say, 'Puss, puss,' myself, she always answers 'Mew,' till I begin mewing, and then she begins calling 'Puss' as quick as possible. She imitates every kind of noise, and barks so naturally, that I have known her to set all the dogs on the parade at Hampton Court barking; and I dare say, if the truth were known, wondering what was barking at them; and the consternation I have seen her cause in a party of cocks and hens, by her crowing and clucking, has been the most ludicrous thing possible."

With regard to reptiles, as they, for the most part, must necessarily swallow their prey entire, organs of taste, as in the case of fishes, would be of little use. The tongue, therefore, is generally an instrument by which the food is seized, and conveyed into the mouth.

The tongue of the chameleon is cylindrical, worm-like, capable of being greatly lengthened, and ending in a fleshy projection, lubricated with a viscid saliva. It is the only part of the creature which moves with quickness. With the ex-

ception of this projection, forming the tip, it consists of a hollow tube, so constructed that when withdrawn into the throat it is folded in upon itself, somewhat in the way in which a pocket-telescope is shut up. When fully extended, the tongue reaches to a distance, at the least equal to that of the animal's body. Its movements are invariably rapid. An insect on a leaf, apparently at

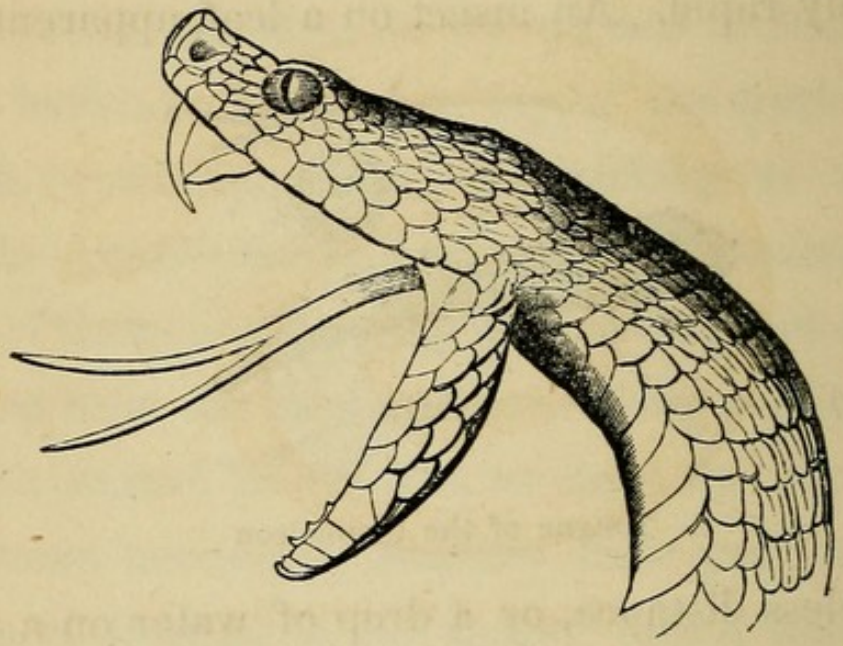


Tongue of the Chameleon

a hopeless distance, or a drop of water on a twig, disappears, as if by magic, before the chameleon. So unerring, too, is its aim, that an acute observer, who had kept many of these animals, remarked, in the hearing of the writer, "I never knew a chameleon miss his mark but once, and then the fly was on the other side of the glass."

A very erroneous opinion is often held of serpents, to which it may be well here to allude. It

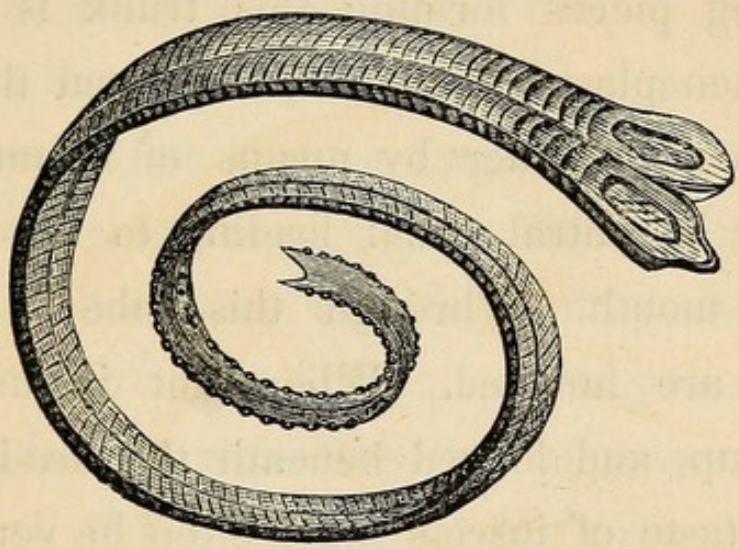
is not the tongue which conveys the venom with which some are supplied; neither can they be said to sting. The fact is, that in each branch of the upper jaw is a long, recurved, pointed tooth, traversed by a canal, leading from a large gland situated beneath the eye. Here the fluid is secreted which passes through the tube into



Tongue and Fang of a Rattlesnake.

the bottom of the wound which the poison-fang inflicts. The fatal wound is therefore produced, not by a sting, but a bite. When the fangs are not used, they lie concealed in a fold of the gum. When about to bite, the creature raises them up, and in the act of biting compresses the poison glands, and so distills a few drops of venom into the wound.

The tongue of insects frequently differs from that with which larger animals are supplied, but in the locusts, grasshoppers, crickets, and dragon-flies, it is rounded and fleshy, somewhat resembling that of quadrupeds. The dragon-flies have, besides, a sort of palate, formed of a square fleshy cushion, thickly set, like the upper surface of their



Tongue of the Butterfly.

tongue, with small black tasters, ending in a short bristle. Other insects have been observed to have a similar provision. The hairs are supposed to be mechanically useful in securing food.

Some organs of insects are adapted to pump up the juices from the cups of flowers. Accordingly, the tongue is of great length, to enable them to reach the store of the nectar. It

has been described by Professor Jones as representing, when unfolded, a long double whip-lash. If carefully examined under the microscope, each division is found to be made up of innumerable rings. These are connected together and moved by a double layer of spiral fibers, that wind in opposite directions round its walls. Each of the two long pieces forming this trunk is tubular, and, when placed in contact, it is seen that their edges lock together by means of minute teeth, forming a central canal leading to the opening of the mouth. Through this tube it is that liquids are imbibed. When not in use, it is curled up, and lodged beneath the head.

The taste of insects must often be very acute. Were any of us to taste the fox-tail grass, we should find little, if any, difference between this and many others; and yet the caterpillar of the antler-moth will not touch this one, though it will devour greedily a great variety of other herbs. Other instances of discrimination, preference, and dislike, have often been observed. It seems probable, however, that the sense of taste is the least perfect of those enjoyed by bees. Contrary to

the received opinion, they display, according to Huber, little choice in collecting honey; nor are they very nice in the quality of their water, for corrupted marshes and ditches appear to be preferred to limpid streams, and even to dew itself. To this the great inequality of honey is owing. The produce of one district differs from another; the honey of spring is unlike that of autumn; and even the contents of one hive may differ from those of one that is near.

Quantity is, however, a great object with bees. They soon find, and visit frequently, the spots where most is to be found; and they leave the hive, much less regarding the fineness or temperature of the weather than the prospect of a scanty or plentiful collection. Let but the lime-tree and black-thorn blossom, and they depart before sunrise, brave the rain, and return later than usual. But when the flowers begin to fade, and the scythe has been busy in the clover-fields, they are seldom tempted to leave their home, even by the most brilliant sunshine.

Taste appears as possessed of its highest power, among the mammalia. Those cattle and other

animals which feed on green herbs have a tongue which is large and studded with tubercles, or pimples, which may be properly called tasters. These are abundantly moistened with saliva, and also with a peculiar mucus. A special provision is more necessary for these creatures than for those which feed on flesh. So great is the variety of herbs, and so frequently do they grow promiscuously together, that, but for their having a nicety of taste, they would be poisoned, instead of fed. Against this, however, they are defended by instinct, excepting only the case of a few quadrupeds, which are disposed to crop the young shoots of the yew-tree. Generally speaking, nothing will induce them commonly to eat any plant which is not their natural food.

In cattle, the tongue occupies the base of the mouth. It is firmly held in its situation by appropriate muscles. They extend their fibers through every part of it, and being intermingled with a considerable quantity of fatty matter, the tongue has, when cut into, its peculiar appearance and taste. It is covered by the membrane of the mouth, curiously modified, resembling more the

cuticle, or scarfskin. The internal layer is fibrous and sensitive; and between the two is a soft net-like substance, which seems as a bed for the tasters, scattered all over the tongue. The use of the tongue, generally, is to dispose of the food between the grinders during mastication; to collect it afterward; and to aid in forming it into a pellet for swallowing. It is also the chief instrument in drinking, and forms the canal through which the fluid passes in the act of doing so. The outer covering of the ox's tongue is harder and rougher than that of the horse. This is necessary from the way in which its food is gathered.

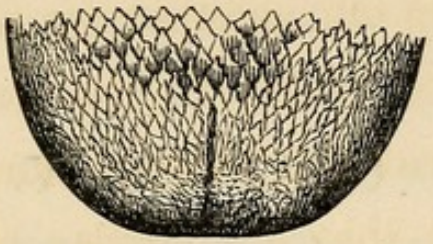
The tongue of the ox answers also another purpose. It helps to collect the grass together, and to form it into a roll before it is brought between the pad of the upper jaw and the cutting teeth of the lower one. It seems to free the mouth from dirt, or insects. It is shorter than the tongue of the horse, and yet it is able to perform all those functions which are only imperfectly performed, and some which can not be performed at all, by the tongue of the horse. The horse

shows his friendship for his companion by nibbling him with his teeth; two cows, on the contrary, will rub or rasp one another for an hour or two at a time. The reader familiar with country-life will readily recall this habit of cows in the fields, and will admit that no prettier picture of good-will can be seen.

The giraffe, feeding, as it does, on the leaves, twigs, and shoots of lofty trees, and especially on a species of mimosa, has a tongue specially adapted to its purposes. It has the power of motion to an extraordinary degree, and at the same time one of extension, so as to perform, in miniature, the office of an elephant's proboscis. It is indispensable in procuring food. Coiling its tongue round the branches, it draws them down between its very movable and flexible lips, and thus nips off the tender portions.

The highest power of taste seems to be confined to man, and those herb-eating orders of animals which masticate, for a long time, their food. Carnivorous quadrupeds, accustomed to tear their food in pieces, and to swallow it in large morsels, can not pay much attention to its peculiar taste.

The tongue of all animals of the cat kind is used for mastication, as well as taste. When, for in-



Tip of the Tongue of the Lion.

stance, a lion gnaws a bone, the flesh left on it by the teeth is scraped away by sharp and horny points, inclining backward, with which the tongue is furnished.

From these various orders of inferior creatures, it becomes us to rise to man, in whom the organ of taste attains its highest delicacy, and whose powers of speech may well fill all, who seriously contemplate them, with astonishment and admiration. While the display of the Divine perfections, so apparent in innumerable objects around, should not appeal to us in vain, it is of the highest moment that the mind should be attracted to the gospel — the gosple of the crucified Redeemer; the gospel in which whosoever believeth shall be saved.

CHAPTER V.

Structure of the Tongue in man. — The Tasters. — Benevolence of God.— Knowledge and Industry of Man. — Pleasure of Taste.— The Voice. — Speech. — Eloquence. —Government of the Tongue. — Praise to God.

THE organ of taste in man is the tongue, of which the surface is peculiarly sensitive, the skin being furnished with a large proportion of blood-vessels and nerves. Here a distinct layer is formed, through which a great number of

Piece of the Tip of the Tongue, magnified, to show the Tasters.

tasters pass, and project from the surface, covered with a thin cuticle, like the pile or nap of velvet. Some tubercles or projections there are, however, which can not be called tasters, as those only which are of a conical shape are the seat of taste. In the fore-part of the tongue these tast-

Magnified Section of one of the Tasters of the Tongue; showing the Nerves and Blood-vessels.

ers are visible to the naked eye. They are especially so in some cases of disease. Thus, in the early stage of scarletina, they become long, and of a bright red color, from their minute blood-vessels being distended with that fluid. As the fever subsides, the points of the tasters collapse, and acquire a brown hue, an appearance

which has given rise to the name of "the strawberry tongue." If these be touched with vinegar, by means of a camel-hair pencil, they will appear to be lengthened by this stimulus ; an effect supposed to accompany the sensation of taste.

Pleasure in the act of eating is granted to some inferior creatures. A horse, at liberty, passes a great part of his waking hours in eating. To the ox, the sheep, the deer, and other ruminating animals, the pleasure must be greatly increased. Nearly their whole time is occupied in browsing on their pasture, and chewing their cud. Whatever, therefore, their pleasure be, it is spread over a large portion of their existence. Is there any object of greater contentment than a cow lying upon the soft grass under the shade of some thick-leaved tree, leisurely chewing her cud?

Here, then, we have a fact specially deserving notice. The primary use of the sense of taste is, obviously, to guide animals in choosing their food, and to warn them against receiving noxious substances into the stomach. But there is something more to be observed. "Why," as Paley

has asked, "add pleasure to the act of eating; sweetness and relish to food? Why should the juice of a peach applied to the palate, affect the part so differently from what it does when rubbed on the palm of the hand?" Such questions can only be answered by referring to the pure benevolence of God. Eating is necessary, but the pleasure attending it is not necessary. The gratification thus enjoyed is peculiar; it depends not only on our possessing the sense of taste, but on a particular state of the organ in which it resides. The adaptation of the organ to the object will be considered happy by those who have suffered from fevers, when every taste is irregular, and sometimes every one is unpleasant.

The goodness of God, which is thus apparent, may be observed as clearly in other senses. Thus, there might have been smell without fragrance, and we might have seen and heard, and yet it might never have been said:

> "Thou mak'st all nature beauty to his eye,
> And music to his ear."

Such special adaptations to render what is neces-

sary delightful should call forth our highest gratitude. But it will be well to trace the Divine beneficence, as illustrated by the sense of taste, still further. There is, for example, among plants a particular secretion, or substance, in which the taste it affords resides. There is, therefore, a system of vessels appointed to secrete whatever has this quality, and, consequently, a special arrangement for it. These vessels, and their products too, are different in different plants, and are unnecessary to the existence of the plant itself. In like manner, we often find this produce useless to other animals, or else disliked by them, and useless also for any other purpose than our own pleasure. What a range may the mind take, from wheat or rice, to cinnamon or pepper! The former belong to those plants where we can not detect the specific source of taste, and the latter to others where it is easily separated, and where the special organs to produce it can also be observed.

To take one class from the many: the fruits form a very peculiar set of productions, united by a common bond, which yield gratification to the

taste. How striking is the succession in which they have been destined to appear! Nor is the arrangement less admirable by which we have the greatest variety, from those which require to be eaten as soon as ripe, to those which we are enabled to preserve through an entire year, till a new summer comes, to recommence the same round.

Thus far, then, benevolence is manifest, since all the useful qualities might have existed under one variety, just as the nutritious properties might have excluded not only variety, but taste itself. But this is not all; there remains to be noticed that marvelous compound, or set of substances, which forms the principle of flavor. No chemist can tell us what this is; and yet it is expressly appointed in the exercise of the Divine goodness. Deprive the finest fruits of their flavor, and they are nothing. The peach, or the nectarine, so delicious when ripe, is often cast aside with distaste when an unfavorable season prevents its being matured by the beams of the sun.

It is a remarkable fact, in connection with the present subject, that enjoyment is made greatly to

depend on industry and knowledge. Man is thus enabled to change the characters and qualities of vegetables for his own purposes, so as to form new species and previously unknown substances. A simple effort now converts an useless wilding into a plum or peach. And if the rude ore was placed in the earth for man, while all beside was left to his own industry, as little can it be doubted, that as certain fruits would not have existed but for his exertions, so here we see again the beneficence of God.

The pleasure of the sense of taste, which duty and privilege alike require us to keep fully under control, it may further be remarked, is associated in a peculiar manner with domestic enjoyment. To have met at the same table affords gratification amidst the remembrances of friendship; and to meet there again after long absence is a source of great pleasure. In some half-civilized countries, in which feelings of this kind operate more powerfully, and with less restraint, than in our own, this hospitable bond forms one of the strongest ties of mutual obligation. Troubles seem to vanish at a well-filled table, and cheerfulness and

good-will to make all hearts light and happy. Had there been no pleasure attached to a repast, independent of the mere relief from the pain of hunger, the coarse and equal food would probably have been taken by each one apart; social and domestic feelings, far inferior to those now commonly exercised, would have been the result. It is indeed difficult to say how much of pleasure, and of kindly feeling too, would be lost by a change of manners which would simply put an end to the social meal, — that meal, which now calls all the members of a family to suspend their engagements for a while, and to enjoy the cheerfulness which is best reflected from others.

One remarkable power of the tongue still remains to be noticed, connected as it is with the utterance of vocal sounds. Sound, as is well known, is produced by the vibration of air emitted from the lungs of animals, caused by an organ termed the larynx. Mammals, birds, and reptiles, are the only animals which, according to this definition, possess a voice. But many species of other classes produce peculiar sounds, by which the individuals are attracted to each other, or

express their wants and feelings. A true organ of voice includes various parts: the lungs, bronchi, trachea, larynx, and mouth. The most essential portions are two vibratile chords, bounding a slit-shaped opening, called the glottis; and this may be situated at different parts of the air-tube in different animals; the part of the tube between the glottis and the oral outlet being the true sonorous instrument. In mammals and reptiles the glottis is situated at the end of the windpipe, which communicates with the bronchial tubes, and consequently the whole trachea becomes, in this class, part of the vocal instrument.

The admirable apparatus by which man is enabled to produce a sufficient variety of sounds to answer his purposes, consists of the chest for containing air, of the larynx at the top of the windpipe for producing the voice, and of the short tube of the mouth for modifying it. When, therefore, air rushes from the lungs through the opening at the top of the windpipe, it causes the elastic tips of that opening to vibrate, and to excite the tremblings which produce sound. This is modified at the will of the individual in a great

variety of ways; a variety which is, however, still very simple. The principal means of doing this appears in the tongue and the lips, which are expressly adapted to render sounds articulate.

The modifications of the voice, easily distinguishable by the ear, are reckoned to be about fifty in number, but no single language contains more than about half of them. They are divisible into vowels and consonants; the one class being formed by the voice issuing through the open mouth, and influenced only by the degrees in which this is done; the other by some interruption of the sound. How beautiful in its simplicity is such an arrangement! The combinations that are thus produced are indeed immense. Tones of joy and sorrow, the endless variety of musical notes that so delight us in their beautiful arrangements, all have this simple origin.

Command is acquired over other muscular organs of the body, as the feet in walking, or the fingers in playing on musical instruments; and just so is it obtained over the organs of speech. At first, there must be a distinct act of the will for every muscular movement; but the action is

easier each time it is repeated; and, at length, habit renders a series of such movements easy and prompt in obeying a single wish. The child, for example, must exert as distinct and powerful an act of the will to pronounce the single syllable Ma, or Pa, as, after a little practice, is required to double it, or, when there has been a little more, will be necessary for the hardest word it can utter. So far, however, may the ability improve, that an accomplished speaker will pour forth complete sentences, most powerful and eloquent, in rapid succession; and yet his oratory, fascinating and impressive as it is, grew, as the result of effort and habit, from the imperfect utterance, and the comparatively feeble wish, of a little child.

Speech is, indeed, the peculiar privilege of man. His intellect does not more surely indicate his sovereignty over the animal world, than does the power of expressing his thoughts. So far as relates to their wants and desires, their attachments and aversions, methods may be observed of communication between one animal and another. There are cases, too, in which words are

uttered by the force of imitation. But speech, which alone can embody thought, and cause mind to interchange with mind, is confined to man alone. It is the product and the vehicle of intellectual power. It is the last seal of dignity impressed by the Creator on the first of his earthly creatures.

In early times, knowledge was communicated by the living voice from fathers to their children. These, again, adding to the store, transmitted it to their descendants, and thus the amount of intelligence was increased from age to age. Thus tradition was for a long time the only history, the only source of knowledge. Most admirable, indeed, is the power of speech. But for this, how degraded would have been the condition of tlose who have been distinguished as the noblest of our race! At the present time, in circumstances where language may be said scarcely to exist, the people are greatly debased; while, on the contrary, progress in civilization may be traced as one of the results of a larger vocabulary.

"Thoughts shut up, want air,
And spoil, like bales unopened to the sun.

Thought in the mind may come forth gold or dross;
When coined in words, we know its real worth.
Speech ventilates our intellectual fire;
Speech burnishes our mental magazine;
Brightens for ornament, and whets for use."

Many instances might be mentioned of human eloquence. To the records of some we may easily turn with pleasure; but how much greater is the effect when we can hear it from the living voice! When Æschines, the rival of Demosthenes, struggled in vain to share with him the palm of eloquence, he withdrew from the public gaze. In his retirement, he had sufficient strength of mind to place the oration which caused his disgrace in the hands of his pupils. He watched their countenances kindling as they read it, and found that, at length, unable to suppress their feelings, they broke out into expressions of unbounded admiration. Nor did he check, he rather stimulated the glowing emotions of their bosoms, exclaiming, "What then would you have said, had you heard him deliver it!" Such freedom from jealousy, such pleasure in the triumphs of another, even to his own disadvantage, casts great

honor on the name of Æschines, while the fact pleasingly illustrates the influence of the power which has been granted to man.

It is ours, however, to be familiar with a higher order of eloquence still — the eloquence of the prophets of the Most High, of the apostles of our Lord, of Him who "spake as never man spake." Here the orators of times past, present, and to come, are, and will be, unspeakably surpassed. From them gratification and instruction may often be derived; but it is only in reference to those who "spake as they were moved by the Holy Ghost," and to Christ, in whom dwelt "all the treasures of wisdom and knowledge," that it can be said, "Hear, and your soul shall live."

The government of the tongue is of difficult attainment; and yet it is as certainly of great importance. The apostle James expressly says, that the degree of subjection in which the tongue is held is a standard of the power of religion in the heart — a measure of our real Christianity. "If any man among you seem to be religious, and bridleth not his tongue, this man's religion is vain," James i. 26.

The whole reasoning of this apostle, in the passage referred to, shows the necessity and the difficulty of controlling this "little member." As the bridle governs the horse, as the helm guides the vessel, so the influence of the tongue is great in society. It is even "a fire," burning and destroying; and "a world of iniquity." No words could, therefore, more impressively urge us to "set a watch at the door of our lips." We should obey the precept of the Psalmist, "Keep thy tongue from evil, and thy lips from speaking guile;" and also remember that "the mouth of the righteous speaketh wisdom, and his tongue talketh of judgment."

A strong reason for placing such a guard may be derived from a recollection of the past. Who can refer to the words he has uttered, considering them in the light which the Scriptures throw around them, without feeling that there is much cause for deep humiliation of spirit? Here our sins appear as a great mountain. And only can our iniquities be blotted out through "the blood of the Lamb." Now Jesus invites us to trust in Him with whom the Father is always well

pleased; and if he is our confidence, we may say, "Who is he that condemneth? It is Christ that died, yea rather, that is risen again, who is even at the right hand of God, who also maketh intercession for us," Rom. viii. 34. Great, inconceivable great, is this blessedness.

Thomson has said, as he contemplated the works of God:

> "For me, when I forget the darling theme,
> Whether the blossom blows; the summer ray
> Russets the plain; inspiring autumn gleams;
> Or winter rises in the black'ning east;
> Be my tongue mute, my fancy paint no more,
> And, dead to joy, forget my heart to beat."

And truly, the providence of God, and the discoveries of his Word, should also employ our tongues now, as in them eternity itself will be occupied. Our rank in the creation, our unfailing supplies, our distinguished mercies, our religious privileges, alike demand our tributes of thanksgiving. On all the followers of Christ it devolves, to show forth the praises of Him who hath called them "out of darkness into marvelous light." It becomes each one of them to say,

with the sincerity and fervor of the Psalmist, "Bless the Lord, O my soul: and all that is within me, bless his holy name. Bless the Lord, O my soul, and forget not all his benefits. While I live I will praise the Lord: I will sing praises unto my God while I have any being," Psa. ciii. 1, 2; cxlvi. 2. And with a modern writer we may exclaim:

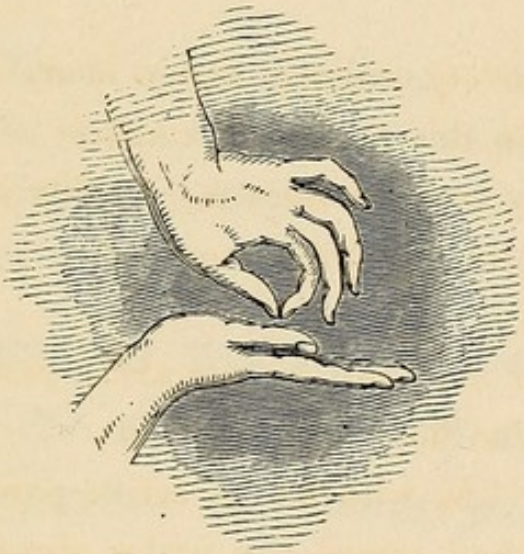
"In every smiling, happy hour,
Be this my sweet employ;
Thy praise refines my earthly bliss,
And doubles all my joy.

"Nor shall my tongue alone proclaim
The honors of my God;
My life, with all its active powers,
Shall spread thy praise abroad.

"How will my happy spirit mount,
Confined in flesh no more,
Up to thy courts, where kindred minds,
In countless ranks adore!

"There shall my lips, in endless praise,
Their grateful tribute pay;
The theme demands an angel's tongue,
And an eternal day."

TOUCH.



POWER OF THE HAND

TOUCH.

CHAPTER VI.

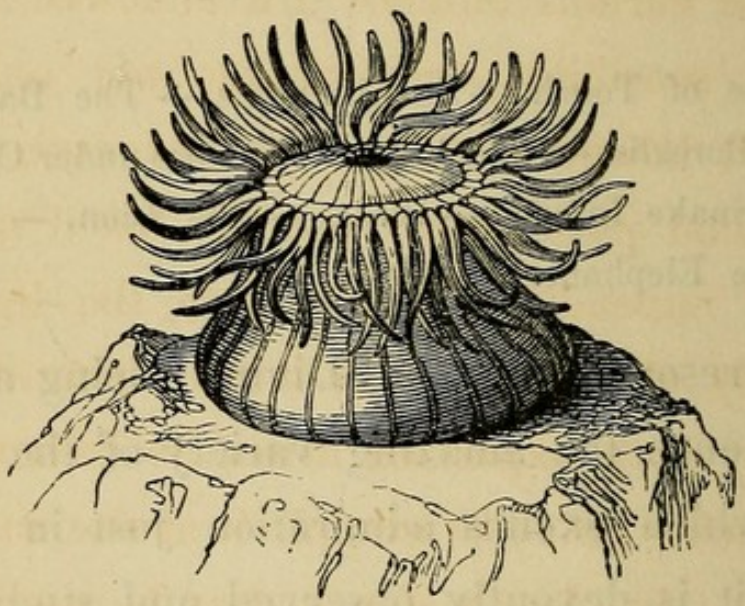
The Sense of Touch. — Sea-Anemone. — The Barnacle. — Clio Borealis. — The Angler. — Fishes under Control. — The Snake Insects. — Birds. — The Lion. — Proboscis of the Elephant.

THE resources of the Divine Being are infinite. Hence the amazing variety of the natural world, which excites admiration just in proportion as it is devoutly observed and studied. It presents before us not only a vast diversity of objects, but also of means by which the same end is secured, in different circumstances. We have an interesting illustration in the sense of touch, the examination of which will amply reward the attention it demands.

The little creature which can only be brought under inspection by the power of the micro-

scope has unquestionably this power; while it is more observable in other tenants of the waters.

In a walk on the shores of the ocean, when the heat of mid-day is past, and the refreshing sea-breeze invigorates the exhausted frame, many objects of interest claim our attention.



Sea-Anemone.

When, for instance, the retiring tide has left bare a cluster of weed-covered rocks, with little pools between, we are sure of finding something worthy of our scrutiny. What an interesting object is the sea-anemone, or the sea-sunflower, as it is sometimes called! The mouth is surrounded by several rows of arms, which

are capable of being expanded or contracted, or moved about, as may be required. When they are fully expanded, the appearance of the creature is very beautiful; and the effect is increased by the fine colors which these arms often assume, and which vary in different individuals.

These curious animals are endowed with the highest sensibility, contracting not only when touched, however delicately, but even when a dark cloud passes over the sky, as if apprehensive of impending danger from the light being suddenly obscured. The sea-anemone waits for its prey with expanded arms, its instruments of touch being ready to grapple it at the moment of contact. In clear water it may be watched thus engaged, and it is curious to see how the wandering crab, brought within its grasp, is seized, and how firmly it is held.

In the mollusks, or soft-bodied creatures, we detect a similar provision. Thus, from the body of the barnacle proceed two rows of stems, six in each row, and each of these stems supports two jointed arms, with hair-like appendages springing

from each joint, and forming a fringe along each little fiber.

The barnacle can protrude or retract these organs at pleasure, and move them about with great facility. It is by their means that the seizure of food is effected. The delicacy of touch possessed by them is extreme. They feel the contact of the smallest bodies, and infold them in their grasp.

A little mollusk, called the clio borealis, which is sometimes found near the coast of England, and which abounds on the Arctic Ocean, is entitled to special notice. It is not more than an inch in length. Its head is covered with a mantle, which can be retracted at pleasure, so as to expose the mouth, surrounded by three conical appendages on each side, like fleshy arms, which are instruments for taking prey. Examined by means of a microscope, each of these appendages is seen to be regularly and profusely covered with red points, which, when examined by a lens of great power, are found to be distinct transparent cylinders, covering about twenty minute suckers, capable of being protruded, and acting as organs for seizing and retaining prey. It has

been calculated that the total number of these suckers, on the head of a single clio, amounts to three hundred and sixty thousand, constituting a seizing apparatus, perhaps unparalleled in the animal creation. Besides these appendages the clio can protrude from its head, even when the mantle is closed, two slender horns or feelers, in order to ascertain the presence of food; and, apprised of it by this means, it prepares its instruments for securing its captives.

In general, fishes are not intended to exercise the sense of touch. That part of the surface which possesses the most acute feeling is the under side, where the coverings are the thinnest. The chief seat of the sense of touch, however, is the lip, or end of the snout, which is largely supplied with nerves; and perhaps the barbels, which, in some species, are appended to the mouth, may be subservient to this sense.

These instruments are remarkable for their length and power of motion in the fish called the angler, which is said to use them, while lurking in ambush, as a decoy to other fishes, that are enticed by their resemblance to worms. In its

appetite this creature is most voracious, and as it possesses but little power in its breast-fins, and is, therefore, not a rapid swimmer, we have here one of the instances of compensation, so often observable, by which the angler may obtain a sufficiency of food. The parts referred to appear on its head; they are two long, slender appendages, the first of them broad, and flattened towards the end, and having, at this part, a shining, silvery appearance.

These fibers are formed of bone covered by the common skin, and are curiously jointed at the base with the upper surface of the head. The first is joined by a process resembling two links of a chain, by which motion in any direction is obtained, no less than twenty-two muscles being provided for this purpose; the second is united in a different way, so that it appears only capable of being brought forward or backward. The soft parts are abundantly supplied with nerves, and thus serve as delicate organs of touch. The uses to which they are applied are singular. The fish, while keeping close to the ground, stirs up the sand or mud, by the action of its fins. Thus hidden

by the obscurity produced, it raises these fibers, moves them in various directions, by way of attraction as a bait, and the small fishes, approaching either to examine or to seize them, immediately become the prey of the angler. Fish of considerable size also prove equally acceptable.

In the time of the Romans, fishes were brought, to a remarkable degree, under the control of man; and it appears highly probable that the sense of touch, aided by that of sight, contributed to this result. In a pond belonging to the emperor Domitian, each fish is said to have come on its name being called. Plutarch describes this as being done by the lampreys of Marcus Crassus. It has been supposed, however, by M. Arderon, quite as probable that fishes in ponds, either by their feeling or sight, discovered the approach of their benefactors, whose coming they were accustomed to expect, as that they were sensible of their voices calling them.

Some experiments he made led to this conclusion. He had frequently struck with his thumbnail against the edge of a glass jar in which he kept two fishes. The stroke was not harder than

the beat of the pulse, yet it would cause them, in a moment, to dart from the bottom of the jar to the top; though he was sure they did not see him. But if he made the same motion, without hitting the glass, or if he made a hundred times louder noise than the striking of his nail against the glass, at a very small distance from it, he could not perceive that they were affected by it in the least degree. This certainly seems to show that a delicate power of feeling supplies them with a knowledge of the motion of bodies, when their other senses fail.

Serpents, from their structure, are endowed with great flexibility. The vertebral column of a snake consists of a series of bones beautifully united together; the head of each vertebra being received into a deep cup-like cavity of the succeeding one. Thus the animal is capable of twining in the most extraordinary manner, and in common with kindred creatures, is capable of grasping and twining round objects of almost any shape. Such a structure must be very favorable to the exercise of touch. It has been said of serpents, that their whole body is a hand, conferring some

Boomslange.

of the advantages of that instrument. The slender tongue is also used for the purposes of touch.

In those species of lizards which are enabled, by the structure of their feet, to clasp the branches of trees, as the gecko and the chameleon, and whose tails also are adapted for seizing objects, it must be supposed that the sense of touch is greater than in other reptiles, who have not such an advantage.

Insects are variously endowed with the sense of touch. Spiders, for instance, in constructing their webs must use their eyes in planning their frameworks, but they can not be guided by sight in the details. As the spinneret, from whence their threads are drawn, is situated behind, they must depend, in a great degree, on the delicate tact of this organ for the accuracy of their work. The claws, also, must have this sense in great perfection, for, in making the various rays, as well as the cross-lines of a web, the spider always guides the thread from the spinneret by one of its hind claws, which it can not possibly see, as all its eyes are placed forward on the head. The harvest spiders, which have only

two eyes, and do not spin webs, use their long legs not only to escape from enemies, and to pursue their prey, but to explore by touch the objects among which they travel. The chief organs of touch in insects, however, are the antennæ or fibers and palpi.

Antennæ and Palpi

In looking at birds, it might be supposed, from the scaly covering of their feet, and the feathered surface of the body, that they were not remarkable for the sense of touch. Yet, it is certain that they possess it in a high degree. In them it resides in the mouth, the bill, or the tongue, for which purpose there is a copious supply of nerves. In water-birds, and particularly in the duck-billed animal of Australia, this sense dwells

in the coverings of the expanded proboscis of the jaws, particularly the upper, where the nerves are also very abundant. Such a power must be of great importance, to enable them to detect, so easily and certainly, the food for which they have to grope in the mud and water.

The mole is provided with an elongated muzzle, which acts as an organ for seizing its food. In the seal, a long nerve proceeds from below the socket of the eye to be distributed to the projecting lips. This nerve is composed of forty branches or more. The whiskers on a cat's upper lip have frequently been noticed, but the importance of them in a state of nature, has not been as commonly perceived. They are, in fact, organs of touch. As they are attached to a bed of close glands under the skin, and each of these long and stiff hairs is connected with the nerves of the lip, the slightest contact of the whiskers with any object is thus distinctly felt, although the hairs are insensible.

The same provision is made for the lion. The whiskers stand out on each side of the animal as they do in the common cat; so that from point to

point they are equal to the width of the lion's body. Let this animal, stealing through a covert of wood in an imperfect light, pass before the eye of the mind, and the use of these hairs will at once appear. They indicate any obstacle to the passage of his body, and preventing the rustle of the boughs and leaves, which would give warning to his prey, enable him to move towards his victim with a remarkable stillness. In the rhinoceros the soft upper lip is used as the organ of touch.

Perhaps the most remarkable instrument of this kind among inferior creatures, is the proboscis of the elephant. Most admirable is the structure of this instrument. It is composed entirely of

Extremity of the Proboscis, showing the Finger and Thumb, with the Canals.

bundles of muscular fibers, disposed in order longitudinally and transversely, and enclosing two canals. These canals are for the purpose of

drawing up water, to be afterward discharged into the throat, or over the body at pleasure. They are, in fact, two self-acting syringes. The number of distinct muscles with which the trunk is furnished, each having its distinct action, is not far short of forty thousand. By their contraction or relaxation they are capable of drawing up, shooting out, or twisting in any direction the instrument they compose. The proboscis is terminated by a flexible prolongation of the muscles, not unlike a finger, and indeed usually so called, the end of the trunk being concave, the division between the two canals serving as a thumb, against which the finger can press so as to hold any small object with the greatest facility. With this instrument the elephant can pick up the smallest coin, or even a pin. How various and wondrous are the works of the glorious Creator!

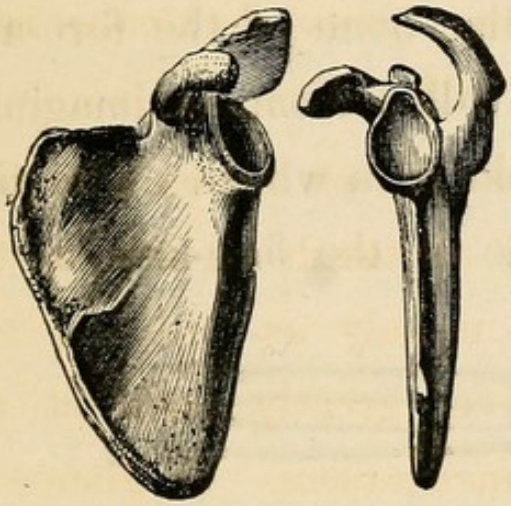
CHAPTER VII.

Parts of the Frame on which the Hand is dependent. — Bones of the Arm. — Radius and Ulna. — Cavities and Tubercles. — Bones of the Fingers. — The Thumb. — Muscles of the Hand. — Rapid Movements of the Hand. — Covering of the Hand. — Nails of the Fingers. — The Spider Monkey. — Nerves. — Paw of the Lion. — Value of the Hand. — Praise to God.

It is now desirable to enter on the examination of the principal organ of touch in man — the hand. To consider it merely as detached and separate, would, however, greatly contract the view of its admirable mechanism. A glance at those parts with which it is connected, and on which its power is so materially dependent, will therefore precede an account of its structure.

To begin with the bones of the shoulder, it may be remarked, that they give firm attachment to the upper extremity of the human frame, and supply origins to the muscles of the arm and fore-arm. The square form of the chest, and

the free use of the hand, are greatly owing to the clavicle, or collar bone, which runs across from the breast-bone to the top of the shoulder. The scapula, or shoulder-blade, is flat and triangular; it lies upon the ribs, and is cushioned with muscles. It shifts and revolves in its place with every movement of the arm. It has the



The Scapula, showing its Cavity.

Bone of the Upper Arm, showing the Ball, to fit the Cavity of the Scapula.

power of moving upwards, downwards, backwards, and forwards; and when these motions succeed rapidly, the arm is rotated.

The upper arm consists of a single bone. The

head is hemispherical, standing obliquely backward from the bone; and when received into a cavity with which the scapula is provided, a ball-and-socket joint is formed. In this there is a provision for the rotating or rolling movement of the arm-bone, as it is called, on the scapula. In other cases, the wrist has a finer and easier rolling, but this is from the motion of two other bones, the radius on the ulna.

The radius, or smaller bone of the fore-arm, is supposed to be so called from its imaginary resemblance to the spoke of a wheel. The ulna is placed on the inside of the fore-arm by the

The Radius and the Ulna, showing their Tubercles and Cavities.

side of the radius. The upper extremity is large, and scooped out in front, forming a cavity which unites with the base of the bone forming the upper arm. There is a smaller cavity for the head of the radius. Here, then, we observe a beautiful contrivance. That there may be a perfect use of the arm, two motions are wanted:

one at the elbow, backward and forward, like a hinge-joint; and a rotating motion, by which the palm of the hand may be turned up at pleasure. How, then, is this power secured? Most simply and admirably. The two bones of the fore-arm lie along side each other, and touch only toward the ends. Only one of them is joined to the upper arm, at the elbow; the other only to the hand, at the wrist. The former, by means of a hinge-joint at the elbow, swings backward and forward, carrying with it the whole fore-arm. As often, too, as there is occasion to turn the palm upward, the latter bone rolls upon the other, by the help of a cavity near each end of one bone, to which there is a corresponding projection in the other. If both bones had been joined to the upper arm at the elbow, or both to the hand at the wrist, these motions could not have been made. But, as the first is free at one end, and the second at the other, the two actions may be performed together. The bone which carries the fore-arm may be swinging on its hinge at the elbow at the very time that the lesser bone, which car-

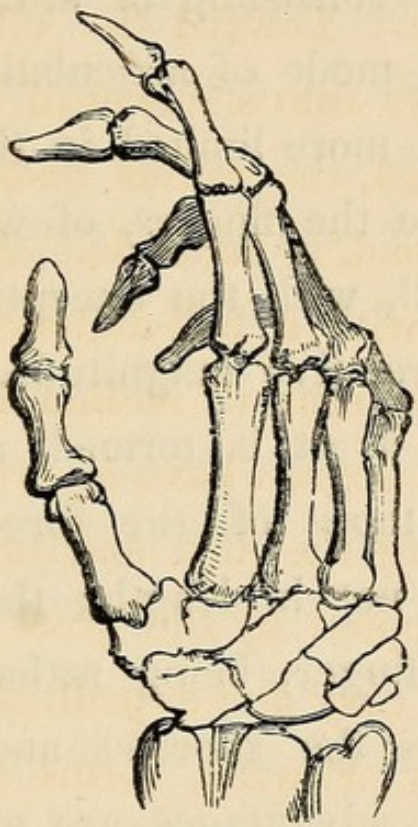
ries the hand, may be turning round it in the cavities.

The cavities, and the projections or heads of the bones which play in them, are equally entitled to notice. Toward the elbow, a head of the radius plays into a socket of the ulna; while toward the wrist, the radius finds the socket, and the ulna the head, or tubercle. A single bone in the fore-arm, with a ball-and-socket-joint at the elbow, which admits of motion in all directions, might, in some degree, have answered the purpose both of moving the arm and turning the hand. The mode adopted by the great Creator is, however, far more easy and expeditious.

The carpus, or wrist, forms the base of the hand, and is joined to the bones of the fore-arm. It is composed, as may be seen in the engraving, of eight small bones, compacted together, with none, or with little motion among each other, and thus constitutes a solid mass. The hand comprehends all, from the joint of the wrist to the tips of the fingers. At the back part, it is convex, for greater firmness and strength; and it is concave before, for contain-

ing more surely and conveniently such bodies as it can hold.

The orderly disposition of the bones of the fingers into three rows, has led to their being



Back View of the Skeleton of the Hand.

called the three phalanges, into which each finger is divided; the whole resembling, in some degree, the martial phalanx of the Greeks. The first of these phalanges of each finger is united to its corresponding part by a simple joint, or articulation, which admits only of the hinge-like motion of bending and extension. To this first

row succeeds a second, consisting of smaller bones, but of a similar character, that of each finger being united to the previous one by a simple hinge-like joint. Next succeeds the third and last row, consisting of still smaller bones, with a similar mode of articulation, but less independent, and more limited in their movements. Such, then, are the fingers, of which the bones are alike in all, with the exception of a difference in their relative magnitude. Those of the middle finger, as it is termed, are the longest and largest; those of the fore-finger next in thickness, but not in length; the bones of the ring, or third finger, being rather longer. The little finger has the shortest and most slender bones. Many advantages are owing to the division of the fingers. Suppose they were one and undivided, or that the delicate power of touch resided only in one, we should lose all the aid which, in the exercise of this faculty, they mutually give and receive.

The thumb is situated obliquely, as it respects the fingers. It is neither directly opposite to them, nor in the same plane with them, but

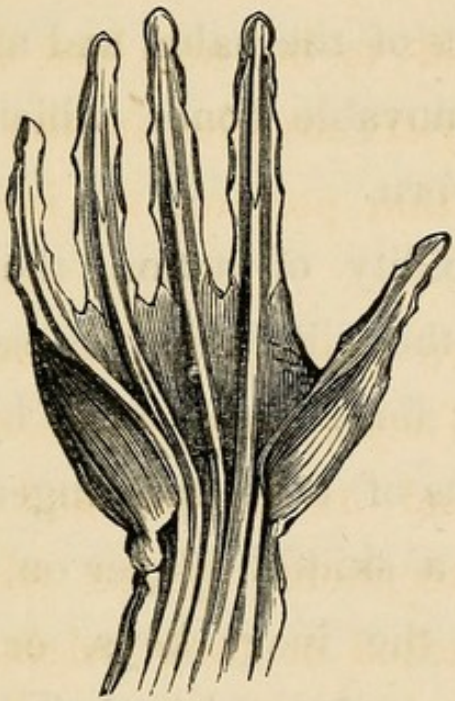
capable of being brought to bear on all, or each separately. As it is designed to maintain a counteracting agency against the fingers, its bones are necessarily thick and strong in proportion to their length. They are three in number: the first is joined with a bone of the wrist, so as to admit of but a limited degree of motion; strength and firmness being aimed at. The second bone is stout and short, and has a large base formed into an oblong cavity for its union with the preceding. The joint thus formed is especially strong and secure, but more confined and less expeditious than hinge-like joints in general. The third and last bone arises also from a base of great extent, hollowed into two cavities, into which fit pulley-like projections of the preceding bone, forming by this mode of union a joint of great strength and tolerable freedom.

With these bones are connected various muscles. A muscle consists of minute threads bundled together. They are placed close and parallel to each other. They are much the same in shape, size, and general appearance. Consisting only of a tender pulp, they are still solid.

The threads, which appear to the naked eye to be single, are shown by the microscope to divide successively into others still smaller. The minutest are supposed not to exceed the forty-thousandth part of an inch in diameter. Thus innumerable fibers are joined together to form one muscle, every one being a distinct organ. There are said to be not less than four hundred and thirty-six muscles in the human frame, besides those that perform the internal vital motions.

Muscles are throughout the body the agents of motion. They have a marvelous property of contraction and relaxation, and are governed, with some exceptions, by the will. They are generally attached at their origin to one bone, and are inserted into that upon which they are to act by tendons, or small cords, of greater or less magnitude and length; at least, such is the case with the muscles of the limbs. It is by these agents that the hand is closed and opened, and that each finger is moved; and it is by their firmer or slighter contraction that the pressure of the grasp is regulated.

The principal flexor and extensor muscles of the hand, or those used for bending or extending, are situated in the fore-arm, of which they constitute the fleshy portion. Their tendons may be easily seen at the wrist, where they pass beneath a band, or ligament, which binds them in their



Muscles of the Hand.

place as they proceed to their different points of insertion. The flexor muscles are situated on the inside, the extensor muscles on the back of the arm; and the tendons of the latter are seen on the back of the hand, passing to each finger. These two sets of muscles have, of course, a con-

trary action. When the flexors close the hand, the extensors are relaxed, and *vice versa.* Besides the muscles of the fore-arm, there are on the palm a number of accessory muscles, flexors of the fingers, and especially of the thumb; and also abductors and adductors, muscles to separate and draw together the fingers. These arise from the fixed bones of the palm, and are inserted into the relative movable bones which they are appointed to govern.

Of the rapidity of action, the precision, the obedience to the will, which these muscles display, we may form some idea by attending to the movements of our own fingers, by watching the hands of a skillful player on the piano-forte running over the ivory keys, or by observing other movements, in which the rapidity secured is truly surprising. The muscular machinery by which the hand and its fingers are moved is well adapted to bring before the eye of the mind that great Being, whose skill is throughout his works so strikingly apparent. The individual who can consider this beautiful apparatus without feelings of profound admiration, and without the

offering of a glowing tribute to the adorable Creator, must be insensible indeed.

The covering of the hand is very remarkable. It is a tissue of cellular structure, nerves, arteries, veins, and other vessels, over which is spread the network of the true skin. But this is not left alone; it is guarded by that thin, transparent membrane called the cuticle, or epidermis, — the same which is detached in blistering or by scalding water. The cuticle is thicker on the palm of the hand than the back of it, as if it were designed to lessen the sensitiveness of that part. This is commonly desirable, and, indeed, in the hands of those who lead a life of toil, it becomes hard, thickened, and almost horny. This state is, however, attended by a lessening of the liveliness and accuracy of impression. Hence arises a want of adroitness, and of the power of regulating the pressure of the fingers in the holding of slight and fragile bodies, which, in such hands, are seen to suffer.

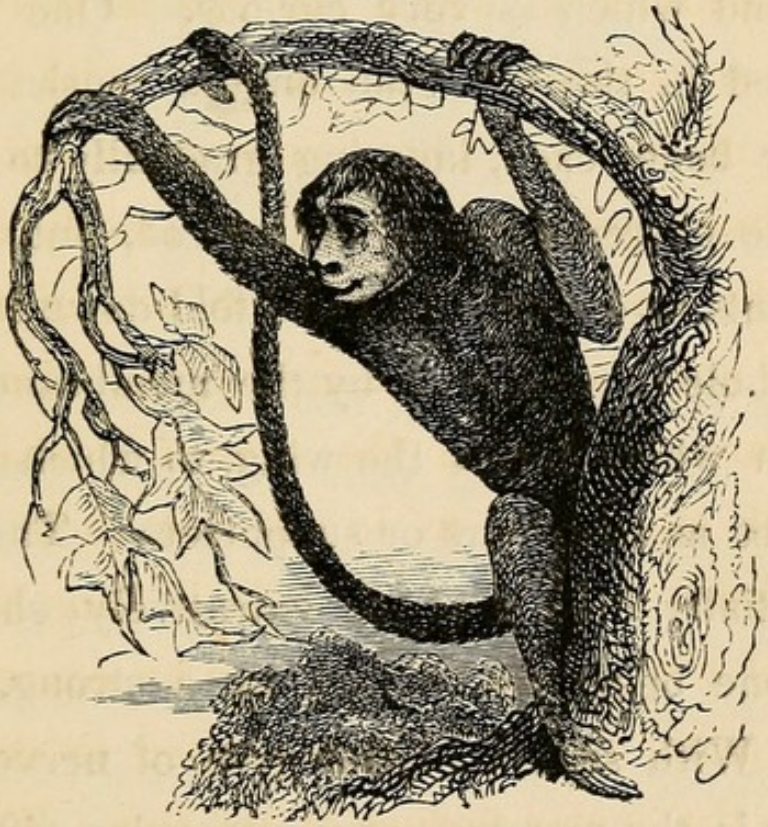
If, however, there appears in one sense an imperfection, there is no less clearly a wise and kind law of Providence, by which the laborer and the

artisan are fitted for their daily and useful toil. Were the hands of the farmer or the mechanic tenderly susceptible of every impression, he would be in constant pain, and be restrained by fear from pursuing his rugged work; but early use has accustomed and hardened them to labor; he grasps the axe, the spade, or the plough, with indifference; handles the iron at a heat which by others could not be endured; or thrusts his hand among the rough briers and thorns of the thicket or hedge-row with impunity.

The manner in which the tips of the several fingers are defended on the back with nails, is worthy of notice. These nails grow out of the skin from a pulpy root; and are closely attached to the fingers. They appear to be designed not only as a defense against injury, but also to act as a barrier between the nerves beneath and external objects, so as to prevent their receiving definite impressions. This is done that the whole of the nervous touch may be concentrated at the point expressly appropriated to that purpose, — the under surface of the tips. The nails are intended also for other purposes. Man is

designed to make use of various instruments for the accomplishment of his purposes. The talon of the lion, the scraper of the mole, the hoof of the horse, and the delicate nail of the human hand, are all indications of the same organ, each being fashioned according to the use for which it is intended.

As the sense of touch, so refined and delicate in man, as a means by which ideas are acquired, is not wanted by other creatures, so among them it is not found in perfection. The hands of the



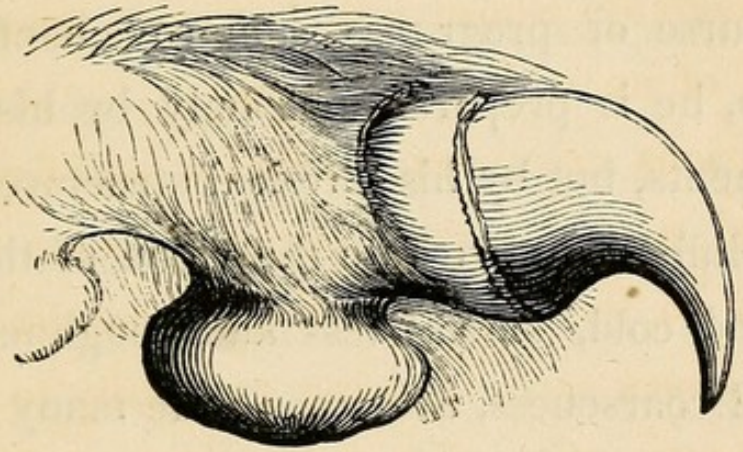
The Spider Monkey

monkey, for instance, are rather to be regarded as hook-like in action, the pressure of the fingers, with which the thumb concurs, being directed against the solid under part of the palm. In their case, the thumb is of little importance; in some instances, it is altogether rudimentary, or, to speak familiarly, the mere root of a thumb, and in others entirely wanting. It is so with the spider-monkey, whose tail, however, answers the purpose of an additional hand.

In various creatures, we find a modification of the hand which is very curious. One may be observed in the bat: the fingers consist of two slender bones each, tapering gradually to a point, like the extremity of a fishing-rod, and having the joints so constructed as to fold down laterally. The whole is connected by the membraneous expansion which forms the wing, to which the fingers act as stretchers or supporters. The thumb is partially free, and comparatively short, the last bone being terminated by a strong, hooked claw. With such a high degree of nervous sensibility is the membraneous expansion gifted, that the wing is not only an apparatus for flight, but

an organ of sensation, capable of detecting changes in the atmosphere, and of aiding the bat in its course.

To mention only one other case, the paw of the lion consists of four fingers and a thumb, which does not, however, possess the property of meeting or antagonizing with the fingers. The



Paw of the Lion.

last joint alone has much freedom of motion; the terminating bone of each finger being armed with a talon. The talons can be drawn back into sheaths, so that the point of each only just peeps out, being hid beneath the fur, and raised above the ground by a pulpy pad below. Thus the lion at play with his mate or his cubs uses an unarmed paw; but when he strikes in anger, the toe ap-

pears with the claw unsheathed, as will be seen in the sketch.

The paw of the cat is similar to that of the lion.

Inferior creatures are perfectly adapted to the circumstances in which they are placed; but knowledge is not their sphere. Their wants and desires are merely animal. Man, on the contrary, is intended to acquire knowledge, and to advance in a course of progressive improvement. And for this, he is prepared not only by his mental endowments, but by his physical structure.

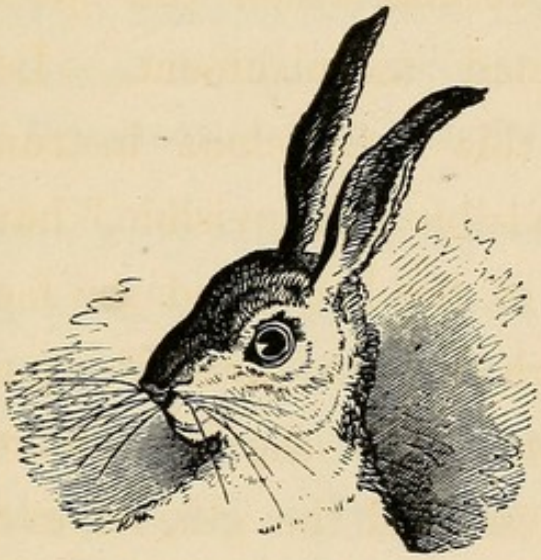
It is difficult to overrate the value of the hand. Heat and cold, smoothness and roughness, fineness and coarseness, are among the many sensible qualities of matter it enables us to recognize. This power depends on the nerves, with which the hand is abundantly supplied. These wondrous fibers, too delicate for the anatomist to trace beyond a certain point, form a net-work which is minute beyond conception, so that the finest instrument can not puncture the skin without producing pain. This nervous tissue is especially provided for the pulpy tips of the fingers, and hence we find there the actual sense of touch. It

is well known that, by applying the tips of the fingers to various bodies, the most distinct impressions are obtained. Alluding to the hands, Quintilian says: "Other parts of the frame assist the speaker, but these, as I may say, speak themselves. By them we ask, we promise, we invoke, we dismiss, we threaten, we entreat, we deprecate; we express fear, joy, grief, our doubts, our assent; we show moderation, profusion; we mark number and time."

In the absence of this faculty, a formidable barrier would be raised to human improvement. All that knowledge which depends on the exquisite power of discernment of the fingers would then be unknown. We should be effectually shut out from all those performances and arts which depend on the nice and delicate use of the hand. We should be unable to use with any skill the pen, the pencil, or the engraving tool. What would then be the products of the loom, the structure of our machinery, or the furniture and utensils of our dwellings? Our condition would indeed be comparatively helpless — that, indeed, of abject barbarism.

With what gratitude, then, should we ever regard this bestowment of a gracious God! It is difficult to conceive how inferior our circumstances would have been had there been a different termination of the fore-arm to that which has been wisely appointed. What the hand is not equal to, as desirable to be possessed, it can fashion, under the guidance of the mind, and thus attain results which the spectator beholds with unfeigned astonishment. Let, then, the Creator of this marvelous instrument, and of "all things visible and invisible," have the praise. The powers of the body, and the faculties of the soul by which they are directed, should be consecrated to him. On the altar which sanctifieth both the giver and the gift, let every reader be concerned to present them. Whatever has been the guilt accumulated, salvation may be sought through the Lamb that was slain. "The blood of Jesus Christ, the Son of God, cleanseth from all sin."

HEARING.



EARS OF THE HARE.

HEARING.

CHAPTER VIII.

Sound. — Air a Medium of Sound. — Sound conveyed by Solid Bodies. — Sonorous Bodies. — Vibrations. — External Structure of the Ear. — Internal Structure. — The Bones. — Tympanum. — The Labyrinth and Cochlea.

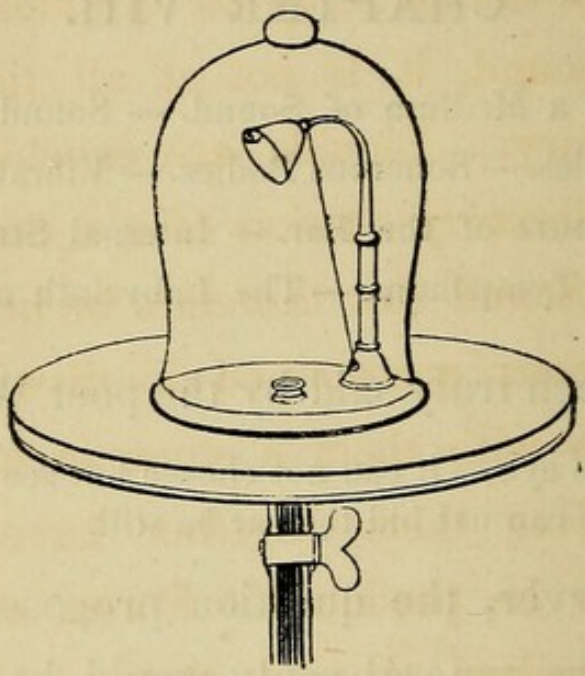
It has been truly said by the poet Wordsworth:

> The eye — it can not choose but see;
> We can not bid the ear be still.

Were, however, the question proposed, What do we hear? the general reply would be, "Sounds." Yet this, as will presently be seen, would not be accurate.

Sound is commonly supposed to be produced by solid bodies. We are all familiar with the voices of animals, the ringing of bells, and the notes produced by musical instruments; but these are merely the means employed. They are, it is true, solid bodies, but did they act alone

there would be no sound; this can only be produced by their giving a tremulous motion to the air. This may be proved by experiment. For instance, if a bell be struck in the air, we are aware of the circumstance by the sound it gives forth. But if the bell be placed under the re-



Bell in a Receiver.

ceiver of an air-pump, and the air be exhausted, the hammer may strike, but there will be no sound. And why? Because there is no air to receive or transmit the vibrations of the bell. If, however, air is gradually admitted, as it may be, into the receiver, by turning the valve below the plate, and the hammer be made to strike,

the usual sound of the bell will be heard. Here the fact is placed beyond all doubt; it is clear that the glass was not the cause of obstructing the sound, for it remains as it did when the sound was heard; the air, then, is necessary, in this case, to the production of sound.

But, though the air is by far the most common medium of sound, it is not at all times absolutely necessary. Liquids are capable of conveying the vibratory motion of a sonorous body to the ear. Sound can therefore be heard under water. Persons accustomed to dive have frequently taken with them a stone in each hand, and on rubbing them together have found a loud noise to be produced. Force, or motion, is thus transmitted through water, and fish are sometimes caught from a knowledge of this fact. When the smaller lakes and rivers of Lapland or Siberia are completely frozen over, the hardy peasant watches attentively on their banks. As soon as he perceives, through the clear ice, a fish, perhaps at a considerable depth, but lying close to the bottom, he strikes a smart blow against the firm surface. The result is remark-

able: the impulse sent through the water instantly stuns or kills the prey, as if the blow had been struck without an intervening medium, and the fish is drawn up by a hook let down through a hole made in the ice.

Another curious fact, illustrative of the power of solid bodies to convey sound, may here be mentioned. A gentleman, who had nearly lost the ability to hear, was sitting one day near a piano, while some one was playing, and found that as his pipe rested on the body of the instrument he could distinctly hear all its notes. This suggested various experiments. He soon learned, in consequence, by means of a piece of hard wood, one end of which he placed against his teeth, while another person placed the opposite end on his teeth, to keep up a conversation, and to be able to understand even the least whisper. In this way, two persons who have stopped their ears may converse with each other, when they hold a long stick between their teeth, or rest their teeth against it.

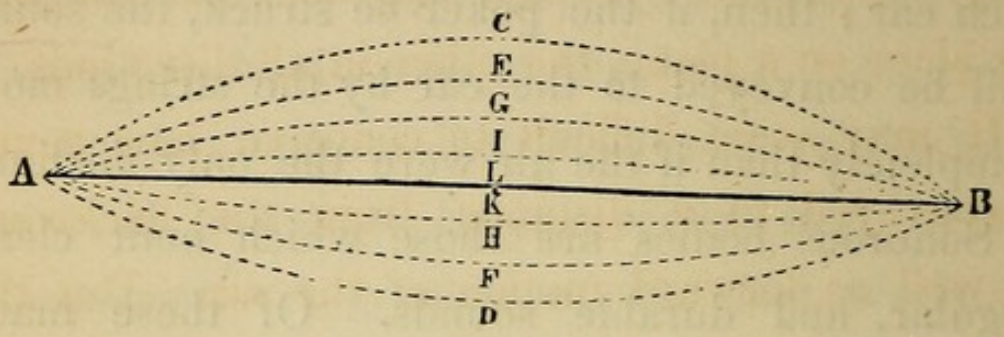
A very simple experiment, equally conclusive, may be tried by any one. Let a string be

fastened by the middle round a poker, and the poker be raised from the ground by the two ends of the string, and one of these he held to each ear; then, if the poker be struck, the sound will be conveyed to the ear by the strings more completely than if the air were the only medium.

Sonorous bodies are those which emit clear, regular, and durable sounds. Of these many examples will instantly come to mind, as drums, trumpets, and stringed instruments. These, and similar bodies, are sonorous, because they are elastic. When an elastic body is struck, it not only returns to its former place, but, gaining momentum, or force, it springs out, like a pendulum, to the opposite side. If, for instance, a thin plate of tempered steel have one of its ends fixed and the other drawn a little aside, then, as soon as the force is removed by which the plate is bent, the plate commences a series of vibrations, which become smaller and smaller, until the plate is again at rest.

To take another example. If a string, A, B, be made fast at both ends, and then pulled to C, it will not only return to its original position,

but proceed onward to D. At the end of this its first vibration, it will retain sufficient force to bring it to E, and back again to F. The third



Vibrations of a String.

vibration will carry it only to G, and so on through the lessening distances, H, I, K, till motion is destroyed by the resistance of the air, and it regains it original position, L.

The vibration of a sonorous body gives to the air a tremulous motion. This is similar to that communicated to smooth water, by throwing in it a stone. A small circular wave is first produced round the spot in which the stone falls. The wave then spreads, and gradually communicates its motion to the neighboring waters, thus producing similar waves to a considerable extent. The motion of a sonorous body produces in the air the same kind of waves, but with some difference. As air is an elastic fluid,

the motion does not consist of regularly extending waves, but of vibrations, moving forward and backward, similar to those of a sonorous body. Another difference appears; the one taking place on a plane, the other in all directions.

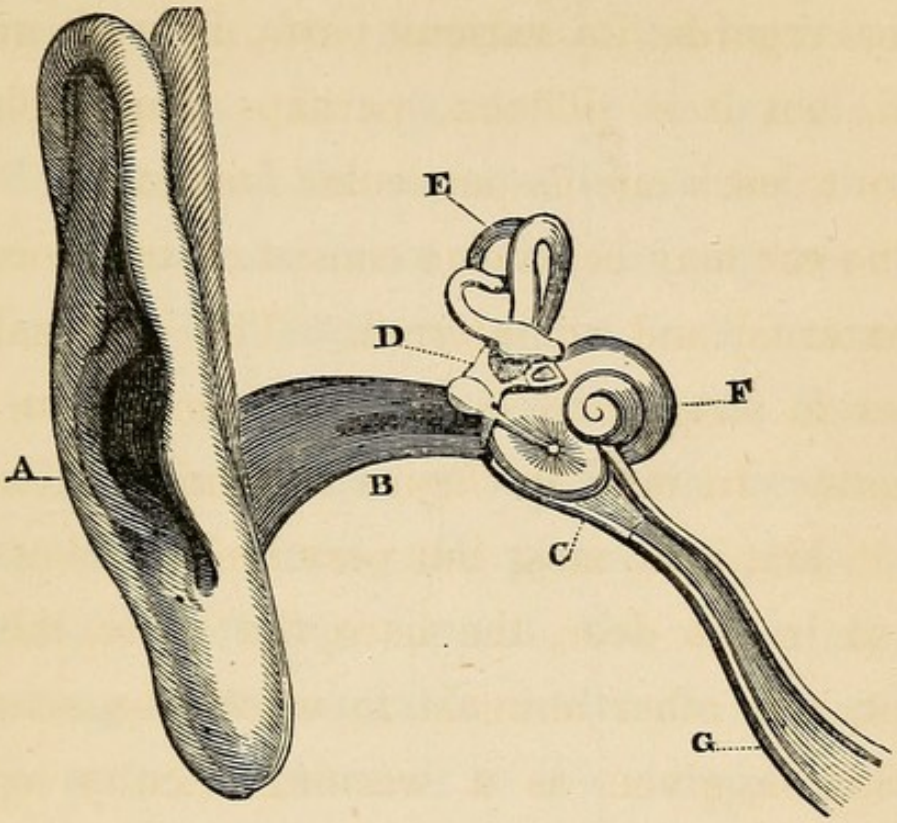
It may seem difficult to conceive how sound is conveyed to a distance from the backward as well as forward motion of the air. But the first sphere of undulations, produced immediately round the sonorous body, condenses the air, and this, though impelled forward by the pressure, reacts on the first set of undulations, driving them back again. The second set put in motion also give their motion, and are driven back, in like manner, by reaction. Thus a succession of waves occurs in the air, like that of waves in the water. The vibrations of sound extend much farther than the undulations of the water, from the elasticity of the air.

With these facts before the mind, in reference to sound, how may the ear be described? Simply as an organ so constituted as to feel and appreciate the vibrations produced among the particles of the atmospheric fluid; and it is this which

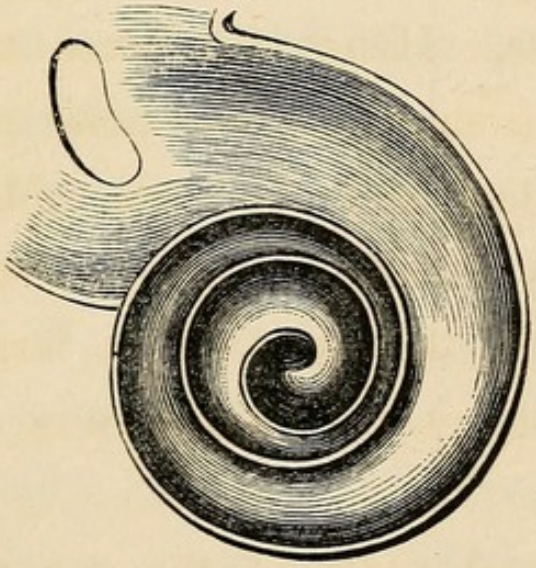
we call hearing. The structure of this organ, so far as regards its various parts, is well understood, but it is difficult, perhaps impossible, to assign to each one its particular function.

The ear may be said to consist of two portions, an external and an internal. The external ear varies in shape and in power of motion in most animals. In man, its figure is familiar; its motion in him is at most but very limited; but it is not so in the deer, the hare, the horse, the elephant, and other animals, to whom the sense of hearing is given as a warning faculty against the approach of enemies. The use of this part seems to be that of collecting and concentrating the vibrating currents of air proceeding from certain points. Hence the horse turns his ear to the side from which the noise proceeds, and so do the deer and the hare. Many animals have a very small external ear, some none at all. In birds, the aperture is large, and protected by feathers. Fishes have no external ear nor orifice.

The internal parts of the ear are the most important, as actually constituting the essential



Internal Structure of the Ear



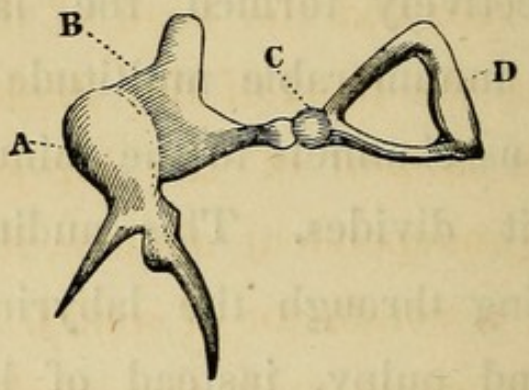
Section of Cochlea, (enlarged.)

organ. They consist, in quadrupeds, of cavities hollowed out in the substance of the hardest bone of the skeleton. In a portion of the temple bone is a fluid, termed the water of Cotunnius, through which the minute fibers of the auditory nerve are dispersed. The auditory nerve is a branch of the seventh pair, which takes its rise from the under surface or base of the fourth ventricle or cavity of the brain. It penetrates into these cavities, collectively termed the labyrinth, by traversing an innumerable multitude of openings, which serve as channels to the minute filaments into which it divides. This auditory branch, when spreading through the labyrinth, becomes there soft and pulpy, instead of being in the form of a firm cord, as the other portions of this and most other nerves become.

The internal structure of the ear will be best understood from the figure on the opposite page. A is the external ear, or conch; from this a tube, or canal, B, (meatus auditorius,) proceeds internally, in a curved direction, and is terminated by a ring, into which is fixed a membrane, (membrana tympani,) C, stretched

over a shallow cavity, termed the tympanum, as the parchment is stretched over the head of a drum. In this cavity are situated four little bones, D, but which are respectively named malleus, or the mallet; incus, or the anvil; os orbiculare, or the spherical bone; and stapes, or the stirrup.

The first and largest bone is the malleus, A; it consists of a head and two projections, of which



Magnified Representation of the Four little Bones.

the longest is connected with the temple bone. Immediately below the head, we find two minute muscles inserted; one for relaxing, and called the laxator tympani; the other, tensor tympani, for tightening, the membraneous expansion, or membrana tympani; by the head, it is united to the incus, B. The principal use of this bone is to act as a lever, for enabling the muscles attached

to it to increase or diminish the tension of the membrana tympani, and thus modify the impulses of the air which strike upon that membrane. Like the succeeding bones, it contributes materially to communicate the vibrations, caused by the impulses of the air upon the membrana tympani, so as to continue them towards the most internal cavities.

The second bone is the incus, B; into a hollow in its body is received the head of the malleus, which plays, as the head of the thigh-bone does, in the cup-like hollow of the hip-joints. The incus has little independent motion; its chief use seems to be as a conductor of sound. The third bone, or os orbiculare, C, is the smallest of all; in shape, it is nearly round; it serves as the link of communication with the fourth or last bone, the stapes, D. This singular bone is in shape a close resemblance of a stirrup (whence its name); by its point it is united to the os orbiculare, and its foot fills up the oval entrance into the labyrinth. Its use is to communicate the impulses of the air, through this oval entrance, to the labyrinth. It is, however, at the same

time, the most essential of these little bones; as it has been remarked that, while it remains, though the other bones have been destroyed, the hearing is not entirely lost, and may even be improved by time.

Thus are these four bones arranged in the cavity of the tympanum. But there is another circumstance connected with the tympanum which must not be passed by. From its floor, or lower part, a tube, bony at its commencement, and cartilaginous in its remaining length, takes its rise, and terminates in the back of the mouth, at the side of the soft palate. It is termed the eustachian tube (see G, p. 128). By this tube, the air is admitted into the cavity; and hence persons who are dull of hearing are observed to listen to a speaker with open mouths, so that the little bones of the ear may be acted on as freely as possible by the uninterrupted impulses of the air, and this they do habitually and unconsciously. Dr. Paley observes, that the eustachian tube answers the same purpose as the hole in a drum; that it would not, for example, have done to have made this cavity a vacuum, as the pres-

sure of the external air would then be liable to burst the membrane. Nor yet would it have answered the purpose to have made it enclose a confined volume of air, which, by contracting and expanding, according to temperature, would have contracted and expanded that membrane, so as to have prevented the due performance of its duties. As, however, air is required within the cavity, so by this safety-pipe every evil is avoided.

How beautifully has God arranged every part of our system so as to conduce to our comfort, happiness, and safety! Thus it is seen that there is a chain of bones communicating from the membrana tympani, or vibratory membrane of the tympanum, to the labyrinth, in the complex and winding cavities of which the pulpy nerves of hearing are distributed. Still further, it is manifest that this chain is the conductor of the impulses of the external air, directed upon this membrane, which the first bone, by some secret law, is appointed also to brace, or relax, according to the modifications of these impulses.

On referring to page 128 it will be perceived

that the labyrinth is represented with the membrana tympani and small bones; but the representation of the labyrinth is to be considered in the light of an outline of the cast of the cavities of that part, and not of the cavities themselves. With this caution, it may be remarked, that the labyrinth consists of three parts; the semicircular canals, the vestibule, and the cochlea.

The semicircular canals, E, are three in number, each of them opening into the vestibule at both extremities. They are lined with a very fine membrane.

The vestibule is between the semicircular canals and the cochlea. It is a chamber with several openings, one termed the fenestra ovalis, or oval window, already noticed as leading from the tympanum, and covered by the foot of the stapes, or stirrup-bone. Besides this, and the openings leading into the semicircular canals, it has also another, which leads to the cochlea, F; besides minute channels for the transmission of nervous filaments. The cochlea is a double spiral cavity, resembling the inside of the shell of a snail, or periwinkle; or it may be considered

as a tube revolving round a hollow conical axis. The cavities thus formed are filled with a peculiar fluid.

Who, that has proceeded thus far, is not impressed with the admirable completeness of an organ to which we are so much and so constantly indebted? Well might Cowper say, in one of his letters, "It strikes me as a very observable instance of providential kindness to man, that such an exact accordance has been contrived between his ear and the sounds with which, at least in a rural situation, it is almost every moment visited. All the world is sensible of the uncomfortable effect that certain sounds have upon the nerves, and consequently upon the spirits; and if a sinful world had been filled with such as would have curdled the blood, and made the sense of hearing a perpetual inconvenience, I do not know that we should have had a right to complain. But now the fields, the woods, and the gardens, have each their concerts, and the ear of man is for ever regaled by creatures, who, while they please themselves, at the same time delight him." As

we wonder at the perfection of the ear, its adaptation to the wants of man, we call to mind the words of the Bible: "The hearing ear and the seeing eye, the *Lord* hath made even both of them."

CHAPTER IX.

The Sense of Hearing in Inferior Animals. — Sense of Hearing in Reptiles. — Snake Charmers. — Ear of the Common Barn Owl. — Hearing in Mammalia. — The Long-eared Bat. — Ears of the Horse. — Special Provision for the Whale. — The Human Ear. — Musical Sound. — Velocity of Sound. — Extraordinary Echo. — Echo Lake. — Faith cometh by Hearing.

A FEW remarks are now desirable on the sense of hearing in inferior creatures. Of the organs for this purpose in insects, we know very little. That they are able to receive sounds, is evident from many tribes being capable of producing audible noises, by which they communicate. There seems reason to conclude that the power of hearing is, in some way or other, connected with the antennæ, or horns.

A distinct apparatus for hearing is found, for the first time, among creatures inferior to man, in the higher crustacea. Here, however, it is extremely simple. The ears of the lobster are

situated on the under surface of the first joints of the second pair of antennæ, or feelers. The attentive observer may find a prominent tubercle formed by its shell, the top of which has a small circular opening, covered with a tightly-drawn membrane. Behind this opening is placed a small vessel filled with fluid, on which a delicate nerve is distributed. By this simple structure the effect is produced. The vibration of the water strikes on the outer membrane, the fluid just mentioned partakes of the tremor, and the nerve conveys the sensation thus produced to the brain.

Some persons have considered that fishes have no sense of hearing; but this appears to be erroneous. The internal structure may be observed most clearly in the various species of skate. The Chinese breed large quantities of gold fish, and call them to their food by means of a whistle. Sir Joseph Banks used, by sounding a bell, to collect his fish. Carew, who wrote the history of Cornwall, made a noise with two sticks when he wished to feed those he had. A friend of the writer's has mentioned to him a similar instance. A fish kept in a pond was accustomed to make

his appearance when called. In some cases, however, it seems reasonable to conclude that the sense of touch may contribute to such results.

On attentive examination, reptiles show a higher form of the organ of hearing than fishes. The latter, being designed to hear sounds conveyed by the water, have only a membraneous labyrinth, enclosed in the cavity of the skull, and without communicating with the exterior of the body. Reptiles, on the contrary, living in air, must be enabled to appreciate its sonorous vibrations, and have therefore organs which are affected by sounds of far greater delicacy. Among these are detected, for the first time, as we ascend in the series of animated nature, a tympanic cavity, and a membraneous drum.

A considerable variation of the power of hearing appears in different groups. In tortoises and some other creatures, it appears to be dull; but in lizards it seems to be otherwise. Thus, it is said, there are lizards in the West Indies, often caught by boys, who take advantage of their fondness for musical sounds to arrest their attention, and then throw a little noose over their heads as they perch

in a listening attitude on the branches of the trees. In serpents this sense is very acute, and these animals evidently derive pleasure from musical notes. Of this the persons called serpent-catchers, or charmers, who practice chiefly on the species called cobras, are fully aware.

They pretend to draw these reptiles from their holes by a song, and by an instrument somewhat resembling an Irish bagpipe, on which they play a plaintive tune. That music has power over them there is reason to believe. One gentleman describes the efforts of a snake-catcher, who had been sent for to capture a cobra, which some persons had in vain attempted to kill. He had in his hands, when he arrived, two baskets; one containing tame snakes, the other empty. These and his musical pipe were the only things he brought; and he was required to leave his two baskets at some distance, and to ascend a high green mound, having only his pipe. As he began to play, the cobra, coiled up in a hole, came out gradually and slowly. When it was within reach, the snake-catcher seized it dexterously by the tail, and held it at arm's length, while the

cobra, enraged, darted its head in all directions, but in vain. Thus suspended, it has not the power to raise itself, so as to seize hold of its tormentor. In these exertions it became exhausted, when the snake-catcher descended the bank, dropped the creature into the empty basket, and closed the lid. He then began to play, and shortly after raised the basket-lid. The cobra darted about wildly, and tried to escape. The lid was shut down again quickly, the music being still played. This was repeated two or three times, and in a very short interval, the lid being raised, the cobra sat on its tail, opened its hood, and danced as quietly as the tame snakes in the other basket; nor did it again attempt an escape.

In the crocodile, the external opening, instead of being closed, as in some other reptiles, has a firm, hard, movable lid, by which the aperture may be either opened or stopped. Thus, while basking on the margin of the river, or lying there in ambush, it has the power of raising the ear-lid to catch any sound; but when it dives under water, it closes the opening by this means.

The organ of hearing in a bird is nearly the

same in its structure as that of one of the more perfect reptiles, such as the crocodile. There is still no external ear; yet, in a few rare instances, such as the bustard, the feathers are so arranged around the ear as to collect faint impressions of sound. The ears of owls are highly susceptible. The cavities within the skull are of unusual size, and the outer opening is very large. It is concealed between two extensive and membraneous valves, from the edges of which proceed the feathers which form the outer rim of the disc which encircles the face. The leaves of this double valve can be thrown apart, so as not only to admit freely, but to concentrate every slight vibration of the air. The effect is also increased by the widely-diffused cavities connected with the mechanism within. Here is preparation for its pursuit of prey. During the day, the owls remain in their retreat, with their eyes half-closed; but at night, as they go forth to the chase, the eyes are fully expanded, and the power of hearing is equally vigorous and active. No noise escapes that sense; the faintest sound is caught,—even the cry of the mouse, or its rustle in the straw.

In ascending from these creatures to the mammalia, we observe an increase of power. One remarkable difference appears in the increased complexity of the cochlea. Another, that is observable in the tympanic cavity, is still more remarkable. In the instances now referred to, it is very large, and communicates freely, by means of the eustachian tube, with the throat. Other points of superiority will reward the observations of an attentive student.

The Head of the Long-eared Bat.

One of the most common kind of bats is that which is remarkable for its long ears. These are beautifully transparent, and are thrown by the

animal at pleasure into elegant curves. They are usually folded under the arm during sleep, especially if it be profound. It is said that a person who had not seen it in the act of folding its ears could never imagine it to be the same species when they are fully expanded.

The sense of hearing in many quadrupeds is particularly keen, and seems to be given especially to the herb-eating tribes. The elk, though not remarkably swift, avoids its enemies by its acute sense of sound. A similar power, it is well known, is possessed by the stag. The chamois and the antelope are still more highly gifted than either of these creatures. With the power of hearing in hares and rabbits we are all acquainted. The ears of the horse demand particular notice. The interior of the external ear is covered with long hair, which stands across the passage in every direction: this is to defend the ear from insects, which can only penetrate it with great difficulty. Cold air is also prevented from reaching the interior of the ear, and the sound is moderated, penetrating readily, but not violently, so as not to injure the membrane which covers

the drum. The hearing of the horse is very acute. He attends to many vibrations of the air, far too slight to impress the human ear. He catches the cry of the hounds a considerable time before his rider becomes aware of the slightest sound. How absurd and cruel is the practice of cropping this part! In itself it is perfect; to cut is to mutilate one of the most beautiful parts of these animals. It is more intelligible than the eye; and an attentive observer can tell, it is said, "by the expressive motion of the ears, almost all the horse thinks and means."

It is considered that ears rather small than large, placed not too far apart, and erect as well as quick in motion, show both breeding and spirit. If a horse is in the habit of carrying one ear forward, and the other backward, and especially if he does so on a journey, he will generally have both spirit and continuance. The stretching of the ears in contrary directions indicates attention to what is passing around the animal, and while doing so he can not be much fatigued, or likely soon to suffer from weariness. Few horses sleep without directing one ear

forward, and the other backward, that they may hear the approach of objects in every direction. When horses or mules march in company at night, those in front direct their ears forward; those in the rear point them backward; and those in the center laterally, or across; the whole troop appearing to be actuated by one feeling of regard to the general safety. Such intelligence is wonderful, and leads us to adore Him who is so manifest in all his works. It is a common belief, that when a horse lays his ears flat back on his neck and keeps them so, he is most assuredly meditating mischief, and the stander-by should beware of his heels or his teeth. The ears will be laid back in play, but not so decidedly, or so long. A quick change in their position, and more particularly the expression of the eye at the time, will distinguish between playfulness and vice.

A special provision is made for whales, whereby they hear either through the medium of the air they breathe, or of the water, in which they live. Let the reader consider for a moment the difficulties which are here to be overcome. The

ear of a fish, having no external communication, though best adapted to receive the violent concussions conveyed through the water, could never appreciate the more delicate vibrations of the air. The common ear of the mammalia would be constantly deafened by the tumult of the waters. What, then, shall be done? The wisdom of God has furnished the reply. The outer opening of the ear is made as small as possible, and this part only is exposed to receive aquatic sounds. The eustachian tube, on the contrary, is very large, and opens into the blow-hole, through which the whale respires atmospheric air. When, therefore, the creature comes to the top of the water to breathe, it is this that conveys aërial sounds to the ear, and thus it hears sufficiently in both conditions. How admirable are the arrangements at which we have thus rapidly glanced!

> "Above the earth, around the sky,
> There's not a spot, or deep, or high,
> Where the Creator has not trod,
> And left the footprints of a God."

In returning from this survey of inferior creat-

ures, to man, his sense of hearing appears most admirably adapted to his knowledge and delight. The power with which the human ear is gifted may well fill us with astonishment. Allusion has already been made to a thin plate of tempered steel made fast at one end, and the other being drawn aside. On this being done, it has been proved that the plate begins to sound when there are thirty-two vibrations in a second, and at this rate of movement the sound which it gives is of the same pitch as that of an organ pipe, open at both ends, and thirty-two feet in length. By vibration is meant, in this instance, the passage of the plate from the extreme excursion on one side of the point of rest to the opposite. The velocity at which sound ceases to be appreciable is not so easily determined. Until recently, it was usual to fix it at 8200 vibrations, but it has been discovered that acute sounds may be distinguished at a velocity of 24,000 vibrations in a second. It is possible that the limit may be considerably beyond that number.

It is by a sense so exquisite that we derive pleasure from the melodies of nature and of

art. What observer of nature has not been delighted with the song of the lark, which has been said, from its admirable structure, "to convert the atmosphere into a musical instrument of many stops"? That bird can produce an exceedingly wild and varied song, a song which, though not equal in power and compass to that of many warblers, is more varied in the whole succession.

A number of single and separate sounds following one another in quick succession, produce a continued sound, as a burning stick whirled round before the eye forms a circle of light. That the sound may be a single one, nearly sixteen separate sounds must follow one another every second, and when these are exactly similar, and recur at equal intervals, they form a musical sound. Of no consequence is it to the production of a tone in what way the pulses of the air are caused, provided they follow with sufficient regularity. The sounds of a stick pulled along a grating, are not tones, only because the pulses follow too slowly. And whenever a continued sound is produced by impulses which do not follow

in regular succession, like those of an elastic body, the effect is called a noise.

The velocity of sound is far inferior to that of light. The ax of the woodman working on the hill is seen to fall a considerable time before the sound of the stroke is heard. In like manner the flash of a gun precedes the report. Sound travels at the rate of 1142 feet per second, or a mile in about four seconds and a half, varying little with the density or temperature of the air. The pulse at the wrist of a healthy man is a convenient measure of time for ascertaining distances by the progress of sound. Each beat marks nearly a second, and therefore indicates a distance of nearly a quarter of a mile.

A wave of water turns back at any obstacle, so that it appears at any distance after the reflection what it would have been at the same distance beyond the wall, only moving in an opposite direction. In like manner, the pulses or waves of sound are regularly reflected from flat surfaces, and produce what is called an echo. The rapidity with which it is returned to the spot where the sound originates, depends on the

distance of the reflecting surface; and the latter may therefore be determined by the former.

Some echoes are very remarkable. One of these is at the palace of a nobleman near Milan. About one hundred paces before the mansion a small brook glides gently; and over this is a bridge, forming a communication between the palace and the garden. On firing a pistol from this bridge, fifty-six vibrations of the report have been heard. The first twenty were distinct, but in proportion as the sound died away, and was answered at a greater distance, the repetitions were so doubled that they could scarcely be counted, the principal sound seeming to be saluted in its passage by reports on either side at the same time. There is a beautiful little lake in the Franconia Notch, in New Hampshire, so remarkable for its echoes as to bear the name of Echo Lake. It is one of the most charming spots in the country, and the reverberations which thunder back and forth among the mountains, and gradually die in the distance in quick repeating notes, are as startling as they are wonderful. The report of a gun, or the faintest tone of the human

voice, even a footfall, is tossed about among the high mountains that surround the lake in the most vivid manner.

In concluding these remarks, the importance of the sense of hearing, as a means of improvement, demands particular attention. How much valuable knowledge have we thus received! It is only for us to visit those who are deaf, especially those who were born so, to have a lesson which should excite our gratitude to God for granting to us, and continuing in exercise, so precious a power. And well may our sense of obligation be increased, as we observe the words of the apostle Paul: "Whosoever shall call upon the name of the Lord shall be saved. How, then, shall they call on him in whom they have not believed? and how shall they believe in him of whom they have not heard? and how shall they hear without a preacher? and how shall they preach, except they be sent? As it is written, How beautiful are the feet of them that preach the gospel of peace, and bring glad tidings of good things! But they have not all obeyed the gospel. For Esaias saith, Lord, who hath believed

our report? So, then, faith cometh by hearing, and hearing by the word of God." Rom. x. 13–17.

Reader! have you so heard the gospel as to have this faith? It is not yours, unless, under a conviction that as a sinner you are lost, you have fled to the only Saviour to put your whole trust in Him. Should you have delayed the exercise of this confidence till now, defer it no longer, for all must perish who have not an interest in Christ; and our life is but "a vapour, that appeareth for a little time, and then vanisheth away."

SMELL.

MUSK DEER.

SMELL.

CHAPTER X.

Odors. — Fragrance of the Fields. — Odor of Flowers and Wood. — Sandal-wood. — The Civet. — The Musk Deer. — Duration of Perfumes. — Minuteness of the Particles of Scent.

Odors demand our first attention, in considering the sense of smell. Many highly interesting facts will thus be disclosed. Some of these are little known, and others are likely to appear in a new light. In this way knowledge may be improved and increased, — an object worthy of constant effort.

The fragrance of the fields enters largely into that delightful group of images which often arises in our minds. How are they called up, even by the mere names of the country, or of spring and summer! Only let it be imagined that all

the flowers rising from the surface of the earth, like a tribute of incense poured forth to its God, were stripped in a single moment of their odor, and what a loss would there be! Cold and dead would they instantly appear; and one of our pleasures, large in itself from its frequent occurrence, would be utterly destroyed.

The poet Gray felt that odors greatly contribute to the joys of spring when he said —

"In vain the golden morn aloft
Waves her dew-bespangled wing;
With vermeil cheek and whisper soft
She wooes the tardy spring;
Till April starts and calls around
The sleeping fragrance from the ground."

The basis of all the vegetable perfumes is formed by the volatile or essential oils. These are found, more or less, in every part of the plant, except the seed. As few organized bodies, in their natural state, are without some volatile part, so there are not many entirely without smell. The odors of flowers will at once occur to the reader, but the volatile oil that produces them is often most abundant in the rinds of oranges, lemons, and other fruits. That it may be easily

extracted by the slightest pressure is well known. This oil is also plentiful in the leaves of mint, thyme, and many other sweet smelling herbs. Geranium leaves are remarkable for yielding a much more powerful odor than the flowers.

But though we may proceed thus far, let us not boast of our knowledge on the subject. Here, as in many other cases in the survey of natural objects, pride should be abased. Mysteries are

The Rose.

constantly met with, which we can not unravel. Even in reference to the odor of plants much obscurity remains. The senses are gratified by the sweet perfumes of leaves and flowers, and

art employs its skill to preserve them. But as to the reasons why they are yielded by one flower, while another is scentless, or why one is so at noon, and odorous in the evening, we know at best extremely little.

Some odors are transient. They are produced only during the life of a plant; are scattered as soon as formed, and, when dead, leave no trace behind. Such are the orange and the violet. In general, the power of smell varies according to the hight of the temperature and the dampness of the air. When the weather is hot and dry, flowers lose much or all of their usual fragrance. Even the most odorous among them need to be bruised or trampled upon to yield their perfume; but only let a heavy shower fall, and every leaf and flower will soon give forth its usual odor. The musk plant, for instance, will diffuse its peculiar perfume through the air; and thus it will be found, that, when moisture is added to the atmosphere, a total change is produced in the scent-yielding organs of plants.

So it is, too, in the driest days of autumn. Well has Milton said—

"Sweet is the breath of morn;"

and those only who have inhaled its fragrance in their early walks are aware how different a well-stored garden is a few hours afterward. It is before the dew is dispersed that every herb, tree, and flower pours forth a stream of the most varied and delicious odors. Why there should be so great a difference between a thicket of roses, when visited in the morn of one day, and in the morning of the next, like many other things in the vegetable world, is utterly unknown.

Some odors are called intermittent. Many plants are almost entirely without scent during the day, but are deliciously fragrant at night. One exhibits a very great peculiarity: if exposed to the direct rays of the sun, it exhales an aromatic odor, but if any thing comes between it and the sun, the fragrance is gone, only to return when the solar beams are restored.

Odors are more durable when the volatile matter is so shut up in cells and concentrated as to be slowly dispersed. Many instances of this kind occur in wood and bark. Thus, resinous woods, such as cedar and cypress, are

fragrant for a long time. Parts where scent resides in essential oil long preserve their odor, where the oil is but slightly volatile, or the wood is thick and hard. In this way, the rose-wood of Teneriffe continues to be fragrant, but it requires to be rubbed strongly, that heat may volatilize the matter which is lodged in its very compact tissue. The friction of a turner's lathe, in like manner, renders many woods odorous which are otherwise scentless. Beech is said, in this way, to smell like roses. In other cases, the scent escapes rapidly, as in cinnamon and cassia.

Sandal-wood is highly esteemed in some parts of the earth. It is, for instance, the most precious commodity for commerce produced in the Sandwich Islands. The king, at one time, monopolized the property of these trees, which grow on the highest mountains, and required his subjects to cut down and bring the supplies, as they were wanted, to the coast, at their own toil and expense. At a later period, he permitted some of his more favored chiefs to share with him in this traffic.

The wood which is used by the Chinese, for

its agreeable fragrance, in the manufacture of fans and other toys, as well as burned by them before their various idols, is exported for these purposes to Canton and the islands of the Eastern Archipelago. On one occasion, some travelers observed nearly two thousand persons, laden with fagots of sandal-wood, coming down from the mountains, to deposit their burdens in the royal storehouses.

All vegetable odors are produced by the evaporation of particles of these volatile oils. They vary greatly as to consistence. Some of them are as thick as butter, whilst others are as fluid as water. To be prepared for perfumes, they are first purified, and then either mixed with a large proportion of water, or distilled with spirits of wine. Peppermint-water is often produced by the former method, and lavender-water by the latter.

Vegetable odors are usually agreeable to the senses; but there are some curious exceptions. There are flowers, for instance, of a deep livid color, which have a smell so much like that of putrid meat, that flies actually deposit their eggs

in them by mistake. Some perfumes act powerfully on the nerves, and even the most prized, when concentrated, prove offensive. A perfumer's shop, although the repository of the sweetest essences, is by no means an agreeable place. Few persons can bear the fragrance of the lilac, especially in a room; and the jonquil and tuberose have proved insupportable when the nerves were delicate. De Candolle states, that he has seen many ladies faint from carrying too large a number of violets on their persons, or placing them too near their beds. Many physicians will not allow flowers in the sick-room on account of the supposed injurious effect of the perfume upon the patient.

Odors, it should be remarked, may have an animal as well as a vegetable origin, of which two examples must now suffice. The civet, which is a native of the hottest parts of Africa, is celebrated for its musky perfume, which is the product of a peculiar apparatus. This substance was formerly in great repute; it was an article of commerce, and, to a considerable extent, was imported into Europe by way of

Alexandria and Venice. At a town in Abyssinia, great numbers of these animals were kept for the purpose of supplying the markets; and a similar practice has prevailed in Holland. In certain parts of the East, they are also much valued. Some travelers observed, in the palace of the ranee, or sovereign princess at Trivanderam, several of them, which were caught in the jungles among the mountains. They were carefully kept in cages, having a bamboo placed perpendicularly in them. Against these they rubbed the parts from which the perfume oozes, and thus their royal mistress was supplied with what she required for her own use, in native purity.

Another creature, remarkable in the same way, is the musk deer, which is confined to the continent of Asia. It is as large as a roebuck, and is a wild, solitary, timid animal, dwelling among broken crags and mountain precipices, and ever watchful against surprise. It is eagerly pursued for the sake of its perfume, which is peculiar to the male alone. As soon as the hunter has killed one of these animals, he removes the musk

pouch, which is situated on the abdomen, and ties it up to be ready for sale. It usually contains about two drachms. The highest scented musk is imported from Thibet and Tonquin. As we pass northward, it becomes inferior in quality, and almost inodorous.

In the diffusion of odors, there is a remarkable proof of the divisibility of matter. Let, for example, the stopper be taken out of a bottle of attar of roses, and the scent spreads itself through the room. In this case, very minute particles escape. Some idea of their extreme smallness may be formed from the immense number that must be released to perfume the whole room. And yet the liquid is really, though not sensibly, diminished.

The duration of some perfumes is, also, remarkable. The Empress Josephine, the first wife of Napoleon Bonaparte, was extremely partial to the smell of musk, and with this substance her private apartments were highly perfumed. Many years after her death the scent remained, and its power, after that lapse of time, produced among visitors no little surprise. It is, however,

more astonishing, that if a small quantity of musk be inclosed for only a few hours in a gold box, and then taken out, and the box cleaned as carefully as possible with soap and water, it will retain the odor for many years, though the nicest balance will not be able to detect the slightest addition to its weight.

Most animal and vegetable bodies appear to be continually emitting a subtile effluvia, of which our own organs do not apprise us, except when the odor is highly concentrated. A dog it is well known will follow his master through the lanes and turnings of a crowded city, and accurately distinguish his track from that of any other passenger.

The minuteness of the particles of scent which animals are able to detect is most surprising. Hundreds of hares have been taken by one person, after a chase of two, three, four, or five hours: and yet, he says, he "could never perceive the least difference in bulk or weight from those he has seized or snapped in their forms." Supposing, however, as he says, an abatement were made of two or three grains, or even drachms,

after so much fatigue, yet how minute must be the division of so small a quantity of matter, when it affords a share to so many couples of dogs, for eight, ten, or twelve miles successively! The fact is still more curious, when it is considered, that a large number of these particles must be dissipated in the air, obscured by the perspirations of the dogs and other animals, or by the exhalations of the earth. It is also observable, that there is no small difference in the very particles of this animal's scent. Sometimes they are stronger, sweeter, or more easily distinguishable, than they are at others. Nor is this difference found only in various animals, but often in the same creature, according to the changes of the air or the soil, as well as of its own conditions and motions.

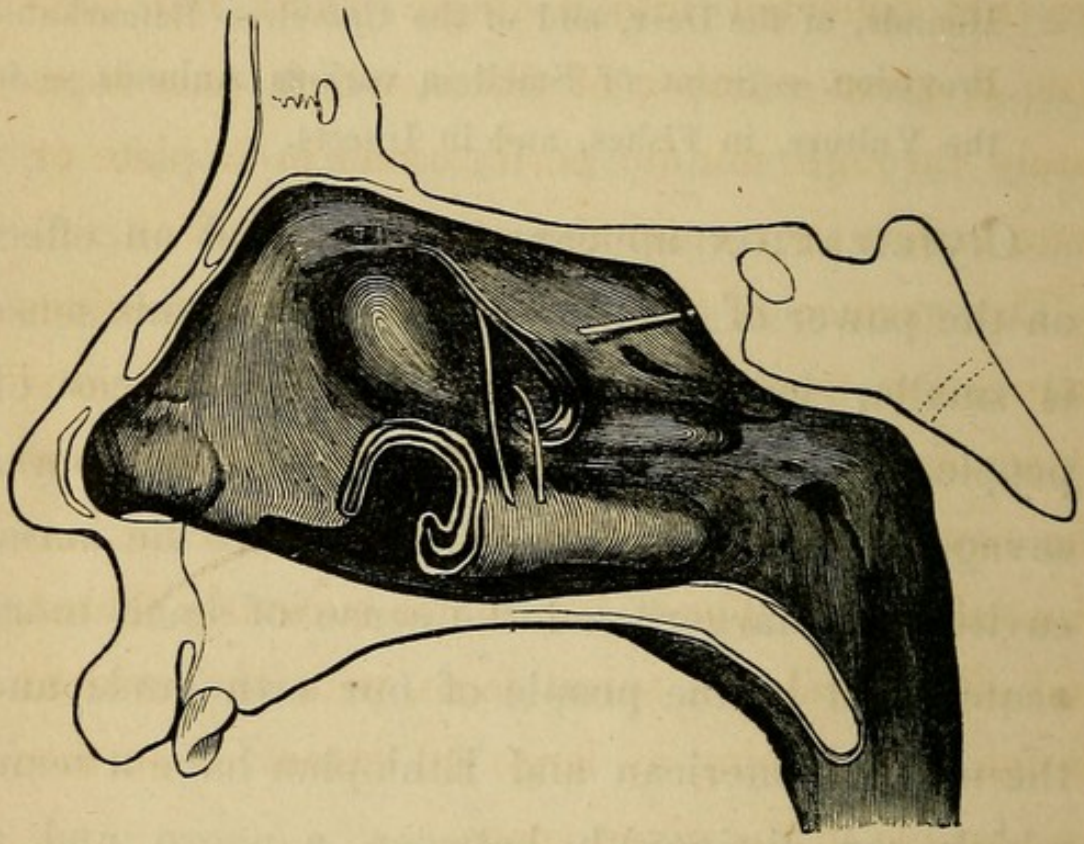
CHAPTER XI.

The Organ of Smell. — Nostrils of the Human Nose. — Turbinated Bones of the Sheep and of the Seal. — Scent of Hounds, of the Deer, and of the Camel. — Remarkable Provision. — Scent of Smell in various Animals. — in the Vulture, in Fishes, and in Insects.

CIVILIZATION appears to have had an effect on the power of smell. The organ for this sense is smaller in Europeans and similar races of people, than in those but little removed from a savage state. Thus, in the negro, the nasal cavities are larger, and the sense of smell more acute, than in the people of our own land; and the native American and Ethiopian have a scent which can distinguish between a negro and a European. The internal nostrils of a chief among the North American Indians, mentioned by Blumenbach, were of a most extraordinary size. The sense of smell is certainly much less developed in man than in most quadrupeds; but it is

well known that the keenest-scented hounds have the largest nostrils; and to this there is a resemblance among human beings, when the power is remarkable.

In all vertebrated animals living upon the land the cavity of the nostrils is divided into two, by a vertical partition. The whole of its internal



Section of one of the Nostrils of the Human Nose, showing the large cavities over which the pituitary, or moist membrane, the blood-vessels, and olfactory nerves are spread. The curved lines in the center of the figure represent the cut edges of the moist membrane, at the points, when, to secure a larger surface for its display, it is spread over several duplications of the nasal cartilages. The passage leading to the eye lies under the lower one.

surface is lined by a soft membrane, constantly kept moist, and supplied with numerous blood-vessels, upon which are spread the ultimate filaments of the olfactory nerves, or nerves of smell. These nerves are much larger in meat-eating animals than in those which subsist on vegetables. In quadrupeds, as well as in man, they are not collected into a single trunk, but compose a great number of fibers, which pass separately through minute perforations in a plate of bone before they enter the cavity of the skull.

The surface of the membrane which receives impression from odors is considerably increased by several thin plates of bone, which project into the cavity of the nostrils, and are called the turbinated bones. These bones are curiously folded, and often receive a spiral form, with the evident design of obtaining as large an extent of surface as possible in the given space.

As the hog in its natural state subsists wholly on vegetable food, it resembles herbivorous tribes in the form and size of the turbinated bones. But they are more simple in structure, being formed of single, and slightly convoluted plates, without

partitions or perforations. Here there is a resemblance to the human structure, which approaches more nearly to vegetable than to animal feeders. Man, indeed, distinguishes more accurately vegetable odors than those proceeding from animal substances; it is the contrary with quadrupeds, which are decidedly carnivorous.

The spiral-shaped bones are chiefly found among herbivorous quadrupeds: the horse, for example, has them of a large size, and extending the whole length of the prolonged nostrils. Their structure is intricate. While they have externally the general shape of an oblong spiral shell, they are pierced freely on all their internal sides. The membrane, with the fine branches of the nerves, passes through these perforations from one side to the other. The cavities resulting from the convolutions are intersected by partitions, which are not perforated, serving both to support the arches of bone, and to furnish a still greater surface for the extension of the membrane.

In carnivorous or meat-eating quadrupeds, the structure of these bones is still more intricate. It is calculated to afford a far more extensive

surface for the distribution of the olfactory nerve. In the seal this may be particularly observed; here the bony plates spread out in many branches. Eight or more principal branches arise from the main trunk; and each of these is afterwards divided and subdivided, with such extreme minuteness, as to form, in all, many hundred plates. The olfactory membrane, with all its nerves, is closely attached to every one of these plates, as well as to the main trunk, and to the inner surface of the surrounding cavity. Its extent is said to be — marvelous to tell — not less than 120 square inches in each nostril. An organ so exclusively sensitive requires an extraordinary power for excluding noxious vapors at will; and this has been provided by the benevolent Creator. The animal can close at pleasure the opening of the nostril.

The qualities of the blood-hound are well known. Most remarkable are the acuteness and certainty of its scent, and no less so the sagacity and perseverance with which it will track any object it has been trained to pursue. This propensity was, originally, adapted to the chase;

but, in after-times, it has been applied to the tracking of offenders. "In this occupation," says the eminent naturalist, Mr. T. Bell, "the intelligence, acuteness, and determined purpose which these animals evinced, were almost incredible; and numerous instances are recorded in which, after the lapse of a considerable time, the hound, being put upon the scent, followed the wretched fugitive for hours, and even days, with a searching and unflinching pertinacity, which, at length, overcame all impediments, and insured the capture of his unhappy quarry." In our own country, at the South, advantage has been taken of the acute scent of the blood-hound in catching the poor fugitive slaves who endeavor to escape from their masters. Let us hope that this barbarous practice will soon pass for ever away with the wicked system of slavery.

The fox-hound will distinguish the scent of the fox he is pursuing from that of another fox which crosses his path. The red deer have, also, a strong sense of smell. Great care is taken, therefore, by sportsmen, in their pursuit, to advance against the wind, so that their approach

may not be so easily known. The reindeer has a power still more remarkable. The traveler at times finds the flatness of Lapland increase as he proceeds, and it is difficult to tell whether he is moving on land or water, from the uniformity of the white surface around. The deer, however, are far better judges than he; for though there may be a depth of some feet of snow above the ice, wherever he stops for a few minutes on any lake, in no one instance have they been observed to commence their usual search after their food. But when on land, their natural quickness of smell enables them to ascertain, with almost unerring certainty, whether there is any moss growing beneath, which, during the winter, is their sole food. It is by the fineness of the sense of this animal, that the Laplanders are chiefly guided in fixing their different winter-quarters. Never do they remain in those parts which they know with certainty produce but little moss, from the indifference of their deer, and the few attempts made by them in removing the snow.

The dogs of the convent of the Great St.

Bernard deserve to be mentioned, from that extraordinary sagacity which often enables them to rescue the traveler from destruction. Exhausted in the vain search for a lost track, and benumbed with cold,

> "He sinks
> Beneath the shelter of the shapeless drift,
> Thinking o'er all the bitterness of death,
> Mixed with the tender anguish Nature shoots
> Through the wrung bosom of the dying man,
> His wife, his children, and his friends unseen."

But though the snow-drift should cover him from human sight, and even rise far above him, such is the delicacy of smell in these animals, that they will discover him, scratch away the snow with their feet, and by their hoarse and solemn bark bring the inmates of the convent to the rescue of the perishing.

Travelers tell us that no idea can be formed by Europeans of the quantity of water necessary for drinking, cooking, and washing, during a journey through the countries of Asia with a caravan. More especially is it necessary to allay the thirst of the traveler, whose palate is con-

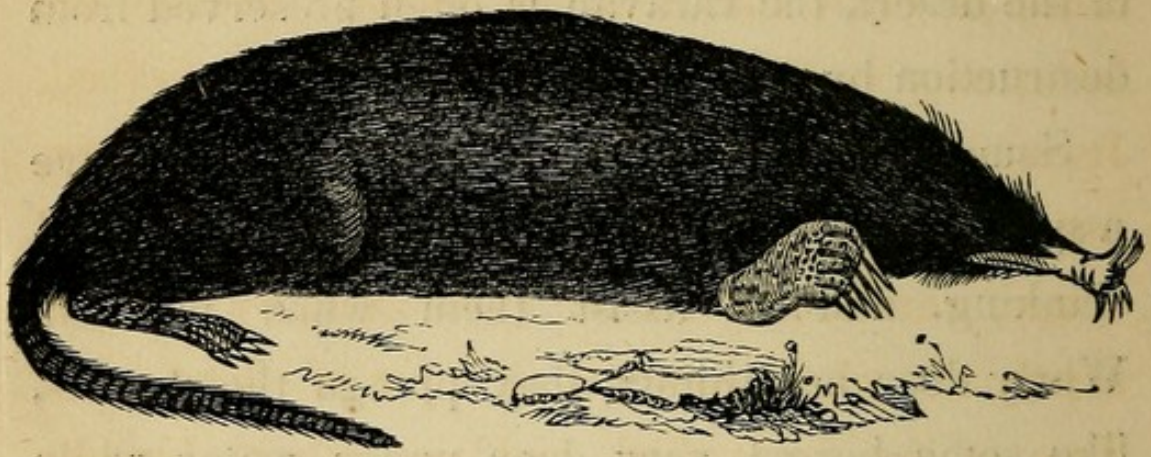
Dog of St. Bernard.

tinually parched by the effects of the fiery ground and air; and who, in addition to having for several days a short allowance of water, lives on food which is calculated to produce extreme thirst. In such circumstances, the extraordinary scent of the camel enables him to discover water at a great distance; and thus, in the wildest regions of the desert, the caravan is often preserved from destruction by this remarkable instinct.

Some animals, it is worthy of remark, have a special provision to enable them to breathe when drinking, and to assist them when pursued. When deer are thirsty, they plunge their noses, like some horses, very deep under water while in the act of drinking, and keep them there for a considerable time. But, to prevent inconvenience, they can open two vents, one at the inner corner of each eye, having a communication with the nose. Mr. Pennant, to whom Mr. White, of Selborne, communicated this fact, replies: "I was much surprised to find, in the antelope, something similar to what you mention as so remarkable in deer. This animal also has a long slit beneath each eye, which can be opened and

shut at pleasure. On holding an orange to one, the creature made as much use of these orifices as of his nostrils, applying them to the fruit, and seeming to smell it through them."

In some instances, a peculiar form of the nose may at once be observed. Such is the case with the animal of which a representation is annexed.



North American Mole.

Animals which have to pursue their prey require larger olfactory nerves, and a more extensive surface for their distribution, than the vegetable-eaters. As the food of the latter is generally near, and as they have only to select the plants which are wholesome, they are prepared to catch odors immediately as they arise. The former have often to search out the distant lurking-places of their prey, and are, therefore,

rendered more sensitive as to smell than others. Odorous particles widely diffused through the air, or adhering to the substances with which their prey has come in contact, are, for them, a sufficient guide.

The same rule applies to birds. The olfactory nerves of birds of prey are much larger than those of birds that feed on grain. Hence the latter may easily be deceived in reference to food. It is related, for instance, that some poultry, usually fed with a mixture of barley-meal and water, were found to have swallowed, by mistake, nearly the whole contents of a pot of white paint. Two of the fowls died, and two others became paralytic.

In reference to the vulture's sense of smell there has been some difference of opinion. Mr. Waterton says, that a man whose powers of scent are by no means remarkable will sometimes smell a putrid carcass at a great distance. And hence he reasons fairly, that as the air produced by putrefaction is lighter than common air, it will ascend in the atmosphere, and as it will be gathered to and fro through the

expanse of heaven, by every gust of wind, so the vulture, soaring above, and coming in contact with this tainted current, will instinctively follow it down to its source, and there find that which an all-wise Providence has designed for its support and nourishment.

At the South the presence of carrion is often first known by observing the turkey-buzzards sailing round in circles high up in air over some particular spot, and at last descending to the carcass which their acute senses have discovered.

Mr. Waterton tells us, that he is intimately acquainted with the common vulture of the West Indies, the *Vultur aura* of Guiana, the king of the vultures of Terra Firma, and the vulture which is found in European Andalusia. And yet he has never known any of them to kill the food on which they feed, or when free from the restraint or allurements of man, ever feed on that which was not putrid. On one occasion he killed a large serpent, and, aided by others, carried the body into a forest. The foliage of the trees, where the dead serpent was laid, was impervious to the sun's rays, and,

had any vultures passed over it, he thinks they could not have seen the remains of the reptile through the shade. For the first two days not a vulture made its appearance at the spot, though here and there, as usual, a *Vultur aura* was gliding, at a moderate hight, over the tops of the forest trees. But, during the afternoon of the third day, when the carcass of the serpent had become putrid, more than twenty of the common vultures perched upon the neighboring trees, and the next morning, a little after six o'clock, Mr. Waterton saw a magnificent king of the vultures. He killed this bird, which had taken its station on the topmost branch of a stupendous tree, before he had descended to partake of the savory food that had attracted him to this spot. Soon after another king came, and when he was satiated, the rest pounced down on the remains of the serpent, and stayed till they had devoured the last morsel.

This naturalist confirms his opinion by various facts, which show that these birds clearly distinguish between dead and living animals. In Andalusia, he stood, one day in particular, to

watch the vultures feeding on the putrid remains of a mule. Kids and lambs were reposing and browsing up and down in the neighborhood, but the vultures touched them not. Nor did the shepherds seem to consider their flocks in dangerous company, or they might have despatched the birds with little trouble, as they were so gorged with carrion that they seemed unwilling to move from the place.

An objection has been raised to his conclusion, from the idea that putrid effluvia would always be driven to one quarter in the tropics, where the trade-winds prevail. But to this Mr. Waterton replies, that often, at the very time that the clouds are driving from the north-east up above, there is a lower current of air coming from the quarter directly opposite. In Guiana there is a tree called hay-awa, which produces a deliciously smelling resin; it is found in a hardened lumpy state, all down the side of the tree, out of which it has oozed. It is also seen on the ground, at the foot of the tree, mixed with the sand. When the Indians stop on the bank of a river for the night, they frequently burn this resin for its fine and wholesome scent. "When," says Mr. Waterton,

" we had taken up our nightly quarters on the banks of the Essequibo, many a time we perceived this delightful fragrance of the hay-awa, which came down the bed of the river to the place where we were, in a direction quite opposite to the trade-wind. My Indians knew by this that other Indians were encamped for the night on the river-side above us."

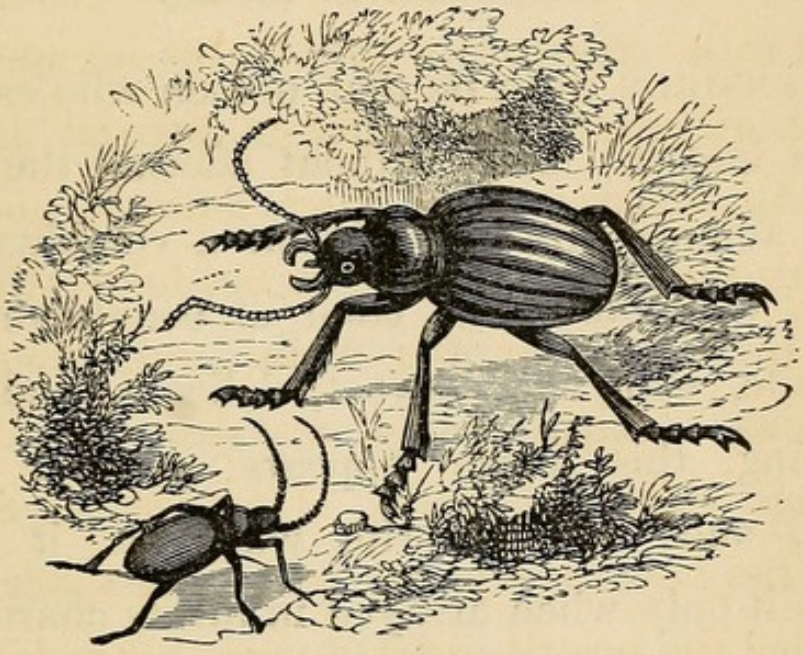
It has been doubted whether fishes and other aquatic animals have the sense of smell. In some of the whale tribe, indeed, neither the organ of smell nor the olfactory nerves are found; and yet, in a large number of instances, the power of smell must be possessed. Water is certainly a vehicle of odors. The baits of anglers are rendered more attractive by perfumes. A gland, secreting an unctuous matter, of a very strong musky odor, has been discovered by Mr. T. Bell, situated beneath the lower jaw, on each side, in the crocodile and alligator. The external opening of this gland is a small slit; the cavity containing the odorous substance is surrounded by two delicate bands of muscular fibers. These appear to be provided to bring the gland into a proper position, and then, by compression, to

discharge its contents. It is supposed by the discoverer, that the secretion is used as a bait for attracting fish towards the sides of the mouth, where they can be readily seized, as the alligator snaps sideways at its prey. Other facts show that fishes have the power of smell, while an appropriate organ may be frequently observed, varied in its structure according to circumstances.

The experiments of Huber proved that the organ of scent in bees (and there is no reason to think that other insects do not follow the same law) is in or near the mouth, and above the proboscis. Kirby found, on dissection of the common burying beetle, *Necrophorus vespillo*, under the nose, and partly under the space which he called the nostril piece, a pair of circular pulpy cushions, covered by a membrane, which he considered to be the organ of smell, and which remained distinctly visible in a specimen he had by him more than fifteen years.

Some insects discharge offensive odors, it would seem, to annoy and frighten their enemies. A familiar instance of this appears in the large family of bugs the fetor of which is always similar, though their food is various. A small

green beetle, *Anchomenus prasinus*, is remarkable for its repeated discharges of smoke and noise. But it is not so well known as another, the bombardier, *Brachinus crepitans*, whose discharge resembles a popgun, accompanied by a sort of smoke. It is said to have a bladder sufficiently



The Bombardier and its Enemy

furnished to fire off twenty shots in succession. A beetle, larger than itself, *Calasoma inquisitor*, is its chief enemy. The little creature, unable to escape by fleetness, stops short on its way, and just as its adversary is about to seize it, a discharge takes place, and, while it is stupefied by surprise, the wished-for prey escapes.

CHAPTER XII.

The Benevolence of God. — A Child with only one Sense. — Preparation for Eternity.

INSENSIBLE must be that person who can take a rose into his hand, without adoring the Giver, as he admires his gift. What a combination is here! With form and color of beauty the most exquisite, with odors sweet, delicate, and never wearying, this flower appears adapted to all climes, and is a favorite wherever it grows. Nor is it only when arrayed in all its charms that it yields us pleasure. If we say with the poet —

"The leaves are beginning to fade in an hour,
And they wither and die in a day;"

we must add with him —

"Yet the rose has one powerful virtue to boast
Above all the flowers of the field,
When its leaves are all dead, and fine colors are lost,
Still how sweet a perfume it will yield!"

The objects about which the sense of smell

is employed are manifestly no casual productions. No power but that which created the light could have produced aught so incomprehensible. Of this there seems, too, to have been required a very specific exercise. In the case of inferior animals, we discover a wise and benevolent adaptation to particular purposes. In reference to ourselves, the scent is as constant and precise as the very form of the plant, and the seed by which it is to be continued; and as it is superfluous to the vegetable product, and a source of pleasure to us, it is beyond all doubt that odors were created for our enjoyment, and are proofs of the purest beneficence.

Of this source of pleasure we may speak more freely than of that which concerns the organ of taste. "It is at least," says a writer, "the poetry of sense; and whatever impressions the other animals may receive from the same sources, we are sure, that in all its variety and delicacy, and power of influencing the mind, it has been reserved for us; a truly mental enjoyment, akin to those of poetry and music."

Another fact is equally worthy of remark. A

person determines to look at a certain star through a telescope, or to play on a piano, of which he has heard. But is this determination formed by the eye, or the hand? Assuredly not. Neither do they put the determination into practice. They are only the instruments by which the star is seen, or the melody produced. The power of determination, and also of action, is in the mind, — the soul, which is distinct from all the senses. A most interesting case that occurred in Boston illustrates this. A child lost, as the consequence of serious illness, all her senses but one, — that of touch. Dr. Howe took her under his care, and tried various means for her benefit. The first experiments were made by taking such articles as knives and forks, spoons and keys, and pasting on them labels with their names printed in raised letters. These she felt very carefully, and soon distinguished that the crooked lines *s p o o n*, differed as much from the crooked lines *k e y*, as the spoon differed from the key in form.

After a while, instead of labels, the individual letters were given to her, on detached bits of

paper: they were arranged side by side, so as to spell *b o o k*, *k e y*, etc.; then they were mixed up in a heap, and a sign was made for her to arrange them herself, so as to express the words *b o o k*, *k e y*, etc.: and she did so.

"Hitherto," says her benevolent teacher, "the process had been mechanical, and the success about as great as teaching a knowing dog a variety of tricks. She, poor child, had sat in mute amazement, and patiently imitated everything her teacher did; but now the truth began to flash on her; her intellect began to work; she perceived that here was a way by which she could make up a sign of any thing that was in her own mind, and show it to another mind; and at once her countenance lighted up with a human expression: it was no longer a dog or a parrot; it was an immortal spirit, eagerly seizing upon a new link of union with other spirits! I could almost fix upon the moment when this truth dawned upon her mind, and spread its light over her countenance."

How striking is this proof of the independence of the soul of all that is material, — the soul which

should be the object of our first and chief care! While dwelling in the body, it is preparing for an eternal state. Passing into the unseen world in its native defilement, it must be miserable; and, as no change can pass on it *there*, it must be wretched for ever and ever. Who, then, can estimate the value of "the blood of Christ," and of the purifying operation of the Holy Spirit? Who can describe the importance of faith, by which alone the soul can be justified and sanctified? To every reader, then, the question is solemnly proposed: "Dost thou believe on the Son of God?" It is only as the soul relies entirely on Him, and is conformed to His image, that it is prepared for eternal blessedness.

THE END.

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