ANALOGIES

OF

ORGANIZED BEINGS.

From the Author

J S Duncan.

Duncan

RB Freeman

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ANALOGIES

OF

ORGANIZED BEINGS.

For thou, Lord, hast made me glad through thy works: and I will rejoice in giving praise for the operations of thy hands.

O Lord, how glorious are thy works! thy thoughts are very deep. An unwise man doth not well consider this; and a fool doth not understand it. PSALM xcii. 4, 5, 6.

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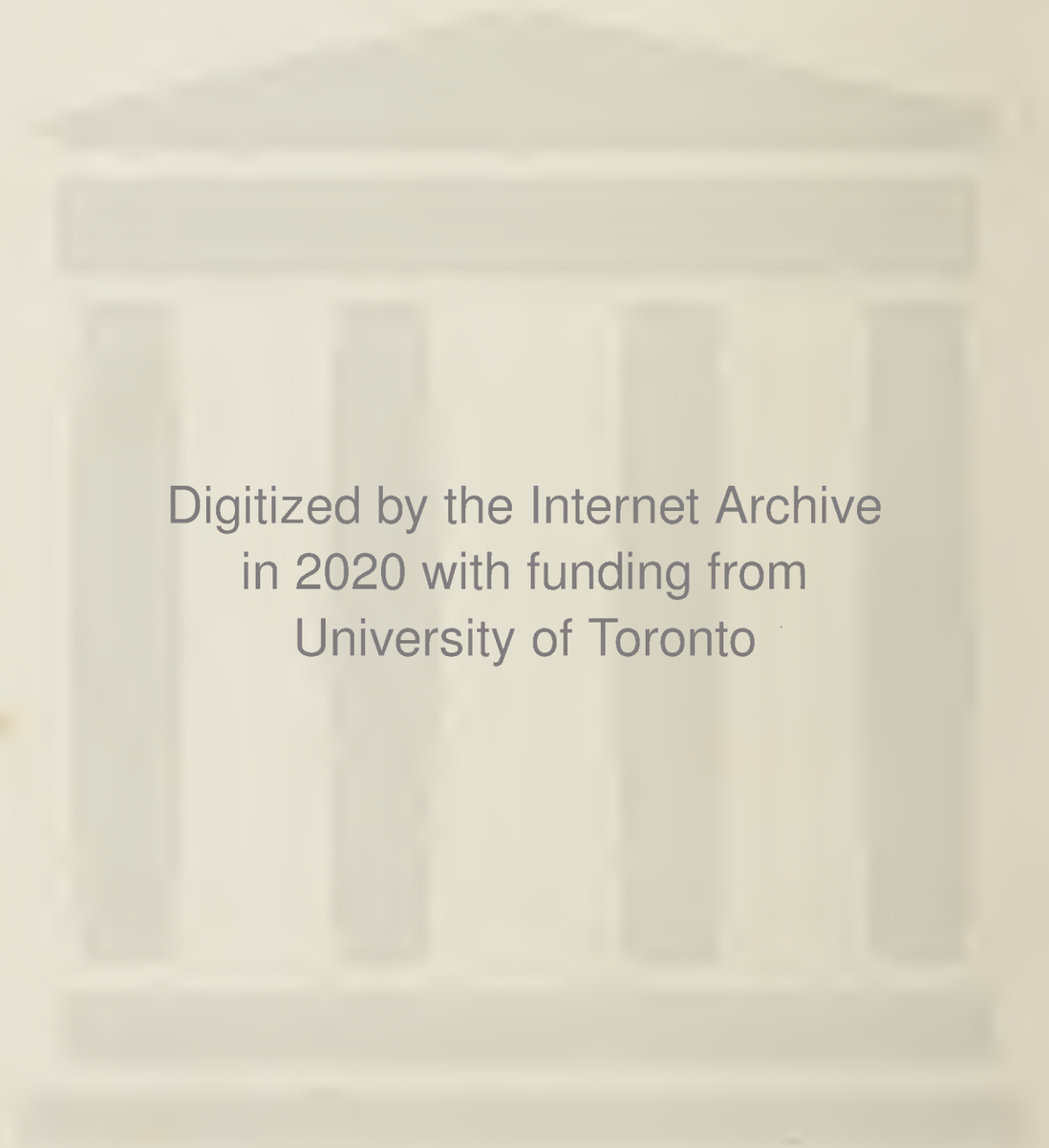

TO THE

RIGHT REV. EDWARD LORD BISHOP OF LLANDAFF,

AND TO

THE REV. R. WHATELY,

PRINCIPAL OF ALBAN HALL,

FROM WHOSE VALUABLE DISQUISITIONS

ON THE SUBJECT OF ANALOGY

I HAVE DERIVED MUCH INSTRUCTION:

AND TO MY BELOVED BROTHER,

P. B. DUNCAN,

(MY SUCCESSOR AS CURATOR OF THE ASHMOLEAN MUSEUM,

AND MY CONSTANT SUSTAINING AND CHEERING COADJUTOR IN ALL

LABOURS OF JOY OR OF SORROW)

THIS SPECULATIVE ESSAY

IS HUMBLY DEDICATED,

IN THE HOPE THAT THEY MAY NOT CONTEMN

THE OFFERING, HOWEVER IMPERFECT, OF

J. S. DUNCAN.

WESTFIELD LODGE,
May, 1831.

ANALOGIES

OF

DIFFERENT CLASSES

OF

ORGANIZED BEINGS.

CLASSIFIED lists of animals and plants express, or ought to express, and exhibit the prominent differential character of each order or genus, that peculiar mark in which all species and individuals, included in each division, agree among themselves; and by which they are readily to be distinguished from all those species of other divisions which do not possess such mark or character. It were assuredly desirable that every generic name should be adapted to suggest the characteristic mark by which the division is to be defined; as *Mammalia* rather than *Feræ*. The best arrangements are those which exhibit the best selection of such characters. But genera and species possessing these characters of dissimilitude, however wide and striking, may possess analogical agreement amongst themselves scarcely less clear, and at least equally deserving our attention.

"Some animals," says the father of zoology and

of logic, in the very commencement of his work, Περὶ Ζωῶν, " have parts which are neither specifically the same with those of other animals, nor generically the same, with mere difference of quantity, excess or defect, but are merely accordant, or the same in the relation of analogy: as the bone is by analogy the same with the cartilaginous spine of the acanthus, (probably the thornback,) the nail with the hoof, (as of a horse,) the hand with the claw, (as of a bird,) the scale with the feather: for the feather in the bird agrees analogically in its relation, though not in appearance, with the scale of the fish."

An author, whose writings afford the best key and clue to Aristotle, to logic, and to nature, thus defines analogy: " Strictly speaking, analogy ought to be distinguished from direct resemblance, with which it is often confounded, in the language of even eminent writers, (especially on chemistry and natural history,) in the present day. Analogy being ' a resemblance of ratios,' Λόγων ὁμοιότης, (Aristotle,) that should strictly be called an argument from analogy in which the two things, viz. the one *from* which, and the one *to* which we argue, are not in themselves alike, but stand in similar relations to some other things: or, in other words, when the common genus, under which they both fall, consists in a relation. Thus an egg and a seed are not in themselves alike, but bear a like relation to the parent bird and to her future nestling, on the one hand, and to the old and young plant, on the other, respectively. In this kind of argument one error is

very common, namely, that of concluding the things in question to be alike, because they are analogous; to resemble each other in themselves, because there is a resemblance in the relation which they bear to certain other things." *Whately, Elements of Rhetoric*, chap. ii. §. 6. p. 65. Also Appendix B. He quotes largely Copleston's Four Discourses on the Doctrines of Necessity and Predestination. "*Analogy* does not mean the similarity of two things, but the similarity or sameness of two relations," &c.

Most of our modern systematical writers of natural history have drawn up differential tables, or synopses of their different arrangements. Every one, who has deserved any praise for his diligence and acumen, has added more or less to the number of preceding discriminations, has pointed out new differences and agreements, which repeated investigations and newly discovered objects have suggested. These have led to various changes of classification; which have sometimes been hastily and rashly adopted, and sometimes opposed and decried with petulant pertinacity, of common occurrence in all argumentation.

A synoptical table of different systems of classification may be seen in the Introduction to the Catalogue of the Ashmolean Museum. But I have long felt a wish to see a table, not of striking differences, but of remarkable analogies. If the term *chance* be defined an effect without either an uniform or a designing cause; then indeed differences, issuing from an impulse uncertain and perpetually inconstant,

might exist in endless mazes of incongruity. Analogies would of course be untraceable. But analogies are coordinate with differences throughout all creation. Therefore in analogies we chiefly trace the unity of the designing Cause. Analogies are to be found in the relations of whole classes of organized beings to different portions of creation. As some portions of the globe are constantly subject to the rigour of perpetual cold, viz. the arctic circles, and the summits of the Alps, Andes, and Himalaya; others to equal severity of heat; so animals and plants of all classes exhibit peculiar adaptations to each condition of temperature. Land, air, and water are appointed media for purposes of locomotion. Legs and feet, and wings, and fins, and paddles, as in the turtle, and sails, as in the nautilus, and argonauta, and velella, and spirula, perform analogous offices in each. Here are analogies of wholes and of parts. Analogies appear singly in wholes, but are duplicate or multiplied in the complication of parts. Thus in the instance of teeth, as the lion is to the ant-eater amongst mammalia, so is the crocodile to the frog amongst amphibia, &c. I defer further detail to a particular illustration of the synoptical table of analogies. It may be here observed, however, that in such cases as that last instanced the double analogy is manifested in the continued duplication of excess and defect through every class.

As to the possible extent of physical analogies, there seems to be no clue to direct our judgment on the superficies of nature. They are discoverable

even in the objects of different senses; as between the proportions of the diatonic scale and the colours of refracted light. They may therefore be conceived to have a probable existence even in objects wherein they have been hitherto untraced by minute investigation[a]. The absence of a cranium and of vertebræ is not found to be incompatible with the existence of a nervous system, nor the absence of a heart with that of a circulatory system, of a circulating fluid essential to the purposes of life and growth. This has been very lately traced, by the microscopic research of Carus, in the bodies of insects. In similar forms we constantly expect similar relations. But analogies excite our attention and admiration in direct proportion to the general dissimilitude of the objects in which they are traced. They thus burst upon our apprehension with a sudden excitement of surprise, and stimulate one of the

[a] A scale of proportions in which the minutest particles of different bodies unite chemically or intimately to produce compounds possessing very different and almost opposite properties, may be found in Dr. Thompson's Chemistry, enlarging on the suggestions of Mr. Dalton. "A remarkable instance of such a relation is the curious law which Bode (professor of Berlin) observed to obtain in the progression of the magnitudes of the several planetary orbits. This law (or order of relations) was interrupted between Mars and Jupiter, so as to induce him to consider a planet as wanting in that interval; a deficiency long afterwards strangely supplied by the discovery of four new planets in that very interval, all of whose orbits conform in dimension to the law in question, within such moderate limits of error as may be due to causes independent of those on which the law itself ultimately rests." *Herschel's Discourse on the Study of Natural Philosophy.*

most powerful instincts of our nature, the love of wonder. A peculiar sensation of delight is connected with this emotion, the germ of that compound, that aggregate of rapturous associations, which we distinguish by the term *sublime*. This emotion, or aggregate of emotions, affords a continually increasing impulse to every intellectual exertion, continually augmented in energy in proportion to the growth of knowledge, to the consciousness of intellectual strength and expansion: constantly elevated in proportion to the magnitude of the contemplated objects, and fervent and enthusiastic in proportion to our apprehension of benefit to other sympathetic beings throughout all generations.

Analogies thus traced in objects most remote and most dissimilar have an especial tendency to produce an effect which Dugald Stuart observes is common to all our philosophical pursuits, namely, that "of impressing the mind with a sense of that mysterious agency or efficiency into which the general laws of nature must ever be resolved,"—"and to revive those emotions of wonder and of curiosity which the appearances of nature are so admirably fitted to excite." But these emotions, he observes, are attended with a natural, inevitable conviction, that the effects which we notice in all our physiological inquiries cannot belong to inert matter, but proceed from powers of more exalted nature: chap. i. §. 3. "and form a part of our *moral* nature." They are a portion of that Mind, in which those who attend to the operations or diversities of consciousness may perceive,

with apprehension not less clear than that which follows the impressions of the senses, an adaptation of the variously modified arrangements of an inward nature, not visible or tangible, but having nicely adjusted relations to all that can be seen and touched, and to something far beyond all with which our senses are conversant, namely, to that mysterious Power which throughout the whole range of existence has adapted part to part, and all to the whole: the external objects of perception to internal objects of consciousness, the external terrible to internal fear; the externally lovely to internal love; the externally magnificent to the heart-swelling emotions of sublimity—and which has filled the mind or soul of man with a moral organization especially adapted to the social state. Even between this moral organization and that of the external forms of physically organized beings, many curious analogies are obvious. In each we may observe a nice adjustment of conflicting principles; amongst which, excess on the one hand, and defect on the other, tends alike to particular or general injury, and general disorder to certain destruction. These Analogies, however, demand distinct consideration; and are in this place only noticed to shew that here also is manifested the unity of that Power which has balanced the forces of the extensor and the flexor muscles in the legs of a grasshopper, as well as those of attraction and repulsion in the orbits of the planets: which, having filled the universe with beauty and with majesty, has endued the most perfect of organized be-

ings, adapted to the highest and most varied purposes, with powers of proportionally elevated apprehension, with aspirations towards a yet more and more exalted commerce with a purer and higher state of existence, with "longings after immortality."

A tabular synopsis of analogies which might approach toward completeness in extent and accuracy would require the continuous labour of many years. An outline is here given, which others may from time to time correct and fill up, in the whole or in part, according to the direction of their peculiar studies.

Linnæus and Cuvier nearly agree in their primary divisions of animals: vertebrated and invertebrated, &c.

Vertebrated.	With warm red blood. Heart with two ventricles. Two auricles.	Viviparous, with teats.	*Mammalia.*
		Oviparous, no teats.	*Birds.*
	Cold red blood. Heart with one ventricle. One auricle.	Lungs; occasionally with gills.	*Reptiles.*
		Gills; without lungs.	*Fishes.*
Invertebrated.	White and cold blood. Heart with one ventricle. No auricle.	With antennæ. Not suffering transformation. Knotted spinal marrow. Articulated members. Gills.	*Crustacea.*
		With antennæ. Suffering transformation. Articulated members. Stigmata.	*Insecta.*
		Simple spinal marrow. No articulated members.	*Mollusca.*

The simplest and broadest outline of difference is sufficient for the present occasion; the proposition being to trace a continuity of agreement amongst the most widely discriminated classes.

Classes.	Locality.	Climate.	Food.
Mammalia. Quadrupeds.	*Land.* Lion, Dog, Bull, &c. *Land and Water.* Otter, Hippopotamus. *Water.* Dugong, Whale.	*Hot.* Camel, Giraffe, &c. *Temperate.* Horse, Sheep. *Cold.* Rein Deer, White Bear, &c.	*Carnivorous.* Lion, Wolf, Ferret. *Herbivorous.* Bull, Sheep, Horse.
Aves. Birds.	*Land.* Eagle, Pigeon, &c. *Land and Water.* Heron, Snipe, &c. *Water.* Penguin, Diver, &c.	*Hot.* Parrot, Humming Bird, Ostrich, &c. *Temperate.* Rook, Nightingale. *Cold.* Eider Duck, Auk.	*Carnivorous.* Eagle, Owl, Lanius. *Piscivorous.* Pelican, Cormorant. *Herbivorous.* Gallinæ, Pigeons, Geese.
Amphibia. Reptiles.	*Land.* Tortoises, Lizards, Vipers, &c. *Land and Water.* Turtles, Crocodiles, &c.	*Hot.* Chamæleon, Iguana, Boa, &c. *Temperate.* Salamander, Tree Frog. *Cold.* Eft or Newt, Frogs.	*Carnivorous.* Crocodiles, Snakes. *Herbivorous.* Tortoise, Turtle, Iguana.
Pisces. Fish.	*Land and Water.* Eels, Hassars. *Water.* The greatest part.	*Hot.* Coryphæna, Dolphin, Gymnotus, Electric Eel, Gold Fish. *Temperate.* Turbot, Flounder. *Cold.* Cod, Herring, Salmon.	*Carnivorous.* The greater part. *Herbivorous.* Carp, Chub. Perhaps most wanting teeth take bread and grains.
Crustacea. Shell-covered, or with head and trunk under the same shell.	*Land.* Crabs and Scorpions. *Water.* Lobsters, Prawns.	*Hot.* Scorpion, Tarantula. *Temperate.* Crayfish, Prawns. *Cold.* Norway Crab.	*Carnivorous.* Scorpions, Spiders. *Herbivorous.* Land Crabs, probably Water Crabs, &c.
Insecta. Insects.	*Land.* Butterflies, Bees, &c. *Water.* The Water Spider, Water Beetle, Dytisci, &c.	*Hot.* Mantis, Fulgora, Butterflies, and Locusts. *Temperate.* English Moths and Butterflies, Glow-worms. *Cold.* Bombus Arcticus.	*Carnivorous.* Flies, Beetles, Ichneumons. *Herbivorous.* Chafers, Larvæ generally.
Mollusca. Slugs.	*Land.* Slugs and Snails. *Water.* Medusæ, Oysters, &c.	*Hot.* Argonautæ, Nautili, Caput Meduæ. *Temperate.* Actiniæ, Common Slugs. *Cold.* Holothuriæ, &c.	*Carnivorous.* Sea Slugs, inhabiting pointed shells with channelled mouths. *Herbivorous.* Land Slugs, Snails, &c.
Plantæ. Vegetables.	*Land.* Oak, Elm, Apple. *Land and Water.* Reeds and Rushes. *Water.* Confervæ, Algæ, &c.	*Hot.* Palms, Bread Fruits, Butter Tree, Milk Tree. *Temperate.* Elm, Oak, Beech. *Cold.* Pine, Lichens.	Require putrid animal and vegetable substances for nutrition.

Disposition.	Covering.	Mouth.	Feet.
Ferocious, active. Lion, Wolf. *Mild, inactive.* Sheep, Sloth, Mole.	*For defence or warmth.* Rhinoceros, Manis, Porcupine, Sheep. *Bare.* Hippopotamus, Walrus, Barbary Dog.	*Armed to lacerate.* Lion, Wolf. *Contra.* Edentata, Sloth, Ruminantia, Cow, Sheep.	*Armed.* Lion, Tiger. *Contra.* Camel, Hyrax.
Ferocious. The Falcons. *Mild.* Pigeons. *Active.* Swallows, Terns, &c *Indolent.* Owls, Boobies.	*Thick and Warm.* Ducks, Cassowary, Ostrich. *Partially Bare.* Jabiru, Ostrich, Vulture, Ibis.	*Armed to lacerate.* Eagle, Lanins. *Contra.* Duck, Spoonbill.	*Armed.* Eagle, Strix. *Contra.* Duck, Diver.
Ferocious. Crocodiles. *Mild.* Salamander, Tortoise. *Active.* Lizards generally. *Indolent.* Turtles, Toads.	*Thick and Hard.* Crocodile, Tortoise. *Bare.* Frogs, Toads, Sirens.	*Armed.* Crocodile. *Contra.* Turtle, Frog.	*Armed.* Crocodile. *Contra.* Salamander, Frog.
Ferocious. Shark, Pike. *Mild.* Carp, Tench, Sole. *Active.* Salmon, Herring. *Indolent.* Miller's Thumb, Flounder.	*Tubercled. Hard.* Diodon, Histrix, Ostracion, Sturgeon. *Bare, or with soft covering.* Eels and Lampreys.	*Armed.* Shark, Pike. *Contra.* Carp, Chub, Gudgeon.	*Armed.* *Thorny Fins.* Flying Scorpion, Perch, Stickleback. *Contra.* Eel, Muræna.
Ferocious. Scorpions; all the genus Cancer. *Mild.* Prawns, Shrimps.	*Tubercled. Hard.* Sea Crayfish, Lobsters, Crabs, Cancer Hirtus, &c. *Smooth and Soft.* Prawns & Shrimps; all during change of shell.	*Armed.* Prawns, Lobsters. *Unarmed comparatively.* Shrimps, Monoculi.	*Armed.* Lobster, Crab. *Contra.* Shrimp, Prawn, &c. Monoculi.
Ferocious. Hornets, Wasps. *Mild.* Butterflies, &c.	*Soft and Downy.* Lagoia, Lepidoptera generally. *Hard and Bare.* Coleoptera.	*Armed.* Mandibulata, Bee, Beetle, Larvæ. *Unarmed.* Haustellata, Butterflies.	*Armed.* Gryllo, Talpa. *Contra.* Papilio.
Ferocious. Tænia, Furia, Filari, Medinensis. *Mild.* Slug, Earthworm.	*Hairy and Tuberculated.* Asterias, Aphrodite Aculeata. *Bare.* Actiniæ, Medusæ.	*Armed.* Carnivorous and boring Mollusca, Snails, Sepiæ. *Unarmed.* Herbivorous Earth Worm.	*Armed.* Sepiæ, Asteriæ. *Contra.* Slugs, Helices, &c.
Ferocious. Thorns, Thistles, Nettles, Cactus. *Mild.* Sedum, Purslane, Lettuce.	*Hairy. Bristly.* Thorns, Furze, Mullein. *Bare.* Cabbage, Lettuce, Tulip, Orchis.	*Armed.* Thorny Calyx, Dipsacus, Eryngo, Saracenia, Dionæa, Personatæ, &c. *Unarmed.* Cruciform blossom. Naked receptacle.	*Armed.* Forest trees with hard and tough roots. *Contra.* Most Annuals. Bulbs.

Classes.	Tails.	Wings.	General Form.
Mammalia.	*Long & Powerful.* Lion, Bos, Kangaroo, Monkeys. *Short.* Bear, Sheep, Wombat.	*Without.* The greater number. *With.* Cheiroptera, Colugo, Flying Lemur, Petaurine Opossum, Flying Squirrel.	*Heavy.* Hippopotamus, Mole. *Light.* Antelope, Deer, Giraffe, Ferret.
Aves.	*Long.* Peacock, Paradiseæ, Widah Birds. *Short.* Wren, Water Ouzel; divers.	*Without.* Penguin, Cassoary, Ostrich, Dodo. *With.* The greater number.	*Heavy.* Dodo, Duck, Goose. *Light.* Anhinga, Tern, Wagtail.
Amphibia.	*Long.* Lizards and Serpents. *Short or none.* Tortoises, Frogs.	*Without.* The greater number. *With.* Draco volans.	*Heavy.* Toads, Turtles. *Light.* Snakes, Lizards.
Pisces.	*Long.* Ray, Gar or Pike, Eel, Ophiognathus Ampullaceus. *Short.* Sole, Lump, Diodon.	*Without.* The greater number. *With.* Trigla volitans or Flying Gurnard, Exocætus evolans or Flying Fish.	*Heavy.* Diodon, Lump. *Light.* Lampern, Herring, Trichiurus.
Crustacea.	*Long.* Lobsters, Crayfish. *Short.* Crabs.	*Without.* Almost all. *With.* The Gossamer, and some others which eject threads for flight in the air.	*Heavy.* Crabs. *Light.* Prawns, Scolopendra.
Insecta.	*Long.* Libellulæ, Ephemeræ. *Short.* Scarabæi, Acari, &c.	*Without.* Aptera, Ticks, Fleas. *With.* The greater number.	*Heavy.* Beetles, Ticks. *Light.* Dragon Flies, Gnats, Ephemeræ.
Mollusca.	*Long.* Tænia, Gordius. *Short or none.* Limax, Medusa, Ostrea.	*Without.* The generality. *With.* Wing-like sails, Nautilus, Argonauta, Velella.	*Heavy.* Slugs. *Light.* Gordius.
Plantæ.	*Long.* Tendrils, Peas, Clematis, Vine. *Short.* Truffle, Puff Ball.	*Without.* The generality. *With.* Many seed vessels, Ash, Maple, Dandelion, Thistle.	*Heavy.* Fungi, Truffles. *Light.* Reeds, Grasses.

Forms.	Height&Length.	Colours.	Eyes.
Powerful. Elephant, Lion. *Weak.* Mouse.	*Lofty.* Giraffe, Camel. *Lowly.* Dormouse, Mus messorius.	*Dusky.* Hippopotamus. Elephant. *Brilliant.* Baboon, Leopard, Ermine.	*Large and Bright.* Tiger, Lynx. *Deficient, no eye-lid.* Whales. *Covered.* Typhlus.
Powerful. Ostrich. *Weak.* Wren.	*Lofty.* Ostrich, Casoary. *Lowly.* Wren, Creeper.	*Dusky.* Vulture, Crow, Shag. *Brilliant.* Parrot, Trogon, King's Fisher.	*Large and Bright.* Eagle. *Deficient or Small.* Divers, Auks.
Powerful. Crocodile, Boa. *Weak.* Tree-frog, Blind-worm.	*Long.* Crocodile, 25 feet. *Short.* Green Frog, 2 inches and a half.	*Dusky.* Black Toads, Snakes, and Lizards. *Brilliant.* Many Snakes, Lizards, &c.	*Large.* Crocodile. *Small.* Snakes.
Powerful. Shark. *Weak.* Minnow.	*Long.* Sharks, 30 feet. *Short.* Stickleback, 2 in. and a half.	*Dusky.* Black Ray, Sole, Eel. *Brilliant.* Gold Fish, Mackarel, Dolphin.	*Large.* Trichiurus. Most bony fish. *Small.* Most cartilaginous.
Powerful. Lobster. *Weak.* Cancer Pulex.	*Long.* Lobster, 2 feet. Centipes, 10 inches. *Short.* Shrimps, 1 inch and a half.	*Dusky.* Lobster. *Brilliant.* Several Crabs and Cray fish.	*Large.* Lobster. *Small.* Scorpion, Monoculi.
Powerful. Hercules Beetle. *Weak.* Gnat.	*Long.* Mantis, 10 inches. *Short.* Acarus, 20th of an inch.	*Dusky.* Beetles and Brown Moths. *Brilliant.* Butterflies.	*Large.* Gryllus. *Small.* Dytiscus.
Powerful. Sepia. *Weak.* Nerita Slug.	*Long.* Sepia, arms 30 feet. Gordius Marinus 30 feet. *Short.* Least Nerita, 20th of an inch. Infusory Insects.	*Dusky.* Black and Brown Slugs. *Brilliant.* Actiniæ.	*Large.* Sepia, Strombidæ. *Small.* Snails. *Doubtful.* Myæ, Mytili.
Powerful. Oak, Cedar. *Weak.* Mosses.	*Lofty.* Araucaria, Lambert pine, above 200 feet. *Lowly.* Lichens, Mosses.	*Dusky.* Atropa. Many Fungi. *Brilliant.* Dahlia, Tulip, Ranunculus, &c.	*Sensibility to light.* Strong in most. *Weak.* Clavaria digitata and Hypoxylon. Truffle.

Classes.	Scents.	Lungs.	Stomachs.
Mammalia.	*Strong & offensive.* Mephitis, Skunk, Badger, Fox. *Sweet.* Civet, Musk, Cow.	*Lungs.* *Large and double, Indispensable to circulation.* Generally. *Relatively small; not constantly in action.* Aquatic, Phoca, &c.	*Simple.* Carnivora. *Complex.* Herbivora.
Aves.	*Strong.* Gannet. *Sweet.* Grous, to some, especially when dressed.	*Large in proportion: requisite to flight, &c.* Most Birds. *Admitting suspended action.* Diving Birds.	*Simple.* Carnivorous. *Complex.* Granivorous and Herbivorous.
Amphibia.	*Strong.* Crocodile. Snake, when angry. *Sweet.* Crocodile, to Indian olfactories.	*Large and double.* Crocodiles, Turtles. *Small, and almost single.* Serpents, Frogs, and Lizards. With gills when young.	*Simple.* Serpents, Lizards. *More Complex.* Turtles, with papillæ in the æsophagus.
Pisces.	*Strong.* Shark. *Sweet.* Smelt.	*Large relatively.* In the cartilaginous the branchiæ take the form of sacs, like the cells of lungs. *Small.* Gills.	*Simple.* The generality. *Complex.* Squalus Maximus, living chiefly on vegetables.
Crustacea.	*Strong.* Crabs when boiled. *Sweet.* Prawns when boiled, at least more agreeable.	*Large & interior.* Crabs, Cray fish. *Small & exterior.* Shrimps, Apus.	*Various.* With internal teeth. *Membranous.*
Insecta.	*Strong.* Bugs, Coccinella. *Sweet.* Cerambyx, Moschita.	*Large and Small according to species.* Air penetrates the vascular system by a variable number of stigmata, small apertures.	*Simple.* Neuroptera. *Complex.* Grylli, Coleoptera. With and without gizzards.
Mollusca.	*Strong.* Murex, like garlick. *Sweet.* Sepia Moschata.	*Large.* Pulmonary bags in Slugs. *Small.* In most Gasteropoda. *Various.* In gills of Cephalopoda.	*Simple.* Helix. *Complex.* Sepiæ.
Plantæ.	*Strong.* Crown Imperial, Onion, Stapelia, several Fungi. *Sweet.* Rose, Jasmine, &c.	*Large.* Leaves of Musa Paradisiaca, 8 feet in length, and 3 in width. *Small.* Pines, Grasses, Junci.	*Simple.* Acotyledonous and Monocotyledonous. *Complex.* Dicotyledonous.

Viscera.	Nervous System.	Osseous System.	Sleep.
Vascular System. *More complex,* Terrestrial. *Less,* Aquatic.	Brain. *Plus.* Man and proximates. Hemispheres to cerebellum 1 to 1-9th. *Minus.* Mouse. Hemispheres to cerebellum 1 to 1 half.	*Plus and Minus.* Dorsal vertebræ. Bradypus 23. Man 12. Supporting ribs. Cervical, Man 7. Bradypus 9.	*By day.* Carnivora. *By night, at intervals.* Herbivora, Rodentia.
More complex. Terrestrial. *Less.* Diving Birds.	Brain. *Plus.* Eagle, 1 to 160 weight of body. *Minus.* Siskin 1 to 230.	Owl, vertebræ 40. Heron 42. Dorsal vertebræ fixed in most birds, moveable in Ostrich and Cassoary.	*By day.* Owls, Caprimulgus. *By night.* The greater number.
More complex. Lizards. *Less.* Batrachia.	Central Mass. *Plus.* Lacertæ, Chelonia, and Ophidia. *Minus.* Batrachia.	Vertebræ dorsal and sacral. Fixed in Tortoises. Moveable in Sauria. Number variable.	*By day.* Serpents. *By night.* Lizards.
More complex. Cartilaginous. *Less.* Osseous.	Spinal Mass. *Plus.* Long in Salmo, &c. *Minus.* Short in Lophius, &c.	Carp, vertebræ 41, caudal 16. Gadus lota Barbel, total 57, caudal 33, Eel 115, Shark 200.	*By day.* Eels. *By night.* Those which feed and sport in sunshine. Salmon, &c.
More complex. Crabs. *Less.* Scolopendræ.	Cerebral Ganglion. *Larger.* Varying in most divisions. *Less.* Variable.	Jointed Shells. *Plus.* Lobster. *Minus.* Crab. *Plus.* Scolopendra. *Minus.* Scorpion.	*By day.* Scorpions. *By night.* The smaller aquatics, Prawns, &c.
More complex. Grylli. *Less.* Hymenoptera and Diptera.	Cerebral Ganglion. Variable with respect to nerves. Some more, some fewer ganglia.	Sections of Abdomen, &c. *Plus.* Hymenoptera, Neuroptera, &c. *Minus.* Pediculus, Acarus.	*By day.* Chaffers, Moths. *By night.* Butterflies, Bees.
More complex. Snail, Leach. *Less.* Tænia.	Ganglia. In all diminish, in some disappear. Nerves radiate from a collar. Nerves appear as separate globules.	Vertebral-shaped cartilages of Cephalopoda. Jelly like fibres.	*By day.* Snails, Worms. *By night.* Nautili, and others which expand in sunshine.
More complex. Those which live wholly in air. *Less.* Aquatics and Acotyledonous.	Sensibility. *Plus.* Hedysarum. *Minus.* Musci: and Lichens, which bear drying and revive.	Jointed and hard externally. Bamboo. Unjointed, Rush. Hard internally. Box, Ebony, &c.	*By day.* Anagallis, Cereus. *By night.* Tulips, Anemones, &c.

Classes.	Growth.	Life, Long or Short.	Offspring.
Mammalia.	*Quick.* Mouse, 3 months. Hare, 1 year. Sheep, ditto. *Slow.* Oran Otan, 20 yrs. Elephant, 18. Horse, 5. Lion, 5.	*Long.* Elephant, 100 yrs. Lion, 70. Horse, 30. *Short.* Mouse, 3 or 4. Hare, 7 to 11.	*Numerous.* Swine, 12 to 20. Rabbits, 6 to 8. *Few.* Lion, 4. Horse, Cow, &c. rarely more than 1.
Aves.	*Quick.* Passeres, 3 to 4 months. *Slow.* Eagles, 1 year. Swans, 1 year. Many not in ma- ture plumage till 2 or 3 years.	*Long.* Swan, 150 years. Eagle and Raven, 100. *Short.* Pigeons & Finches. 10 to 20.	*Numerous.* Parus caudatus, 16 to 18. *Few.* Eagle, 1.
Amphibia.	*Quick.* Serpents and Frogs. *Slow.* Tortoises and Tur- tles.	*Long.* Tortoises, 120 yrs. Toad, 36. *Short.* Frog, 10 or 12.	*Numerous.* Testudo Mydas, eggs, 1000. Crocodile, 100. *Few.* Viper, 10.
Pisces.	*Quick.* Minnows and Gud- geons, 6 months. *Slow.* Salmon, 3 years. Shark, ditto. Pike, ditto.	*Long.* Pike and Carp, above 200. *Short.* Minnow, 3 years.	*Numerous.* Roe of a Herring, 10,000. *Few.* Rays and Sharks one at a time.
Crustacea.	*Quick.* Prawns & Shrimps. *Slow.* Lobsters.	*Long.* Probably the larger. *Short.* Probably the smaller.	*Numerous.* Lobster, 10,000. *Few.* Scorpion, 50 to 100.
Insecta.	*Quick.* Ephemera. *Slow.* The larger Scara- bæi.	*Long.* Some 2 years. *Short.* Some barely 2 days. Grubs. Some 5 years. Some 5 months.	*Numerous.* Fleas, Lepidoptera, Bees. *Few.* Apis Muraria, 8 cells with an egg in each.
Mollusca.	*Quick.* Slugs. *Slow.* Marine Testacea.	*Long.* Probably the larger. *Short.* Probably the smaller. Gordius revives after it has been dried.	*Numerous.* The smaller Snails. *Fewer.* The larger.
Plantæ.	*Quick.* Annuals. *Slow.* Perennials.	*Long.* Oak, Yew, and Ce- dar, 1000 years. Indian Fig, 2000. *Short.* Annuals, Biennials, &c.	*Numerous.* Poppy. *Few.* Drupæ, Bilocular, &c.

Care of Progeny.	Docility or Contra.	Nidification.	Migration.
More Careful. Carnivora generally. *Less.* Herbivora.	*More.* Elephant, Dog. *Less.* Grizzly Bear, Hyæna.	*More perfect.* Beaver, Rabbit, Squirrel, Carnivora, and Rodentia. *Less.* Herbivora generally.	*Migrant.* Aretic Beasts, Lemmings, &c. *Remanent.* Aretic Wolf, Bear.
More. The weaker generally. *Less.* The stronger generally. Aquatics, Alca Torda, &c.	*More.* Finches, Parrots, Starlings. *Less.* Woodpeckers, Birds of prey.	*More complete.* Loxia Phillippina, Parus Caudatus. *Less.* Eagles, Crows, several Water Birds, Alca, Torda, &c.	*Migrant.* Swallows, Cuckoos, &c. *Remanent.* Crows, Robins.
More. Snakes, Vipers. *Less.* Turtles, Crocodiles.	*More.* Snakes, Tortoises. *Less.* Frogs.	*More.* Snakes and Vipers. *Less.* Turtles.	*Migrant.* Frogs, partially. Turtles, partially. *Remanent.* Most hybernate.
More. Salmon, Minnow, continue with the small fry. *Less.* The purely marine.	*More.* Carp, Dolphin or Porpoise. *Less.* The prickly fish, the Torpedo.	*More.* The Cartilaginous, Dog Fish, Shark, Ray, &c. *Less.* The Bony Fish generally.	*Migrant.* Herrings, Pilchards. *Remanent.* Soles, Perch, Tench.
More. Lobster and Crayfish, under their tails. *Less.* Crabs, which bury eggs in sand.	*More.* Uncertain. *Less.* Ditto.	*More.* Some of genus Cancer bury eggs in sand. *Less.* Some hatch their eggs under their tails.	*Migrant.* Land Crabs. *Remanent.* Cray fish, &c.
More. Bees, Termites, Ants, Elateres. *Less.* Lepidoptera, Neuroptera.	*More.* Bees, Fleas, Puces Travailleuses, Spiders, Trencke, &c. *Less.* Lepidoptera, Ephemeræ.	*More.* Bees, Wasps, Leaf Rollers, &c. *Less.* Lepidoptera, Neuroptera, generally.	*Migrant.* Locusts. *Remanent.* Many hybernate.
More. Buccina, Helix vivipara. *Less.* Ostrea, Bivalves generally.	*More.* Untried. *Less.* Uncertain, because untried.	*More.* Heliees, Buccina. *Less.* Ascarides, &c.	*Migrant.* Some Museles appear (as the fishermen say) in some years, not in others. *Remanent.* Many are fixed.
More. Pendulous Bells, Insect Snarers. Turning to the sun. *Less.* Naked Receptacle, open Corolla.	*More.* Capable of training, capable transplantation, Laurustinus. *Less.* Hedge Hog Cactus. Olive untransplantable.	*More.* Drupæ, Siliquæ, Capsulæ, Bulbs, Ophrys, Nidus, Avis. *Less.* Bare receptacle. Lemna.	*Migrant.* Pappus, Misletoe, Vallis neria. *Remanent.* Trees.

Classes.	Hybernation.	Benefit or Injury to Man.	Social.	Parasites attack all.
Mammalia.	*Hybernant.* Bears, Marmots, Dormice, &c. *Non-hybernant.* Dogs, Cats, Ruminants, &c.	*Benefit.* Herbivora, generally. *Injury.* Some Rodentia. Carnivora, Dog & Cat excepted.	*Social.* Herbivora generally. Lemmings, Rabbits. *Unsocial.* Carnivora generally.	Ascarides, Tæniæ, Pediculi, Acari, Echinorynchi.
Aves.	*Hybernant.* Query, whether any. The Barn Owl less abroad in winter than summer. Most silent in winter. *Non-hybernant.* The greater part.	*Benefit.* Granivora, Rasores,&c.generally. *Injury.* Rapacious, generally. Coni-rostres, many.	*Social.* Pigeons. Loxia Philippina. *Unsocial.* The rapacious.	Ascarides, Tæniæ, Pediculi, Pulices, Ricini.
Amphibia.	*Hybernant.* Most. Some exceptions between the tropics. *Non-hybernant.* Crocodile in Upper Egypt.	*Benefit.* Turtles, Iguana, Frogs. *Injury.* Rattle Snake, &c. Viper.	*Social.* Frogs, Turtles. *Unsocial.* Serpents, Toads.	Tæniæ, Fasciolæ, &c.
Pisces.	*Hybernant.* Eels. *Non-hybernant.* Salmon, Herring, &c. Most fish.	*Benefit.* Salmon, Cod, &c. *Injury.* Shark, Torpedo, Caribito.	*Social.* Herrings, Mackarell. *Unsocial.* Pike.	Tæniæ, Fasciolæ, &c.
Crustacea.	*Hybernant.* Scorpions, Spiders, Scolopendræ. *Non-hybernant.* Lobsters, Cray fish.	*Benefit.* Lobster, Crayfish, Prawns. *Injury.* Scorpions, Scolopendræ.	*Social.* Prawns, Shrimps. *Unsocial.* Cancer Bermardus.	Onisci.
Insecta.	*Hybernant.* Locusts, Cicadæ, Mole, Cricket, Beetles. *Non-hybernant.* Lepidoptera, Ephemeræ.	*Benefit.* Bees, Silkworms. *Injury.* Locusts, Mosquitoes, Chigers, Fleas.	*Social.* Bees, &c. *Unsocial.* Lepidoptera.	Acari.
Mollusca.	*Hybernant.* Worms, Snails, &c. *Non-hybernant.* Tænia, Ascaris,&c.	*Benefit.* Oysters, &c. *Injury.* Tænia, &c. Medusa urens, &c.	*Social.* Some Snails more, some less. Avicularіæ. *Unsocial.* The rarer Bivalves. Gordius.	Onisci.
Plantæ.	*Hybernant.* Most. *Non-hybernant.* Evergreens.	*Benefit.* Oak and Cabbages. Pine and Potatoe. *Injury.* Nettles and Night Shade.	*Social.* Grasses. *Unsocial.* Rafflesia, Missletoe.	Missletoe, Dodder, Lichens, Fungi, Clavaria, &c.

Observations on the Table of Analogies.

It is not assumed that the subjects selected and named at the head of each of the foregoing columns are, even nearly, all which might have been chosen for a synoptical exemplification of analogies between different classes of animals and the vegetable world in general. Nor will it be contended, against any precise critic, that the columns are arranged in the best order, or that all the instances are certain.

The use of synoptical tables in every branch of science is obvious. They afford great aid to memory: but also on frequent review they suggest continually to the inquiring mind new traces of undiscovered relations.

Differences for the most part strike the senses readily. Similitudes require a second thought; perhaps a third. Analogies, or the mutualities of relations, demand a fourth, a fifth, or a sixth. Differences are numerous as the possible objects of the senses or of thought. Similitudes and analogies are limits of differences; the indices of groups, of distinct assemblages, the standards or insignia which designate divisions as in military arrangement, brigades, regiments, companies, &c.

Infinite diversity indicates infinite extent of power. Innumerable adaptations to good display immeasurable goodness in the Power which has ordained the adaptation.

Universal analogy, as already observed, demon-

strates unity of design, and therefore of the designing Mind, coextensive with infinite diversity, with infinity of power.

Some writers on natural objects have contented themselves with detailing particulars respecting individuals, either animals or plants, without extending their thoughts or inquiries to any relation which may connect these, or those which are absolutely in all respects similar, with others which are strictly and constantly similar in one important respect, or in two or in three respects, but differ widely in many others, or in most respects.

" Buffon (says Dr. Shaw, Lecture II.) seems to have taken a pleasure in endeavouring to depreciate the merit of systematic arrangement in general, and more particularly that of Linnæus." Linnæus disdained a reply to one who could reckon the objects of nature without admiration of their mutual relations: like a child amused with a miscellaneous heap of coins, the relative values of which it might be incapable of comprehending. Buffon, indeed, collected much important fact, and detailed his knowledge with eloquence: but his eloquence becomes tedious, because his details are without connexion. Classification would have given continuity of interest to his narrative, while it would have abridged his diffuseness.

It seems to be scarcely conceivable that any rational being should look around him and discern the various conditions of variously organized beings without observing at the same time that some single

relation or affinity belongs to all: organization, for example, which is predicable of plants as well as of animals. Some additional affinity, indeed several affinities, are common to animals and not to plants. The former exert voluntary power to obtain food not in contact with their cuticle: and to move themselves, while seeking it, for the greater part, from place to place, or to change their positions on several other occasions important to their well-being. They are altogether nourished by portions of animal or vegetable matter received into interior cavities, in which such matter is destined to undergo a peculiar change, digestion. Vegetables absorb fluids by roots; but however wide their general difference, they possess many similar relations one with another of their own kind, and many analogous relations of their several kinds to various divisions of general creation, and to occasional changes in the condition of such divisions. For example; some animals are covered wholly or in part with soft fur, some with scales; some are nearly or wholly smooth, some are viscous, as eels. The verbascum, mullein, the fir cone, the tulip, the lychnis viscaria, or German catchfly, are familiar instances of similar diversities among the families of plants. Some animals require a continual supply of atmospheric air for the support of life, and die when immersed in water: some require constant immersion in water, and soon die on exposure to air. The same observation may be extended to various tribes of plants. Many animals and many plants require a high at-

mospheric temperature: many of both flourish only in a cold, and wither in a warm climate. Thus various portions of the whole terraqueous globe are adapted to various conditions of the well-being of organized creatures, and the earth is filled with goodness and enjoyment.

To those who will ask why enjoyment has its diversities, as well as other conditions of being, its plus and its minus, the natural historian can only answer, "It is a question not within the sphere of my inquiry. It relates to the motives of the great Cause of causes, of whom we are told, *the eye of man hath not seen him at any time: man cannot behold him and live. Yet hath he not left himself without witness, in that he gives us rain from heaven, and fruitful seasons,* Acts xiv. *For the invisible things of him from the creation of the world are clearly seen, being understood by the things that are made, even his eternal power and Godhead,* Romans i. 20." Pope, however, gives the true confession:

> In vain the sage, with retrospective eye,
> Would from th' apparent *what* conclude the *why*.
>
> *Moral Essay*, Ep. I.
>
> Say, first, of God above or man below,
> What can we reason but from what we know—
> He who through vast immensity can pierce,
> See worlds on worlds compose one universe,
> Observe how system into system runs,
> What other planets circle other suns,
> What varied being peoples every star,
> May tell why Heav'n has made us as we are.
>
> *Essay on Man*, Ep. I.

Locality.

Peculiarities of external form and of internal structure manifest the destination of the greater part of several distinct classes of organized beings to live wholly in atmospheric air. Animals of these classes have lungs through which the circulating blood finds continual passage to the double or four-chambered heart; the principal chambers of which have no common or direct communication with each other, but send blood from one to the other through valvular passages or tubes. The right ventricle opens into a minor chamber, the right auricle, and this into the trunk of the pulmonary artery, which conveys the blood into the left ventricle, from whence it is impelled into the left auricle, and into the great tube or trunk of the aorta. Valves opening only in one direction admit the progress of the blood from veins and lungs, through the heart, to arteries, but, closing against all impulse in an opposite direction, wholly prevent its regress.

But in the fœtal state all these animals live and grow without access to atmospheric air. Their lungs, though fully prepared for future use, are then useless, as the eye, so excellently instanced by Paley, is prepared in darkness for future light. During this period, however, the communication between two of the chambers of the heart is direct through the foramen ovale.

This opening between the auricles is closed in almost all mammalia as soon as the lungs begin to exercise their functions: but not in all. Such as

seek their food chiefly under water, and whose breathing is frequently for a long time suspended, retain the aperture; as the beaver and sea otter. Other peculiarities, connected with the principal organs of respiration and circulation, connect together seals and sea otters, porpoises and tortoises, and the diving birds; such as a considerable dilatation of the vena cava. Varieties, even partial exceptions, exist however in different genera, as in the dugong, in which the ventricles of the heart form two distinct organs. The foramen ovale was found closed in the young animal. Home Phil. Trans. 1820[b].

Varieties of structure manifestly adapt all organized beings to different conditions of existence: but the same mode of adaptation is not always chosen to fit all, placed in any definite condition, to such state.

[c] Again and again, in every part of nature this

[b] See Carus, Introd. to Comp. Anatomy, translated, with notes, by Gore, p. 296, 297.

[c] In Dugald Stewart's "Philosophy of the Active and Moral Powers of Man," vol. ii. book 3. chap. 2. sect. 2. 8vo. in a chapter containing a beautiful and comprehensive survey and refutation of the perverse sophistry of the most *mis*-leading sceptics and atheists, the remark in the text is thus anticipated.

"There *are* a great variety of cases, particularly in the animal economy, in which we see the same effect produced, in different instances, by very different means; and in which, of consequence, we have an opportunity of comparing the wisdom *of nature* with the ends *she* has in view." "Art and means," says Baxter, (Inquiry into the Nature of the Human Soul, vol. i. p. 136, 3d ed.) "are designedly multiplied that we might not take it (in the order of creation) for the effect of chance: *and in some cases the*

fact is forcibly obtruded on our notice. A certain definite mode of being is generally adapted to a certain definite end. But no absolute necessity binds the means to the end. The mode generally adopted may be, and doubtless is, the best; but the varieties of modes adapted to similar conditions demonstrate that the end has not influenced and controlled the contriving and adapting power, which might have chosen another mode, and which does occasionally adapt widely different modes to the same purposes. In man the principal organs of locomotion are the lower limbs: in the bat tribes, and in the aquatic mammalia, they are the fore limbs. In most quadrupeds the locomotive power is equally allotted to all the four extremities.

If we survey the seven different classes of animals, so widely separated from each other in their leading differential characters, and by their general locality, we shall readily observe a capability possessed by several in each class of animals, and in the vegetable kingdom, to subsist in a local condition for which the generality are unfitted. Of these, the first and second columns notice familiar instances. The lion is thus viewed in analogical ratio to the otter and manati, as the eagle to the coot and the penguin; as the boa constrictor to the turtle, or allegator, or siren; as the flying exocœtus, and eel, and callichthys to the herring, pilchard, and trout;

method itself is different, that we might see it is not the effect of surd necessity."

as the land crab[d], scorpion, and scolopendra to the lobster and cray fish; as the bee and butterfly to the gyrinnus natator, hydræna, dytiscus hydrophilus[e], &c. or the tarantula to the diving spider; as the helix pomatia to the medusa; as the oak and thorn to the fucus and alga.

Climate.

Britain is too cold for the giraffe, too hot for the

[d] Some crabs appear to prefer fresh to salt water; some live almost woolly on land; some live and burrow in banks near the sea, but never enter it, and even die when plunged into it. See Mr. Broderip's Essay on the habits of Paguri, Zoological Journal, No. XIV. 1828, p. 207. In the same number is a very curious account, by Dr. Hancock, of fishes, &c. in Demerara; particularly of a fish called *callichthys littoralis*, which by peculiarities of organization is enabled to travel to a great distance, and during a whole night, over land. "I have ascertained," he says, "that the flat head hassar will live many hours out of water, even when exposed to the sun's rays. The Indians say they carry water with them for a supply on their journey. Their motion is said to resemble that of the two-footed lizard. They project themselves forward on their bony arms, which form the front of each pectoral fin, and advance by the elastic spring of the tail." Some aquatic mammalia are wholly maritime, as trichecus rosmarus, phocæ, &c.; some belong to fresh water, as the rat, the common otter, and beaver. Thus among birds the albatross and puffin are marine; the brown diver and water hen fresh water inhabitants; the turtle and hydrus are oceanic; the crocodile and natrix fluviatiles; the turbot and dory of salt, the trout and chub of fresh water; monoculi pycnogonides of salt, gyrini of fresh water. So also the nautilus, conus, &c. are of salt, the planorbis and limnæa of fresh water: and among plants, fuci, algæ, and confervæ, live wholly in marine, stratiotes, water milfoil, &c. only in fresh water.

[e] See Kirby and Spence, vol. iv. p. 500.

polar bear; too cold for the touraco and the humming bird; too hot for the eider duck, perhaps for the fieldfare and brambling in summer; too cold for numerous lizards, and most of the snakes, yet the lacerta aquatica is found torpid indeed, but embedded in ice in Lapland. The herrings which abound in the northern seas are unknown between the tropics. The tropical seas abound with genera unknown to the more temperate, and of course to colder latitudes. Many of the crustacea, both of land and water, never pass the tropics. The Mediterranean sea has many which never reach the British channel. We are safe from the scorpion, and need not regret the absence of some singular varieties of crabs and crayfish. The cancer Norwegicus, of a pale red, mottled with yellow, is not found even so far south as our coasts. The land crab abounds in the Bahamas, but does not appear beyond the tropics. A species of humble bee, bombus arcticus, is not known to leave the arctic circle: the bombus lapponicus is found a little further south: the dytiscus marginalis, common in Greenland, is found throughout Europe. Elevation of land above the level of the sea must in this view be considered as equivalent to variation of climate; at least to the change from the climate of the mountain base to that of its summit[f]. Meridians of longitude also limit the distribution of insects. Mr. Latreille enumerates insects which he calls *meridional*, *onitis*, *mantis*, *ful-*

[f] Kirby, vol. iv. p. 485.

gora, &c.; but for copious information upon this head, it suffices here to refer to the chapter on the geographical distribution of insects, in the fourth vol. of Mr. Kirby's Introduction to Entomology.

"The insect climates," he observes, "or those in which certain groups or species appear, may be regarded as fixed by the will of the Creator, rather than as certainly regulated by any isothermal lines. Tournefort observed at the summit of mount Ararat the plants of Lapland; a little lower those of Sweden; next, as he descended, those of Germany, France, and Italy; and at the foot of the mountain such as were natural to the soil of Armenia. The same has been observed of insects. Those that inhabit the plains of northern regions have been found on the mountains of the southern: as the beautiful and common Swedish butterfly, Parnassius Apollo, on the mountains of France, and prionses depsarius on those of Switzerland."

Latreille, after dividing the globe into twelve climates, seven above and five below the equator, and subdividing these by lines of longitude, "has also pointed out another index to insect climates, borrowed from the flora of a country. Southern forms in entomology," he observes, "commence where the vine begins to prosper. They are dominant where the olive is cultivated. Species still more southern are compatriots of the orange and palmetto. Some equatorial genera accompany the date, the sugar cane, the indigo and banana[f]."

[f] Kirby and Spence, vol. iv.

The pine of Norway withers, and the oak is unknown, where the araucaria rises to the height of 200 feet. The adansonia is found 80 or 90 feet in girth. The climate of Spitzbergen has about 30 or 40 species of plants; Iceland a few hundred species. Some thousands belong to the temperate, many thousands to the torrid zone.

Dicotyledonous plants increase in warm climates; acotyledonous toward the pole. The monocotyledonous, requiring generally much moisture, abound in temperate rather than in hot climates. Annuals for the most part shun the extremes of heat and cold. The total number of plants now known is about 60,000, divided by Decandolle into about 5000 genera[g].

Food.

All organized beings appear to be endowed, within certain limits, with means of inflicting or repelling injuries. The manifest possession of these means is doubtless more or less connected with, produces or influences, and becomes the index of peculiar habits.

But as some are destined from their birth to some peculiarity of local condition, as to live on land or to live in water, to flourish in a warm or in a cold climate; so some appear to be destined to seek their food from the flesh of other animals, either fresh or

[g] See Mrs. Marcet, "Conversations on Vegetable Physiology," said to have been revised by Mr. Decandolle; the substance of whose lectures it professes to convey in the form of dialogue.

putrid, and to be therefore especially endued with adequate implements and powers of destruction, cutting, piercing, and lacerating, or of suction and ingurgitation; some to subsist chiefly or wholly on vegetable food, and to be endued accordingly with teeth for crushing and grinding; and to be deprived of claws, which are not wanted for seizing and rending herbage. These circumstances doubtless decide the dispositions and influence the habits of animals in the first instance. They are active, because they are destined to and fitted for activity: they are ferocious, in obedience to a primary instinctive impulse. Others are mild and sluggish, timid and shy, as if conscious of deficient power. There are in these cases, as in most other conditions of natural objects, certain extremes, and media occupied by individuals between those extremes. These natural characteristics approach nearer to, or recede further from, either extreme in the same individuals, perhaps, at least, amongst those of the same species, according to other influencing circumstances: such as a copious and constant supply of natural food, and greater or less familiarity with man; or peculiar states of body.

Considered as endued with means of offence and defence, with characteristics of a repellent or attractive nature, some individuals at least, in every class, bear to others of the same class a similar relation to that which is borne by other individuals of wholly dissimilar form and of a different class to some individuals of the latter class. Thus the lion is to the

sheep as the eagle is to the pigeon; the crocodile to the slender wall lizard; the shark to the mullet; the scorpion to the shrimp; the hornet to the aphis; the sepia octopus to the earth worm[h]; the thorn, the bramble, the thistle, the nettle, the aloe, and the cactus to the cabbage, the spinache, and the purslane. On the front of each, on one side, appears inscribed *Noli me tangere;* on the other, *Yielding and mild inoffensiveness.*

We may here extend our notice to the column

Covering.

The rhinoceros, the porcupine, the manis, the armadillo are clad in external armour, of which man and most animals are destitute; none indeed being without adequate compensation: man, the most bare, having reason, Τῷ καὶ σίδηρον νικᾷ καὶ πῦρ καὶ πάντα, by which (not without his share of instinct, and further aid of divine instruction) he softens metals, and gives form to rocks, marches on the ocean, mounts the air, controls the steam, and gas, and fire, and the electric fluid to his purposes;

> "The powers of all subdued by this alone,
> Is not this reason, all these powers in one?"
>
> Pope, Ep. I. 231.

The plumage of some birds is compact, stiff, and redundant: that of the turkey is remarkable among the larger, of the humming bird among the smaller

[h] Meckel says of the mollusca generally, "Les acéphales sont zoophages, les gasteropodes, la plupart, phytophages."

land birds; that of the shag among water birds. It may suffice to instance the owl amongst the land, the eider duck amongst water birds, as thickly clad, having in this respect analogy with the sheep and the lama. The camel is partially bare, with numerous callosities; the baboon has bare portions; the deer tribes are thinly coated; the hog yet more scantily; the elephant[i], hippopotamus, and manati are almost bare[k]. The neck of some vultures, of the jabiru and of the ibis, are bare; the neck and leg of the ostrich are nearly featherless. The grakle, the pintado, the turkey, are bare-headed; the penguin is bare-winged, the cassowary nearly so. The palamedea or anhima has a horn upon the head and spurs on the wings; the wings of the ostrich are terminated by a claw, and another is on the spurious wing; those of the parra are armed with spurs. The quills of the cassowary are plumeless, almost like those of the porcupine. Many birds have leg armour: the gallinæ have for the greater part spurs which they employ in combat; in some these are doubled, and occasionally trebled on each leg. The horn of the anhima has been mentioned. To this notice may be added a singular horn upon the head of the ampelis carunculata[l]. The whole tribe of buceros are crested with a vast expansion of horny

[i] Bishop Heber mentions a hairy variety of elephant among the Himalaya mountains.

[k] A variety of dog from Egypt, commonly called the *Barbary dog*, is quite bare; chien Turc, of Buffon.

[l] Procnias, of Illiger, Araponga.

excrescences, equal in proportion of magnitude, compared with the body, to those of the rhinoceros, the bull, or the deer.

The amplitude of covering and external armature which is observable, augmented in some to a maximum, diminished in others to a minimum, among beasts and birds, is no less remarkable in other classes of animals and in the vegetable kingdom. The crocodile is coated in mail, with elevated laminæ extending down the back in a double line united in one line on the upper part of the tail. The frog is bare. The backs of the iguana and lacerta basiliscus exhibit spinous processes[m]. Among fish some are conspicuous in their scaly covering: the salmon, the carp, and the perch afford familiar instances. In some the whole body appears bare, or only enveloped in slime, the scales not being visible without a microscope; as in the muræna and eel. Some are remarkable for the glossy smoothness of their appearance, as the mackarel; some are tuberculated and thorny, as the ray; some with partial bony plates, as the sturgeon; some rough like a rasp, as the shark and dogfish; some covered with spines like those of the porcupine, as the sea scorpion, the diodon hystrix, ostracion, &c. Of the crustacea several crayfish are remarkable for their tuberculated, spinous, and hairy covering[n]; some, both of land and water, are clad in smooth and polished mail, as the scorpion and the prawn.

[m] The sirens of Carolina and of Carniola are smooth as eels.

[n] Cancer araneus, C. hirtus, C. scorpio, C. maia, C. homarus, &c.

[o]Insects are either covered with hair or without hair; with slight scales or without them; with horny armour or without it; endued with formidable horns, or without them. Of the first, Mr. Kirby observes, " I may mention the long hairs, stiff bristles, sharp spines, and hard, tubercular prominences with which many caterpillars are clothed and studded. That these are means of defence is rendered more probable by the fact that in several instances the animals so distinguished, at their last moult, previous to their assuming the pupa, in which state they are protected by other contrivances, appear with a smooth skin. The powers of annoyance, by means of their hair, with which the moth of the fir and the procession moth are gifted, are doubtless a defensive armour to them. But the most striking instances of armour are to be found in the hemiptera order, amongst the cicadiadæ: of this kind is the cicada spinosa, the centrotus clavatus, and centrotus globularis, so remarkable for the extraordinary apparatus of balls and spines, which it appears to carry erect,

[o] See Carus, Introduction to Comparative Anatomy, translated by Gore, vol. ii. p. 118. One kind of productions from the surface of the skin which arrives at a high degree of developement in the articulata, first presents itself in the vegetable kingdom, viz. hair. The dew-worm has small bristles, which serve partly as organs of motion. The hair of the nereides, particularly those which glitter so abundantly in the aphrodita, is soft and bristly. Even in the crustacea, notwithstanding the petrified surface of the skin, the hairs do not disappear; we find them evident on the edges of the scuta; on the legs, where they protrude from the pores of the shell; and, above all, on the outermost pair of maxillæ in the crayfish, &c.

like a standard, over its head. The soft cicada spumaria is protected by its froth, the aphides are involved in their soft, cottony secretion. The slime which covers the caterpillars of the saw flies, tenthredines, retains its humidity though exposed to the fiercest sun[p]."

Of the class Mollusca some of the most known are nude and smooth, as several of the garden slugs; some are covered with shells of various degrees of hardness, and conspicuous for their spinous processes. The most remarkable of these are the echini, the crust of which, however, is not identical with the shelly covering of the true testacea. The starfish have also a crustaceous, tuberculated skin, more or less rough and hard in different species: the nereis gigantea appears to be covered with long iridescent hairs of great beauty: in the aphrodite aculeata the bristles are arranged along the whole of the lateral surfaces of the body in about thirty-five transverse rows: the Medusa pulmo is of a gelatinous consistence, and throughout of glassy transparency. Analogous coverings of plants are amongst the most familiar of natural objects. The downy verbascum is contrasted with the smooth tulip and orchis, the bristly cactus with the crinum; the rugged coated ilex with the smooth birch, the elm with the beech; the white thorn, mespilus oxyacantha, with the euonymodus in the same hedge; the nettle and thistle with the harebell; the rosa spinosissima with its neighbour the honeysuckle.

[p] Introduction to Entomology, vol. ii. p. 225 and 228.

Mouths.

The mouths of all animals, of every class, which prey on the blood or flesh of others, are provided with adequate instruments to pierce, to cut, and to masticate, or prepare for the stomach their necessary food. Those which are destined to seek subsistence from vegetable juices possess an equally suitable but different formation. Here again we may observe a maximum and minimum, with variations between the extremes: between the lion, and tiger, and wolf, the sloth, the ant-eater, the echidna and ornithoryncus. The quadrumana, many cheiroptera, many plantigrada, are mixtivorous: their cutting and piercing teeth are varied accordingly. These diversities and important adaptations afford a basis for scientific classification: the detail is duly exhibited in the best modern books of natural history. It may here suffice to observe, as the formidable array of fangs in the mouth of the lion contrasted with the half toothless sheep and toothless ant-eater; such are the terrors of the eagle's beak compared with the flattened mandibles of the grazing goose and the pipe-shaped sucking bill of the woodcock; such the terrific jaws of the crocodile, to the smooth mouth of the turtle and frog; such the serried rows of spikes within the mouths of the shark and pike, and the various teeth of the anarrichas, or wolf-fish, to the unarmed sucker of the sturgeon, and the soft, leather mouth of the carp, the chub, and the gudgeon. The mouths of crustacea are not conspicuous; but some are armed with more, some with less powerful jaws in

proportion to the hardness of their general armour: some have a long, projecting, serrated spear over the mandibles, of which others are destitute, as those seen in prawn compared with the shrimp. The instruments for crushing their prey, however, whether vegetable or animal, in most of the tribe are their claws; which in some are tuberculated and serrated, and are formidable means of offence and defence, as in the lobster: in some, as in the shrimp and prawn, and especially the monoculus, they are little if at all applicable to these purposes. The mouths of insects possess, according to their various destinations, almost all the cutting, boring, and sawing instruments of human artisans. Yet many live their allotted period, with abundant supply of food, and all other comforts, without such machinery, imbibing liquids by the means of suckers. Cuvier has, accordingly, in his Anatomie Comparée, divided Insecta into two sub-classes, thus: with maxillæ, gnathaptera, neuroptera, hymenoptera, coleoptera, orthoptera: without maxillæ, hemiptera, lepidoptera, diptera, and aptera. These divisions include the mandibulata and haustellata of Clairville, admitting also some crustacea. See Kirby and Spence, vol. iv. p. 463. See also the minute, curious, and amusing detail of the carpentry of tree-hoppers and saw-flies, chap. vii. vol. iii. part i. of the Library of Entertaining Knowledge. The instruments indeed there described are not placed in the mouth, but in the tail, and adapted not to procure and secure prey, but for the purposes of oviposition. The parrot-beak of the cuttle-fish is the

most powerful instrument possessed by any of the animalia mollusca: but the garden snail possesses eight effective teeth, and all gardeners know too well the extensive ravages to which he is capable of directing them. The pyrosoma, holothuria, the pulmo, or sea jelly, the actiniæ, are either one single soft sucker, or composed of many. The mouths of plants may be generally said to be in their roots: but in fact they are for the most part all mouth: the blossoms, leaves, and stem of many exhibit several analogies with mouths of animals. Blossoms, leaves, and stems are not unfrequently armed for offence and defence. The blossoms of the stapelia and of the apocynum attract flies into their throats: when bristles pointed inwards, like those on the lion's tongue, and like teeth on the palates of many fish, prevent their escape. The hollow leaves of the saracenia swallow numerous insects, the putrescence of which probably contributes to the vigour of the plant. The ensnaring leaves of the dionæa muscipula and sundew are well known. The calyx, the stem, and the leaf are often surrounded with repulsive thorns or prickles, or with stinging hairs or bristles, and with viscous varnish, by which insects are entangled and destroyed, and other assailants deterred.

Feet.

The feet and teeth, in most classes of animals, have a striking mutual accordance: with exceptions, however, which are just sufficient to shew that even

here no strict physical necessity controls the designer and framer of the organs. As the roots sustain the trunks of most plants, so do the feet those of most animals. They are, amongst animals, not merely props to the body, but, to most tribes, these, or parts manifestly analogous, as wings and fins, are principal organs of locomotion. They are, in many classes, concurrent with teeth, as instruments of defence and offence. In every class there appears to be a designed division of the whole into at least two sub-classes, as, those with armed, and those with unarmed feet. These distinctions, in concurrence with the teeth, are indices of destination to particular food. The concurrence serves to remove doubt as to destination, where each singly may be given to compensate for a deficiency of the other, either separately or in cooperation with other parts of the form or frame. The sloth, for example, without incisive or canine teeth, possesses powerful claws, used in struggling with assailants, rending bark and climbing stems of trees. The mouth of the wolf is less formidable in appearance than that of the tiger: his claws are less hooked, and they are not retractile: but this small difference is abundantly compensated by the tight muscular bracing of his frame, and other conditions of organization which give him superior power to pursue his prey. Neither the lion or tiger, or any of the cat kind, with one exception, chase and pursue their prey. They attack from ambush by a sudden and tremendous spring. Their descent from their leaps would be attended in

most other animals with a rupture of blood-vessels, muscles, and tendons, and fracture of bones. As a ball of glass thrown on a pavement is splintered in pieces, while a ball of India rubber bounds away uninjured, so the elastic soles of the feet of the lion and leopard, &c. sustain them in safety where the legs of a horse or even of a dog would have been broken[q]. The flexibility of the vertebral column is also suited particularly to the action of these animals: a rupture of the brachial artery would attend such exertion of the fore limbs in other quadrupeds[r], in these it is protected by a peculiar passage through the os humeri. The bones of the lion, and of the cat kind in general, are harder than those of other animals. But the prominent character of their feet is to be found in the retractile, arched, and pointed talons[s]. As the tremendously armed foot of the lion, when compared with that of the camel, the elephant, or the hyrax; such is the five-taloned foot of the eagle compared with the bisulcate pad of the

[q] See Library of Entertaining Knowledge, vol. i. part i. p. 173, where the foot of the lion is ingeniously compared with that of the gryllus salticus, and of the acryolium biguttulum.

[r] But Bingley observes of the chamois, "They throw themselves from a rock of nearly thirty feet perpendicular height, and continue so to descend till they reach a proper resting place. The spring of their tendons is so great, that when leaping about among the precipices one would almost imagine they possessed wings instead of legs."

[s] The cheta, or hunting leopard, felis jubata, is said to differ from all of the cat or tiger kind, in having claws very slightly if at all retractile. Its habit in pursuing its prey also differs proportionally from that of other leopards.

ostrich, or the webbed paddle of the duck: such the powerful claw of the crocodile compared with the soft, round-tipped paws of the stellio inunguis, the salamander, and the frog[t]: such the pointed, thoracic fins of the scorpæna and perch, to the soft, round, and short paddles of the sole and lampern: such the powerful claws of the lobster and scorpion to the weak feet of the shrimp, and the foliaceous feet of the order xyphosura, genus limulus, the monoculus polyphemus, and to the ovate hinder feet of cancer depurator; also of the cancer latipes and velutinus of Pennant; also cancer salinus, in salt pans at Lymington: such the deep-notched paws of the mole-cricket[u], to the plush-lined soles of the chrysomela and curculionidæ, and the suckers of the fly and the gnat. The mollusca, indeed, do not afford any instances of horny claws: but some possess formidable limbs armed, for their especial purposes, with antennæ and papillæ, as the sepia and asteriæ, of which others, as the slugs, &c. are notoriously destitute. Roots, which are the feet of plants, are in some so hard as to pierce the toughest soil, through the foundations of walls, and to split rocks by expansion of their fissures: others, as most perennials, wither, unless the soil around them be soft and light, and yielding to their gentle impulse.

[t] Land tortoises have thick, round feet: sea tortoises feet flattened almost into fins: fresh-water tortoises divided, but webbed claws.

[u] Kirby and Spence, vol. ii. p. 322, &c.

Tails.

Amongst quadrupeds the most cursory observer will perceive that some are distinguished by the length of their tails, some by the brevity, some by the absence of these organs. This distinction is noticeable not only amongst animals of the same class, but amongst those of the same order: as amongst the quadrumana, including monkeys, apes, baboons, lemurs, macaucos. Many, as the genus simia, are distinguished by Illiger *cauda nulla, natibus tectis;* genus hylobates, *cauda nulla, natibus callosis nudis;* genus cercopithecus, *cauda elongata laxa;* and amongst his prosimii, lichanotus or lemur laniger, *cauda aut elongata aut nulla,* referring to varieties; lemur macauco, *cauda elongata;* lemur tardigradus, *cauda nulla.* The tail affords powerful aid to most climbers, and to most of those whose progress is neither a walk nor a run, but a continual succession of springs: it aids the spring in the kangaroo; it balances the body in the bound in the jerboa, and in the cat kind, the squirrel, the fox, and the monkey, &c. Amongst horses and kine, and even amongst lions, the long tail is a valuable fly-flap. Mr. [illegible]rchell, in his very interesting account of his journey into the wild interior of southern Africa, mentions the hunting hyæna as addicted to assail the larger cattle in the night, and suddenly biting off their tails: the consequent loss of blood, and distress from the torment of insects, may reduce their strength, and render them afterwards an easy

prey to the lion or leopard perhaps in the first instance, and the hyæna in the next. The tail of the hyæna is short, but his general covering a better protection against insects than that of the lion; that of the bear is still shorter: few of our ladies are unacquainted with the abundance of his fur. Amongst ruminants, the bull has a long tail, the sheep of moderate length, the deer tribes short. So amongst birds; many of the humming birds, the paradiseæ, the muscicapæ, hirundines, the tropic birds, the pheasants, the common cock, &c. exhibit a great elongation of tail-feathers; perhaps in this general contrasted view the peacock may be included, although his grand train be not the real tail. On the other hand, many hawks and owls have short tails; wrens, the cinclus, the tringa, the scolopax, charadrius, &c. still shorter; in the colymbus, grebe, Mormon puffin, and aptenodytes or penguin, it is scarcely visible. The contrast in amphibia is yet more conspicuous: we have only to compare lizards and serpents in general with tortoises and toads. Amongst fish the length of tail[x] is remarkable in those which nearly approach in form to serpents, as eels, the gar or pipe, the trichiurus, the sturgeon; the shortness

[x] Some species of ray are furnished with a very long and slender tail, having a sharp serrated and prickled spine extending along it, which it uses as a weapon of defence and offence. In Brewster's Journal, April 1828, is a paper by Dr. Harwood, describing a fish from Davis's Straits, which he proposes to call ophiognathus ampullaceus. It has an oval smooth bladder-like body, with a slender thong-like tail, nearly twice the length of the body. See Loudon's Mag. Nat. Hist. No. II. July 1828.

is equally obvious in the sole and the diodon. Of diodons, the most remarkable is distinguished by the agnomen, mola. "It is," says Dr. Shaw, "of a silvery colour, with a cast of bluish brown; grows to a very large size, and perfectly represents the head of some very large fish, abruptly cut off from the body." The long tails of lobsters and crayfish, which they employ with great activity in springing and swimming, are readily contrasted with the short, close, compressed tail of the crab: and if spiders be included amongst the crustacea, these may afford a no less striking contrast with the form of the scorpion. It would be difficult to shew whether amongst insects the greater number belong to the short-tailed or to the long-tailed division. One of the bright blue libellulæ, or dragon flies, and a coccinella bipunctata, called by children lady-cow, are on the same plant before my window. Not to mention the long hairs in the tails of ephemeræ, in contrast with tailless tick. "There is a tribe of minute insects amongst the aptera, found often under bark, sometimes on the water, which Linnæus has named podura, a term implying that they have a leg in the tail. This is literally the fact. For the tail, or anal extremity, of these insects is furnished with an inflexed fork, which, though usually bent under the body, they have the power of unbending; during which action the forked spring, pushing powerfully against the plane of position, enables the animal to leap two or three inches[y]." What is more remark-

[y] A common child's toy, sometimes formed to resemble a frog,

able, these little animals are thus enabled to leap upon water. Another is named by Latreille sminthurus. Amongst mollusca, the Gordius, the lumbricus, the tænia, the Argonauta, the helix, may be contrasted with the oyster, the muscle, and the medusæ, or sea-bladders. So amongst plants, numerous climbers, as peas, vines, the clematis, &c. throw out tendrils and claspers, and some send downward from their height[z], the summits of trees, long shoots to reach the ground, to take fresh root and reascend. These may be contrasted, as above, with the cactus meloe, with truffles and puff-balls.

Wings.

Undoubtedly, had it pleased the Creator, the mammalia might have been generally inhabitants of the waters, as whales and seals, or might have moved through the air, as bats. These possibilities are evinced in some species of every class. The class mammalia has its bat. Aves are, some, without the means of flight, as the struthiones and aptenodytes. Fish have their exocœtus volitans[a]; am-

sometimes a cat, is so constructed as to produce a similar spring by the elastic force of twisted catgut.

[z] The clusia rosea is a tree growing on the summits of other trees, (Mirbel.) The roots descend, and often twist together so as to form a case for the sustaining stem.

[a] Bishop Heber, just entering between the Tropics, thus notices the flying fish: "The flocks in which they skim along the surface of the waves gives them so much the appearance of water-wagtails, that a repeated and attentive view is required to convince a stranger of their actual fishhood." Letters, by Mrs. Heber.

Walsh, in his Notices of Brasil, says, "The flying fish is dis-

phibia their draco volans; crustacea, including spiders, have the means of flight in their curiously projected webs, well known to the observers of the gossamer. Amongst insects the pterota are nearly equalled in number by the aptera. Nor is the mollusca class wholly regardless of air, as a medium of locomotion.

> Learn of the little nautilus to sail,
> Spread the thin oar, and catch the driving gale.
>
> Ep. III.

The wings of the sycamore, the ash, and the maple; the feathers of the thistle, the dandelion, the epilobium, the traveller's joy, &c. present familiar instances of vegetable volatility.

Form, Height, and Length.

In surveying the exterior forms of animals and plants, no circumstance can be so obvious to general

tinguished by its immense fins, situated immediately behind the gills, which it uses as wings when it wishes to change its element. Those I saw flew forty or fifty yards when they met a wave, and plunging into the bosom of it, disappeared. A few rose over the crest, and apparently bathing their wings in the spray, pursued their flight with renovated powers. I know no object of natural history more interesting than a flock of stormy petterels, sporting amongst a shoal of flying fish, and alternating with each other's element: the little bird descending into the depth of the sea, and becoming an inhabitant of the water; the fish ascending to the heights of the atmosphere, and becoming inhabitants of the air. It is one of those exquisitely curious and beautiful links in the chain of creation, by which we suppose spiritual, and we know corporeal beings are connected; forming a regular and insensible gradation of existences, from the ministering angels below God's throne to the lowest mass of organized matter."

notice as the difference observable in every class with respect to the general character of those forms; some being low, heavy, and clumsy; others lofty, light, and graceful. Of the former, among mammalia, we may instance especially the mole, low, heavy, and ungraceful, whom we may contrast with the light and active monkey, mus jaculus, or kangaroo. We may contrast the low and massy hippopotamus, the elephant and rhinoceros, the tapir and the boar, with the lofty giraffe and the light deer and antelope, the leopard or weasel. Thus the unwieldy goose, duck, penguin, dodo, may be contrasted with the light and graceful phaethon, anhinga, tern, swallow, wagtail. Amongst amphibia, the clumsy turtle and toad with the light lizard and graceful serpent. So among fish, the ray tribe, the flounder, the appropriately named lump and diodon, with the gar, the mackerel, the trichiurus, the lampern. Among crustacea, the crab with the scolopendra: amongst insects, the beetle tribes with the libellulæ, tipulæ, &c.: among mollusca, the slug with the Gordius: among plants, the fungus and tuber, the toadstool and the truffle, with the panick and all grasses, and reeds, the birch, the mountain ash, &c. So regarding them all as contrasted in relative loftiness and length, how striking is the contrast of magnitude between the giraffe and camel, the dormouse and the minute harvest mouse, mus messorius! How singular in analogy the contrast of the ostrich with the wren and trochilus, the former eight or nine feet in height, the latter two inches and a half! The

crocodile attains the length of twenty-five feet, the alligator of eighteen; the lacerta agilis does not exceed six inches; the green tree frog is about two inches and a half. Among fish, sharks of thirty feet in length have been seen. The stickle back, like the tree frog, trochilus, and mus messorius, is rarely found to exceed two inches and a half. Lobsters have been found two feet in length, monoculus polyphemus of four feet, shrimps rarely of two inches. Amongst insects, a species of mantis is found nearly a foot in length; centipedes are seen of eight or ten inches. The acarus, or mite, is a giant amongst his kind, if he reaches the dimension of one twentieth part of an inch. Among mollusca, the sepia octopodia is said to possess arms of thirty feet in length; and the Gordius marinus is said to stretch its slender form to an equal extent. The slug, inhabiting the least nerita, scarce exceeds an eighth of an inch; the infusoria perhaps barely equal a thousandth. Thus among plants, the larch exceeds 100 feet in height, the araucaria 200, the lambert pine 215 feet: the lichen jolithus appears to be a mere purple pigment on the stone to which it adheres.

Colours.

The primary object of sight, even before distinct form is seen, is colour. Visible form indeed (as painters know full well) is only an enlightened, bounded by a shadowed, portion of space, or one colour limited by another. Faintness of light, di-

minished depth of shade, diminished brightness of colour, as well as gradually diminished form of known objects, suggest ideas of distance, and afford the means by which it is imitated on a uniform smooth surface. Light naturally exhilarates, and is associated with all our remembrances of active enjoyment. Music heard from a lake may ravish the ear with sweetness; but the sight of a happy party, with the band, in a boat gay with awnings and streamers brightly coloured, under a glowing sky, on a glassy surface, reflecting the images of lawns and cattle, and scattered villas and cabins, and woods and mountain coombs and peaks, redoubles the rapture of the harmony. The ideas of light and of colour are not to be dissociated. The solar brightness is white in its source, and infinite in its variety of refractions. But light and colour are adapted to produce in sentient beings a countless diversity of sensations beyond that of exhilaration. They are mysteriously adapted to the excitement of instincts, peculiar delights, emotions, passions, appetites. They possess powers of electric excitement, acting primarily upon the nervous system, and secondarily upon the mind: or they operate primarily upon the mind, or some analogous faculty in animals below the grade of rational; and secondarily upon the nerves and organs of healthful action. Most organized beings droop, become torpid, and wither in long continued darkness. Some eyes receive gratification in a superior degree from one colour, some from another. St. Pierre observes,

that children are generally agreeably excited by scarlet colour. It is said to produce painful excitement and angry emotion in some animals; as bulls and turkeys. Pliny observes of emeralds: "The pleasure excited by the verdure of leaves and grass is nothing compared with that derived from the emerald. It fully possesses the eye with enjoyment, yet never produces satiety: so that lapidaries, when their eyes are wearied by working on stones of other colour, refresh and reinvigorate them by looking on the emerald. The diamond," he says, "has the property of counteracting poison through the eye, and of driving away phrensy," &c. One of the Roman emperors is said to have kept a sapphire continually in his hand, observing, that the sight soothed his mind under frequent irritation. Some colours excite nausea when viewed while the nerves are in a diseased state. The most beautiful to ordinary healthful eyes may be occasionally obnoxious from ungrateful association. Every writer on the subject of the suggestion, as it is called by Brown, or association of ideas, or taste, since the publication of Allison's Essay, and on our ideas of sublimity or beauty, recognises the complexity of these ideas; which are assuredly aggregates of several simple agreeable sensations linked together in memory. It is a known fact that certain sweet notes delight the ear, certain sweet scents the nostrils, sweet savours the palate and tongue. The rose tint of the rose flower, or that of the British female's cheek, is sweetly beautiful. All produce a common emotion,

namely, delight; although the sensible objects have no resemblance. No anatomist, no microscopist,

"Can from the existing *what* conceive the *why:*"

so neither can we guess how various colours and forms act on nerves apparently identical in form and substance, and chemical properties, and local relation, in individuals of different genera and species; determining the preference of similar to similar beings, and their indifference or aversion to dissimilars. Thus the lion, in a state of nature, prefers his homely Quaker-coloured mate to that of the panther or Bengal tiger. The elephant sighs not for the giraffe, nor the swarthy hippopotamus for the gaily-striped zebra. The dull-coloured brown or grey vulture is not attracted by the hyacinthine macaw; nor the black by the scarlet ibis; nor the common blackbird by the golden oriole; nor the black and white by the green woodpecker; nor the brown by the emerald creeper; nor the sober vested heron by the bright flamingo. Undoubtedly the organs of sensation in every genus and every species of every class are especially endued with instinctive capacities for receiving gratification from such forms and colours as are adapted to guide them to their appointed destinations. Those who have ever employed themselves in colouring maps know the difficulty of selecting tints of sufficient number and contrast to distinguish numerous subdivisions. The tints of furs, and feathers, and scales, are so diversified, so combined, and so contrasted, that ordinary

eyes readily distinguish species one from another, and the males of many from the females. These discriminations act on the optics of the individuals of distinct species so as to produce peculiar excitement; doubtless barely analogous to any of which we are conscious; perhaps very different in every species of every genus and of every class. Were colours merely placed in a uniform plan, as for example, were each of the seven prismatic colours, with black, brown, and white, singly characteristic of any ten species, animal or vegetable, and their possible changes with relation to one another, as in stripes, ordained to designate other genera and species, the calculable changes of such stripes would exceed three millions. But the total known species of plants and animals do not exceed 300,000. But this methodised plan is characteristic of human operations: it has its calculable limit: not so the works of the Almighty; the stars of the milky way above us, and the dust of our summer footpath, alike baffle our calculation. But the system of stripes or spots, however exact, would not afford that instantaneous indication of each object which is afforded by the distribution of external indices, which enable species to distinguish species, and males to know their mates, even individually.

But the colours of nature are, indeed, not formally distributed in spots and squares and lines; but they are combined so as to exhibit the most elegant gradations, blending gently one with another, or contrasted so as to produce the most sur-

prising brilliancy, or bounded one by another so as to exhibit the exact tracery of patterns, not exceeded in precision by the multiplied reflections of the kaleidoscope, or the repeated impression of the same block or cylinder of the calico printer, by the lithographer, by the copper-plate graver and presser, or by the typography of the printer. The common robin, goldfinch, and bullfinch, and redstart, exhibit familiar instances of strikingly contrasted colours. The black and white woodpecker, with a scarlet poll and vent, and the green woodpecker, and the kingfisher, exhibit contrasts of yet more brilliant hues. The black lines on the white cheek of the maccaw appear to be stamped on either side by the same block: but the common pheasant, the argus pheasant, the peacock, and the tail-feathers of the menura, may be selected as the most striking specimens of exact patterns accurately repeated, the left side corresponding with the right amongst birds. Amongst insects of all kinds such instances are innumerable: the peacock butterfly, the phalæna Caia, or great tiger moth, the sphinx filipendulæ, the phalæna pavonia, the chrysis ignita, the silpha vespillo, may be named at random as the most familiar, although falling far short of the magnificent insects of Asia, Africa, and of South America, in beauty, or wonderful diversity of tracery. The tiger and leopard, many of the squirrel kind, the fallow-deer, the camelopardalis, the zebra, are sufficient examples of the same kind amongst mammalia [b]. The spectacles

[b] It is especially worthy of observation, that each hair of the

apparently drawn on the cowl of the snake, which derives its common name from them, the reticulated yellow and brown lines so regularly drawn on the scales of the boa constrictor, the checquers, the zig-zags, the diamond forms and bands of various colours in many serpents, appear like painting laid on subsequent to the formation of the scales, in continuity of pattern from the head to the tail. Similar decorations of the bodies of lizards and the shells of tortoises afford conspicuous distinctions of species, although they do not point out to the philosopher the generical indices of allied character or peculiar destination. Fish of every order exhibit markings of nice adjustment to parts and to changes of growth, with regularity of lines both strait and waving, and balanced intervals of spots of various colour. The trout, the mackerel, the flounder, afford obvious instances; but the scorpæna, coryhæna, anarrichas, and many others of rarer occurrence, are not less remarkable as to the disposition of their spots, lines, and tints, than birds or insects. The animal inhabiting the argonauta, and that of the pearly nau-

axis deer or zebra, each fibre of the feather of the peacock or Argus pheasant, each scale of the mackerel, each grain of scaly powder on the butterfly's wing, bears a definite relation to the general pattern, as much as each thread in a piece of tapestry: also that each hair, scale, and fibre is often marked with more than one colour in different parts of its length and breadth, and even on its upper and lower surface, like the threads of printed linen and calico, and of watered silks and stuffs: and the pattern owes its exactness to the nicely-adjusted juxtaposition of all these parts of each hair, scale, and fibre.

tilus, if the plate in Shaw's Zoological Lectures be correct, and many actiniæ, shew that such graphic decoration has been extended to the mollusca. It is not denied to, though less conspicuous in, the crustacea. Several species of crabs and crayfish are elegantly spotted, barred, and tinted. But in no department of nature is such regularity of delineation more strikingly and beautifully diversified than in the shells of those multivalves, bivalves, and univalves, the pholades, tellinæ, veneres, nautili, coni, volutæ, trochi, helices, &c. which enrich the cabinets of the conchologists. The blossoms and leaves of numerous plants exhibit similar instances of lines, resembling, but surpassing, the most delicate works of the pencil or the graver. Many geraniums, heart's-eases, tulips, ophrys apifera and arachnitis, carnations and poppies, sufficiently exemplify the proposition amongst blossoms: and the common striped grass, and the carduus benedictus, and the vernal orchis amongst leaves.

It yet remains to observe, that in every class of plants and animals some are as remarkable for their dark and gloomy covering as others for their gaudy colour. The instances are too familiar and numerous to need much trouble in selection. The hippopotamus may be contrasted with the leopard, the black gibbon with the variegated baboon, the crow and shag with the parrot and kingfisher, black snakes and lizards with the blue, red, and yellow species of the same races. So amongst fish we may contrast the dark grey eel with the golden lampern, the

brown sole and black ray with the surmullet and gold fish: among crustacea, the dark-coloured crabs and crayfish, with others of violet, yellow, and pink colours: amongst insects, many black and brown beetles, moths, and even butterflies, with others of their kind, the most splendid in colour of all the objects in creation. Amongst the mollusca, the actiniæ may be contrasted with many swarthy slugs, the common river muscle and the common periwinkle, buccinum Anglicum, with helix ianthina, the purple snail, the trochus pharaonis, cones, olives, &c. the common oyster with bright-coloured spondyli and pectines: and among plants many lurid and livid fungi and lichens, the atropa bella donna, plantain, carrot, and parsnip, with the rose and the tulip and the ranunculus; the burdock and hemlock with dahlia and the holyoke.

Eyes.

Animals of different classes, as well as plants, exhibit other analogies, in other relations to light. Of these relations the most important amongst animals are found in the variously modified structure of the eye. Some require, and rejoice in, the meridian splendour of the sun, some in the penumbra of evening, some in utter darkness. Of the beasts of prey, some pursue and devour, partly, not wholly, by day, and sleep partly by night; as wolves, almost all the dog kind, not excluding foxes. Although they all love to bask indolently in the sunshine, they lose no opportunity of seizing their prey within view. Yet

they commonly seek their prey in the beginning of night, in silence, being under the cover of twilight able to approach the herbivorous animals, whom their appearance would scare. The hyæna, however, sleeps by day in his cave, and the jackal in his burrow. The structure of the eye, whereby the cat kind is generally enabled to expand the pupil more widely than other quadrupeds, peculiarly fits this order of animals for nocturnal exertion. The lion, and tiger, and leopard, and all those which have retractile claws, creep, with their stomachs close to the ground, behind the thickest covert, as near as possible to their unsuspecting victims, on which they make a sudden spring; and which, on failure of their aim, they rarely pursue, or but for a very short distance [c]. Ruminant animals feed about equally by night and by day, at regular intervals, and occupy the intervening portions of time in chewing the cud. The hare and rabbit kinds feed mostly at morn and eve: the bat, the mole, and hedgehog, shun the light of day. The typhlus hardly shews even the place of an eye: the cornea is permanently covered by the epidermis, as that of the snake. Eyes vary in magnitude: those of the field mouse are large and prominent; as large in proportion to its bulk as those of the Bengal tiger. The eyes of the elephant and rhinoceros are proportionately small; as also are those of the sorex, the little proboscis

[c] The cheta, or hunting leopard, which pursues its prey, is without the retractile claw. Query whether the eye be less cat-like than that of other leopards.

bearing shrew mouse, the least of quadrupeds. The proverbially large and bright eye of the golden eagle forms a striking contrast with the small sunken eye of the duck. The eyes, indeed, of all the rapaces, or *raptatores*, (as they are called by Illiger,) when compared with those of divers and grazers, are large, and forward in the head. As the eyes of the cat kind are generally larger in proportion than those of the dog, so are those of the owls than those of the falcons. Those of the twilight-loving caprimulgus, goat-sucker, are large; those of the volatico-pascentes, the birds which feed on the wing by day, are proportionally small. The burrowing puffin, and the crevice-lurking apus, swift, or deviling, are the moles of the bird kind. Amongst amphibia, some have large and bright eyes; some, as in the former tribes, are remarkable by their minuteness. The crocodile has large eyes, so has the chameleon: in the small, burrowing, timid lizards of the perforated wall and sand banks, they are proportionally small: in serpents they are generally small, but smaller in the venomous than in the unvenomed. Of fish, the different orders exhibit similar diversities. The scaly and bony fish have generally large eyes, and appear to delight in sunshine, although they do not appear near the surface in water where the sun's rays augment its temperature. The noon is unpropitious to the fly-fisher: the scaly tribes then sink lower in the stream. Some seem to bask in light devoid of heat. Some, however, seek the shade of overhanging banks or willow roots, some the thick shelter of sub-

aqueous plants. The eyes of lobsters are large, and singularly prominent; those of scorpions, minute: the latter are eight in number, and in position resemble those of spiders. The greater number of animals possesses only two eyes: spiders have six, or more commonly eight. I know not any animal which possesses only one eye, although the ill-compounded name monoculus has been not quite correctly given to certain apterous insects [d]. The eyes of grylli and libellulæ, of wasps and of butterflies, are large and prominent; those of moths comparatively small. Those of most coleoptera and aptera are small and fixed. The eyes of snails are conspicuous at the extremity of their upper pair of flexible and retractile horns. The large eyes of sepiæ or cuttle fish are said (by Shaw) to be strung, as pearls for necklaces, on the shores of Sicily, and in other maritime parts of the Neapolitan empire. In the numerous soft-bodied inhabitants of multivalve and bivalve shells, eyes are not discoverable. Sensibility to the presence of light is unquestionable

[d] The cyclopes have two eyes, but so close together that a microscope is required to perceive their division. Monoculus polyphemus, or king crab, said by Linnæus to be the largest of insects, is stated to have two pair of eyes; two on the sides of its shell, and two on the abrupt ends of two apparently rudimental claws. Over these the shell is diaphanous, elsewhere opaque. See a paper on the curious structure of the eyes of the monoculus polyphemus by Mr. André in Philosophical Transactions. The giant strombidæ, which inhabit the Caribbæan sea, are said to have "eyes more perfect than those of many vertebrated animals; viz. a distinct pupil and a double iris, equal in beauty to those of birds and reptiles." Zoological Journal, No. XIV. p. 172.

in actiniæ and in polypes, and probable amongst the infusorial animals. Plants, for the most part, require light for the continuance of their well-being. Yet some flowers expand at morn and close at noon: some expand only at noon; the hemerocallis, the ferraria tigridia, &c.: some at eve, as œnothera, &c.: some at or near midnight, as cereus or cactus noctiflorus. Most plants, when set in shady places, turn from the perpendicular, and even twist toward the light. Yet some, as clavaria hypoxylon, and several fungi and truffles, seem wholly to belong to darkness.

Sleep.

The wakefulness and sleep of organized beings is a subject so nearly connected with that of their sensibility to light, that it shall be here briefly noticed. It appears to be requisite that nervous or other excitement from external causes, from light and sound, from objects stimulating attention, either agreeably or otherwise, should be frequently suspended by stillness, by quiescence, by darkness, by sleep: or by a state analogous to sleep in plants. It is requisite to digestion and assimilation of food, to nutrition, to growth in youth, to the preservation of health in maturity, to the various changes connected with absorption and reproduction. During such intervals, animal activity and intellect are like a bell in a clock from which the hammer is forcibly withdrawn by a turn of the machinery connected with the index, which is pointed at the word *silent*. Of mammalia,

the carnivora sleep for the most part by day, and seek their food by night: the herbivora feed and sleep at intervals by day and by night. Total darkness, however, suspends all activity. Moonlight, on the other hand, calls forth the squirrel tribes to sport in the summer, and guides wolves, the cat tribes, and the aquatic carnivora, to their prey. The Scythian antelope[e] is said to feed by intervals, which appear to be regulated by a sort of covenant. Some of the herd are constantly on the watch while the others sleep: when those of the first watch become weary, they give a signal to those who have slept, who quickly rise and relieve guard. The eyes of many quadrupeds, especially of the feline tribe, are offended by strong light: those which feed with the eyes downward are unwilling to gaze upward. Sheep form circles, turning their heads towards a centre, which is darkened by the shadow of those whose tails are turned to the sun. Kangaroos are said to possess nictitating membranes like those of owls, &c.: they lower their fore-legs when feeding. The dew on the grass and leaves of plants induces most of the herbivora to feed at the hours of twilight. Observations on the wintry sleep or torpor of many genera must be deferred till I consider the subject of hybernation. A strongly marked division of birds is notoriously nocturnal; that is to say, feeds almost wholly by twilight or moonlight. Yet more than one order, family, and genus, has its night feeders: owls, of the order raptatores; caprimulgus, of the

[e] Saiga, Linnæus, and Buffon.

family hiantes, (of Illiger;) many, perhaps most, of the waders and swimmers: hawks, rooks, the passerine genera, the gallinaceous, &c. finding all their food by daylight, sleep throughout the night. Of the amphibia a great part sleeps by day: frogs and toads come out by night in abundance: tortoises appear to be diurnal feeders, and to love the sun: turtles sleep much by day, but feed in the morning and evening: the lizard tribes in general are lovers of heat, and seek their prey in sunshine: the serpent tribes sleep and feed both by day and by night. Of fish, those which take ground baits, or feed at the bottom of waters, seek their food rather by night than by day. The land crustacea shun the blaze of noon, and feed by twilight: the aquatic feed (perhaps at intervals) by day and night. Snails and slugs, the species of mollusca with the habits of which we are best acquainted, feed at night more than by day, except in rainy or cloudy weather. Nautili, after sporting at noon on the surface of the calm Indian sea, may probably require night-sleep. Scallops, which, when deserted by the tide, move themselves by jerking motions of their shells back to the water, are said also to sail on the smooth surface of the calm sea, using one valve as a boat, the other as a sail, and forming little fleets. These, as well as nautili, may require a night's repose, while the oyster, fixed to the sunken rock or submarine roots or stakes, feeds chiefly by night. I have omitted insects: but the habits of many are so familiarly known, that a mere notice will suffice to il-

lustrate their analogous condition. Bees, wasps, house flies, butterflies, are well known as diurnal, most beetles and moths as nocturnal animals. Many plants, it is well known, are nocturnal, as the night-flowering stock and cereus. Several expand their blossoms with the dawn of day, and close them at noon, as anagallis. Tulips and anemones close their petals at eve, when œnotheræ open them. Ferraria tigridia expands about three hours before noon, and droops in as many after it. But nightly sleep, or a condition strikingly analogous to it, may in a certain sense be predicated of all plants. I shall exhibit this proposition in the clear words of Mrs. Marcet, Conversation VII. on the action of Light and Heat on Plants.

" B. The first rays of the rising sun seem to awaken the vegetable creation from a state of repose.

" C. You do not mean to infer that plants sleep during the night?

" B. I doubt whether the term *sleep* be literally appropriate to that state of relaxation and inaction which appears to afford them repose during that season. The leaves and flowers usually change their position as soon as it grows dark; in many plants the leaves drop; in others they close, as well as the petals of the flowers, and are opened by the first rays of the morning sun. The leaves then recommence their chemical operations; the spongioles (porous roots) draw up a provision for their labours; every function, which had ceased or diminished during the night, is again renewed, and the whole plant

reanimated. It is this effect, produced by light on plants, which I call being awakened." p. 137.

Scents.

The organs of sight, indeed, above those of all the other senses, display mechanical relations of parts to parts, and of each and all to the whole, and to an obvious end: but as the eye is manifestly arranged and given for the especial purpose of enabling creatures, so endued, to see; so nostrils are as plainly given and adapted to purposes of smelling, and, through that sense, to the well-being of individuals possessing them. As the sense of sight is enabled to distinguish a great variety of forms and colours, so the sense of smelling discriminates a great variety of odours; some highly agreeable, some almost insupportably oppressive and disgusting. These scents readily aid the sight in distinguishing similar objects. The house bug may be thus distinguished from some other cimicidæ which are less disgusting; "particularly lygæus hyosciami, which yields an agreeable odour of thyme[f]." The common garden balm, from the stinking horehound. Some quadrupeds, as the viverra putorius, repel assailants by offensive scents. The greater number is without much ordinarily noticeable odour, at least by ordinary nostrils, although sufficiently powerful in the deer, the hare, &c. to guide the dog in his pursuit. But in the fox and badger the scent is disagreeable to most human nostrils; while, on the other hand, civet-musk

[f] Kirby, vol. ii. p. 243.

and ambergris[g], the products of different species of mammalia, are to many highly grateful. The scent of the Solan goose is notoriously coarse, and to many nauseous: many of the carnivorous and insectivorous birds, the flesh of which is vulgarly called carrion, although not remarkable for scent when living, emit most fetid odour when heated by fire: even the elegant hoopoe is an instance of this kind. The heath tops and wild thyme impart a fragrant and generally agreeable savour to the flesh of grouse, and the pine buds to that of the capercaile. The snake when incensed emits a most nauseous odour, although scentless in its tranquil state. The crocodile is musky, and offensive to the olfactories of Europeans, perhaps grateful to those of the Indians, who eat it. The flesh of the shark is similarly disgusting. The smelt derives its name from an agreeable savour, not unlike that of our garden cucumber. Sea crabs, when boiled, yield an odour stronger and less generally agreeable than that of fresh boiled prawns. The common ant is scentless; but another species, formica fœtida, is most nauseous. Many wild bees are distinguished by a pungent smell of garlic, apis melitta, and andrena[h]. Musca cynipsea emits a fragrant odour of balm. Julus terrestris

[g] Ambergris is a hard light substance found in the viscera of whales of the physeter kind. It probably derives its odour from one of the cuttle fish, sepia moschata, on which these whales are known to feed. In the larger pieces of ambergris the horny beaks of these small cuttle fish are frequently found imbedded. Shaw's Lectures.

[h] Kirby, vol. ii. p. 244.

leaves a strong and unpleasant scent upon the fingers when handled. The cerambyx moschata, allied to the beetles, retains long, even after death, a mixed scent of musk and rose water. The slug of the murex, famed for its purple dye, yields, with its rich colour, a scent of garlic; one of the sepiæ, an agreeable odour of musk. Among plants, the memory of every one will readily supply instances of contrasted savours. The bulb of the crown imperial and of the wild garlic, the leaf of the common geranium robertianum, and alliaria, the blossom of the stapelia, the whole substance of several fungi, may be contrasted with the blossoms of the rose, the carnation, and the jasmine.

Lungs.

The organization which is unceasingly in action by night and by day, the activity of which is so continually necessary to the sustenance of life, which gives energy to the nerves, and heat and health to the blood, is that of respiration. "The respiration of animals," says Mr. Carus[i], "as it consists in the mutual action upon each other of the individual and the surrounding element, renders necessary the free and constantly renewed access of that element to the respiratory organs. This element is air, and is applied either immediately, or mediately by means of water; which must itself, as it were, have inhaled air, and must be thoroughly penetrated by it, in order to be fitted for supporting the animal respira-

[i] Introd. to Comp. Anat. translated by Mr. Gore, vol. ii. p. 141.

tory process. But in order that the access of these elements, or rather that of the single one, air, may be given to the organs of respiration, the air must in some mode envelope the surface of the body: nay, the cutaneous surface itself appears at first as the sole respiratory organ; and it is only in a more advanced state of developement of the animal body that peculiar structures, air and water cells, (lungs, air vessels, and gills,) appear; which, however, may be considered collectively as processes of the skin, ramifying sometimes internally, sometimes externally[k]. In zoophytes, polypes, and gorgoniæ, the whole surface appears to be a respiratory organ; as in plants without leaf, or where leaf and stem are undistinguishable, the cacti and junci. In the medusæ more distinct organs appear in the form of air bladders, on the upper surface of the physophora and rhizophysa: in the echini and asteriæ the tentacula appear to absorb water for respiration. These may be considered as rudimental gills; and they are noticeable as so operating in the actiniæ. The cavities of the medusæ appear to be rudimental lungs. Cavities for respiration, and external respiratory organs, appear in different species of other classes nearly allied. The ascidiæ exhibit a large respiratory cavity. In most other of the mollusca acephala, particularly those which have shells, the or-

[k] See Outlines of Physiology, by William P. Alison, M. D. Edinburgh.

Of Respiration, sect. ix. p. 173. for an interesting synopsis of facts relative to this subject.

gans of breathing have the structure of gills. In the fresh water muscle are two pair of gill-like laminæ at the mouth, and two pair on the back. In the gasteropoda, some respire water altogether, and exhibit fibrous gills, some in tufts, some in fringes. In helix and limax, which breathe air wholly, the respiratory cavity is easily distinguished. In cephalopoda, the sepiæ, is a compound apparatus, a muscular sac receiving water to convey it to the gills. In the articulata are varieties of respiratory apparatus; bladders in the dew worm and leech; gills in several marine worms, spirillum, serpula, living in calcareous tubes; and in lumbricus marinus. In the aphrodite aculeata, the matted hair is connected with respiratory organs. Amongst insects, numerous larvæ respire water by fibrous gills: some, in the perfect state, have respiratory tubes, as the nepa, in the form of bristles, extending backwards: most breathe air through stigmata, small apertures on the sides of their bodies. The gills of the crustacea are in some external, as in squilla, apus, &c.; in some internal, as the crab, lobster, &c.

"We commonly find that some species in a given class or order are its proper representatives, whilst others may be considered rather as connecting links with superior and inferior formations: so in fishes, the abdominales, salmon, carp, pike, &c. decidedly present in their structure every distinctive character of fish; while rays and sharks approach, even in their respiratory organs, to the amphibia: myxines and lampreys to worms." Amongst amphibia, sirens,

the Proteus, &c. and larvæ of frogs and salamanders, possess external gills. Amongst the ophidia, and perfect chelonia, batrachia, and sauria, we find lungs supplied with air through tracheæ, yet for the most part having much nearer analogy with the sacs or swimming bladders of fishes than the more developed lungs of the superior classes. "The lungs of birds are distinguished generally from those of all other animals by this peculiarity; they do not hang in the cavity of the trunk as loose bags, but are fixed to the interior of the back and of the sides, surrounding the viscera, and extending to the pelvis in the form of two flattened masses of red spongy cellular texture. From these, distinct cells convey the air to cavities throughout the whole of the bony structure, diffusing through them the inspired, changed, heated, and rarefied air; thus filling the solids with a fluid lighter than the atmospheric, and aiding the operation of flight[m]." These conditions, however, are varied with respect to birds not destined to fly, as the ostrich and cassowary, and to those which are not only unable to fly, but which pass much time under water, as alca impennis and aptenodytes, the penguin, northern auk, &c. The superior magnitude of the venæ cavæ of diving birds is shewn by Cuvier, Meckel, and Carus to be important to their long continued interruption of respiration. In the porpoise, seal, common and sea otter, and in tortoises, similar dilatations have been found. The

[m] Carus, by Gore, vol. ii. passim.

lungs of the mammalia vary according to the several destinations of genera and species. In many the structure is closely related to that of man: in some, as in the cetaceous and amphibious mammalia, there is an approximation to the more simple sac-shaped lungs of ophidia, chelonia, sauria, &c. The varieties in the number of pulmonary lobes are numerous. The greatest number is in man. The number in the right is usually greater than in the left. In some, however, the lung on each side is undivided, as in the horse, elephant, and rhinoceros. In the bat and flying maki, it bears resemblance to the single lungs of birds. "If, however," says Carus, "we view the respiratory organs as an index of mind, and of its feelings, what animal can be compared with man[n]?" Having shewn that this superiority does not consist in the greater force of his lungs, but in the peculiarity of adaptation to the trachea and glottis, &c. as organs of voice, he adds, "As thought, produced in the head of man, crowns his completely independent and harmonic organization, so speech also receives its full perfection (of articulation) in the mouth of man. Nay tone alone, without reference to the expression of ideas, (*by words*,) has the power of indicating the minutest shades of passion and mental emotion, (as in impassioned singing, *although the language be unknown*,) and becomes to the feelings what speech is to the intellect."

[n] Vol. ii. p. 208.

Stomachs.

Nature is an immensely wide and various feast, and very numerous and very wonderful in their variety are the guests assembled to partake of it. They are varied in their modes of taking their food, in their analogous means and modes of mastication, in their instinctive tastes and appetites, in their peculiar powers of digestion, concoction, and assimilation. And precisely in accordance to such variety of organs, adapted to the reception of nutrition and concomitant delight, is the variety of the repast. There is solid and strong meat for those with good teeth and quick digestion, and tender, pulpy, or minced meat for those which are nearly or wholly toothless, with weaker stomachs. In general the carnivora of every class have stomachs of comparatively simple structure; the herbivora stomachs more complex in their apparatus.

The stomach of the lion and dog is single; the digestion quick; the viscera short; shorter than those which use vegetable food occasionally, as monkeys and bears. The insectivorous mammalia have more complex stomachs, of a character approaching to those of birds. The herbivorous, ruminants especially, are supplied with stomachs both numerous and complex. "In the ruminants, with horns or antlers, as it is generally stated, there are four stomachs, though the three first, which are lined by a continuation of the epidermis of the œsophagus, should, perhaps, be considered merely as sepa-

rate portions of the left or cardiac extremity, and chiefly because, like that portion in other animals, probably (according to Home) even in man, their operation is to prepare food for the digestion, which is accomplished in the fourth or pyloric stomach[o]." The stomachs of the camel, dromedary, and lama, are distinguished by two cellular appendages to the first cavity, and by a peculiar musculo-cellular structure of the second. The fluids which these animals take at distant intervals, though in large quantities, pass into the second stomach, (or honeycomb bag.) The cells of that cavity are about an inch in diameter, and possess a power of contracting and closing their orifices so as to retain water without allowing it to be contaminated by intermixture with other contents of the stomach, even during the repassage of the ruminated food[p]. Amongst hoofed animals the solipeda exhibit a more simple form of stomach. The stomachs of amphibious mammalia, the seal, &c. approximate to those of fishes; those of ant-eaters and armadilloes, to those of birds. Having no teeth, they swallow small stones into muscular stomachs, to give aid in crushing their food. The viscera of carnivora, as before said, are proportionally short, those of herbivora very long. But the general rule has frequent exceptions, which however appear to be explicable by reference to a greater com-

[o] Carus, vol. ii. p. 97, 98.

[p] Home mentions, that a camel observed by him drank but once every two days, but then to the amount of six or seven gallons at once.

plexity of other portions of the intestinal system, to diversities of cæca, &c. Amongst birds nearly the same differences are observable. The organs of digestion are more simple amongst the carnivorous, more complex in the herbivorous orders. The crop is less developed in the carnivorous, more in the granivorous. The gizzard possesses its full powers of muscular structure and horny lining only in the granivorous: with some exceptions, however, dependent on climate and food, as in the differences observed by Home in the African and American ostrich: which demonstrate that a different condition might have existed, had it suited the plan or been accordant to the will of the great Ordainer.

"The form of the stomach in amphibia is usually simple:" but in turtles the œsophagus is furnished with horny points, directed backward, and serving to prevent the escape of food. Home found in the eft a croplike dilatation of the œsophagus. He has noticed the thickness of muscular membrane in the stomach of a turtle, (testudo mydas,) living wholly on vegetables: and in the stomach of the siren, in which the intestine is also found to contain little pebbles, which assist in the trituration of food [q]." The digestion, however, is slow, although the stomach is less complex than that of birds, and the alimentary canal comparatively shorter. To this, however, the coldness of the blood may contribute. It probably is the cause, contributing to their power

[q] The stomach of a crocodile was observed by Home to bear great resemblance to that of birds of prey.

of long abstinence from food. The power observed in the frog of protruding the stomach through the mouth is analogous to a corresponding power and mode of action in some of the mollusca. The whole intestinal canal in serpents approaches closely to that of lampreys [r].

The stomachs of fish are various: generally simple, scarcely distinguishable from the œsophagus, and the intestine shorter than the body: yet they retain food for a long time, and only feed at distant intervals. The squalus carcharias, the most voracious of marine monsters, corresponds with the generality of toothed fishes: but the basking shark, squalus maximus, which lives chiefly on vegetable food, was found by Mr. Home to have two stomachs, the second of which opened into the intestine by a narrow pylorus: and in it he found pebbles, doubtless taken, as by birds into their gizzards, for the purpose of trituration. "The œsophagus of the crayfish is generally short, and formed by thin membranes: it quickly expands into a large membranous stomach, which, particularly at its upper part, and in the region of the pylorus, is supported by a peculiar bony frame, consisting of five flat bony masses moved by muscles. To these bones are attached interiorly three larger and two smaller teeth, surrounding the pyloric opening of the stomach." "The same form of organization," according to Cuvier, "prevails through most of the corresponding species. In some, however, the stomach is merely membranous, and provided with small teeth [s]."

[r] Carus, vol. ii. p. 55.

[s] Ibid. p. 19, 20.

The stomachs of rapacious insects, like those of the carnivorous mammalia, are more simple and less firm of texture than of those which devour vegetables. "In the orthoptera, e. g. the grylli, we find, in the larva, as well as in the perfect insect, a short and strait intestinal canal: but the œsophagus first expands into a crop-like cavity, which is followed by a small, roundish, muscular stomach, plentifully furnished with horny teeth on its internal surface: next comes a circle of little cæca, or, in some species, a heart-shaped expansion with folds at its inner and upper part; and, lastly, a narrow, gut-like stomach. On account of this complicated structure, which is pretty closely imitated in the ruminating mammalia, the power of ruminating has been ascribed to these insects [t]." The organization is more simple in the neuroptera, in which the organs of mastication are powerful, and their habits rapacious. "The coleoptera," says Mr. Gore, "may be arranged in two divisions, according to the presence or absence of a gizzard."

Of infusory animals and zoophytes some appear to imbibe their liquid food into a hollow body, which is all stomach, through pores in all parts of the body. Some, called *rhizostoma*, imbibe in a similar manner, through a distinct portion of their frame. Some of the mollusca, consisting of merely hollow sacs, receive and evacuate the substance of nutriment and excrement by the same single aperture. Many discharge superfluous matter by a distinct aperture,

[t] Carus, p. 27.

either near the mouth or the aperture of respiration. Some are simple, some complex : as helix pomatia and slug compared with sepiæ. Some exhibit muscular thickenings like gizzards, some bony formations, as stomachal teeth. These secretions, formed in the genus bulla, have been distinguished as the shells of an unknown animal. The simple organization of acotyledonous and of monocotyledonous plants may be analogically contrasted with the more complicated vessels of the dicotyledonous vegetables.

Viscera and vascular system.

Comparative anatomy in truth presents in all its parts such a complete display of analogies, connecting each with each, demonstrating unity of system throughout the whole, and wonderful adaptation of contrivance to the most minute diversities of condition, with unquestionable evidence that the organization is independent of the condition to which it is adapted, that a general reference to the works of Cuvier, Meckel, and Carus, and the authors cited by them, might suffice to confirm the leading principle which is here proposed to be established; namely, an intended manifestation of the unity of designing power, imposing laws on all conditions of existence, itself independent of all, and uncontrolled by any.

In the vascular system, the veins, the heart, and the arteries, the same continuity of contrivance advancing through different gradations of organization, varying widely in appearance, connected closely by

analogy, is wonderfully manifested. "In man, and the more complicated animals of the vertebral division, circulation is a function of the first importance. The blood, proceeding from the left ventricle of the heart, spreads itself by the arteries through the whole body, takes the capillary system in its way, passes into the veins; returns to the heart, enters into the right auricle of that organ, then into the corresponding ventricle; which in its turn sends it into the pulmonary artery, to be distributed into the lungs; from which it issues by the pulmonary veins, to repair to the left auricle and ventricle, and proceed from thence in its round anew. In this course, the blood evidently describes a double circle; one in the lungs, the other in the entire body. This is not the case with the reptiles. The heart in these animals sends into the lungs, at each contraction, but a portion of the blood: therefore the pulmonary circulation is but a fraction of the general circulation. The quantity of their blood, e. g. in the saurians, is very small in comparison with that of mammifera and of birds [u]." In zoophytes, intestinal worms, &c. the circulatory system is not distinguishable from ramifications of the intestinal canal. In the leech and earthworm the vascular system is more developed. In crustacea, generally, the heart is an elongated aorta stretched along the back, as in vermes. Yet in crabs are traces of a rounded heart. Amongst insects there appear to be differences of

[u] Cuvier's Animal Kingdom, translated by Griffith, part xxv. p. 181.

plus and minus in simplicity and complexity of vascular organization. The heart in fish is found to differ in position and in arrangement of valves, which are more numerous in the cartilaginous than in the osseous fishes. The heart in amphibia is larger than in fish, smaller than in birds and quadrupeds. The batrachia approach nearest to the fishes. The circulation is more complex in tortoises, and in lizards, and in serpents. In birds the warmth of blood gives clear indication of extended developement of the respiratory and vascular system. Here are distinct pulmonary and aortal hearts; and not a part merely, but the whole of the blood is exposed to the action of air. Yet certain differences enable the anatomist to trace a connection with the preceding class, the transition in the form of the heart, and the distribution of the vessels, particularly from the lizards. Respecting the veins of birds, their parietes are thicker than in other animals; and the enlargement of the inferior caval trunks, which Cuvier and Meckel have observed in diving birds, explains the long continued interruption of respiration which these birds can sustain [x]. Amongst mammalia, some have the circulatory system solely adapted to continuous access of air to the lungs; some, like diving birds and tortoises, have an organization adapted to long continuance under water. This is particularly noticeable in the porpoise and the seal. The foramen ovale in the septum of the auricles,

[x] Carus, p. 294.

almost always open in the fœtal state, and close after birth in land animals, is open through life in the beaver and sea otter, and other diving animals. The eustachian valve, which is remarkably strong in seals, is wanting in lions, bears, and dogs. Plants have not stomachs, but the mode in which roots universally absorb their liquid nutriment is analogous in operation to the similar absorption of nutriment by pores observed in zoophytes and certain mollusca, in gorgoniæ and tæniæ. The vessels of the stems of plants present striking analogies with the vascular or sanguiferous system of animals, adapting the greater number to live in air, many to live wholly in water.

Nervous system.

Animals are divided by Cuvier into two grand divisions. 1. Those with brain and spinal marrow, and a vertebral column. 2. Those without either. Of the former, the first class is mammalia. The preponderance of the brain above the rest of the nervous system is here most remarkable. "The proportion of the spinal marrow to the brain in man (says Carus [y]) I have found to be as 1 to 43 [z]: in a cat as 1 to 4: in a rat as 1 to 3: in a fish as 1 and a half to 1, the brain being least in quantity in the latter instance." In this class the brain is one of the first organs to attain its full growth; and conse-

[y] Pag. 274.

[z] A female brain, 43 ounces 6 drachms; male ditto, 41 ounces 1 drachm.

quently the longer the period of growth of the rest of the body, and the greater the bulk acquired, the greater the disproportion between the general bulk and that of the brain. In man it is about 1 to 25 or 30: in simia capucina 1 to 25: in simia lar, lower in the scale, 1 to 48. In a rat the weight of the brain to that of the body was as 1 to 80: in a cat 1 to 40: in a sheep 1 to 35: in an elephant 1 to 500. In quadrupeds the bulk of the cerebellum is greater in proportion to the rest of the brain than in man; where the hemispheres are so much developed that the cerebellum forms but one ninth of the brain. In the mouse it is one half, in the beaver one third, in the horse one seventh.

The body of a pigeon without feathers weighed against its brain was found to be nearly as 1 to 95, 37 grains to 3360. The brain of an eagle is to the weight of the body as 1 to 160: in a siskin as 1 to 230. The proportion of the spinal marrow to the brain is generally greater in birds than in mammalia: in a pigeon the spinal marrow weighed 11 grains, the brain 37, together 48: about 1 to 3. This proportion is nearly the same, however, in the rat.

"In amphibia[a], the two divisions of the great central nervous mass are nearly similar: for although the brain is somewhat more developed than in fishes, the spinal marrow preponderates considerably in point of size. A tolerably large salamander weighed

[a] Carus, §. 307. p. 247.

380 grains: the brain and spinal marrow 3 grains: the brain singly 1 grain. The great hemispheres of the brain are smallest in the batrachia, larger in the chelonia and ophidia: most fully developed in lizards, iguana, and crocodile."

In fishes the spinal marrow preponderates in bulk over the brain. It is generally longer than in the former classes, extending through the caudal vertebræ. Yet it is in some peculiarly short, as in tetrodon, mola, and lophius piscatorius.

In the crustacea is found a chain of ganglia, or knots, united by a central thread. From the foremost of these proceed branches surrounding the œsophagus, and nerves for the eyes, mouth, antennæ, &c. the cerebral ganglion being in some larger, in others less.

Spiders and scorpions form a medium of transition from crustacea to insects. Thus the nervous system of aranea diadema may be compared with that of the crab [b]; for in it also, besides the cerebral ganglion, a large nervous mass is found in the thorax, giving off nerves for the legs, and from which a nervous cord passes backward to a postern ganglion. "In the parasitic genera, pediculus and ricinus, the cerebral ganglion consists of two oval lobes; and instead of two cords surrounding the œsophagus, it is elongated into a single cord, on which there are three ganglia closely approximated. In the diptera, neuroptera, lepidoptera, &c. the nervous

[b] Carus, vol. ii. passim.

system presents a cerebral ganglion variable in size, and a knotted spinal marrow, which has generally one ganglion in the corslet, two in the thorax, and four, six, or more, in the abdomen. In some species of neuroptera the optic nerves are larger than the brain itself [c]."

Amongst the mollusca the ganglia diminish in number, and gradually disappear. The nervous ring surrounding the œsophagus is either repeated, as in the leech, or imperfectly repeated, as in articulata.

In holothuriæ and siphunculi slightly serpentine threads are seen radiating from the nervous collar round the œsophagus, one passing between each of five pair of longitudinal muscles [d].

" Cuvier was the first to remark that a whitish thread-like ring surrounds the commencement of the œsophagus in the asterias, siphunculi, and some holothuriæ. We here look for the first definite existence of the nervous system [e].

In the substance of zoophytes and of medusæ the most powerful microscopes have discovered only a gelatinous mass composed of minute globules: neither muscular nor nervous fibre being traceable. Trembley remarked in the fresh water polype an inclination to the light. Cavolini observed in gorgoniæ and sertulariæ an evident aversion to it [f].

The motions of the hedysarum gyrans when affected by the sun's rays; of the Dionæa muscipula when touched; of leaves when reversed, or placed

[c] Pag. 53. [d] Pag. 50. [e] Pag. 44. [f] Pag. 43.

remote from light; of the stamina of many plants, of tendrils to grasp neighbouring stems, of climbing plants to twist, as the hop and honeysuckle, from right to left, and the convolvulus from left to right, appear to indicate some property analogous, at the least, to the nervous constitution of zoophytes and medusæ.

Osseous system.

"The skeleton of mammalia reaches, on the one hand, the highest degree of symmetry, and, on the other, descends in some instances to that of the inferior classes. Thus the palmata approximate to fishes; the bats to birds: whilst the armadillo, manis, and ornithoryncus constitute a complete transition into the amphibia [g]."

The existence of analogy, not the detail of anatomy, being the object of this Essay, a single instance will, for the sake of conciseness, be selected for illustration. Or, in other words, the analogy of one portion of the various structures of animals and plants will be noticed, referring generally, for the application of the argument to all other parts, to the writings of Cuvier, Meckel, and Carus, and the notes of Mr. Gore to his translation of the latter, and the authors there cited.

The dorsal vertebræ which support the ribs in man are 12, in the horse 18, in the elephant 20, in the bradypus unau 23. The cervical in man 7, in

[g] Gore's Carus, vol. i. p. 186.

the bradypus 9. Caudal in man, including ossa innominata, 4, lumbar 7; in all 30. The caudal in monkeys vary from 20 to 30, in myrmecophaga didactyla amount to 40, in the porpoise to 66.

In birds, the owl has of vertebræ 12 cervical, 8 dorsal, 12 sacrolumbar, 8 caudal; in all 40. In small hopping birds the sacro-lumbar are 8 or 9. In the heron (ardea cinerea) there are 18 cervical, 7 dorsal, 10 sacro-lumbar, 7 caudal; in all 42. The sacro-lumbar in ostriches are 20. The dorsal vertebræ are moveable in the ostrich and cassowary, not in other birds. The bones of all birds are hollow, and admit a great quantity of air, which is heated, and therefore lighter than the atmosphere: which circumstance, in running as well as in swimming and flying, facilitates motion by imparting buoyancy. This, however, is not the case in the bones of bats, so that the connection of the bones with air-vessels in birds doubtless is adapted to an ulterior, probably to a double purpose.

In the class mammalia, as well as that of birds, we see in this case not only a difference of plus and minus, but also a tendency amongst some of each class to exhibit an affinity with the other proximate class. Several analogies between mammalia and aves are noticed by Carus[h]. "In the sloth the greater number and consolidation of the sacral vertebræ and their breadth remind us of the sacrum of birds."

"The vertebral column of birds so far resembles

[h] Pag. 194.

that of tortoises, that only the cervical and caudal vertebræ have true articulations admitting of motion. The dorsal and sacral vertebræ, even when they are not consolidated, are connected by strong ligaments, so as to form an inflexible column."

As in the frog the first tarsal bones, viz. the astragalus and os calcis, which are much elongated, and, placed in the same relative position to each other as the tibia and fibula in the human subject, form a separate phalanx below the bones of the leg; so in birds we find a single long bone (commonly called the leg) which supplies the place, not only of some of the tarsal bones, but also of the metatarsal. From the lower end of this bone project usually three, but in the two-toed ostrich only two processes or rudiments of metatarsal bones, supporting the toes. In the penguin the true character of this bone is evident, as its body divides in the middle into three distinct bones. The penguins, auks, and puffins, being nearly plantigrade, vary from all other birds, approaching to the type of the mammalia in this respect.

" In frogs the bones of the trunk are very simple. The ribs are wanting; in which respect, as well as in many others, we may observe an approximation to the type of cartilaginous fishes, e. g. of rays. It is occasionally only, as in the rana pipa and the salamanders, that small appendages, rather cartilaginous than bony, forming rudiments of ribs, are attached to the transverse processes of some of the vertebræ. In these animals there is consequently no

distinction of the vertebræ into cervical, dorsal, or lumbar, but, as in fishes, merely into dorsal and caudal [i]. In the perfect frog the caudal are wanting; there is only a strait elongation of the os coccygis. In salamanders the caudal vertebræ are 27. In these, as in fish, joints with opposing cavities, filled with fluid, facilitate the lateral motions of the spine. One of these cavities in a shark was found to contain three pints of fluid.

Of 41 vertebræ in a carp 16 are caudal: in the turbot, gadus lota, the vertebræ are 57, caudal 33.

The number of vertebræ in proteus anguinus is 59, caudal 27. In eels the total is 115, in the shark above 200.

"The fins, which in fishes supply the place of external extremities, may be considered as hands for swimming, provided with numerous and delicate fingers, often having numerous articulations, as in rays [k]."

The general use of bones is their operation as a fulcrum and stay to the muscles. In this view the shells of the crustacea will be found analogous to the skeletons of the vertebrata.

In a review of the organs of motion, Carus observes, "In the lower species of animals, worms and slugs, (mollusca,) we find the body frequently without any solid parts serving as points of support during motion: in others, on the contrary, as testacea, insects, and crustacea, in addition to muscles, the

[i] Pp. 137, 138.

[k] Pag. 121.

effective organs of motion, we also find external shells, analogous to skeletons; and, lastly, in the internal shells of several snails and sepiæ, and the vertebral-shaped cartilages of the cephalopoda, we meet with the commencement of the vertebral column or true internal skeleton."

As in some the rudiment of a bony skeleton is barely indicated by cartilage or jelly-like fibre, in some it is chiefly or wholly external, in some wholly internal; so in plants the substance of the stem is in some almost a jelly, as in tremella; in some leathery, as in the tulip, the iris, and the rush; in some externally hard, as in the bamboo; in some of extreme internal hardness, as in Brazil wood, ebony, box, and iron wood.

Sleep.

The analogies respecting diurnal and nocturnal sleep in different classes of animals and plants, have been noticed in the previous remarks on greater or less sensibility to light. It is obvious, however, that the eye is but a small part of the nervous organism affected by sleep. Many animals sleep soundly which have no power of closing their eyes, and others which have no analogous organ. Rest is as necessary to plants as to animals: and their especial rapidity of growth during the night is a proof that the organs employed in assimilation had during the day been checked in the full discharge of their functions. The great propensity to sleep in all young animals, when growth is most rapid, bears an obvious analogy

to this case in the growth of plants. Sleep is the appointed means of restoring bodily and mental activity, which after a limited continuance yields again to torpor, from deficient energy, and to a desire of the recruiting influence of sleep. In all classes of animals some appear to require more, some less of sleep. The same case occurs amongst individuals of the human race. Some animals and plants flourish under degrees of heat and of cold which depress irritability, induce drowsiness or languor in others. But high degrees of heat and cold equally destroy activity and induce sleep in human beings and in most warm-blooded animals, endangering life in most species of every class, yet not in all of any[1]. The arctic circle has its fauna. Snails which have been deemed to be dead have survived even after immersion in boiling water. Plants and zoophytes have been dried, and revived on being moistened. Fish have been frozen and restored. Insects have been found in Alpine and arctic snow. Birds roost within the arctic circle, and sleep where sleep would be fatal to most of the class: and the wolf of Melville Island sleeps securely where the wolf of Germany would sleep to wake no more. This notice of the various conditions of the sleeping propensity

[1] De Soissy, Recherches Expérimentales sur la Physique des Animaux Mammiferes hybernans, remarks, that the greater size of the superficial vessels in hybernating mammalia, in connection with the non-coagulability of their blood, serves to explain their torpidity. Meckel finds the thymus, a glandular body connected with the trachea, to be peculiarly remarkable in animals which dive, burrow, or hybernate. Carus, vol. ii. p. 261.

may naturally suggest that of annual torpor, by which some of almost every class are affected. The most familiar instances present themselves in the hybernation of snails, which congregate towards the end of autumn; close up the orifice of their shells by a horny cuticle, and secrete themselves in cavities of trees and walls during the winter months; and in the deep burrowing of grubs and slugs, and worms, of mole-crickets, &c.

Hybernation.

"A much greater number of insects pass the winter in the pupa than in the egg state; probably nine tenths of the extensive order lepidoptera, many of the hymenoptera, and several in other orders."

"To the class of insects which hybernate in the larva state, belong, in the first place, all those which exist under that form more than one year; as many melolonthæ, elateres, cerambyces," &c.

A very considerable number of insects will be found to winter in the perfect state: chiefly of the orders coleoptera, hemiptera, hymenoptera, and diptera. Papilio, urticæ, io, and a few other lepidoptera, occasionally survive the winter [m]."

They seek different situations. Some crowd together in torpid society; some, like hermits, torpify in solitude. The aquatic tribes, dytisci, burrow into the mud of their pools. "In every instance," says Kirby, "the selected dormitory is admirably adapted

[m] Kirby, vol. ii. p. 435, &c.

to the constitution, mode of life, and wants of the occupant."

"The degree of cold which insects in their different states, while torpid, are able to endure is various." The pupæ of papilio brassicæ, exposed to a cold fourteen degrees below the freezing point of Fahrenheit, became a lump of ice; yet were afterwards thawed, and produced butterflies. It is probable, however, that many do not survive even a less degree of cold. But Kirby argues from various and minute investigation, that although cold may be a cause of torpidity in many animals, in man for example, when exposed to a severe cold, yet it is not the immediate cause of hybernation; for which, animals begin to make careful provision in mild weather, even such as have had no previous acquaintance with the cold season. "What then," says he, "regulates these preparations? I answer, Instinct."

"We find torpidity," says sir W. Jardine, Notes on White's Selborne, "occurring among various animals, fishes, the amphibia, reptiles, and insects; but we have never found any authenticated instance of this provision amongst birds."

What has been said of insects above may probably apply to crustacea [n]. Certainly spiders and scorpions hide themselves, and fast, during the winter;

[n] In the early part of spring, lobsters and crayfish, &c. change their shells. This is not effected, as I learn from an excellent naturalist, Mr. Dillwyn, by throwing off their old shells, but by a general deliquescence of the shelly matter.

and are probably torpid. Many fish must be in the same condition; for worms and insects, their sole food, are not to be obtained. Some fresh-water fish probably bury themselves in mud: some migrate to the depths of the sea at the approach of winter.

"That snakes and fishes [o], after being frozen have still retained so much of life, as, when thawed, to resume their vital functions, is a fact, says Mr. Hunter, so well attested, that we are bound to believe it." "Yet," says the writer [p] in the Encyclopædia Britannica, "how came it to pass that the fishes which were frozen by this truly ingenious physiologist never recovered?" He, however, suggests the probable reply, that the fish selected were either not the fittest, or not in a proper condition for the experiment.

Cuvier observes, (or his translator Griffith,) tortoises remain lethargized during the winter; but this lethargy is merely a diminution of the vital force, not a suspension of certain faculties, as in the hybernating mammalia."

"The common tortoise, about the end of October, buries itself about two feet under ground, and does not emerge till April. We are told that it hybernates in this manner even in Barbary, without being determined to this state of torpor by the cold."

In cold and temperate climates, snakes, and the batrachia and lizards, hybernate. The pike-muzzled

[o] "Eels approach the serpent race in external form in their motion and their hybernation." Stewart's Elements, &c.

[p] Art. Physiology.

cayman is said to hybernate throughout the southern parts of North America. I believe this is not the case with the crocodiles of Africa, or the gavials in the Ganges [q].

"Birds," says sir W. Jardine in the note above cited, "are occasionally found in holes, in what has been called a torpid state, and have revived upon being placed in a warmer temperature; but this, I consider, has been a suspended animation, which would soon have terminated in death, not torpidity, where various functions and secretions are still going on."

Owls, like almost all birds of prey, are capable of bearing a long abstinence from food, and never drink. Bingley says they sleep through the winter: but they are often seen abroad even in very severe seasons, though not so commonly as during the summer. All the birds on the lakes of Siberia are said by Professor Gmelin to retreat southward on the commencement of frost, except the rail, which sleeps buried in the snow. (Account of Siberia quoted by Darwin in Loves of the Plants.) Some birds, like snakes, sleep profoundly after having gorged themselves with food, as most vultures; and the pelecanus bassus, solan goose, which is easily captured in such state [r].

[q] "At the present day the crocodile is found in the Nile only towards the region of Upper Egypt, where it is extremely hot, and where this animal never falls into a lethargic state." Griffith's Cuvier, Suppl. on Sauria.

[r] The Saurian reptiles sustain long fasting, and never drink.

Even should Gmelin's account of the rail, Bingley's of the owls, and many accounts of hirundines prove to be erroneous, it is certain that a part of the class, in most countries where hybernation exists, feel, about the time when insects and tortoises, &c. seek their hybernacula, the impulse of an instinct scarce less powerful, and apparently analogous, which urges them to remove from a cold to a warmer climate. Some, however, of every class appear to acknowledge this instinctive impulse, and those the most, amongst which the evidence of hybernation is least traceable [s].

Quadrupeds are less adapted for a rapid passage from climate to climate, and therefore many natives of cold, and some of temperate regions, appear to pass the winter in a state either of long protracted sleep, or a deeper state of torpor. With us the badger retires to his den, the squirrel to his chambered store and nest, the dormouse to his warm cavity. But the dormouse is torpid; the bat, and

[s] Noctuas sexagenis diebus hiemis cubare tradit Nigidius." Pliny, Nat. Hist. lib. x. c. 17.

In Sisson's Manuel d'Ornithologie, Paris, 1828, I find, " D'autres (oiseaux) paroissent éprouver une véritable hibernation, et ce fait, nié par les uns, affirmé par d'autres, est encore dans l'obscurité." p. 11.

One kind of hybernation affects birds in a particular by which they are eminently and most agreeably distinguished from all other classes of animals, namely the voice. Thompson thus notices the winter silence of the grove:—

> " How dead the vegetable kingdom lies!
> How dumb the tuneful!—"

probably the hedge-hog. The squirrel feeds on his hoard, the badger sleeps in abstinence.

The marmot, the bobac, the myoxus[t], the hamster rat, and the jerboa are torpid. The brown bear sleeps: the lemmings are said to feed under the snow.

The alactaga, a species of jerboa, described by Griffith in his translation of Cuvier's Regne Animal, is found in the deserts of Tartary, on the sand-hills which border the Tanais, the Volga, and the Irtisch. "The least degree of cold reduces these animals to their lethargic state; and what is more remarkable, a great degree of heat will produce on them a similar effect."

The vegetable world presents, during the winter of the colder climes, a death-like scene of general hybernation. The stems afford hybernacula to the dormant energies of perennials. The bulb, which is the subterraneous stem of onions, and lilies, and crocuses, and tulips, like the pupa and chrysolis, protects the half-born progeny. The bud is a bulb upon a twig. The seed is analogous to the egg.

Migration.

Nearly allied to the subject of hybernation is that of migration. In both cases natural causes operate

[t] The ancient Romans had their gliraria, in which the glis myoxus, or fat dormouse, was fattened for the table. They are still eaten in Italy, and Martial says, they are fattest after hybernation, when they have had only sleep instead of food on which to fatten. Griffith Rodentia, p. 148.

on the constitution, and impel beings of different classes to temporary changes of condition and locality.

Amongst the mammalia of northern regions some are impelled to migrate during the severity of the long winter, by the total disappearance of all vegetation. The musk-ox and reindeer deserted Melville Island and the northern shores of the arctic sea, and fled southward from the rigours of the nine months winter, leaving captain Parry and the other officers, and the crews of the Hecla and Griper, nearly the sole living and moving beings within the seventy-fourth degree of north latitude.

In the months of June, July, and August, the deer are driven by the gad-fly, œstrus tarandi, from the valleys of Lapland to the lofty and snowy regions of the mountains, where the cold is fatal to their tormentor. This, no doubt, with other insects, co-operating probably with other impelling causes, drives the herds, which had left the arctic circle during the winter, back again during the summer months.

As my excellent and accomplished brother has given already a synopsis of the leading facts relative to migration in his Lecture on that subject, read in the Ashmolean Museum, and published at Oxford; I shall only observe, that amongst mammalia, the most remarkable migrators, are the lemming rats or mice of Lapland, Sweden, and Norway, which are said to march in swarms of congregated millions, leaving barrenness and famine to

mark the direction of their destructive course: much resembling those northern hordes of human beings in numbers and ferocity, the acknowledged ancestors of the greater part of the population of Europe, who trampled down the arts of Greece, and the splendour and the power of ancient Rome. The mus œconomicus, or Kamtschatka rat, is said to rival the lemmings in its armies of migration. Excess of population seems with these animals to be the impelling cause of migration. Squirrels are also said to migrate from the same cause, and even to make long voyages on pieces of pine and birch bark. See Bingley, vol. i. p. 392. and his references. Some, however, of either genus do not migrate. The wolf and fox appear to prowl abroad during the utmost severity of the arctic winter. The wolf was attracted by the odours from the ships in Melville harbour, long after the total disappearance of all other animals.

It is notorious that while swallows, blackcaps, redstarts, &c. regularly leave Britain on the approach of winter, the robin, the wren, and even the little golden-crowned wren, remain during our most severe seasons. Of pigeons, some remain with us, as the stock-dove; some migrate, as the ring-dove. The columba migratoria of North America is only to be compared in respect to vastness of the migratory multitude, and to the destruction attending their visits wherever they alight, to the lemmings amongst quadrupeds. Land-crabs migrate among crustacea;

herrings and pilchards amongst fish [u]. Of the migrations of amphibia little is recorded. Turtles probably wander occasionally in search of more abundant food. But by far the greater number of amphibia hybernate. Frogs, however, migrate in vast numbers from their native waters about the end of July. They travel during the night, and conceal themselves by day, till they have dispersed themselves widely through woods and meadows. Bingley, vol. ii. 392. &c. Of insects many perish, many hybernate, many migrate on the approach of the northern winter [x]. The marine mollusca probably migrate in part from the shallower to the deeper waters in cold winters; many however hybernate. Plants migrate extensively; not indeed as animals, by means of instinct operating upon will, but by the impulse and direction of that mighty Power to which the planets, the locusts, the swallows, and the storks, are equally obedient. Some migrate in the bowels of birds, as the misletoe; some on the wings of the wind, as the dandelion and the thistle, &c.: some on the waters, as the callitriche, the lemna, or duck-weed [y]: the fucus natans, which floats over

[u] For a curious account of the migrations of eels, see Sir H. Davy's Salmonia.

[x] The vast swarms of locusts in Asia, Africa, and South America, need only be noticed in this place. The Ashmolean Lecture above mentioned refers to them with due detail.

[y] The vallisneria spiralis is diœcious. The female plant produces blossoms on long spiral stems, which enable them to rise to the surface of deep water. But the blossoms of the male plant, when ready to expand, detach themselves from the root and

many leagues of the Atlantic, between 18 and 30 degrees of north latitude, (see Walsh's Notices of Brazil,) and the conferva vagabunda floating loosely from shore to shore over many of our English lakes.

Growth.

The elephant is said to attain to its full growth and maturity in eighteen or twenty years; the horse and ass in five ; the mouse and rabbit in five or six weeks. The duration of life is nearly proportionate. A mouse and a rabbit are aged in three and six years : horses and asses live to thirty, and even to forty years. A lion, which is full grown in five or six years, attained to the age of seventy in the Tower menagerie. The elephant reaches 100 or 200 years. The whale suckles its cubs for a whole year. They are probably long lived : but in our eagerness for oil we have no leisure for experiments or physical inquiry.

Eagles, ravens, and swans, parrots and pelicans, are said to live to above 100 years. They do not reach their full growth in less than a year, and vary in their plumage so as to indicate incomplete maturity for two or three years. Gallinaceous birds, which run as soon as hatched, are mature in a year ; and

float widely over the waters, heaven-directed to their destined objects. Many fruits of America and the West Indies are carried by tides and by the gulf-stream to the shores of Europe ; as the cashew-nut and the cocoa-nut : the latter, thus carried from shore to shore, is the first species which takes root on the newly-formed islands of coral, not unfrequent between the tropics.

their life varies in length from twelve to twenty years[z]. Perhaps the lives of smaller birds vary within these limits. Bingley quotes good authority for a goldfinch which reached the age of twenty. They attain their full size in about six months.

Turtles and tortoises are slow of growth, and very long lived[a]. "Frogs do not arrive at maturity till their fourth year, though they hardly live above twelve." Stewart's Elements of Nat. Hist.—Of the ages of the ophidia I find no record. Vipers are said to attain their full growth in seven years; but to produce in their second or third. (Bingley.)

The carp is said to live 200 years; the pike 260[b]. (Stark's Elements.) They are said to attain their full growth in three years. The minnow attains its full size in six months, and is reported to live only three years: but I have forgotten my authority. They appear in March, and disappear in October, probably leaving the shallower for the deeper water. Trouts live nine or ten years. (Bingley.)

Of crustacea I find no memoranda in any author to which I have any means of access which relate to their growth or length of life. As they vary much in size, so we may venture from analogy to

[z] Pigeons are said to live about twenty years.

[a] Lambeth tortoise lived 120 years.

[b] There is a common story of a pike caught in Germany which had fixed to it a brasen ring, with an inscription, purporting that it was put into the lake by the governor of the universe, Frederick the Second, in the year 1230. It was taken in 1497, being then above 267 years of age. Bingley mentions a carp at Cambridge above 70 years old, and Gesner speaks of one above 100.

conjecture that they vary in the times of attaining their maturity and in the length of their lives.

Of the mollusca, little more is known. Bingley relates two stories of snails, some of which revived after an interval of fifteen years, during which they had been kept as dried specimens in a museum: others survived after immersion in scalding water. Observations on the vitality of gold-fish snails, and others of the lower classes of animals, might easily be made, and probably would be made, were it probable that the knowledge would tend to pecuniary or other profit. Yet it has never been tried whether the purpura might not be bred in pans of salt water, yielding the famed Tyrian dye, at small expense. Large snails, the helix pomatia, are bred in Germany for the table; but probably the quick demand for the delicacy may prevent observation upon the periods of their growth, and on the natural duration of their lives.

Most mature insects perish every winter, leaving their progeny in the egg or grub or pupa state. Yet some may be found torpid in light soil and heaps of rotten vegetables. Mole-crickets burrow during the winter. Some, after leaving the grub state, attain maturity, breed, and die in a day, as the ephemeræ.

Of plants, it is well known, some are annuals, some biennials, some triennials, some perennials. It may suffice to refer generally for instances to Mawe's or Loudon's Calendars. Pliny speaks of oaks in the Hercynian forest coeval with the world. Mons. Decandolles, in his Flore Françoise, says, " Mons.

Adanson estime par des calculs ingénieux et très plausibles que les Baobabs (the Adansonia) des isles de la Magdaleine ont plus de 6000 ans." Forbes, in his Oriental Memoirs, speaks of an Indian fig, the banyan or burr-tree, supposed to be the same described by Nearchus, commander of the fleet which attended the Indian expedition of Alexander the Great. This tree, which probably still exists, must be at least 2500 years old.

Offspring, and Care of Progeny.

In all classes of organized beings, some are more, some less prolific than others. Those animals which bring to maturity in the aggregate the greatest number of progeny, though not producing the greatest number from a single pair, are generally the prey of those which rear the fewest; and amongst vegetables, the most prolific, abundant, and widely diffused, are those which afford nourishment to the greatest number of animated beings. This remark, however, requires much limitation.

The lion produces commonly four young: the sheep less frequently two lambs than one. But man's dominion checks the multiplication of lions, and encourages that of sheep; so that the original wild race of the latter is uncertain, perhaps untraceable, even from the days of Abel. This observation also applies to the bull and cow, as to man's protection; but the bos taurus is said to have been formerly wild in Britain, to be still wild in Poland and

in the East Indies. Some of these are, by their muscular strength and powerful horns, an overmatch for the largest beasts of prey. They have multiplied to a countless extent in the wide pampas or plains of South America, where they derive their origin from cattle imported from Europe. Horses also are there almost equally abundant; although the aboriginal inhabitant of the adjoining forests, the solitary jaguar, rarely attended even by his mate, is found to range without a rival of his own kind, in a portion of the wilderness of more than a mile, perhaps of several miles, in extent.

The cat kind, lions, tigers, the puma, felis concolor, called the American lion, and felis onca or jaguar, panthers, and leopards, are solitary animals. The lion is rare in Asia, but the race is still numerous in Africa. The tigers of India are numerous in the extensive and dense reedy jungles, but each attacks his prey singly, never in a pack. Their range is limited, and their numbers are thinned, no doubt, by the advancement of civilization: and the attacks of man are facilitated by the solitary habits of his ferocious enemy: for against an equal number of tigers acting in concert, an army, even with musketry and field artillery, would perhaps be in a state of peril. Wolves indeed hunt in packs, as we may remember from our Robinson Crusoe days; but they do not unite except when urged by general famine. Jackals hunt in packs; foxes singly. They produce at a birth as follows: the lion about four; the cat three to six; the wolf and dog tribes four to

eight: the horse, the deer, the sheep, the cow, rarely more than one. Swine produce litters more than once in a year from twelve to eighteen in a brood[c]. Rabbits breed six or seven times in a year, producing six or eight young. Hares once a year, producing from two to four. The power of man cannot be the sole cause which prevents the beasts of prey from outnumbering the more defenceless ruminantia and rodentia, for the cattle of the pampas and the antelopes of Africa are innumerable, although the puma and the jaguar, the lion and the leopard, satiate their hunger amongst their herds, afar from all human invasion. The tiger is said to wage war with his own kind, and with the lion, and to kill his own offspring: a fact rather, unfortunately, adverse to Juvenal's poetical remark, Sat. 15—

> Indica tigris agit rabida cum tigride pacem
> Perpetuam.

But Pliny's affirmation, "Leonum feritas inter se non dimicat," seems to be more justifiable. As, however, the lion seeks his prey alone, it is probable that a fatal conflict would take place with another which should intrude to share his feast. The scanty numbers of beasts of prey, compared with those of

[c] "A sow produced 350 young in twenty litters." *Stark.* They have twelve mammæ in two rows, six on each side. Pliny says, "Suilli pecoris—partus bis anno: tempus utero quatuor mensium: numerus fœcunditatis ad vicenos: sed educare tam multos nequeunt."

the less prolific herbivora, seems to be jointly attributable to mutual destruction of the former, and to human protection of the latter, coupled with abundant supply of vegetable food. The ruminating animals are generally bad providers of shelter for their young; they seek no shelter, and they make no nest. Hoofs are less suited than claws to nidification. Beasts of prey are doubly careful in this respect; the female, fearing the fury of the male against her young, secretes her brood from his knowledge with especial care. The care of apes and many monkeys for their young, is a subject of frequent narrative. Foxes, cats, rabbits, mice, hedgehogs, are notoriously careful in providing secret shelter for their progeny. Indeed almost all carnivora, and almost all rodentia, the hare being the worst provider among the latter.

Amongst birds, the most powerful and rapacious lay rarely more than two eggs, most eagles only one, and protect their young by choosing the most inaccessible rocks, Alpine peaks, and lofty summits of forest trees most remote from the haunts of men. Their nests are coarsely constructed. Owls lay from two to four eggs[d], in hollow trees and rifts of ivied towers. The lanius, approaching to the insectivorous

[d] "The brown or tawny owl, strix aluco, breeds in the hollows of trees, and sometimes in barns; which last it frequents for the sake of mice, being a better mouser than the cat. It prepares very little nest, and sometimes deposits its eggs on the decayed wood, which are two in number, rarely three." *Montague's Ornith. Dict.*

tribes, lays six eggs. The crow tribes lay from four to six: thrushes, larks, finches, swallows, from five to seven. The parus caudatus, long-tailed titmouse, from ten to eighteen. The wren Motacilla Troglodytes about the same number. The golden-crested wren Motacilla Regulus from six to eight. Boarula the grey wagtail, the same number. The nestless cuckoo lays but one egg. Amongst water birds, the alca torda, or razor-bill, lays one egg on the bare rock, so nicely poised as not to be replaced after removal. The birds when hatching sit close together in numerous ranks; the males and females doing the duty alternately. The gannet, pelecanus bassanus, lays one egg, and makes a rude nest. The wild swan lays four eggs; the tame, from six to eight.

The wild duck lays from ten to fifteen eggs; the teal rather a larger number.

The ostrich has been proverbial, since the days of Job, for its negligence as to due provision for its offspring. It is true that "she leaveth her eggs in the earth, and warmeth them in the dust." She has deposited them in the open desert, where the sand is easily trodden into a slight cavity. She is compelled to seek her food at a great distance, and rearing her lofty neck amid the level plain, she sees from afar the approach of man or beast, and leaving her eggs to the influence of the tropical sun, is hardly ever to be found near her nest. "What time she lifteth herself up on high (or starts away in her alarm) she scorneth the horse and his rider." This is a description of one well acquainted with the bird

and its habits. But Job is asked, Can'st thou tell why the ostrich seems to be hardened against her young, as though they were not hers? why without fear she deposits her eggs in such exposed places, her labour being in vain? The answer, from Him who alone can tell, is, Because God hath so decreed. He has appointed the desert for the ostrich, and the ostrich for the fiery desert. He hath not given to her wisdom, nor imparted understanding: He hath not given her the instinct which he hath bestowed on the parus caudatus; or on the various species of the genus ploceus, the weaver bird, which suspends its nest over a river from the end of a slender branch, so that neither monkeys, nor even snakes, can approach it; for the attempt would be attended with a certain fall into the flood. How beautiful is the accordance of the book of nature with the page of the most ancient Scripture!

Amongst amphibia there is great diversity as to the number of their offspring, and to the care required by and bestowed on them. Of the genus testudo, for the comfort of hungry sailors and of feast-loving epicures, the testudo mydas lays at least a thousand eggs as large as duck's eggs, and covers them lightly with sand. The testudo Græca, often exhibited for halfpence in our streets by little vagabond Italian boys, lays four or five eggs, and protects them by burrowing deeply. The pretty little testudo geometrica lays from ten to fifteen. The crocodile deposits 100 eggs in the sand, of which a great part becomes the easy prey of the viverra

ichneumon. The male is said to destroy many of the young when they first make their way into the water. The alligator builds a truncated cone of accumulated mud, depositing alternate layers of eggs and mud to the height of four or five feet, and of nearly the same diameter. When the young are hatched by the sun, the female is said to attend them with care. The cry of the young is said to be whining, like that of puppies; but the parent animals utter a loud and terrifying roar. In the rivers of South America they are often very numerous, and fill the air with offensive musky effluvia. The chamæleon is said to lay from nine to twelve eggs. The coluber berus, the common viper or adder, produces about ten young from eggs hatched within the matrix. In cases of sudden alarm, the young rush for shelter into the mouth and gullet of the parent. The coluber natrix, or common snake, deposits its string of eggs in dungheaps or other piles of rotten vegetables, in number about twenty. Frogs and toads produce a numerous offspring: the latter, however, much fewer than the former. The rana pipa, or Surinam toad, matures its young in singular cells, which cover the surface of its back, bearing from ten to twenty in these strange postnatal matrices. This animal lives on land; but when its young, which are tadpoles, and provided with external fins in their early state, are just ready to emerge from their cells, it seeks the water, that its brood may be deposited in their watery cradle.

Fish are, for the most part, oviparous; and very

numerous in their produce. The squalus squatinus, however, or angel fish, probably so called, says Stewart, from its deformity, brings forth thirteen young. Probably most of the oviparous, as those of the genus raia, to which the torpedo, skate, and thornback belong; and those of the genus squalus, the sharks and the dog-fish, which produce their full-formed young in horny square bags or sheaths, with long-twisted strings, or bristles at the corners, have a proportionally small progeny, compared with most other fish. The roe of a herring is said to produce 10,000 ova. Stewart says of the bream, Cyprinus brama, that it deposits in May about 137,000 ova. Of the rays, Stewart says, they are not very fertile, and produce but one young at a time. Lewenhock found in the roe of a sturgeon many thousand millions.

The progeny of most insects is very numerous; but the apparent paucity of some species demonstrates a great diversity in this respect. For example: a common wasps' nest is said by Mr. Kirby, vol. I. p. 501. to contain about 16,000 cells: that of the vespa holsatica about thirty. The vespa parietum attaches its small group of about twenty inverted crucible-like cells to a piece of wood without any covering. Humble bees are said to vary in their numbers, rarely exceeding 300; often not more than twenty. The apis muraria forms with fine sand, agglutinated by her own saliva, an assemblage of cells, rarely exceeding eight in number, depositing an egg in each, with a store of honey for

the first supply of the progeny, which will never know the provident parent[e].

The rarity of some testacea may warrant a conjecture that the fertility of some is much less than that of others. The paucity of specimens of gordius aquaticus, and of gordius argillaceus, (query, whether decidedly distinct?) suggests also a similar supposition.

The fruit or seed-vessel of many plants bears only one seed, as the plum, the nut, &c.: others are bilocular, and produce two seeds, as staphylæa or bladder-nut, anthyllis vulneraria, kidney vetch, trifolium suffocatum, &c. melilotus, &c. Some produce three seeds and some four, as several species of trefoil, enonymus the spindle tree. Spiræaceæ produce seeds from one to six. Poppies innumerable. Alismaceæ, pods one or two seeded. Triglochin, fruit dry, one or two seeded.

The various modes by which fructification is protected in the blossom and in the seed-vessel are very numerous, beautiful, and wonderful. In some the corolla folds its tender petals over the antheræ and pistilla, to guard them from rain and from invading insects. In some the pendulous corolla throws off the falling shower from its conical or bell-formed surface. The seeds of most plants are protected within hard or elastic shells, drupæ or siliquæ. But many are fixed upon a bare receptacle. These, how-

[e] On this part of the subject it suffices to make a general reference to the Introduction to the Study of Entomology, by Kirby and Spence.

ever, have their peculiar protection in the hairy pappus or down which first guards the infant progeny to the full period of maturation, and then wafts them through the air, for the purpose of extensive distribution.

Nidification.

In noticing the care of offspring, I have already remarked that some animals of every class exhibit more and some less care in providing for their future progeny, by the construction of warm and convenient nests.

Among mammalia, those with hoofs, and with pads, as the elephant, &c. equally unfit for manufacturing purposes with hoofs, are bad nest-makers : while those, whose claws are scarcely less fitted for diversity of operation than the human hand, almost rival man in the construction of bridges and superaqueous habitations, and may enter into competition with birds as nest-makers.

The wonderful edifices effected by the combined exertions and ingenuity, or yet more inexplicable instinct of beavers, are too familiarly known to all who have ever looked into the most common histories of animals to need repetition of description. The nests of squirrels, of marmots, of rats, especially the hamsters, of field-mice and dormice, resemble and rival those of birds. The larger birds of prey, and the largest and strongest of the insectivorous, or rather of the mixtivorous, employ coarse materials, and build loosely-compacted nests. The mag-

pie among the latter disposes dead twigs in a peculiar manner, employing part as a basis on which the warm nest of straw and wool and feathers is to be supported, and part as a canopy, either to protect her eggs and young from rain, or more probably from the invasion of others, addicted like herself to egg-stealing. The nests of very many of the genera loxia, motacilla[f], fringilla, parus, may be here adduced as instances of most delicate art, most skilfully applied to the purpose of cherishing with warmth the tender brood, and of securing them from the invasion of every kind of enemy. In general there is a curious adaptation of the exterior of the nest, even in its colour, to that of the surrounding objects, so as to baffle the search of the most scrutinizing invader. The nests of the chaffinch, of the skylark, of the water-hen, and coot, equally serve to illustrate this observation, by the adaptation of lichens and mosses, of dried grasses, of reeds, and leaves of the Iris and sparganium, to these purposes. The floating nest of the coot is artificially moored to the stems of reeds or rushes. The nests of loxiæ, now named plocei or weavers, are among the most remarkable. Some hang in numerous strings from the terminal twigs of lofty branches,

[f] "The motacilla sutoria, or taylor-bird, sews one or two leaves dexterously together, making a bag close at the bottom and open at the top. This bag it fills in part with cotton, and in this abode deposits its eggs and hatches its young; the weight of the parent bird and the progeny not being sufficient to break the slight leaf stem to which the nest is suspended." *Shaw's Lectures*—202.

having their openings at the bottom of the gourd-shaped nest. Some are accumulated so as to form an impenetrable mass for security against the attacks of monkeys and snakes, with labyrinthine passages to numerous cells and nests, forming in each assemblage a vast college of the ploceus socialis. The nest of the reed wren is said by Montague to be composed of long grass and of the downy seed branches of reeds, and lined with the down. It is very deep, and conceals the bird when sitting. This nest is fastened by long grass to several reeds, which are bound together for that purpose. The mud nests of house martins are no less admirable instances of laborious perseverance and ingenious contrivance. The amphibia in general exhibit little ingenuity in constructing places for the protection of their eggs. It is well known that almost the whole of this class is oviparous; with, however, a very few exceptions, as the rana pipa among the batrachia, which produces its young in a manner quite peculiar to itself; demonstrating that although a general unity of plan is traceable throughout creation in this part of animal economy, yet one in many respects different might have been adopted, had it pleased the Universal Ordainer. A number of pits or cells on the back of this animal perform the double office of nest and womb. The young are there mysteriously matured, and there pass in quiescence through the tadpole state, till ready to emerge minute but perfect toads. The shell serves as a nest to the tortoise in his earthy burrow. The alligator, I have before ob-

served, raises an artificial structure for its eggs. Vipers burrow in light vegetable soil, or in sand-banks. Snakes in heaps of rotting vegetables. Most fish, even those which inhabit the deepest waters, come during the breeding season to the shore, to deposit spawn. The spawn is generally protected by a jelly-like soft envelope; sometimes by a tough skin; sometimes by a square horny bag. The genus raia, to which the torpedo and the skate belong, is not very fertile; produces but one young at a time, instead of a multitude in a mass, and this is enclosed in a black four-cornered bag. The genus squalus, to which the shark and dog-fish belong in the same way, each being enclosed in dark brown bags, with long setæ or threads at the corners. These bags of the dog-fish are found frequently among the sea-weeds on our coast. Amongst the crustacea, some species of the genus Cancer bury their eggs in the sea sand. The lobster and crayfish, it is well known, carry them under their tails. Spiders enclose their eggs in downy bags, which are found hanging in corners of unswept apartments and on houses. Some carry these bags about with them. Scorpions lurk in holes of walls and hollow timber. Of insect architecture, nothing need be said in this place. The solid substantial edifices of the Termite ants, and those of more than one species well known at home; the various combs of the bee tribes, duly and forcibly demonstrate the operation of a guiding Power, independent of reason and of instruction, which directs these creatures, who, by the inevitable condi-

tion of their birth can never know a parent's care and teaching, to employ the same means to the same ends with unerring accuracy. Among the mollusca, many make the bodies of other living animals serve them for a nest. Of the order intestina, ascarides, tæniæ, &c. above 200 species breed in the viscera of almost all the species of other animals. The tænia bufonis in the toad, the fasciola loliginis in the cuttle-fish. The habitations wrought from the secretion of their own bodies by the order testacea, univalves, bivalves, and multivalves, are too well known to need particular mention, too numerous to admit of detailed description in this place, and too beautiful to be overlooked by those who have the slightest curiosity to regard either graceful varieties of form or harmonies of colour.

In the cardita concamerata there is however an inner chamber within the exterior shell, in which the eggs are actually deposited and hatched. Many of the testacea form clustered grape-like balls: for example, the buccina, commonly found among sea-weed on our shores; others form strings of discs closely connected by a single point of their edge, near to which the eggs are deposited, like seeds under the scales of fir cones: such, I believe, are nides of the murex, purpura, &c. The helix vivipara may be noticed as a species which hatches its young within the shell.

It may be said that shells are not nests. This is true for the most part, if the term *nest* be limited by definition to mean a place for the deposit merely

of the young progeny. They are habitations; but the habitations or holes of many insects and fish, and amphibia and birds, as the burrows of puffins and of rabbits, and badgers and foxes, are places of breeding, and also of permanent shelter. The roots of most plants, excepting annuals, are hybernacula, or winter quarters for the vital energies of the vegetable world. Bulbs have great analogy with nests. The future plant is there nurtured, protected, and fed, till it is so far advanced in growth as to be able to sustain itself. The singular root of the ophrys nidus avis, the complicated form of which gives name to the plant, appears to be a compound of bulb, root, and tuber. The fleshy fibres are fixed laterally to the bottom of the stem in a thick intricate bunch, resembling the woven structure of a bird's nest.

Social habits.

The nidification of different animals, and the connected or disconnected roots and seeds of different plants, determine in a great degree, no doubt, yet in connection with instinct, the social or unsocial character of some species of every class. Some plants are thinly scattered, and are found delighting the fortunate botanist in the rarity of solitude. See Dr. Arnold's and sir Stamford Raffles's account of Rafflesia Arnoldi; names well coupled with the most singular of vegetables, their joint discovery in the woods of Sumatra. The lathræa squammaria, the monotropa, the ophrys nidus, avis, may be cited as familiar instances of solitary plants. Couch grasses,

agrostis stolonifera, hieracium, pilosella, &c. &c. are equally familiar instances of plants which become social from their mode of propagation. But a more rare, and not less striking instance, is that of the willow grass, called Saule en herbe. Let us suppose the seed of a willow springing up at the foot of a mountain, and that the earth which is annually carried down by the rains from this mountain should be sufficient to bury the young plant. The following spring it would again shoot out with redoubled vigour; for the growth of the plant having been checked by the fall of the soil, the sap, which should have been expended in the produce of foliage, being accumulated in the little stem, will be sufficient to afford nourishment for a double shoot; two little branches will therefore now appear. This, like its predecessor, flourishes but for a season, and is buried: the two stems the following spring produce four, which expand their leaves, and in the autumn are consigned to the earth; the third year eight stems arise; the fourth, sixteen; and the plant goes on thus doubling its sprouts every year, the surface of the soil rising, till at length a plain is formed, covered with verdure, consisting of the leaves of the willow tree [g].

The rarity of some sea-shells seems to shew a less social habit in some species than in others. The dentalium is an example of solitude, living immersed in mud on shores rarely exposed to tempests. Se-

[g] Mrs. Marcet's Conversations on Vegetable Phys.

veral of the helices are found to congregate in vast numbers. The ocean swarms with medusæ. The congregation of coral insects forms islands in the Pacific; yet the isis hippuris, or jointed coral, the antipathes, or black coral, and the gorgonia nobilis, or red coral, have great analogy with solitary plants. They are produced apparently from the beginning of time in the same, or nearly the same places, but they have no connection of common impulses. They are separately fixed, by apparent roots, to rocks: these, however, are not real roots, for they do not imbibe nourishment. The animals exactly resemble plants covered with soft flesh, which exhibits numerous cells, or polypiformed mouths, which serve to imbibe nourishment, and to send forth spawn. A common impulse to hybernation compels garden snails to assemble toward the approach of winter, and to cluster together in some appropriately chosen cavity for shelter against frost, and other sources of injury.

The arachnides are for the most part solitary, and ferocious in destroying intruders on their solitude, even those of their own species.

The gossamer spiders appear, however, to be an exception. See Letter 65 of White's Natural History of Selborne, where he mentions a shower of gossamer extending about eight miles in every direction and many hundred feet in height, according to the notice of a person who rode up the side of a steep hill above 300 feet, and found the gossamer still far above him. The scorpion, scolopendra, and

iulus, are all of solitary habits. Some rare insects of the genera papilio and phalæna[h] are usually found single or in pairs: even those which are numerous can hardly be said to be social. But on imperfect and perfect societies of insects such ample and interesting detail is given by Kirby and Spence, vol. ii. that a reference to that excellent work may here suffice; with the bare remark, that ants and bees afford the most remarkable instances of perfect societies. Some however appear to have solitary habits, as the mason bee. The apiarian tribe is divided into two subdivisions, the solitary and the social: among the former is the genus xylocopa, among the latter, eminently, apis mellifica. Crabs are, in some species, of solitary habits, as the cancer Bernhardus, or hermit, which having an unprotected tail takes shelter in deserted shells of univalves, chiefly buccina; and pinnotheres, which inhabits the beard of the pinna. In some, the habits are notoriously social, as in the ruricola, or land-crab, so numerous in the Bahama islands; and cancer crangon, the shrimp or prawn so well known on our coasts. Of fish, the solitary habits of some, and the social of others may be witnessed by any who ever look into a clear stream. The trout and the pike may be

[h] Papilio cardui, painted lady: the caterpillar is solitary; the butterfly lays a single egg on a leaf:—the caterpillar unites together the edges of the thistle leaf, and feeds on the upper surface. Papilio iris, purple emperor, flies high over the summits of oak-trees. This, as well as the papilio populi and papilio antiopa, is rare, at least in England.

seen, especially the larger, with their heads opposed to the current, watching in stillness for their casual prey. Gudgeons and minnows are always in shoals. Of marine fish many of the most voracious prey by night and live solitary, swimming often at the bottom; others seek their food by day, and wander in troops from sea to sea, as the herring and the cod, swimming near the surface.

Serpents, even where most numerous, exhibit generally anti-social habits; yet great numbers of the anguis fragilis are said to have been found frozen together in winter. The lacerta iguana is solitary: the species agilis, on the walls of France and Italy, is numberless. Toads are lonely; frogs notoriously social. Turtles congregate. Land tortoises are for the most part solitary, even in their hybernation.

Birds of prey, especially the nocturnal, are unsocial. Granivorous birds flock together, especially in winter. The carrion crow is a bird of solitude: the rook, of even apparently organized society: many which separate in pairing time congregate in winter. The swallow tribes seem to become more and more associated as their season for migration approaches. The common wren, motacilla troglodytes, is a notorious little anchorite. The fringilla domestica, or house-sparrow, is quite opposite in its habits during all seasons. The bulfinch is commonly lonely, or only seen in pairs. Linnets are usually found in flocks [i].

Beasts, as well as birds of prey, for the most part

[i] See White's Selborne, &c.

shun the society of each other; but jackals (canis aureus) hunt commonly in flocks or packs, and wolves occasionally. Most of the rodentia, rabbits and beavers, love society: some, as hares, are lonely. The ruminants assemble in herds, as kine and deer. The hedgehog, erinaceus, is nocturnal and lonely. The mus lemmus Norvegicus is an object of terror from the vastness of its all-devouring multitudes. The sorex fodiens, or aquaticus, is ever solitary.

Docility.

Few characteristics of inferior animals are so immediately interesting to man as their docility. This is obviously not an object, like many previously noticed, of mere observation, however attentive. It is only discoverable by experiment; and that experiment may require, in many cases, much time, and patience, and skill, in adapting various means to the remote end. Experiments made on the young may prove successful, which, applied to animals of mature age, would be hopeless. But this is a truth too well known to the instructors even of boys and girls, and of adults, to need further remark. *Train up a child,* says Solomon.

> " 'Tis education forms the common mind;
> " Just as the twig is bent, the tree's inclin'd[j]."

Plants may be made to twist themselves into a vast variety of forms by ligaments and partial ob-

[j] Moral Essays, p. 150.

structions of light, or to shoot into long and slender poles by being closely crowded; and fruits, as gourds, may be artificially made to grow into various convenient or fantastic forms. Plants may be gradually induced to bear changes of climate, to which a sudden exposure would be fatal. The arbutus and laurustinus from Italy are familiarized to our shrubberies, with roses from Persia and China, and with jonquils and asters, with peaches, and nectarines, and tulips, and geraniums, in fact, with all the chief luxuries and beauties of our gardens. Yet the companions of the arbutus and laurustinus in Italy, and even in the south of France, the ceratonia, or carob, and the olive, are not yet domesticated with us.

I cannot meet with any account of experiments on the docility of any of the mollusca, or crustacea, unless the spiders be reckoned among the latter.

My well informed friend Mr. Pratt, who obligingly arranged the shells in the Ashmolean Museum [k], tells me, that he knew a French naturalist who had contrived to obtain a breed of reversed snails, which he sold with advantage to the lovers of rarities. When a garden snail is placed with its apex vertical, its aperture expands ordinarily to the left. The line of curvature is swelling toward the right. But varieties occur, though rarely. The rarity gives them value to collectors. The Frenchman obtained a living pair, and produced a fine family, all of whom

[k] Some genera of shells are more usually found sinistral than otherwise, such as the pupa; others in which some of the species are not unfrequently so, as achatina, helix, bulimus.

from their very birth went the wrong way; all inclining to the *côté gauche*—revolutionists from the egg.

The history of insects affords numerous instances of their aptitude to receive instruction or guidance from, or to enter into familiarity with man. Some indeed appear to have more, some less capacity for communion with man. But probably the remark applied of old to the education of mankind may be extended with equal correctness to the inferior races of animals:

> Nemo adeo ferus est qui non mitescere possit,
> Si modo culturæ patientem commodet aurem.

Almost any might be tamed, could their attention be duly fixed. Bees become familiar with those who feed them[1]. Men, who enclose their queen in the hand, suffer the whole swarm from the hive to assemble on the bare arm, and thus convey them from one place to another without a sting. A gentleman in the county of Somerset has at this time a tame hornet, which lives usually under a glass in his parlour, but is let out to be fed, and flies to him as soon as the glass is lifted. It has been suffered to take a range in the garden, and has returned, through the open window, to its habitation. I have seen fleas harnessed to tiny cars, drawing them over a plain, not like that of Salisbury, but of card pasteboard, with the perseverance of dray-horses. One was made to draw a minute bucket from a minia-

[1] For an account of Wildman and his bees, see Bingley, vol. iii. p. 237.

ture well. A spider became familiar with, and consoled the sorrows of a solitary prisoner in the Bastile[m], and in the dungeon of Magdeburg.

I have not been so fortunate as to meet with any instance of a pet scorpion, centipes, crab, or lobster[n]. Fish have become so familiar as to obey a call. Carp, by being constantly fed, may be rendered so familiar as to come to the side of the pond to beg for bread. Dr. Smith, speaking of great numbers at the prince of Condé's seat at Chantilly, says, they heaved each other out of the water as they came in shoals to the shore to receive food: they would even allow themselves to be handled. Bingley mentions a carp that would come to the edge of a pond at the whistling of a person who fed it.

The most formidable and the most disgustful of amphibia have been tamed, and have become familiar with man, and subservient to his use. The cobra capello, the most venomous of Indian serpents, is taught to dance to the sound of music. The arts of the magicians who contended with Moses at the court of Pharaoh, give evidence of the antiquity of such subjugation. The Psylli and Marsi, and others mentioned by Pliny, (Nat. Hist.

[m] Baron Trenck. Trenck mentions his familiarity with a mouse, and adds, "I may hereafter publish an essay, in which this my mouse and a spider will appear as remarkable characters." Vol. ii. p. 187.

[n] Pliny relates several wonderful stories of dolphins (apparently porpoises) which suffered boys and men to ride on their backs, and fed from the hands of those who swam about them. Nat. Hist. lib. ix. c. 8.

lib. vii. c. 2.) doubtless controlled serpents by similar contrivances. Lizards are often tamed: tame tortoises are common. The iguana will follow its master like a dog. Mr. Pennant relates the history of a tame toad, which allowed itself to be carried about a room to catch flies. It lived 36 years under the steps of a porch, and came out at night when a candle gave notice of a friendly invitation. It was fed on a table with meat maggots, which it chased over the table.

The domestication of birds is too well known to need illustration; the services of decoy-birds to ensnarers of ducks, finches, linnets, &c. Piping bullfinches, familiar Canary birds, and perroquets, occur in every town and village. Most schoolboys have in their day found an example of docility worthy of imitation in starlings, jackdaws, and greenfinches. A goldfinch has been taught to fire a small cannon; and another, at which it has been pointed, to fall instantly from its perch with closed eyes, in motionless mimickry of death.

Instances of equal or superior aptitude for instruction and propensity toward familiarity with man may be found through all gradations of quadrupeds, from the mouse to the "half-reasoning" elephant. The most remarkable instance within my memory is that of a keeper of beasts entering into a large cage with a full-grown lion and Bengal tiger, which he compelled to leap through a hoop, which he held in his hand, nearly four feet from the floor of the cage. He actually compelled them when apparently

tired and reluctant, by loud menaces and blows with a whip, which he said were necessary to maintain his authority[o]. Moral analogies are no doubt often questionable, are sometimes invidious: sometimes however they may suggest useful thoughts; witness the Fables of Æsop. Freedom from restraint is almost inseparable from ferocity of character in beast and in man. Subjugation of temper and obedience to law are not impressed on lions or on nations without coercion. A Pericles, a Cæsar, a Cromwell, a Napoleon, are whips in the hand of Providence. *The ungodly, Lord!* says the Psalmist, *is a sword of thine.*

Benefit or Injury to Man and to each other.

I shall, in conclusion, observe, that in plants and in all classes of animals, this important analogy is traceable, is indeed conspicuous, is irresistibly forced on our attention; namely, that almost all of every class stand either in the relation of benefit or of injury to others of the same class, or to many of other classes.

It is manifest to all, that the vitality of plants and animals is possessed by each individual but for a definite portion of time.

No chemist will pretend that any of the laws by which bodies subjected to his experiment are com-

[o] On the other hand, see an interesting account of the indomitable ferocity of the grisly bear, p. 121. of the Tower Menagerie, with portraits of animals by W. Harvey, engraved on wood by Branston and Wright.

bined, have any tendency to produce or reproduce active forms endued with automatic power, or have any analogy with organized beings.

While vitality exists, the agencies of chemistry, or mutual re-agencies of animal components, are completely suspended. The moment of withdrawn vitality is that of the commencement of chemical agency, producing the dissolution of organic structure.

Organic structure is a manifest disposition of parts to a predestined end; as of hands to various occupations, feet to locomotion, wings to flight, fins to motion in water, mouths to food, lungs to respiration, &c.

Organic structure then has relation to a power prior to all organic existence, a power to predestinate, to contemplate an end, and to appoint means of attaining such end.

The operation of this power we have traced in unity of plan through numerous analogies in various classes of organized beings.

The formation of creatures merely capable of living for a limited period upon earth, and then dying, and becoming merely dust, could not be the sole object of the great universal Organizer.

The Giver of life has given mind also. Organization requires a moving principle or power to guide it to its end. But were that principle merely a power to originate and continue motion, the moving machines would run over cliffs and be dashed to pieces, and into water and be drowned. But mind

is a discriminating, a selecting, a judging, a preferring, an avoiding, a desiring, a fearing, a hoping, an abhorring principle. These properties of mind are not indeed objects of sight, as mouths and feet and hands are, but they are not less certain. We might as wisely doubt whether we have mouths and hands, as doubt whether we have discriminating, judging, fearing, and hoping faculties. These latter indeed are objects of consciousness, not of the senses; but without consciousness we could have no knowledge of the existence even of the senses.

As organs have a manifest relation to purposes, to ends to which they are especially adapted, so by analogy we may presume that mind, which is to guide the organs to such end, is allotted to each individual for such guidance; to be a guard against peril, to record experiences, to employ past experience as a warning to abstain from action, or as a stimulus to promote it, and for other and yet greater purposes which I do not here specify, because they belong to a distinct science.

Without mind, we should obviously have nothing on which, and nothing with which, to argue. It is the repository of our sensations, of our reflections, of our emotions and our passions; of our judgments on the mutual relations of external objects; of the relations of all to us, and of us to all; of the relations of man to man in society, and of man to the Author of his being.

To confound the active principle with the organized machine would, in arguing on a work of human

art, be too absurd not to meet with instant scorn and ridicule. To affirm that the spring or weight of a clock, for example, derived its power from the wheelwork, and might have adapted itself to the wheels, and the wheels to itself, would be notoriously the babble of idiocy. The machinery of organized beings is subjected to mind; and it is only in its relation to mind that it is capable of receiving benefit or injury. These terms belong to the vocabulary or nomenclature of consciousness, and are strictly applicable only to beings known or firmly believed to be capable of pleasurable or painful feelings or emotions. A field is improved by the addition of manure, but the farmer or landlord is *benefited*. A watch is disordered by a fall, but the owner is injured by the loss of its use. A crystal may be damaged by a hammer, a shell by a fall; but an animal is *injured* by a wound producing disease or inflicting pain.

Thus evil and good belong to sentient and intelligent beings: they are correlative. Sensation or thought, utterly destitute of some degree of gratification or displeasure, would scarcely excite or fix attention: life would be a state of torpor: mind exists to be excited, and to excite; its excitement, active or passive, is either good or evil. This is the condition, more or less, of every sentient being: without the one, the other could not be an object of apprehension or conception; each would be without distinction and without name.

Many have toiled to discover and explain the

cause of this relation between sentiency and pleasure and pain, between intelligence and good and evil. But *we see as through a glass darkly.* The multitude, ignorant of optics and of stage mechanism, gives the name of magic to a phantasmagoria. The cause producing such effects is to them utterly incomprehensible. They are placed where effects only are to be seen: a semiopaque skreen conceals the cause. Our induction is connected reasoning from effect to similar effect, from known relation to similar relation; but between us and the cause of the vast and wonderful display of concatenated effects there is a skreen of impenetrable mystery. We cannot fly or climb over it, nor pioneer under it, nor batter through it. Until we can pass from the effect side to that of cause,

"Reason in vain
"Would from the existing *what* conclude the *why:*"

But a Cause, a mighty Cause, adequate to such immensity of effects, is unquestionable. The eye has a perception of light contrasted with darkness in the phantasmagoria; the mind a perception or conception of order, of wisdom, and of power in the universe. As the relation of the eye to light, producing the perception of the luminous or enlightened objects; such is the relation of mind to an ordering, disposing, adapting Power, capable of ordaining good and evil to the excitement of its faculties.

This is indeed the highest of conceivable rela-

tions; not a relation of subsequent to antecedent effect, but of the ultimate object of intellect, of consciousness or mind itself to the great Cause of causes, necessarily antecedent to all known antecedents, before and above all comprehensible existence, eternal, infinite.

This relation of mind to the great Author of all being, is a relation of an appointed active agent to the source of life and of intellectual activity. The relations of parts to parts of all organizations, of all organized beings to each other, of all known compounds to their elementary components, tend to dissolution; but the relation of life to the source of life, of intellect to the living source of all intelligence, to the Eternal, the Infinite, is one of which the contemplation elevates the soul to its most exalted state of rapture. It points out an hereafter; it intimates eternity to man.

Satisfied with the conviction that the whole of the organized universe is the effect of power immense beyond the scope of comprehension or imagination, above the scan of human judgment, we may rest in humble faith and trust that the Power which has wrought so widely and so wisely, and has ordained such vast diversity of good throughout his works, has consistently with such power and such wisdom permitted the existence of evil, although we may not be able to trace, with our limited faculties, the ultimate purposes of his illimitable ordinance.

Thus far we may reason securely on physical re-

lations; on the relations of organized substance, the object of our senses, to mind; of mind to consciousness, or to itself; and to the relations of that self to its allotted sphere of action, and to the Cause or Power by which such agency has been ordained and allotted.

On the moral relations of intelligent beings in society, on their domestic and political relations, and on the good and the evil which result from a correct apprehension of reciprocal obligations, this is not the proper place to enlarge. It may however be to the purpose to observe, that these relations and obligations are conveyed from generation to generation by instruction, which anticipates experience, and which must have done so from the beginning of creation, at least with relation to rational beings. Inferior animals appear to be guided in a limited sphere of action by a mysterious impelling power, implanted at birth. To some of these, instruction is impossible; for the existing generations have never been born till the whole of their progenitors have perished.

Ἄμμες δ' οἱ μέγαλοι καὶ καρτέροι ἢ σοφοὶ ἄνδρες.

But men, the great, the mighty, and the wise, are long after their birth more helpless than most young animals of other classes.

Is this their extreme weakness and infirmity a benefit or an evil? It is certainly the source of our holiest, our purest, our most rapturous attachments: of all that sanctifies, that blesses, and endears the

names of country and of fellow-countrymen, of friends, of kindred, and of home.

But the first created beings, by whom were they instructed? By the only possible Instructor, the sole, preexisting Ordainer of their existence.

What says the most ancient of traditions? what the most ancient of records?

The Lord God put the man into the garden of Eden, and commanded the man: Of the tree of the knowledge of good and evil thou shalt not eat. What followed, we all know too well: an irresistible veto was opposed to further knowledge.

A book perhaps as old as that of Genesis, perhaps by the same inspired penman, is throughout a solemn admonition to all human beings to abstain from questioning the wisdom and goodness of the Omnipotent in the permission of what we call evil.

Why dost thou strive against him? for he giveth not account of any of his ordinances. Job xxxiii. 13.

He chasteneth man with pain upon his bed. ver. 19.

He looketh upon men; and if any say, I have sinned, he will deliver his soul from the pit, and his life shall see the light. ver. 28.

Who can read the sublime thirty-eighth and thirty-ninth chapters of Job, and not feel disposed to repeat in humility with him, *Behold, I am vile; what shall I answer thee? I will lay my hand upon my mouth.* Job xl. 4.

Who is he that obscureth counsel without know-

ledge? therefore have I uttered that which I understood not: things too wonderful for me that I knew not. Job xlii.

He that hath *shut up the sea as with doors,* hath here fixed a barrier against the swelling of the mind of man. Here must we rest in faith.

A mixture of good and of evil is found in every class of sensitive and sentient beings: good abundant without evil; evil rarely or never without attendant or succeeding good. "If you do good with pain," says Chrysostom, "the pain flies off, the good remains. If you do ill with pleasure, the pleasure flies, the ill remains." The physical and moral balance is in favour of good.

Plants considered with relation to man supply him with the first allotted, the principal means, throughout all time, of his subsistence. The seed, the root, the stem, the leaf, the flower, the solids, and the juices, all supply nutritious and delicious food; all supply medicines which alleviate or heal diseases, nearly of opposite diversities of character. Some, however, but few in proportion to the total number, produce thorns and poisons. The thorns arranged by art become useful fences; the poisons, modified by experience, as the juices of the poppy, the hemlock, the henbane, the thorn-apple, the deadly night-shade, the foxglove, are the most potent balms of the most improved pharmacopœia.

The plant kind, as well as mankind, is subject to inconvenience and injury from excess of population, and from parasites which overwhelm their luxu-

riance and exhaust their vital juices. The gardener who has been too profuse of seed must thin out the young plants of cabbages, lettuces, carrots, &c. if he hopes to obtain vigorous plants. He prunes redundant shoots, and suffers not more than a limited number of fruits to ripen on a branch. Trees in thick forests weaken the growth one of another. They are said to be drawn upward. They become tall and slender, without side branches. Their close meeting summits exclude sunshine from their roots. The impediment to evaporation converts the soil to a watery bog, too loose to afford a firm basis for their roots. In such condition storms lay prostrate large tracts covered with timber, destined in time to become peat moss. Some forests are called tolerant, when the lofty trees allow underwood to grow beneath them, as oaks. Some are called intolerant, beneath which inferior plants wither and perish, as pines. Innumerable climbing plants and parasites affect forests, meadows, and corn-fields. The descriptions of Brazilian forests in many late publications render detail needless of the lianes, or climbers, which obstruct all progress through them without laborious use of the axe. Tares overwhelm wheat and barley crops. Dodder is often oppressive to beans;—ivy to our forest timber. The rhizomorpha creeps under the bark of aged trees, and hastens their decay. Fungi, called false parasites, destroy leaves and roots. Lichens and mosses injure timber by attracting moisture to the bark, and affording a lodgement for insects.

Amongst the mollusca useful to man we may instance those which supply food, as oysters, the large snails, fattened for the table in Germany, cockles, and limpets: those which yield treasures for commerce, as corals and pearls: those which yield a small contribution to clothing, as the silk of the pinna.

Of vermes the gordius is said to have a poisonous bite producing inflammation: the furia of Bothnia to be fatal when it penetrates the skin. The leech is well known as a useful auxiliary to the surgeon.

Dr. Shaw says, the soft holothuriæ, which float occasionally on calm seas, have the power of causing great inflammation of the skin of those by whom they are incautiously handled. The medusæ, which abound in all seas, possess generally a stinging quality, which has obtained for them the name of sea-nettles. Even mollusca are not exempt from parasitic mollusca. The cuttle-fish has its internal worms, the fasciolæ loliginis; the earthworm, its ascaris lumbrici.

From the crustacea we may select lobsters and prawns as supplying to man agreeable repasts: scorpions and spiders as injurious by their venom. Crabs and prawns are the prey of onisci; and perhaps most others either of tæniæ ascarides, or echinorynchi.

Of insects, whole tribes are eminently useful to man. I need only mention the silkworm, the caterpillar of the bombyx mori, originally from the northern provinces of China. In the days of the emperor Justinian, Greek missionaries are said to have brought the eggs concealed in reeds from India to Constan-

tinople. They were afterwards brought by the Moors into Spain, and were brought into France by the followers of Charles the Eighth, after his conquest of Naples. Queen Elizabeth first introduced silk stockings to the royal wardrobe. The substance has exercised the industry of thousands; I might say of many millions, including Europeans and Asiatics[p]. The wax of bees, used in medicine, for candles, &c. is also a considerable article of commerce; and the dried bodies of cochineal insects are said to be imported into Europe for purposes of dyeing, painting, and japanning, in quantity amounting to the weight of near a million of pounds. The Spanish flies, lytta vesicatoria, green beetles, killed by fumes of hot vinegar and dried in the sun, destined wholly for blisters, are imported in vast numbers from Italy and Spain.

Gnats, mosquitoes, chigoes, fleas, bugs, lice, wasps, hornets, even bees, occasionally give severe annoyance by their stings, or bites. They employ their weapons, and their poisons also, against one another very extensively. The libellulæ prey generally with great rapacity[q] on most other insects. Wasps and

[p] In May 1795. Sir F. M. Eden thus notices the silk-manufacture of Derby: "There are twelve mills, which give employment to about 1000 people, chiefly women and children;" above one tenth of the whole population.

[q] Scarcely any, perhaps none, are exempt from their peculiar parasites, which tend to reduce their rapidly increasing population,

"Fleas have lesser fleas to bite 'em,
"And so proceed *ad infinitum*."

hornets use their stings in overpowering other insects, on which they prey extensively, and also in their wars for plunder. The Pennsylvanian sand-wasp is said to seize on grasshoppers, as the appropriate food for its own larvæ. It plunges its sting into the body of the grasshopper so as not to produce death but torpor, lest the body, when deposited in its nest, should putrify and become a nuisance, and unfit for nourishment. I need only refer for full information to the interesting chapters of Kirby and Spence, on benefits and injuries from insects.

Fish supply mankind with nearly one third of their food: with the varnish of the Roman pearl; with shagreen, with isinglass and caviare. The pursuit of fish for commerce exercises the industry of many thousands in all commercial countries. The occupation of angling has been invested, by the enthusiastic Isaac Walton, with a character of elegance approaching to dignity.

Fish present, however, some annoyance to the human race. The perilous rapacity of the shark is notorious. Humboldt mentions a small fish, four or five inches in length, in the Oroonoko river, named caribee, or caribito, of most bloodthirsty propensities. "It attacks bathers and swimmers, from whom it often carries away considerable pieces of flesh. When a person is slightly wounded, it is difficult for him to leave the water without receiving a second and severer injury. These cruel and voracious fish live at the bottom of rivers; but if a few drops of blood be sprinkled on the water, they come

to the surface by thousands. As no one dares to bathe where this fish is to be found, the caribito may be considered as one of the greatest scourges of those climates in which the sting of the musquitoes and the general irritation of the skin render the use of the bath so necessary." The trachinus or weaver inflicts severe wounds with a strong spine in front of its dorsal fin, which cause inflammation, supposed to be the result of poison. A species of perch is called perca venenosa for the same reason. The raia pastinaca, or sting-ray, has a long serrated spine on the fore part of the tail, which is a formidable weapon of defence : it is shed, and renewed annually ; and is believed by fishermen to instil a poison into its wound.

The genera and species of fish which subsist wholly by preying on other fish, and even the young of their own kind, are very numerous.

The peculiar weapon of the gymnotus electricus and the torpedo ray is in its effect allied to poison. Mr. Humboldt states the shock from the electric eel to be equal to that from the largest Leyden jar. His description of the capture of wild horses and of the eels, by the hunters driving the horses into pools filled with the eels, where the horses are stunned by electric shocks from the eels, and the eels exhausted by the discharge of their internal batteries, has been repeated too often to need further repetition.

Not a few of the amphibia are useful to man as food. Foremost in these ranks comes the turtle, testudo mydas. His shell, and that of his congener,

the testudo imbricata or hawksbill turtle, are largely used in elegant manufactures, especially the latter, which affords the true tortoiseshell. The frog, rana esculenta, is a favourite article of food in France, Germany, and Italy. A scarcity of frogs at Vienna would occasion as much discontent as a scarcity of corn in England, and would probably be attributed to the emperor or his ministers. The lacerta iguana, however hideous in appearance, is eaten with great relish, and esteemed to be rich and delicious food, in South America.

Crocodiles and alligators are dangerous to the unwary in their native rivers. Their fangs are terrific; their armour, on the back at least, impenetrable. The roar of numerous alligators in the South American rivers resembles thunder, and seems to shake the shores of the Oroonoko. The lacerta gecko is said to be poisonous. The Japanese are reported to poison their arrows with a juice extracted from the feet of this animal, which is said to communicate its poison to meat over which it has casually passed.

The flesh of vipers used in broth has been thought to prove beneficial to some consumptive patients. The flesh of some innoxious serpents is eaten by Indians. Amongst the serpent tribes, however, are found the inflictors of most deadly wounds by means of their quickly fatal poisons. These are found in the genera crotalus and coluber. Of the former, the most commonly known is crotalus horridus, the rattle-snake, the bite of which has killed a dog in two minutes. It is said that hogs devour

it with impunity. Of the latter genus, the coluber berus is the only poisonous British species. Olive oil rubbed early on the part bitten is said to effect a speedy cure. The cobra capello of India is the most venomous of serpents, but is devoured by the viverra ichneumon.

Frogs, lizards, and probably the serpent tribes, are subject to attacks from internal parasites, ascarides and tæniæ.

Birds are extensively serviceable to man. All will acknowledge the benefit derived from our domestic poultry. To how many does the mere rearing the broods afford a cheerful and hope-sustaining occupation? Yet, over and above those reared in England, the demand occasions a vast importation from Ireland and from France both of poultry and of eggs. One man told me that he sold in Bath during the winter of 1830, 1831, above 1000 Irish turkeys. Quills for pens, feathers for female ornament, as those of the ostrich and Argus pheasant, are important objects of commerce, and yet to a much greater extent those which are dried for stuffing beds; and the down of swans and eider ducks for pillows, muffs, and quilts. Sea-birds and their eggs afford their chief sustenance, perhaps, to millions of islanders, where agriculture is unknown, or scarcely practicable; and to the inhabitants of cold regions, where grain cannot ripen. Wild pigeons and turkeys to the Indians and wood-settlers of North America. The rapid advance of cultivation is said to have much reduced the numbers of the latter,

which may possibly at no very distant period be, like the British bustard and capercaile, extirpated; or, if preserved, domesticated.

Birds are useful to man by diminishing the broods of insects ever tending to redundance. Myriads of sea fowls doubtless modify the excess of oceanic life. Plovers, rooks, starlings, and almost all passeres, are of great benefit to farmers and gardeners, by devouring innumerable slugs and caterpillars.

Some, indeed, assail our pigeon-houses; attack and destroy young poultry; are thought to take an undue share of young pheasants, partridges, hares, and rabbits, as falcons, owls, crows, &c. Some, indeed, make their descent on larger animals, as lambs and fawns; but these are rare in Britain: as the falco albicilla or erne; the white-tailed eagle, found in Scotland. The vultur gryphus or condor is said to attack and kill the larger animals, as sheep and cows; and are said to have carried off children much above the state of infancy. It is due, however, to the vulture race, to acknowledge that some of them are excellently useful as scavengers. The ancient Egyptians held the vultur percnopterus, the Alpine vulture, so sacred, from its usefulness in clearing the ground from carrion, that it was a capital crime to put one of them to death. They held the tantalus ibis in equal or superior veneration, from its activity in destroying serpents and other reptiles. The stork is scarcely less regarded at this day in Holland for the same reason. The ciconia marabou or argala is similarly respected and

protected in the negro villages of the interior of Africa, and among the Brahmins of India. The latter suppose these birds to be animated by the souls of those of their own sacred caste. They are voracious devourers of carrion. They follow the tiger, the jackal, and the vulture, and devour even large bones. On opening the body of one of these gigantic birds, a land tortoise was found in the craw ten inches in length, and a large cat in the stomach.

Birds are abundantly provided with means of offence and defence, as before shewn. I am not aware that any are directly poisonous, but the flesh of many is disgustful, and produces nausea on being received into the human stomach. The flesh of that elegant bird the hoopoe is rancid and nauseous. The (now probably extinct) dodo was called by the sailors, who first eat it on the isle of Mauritius, the emetic bird, because the attempt to eat it was attended with effects which the name suggests. The buceros rhinoceros and the gracula fœtida are disgustingly inodorous, even while living. The solan goose, pelicanus bassanus, is indeed potent in offensive odour; although, when dried and salted, there are palates to which it is almost delightful. The fulmar feeds entirely on fish, and seems to be through its whole substance quite surcharged with rancid oil, which it has the power of ejecting forcibly from a tubular process of the bill peculiar to the petrel genus. This oil it spouts into the face of the invaders of its nest, to the frequent peril of the climbers of St. Kilda's cliffs.

The benefits of quadrupeds to man are too obvious to require more than the bare enumeration of the names of the most useful. With the ancient Egyptians and Brahmins, I do not hesitate to give the first honour to the cow. " Le bœuf, le mouton, et les autres animaux qui paissent l'herbe non-seulement sont les meilleures, les plus utiles, les plus précieux pour l'homme, puisqu'ils le nourissent, mais sont encore ceux qui consomment et dépensent le moins : le bœuf surtout est à cet égard l'animal par excellence, car il rend à la terre tout autant qu'il en tire," &c. (Buffon.) The quantity of hides imported into England forms the most bulky, and nearly the most valuable article of our commerce. A volume might be filled with an account of the different preparations of tanned ox-hides and dressed calves' skins, in the form of soft leather or of vellum ; on the preparation of glue from the parings ; on the various manufactures of horn and of bone ; on the uses of the blood in our sugar manufactures, &c. : but the benefit from this race of animals in supplying us with milk, butter and cheese, and beef and tallow, is varied and extensive beyond all possibility of calculation. The labour of the ox is in many cases equal or preferable to that of the horse. Next in value to the bull or cow kind is the sheep. Although this race affords no aid to human labour, yet the quantity of industry which is promoted, and the quantity of comfort which is diffused by its fleece, has rendered it one of the most early and most highly valued of human possessions.

The value of the horse, as a fellow-labourer with man in the fields, from his superior activity to the ox, is unquestioned by the possessors of light lands. His importance in facilitating land commerce has been duly appreciated in all times, and by all nations. His celebrity may be said to prance on loftier ground, when historians and poets speak of rushing squadrons which descend with the rapidity of lightning on the plain of blood, where the hoofs are red with the gore of trampled battalions. But, alas!

In evil hour, and with unhallow'd voice, (pace Homeri)
Profaning the pure gift of Poesy,
Did he begin to sing. He first who sung
Of arms and combats, and the proud array
Of warriors on th' embattled plain———
——If the stroke of war
Fell certain on the guilty head, none else;
If they that make the cause might taste th' effect;
Then might the Bard, though child of Peace, delight
To twine fresh wreaths around the Conqu'ror's brow, &c.

As sings a learned and amiable poet of New College, the bard of Lewesdon Hill. These poems may well excite regret that he wrote no more of this kind.

The renown of the racer and the hunter is scarcely less than that of the charger, and is perhaps more highly and more correctly appreciated in England than in any other country[r]. Feats of horsemanship in Turkey and Persia, and perhaps throughout all

[r] Perhaps no where better than at Oxford and Cambridge, from the Odes of Pindar, and the plains of Bibury and Newmarket.

civilized and half-civilized Asia, are, however, unrivalled by any in Europe. The skill also of the Gauchos in Brazil in subduing wild horses, and guiding them in the chase and capture of wild bullocks, is singular in its kind, and the performance of the horse in such pursuit is almost as wonderful as that of the men. The importance of the horses of draught, used in waggons and stage-coaches, appears to be in danger of much depreciation, if not of annihilation, from the rapid advancement of railways and steam-carriages, with tenfold power and quadrupled speed.

The dog has been the familiar companion and friend of man from the earliest days of man's existence. Abel had, probably, a dog for his flocks; and Nimrod, soon after the deluge, for his hunting. The name is first mentioned in Exodus, chap. ii. where the Lord says, "Against any of the children of Israel shall not a dog move his tongue." For a detail of his feats and services, I will content myself with referring to his biographer Bingley. To how many Newfoundland-dogs has Homer's Argus given name? To whom does not that name recall a delightful remembrance of youth, either the recollection of most tender poetry, or of some affectionate, though shaggy, playfellow? The patient ass and mule deserve respectful mention; and the camel and the lama of Arabia and Peru afford, in their peculiar regions, all that is estimable in the sheep, the cow, and the horse, to the sons of the desert

and the natives of the Andes. Even the tiger kind, as the Indian cheeta, has been rendered subservient to man's uses; and the ferret and the otter.

The injuries of beasts of prey to man are at this time of the lowest class in Britain. The fox occasionally invades our hen-roosts, and devours a few hares, rabbits, pheasants, and young partridges; but he is a privileged and protected marauder, and would be extirpated in the course of a year, were he not under the unmerciful guardianship of the chase-loving squirearchy. The stoat, the weasel, and the polecat; the rare pine-marten, the rat, the mole, the mouse, and the otter, are guilty of small injuries, and forfeit their lives accordingly; but they cause no fear for our persons. The bite of the rat is said to be venomous; but probably the venom may be the result of saliva flowing into a wound when the animal is highly excited by fear or fury, which gives a peculiarly fatal character to the bite of dogs, foxes, and cats, in causing hydrophobia ;—more dreadful than the speedier and more tranquil death-stroke of the cobra di capello.

Britain was, however, in its early days, so much infested by wolves, that king Edgar is said to have commuted several punishments into a fine of a number of wolves' tongues from each criminal; and he converted a heavy tax on a prince of Wales into an annual tribute of 300 wolves' heads. "It appears from Hollinshed that wolves were very noxious to the flocks in Scotland in 1577; nor were they en-

tirely destroyed till about a century afterwards, when the last wolf fell in Lochaber, by the hand of sir Ewen Cameron of Lochiel." Bingley.

The terrors of tigers and lions, of panthers and leopards, are confined to countries within, or nearly bordering on the tropics; but wolves are the natives of most of the temperate, and even of the frozen regions, where, impelled by hunger, they often attack travellers, and even invade unguarded habitations. They are not only destructive to herbivorous animals in general, but frequently wander over the ice in quest of young seals. Between lions and tigers, perhaps among most beasts of prey, furious combats take place, terminating with the death of one or both the combatants.

Parasites.

However disposed these powerful destroyers of one another be to shed the blood of their own kind, or of herds which have no arms for warfare, yet they are not exempt from the attacks of foes as fierce as themselves, but secure from their force, by the insidious secrecy of unseen invasion, which penetrates even to their vitals. These foes are the numerous tribes of parasitic insects. The whales have their echinorynchi, which adhere to their intestines. The cat and dog kinds their ascarides. All kinds are subject to peculiar tæniæ. Another genus called fasciola torments the intestines of man, fox, badger, polecat, and probably of lion, tiger, lynx, &c. as well as of most herbivora. None are free from the tor-

turers of the skin, pulices, pediculi and acari, fleas, lice, and ticks, chigoes, mosquitos, bugs, &c. "To each his sufferings—for a time—condemned alike to moan." But for a time, however, with mysterious modifications: death is the common boundary of that time. This analogy, or relation to all around it, belongs to each individual; to every species, genus, order, class; to all that has preceded and to all that is to come.

Who can survey the analogical connection of the classes, so widely different on a primary view, in their apparent conditions of being; who can observe these analogies, so varied as to the subjects in which they are traced, so curiously fitted to changes of existence, and yet believe that all are casual, all undesigned? Who can observe these repeated evidences of Unity of plan, and doubt whether all be not the work of One all-designing Intelligence, One all-operating, all-sustaining Power? Who can contemplate the general delight in existence, which, in opposition to all assaults of major or minor evils, manifestly predominates throughout creation in all sentient beings, without conviction that the goodness of the Author is, at the least, co-extensive with the immensity of manifest good? Who can contemplate his own relation as a creature to such a Creator, such an atom, even when compared to the globe on which he is placed, and, in the pride of profound ignorance, presume to question the wisdom or the justice of the ordered whole, the minutest particle of which presents to the most powerful microscope,

to the most laborious, the most penetrative analysis of chemistry, only fresh matter for wonder and admiration, fresh proofs of Universal Order?

It may be objected to the limited survey of physical analogies, which I have thus cursorily made, that it is confined to a few superficial features of a small portion of creation: that if the whole exhibit evidences of design, why narrow the scope of observation? If the whole be organized, why contract the application of the term *organization* to a part? The answer is obvious. The survey of analogies must begin at some point. In every survey the mind advances with most secure satisfaction when it expands from the proximate to the remote, from objects near at hand and easy of analysis to those more difficult of access, and of minute scrutiny. A person who should alight from a balloon on the summit of a mountain, would be as uninformed respecting his relation to the country round the foot of the mountain as of his relation to the objects of the fainter distance: but one who has ascended from the previously surveyed base, and looked from time to time around him during the gradual ascent, will be able to distinguish, under the most acute angles, the minute differences; and to certify their bearings, and all their mutual relations.

I might have enlarged the number of objects through which analogies may be traced, but I trust that the few instances which I have selected, however slightly designated, will have fully answered the object which I proposed at the commencement,

namely, to exhibit even to those most slightly acquainted with natural history very striking analogies or relations between the most widely separated classes of plants and animals. The distinction between the greater divisions of objects, as of kingdoms and classes, is more palpable, and more readily apprehensible, than between those of genera and species. It is easier to distinguish a crow, for example, from the sheep on whose back he may be perched, than from the raven which may be near to him.

Of anatomical analogy, the extensive and varied detail must be sought of course in the works of those excellent anatomists and authors who have especially devoted their attention to that object. Hunter and Home are distinguished in Britain, Cuvier and Geoffroi in France, Blumenbach, Meckel, and Carus in Germany. From these, especially the latter, every portion of animal organization, all which contributes to the perfection of the senses, to the energies of motion, to growth, nutrition, and transmission of life, is compared in every change with every analogous condition in every class of animals, and in almost every remarkable diversity of genus or of species. The connection of such analogies with the anatomy of plants may be found in Mirbel and in Keith.

But although in a very general survey of the terraqueous globe we commonly distinguish some parts which we call *organized*, namely, specially adapted to the production of manifest and important pur-

poses, as mouth and stomachs, roots, and various vessels, to nutrition: yet it is not less clear, that every portion of creation, large or small, has its allotted limited relation to others and to all; and therefore each must present numerous analogies with others which are connected with different conditions of locality, and different functions, either respecting sensitive creatures, or the great globe itself, its land, its water, its atsmosphere, its relations to the sun, to the moon, and other planets, and to the constellations of the starry concave.

Every division of science presents such analogies. Mechanics with anatomy, with astronomy, with hydrostatics, with chemistry; optics with acoustics, with electricity; geology with chemistry, with zoology and botany. The objects of all senses may probably possess many unexplored relations to each other. The senses of touch, of taste, of smell, although not so readily discriminable as those of sight and hearing, would, on minute scrutiny, be found no doubt to be analogically limited as to proportions of combination productive of definite results. As atmospheric air, for example, is always composed of certain definite proportions of three gases; so certain tastes, scents, and varieties of touch, may possibly be compounds of other more simple conditions of excitement. That tastes or flavours may be imitated is proved by those who have amused themselves and others by combining acids, acrids, bitters and sweets in producing resemblances of Port and of Champagne wines.

In Newton's Optics the analogy of the musical scale, with the proportions of the prismatic colours in the solar spectrum, is suggested. It is largely insisted on by the Rev. William Jones of Nayland. Mr. Herschell, in his lately published treatise on sound, notices many curious facts which demonstrate the exact analogy of its reflections with those of light, especially when under water.

Guided by analogy while investigating the proportional relations of distances of the planets from the sun and from each other, Professor Bode discovered a law, or scale of proportion, which I have formerly noticed.

But I have had occasion to remark again and again in the course of the preceding survey, that the law which constitutes and limits differences, and which connects portions of the universe, most widely different in general character, by a continuous chain of analogies, is a law proceeding from a power not bound by necessity, a selecting and controlling and harmonizing power, itself uncontrolled, and demonstrating its superiority to all control by deviations, which to partial and ignorant observers appear to be discordant and irreconcilable with previously noticed harmony, but which, to the views of the more enlightened, sagacious, and profound, are manifested as subject to the one controlling Power, and by its paramount operation of intelligence resolved into perfect accordance with universal harmony.

I cannot illustrate this important truth more aptly than in the words of Dr. Crombie, chap. 2. sect. 1. of

his valuable Essays on the Existence of the Deity, &c. and a Future State.

"La Place ascribes [*the assumed uniformity of the directions of the primary and secondary planets in their orbits*] to the influence of a revolving fluid, determined, it would seem, rather than admit an Intelligent Cause, to adopt a gratuitous, an unsatisfactory, and, as Vince has shewn, an untenable hypothesis. La Place assumes that all the motions are direct, whereas those of the satellites of Herschel are retrograde, and nearly perpendicular. Vince corrects this error, and, adding the newly discovered primaries which La Place had omitted, calculates the probability that, supposing the revolutions to have resulted from chances, any one would be retrograde, as more than seventeen thousand millions to one." The assumption of necessity, constant and irresistible as the governing cause, excludes in terms the possibility of such variation. "We know that the orbits of the comets are extremely diversified, these bodies traversing the heavens in all points of the compass. These are facts manifestly irreconcilable with the existence of a revolving fluid. In these revolutions we have such regularity as to indicate an Intelligent Cause, combined with such deviations, though few in number, in the planetary motions, as to convince us, that this Cause does not act by a physical necessity, but is capable of producing order and harmony by different means[s]."

[s] See also Robinson's Elements of PhysicalAstronomy, section 736. to the end of vol. i. to the same effect.

The powerful interest excited by the investigation of analogies may be compared to the gathering up a clue or thread, which should indicate the plan of an otherwise inextricable labyrinth. The delight will doubtless be proportionate to the surmounted difficulty. Through the mazes of science, in which distinctions and differences present themselves at every step, continually interesting, continually enforcing claims on our attention, it is a relief to the fatigue of divided attention to feel confident that we perceive the continuous connections of objects, the clue that guides us to the important end of our exertions. Analogies must interest in proportion as differences obvious and extensive appear likely to embarrass us.

I have endeavoured amidst a forest of differences to point out the marks by which the hand of a secret Instructor has indicated his most important information, the way by which we may trace his footsteps, and continually turn to him, to the end of our appointed journey.

Every column of the differential table, marked on the left by the names of classes or grand divisions, and headed by names of conditions of being, or parts of organization, which present analogies more or less clearly traceable in each grand division, is a portion of an inductive series, the foundation of an extended sorites, or syllogistic chain, of which this is the common conclusion.

Innumerable differences, immeasurable in magnitude and in minuteness, display immensity of power,

operating through all extent. Mutual connections, dependencies, analogies, display the unity of the all-operating Power. The continual adjustment of means to ends, traceable through a vast diversity of conditions of organized being, apparent discordances rendered subservient to general order, and general good resulting from apparent partial evil, manifest the intelligence, wisdom, and goodness of the Almighty Ordainer, Operator and Sustainer of all to which man's contracted faculties, even in their utmost advancement, can hope to attain. For innumerable are the checks which solemnly admonish the aspiring investigator, "Hitherto shalt thou come, but no farther," Job xxxviii. 11.

To the vain-glorious builder of systems again and again the Lord declareth, as he answered to Job out of the whirlwind,

"Who is this that darkeneth counsel by words without knowledge?

"Where wast thou when I laid the foundations of the earth? declare, if thou hast understanding.

"Who hath laid the measures thereof, if thou knowest? or who hath stretched the line upon it?

"When the morning stars sang together, and all the sons of God shouted for joy?"

How solemnly just the philosophy, how heart-lifting the sublime poetry of this ancient and hallowed composition!

The wise will answer with Job:

"Behold, I am vile; what shall I answer thee? I will lay mine hand upon my mouth."

Or he will say with David, Ps. cxlviii:

"Praise ye the Lord. Praise ye the Lord from the heavens: praise him in the heights.

"Praise ye him, sun and moon: praise him, all ye stars of light.

"Mountains, and all hills; fruitful trees, and all cedars:

"Beasts (of prey), and all cattle; creeping things, and flying fowl.

"His name alone is excellent; his glory is above the earth and heaven."

These are passages which have infused inspiration into our best of poets:

> These are thy glorious works, Parent of good!
> Almighty! thine this universal frame,
> Thus wondrous fair! thyself how wondrous then!
> Unspeakable, who sitt'st above these heavens
> To us invisible, or dimly seen
> In these thy lowest works; yet these declare
> Thy goodness beyond thought, and power divine.
> Speak, ye who best can tell, ye sons of light,
> Angels; for ye behold him, and with songs
> And choral symphonies, day without night,
> Circle his throne rejoicing: ye in heaven:
> On earth join all ye creatures, to extol
> Him first, him last, him midst, and without end.
>
> PAR. LOST, book V.

ADDENDUM.

I AM proud to acknowledge, that soon after the preparation of this Essay for the press, I received a kind present from the author, " The Application of " Classical and Scientific Education to Theology " and the Evidences of Religion, by the Rev. Will. " D. Conybeare, Rector of Sully." A clear and concise view of the analogies of natural and revealed religion, comprehending more, in less compass, of physical science, general learning and original cogent and important arguments, than, I believe, was ever before so compressed and concentrated for the support of truth. The argument from the uniformity of the Creator's work to the unity of divine intelligence is admirably illustrated in pages 47, 48, 49. The diversity of operations of the *One* intelligent Author, not only as to mode, but in successive periods of time, is exhibited in a sketch of geology, evincing the hand of a master, from page 29 to p. 35.

ERRATA.

Page 11. column 4. l. 26. *for* Gryello, Talpa *read* Gryllotalpa.—P. 23. *for* blood into the left ventricle *read* blood through the lungs and pulmonary veins into &c.—P. 35. *for* Euonymodus *read* Euonymus.—P. 48. *Dele* is said *after* Gordius marinus.—P. 54. *for* Coryhæna *read* Coryphæna.—P. 80. *for* 1 to 95 *read* 95 to 1.