By the time Abraham journeyed into Canaan, about 400 years had elapsed since the Flood. There were then apparently a number of well-populated cities and countries in the world, as mentioned in Genesis 12 through. 25 (Egypt, Chaldea, Philistia, etc.). Abraham died at age 175, leaving eight sons (Genesis 25:1-8).

It seems reasonable to assume, for this 400-year period of history, say, ten generations and an average family size of eight, with an average life-span of five of the 40-year generations. That is, in our population formula, assume c = 4, n = 10, and x = 5. The world population at the time of Abraham (neglecting any possible gaps in the genealogies of Genesis 11) is then calculated as 2,800,000, a figure which more than adequately explains the Biblical and archaeological population inferences for this period of earth history.

The Tower of Babel seems to have been built about the time of the birth of Peleg (whose name, meaning "division," probably was given by his father Eber in commemoration of that event–Genesis 10:25) 101 years after the Flood. Using the same constants as above, the population at this time would have been only 85 people (using equation (2)). However, it is probable that at least one generation is missing in the genealogy of Peleg as given in Genesis 10:21-25 and 11: 10-16. In the corresponding record in Luke 3:35, 36, the name of Cainan is inserted between those of Arphaxad and Salah.

If we assume that, in the course of transcribing the lists in the Old Testament, Cainan's name somehow was omitted from the received text, but that his name was preserved in the Septuagint version from which Luke obtained his data, this would mean one more generation in the interim from the Flood to Babel. On this basis, the population would be 340.

This is probably still too small, but the assumed family size of eight may very well be too small for the early centuries after the Flood. Assuming an average family of ten children gives a population at Babel of over 700. An average of twelve children gives 1250. Both these figures assume 40-year generations, with, therefore, 3.5 generations from the Flood to Babel.

Since there are 70 nations mentioned in Genesis 10 as resulting from the "division" at Babel, it is reasonable to infer that there were 70 families at Babel, representing probably the generation of Noah's grandsons and great grandsons. Seventy families containing 800 or 1000 individuals altogether seem to fit the situation described at Babel very adequately.

We conclude, therefore, that the Biblical chronologies are all eminently reasonable in the light of population statistics, and that any significant departures from these chronologies, as required to meet evolutionary speculations, are highly unreasonable and improbable.

FURTHER HIGHLY SPECIALIZED ADAPTATIONS

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The writer believes that nature's adaptations are so extraordinary in complexity and finesse that it is impossible to explain them as evolved. They must have been planted in the creature by its Creator. Adaptations display incredible virtuosity.

To illustrate, the writer discusses in some detail scores of examples of remarkable adaptations for predation and defense, respiration, pupation, detection in space, locomotion, reproduction, etc.

One of the great defects of evolutionary writing is that evolutionists dodge difficulties like these and dwell on generalities. On the whole, too, they tend to avoid insects and instinct and argue about vertebrates, especially mammals. They should be held to account for specifics, especially in insects, and not excused until they produce an adequate evolutionary explanation. This cannot be done. Nature is too complex, too intellectual and too versatile.

Let the critics of evolutionary theory continue to pin evolutionists down to specifics. It will make evolutionists a good deal less arrogant.

Introduction

The finesse, intricacy and perfection of adaptation in all systems in all animals seem endless. Here are a few more samples culled from this apparently infinite series, all illustrating the artistry and virtuosity of the Creator.

For Predation and Defense

The praying mantis[1] has an unusually long front segment of the thorax, its foremost legs no longer adapted to locomotion but large and powerful so that the tibia can be snapped back against the femur like the blade of a pocketknife. This femur bears a groove on its under surface with a row of stout spines on either side of the groove. The lower edge of the tibia which fits into it is knife-edged and also spined. It is a perfect gin-trap.

Predacious fungi[2] capture and eat amoebas, rotifers, nematodes and springtails. The nematode-trapping fungi are really giant-killers, but are threads of the finest gossamer. More than 50 such fungal species are known. Some are Phycomycetes, some Deuteromycetes, and at least one is a Basidiomycete.

Some species produce sticky processes, others sticky knobs on short stalks. Some species produce sticky folds and curls and rings. Some have non-adhesive loops and act merely like rubber bands. The cells of the ring promptly swell to three times the normal size if a nematode enters it, thus obliterating its lumen. The ring closes in 0.1 second. Probably the fungus then kills its prey by a toxin. These predators can function only if their prey is present—in pure culture no traps are formed! These fungi are unique among micro-organisms.

In Myrmecine ants the sting is well developed.[3] The sting in *M. gerlosa*, the Australian bull ant, consists of a pair of gland filaments lying free in the body cavity, a spheroidal venom reservoir where they may be inserted, an accessory gland, and the sting itself supported on each side by modified chitinous plates.

The proteinaceous venom is more closely related to that of wasps and bees than to venoms of "higher" ant genera and the venom apparatus is highly "evolved"! Thus the study of the venom apparatus here is slightly disturbing to taxonomists. There appear, however, to be an even more complex venom apparatus among the Formicoidea.

The bombardier beetle if assaulted by an ant merely pushes a flexible tube from its rear end and emits a cloud of paralyzing, acrid vapour. Schildknecht[4] has found that paired cannons each had a sac which discharged fluid into a reservoir. The fluids were hydrogen peroxide, hydroquinone and toluhydroquinone–but these do not react to form gas as long as they lie undisturbed in the beetle's sac, for some queer reason. On attack, the beetle lets some of this fluid out into a combustion chamber where enzymes ignite it. The peroxide supplies the charge.

The Epeira spider-drains her captured locust prey while it remains alive, killing it only at the very end.

The John Dory fish is so laterally compressed it can scarcely be seen from either end. It stealthily creeps near its prey, then rushes on it while its mouth shoots outward like a great tube to engulf the victim.

The Koala bear has only one food, the leaves of certain kinds of eucalyptus trees, and even these are taken from mature, undamaged trees only!

Dewar[5] points out that the nipples of marsupials and placental would be useless unless the young possessed soft muscular lips–organs unknown in reptiles!

The Anthrax larva feeds on the grub of the Mason-bee. Not a gash appears on the latter, which lives on and on as the parasite feeds on it, for the Anthrax larva actually inhales its prey, If the bee grub is inflated it does not leak air! For the fortnight that the meal lasts the bee grub does not decompose. Yet if it is punctured anywhere it rots at once. Only liquid material can be aspirated. The breathing apparatus and nervous system of the parasitized bee grub must remain intact to the last!!

The antlers of deer remain a great puzzle, They are rarely used, even in fighting, may be found in females, are defective in castrates or unilateral castrates, and seem to be largely fortuitous.

If the larva of the large Elephant Hawk Moth is alarmed, the caterpillar quickly draws its head and first three rings into the next two rings, which swell and exhibit eye-like marks. A terrifying appearance results, An Indian larva *(Ophederas)* has its eye marks placed so far back that this cannot be attempted, so it bends the forepart back under, the apparent head being at the location of the eye marks, but the real head being hidden.

Hingston[6] tells of certain caterpillars with whips on their tails which they swish about in the face of enemies *(Isognathus swainsoni).* When this South American caterpillar rests with its mates, all face in the same direction and lash out with their tails simultaneously. If the puss moth caterpillar is attacked by ants it turns up its tail and shoots out a pair of flexible scarlet whips, which it can supplement with a jet of narcotic fluid. The American fire-fly, *Pyrophorus noctilucus*, has two sulphurous eyes that glow if it is taken up, but if handled more roughly still, it bends back to reveal another light ordinarily concealed under its overlapping breast plates. This has been seen to intimidate its foes. Even its larvae and eggs are luminous.

The Malayan hooded locustid *(Capnoptera)* does not resist when picked up, but casually lowers its head, opens a cleft between its head and thorax, thus forcing out a scarlet bladder or hood, as if its entrails were extruding. The Celanese grasshopper, *Acridium violescens*, if chased by Mynah birds, rolls over on one side, and deliberately draws up a hind leg to expose a series of grey and black eye-spots. The bird usually withdraws, even after several approaches. The rolling over is done deliberately and slowly.

How could such an unusual habit evolve to reveal the warning colour pattern so perfectly? The mantids also reveal menacing bright colours and make a noise when attacked. Predators show fright,—as do humans, indeed.

Strains of flies resistant to DDT develop, as is true of mosquitoes, cockroaches, bed bugs, body lice and bark bettles. How permanent these strains are seems to be unknown as yet! Most mutants are harmful, but such helpful (to the insect) mutations as these could not develop if random mutations did not occur in all directions. The mutation precedes the environmental stress in such instances. As R. A. Fisher has pointed out, selective survival must have worked a miracle of evolutionary progress in the teeth of a storm of deleterious mutation.

The African beetle, *Dictyophorus laticincta*, when picked up by a monkey, distends its abdomen to show its red-marked sides. Then it can eject a yellow acid froth from the sides of its thorax with a loud hissing noise, and display its red wings. The monkey usually drops it.

A batrachoid fish of Central America, *Thalassophryne*, has an opercular spine which is canalized and communicates with a poisonous fluid –but no sac!

Most marine fishes have a very large bladder, frequently full of urine. Thus urine is not released constantly, and predators are not afforded a means of tracking them down by detecting it.

Roberts[7] refers to the poison fangs of the vipers and rattlesnakes. They do not move in a socket. It is the short maxillary bone which really moves, pushed by the ectopterygoid on its loose articulations with the prefrontal when the fang is erected or laid back. The tooth is ankylosed to the maxilla. Some snakes do not have this ankylosis and occasionally lose the fang, but these forms have embryonic teeth on the root surface which replace these fangs!

The snakes with a huge, distensible gape have the ability to disarticulate the mandible from its site when closed; then it is suspended by very elastic fibres, but these may have a rhythmic power of contraction, like muscle! The quadrate can also be loosened from the squamosal to enlarge the gape still further. Indeed, in pythons there is a third adaptation–there is an actual dislocation of the occipital condyle on the atlas vertebra, with a stretching of the spinal cord!

It is impossible to think of the gradual development of a poison sac and its contents from salivary glands by mutation or any other means. Indeed, in *Calloptus* such a sac extends half the body's length. In *Doliptus intestinalis* this sac is so long that it even pushes the heart out of place.

Poulton[8] described the Asiatic lizard, *Phrynocephalus mystaceus*, which resembles its sandy habitat but has a red, flower-like mouth to attract insects. Some lizards have long, brittle tails which readily break off when seized, allowing the creature to escape, just as do certain free and active Philippine snails *(Helicarion)* and a West Indies snail, *Stenopus*. Such a tail is deliberately conspicuous. Perhaps 10 per cent of snails lose them.

The platypus has on its hind heel a curved spur, attached to the tarsal accessory bone, carrying a poison conveyed by a fine duct from a gland on the back of the thigh. *Synanceia verrucosa*, a fish, carries deep grooves and poison in the dorsal spines.

Thomson comments on the Galapagos lizards, one species able to eat seaweed and another the

Pycraft[18] mentions the unpleasant odours used to protect animals. Skunks need no further mention. The brilliantly coloured palmer-worm, the larva of *Porthesia auriflora*, or the conspicuous hop-dog, the larva of *Orgyria pudibunda*, have glands on the back for the purpose of emitting an unpleasant scent. The larvae of saw-flies such as *Croesus septentrionalis* have such glands on the belly. When disturbed these turn the body forward over the head, evert these glands, and a whole group can set up a "poison gas" barrier about themselves.

He tells of males of butterflies in which the emanation of scent is traceable to peculiarly modified scales, sometimes arranged in tufts on the hind-wings, or scattered irregularly over the wing surfaces or as an edge fringe. Sometimes the scent can be retained–then suddenly released. In the ghost-moth *(Hepialus humali)* the male's hind-legs are altered into scent bottles, filled with scent glands. Moths of the genus *Acentrophus* have wingless, aquatic females. They come to the surface, emit their alluring scent, then the males approach, couple, and are pulled under the water to drown!

The crab spider, *Onustus*, waits in a flower bell till she can leap on a bee, bite its neck and kill it. One temperate belt crab spider, *Misumena vatia*, is coloured white on white flowers, yellow on yellow, pink on pink, and green on leaves. Such a change develops in a few days and is due to a pigment accumulating in its outside cells.

Some of the ciliated flatworms, the *Turbellaria*, may reduce the number of their cilia, but especially their rhabdites. These are small crystalline rods which dissolve in water to produce a mucus-like substance, either defensive or for catching prey. What a device!

Water Metabolism

The desert rat[9] has a kidney so efficient that it can excrete urea as does the human kidney, but uses only one fourth of its water to do it.

The antelope ground squirrel has a metabolic rate that remains constant at temperatures from 90° to 107°, No other non-sweating animal has as high a thermal neutral zone. It shows no bodily discomfort even at temperatures above 110°—if any develops it merely returns to its burrow, or it drools, deliberately spreads saliva over its head, and cools itself by evaporation. It can survive for 3 to 5 weeks on a completely dry diet. It can excrete urine 10 times more concentrated than its body fluids. The desert rat can drink sea water, the antelope ground squirrel water 1 to 4 times more concentrated than sea water. It has unusually long renal papillae, longer than renal tubules, hence greater reabsorption.

Cats can drink sea-water[10] and carnivores can live on the body-water of animals they eat, just as seals may if they avoid halibut and shellfish and confine themselves to Pacific herring. Camels and other ungulates can recycle their urea, when protein-deficient, and pass this urea back into the rumen where bacteria reform proteins which are resorbed lower in the gut.

Homer Smith[11] tells of clothes moths able to live and lay viable eggs when kept in a dessicator whose air had been dried over sulphuric acid, and when feeding on oven-dried woolen cloth, or on dry mink or astrakhan. The resultant larvae contained fully 58 per cent water when such food had contained only 6 to 9 per cent; therefore the animal literally manufactures water from its dry food. The larvae of the bee moth can live on the dry wax of the honeycomb containing less than 2 per cent water, and gets its nitrogen from pollen grains. The pea weavil, the confused flour beetle and flour moth, and the tobacco horn-worm all live on very dry food.

Respiration

The freshwater turtle[12] can dive for long periods in the absence of oxygen, depending on anaerobic glycolysis. Its heart has a functional ventricular septal defect. In ordinary air there is some shunt of blood from left to right through this defect. During diving this shunt is reversed and blood from the tissues bypasses the lungs and enters the aorta directly, anaerobic glycolysis now supplying the energy needed. The exact stimulus for this shunt mechanism is uncertain. It may be the unusual cartilaginous-muscular structures at the origin of the pulmonary arteries.

A creature may use existing organs to conquer a new ecological niche. Thus Weddell's seal is related to seals in warmer climes which also have long incisor teeth. This seal ranges into the Antarctic, however, by using these for cutting breathing holes in the ice. Similarly the giant panda, of carnivore morphology, has become adapted to a completely herbivorous diet. Thus, too, the tree kangaroos have successfully re-invaded trees.

Insects in general have the most efficient heating system yet devised. It gives its owners a hundredfold increase in energy. It does not dissolve oxygen in the blood and so diffuse it, as in mammals, but takes it in directly through spiracles and their branching tube systems. There is no pump or forced draft, and the small size of the insect is what makes this scheme adequate.

Homer Smith describes lungfish hibernating in the mud. The fish squirms into the ooze, then turns a somersault so that the snout comes to lie just under the water surface. As the water level sinks the fish makes a deeper and deeper burrow, this chamber opening, to the air through a small blowhole.

When all the water on the surface has left, it curls up with its tail across its head, covering the eyes. Its body now is coated with a strong mucus, and as this dries it hardens into a waterproof cocoon which extends into all exposed crevices. Only a short funnel between the lips and teeth remains, through which the fish breathes, Its metabolism lowers until it is only 10 to 15 per cent of that in the active state. Crack the cocoon and the fish dries out and perishes.

Foetal hemoglobin and adult hemoglobin differ in all the vertebrates studied to date but the viviparous rays; the foetal type has a high oxygen affinity. Here is a wonderful biochemical "pre-adaptation" which has made possible foetal-maternal oxygen transfer.

Pupation

The wild silkworms all spin a characteristic cocoon.[13] The commercial silkworm and the Asiatic species, *Antheraea pernyi,* construct very stout-walled chambers without any obvious exit. The new moth, however, secretes a fluid which dissolves one end, loosening its fibroin filaments and so forming a large escape hole.

The solvent is a remarkably pure proteinase secreted by the moth's maxillae, with a separate buffering solvent for the proteinase. This enzyme is not secreted by silkworm species whose cocoons have preformed valves. *Samia cynthia,* whose cocoon has a very tight valve, synthesizes a small amount of this proteinase.

When the caterpillar is about to pupate it ceases to eat, then evacuates both the content of the intestines and also their lining. Hence no putrefaction can develop during its long hibernation. Why should an insect doing this just once in a lifetime do it so well?

Fabre[14] described the exit of the pupa of the Anthrax fly. The head is round and large and bears a sort of diadem of six hard sharp spikes, with two more close behind. Four segments of the body farther back are armed on the back with a belt of horny arches set upside down in the skin. These are parallel and each carries a hard point. There are about 200 spikes on the four segments, and they anchor the pupa against the wall of the gallery.

Steadied thus its crown of awls can take effect. Scattered here and there to prevent recoil are long, stiff bristles pointing backward. Two smaller hills of thorns and a sheaf of 8 spikes at the tip of the body complete the boring machine that this pupa really has become. It bores and drills its way out, then two slits appear across the head and through a cross-shaped opening the fly appears.

Imagine all this evolving gradually, as evolutionists must insist, and the caterpillar knowing how to use each weapon as Nature gave it. It can barely escape from the pupa case now. How did it get out when it had less effective equipment? Evolutionists do not stress these things. They dare not. Fossils are safer topics.

Sonar

Bats use at least 3 different systems for echo-location.[15] The small insectivorous bats of North America send out signals at a rate of more than 30,000 cycles per second, the actual discrimination of its prey occurring in the last inch or less of the bat's approach. These echoes, from midges for example, must be faint and yet must be differentiated from many louder echoes. As such a bat can catch a mosquito every 6 seconds, the mechanism is very efficient.

Horseshoe bats in Europe do not squeak through the open mouth but the nostrils. The squeaks are explosive and are guided like a directional range finder by the "nose-leaves." The fruit-eating bats make low sounds by clicks of the tongue. Some birds, porpoises and dolphins, perhaps some small rodents also use sound for echo-location.

Locomotion

Geckoes[16] do not have suction disks on their adhesive feet, such as would enable them to cling to almost any surface, nor any adhesive substance. Instead they carry microscopic hooks, in some species even submicroscopic in size. Despite their small size a single toe can hold up several times the animal's entire weight. In some African geckoes the tip of the tail also has these hooks.

Marine fishes of the genus *Trigla* have taste buds on the three anterior rays of the pectoral fins, which have no web, can be moved independently, and are used by the fish to walk on the bottom.

The man-of-war bird has superb adaptations for fishing. One can hardly imagine a more perfect flying machine. Yet their legs are so weak they cannot rise from a flat surface and if they alight on water their plumage becomes waterlogged!

The king and queen termites originally have well-developed wings, but these later break off at preformed basal sutures and are discarded. Such foresight! Soldier termites, or *Nasuti,* thrust alien termites away by pushing them and by squirting a sticky fluid over them.

The jumping spider can walk on a smooth perpendicular surface, as ordinary spiders cannot, because of a pad of adhesive hairs, called a scopula, between its claws.

The young of the Wolf Spider, *Lycosa,* climb on her back and perch there foodless for about six months. During this time they seem to watch their mother eat with indifference. But *Aranea* does not tolerate the young Lycosae when transferred to her. If a fight with another spider looms, the children run off the fighters' backs to hide. Later they all climb back on the victor's back, and all goes on as well as before. In spring the children leave–if they do not, they are eaten.

Reproduction

Mating is a tremendously well adapted phenomenon.[17] The scent of the virgin *Cecropia* moth can lure a male almost half a mile away. The common eastern firefly switches on her lights and expects a responding male to show his after a two second interval. This timing must be exact.

The Alaska seal female always returns to the Pribilof Islands off Alaska to find her mate. The female cougar waits beside a male's tracks, knowing he tends to make a regular circuit.

The male squid, *Philonexus*, deposits pockets of his sperm in the female by reaching them across to her, perhaps yards away. The male sea horse receives his mate's eggs in an abdominal pouch, seals it over; really he, then, becomes pregnant. The female porcupine flattens her quills to allow mating.

Sperm usually die within hours, but the common American brown bat mates in the fall and conceives in the spring. The male frogfish attaches himself permanently to his female counterpart, atrophies there, but can fertilize her spawn when she is ready.

In the fresh-water clams, *Anodonta* and *Unio,* fertilization is affected in the outer chambers of the female clam's gill and the developing young remain in this brood-pouch until it is a mass of young and their byssus threads. This mass is soon expelled by the mother; then it lies on the bottom of the stream till it can fasten on a passing fish.

Unio larvae usually attach to the gills of such, and *Anodonta* to the skin or fins. There the host encysts them for 10 weeks. This whole process enables the larvae to stay in fresh waters. Otherwise, if their cycles were like those of saltwater types of clams, they would be swept out to sea.

Trypanosome brucei has its first multiplication phase inside a peritrophic membrane, a tube secreted by the walls of the tsetse fly's stomach to contain blood and the parasites. Then the Trypanosomes liberate themselves through the free end of this sac; next they move forward between it and the bowel toward the salivary glands. What an adaptation! A corresponding peritrophic membrane is developed by the sand-fly, *Phlebotomus,* for *Leishmania.*

Fabre tells of the mating of the green grasshopper. The result is that the female has a capsule of sperm left on the end of her ovipositor. The female grasshopper *eats* this and is impregnated!

The male fiddler-crab waves its large claw, to warn off other males and to attract females. When 27 species at Panama were studied, an observer could find a definite individual display in each species, differing markedly from that of every other species. Related species had more similar displays, however.

Fabre tells how the Preying Mantis, without a glance behind her and without the help of her legs, builds a horny plate on which eggs are laid, then covers these eggs in a protecting froth, then lays doorways and passages of overlapping plates, then puts a topping of protective froth over all.

Pycraft tells of species of newts which do not copulate, but in which the male releases spermatozoa on bell-shaped "spermatophores," These last adhere to the bottom of a stream, where the female gathers them by placing herself in such a position that they can be forced between the lips of the genital opening, or by seizing the spermatophore between her hind-legs and pressing it home.

The testes of the spider are connected to a hole in its belly, not to any intromittent organ. He usually weaves a little mat to receive his sperm. The bulbs on the ends of his palps are shaped differently in different species and are very intricate in design. With them he scoops up sperm, and inserts it into his mate by a sort of artificial insemination.

The flatworm, *Gyrodactylus,* is viviparous and gives birth to a well-developed larva already having another larva in its undeveloped uterus, and perhaps another inside that again. A hermaphroditic animal giving birth to children and great-grandchildren simultaneously is unique. A closely related genus, *Isaucistrum,* has at least one species laying two kinds of eggs. The summer eggs develop directly into adults, but the winter eggs lie dormant in the mud till spring.

In the *Acanthocephala,* or thorny-headed worms, the ovary contains many fertilized eggs free in the body cavity or in sacs in a special ligament running from head to gonad. Near the posterior end is a complicated apparatus called the uterine bell which permits only fully developed ova to pass, one at a time. This bell communicates with a uterus and vagina.

The oxyurid worm, *Enterobius,* lives high in the large intestine, and the female accumulates eggs in her uterus until she is merely a sac of eggs. Then she passes out the human intestine, leaves the anus spontaneously, and promptly explodes, scattering her eggs about the anus. The eggs are partly embryonated when laid, and become infective after only a few hours' contact with the air.

The Arthropods, *Danalia* and *Bopyrus,* may become male or female or may even alternate their sexes. In *Bopyrus* the sex depends on the attachment. If the larva attaches to a female prawn it becomes a male; if to a male prawn, female. Male prawns infected by this parasite assume the secondary sex characters of females, but females are unchanged.

In the Nematode life-cycle there is an abrupt change in the third-stage larva, in many forms, from an aerobic to an almost anaerobic environment, and from a metabolism depending on the catabolism of fat to one mainly depending on glycolysis, and from a free life to a parasitic one.

The hydra, only one quarter inch long when contracted, will regenerate totally from a fragment, and the body cut lengthwise will heal if the two halves are approximated. If the halves are kept apart, two hydras will form. If turned inside out, so that its digestive cells are outside, both the inner and outer cell layers migrate back through the walls to their old position!!

The Helminth, *Axygia,* has a cercaria with a pair of large paddles at the end of its tail. These can be extended, then contracted, to let the cercaria jump jerkily ahead until a fish or frog sees and swallows it, as is demanded for the worm's parasitic existence.

The Senses

One kind of Owl[19] can capture its prey by sight in a light equivalent to that thrown by a burning candle 2,582 feet away. Its eyes have rod cells only (no cones for colour vision). The visual purple gives the bird its visual signals. Each eyeball is fixed, hence the neck is extremely flexible in rotation (about three quarters of a circle). It directs itself in complete darkness by its hearing. It has the largest eardrums found among birds. Its head is wide, so that a round wave reaches one ear just before the other—something the owl can probably detect and use for locating prey.

The human ear[20] is a sort of Rube Goldberg mechanism. At the end of a chain of ossicles in the middle ear, the tiny footplate of the stapes has increased the original tiny pressure on the tympanum by 22 times, and this pressure is multiplied by the organ of Corti. At some frequencies the vibration of the ear-drum is no more than one-tenth the diameter of a hydrogen atom, about one billionth of a centimeter. At low frequencies it is less sensitive—hence cannot hear the vibrations of its own body and skull.

Pitch perception is still a matter for debate. Electron microscopic studies[21] indicate an enormous intricacy and integration of the various structures of the ear, whether in insects or man. This must be studied to be believed.

The Cephalopods[22] are adapted in scores of different ways. Nautilus has more than ninety arms and two pairs of kidneys and gills, unlike all the rest of its 8 armed or 10 armed congeners. Many live in the abyss and so have light organs and relatively huge eyes. Some even have light organs on or in the eye-balls. There can be bacterial light, intrinsic cold light produced by chemical reactions in light organs, or secreted light emanating from a secretion.

Many cephalopods produce ink for a screen, but in those needing light the "ink" emits light on contact with the water, not darkness. The *Nautilus* has the only true pinhole camera-type eye known. There is no lens in it and the iris is unique. The squid, *Histioteuthis,* has a left eye four times as large as its right; perhaps the eyes are usable at different depths.

Tinbergen[23] tells us of the Marine snail, *Buccinum undatum,* which takes water samples by aiming its siphon appropriately and sucking in a current of water across a field of chemoreceptor cells. Some crustaceans can thus sample water from a distance of 15 cm. The water bug, *Notonecta glauca,* has touch receptors enabling it to detect water ripples and the movement of prey 15 cm. away.

A dragonfly larva can shoot its "mask" at small prey from exactly the distance at which it can seize it. The horned owl can see in light 1/110 as intense as the human eye requires. Honeybees can respond to ultra-violet light down to at least 3500 A units. The supersonic cries of bats have a frequency of about 50,000 cycles per second, about three times as high as the auditory threshold of man.

European jays far exceed man in detecting cryptically coloured prey. Yet twig-like larvae *(Ennomos)* and countersheded caterpillars *(Smerinthus ocellatus* and others) escape even the jay. An eagle has a weak sense of smell, but can see a small rodent half a mile away. A catfish is almost blind, but can actually taste with its whole body.

Growth

The British caterpillar, the Hedge Brown, does not shed its last skin in the usual way but pushes it off like a rolled-down stocking.

Heat and Cold

The dry seed of the giant cactus or saguaro can be cooked steadily for 7 days at 83°C and live. Other desert seeds are almost as heat-resistant. No mechanisms to explain this are known.

Glycerol does not protect plant cells from freezing—but is very effective for animal and bird cells. Obviously fundamental differences exist between the cells of plants and animals—**which strikes a serious blow at any unitarian theory!!**

Castes

Termites and ants are as different as ants and men, but both have winged, fertile forms and wingless workers and soldier types. Both of these last are arranged in elaborate castes. Both live with other insects and both cultivate fungi. Some live as small societies, but most live in large groups. Both are earth-dwellers, and both live among a host of pets and parasites. Their divergences are also great, for termite young are soon able to fend for themselves. There are permanent kings as well as queens in every colony of theirs, and every caste has both males and females.

Other Anatomical Wonders

The stridulatory file of the Bonerina ant genus, *Leptogenys,* is such a perfectly regular file that it can function as a good diffraction grating! How could a piece of insect anatomy be more accurately made?

When the Hunting wasp first bursts out of her cocoon she cleans her antennae in a special slot situated in the leg. The papier mache cocoon from which she came has several layers in the wall, enclosing fixed air, and so is an excellent insulator.

The mandibles of *Ammophila* bite on a lavender stem when it wants to sleep; then its body hangs out at right angles to the stem as it rests!

The Woodborer caterpillars progress down a hole in a trunk by passing the digested wood through their bodies. The Capricorn caterpillar has only rudimentary legs, but on its first seven segments are distensible facets like sessile feet.

With these it pulls itself along through a burrow in the trunk.

The cricket wing has a bow carrying about 150 triangular teeth of exquisite geometrical regularity. These bite into the ladder-like rungs of the opposite wing-case, setting four little drums into vibration. Thus it chirps.

There is a British group of butterflies, the Skippers, which closes its facewings over its hind wings when resting, and bends its antennae back parallel to the central margins of the wing. These antennae are bent and gradually thickened. Thus they resemble moths closely. All the butterfly caterpillars, such as that of the large Skipper, that pass their lives in a tubular tabernacle, have a special comb-apparatus for ejecting excreta from their habitation.

Fleas, *Siphonaptera,* have a proventriculus provided with backwardly directed needles which peristalsis, simultaneously with a reversed peristalsis in the mid-gut; as a result any ingested blood-cells are disintegrated.

Summary

'Nuff said.' Adaptation is too accurate, varied and purposive to be an accidental feature of Nature. What our minds can barely comprehend certainly points to a Master-mind in the Designer. Surely God is great, and Nature is His prophet.

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TEXTBOOK COMMITTEE PROGRESS

Dr. Thomas Barnes reports rapid progress in the writing of the biology textbook. This summer Dr. John W. Klotz spent a week with Dr. Barnes and Mrs. Rita Rhodes Ward, an experienced teacher, concentrating on editing the first draft of the book from manuscripts submitted by various cooperating authors.

About half of the book is complete enough now for use this fall in several "pilot run" schools. Dr. Klotz will continue to work closely with Mrs. Ward in editing the final half of the book, and they hope to have this ready for use in the same schools by next spring semester.

Some illustrations are now available, and efforts this fall and winter will be concentrated on further collection of such materials. Then, when the final draft is written next year, these will be available for exact reference as to page number in the text. Corrections suggested by the various cooperating high school teachers will be incorporated also in the final draft.

All cooperating authors will receive their respective portions for check on accuracy. By having Mrs. Ward and Dr. Klotz edit the book, a uniformity of style will be achieved which otherwise would be simply impossible.

Response to the appeal for funds has been gratifying and already over $700.00 has been contributed. As previously stated about $10,000.00 will be needed to get this book in final form, so another appeal will be sent out later this winter giving more exact details on expenditures and various tasks yet remaining for which money will be needed. In this way our membership will get a clearer picture of what their contributions are accomplishing and understand just where they can be of help. Perhaps contributions of time can be substituted for money as regards some of these needs.

–W.E.L.