REMARKABLE ADAPTATIONS

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Plants and animals display a superb series of tight adaptations, so remarkably integrated that a multitude of creatures can fill every environmental and ecological niche in sea, on land or in the air and endure, more or less happily, generation after generation. The evolutionist says this process is the result of mutation and natural selection. The creationist does not discount these natural though negative forces but believes that the directing hand of God plays more than a permissive role in the glorious pageant of fitness to live. If He made living forms at all, presumably He would make them "good."

Are there any examples of adaptation so remarkable that they should snap the elastic credulity of those who believe that natural laws free of any interjection of a purposeful Providence are responsible for all life as we know it? Let me try to provide some samples of this sort for everyone's consideration. All are taken from recent scientific journals and therefore some may not yet have come to the attention of other readers. My preoccupation with this theme has found previous expression in a chapter in my book on evolution.

Respiration

Burton[2] remarks that some freshwater turtles can submerge for as long as 15 hours because they have accessory breathing organs — in some a vascular lining of the throat, in others an adaptation of the rear end of the gut, these acting as "gills"!

Diving animals are highly adapted[3]. As soon as the nose of a seal submerges its heart beat falls to a tenth of the normal rate. Bradycardia develops in every diving creature, and in fishes removed from water! But the central blood pressure of the seal remains the same, as the pressure in the peripheral flipper drops to near zero. Muscle circulation is shut off as long as the seal is submerged, even in the mesenteric and renal arteries. Similarly the metabolism of the body is damped down. The heart of the mudskipper in the mudhole in Northern Australia is also very slow. Hibernating animals also show the same kind of metabolic deterioration and peripheral vasoconstriction with bradycardia.

Senses

The Australia Mallee fowl keeps its eggs at constant temperature by burying them under soil and debris. Its thermometer is its sensitive tongue. When it pecks the sand it can decide by this means whether to add or remove soil from its nest[4].

Pacific salmon return to their own stream, even the same tributary, to spawn. How do they orient themselves at sea and recognize it without landmarks? It is due to odour imprinting. An eel can detect as little as 2 or 3 molecules of a soluble chemical such as beta-phenylethyl alcohol! A minnow can differentiate between the smell of water from Georges Bank and samples from the Sargasso Sea! Holzman[6] points out that many fish have electro-receptors to detect obstacles. Each of these species emits waves of a characteristic frequency of 50 to 1600 cycles per second. Such a fish can thus detect the movement of a rubbed comb in front of an aquarium or respond to a magnet there—a sensitivity which will pick up even a change in field in the water of .0003 microvolt per millimetre, a fantastically small change. The rattlesnake has temperature receptors sensitive to a change of 10 to 11 calories (small) in 0.1 seconds, equalling a change in tissue temperature of 0.001 degrees Centigrade. Insects have amazingly accurate smell — and mechano-receptors. Thus the praying mantis integrates all its information about a fly and captures it within 50 milliseconds.

Thorpe and Griffin[7] found that owls were not only silent but ultrasonically quiet — unless they were very large. However, the Asiatic fishing owl which feeds on fish and crustaceans does not need such silence and is not so adapted. The wings of silent owls have a downy upper surface and fringes of feathers on the lead and trailing edges to act as silencers.

Plants

The red flowers of the lousewart Pedicularis densiflora, have purple shades in coastal California where they are pollinated by Anna hummingbirds with gorgets of the same shade. But in the Sierra Nevada, where pollination depends on rufus hummingbirds with orange-red gorgets, the flower is orange-red[8]. The flowers of some tropical trees visited by bats smell like bats. Male hymenopteran visiting the orchid Ophrys in the Mediterranean region find the flower is insect-like and are aroused to copulatory activity by the stimulus of its hairs, this activity leading to transfer of pollen. Tropical epiphytic orchids have the most intricate pollination systems, operable only by particular insects. Unfortunately for evolutionists, there is no high degree of correlation of floral "evolution" with the differentiation in these insect visitors. The orchid, Coryanthes speciora, attracts male bees by its fragrance. As the bee lands on its mesochile it fans its wings vigorously, eventually striking a drop of fluid hanging over its head (which had been secreted by glands at the base of the column). The drop dislodges the bee into the liquid-filled bucket formed by the epichile. The bee struggles but can escape only by pushing up past an anther with two pollinia attached to it. The flower has now lost its fragrance and the bee flies off — till next day the flower becomes fragrant again and bees return to it to cross-fertilize it. Yet this same bee species is involved in the cross-pollination of an entirely different orchid, Gongora maculata, with a very different mechanism— no change appears in the bee designed to fit the two different mechanisms! How could such correlated change have developed gradually? The females of these bees have other tastes, and waste no time on flowers because they lack chemoreceptive hairs on their tarsi.

The fossil record of the bats does not go back beyond the Paleocene, and the flower- and fruit-visiting bats seem to have appeared too late to enter the New World tropics. Here, when the new flowers appeared, nectar-lapping bats were called for immediately from quite a different stock, the insectivorous micro-chiroptera. The tree, Parkia, is pantropical and is pollinated by bats everywhere, with the same specialized adaptations everywhere — a real evolutionary problem since the plants were ready for the bats before the bats appeared! A similar problem is presented by the flowering Kapok tree, Ceiba pentandra, pollinated by bats in Africa and South America[8]! The evolutionist here has to fall back on "lucky pre-adaptations" by either the flowers or the pollinating agents!

How does sap rise in tall trees[9], where perhaps at the tip the sap pressure can run at —20 atmospheres? It seems incredible that water can flow upward in this way. It is done by combining capillarity with check-valved compartmentalization. The latter prevents a cut twig from letting air penetrate beyond the wounded area. What happens to northern trees in winter? Are they frozen or supercooled? It appears that nearly all free water in the xylem does freeze at about —6 to —10 C. There is a real puzzle here.

Ocean Fish

Some fish have been caught at 15,000 foot depths where the gas in their swim bladders must have exerted a pressure of more than 7,000 pounds per square inch to withstand sea pressure[10]. This gas is largely oxygen, unlike that found in the shallow swimmers. In some mid-ocean fishes fat replaces gas in and about the swim-bladder, and thus constant volume is maintained under varying pressures by a material close to the density of water. Other fishes meet the pressure situation in the deep-sea by having lighter body parts. The cuttlefish has a large bone that serves for buoyancy. It is built up of thin lamellae and pillars forming chambers. This constitutes about 9.3 per cent of the total volume of the fish and its density is only 0.6 that of water. The bone chambers hold varying amounts of gas and water. The fish uses this bone as a submarine uses buoyancy tanks, filling up with water or blowing water out with gas. A yellowish membrane over the rear of the cuttlebone by a complex arrangement sucks fluid from the bone into the bloodstream and so changes its osmotic pressure at various depths in the sea. The bone can withstand severe compression by the sea by altering the salinity of its fluid. The squid maintains its buoyancy by holding in its coelomic cavity a great deal of low density fluid containing an astonishing concentration of ammonia (9 gms. per litre). Unlike mammals the squid excretes its nitrogen as ammonia rather than urea, and this is diffused into and trapped in the coelomic cavity. The squid can be almost independent of external water pressure and can dive more deeply than the cuttlefish, but its fluid sac is very bulky (200 per cent of the rest of the cranchid squid). It is really a kind of bathyscaph.

The rhizopod protozoan Arcella (about 1 mm. in diameter) which is found in shallow fresh water produces gas bubbles of oxygen (?) in its cytoplasm to control its buoyancy. A coastal foraminiferan, Tretomphalus bulloides, (size 0.02 mm) lives on the bottom until ready to release its flagellated gametes.. Then it produces a large terminal gas chamber by means of which it floats on the top of the sea. A special gas gland secretes oxygen in the swim-bladders of deep sea fish, involving a *rete mirabile* with the longest capillaries known in Nature, perhaps. 50 times longer than the long capillaries of muscles! Some fish have a valved duct leading to the osophagus through which gas enters the swim bladder. Others have a structure called the oval, which is surrounded by a ring of muscle and this controls the filling of the swim bladder with gas.

Food

The jaws of the ant lion have deep grooves which act as syringes to inject digestive juice into its prey. As soon as its victim's body inside its chitinous covering is dissolved the juices are sucked up by the ant lion. The latter never needs to expel faecal material during its one to two years of life because no undigested material enters its bowel — which has no posterior outlet!

The bees' dance[11] is now regarded as a classic of adaptation. The honeybee talks to its mates in the hive with a round dance for near sources of nectar, but with a tail-wagging dance for sources 275 feet or more distant. It tells them the direction and distance more accurately than could any communication system but human speech. When the other bees seek the original source they go to it directly, ignoring other directions or nearby decoys. By means of a built-in chronometer they allow something for the movement of the sun through the sky in the interim. The language is genuinely innate and not learned, as. von Frisch has proven. However, the Italian honeybee talks a little differently from the Austrian honeybee and confuses the latter with its instructions. Yet they are of the same species and interbreed. Their offspring are even more confused! The Indian honeybee talks the language of the European bees. The dwarf bee can dance only on a horizontal platform, however, and cannot transpose from sight to gravity. The dung beetle and many others can transpose from sight to gravity, although only the bees use this ability to speak to their fellows.

Symbiosis

The symbiosis of fungi and insects is often remarkable, as von Frisch points out[12]. The biscuit weevil, Sitodrepa, excretes its symbiotic yeast cells while laying, thus infecting its eggs as they exit from the rectum. The emerging larvae bite their shells and thus ingest some of this yeast. One kind of leaf bug, Coptosoma, has bacterial symbionts which live in a mycetome communicating with the gut. When this insect lays its eggs batches of encapsulated bacteria are also expelled one at a time in between the eggs. As soon as the embryo opens its egg it pierces a capsule with its proboscis and sucks in the bacteria it needs ! If it does not get them it usually dies before undergoing metamorphosis because of a lack of vitamin B_1. Similarly other insects lacking vitamins live in symbiosis to get them. Or insects may lack nitrogen for the synthesis of what proteins they need, and require nitrogen-fixing micro-organisms for this, just as the roots of legumes do. Many insects contain three or more different symbionts in their mycetomes. Each passes out on the egg and is then allotted its special area in the mycetome of the young insect.

A typical frog egg[13] lies encased in gelatin that prevents jostling or overcrowding and is both unpalatable and slippery to predators. It acts like a tiny greenhouse to concentrate the sun's rays. Chinks between the spheres of jelly are taken up by unicellular plants and rotifers which are oxygen-liberating and so help the tadpoles to emerge in 4 to 15 days.

Small fish cleaning the mouths of big or predator fish present a rare problem[14]. In the Bahamas the Pederson shrimp (Periclimenes pedersoni) waits till passing fish call on it, stop nearby, and present any injured or troublesome part to the shrimp. The shrimp crawls aboard, inspects the client, even makes minor incisions which the client tolerates as it remains motionless. The fish even opens its gill covers seriatim to let the shrimp in to inspect them. Similarly it inspects the mouth (Figure 1). As was said, fish will line up for such inspection, even waiting for it when the shrimp has retired from work! The known cleaners include 26 species of fish, 6 shrimp and Beebe's crab. The little senorita (Oxyjulis californica) cleans black sea bass, ocean sunfish, even the bat ray — both bony and cartilaginous fishes! Even distantly related species of cleaners may have analogous specialized cleaning structures — convergent evolution? Senoritas seem never to be eaten, although they enter the mouths of the kelp bass which eats similar-sized fish. Some fish mimic them in colour and conformation, even doing so to become predators! Shrimps clean the mouth of the moray eel — but do get eaten occasionally. All this suggests that nature exhibits much cooperation, rather than merely a bloody tooth-and-claw struggle for existence!

Immature pelagic octopods or devilfish (Tremoctopus violaceus) have suckers adapted to holding fragments of tentacles of the coelenterate Physalia, the Portuguese man-of-war, using their nematocysts[15] or stinging cells having a trigger-like mechanism discharging barbs and a fluid which paralyzes action of animals penetrated by the barb! These can render fish defenseless with the sting. It is not known if the adult octopod retains this habit. This is a unique use of only parts of a coelenterate as weapons, and may imply the octopod's ability to know when these weapons need to be replaced! Just how the devilfish is able to activate or fire the stinging cells of such an unrelated creature as the Portuguese man-of-war is not too clear, especially since only a part of its tentacle is involved. And how by natural selection was this trick incorporated into the DNA system of the devilfish? The pickpocket type of dexterity required to steal enough tentacle fragments to cover eight. rows of suckers would make even a "big-time" operator envious.

Reproduction

Nestless birds such as the murres lay pear-shaped eggs which cannot roll off the ledges and cliffs where they are laid. Other birds, like some of the sandpipers and killdeer, lay eggs on the ground which hatch into youngsters which can run to safety as soon as they hatch and dry.

The female Indochina swift[16] at nesting time has glands under her tongue which begin to swell. She flies to a cave, presses her beak against the rock wall, thus expresses a crystal-clear fluid which she weaves back and forth on the rock wall. When it hardens it provides a glass-like nest for her eggs — and the source of bird's nest soup!

A malarial mosquito in Panama can lay its eggs through the tiniest holes in bamboo internodes by hovering outside the holes and shooting its eggs in with great force and accuracy[17]. A species in Ceylon that faces the same problem meets it by laying its eggs on one of its legs, then inserting the tiny leg into the tiny hole. The larvae of these mosquitos must escape through these tiny holes, of course. It turns out that they are very persistent and can wriggle through almost any tiny aperture, unlike the larvae of other mosquitoes, being able even to penetrate absorbent cotton.

Locomotion

For the first few days after hatching the moorhen chick[18] cannot stand on its legs but gets about by using its legs and a long claw on each thumb — here is a feature shared with the hoatzin chick. It is a remarkable adaptation for a peculiar defect of locomotion and one shared with one very dissimilar bird, which uses such a claw for climbing trees!

Attack and Defense

The giant electric ray[19] (Torpedo nobiliana) puts out pulses of 50 amperes at 50 to 60 volts, able to electrocute a large fish. The African catfish (Malapterurus) puts out up to 350 volts. The electric eel (Electrophorus) puts out more than 500 volts. The evolutionist is puzzled by such a "convergence" in unrelated families, among the "ancient" cartilaginous fish as well as more recent bony fish. Moreover the electric organs are very differently arranged in the various fish possessing them. They may be longitudinal and constitute 40 per cent of the fish's bulk — or be vertical columns mainly in the wings (as in the ray), or be a mantle under the skin of the whole body. Curiously, to the evolutionist, studies on the giant ray, the skate, a southern Atlantic ray and the bony fish Astroscopus found that the electroplaques in all are electrically unexcitable! Moreover, even the weakly electric fishes use their powers for guidance. Indeed the African Gymnarchus can detect a potential gradient of about .03 microvolt per mm. It was once thought that stalked electroplaques were to be found only in the African freshwater families, but lately they were found in one of the American knife fishes! The firing mechanism in the brain differs in all types of fishes. In the rays and Astroscopus the skin near the trigger area has much lower electrical resistance than the rest of the skin. In the eel, where the organ can be a metre long, the synapse resistance is so arranged in a gradient that all the electroplaques are fired at the same time. The knife fishes discharge repetitively and have a pace-maker which excites the spinal motoneurones at a rate as high as 1500 pulses per second. Even warm-blooded animals show no such rate of continuous nerve activity. The electric skates remain a puzzle to evolutionists for their electric organs are in their long tails, are weak, and seem to have no obvious adaptive value. Elsewhere the picture is one of strange "convergence."

The mormyrid African fish Gymnarchus niloticus[20] has a *weak* electric organ in its tail which emits a continuous stream of discharges. Two other fish do this, too — another mormyrid and a small South American fresh water relative of the electric eel — far removed from the mormyrids. It uses these impulses to dodge objects in the water as small as 2mm. in diameter, even when swimming backward! Skates, which are cartilaginous and not teleosts like the mormyrids and gymnotids, also have a weak electric organ in the tail. All swim rigidly in order not to upset their electrical field unduly. The skin of the mormyrid is made up of many layers of remarkably hexagonal platelike cells. Pores in the skin contain tubes leading to the electric sense organs. These tubes contain a jelly-like substance and widen at their central end into a capsule containing a group of specialized cells. In half these fishes the electric organ emits constant frequency pulses. In the other half of these species the rate varies with the fish's state of excitation. It is interesting to find both types of sensory systems in the two different families, one in South America and one in Africa!

The polydesmid millipede[21] (Apheloria corrugata, Wood) has paired glands in most body segments. Each of these has two compartments. In one is an undissociated cyanogenic compound and in the other a chemical factor able to trigger hydrogen cyanide production when needed — not before. At the instant of discharge, for example against ants, the two compartments' contents mix and cyanide is generated. Among millipedes this two-compartmented gland may be exclusive to the order Polydesmida. Other millipedes may use quinones and phenols similarly. These do not require chemical activation when discharged.

The Mexican bean beetle (Apilachna verivestis Mulsant) displays reflex bleeding when molested or handled[22], always bleeding from the tibio-femoral leg joints, considerable loss of blood being tolerated. This blood drop is larger than the volume of the whole leg! The larvae of this species are densely spined on the top and sides; the spines being hollow and brittle, and bleed when broken. They too can tolerate much blood loss in this way. If ants get entangled in this blood they are immobilized for a few minutes. The adaptation is an eminently useful defense against ants.

Burton[23] calls attention to the purple emperor butterfly of England which at every stage of its life closely resembles something else, either a gall, a slug, a young or an old leaf. He adds that this suggests intelligent design and makes the biologist think of many adaptations towards survival. But Burton adds that this species and many another showing such remarkable adaptations are often not successful in the world!

General Comment

It is possible to contend that all special adaptations have arisen in response to need and have developed gradually by natural selection. But there are certain adaptations which are so intricate and complex that it is impossible to imagine a single mutation having achieved so much, and no half-way measure would have helped toward the end desired. We have given many examples of these. Then there are the even more wonderfuI synchronized and complex adaptations of flower and insect, or of two different families or orders, of which examples have also been given. The world of the parasite is one long instance of this. How could adaptations of such complex inter-action be achieved in one single step or in a series of steps? The snapdragon does not explain this, although we know that in the snapdragon genus, Antirrhinum, the usually two-lipped flower can become radially symmetrical by the mutation of a single gene. Whether the reverse occurs is unknowns.

Creation is a much more plausible explanation — the only one, indeed. These are all instances of lock and key or hand and glove adaptations. It is not enough to use any key, but only the right one. Then imagine the simultaneous development of a hand inside a glove inside a suit inside a submarine — which is approximately analagous to what we have- in many of the more complex adaptations in Nature!

Why the *remarkable perfection* of the dolphin's or bat's sonar or the rattlesnake's perception of heat the moth's perception of odour? Less would have done quite well.

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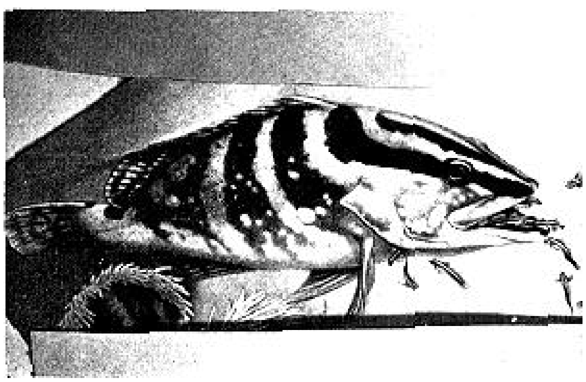

Figure. 1. Grouper fish (Epinephelide) and small fish cleaning off parasites.

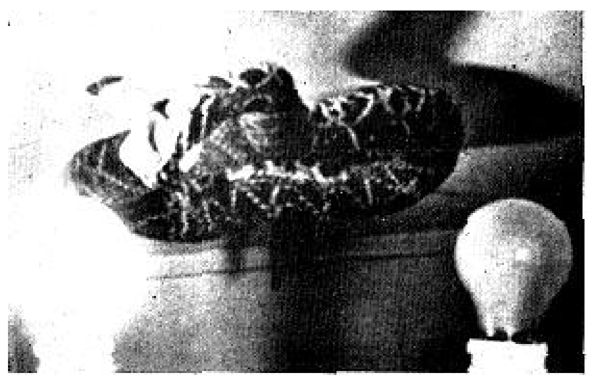

Figure 2. Blindfolded rattlesnake hits light bulb. Courtesy Life Magazine (April 28, 1958).