When theologians asked the famous biologist JBS Haldane, “what could be inferred about the mind of the Creator from the works of His creation’, he quipped in jest: “The Creator, if he exists, has a special preference for beetles.” True. The living world is predominated by various kinds of beetles – small, big, stout and slim. No other group of animals exhibits such a range of size, colour and shape. Imagine, one in four species in the world is a beetle and they account for 40% of all known insect species. How come the world is full of beetles?

Though known from earlier times, beetles were classified and described since 1871 and till now scientists have described about 3,50,000 types. Entomologists (scientists who study insects) claim that the true number of beetles could probably be about a million. Not a month passes without the discovery of a new beetle species. In fact, befitting the bicentennial celebration of Darwin, a new dung beetle species found in the remote forest region of Costa Rica was named after Darwin – Canthidium (Eucanthidium) darwinii in 2009.

Scientists identify beetles by Coleoptera, which means ‘sheathed wings’. Though they have wings beetles hardly fly and some like ground beetles have lost their ability to fly completely. Like other insects they also have three-segmented body and six legs. The unique feature of beetles is the exoskeleton made up of large number of, and particularly hard, forewings that act like armour.

Since there are more than 3,50,000 varieties of beetles, obviously they must come in various shapes and sizes. One of the smallest beetles is the fringed ant beetle (Nanosella fungi) that is just 0.25 mm in length. In fact at these lengths they would be smaller than many single celled protozoa. In contrast, the world’s largest beetles Titanus giganteus and Callipogon armillatus are palm full; these can be as large as an adult human palm. Another large beetle Goliathus giganteus could grow to a body length up to 10 cm.

When Australian tiger beetle (Cicindela hudsoni) is chasing, the prey knows that it cannot show a clean pair of heels ever. This beetle is the world’s fastest running insect; it can run as fast as 9 km/h. It chases down the prey at high speed. The heaviest and bulkiest beetles are the Megasoma beetles of South America. The heaviest species is Megasoma actaeon whose fully grown larva can weigh over 200 g. While most of the insects live for a short duration, Jewel beetles can survive for 30 years or more. The Bombardier beetle can shoot boiling hot puffs of irritating gas from its anus, which the beetle can aim with remarkable accuracy and turn on and off 500 times a second.

As the name suggests, the strongest creature in the world is the Hercules Beetle; it can carry up to 850 times its own weight. In contrast, a huge African elephant can only carry up to 25% of its own weight on its back. In a laboratory experiment, it was found that the Hercules beetle could pull about 850 times its own body weight, equivalent to an average adult (70 kg) lifting seven tractors.

Eat Everything - Anything
If beetles had to evolve in various diverse forms they must have adapted and specialised to feed on any available food, indeed all organic material. Beetles such as red flour beetle are stored food pests and live all their life in the stored food grains. They do not have normal eyesight but are exceptionally good at detecting the light source. Living under sack full of grains they need to know when they are leaving the stored grains. On the other hand, some beetles such as ladybug have pretty good...
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eyesight. They are called friends of plants as they feed upon pest insects such as spider mites and aphids and thus protect the plants.

Leaf beetles, as the name suggests, are herbivores and cause havoc to plants and crops. Various specialised beetles adapted to feed on the roots, stems, leaves, or reproductive structures of their host plants have also evolved. Some species live on fungi; others burrow into plant tissues, and still others excavate tunnels in wood or under bark.

Ground beetles or carabids are carnivorous and devour earthworm and snails while beetles like Staphyliniidae, Amblyopininae are parasites on mammals. A class of beetles are scavengers; they feed on carrion, faecal material, decaying wood, or other dead organic matter. Dung beetles as the name suggest eat dung of other animals. Dung beetles, such as the African Garreta nitens, use their serrated foreleg and broad hoe-like head to carve out chunks of faecal material to use it as food. They ingest huge quantities of dung, using their membranous mandibles to strain out remnants of undigested food, bacteria, yeasts, and moulds. Not even a scrap of food is allowed to go waste. Dung beetles have a crucial role in nature as they

Horns of Beetles

What makes beetles unique in the insect world is their ability to grow horns. Horns at times are about one third of the entire body weight. Studies have found that beetles use their horns in surprising ways.

Science today has pretty good idea of what needs to happen for legs to become longer or wings to become wider. But scientists are still baffled how animals develop a completely new body part. Studying how beetle horns evolved might help answer the question.

A beetle horn is not a horn. Some beetle horns snap together, like pincers. Others are low and curved, like an elephant’s tusk. And watch out—a dung beetle’s horns can be longer than the rest of its body. Beetle horns come in a variety of shapes and sizes. Often, just like male elephant tuskers, it is only mostly males that have fully grown adult horns. For males the horns are weapons to keep off other males from approaching the female in the tunnel-nest. Beetles use their horns to grab other beetles, lift them in the air, and even throw them off trees. Sometimes a beetle will slide its horn underneath another beetle and flip it over.

The horn in adulthood is used as a weapon; it is used to break the head capsule when the beetles are in juvenile stage. Larvae of beetles normally grow inside little balls of packed dung, called brood balls. Inside their cozy brood balls, the larvae grow thick and protective helmets called larval head capsules. But the larvae eventually have to break out of these capsules to become full-grown adults. Larvae seem to use their horns to poke their way out of their capsules. To test this hypothesis, in some of the larva, scientists used electricity to destroy the horn. This stopped the horns from growing normally. Sure enough, these hornless larvae could not shed their head capsules, thus establishing the purpose of the horns.

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consume waste and bury the organic matter in the ground; they contribute to soil fertility and structure.

The Great Survivors
Fossils indicate that beetles originated way back on the geological time scale, a whopping 299 million years ago—way beyond the age of dinosaurs. They have been diversifying since then. How and when the large number of beetles came about has been an intriguing question. Whether beetles diversified into numerous species from a handful of original ancestral species, or whether there were quite a few ancestral species that gave way to copious beetle species that we witness today has been a hotly debated topic for many decades, but never resolved.

The astonishing diversity of beetles was hitherto attributed to herbivory—feeding on plants. Biologists speculated that the huge diversification occurred with the emergence of flowering plants some 140 million years ago. As newer species of flowering plants emerged, newer types of beetle species co-evolved to feed on the roots, leaves, and flowers of the plants.

However, a recent study done with modern techniques of DNA analysis indicates that large numbers of modern-day beetle lineages evolved very soon after the first beetles originated, and have persisted ever since. After millions of years, many diverse lineages appeared during the Jurassic period, when the major groups of dinosaurs appeared too. The study used the DNA sequencing and fossil records to compile a comprehensive evolutionary 'family tree' for beetles. By comparing DNA sequences from 1,880 beetle species, the scientists were able to group beetle species that have descended from a common ancestor, enabling them to build an evolutionary tree for all the species included.

From the study it appears that the large numbers of beetle species existing today are the direct result of this early evolution implying that there has been a very high rate of survival and continuous diversification of many lineages. Evolution of many modern beetle lineages significantly predates the appearance of the first flowering plants. Beetles have displayed an exceptional ability to seize new ecological opportunities and develop a great range of life styles and feeding types; not just feeding on green plants. Studies indicate that adaptations for snail feeding led to the diversification of beetle heads.

If beetles have evolved and diversified to both crush the shells and protrude inside the shell, snails have counter evolved and diversified. It has been demonstrated among the fresh water snails that the shell morphology (shape) has diversified along with the diversification of beetles. Freshwater snails have now two types of shells – elongate and round. The elongate shells protect against entry attacks and rounded shells protect against crushing attacks.

Speciation has occurred in beetles over a considerable period of time. Diversity in beetle species can occur because of their varied feeding habitats. Scientists have recently noticed that a particular leaf beetle is in the process of speciation. Two beetle species have diversified, one specialising in feeding maple tree leaf and the other the leaf of willow. Both beetles are visually indistinguishable but each prefers to feed and lay eggs on its own "host plant".
Although there is some intermixing, the beetles show a decided preference for mates from the same host. Scientists have observed that the willow beetles starve to death rather than feed on the maple leaves readily consumed by their maple beetle cousins. Thus, slowly and steadily in thousands of years both will divide into two separate species—this is evolution in action, and emergence of biodiversity.

These studies have established how ecological factors contribute to evolutionary divergence and the origin of Earth’s millions of species. This reflects the true power of natural selection, which has driven these beetles to become so intimately adapted to their host plant environment, promoting their speciation along the way. It is not a coincidence that plant-feeding insects, such as beetles, are among the most ecologically specialized and the most species-rich groups on the planet.

A Lesson or Two
The Hercules beetle has a trick up its sleeve. This amazing beetle, usually found in the rainforests of Columbia, Venezuela, Peru, Ecuador, Bolivia, and Brazil, is mysterious—it can change the colour of its exoskeleton as it rains. The insect’s exoskeleton or shell changes from green to black as its surrounding atmosphere gets more humid. Scientists have been able to shed light on this mysterious phenomenon only recently.

Scanning electron microscopy has been utilized to study the minute structure of the exoskeleton and spectrophotometer has been used to analyze how the light interacts with this structure. The shells, the study reveals, are not green dyed. When the light interferes with the structure it produces the typical green colour of the shell, through a process called irradiance. However, when water penetrates through the widely open porous layers, it destroys the interference phenomenon leading to black colouration.

As to why the beetle changes colour, questions remain. Some have suggested that the phenomenon occurs for defence and protection. At night the weather is humid. Therefore, it is good to turn black. Others have suggested that it is to do with warmth absorption at night.

Nevertheless, scientists say that they could use the knowledge gained from studying Hercules beetle to design ‘intelligent’ materials. Such materials could be put to work as humidity sensors. This could be useful for example to monitor the moisture level in food processing industry etc.

In fact humans have been using beetles since the dawn of civilisation. A class of beetles called jewelled beetles have a metallic shine and dazzling colours in their exoskeleton. The durability and colour of the beetle exoskeleton has inspired their use in jewellery. Amazonian Indians have been long since using shells from buprestid beetle, Euchroma gigantean, to make jewellery. A Spanish beetle Lytta vesicatoria is the source of chemical cantharadin used by veterinarians as a mating stimulant when breeding cattle and in the treatment of certain urogenital diseases.

Beetles have also been objects of worship! Early Egyptians perceived the Earth as a ball of dung pushed through the universe by a dung beetle, and used this beetle as the image for their sun god, Khepera.

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