THINK venom and you cannot help thinking of snakes. But there are innumerable other species of animals equally capable of spewing venom and dealing a lethal blow.

Originating from the Latin word *Venenem* meaning poison, venom can be defined as a zootoxin or a variety of poisonous substance secreted by an animal, produced by specialized glands and associated with spines, tooth or stings. It may primarily be used for killing prey or may be defensive or may even function as a digestive fluid. The venom may cause localized skin inflammation or almost instant death.

But is there any difference between venomous and poisonous animals? Or are they both the same? Well, while venomous animals deliver or inject venom into their prey either while hunting or while defending themselves, poisonous animals are harmful when consumed or touched. Venom is generally produced in organs specialized for the purpose whereas poison is generally distributed over a larger part of the body of organisms producing it.

Now let’s take a look at some of these venomous animals that could be equally poisonous as snakes.

**Fatal Fishes**

Venomous fishes outnumber not only venomous snakes but also other venomous vertebrates put together. There are more than 1200 species of venomous fishes occupying almost all aquatic ecosystems. Such fishes possess venom-producing glands and have mechanisms like sharp spines for inflicting the venom. Generally used for defence against predators, venom produced by a fish is often referred to as an ichthyotoxin whereas poison in the fish body is known as ichthyosarcotoxin.

Chondrichthyes or cartilaginous fishes (having cartilaginous skeletons) have a highly specialized and dangerous integumentary venom delivery apparatus – the spine or sting. These deciduous spines have grooves for toxic secretions from contiguous glands, producing agonizing wounds that may result in septicemia and even death.

The stinger of a stingray is razor sharp, barbed, or serrated cartilaginous spine that grows from the ray’s whip like tail as a fingernail. On the underside of the spine are two grooves containing the venom secreting glandular tissue. The entire spine is covered with a thin layer of skin called the integumentary sheath in which the venom is concentrated. The venom causes necrosis and tissue breakdown.

Its venom causes punctures, poisoning, severed arteries and even death. Treatment is with scalding water, antibiotics and local anesthetics. The naturalist, conservationist and adventurer, Steve Irwin, better known as the “Crocodile hunter”, was mortally wounded on 4 September 2006 by a stingray while diving off the north Queensland coast during the filming of a documentary called *The Ocean’s Deadliest*. A giant bull stingray pierced his heart with a poisonous barb. Keeping a respectful distance and wearing ballistic nylon vest could have prevented his death.

However dangerous the stingray may be, in the Cayman Islands there is a stingray city where divers can swim with large Bat rays and feed them by hand. The Baltimore aquarium has a large stingray tank where they may be viewed from above or below.

A large number of bony fishes are also known to be venomous. Catfishes can cause painful wounds. Freshwater Noturus have venom glands on the pectoral spines. Marine striped eel catfish *Plotosus lineatus* has highly venomous serrated spine on the first dorsal fin and each of the pectoral fins. These may be fatal.

Toadfishes like *Thalassophryne maculosa* and *Opsanus tau* are ugly short-bodied fish with dorsally placed eyes on head. The dorsal fins and opercular spines are hollow and can inject venom that causes intense pain. Similarly, light colored, brown spotted Weever fish of family Trachinidae found in coastal waters of any temperate sea has a row of spines along its back. It buries itself under the sand waiting for its prey. Venom of the fish is as powerful as the venom of the rattlesnake. It destroys Red Blood Cells and paralyses nerves. Burning pain lasts from thirty minutes to an hour. This intense pain can cause unconsciousness and lead to drowning of the victim. Aspivenin is very effective in treating poisonous fish stings.

Surgeonfishes of the family Acanthuridae have very sharp scalpel like spines protruding from the junction of their body and tail. Inhabiting mainly Indo-Pacific and

**Spewing Venom!**

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Lethal, venomous vertebrates occupy an important niche in the ecosystem. Although their venom could even be fatal, some venoms have proved to be very important as pharmacological and biomedical compounds.
sometimes the Atlantic Ocean, these beautifully colored and compressed bodied fishes are poisonous. Ciguatera poisoning is reported on consumption of surgeonfishes. Similarly, Scorpionfishes also possess venomous spines. The Zebra Turkey fish *Dendrochirus zebra* of Indian and western Pacific oceans has 13 venomous spines along its back as defensive organs.

Then there are Antennata Lion fish that have venomous spines fatal to their prey, though not fatal to humans. But it causes severe pain, headaches and vomiting. Clear fin Lionfish *Pterois radiata* or Tail bar Lionfish inhabiting the Indian and Western Pacific oceans has venomous spines. The Red Lionfish *Pterois volitans* inhabiting Indian and Western Pacific oceans also possess venomous spines.

Stonefishes are the most venomous fishes known. Venom from the Reef Stonefish *Synanceia verrucosa* causes severe pain with possible shock, paralysis and tissue death depending on the depth of penetration. The ugly looking Red sea stonefish *Synanceia nana* also has venomous dorsal spines.

The blood, liver, gut and gonads of Puffer fishes contain a virulent toxin capable killing humans. On contamination, it produces severe gastric disorder. In spite of the toxicity, puffer fishes are a delicacy in Japan and are called Fugu. Porcupine fish, Cowfish, Boxfish, Tobies and Sunfish are equally toxic. These fishes ingest algae covered with bacteria *Alteromonas* that is the source of the toxin. This toxin concentrates in the liver and gonads inhibiting sodium transport thus affecting neuronal transmission in the CNS and also affects cardiac nerve conduction and contraction.

Coral reef fishes such as barracuda, grouper and snapper cause a very common toxicity, known as Ciguatera. Ciguatera poisoning results from the eating of reef fish affected with ciguatoxin. Dinoflagellates (*Gambierdiscus toxicus*) colonizing the coral beds are responsible for the ciguatoxin. The toxin first affects the coral grazing fish and then is passed through the food chain to fish feeding on them like snapper, grouper, and amber jack and finally human beings. The toxin is not affected either by cooking or freezing. Intense itching, joint and muscular pain, tingling of the lips, gastrointestinal complaints are some of the symptoms of the poisoning. Ciguatoxin acts on the sodium channels thereby causing changes in the electrical potential and permeability.

Some popular aquarium fishes like longhorn Cowfish (*Lactoria comuta*) or cube box fish *Ostracion cubicus* and the Pacific box fish *O. meleagris* release a toxin called ostracitoxin into the water if they are alarmed. Due to space limitation in aquarium, this toxin has deleterious effect on other fishes. Twenty-one species of the genus Takifugu contain tetradotoxin. Intestines, liver and ovaries of the tiger puffer, skin and internal organs of smooth puffers and gut and muscles of the green puffers are very toxic.
Poison glands of amphibians are located in the dermis and open to the surface through connecting ducts. They generally contain stored secretions in the lumen, which are a wide variety of irritating as well as toxic compounds. These toxic secretions are potentially harmful only if eaten or injected. Poison glands in amphibians behave primarily as chemical defence systems and their locations are such that predators are exposed to them.

The European salamander (*Pleurodeles waltl*) and two genera of Asian salamanders *Echinotriton* and *Tylotriton* possess ribs that pierce the body wall when attacked by predators. These ribs penetrate poison glands while emerging through the body wall and eventually carry poison drops at the tip. The red eft salamander *Notopthalmus viridescens* and red salamander *Pseudotriton ruber* have skin toxins – the tetrodotoxin – which is a potent neurotoxin. Predators who have once experienced this toxin refuse to attack an eft in future.

The large crested or warty Newt *Triturus cristatus* of Europe if attacked discharges a venomous secretion from its dorsal glands. Most of the toads and salamanders possess small poison glands aggregated together as a prominent swelling. These are parotid glands and are located on each side of the head. The Natterjacks have similar glands on each hind leg. The large and prominent dorsal warts of toads are
perforated by a pore that leads to a prominent gland beneath, capable of ejecting poison. The exudate contains two other active toxins, bufotalin and bufogin. If swallowed these cause nausea, respiratory and muscular impairment and digitalis like action on heart.

Colorado river toads and cave toads have bufotoxins in their skin secretions. These are psychoactive and are used as recreational drugs. The poison dart frogs of the new world tropics have large numbers of cutaneous alkaloids. South American Indians use the toxins of some of these frogs to poison the tips of the blowgun darts used for hunting. Batrachotoxin, a unique alkaloid found in *Phyllobates*, is a potent neurotoxin. About 1900 micrograms of batrachotoxin is available from a single frog. Less than 200 micrograms is a lethal dose for a human if it enters the body through a cut. It prevents the closing of sodium channels in nerve and muscle cells, leading to irreversible depolarization producing cardiac arrhythmia, fibrillation and cardiac failure.

Frog toxin isolated from another poison dart frog *Epipedobates tricolor* contains an anesthetic that acts as a painkiller 200 times more potent than morphine. This makes it of tremendous interest as a potential drug lead.

**Rancorous Reptiles**

Hollow fangs connected with poison glands are found in venomous lizards. The beaded lizard and the Gila monster are the only venomous lizards with an overt venom delivery system.

The beaded lizard is found in the Pacific Drainages from southern Sonora to southwestern Guatemala and two Atlantic drainages from central Chiapas to southeastern Guatemala. Its venom glands are modified salivary glands located in the animal’s lower jaw. Each gland is with a separate duct that leads to the base of its grooved teeth. This lizard hangs on to its victim and chews so that the venomous saliva enters the wound. Although the jaw grip is strong, the unsocketed teeth of the animal come out from their bases.

Their venom is a weak hemotoxin and consists of L-amino acid oxidase, hyaluronidase, phospholipase A, serotonin and highly active kallikreins that release vasoactive kinins. The venom contains no enzymes that significantly affect coagulation. Although human deaths are rare, the venom can cause respiratory failure. Excruciating pain that may last for 24 hours, swelling of the affected part, rapid fall in blood pressure are other effects of the bite. In other smaller mammals such as rats the bite may cause several cardiac anomalies, hypothermia, edema and internal hemorrhages. The compounds found in the venomous saliva are said to have pharmacological value in diabetes, Alzheimer’s disease and even HIV.

Gila monster (*Heloderma suspectum*) is the inhabitant of the deserts of southwestern USA and northwestern Mexico. Venom is produced in modified salivary glands of the lower jaws of the Gila monster quite unlike that of snakes where venom is produced in the upper jaws. The Gila monster lacks the musculature to forcibly inject the venom; instead the venom is propelled from the gland to the tooth. By chewing, the capillary action brings the venom out of the tooth and into the victim. While biting the animal flips over possibly to aid the flow of venom. Since victims of this animal are always helpless prey, it is thought that Gila monster’s venom evolved for defensive rather than for hunting.

The venom of Gila monster is neurotoxic and as toxic as the western diamondback rattlesnake. This monster can bite in quick succession and can hold on ferociously. Though not fatal to humans it can cause excruciating pain, edema and weakness associated with fall in blood pressure.

More than a dozen peptides and proteins have been isolated from the Gila monster’s venom. Hyaluronidase, serotonin, phospholipase A2 and several kallikrein like glycoproteins are responsible for the pain and edema caused by the bite. Four potentially lethal toxins are also isolated from the venom.

**Venomous Snakes**

Recent DNA analysis suggests that the closest relatives of snakes are iguanas and the two venomous lizards. Venomous snakes and lizards shared a common ancestor 200 million years ago. Considered the most dreadful of all animals that cohabit our planet, 750 species are venomous out of 3000 or more species of existing snakes. About 250 species are regarded as dangerous to humans and only 50 or so are
potentially lethal. Though recent findings reveal that more than 2000 species of snakes possess venom and all snakes may be venomous to a certain extent even if the venom is smaller in quantity and is delivered through sharp teeth rather than fangs. There are over 270 species of snakes in India out of which about 60 are venomous.

A venomous snake uses modified saliva as the venom, which is usually delivered through highly specialized teeth such as hollow fangs. In contrast non-venomous species either constrict their prey or simply overpower them with their jaws.

There are four families of venomous snakes:

- **Atractaspidae** comprising burrowing asps, mole vipers, stiletto snakes found in Africa and Middle East and comprise fang-less (aglyphous), rear fanged (opisthoglyphous), fixed fanged (proteroglyphous) and viper-like (solenoglyphous) species.
- **Colubridae** comprising mostly harmless snakes, but some have toxic saliva and at least five species including the Boomslang have caused human fatalities. A few groups of the genus *Boiga* can produce medically significant bites. In venom producing colubrids the fangs are situated in the back of the mouth.
- **Elapidae or elapids** are the family of venomous snakes found in the tropical and sub tropical regions around the world including the Indian Ocean and Pacific. There are more than 60 genera and 230 species comprising Cobras, Coral snakes, Kraits, Mambas, Sea snakes, Sea Kraits and Australian elapids. They possess hollow and fixed fangs to inject venom.
- **Viperidae or vipers** comprise pit vipers (with heat sensing pits) as rattlesnakes and moccasins and such true or pitless vipers as puff adders.

Out of a number of venomous snakes in India the most famous are the Big Four: Saw scaled viper, Russell’s viper, Krait and the Indian Cobra.

Saw scaled viper (*Echis carinatus*) has highly virulent hemotoxic venom and it produces a sharp sizzling sound by rubbing the body sides together. Russell’s Viper (*Dabois russelii*) is a large snake with large triangular head and large fangs producing a low rasping sound by rubbing its scales together. The Krait (*Bungarus caeruleus*) has bold striped patterns of alternating black and light colored area. Their neurotoxic venom is 16 times stronger than cobra venom. Indian Cobra or Spectacled Cobra (*Naja naja*) is the most famous of the big four. Its venom contains a powerful postsynaptic neurotoxin. King cobra (*Ophiophagus hannah*) is another famous snake that can discharge venom equal to 10 lethal doses to a man in one bite.

Venom is highly modified saliva that is produced by special glands. Like all salivary secretions venom is a pre-digestant that initiates the breakdown of food into soluble compounds allowing for proper digestion. It is a complex mixture of proteins such as neurotoxins, hemotoxins, cytotoxins, bungarotoxins and enzymes meant originally for digestion of the prey. The stronger these digestive juices, the more powerful the venom. Almost all snake venom contains hyaluronidase an enzyme that ensures rapid diffusion of the venom.

These prey-immobilizing substances in snakes are composed of approximately 90% proteins. Some of the enzymes present in snake venom are phosphodiesterases interfering with the prey’s cardiac system, mainly to lower the blood pressure; cholinesterase inhibitor making prey to loose muscle control; and hyaluronidase, increasing tissue permeability to increase the rate of absorption of enzymes into the prey’s tissue.
Venom of Cobras and Coral snakes also has neurotoxins or nerve toxins that attack the victim’s central nervous system and brain. This may result in heart failure, breathing difficulties or even total respiratory paralysis. The venom of the viper is hemotoxic or a blood toxin that affects the heart, cardiovascular system and muscle tissue resulting in excessive scurrying and gangrene. This may lead to amputation of the affected area. The toxin destroys the tissue and blood cells ultimately killing the prey. The venom of krait acts both as neurotoxin and hemotoxin. Primary symptoms like severe abdominal pain, dribbling of saliva etc. occur. Death results from asphyxia through paralysis of the respiratory centre.

The most potent venom is produced by those snakes that feed on fast-moving prey. Many venomous snakes have prey-specialised venom. The venom of some marine hydrophis (elapids) is among the most toxic in the world. The reason is that these snakes consume reef fish that would elude them if the venom did not act rapidly. The Australian inland taipan, the black mamba and the king cobra are considered to be the most venomous. But they are rare and not very aggressive and so they kill few people. Asiatic cobras, Russel’s vipers and saw-scaled vipers have less toxic venom, but kill about 100,000 people a year.

Poisonous Birds

A few poisonous birds are also known. They do not produce venom themselves but acquire poisons from their diet. These toxins probably serve the birds as chemical defense, either against ecto parasites or against predators such as snakes, raptors or humans. Birds of the genus Pitohui belonging to the family Pachycephalidae, endemic to New Guinea, have brightly coloured skin and feathers which contain powerful neurotoxin alkaloids of the batrachotoxin group. This toxin is a neurotoxin called homobatrachotoxin that causes numbness and tingling in those touching the bird. The poison is acquired by eating the choresine beetle. It is probably the same beetle that is the source of lethal batrachotoxin in poison dart frogs.

Some species of these Pitohui birds are Hooded Pitohui (Pitohui dichrous); Variable Pitohui (Pitohui kirchopehalus); Blue capped Ifrita (Ifrita kovaldi), and Rufous or little Shrike thrush (Colluricincla megaryncha).

Malicious Mammals

A very few mammals also produce venom either to kill or to disable prey to defend themselves. Venom delivery is a rare phenomenon in the class Mammalia and the reason according to scientists is that modern and smart mammals rather use tooth or claw than venom, which takes longer time to disable prey. Some such mammals are:

Platypus or the Duckbill (Ornithorhynchus anatinus) is endemic to western Australia and Tasmania. Males have sharp, movable, fang-like half-inch-long spur on the inner side of the ankle of the hind limbs. This is connected with a small crucial gland having poisonous albuminous secretion, capable of killing a rabbit in 90 seconds. This venom if injected causes severe pain in humans. Though not lethal, it is so excruciating that the victim may be incapacitated. Oedema develops around the wound, which spreads throughout the affected limbs. Of the four major toxins present in its venom, three cause lowering of blood pressure, pain and increasing blood flow around the wound. It is powerful enough to seriously impair the victim.

The males of Spiny anteater (Tachyglossus = Echidna) possess the poison spur on the leg supplied by a pea-sized gland. Similarly, Short-tailed shrew (Blarina breviceauda), Southern short-tailed shrew (Blarina carolinensis), Elliot’s short-tailed shrew (Blarina hylophaga), Northern short-tailed shrew (B. breviceauda) and Eurasian water shrew (Neomys fodiens) deliver a venomous bite that can immobilize larger animals.

Solenodon is the only living mammal species that is able to inject venom through specially modified teeth just like snake. Solenodons are often referred to as living fossils as they constitute an ancient mammal lineage. There are two species of Solenodons—Haitian Solenodon (Solenodon paradoxus) and Cuban Solenodon (Solenodon cubanus). These Solenodons look like large shrews and their venom is delivered from modified salivary glands via grooves in their second lower incisors.

Slow Loris – Sunda Loris (Nycticebus coucang), Bengal slow Loris (N. bengalensis) and Pygmy slow Loris (N. pygmeus) secrete toxins used for covering their babies in order to protect them from predators. Toxins are secreted from glands situated inside their elbows.

Striped skunk (Mephitis mephitis) and American skunk (Conepatus leuconotus) can eject a strong foul-smelling noxious fluid from glands situated near their anus. This can cause irritation and even temporary blindness in the eyes.

Some of the other venomous mammals are Striped Pole cat (Ictonyx sriatus), which excretes a strong foul-smelling odour; Sunda pangolin (Manis javanica) or the Scaly anteater, which emits a noxious smelling fluid, and Great Long nosed Armadillo, which has spurs on hind legs that can inflict damage to humans.

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