Representatives of the family Nepenthaceae: (1) *Nepenthes ampullaria* lower leaf pitchers; (2) *N. gracilis* upper leaf pitchers.

inhabit coastal waters and estuaries. The spot-tail needlefish (*Strongylura strongylura*) and the hound needlefish (*Tylosurus crocodilus*) are common examples. ■ WLK/KL

Needletails See SWIFTS.

Nematodes Phylum Nematoda
Unsegmented, cylindrical worms whose bodies taper towards both ends. They are commonly called roundworms and include both free-living and parasitic species. They are extremely diverse in many environments, including both marine and freshwater. Many free-living species are microscopic and hardly seen. Parasitic forms attain a much larger size. Free-living nematodes feed on microscopic life such as BACTERIA and organic matter. Their parasitic counterparts are capable of infecting almost all groups of flora and fauna. They are responsible for damaging crops and livestock. Some may cause disease in humans. The majority of nematodes have separate sexes, with some extent of sexual dimorphism. Fertilisation is largely internal with zygotes left to develop in the environment.

At least 40 species of nematodes have been recorded locally. Many new species have been discovered recently: *Bursaphelenchus singaporensis* was first discovered in 2005 in Singapore, where this parasite lives in packing wood. It belongs to the family Aphelenchoididae, which is often associated with FERNS, GYMNOSPERMS, MONOCOTS and INSECTS. *Iotonchus darreni*, *I. singaporensis* and *Mylonchulus paraindex* were first described in 2005 from Singapore. The latter are predators as adults but feed on microbes when young. *Rafflesius singaporensis* and *Oriverutus nusi* were described in 2007. The latter was found along Kent Ridge Road and named after the National University of Singapore (NUS) which has its main campus located at this road.

The family Ascarididae are internal parasites of vertebrates, mostly of FISH and BIRDS and sometimes humans. Members that have been recorded in Singapore include *Polydelphis anoura* and *Camallanus cotti*. Also parasites of vertebrates, members of the family Heterakidae have highly developed reproductive organs and are characterised by having many longitudinal rows of muscle cells. *Heterakis* sp. and *Strongyluris calotis* have been recorded in Singapore. Members of Oxyuridae that have been recorded locally include *Atratcis* sp., *Cissophyllus laverani*, *Falcaustra onama* and *Syphacia* sp., which are all parasites. *Gongylonema* sp. is a parasite of vertebrates but their larvae are known to parasitise arthropods only. *Strongyloides* sp. is a parasite of insects and other animals. Some members of the family Dorylaimidae, such as *Labronema nepalense*, are predators. ■ WLK/HPMW

Nepenthaceae (pitcher plant family)
Family of climbing carnivorous plants containing the single genus, *Nepenthes*, with three species in Singapore. The lidded, cup-like pitchers are formed at the end of a tendril that grows from the tip of the leaf midrib. Pitcher plants use a variety of mechanisms, including colour, fragrance and nectar, to attract their prey which consists mostly of INSECTS, particularly ANTS in Singapore. Most prey are captured when they slide on the wet pitcher rim and fall into the fluid-filled pitcher. Here the prey are digested by enzymes secreted by the plant. The nutrients are then absorbed by the walls of the pitcher. Pitcher plants are typically found in partly open sites on poor soil and are usually absent from dense forest. Two of Singapore's three pitcher plant species, *N. rafflesiana* and *N. ampullaria*, were discovered by Raffles' companion Dr. William Jack in 1819. In a letter to friends from Singapore, Jack wrote: "I have just arrived in time to explore the woods before they yield to the axe, and have made many interesting discoveries, particularly of two new and splendid species of pitcher-plant, far surpassing any yet known in Europe." The third and now commonest species, *N. gracilis*, is less spectacular, which is probably how it has avoided the over-collection that threatens the other two. Hybrids of the three species also occur but are rare. ■ RTC

Nepticulid moths Family Nepticulidae
Some of the smallest MOTHS in the world, with wingspans measuring not more than 10 mm. These moths have short thread-like antennae with an eye-cap located at the base. Wings are usually black and held flat over the body at rest. Adults tend to run when disturbed and are attracted to light. The larvae mine leaves or bore into soft bark or seed coats. *Nepticula argyrodoxa* (wingspan 2–2.5 mm) is the only species that has been recorded in Singapore. It feeds on the leaves of the legume, *Desmodium triflorum*. ■ MC

A mounted specimen of a Neptune's cup sponge (*Cliona patera*).

Neptune's cup sponge *Cliona patera*
First sponge to be described from Singapore in 1822 and was reportedly common at that time. Typically this sponge can grow to more than 1 m in height and diameter. Much sought after in the past by museums and private collectors, this sponge may not exist in Singapore anymore; there have been no reliable records from Singapore waters for more than 100 years. This species was thought to be extinct until it was reported from Thailand and Northern Australia recently. See also SPONGES. ■ LSC

Nerites Family Neritidae
Snails commonly seen in the intertidal to high tide zone on rocky shores where they graze on ALGAE. Some species prefer brackish conditions and a few are found in freshwater. Most genera have globular shells 5–30 mm in length, and many species are highly variable in colour and

Examples of nerites. (1) The shell of *Clithon oualaniensis* comes in various colours and patterns; (2) *Nerita grayana* is common in the upper zones of mangroves.

Hasselt's spiny spider (*Gasteracantha hasselti*).

long, tapering antennae to rub against their exoskeleton, producing a loud rasping screech that deters predators. In Singapore, three species have been recorded. The mud spiny lobster (*Panulirus polyphagus*) is occasionally seen near coral reefs. Growing up to 40 cm in length, this commercially valuable species is sought for its flesh. See also SLIPPER LOBSTERS; SQUAT LOBSTERS. ■ WLK/PN

Spiny spiders *Gasteracantha* and *Macracantha* spp.
A type of ORB-WEB SPIDERS (family Araneidae). Compact and spiny SPIDERS (8–12 mm) that build horizontal or slanting orb webs on shrubs and ground cover. They often have striking colours and patterns on their hardened abdomen, which may bear up to three pairs of spines around its edge. These spines come in different sizes. Six species occur in Singapore. Hasselt's spiny spider (*Gasteracantha hasselti*) is common in rural areas and secondary forests. The long-spined spider (*Macracantha arcuata,* listed in *The Singapore Red Data Book*), is coloured orange and black, is rare and found in certain humid parts of the BTNR and CCNR. It weaves a slanting orb web. The huge downward-pointing spines of the female may function as camouflage or provide some protection against attack by predatory WASPS. Another feature distinguishing this genus is their behaviour of weaving small but noticeable tufts of white silk into the strands of silk on the perimeter of their web. The function of these tufts is not understood. ■ DJC/WLK

Spiny turbots See HALIBUTS.

Spiral melongena See MELONGENAS.

Spitting spiders Family Scytodidae
Nocturnal and usually slow-moving SPIDERS with a unique habit of firing two streams of sticky glue from their fangs. The fangs vibrate extremely rapidly, causing the strands of glue to travel out as a zig-zag net, which then entangles the prey and secures it to the ground or onto a leaf surface. The spider bites the now-helpless victim, injecting venom and killing it. At least six species occur in Singapore. The brown spitting spider (*Scytodes fusca*) grows to a size of 5–7 mm and can be found in buildings and forests. It lives inside crevices, in a retreat made of a loose mass of tangled silk. A larger species, *Scytodes lugubris*, lives in gardens and wasteland, where it builds a nest from a twisted leaf and hides there during the day. At night it becomes active, and leaves the nest area to search for INSECTS nearby. The smaller pallid spitting spider (*S. pallida*) has a beautiful pattern of black lines contrasting with its pale body. It constructs a fine web on the underside of fern- and palm fronds in the rainforest. ■ DJC/WLK

Spittle bugs See FROGHOPPERS.

Sponge crabs Family Dromiidae
Considered to be amongst the most primitive of all true CRABS. Sponge crabs are so-called because of a peculiar habit. The crab will use its pincers to cut off a piece of sponge and wear it atop its carapace. The crab uses its last pair of upward-facing legs to hold the trimmed sponge in place with short, needle-like pincers. The carried sponge is not harmed and continues to grow. This peculiar behaviour provides excellent camouflage and protection. Predators generally avoid SPONGES, as the latter are coated with foul-tasting or toxic biochemicals. Sponge crabs are usually small (carapace size of 2–4 cm across) and very slow-moving, as are all animals that use disguise to fool their predators. They are nocturnal opportunistic scavengers. In Singapore, at least seven species of sponge crabs have been recorded. Perhaps the most commonly encountered is the lipstick finger sponge crab (*Dromidiopsis indica*), with its pink-tipped pincers. The reef sponge crab (*Cryptodromia pileifera*) is rarely sighted among the coral rubble of Singapore's offshore islands because of its excellent camouflage. It is unusual in having larvae which do not feed, drawing instead on their own yolk reserves in their bodies. One of the most effective camouflage artists is the round sponge crab (*Lewindromia unidentata*) which often carries large and elaborate sponges on its back. However, it is rarely seen. ■ WLK/PN

Sponges Phylum Porifera
Probably the most primitive multi-cellular animal living today. They do not have a mouth, stomach, eyes, heart or similarly complex organ systems. Instead, several different types of cells form an organised structure, optimised for filtering large volumes of water for feeding, gas exchange, waste disposal and release of sperm and larvae. Some of these cells form a skeleton made of collagen and minerals, which can be of various configurations to form internal water canals. For this reason, the phylum is named Porifera, which means 'pore bearing' in Latin. Sponges feed on plankton and other micro-organisms by filtering the water which is pumped into the sponge. Sponges are known to exhibit both sexual and asexual modes of reproduction. In sexual reproduction, both ovipary and vivipary modes can be found in sponges. In the ovipary mode, eggs develop within the female sponge, are broadcast into the water and fertilised externally to form larvae that eventually settle on a suitable substrate. In the vivipary mode, the female sponge takes in sperm from another sponge via the inhalant aquiferous system, whereby eggs are fertilised and larvae are brooded within the female sponge. The fully developed larvae are then freed from the parent through exhalant canals and oscules (pores). Asexual modes of reproduction include internal or external budding and fragmentation.

More than 8,000 species of sponges have been described worldwide but the actual number is estimated to be around 15,000 species. They are exclusively aquatic and mostly marine, although a few hundred species of freshwater sponges are distributed around the world in rivers, lakes and inland waters. Sponges are found at different depths, from the deepest oceans to the intertidal zone, and geographically diverse areas from the equator to the poles. However, most prefer warm, shallow water. They come in many different shapes, colours and sizes. They serve an important role in ecosystems by improving the quality of water when they filter-feed. Sponges are classified

Sponge crabs such as this *Dromidiopsis indica* do not have a preference for any species of sponge. Often the same crab species will use sponges of various colours and shape. Sometimes tunicates are carried instead, as shown here.

Coelocarteria singaporensis, described in 1883, is the only sponge named after Singapore. It is one of the most common and abundant sponges in Singapore waters. It has a varied morphology, ranging from sub-hemispherical, tubular, barrel-shaped, oval, to cushion-like forms. This sponge usually has a large (diameter of 2 cm) central fistule (chimney-like structure) which bears large apical oscules surrounded by many blind-ended fistules, up to 15 cm high.

Tethycometes radicosa is the most recent sponge discovered in Singapore, more than 100 years after the previous one (*Callyspongia diffusa*) was described in 1884. The name *Tethycometes radicosa* means 'sea comet with roots' in Latin. This sponge looks like a bean sprout with a globular head, slender stalk body and rooting processes at the basal end. These root-like processes, which serve to keep the sponge anchored to the substratum, cover more than half the length of the stalk and may be completely embedded in the sand and mud.

into three main groups: DEMOSPONGIAE, CALCAREA and Hexactinellida. Sponges are common in Singapore waters, with some 200 species documented. They comprise mainly Demospongiae and a few species of Calcarea. Hexactinellid sponges have not been reported from Singapore waters. They are usually found only at depths of more than 100 m. A well-known example of hexactinellid sponge is the Venus' flower-basket (*Euplectella aspergillum*). ■ LSC

Spoon worms See ECHIURANS.

Spreadwings See LESTIDS.

Springtails See COLLEMBOLA.

Squash bugs Family Coreidae
Rather large, heavy-bodied hemipterans (see TRUE BUGS), ranging from 7–45 mm in length. They have a relatively small head in comparison with the body. Many squash bugs have bizarre leaf-like expansions of the hind tibia, hence they are also known as leaf-footed bugs. The bodies and hind femora of many species are equipped with sharp spines that are believed to be used for defending territories on flower

Squash bug (*Physomerus* sp.) is commonly seen in secondary scrub.

heads. Some species, especially the nymphs, are brightly coloured but most are dull. Many squash bugs are gregarious, living on plants and feeding on plant sap. Like other heteropterans, squash bugs have well-developed scent glands, which release an odour which serves to deter predators. The odour can also serve as an alarm pheromone to cause the aggregation of bugs to disperse. Many species have toxic saliva which can cause severe tissue necrosis in the host plant. Nearly 20 species of squash bugs have been recorded in Singapore. The cletus bugs (*Cletus* spp.) feed on various woody plants, especially legumes (see FABACEAE). Leaf-footed bugs (*Leptoglossus membranaceus*) can be found on a wide variety of plants. The giant twig wilters (*Mictis* spp.) feed on plant sap and have toxic saliva that kills young woody shoots and leaf stalks. ■ WLK/TAD

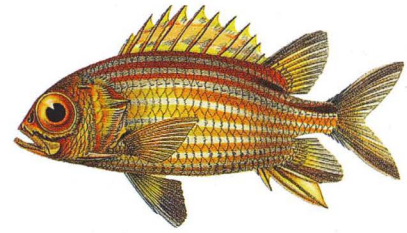
Squat lobsters Family Galatheidae
CRUSTACEANS that resemble true lobsters but belong to the infraorder Anomura, which includes HERMIT CRABS. Squat lobsters are usually colourful and live commensally with feather stars (CRINOIDS), sea whips (see GORGONIANS) and other invertebrates. They have a small oval carapace (1.5 cm wide), which is drawn out in front to form a sharp point (rostrum). The abdomen is bent under the carapace, giving the animal a 'squat' look. The first pair of legs is long with two lobster-like claws. The last pair is reduced and folded under the carapace, and is used to clean the gill cavity. Most squat lobsters are found in rough-sediment substrates in deep water. Six species have been recorded in Singapore, including the colourful crinoid squat lobster (*Allogalathea elegans*)

Squat lobster (*Allogalathea elegans*) living commensally with a feather star.

which lives commensally with feather stars. Uncommon in Singapore, it gets its nutrition by stealing food particles from its host. See also SLIPPER LOBSTERS; SPINY LOBSTERS. ■ WLK/PN

Squids See LOLIGINID SQUIDS; SEPIOLID SQUIDS.

Squirrelfish Family Holocentridae
Group of marine FISH with very large eyes, large scales, two dorsal fins and a forked tail. The external bones of the head are serrated or armed with spines. Most species are red or pink in colour, many with pale longitudinal bands. Growing to about 45 cm, they generally inhabit coral reefs, and are nocturnal predators of small fish and CRUSTACEANS. Squirrelfish are well known for their vocalisations which are produced by muscle contraction, vibrating the ribs surrounding the swim bladder. The redcoat squirrelfish (*Sargocentron rubrum*) is recorded from Singapore waters. ■ WLK/KL



The redcoat squirrelfish (*Sargocentron rubrum*) inhabits coral reefs and is a nocturnal predator.

Squirrels Family Sciuridae
RODENTS with long bushy tails. Most squirrels have a short, blunt muzzle. They are arboreal or ground dwelling, and feed on fruit and various small animals. Common diurnal tree-dwelling squirrels in Singapore include the plantain squirrel (*Callosciurus notatus*) and the slender squirrel (*Sundasciurus tenuis*). The plantain squirrel has a brown body with a reddish-brown belly and a black and white stripe on the sides, while the slender squirrel is olive brown with grey underside. Both inhabit forests, but the

Slender squirrel (*Sundasciurus tenuis*).