

Teresa (Zubi) Zuberbühler

Frogfishes

Southeast Asia
Maldives · Red Sea



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Teresa Zubi

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Frogfishes Southeast Asia, the Maldives and the Red Sea

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Introduction

Frogfishes or anglerfishes belong to the order of Lophiiformes and are found in very diverse habitats, from light-flooded warm tropical coral reefs to cold arctic oceans, down to the dark depths of the bathypelagic zone (to 2,500m). This book is about frogfish species that live in tropical oceans.

Frogfishes belong to the family of Antennariidae (anglerfishes) and are also called *antenna bearers*. Members of this family are characterized by having their first dorsal spine modified into a luring apparatus consisting of a rod and a lure or bait. They attract their prey by pretending that the bait is something tasty to eat, and when the prey approaches close enough, it is engulfed.

Like their name suggests, frogfishes look somewhat like frogs or toads and have pectoral fins with an elbow-like bend and smaller pelvic fins that look like webbed legs. With the help of these nimble fins, frogfishes can climb onto sponges and walk around on sand, quite similar to quadruped animals living on dry land.

Frogfishes are benthic shallow-water dwellers. They live near the reef on rubble and on sandy areas covered with seaweed, or they remain hidden among corals and in crevices. One exception is the pelagic Sargassum Frogfish (*Histrio histrio*) that lives among floating Sargassum weed.

Unlike other bony fishes, which have gills covered by plates, frogfishes have small elongated, tube-like gill openings behind their pectoral fins, or in two species on their anal fin.

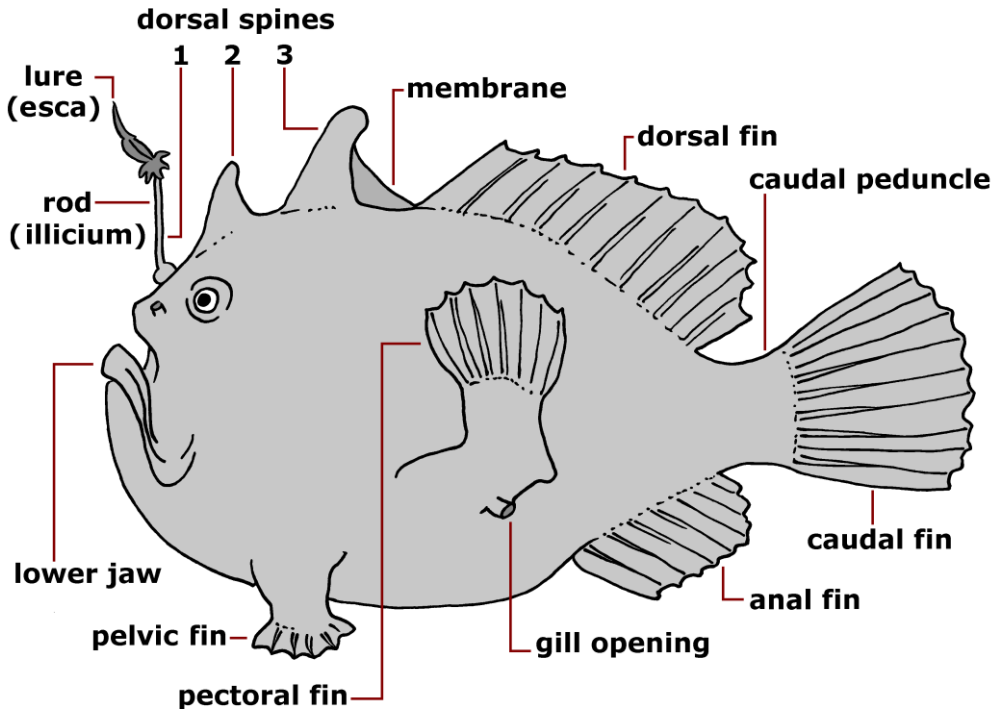
Most frogfishes have no swim bladder, so they don't swim much. To move small distances they use jet propulsion, where water is sucked in through the mouth and then forced out through the gill openings.

Frogfishes are very interesting fishes, but due to their masterful camouflage they are extremely difficult to find in their natural habitats. With coloured patches, warts, stripes, lines, or long skin appendages they are able to perfectly mimic whatever grows around them. Squatting motionless on sponges or between algae, they completely disappear in their surroundings. The ability to change colour in the space of a few weeks also helps them to complete their camouflage and perfectly match their body colour to a particular ambush site.

Previous page: Warty Frogfish (*Antennarius maculatus*), rod on the left side of the head

1. Characteristics of frogfishes (Antennariidae)

Frogfishes are bony fishes. The largest individuals measure around 50cm standard length (19 inches), but most frogfish species are quite small, only around 5 to 10 cm (2 to 4 inches). They are stocky globose fishes covered with small forked dermal spinules instead of scales.



Frogfishes are voracious carnivores and mainly feed on fishes and crustaceans (shrimps and crabs). In comparison with the rest of the body, the head is typically big with a large upturned mouth. Frogfishes can open their mouth very fast and suck in their prey without chewing.

The first dorsal spine, an elongated stalk-like structure, is positioned on the tip of the snout directly above the mouth. It has evolved into a moveable fishing rod or luring apparatus (illicium) tipped with a fleshy lure or bait (esca). The bait is actually a flexible piece of tissue. The baits vary from species to species, but they always resemble food items. The shape of the lure and the length of the rod are two of the main distinguishing characteristics that help even a layman to correctly identify a frogfish species.

The lure or bait comes in different shapes: small and round like a ball, like a small fish with an eye-spot and appendages resembling fins, long and shaped like a thick worm, filaments of different lengths that look like a shrimp or like a bushy tube worm or just a nondescript but temptingly jiggling morsel. A few frogfish species have no bait at all, and others an extremely reduced luring rod.



Antennarius striatus – like a thick worm



Antennarius hispidus – like a tubeworm



Antennarius randalli – like a squid



Antennarius maculatus – like a small fish



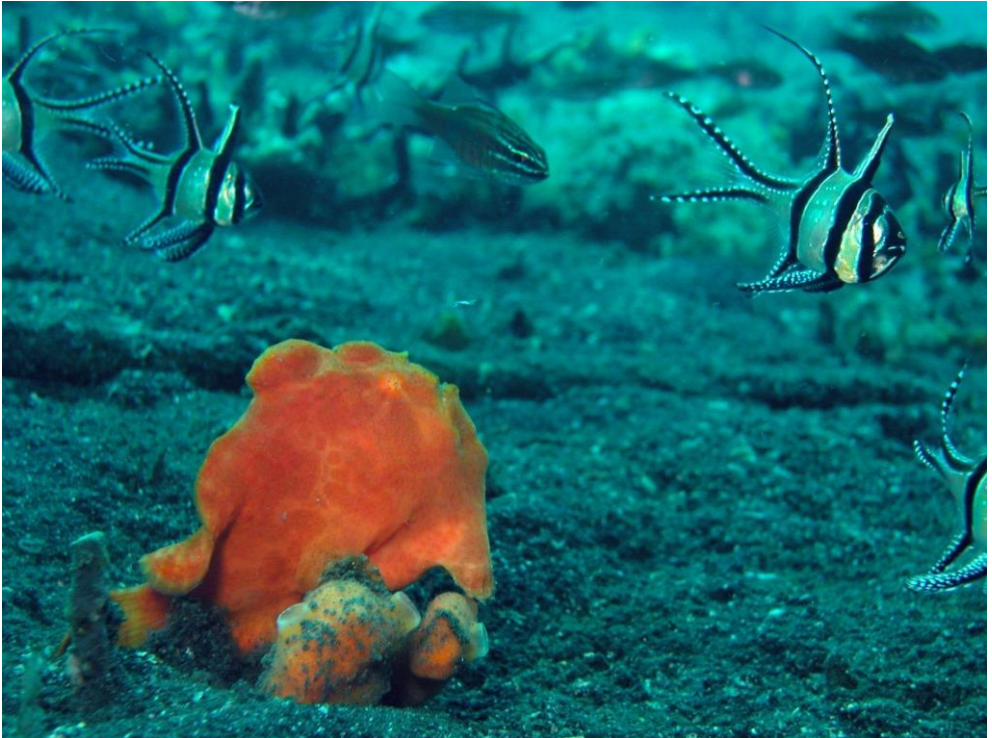
Antennarius commerson – like a shrimp



Lophiocharon trisignatus – like a spidercrab

2. Hunting behaviour

2.1 Aggressive mimicry (aggressive resemblance)



Juvenile of a Giant Frogfish (*Antennarius commerson*) ambushing cardinalfishes

A predator can use several methods for catching prey. He can chase after it, wear it out, and then overwhelm it, or he can sit motionless and then pounce on it. The latter is a typical way to hunt used by ambush predators like scorpionfishes.

Or, like the frogfish, a predator can manipulate the prey's own nervous system in such a way that it actively rushes towards its own destruction. The frogfish squats, motionless and excellently camouflaged, and patiently waits for prey. However it further entices its potential prey by wiggling its lure energetically around above its head and presenting an attractive food item (e.g., a worm, a shrimp, or a small fish). The prey is fooled by these signals, approaches, and it is promptly eaten by the frogfish.

This strategy is called *aggressive mimicry* or *aggressive resemblance*.



The frogfish signals to other animals that it is a place of shelter (e.g., a rock or a sponge) or grazing ground (e.g., algae). The prey's eyes are manipulated, the frogfish is perceived as nothing threatening, and the prey approaches. The fish or shrimp is surprised, overwhelmed, and sucked in. Instead of using the strong body muscles to actively pursue its prey, the frogfish uses the small muscles of its fishing rod to stimulate the prey's nervous system via its eyes. And finally the prey uses its own muscles to close the gap to the frogfish's hungry mouth.

Of course prey is not only attracted by the lure. A more passive approach lies in the excellent camouflage of the frogfish. Many animals just mistake a frogfish for a harmless sponge, ignore it, and swim past it. If they approach too close they are immediately swallowed (lie-in-wait predation). Other animals might try to hide behind the sponge and then are surprised and also engulfed.

Often small gobies or shrimps can be seen flittering all over the body of a frogfish, mistaking it for a sponge and not realizing that they are constantly in danger of getting eaten.



Giant Frogfish (*Antennarius commerson*) with goby / Previous page: *A. maculatus*

2.2 Luring techniques

Luring techniques vary, but the luring apparatus is often wiggled in such a way that it resembles a small moving animal. Each frogfish species uses a somewhat different pattern to attract the attention of potential prey and to entice it to enter the so-called *strike zone*. This zone encompasses about one body length.

The Warty Frogfish (*A. maculatus*) moves its lure in wavy lines either above the head or directly in front of the mouth close to the ground. The rod is moved in a circular motion. The lure curls while it gets drawn through the water, and this looks like the wavy movements of a small fish. If the prey approaches, the frogfish throws its rod back so the prey follows the lure closer to the mouth.

Luring techniques also vary depending on the surroundings the frogfish lives in. The Giant Frogfish (*A. commerson*) sits exposed on sponges or corals and will lure more often above its head. The long lure moves up and down, imitating the jerky backward movements of a small shrimp.



Luring Warty Frogfish (*Antennarius maculatus*)



Striped / Hairy Frogfish (*A. striatus*) while luring, the current coming from behind it

In sandy areas, potential prey prefers to hide in holes and burrows. The Striped Frogfish (*A. striatus*) positions itself exactly in front of such a burrow and starts to jerk its luring apparatus around in front of its head. The bait engorges up to 35 percent and looks like a fat brown worm.

As soon as the resident goby or shrimp shows itself, the frogfish moves the bait a bit higher and nearly out of reach. Slowly it entices the prey to leave its burrow and approach in order to catch the juicy worm. This active luring behaviour can stretch over several minutes and alternates with ambushing behaviour. Then the Striped Frogfish squats between algae or a group of sea urchins and leaves the luring apparatus well visible but rolled up on its head, where it can be spotted by potential prey.

This frogfish species also employs a chemical attractant that is produced by glands in the esca. This chemical is of importance because the Striped Frogfish also lives in turbid water and up to 200m deep and also forages at night. This species is often observed positioning itself in such a way that the water current comes from behind, so the chemical attractants are swept into the strike zone.

Small-sized frogfishes often prefer shallow water and live hidden in crevices between corals and among rubble. When hiding in such a way, they avoid being preyed upon by larger fishes. The preferred prey of these frogfishes are invertebrates and small fishes that also inhabit these sheltered areas.

Small frogfish species probably don't use their lures as much as large species to attract prey. Several of these frogfish species have very small lures (*A. coccineus*) or one that is nearly not discernible (*A. tuberosus*). They use several luring techniques. Sometimes they hold the rod with the lure in front of the mouth, and sometimes they move the luring apparatus back and forth or lift the lure and vibrate the esca.

Frogfishes of the genus *Histiophryne* have a much reduced fishing rod or no rod at all. These frogfishes hide underneath corals and in rubble and prey on small animals living there. They don't actively lure but depend entirely on their good camouflage. Some species have fleshy extensions on the cheeks and chin (*H. pogonius* and *H. psychedelica*), which might help them to better detect their prey in the dark.



Cryptic Frogfish (*Histiophryne cryptacanthus*) hidden among coral rubble

Some frogfishes of the genus *Abantennarius* have long fishing rods but a much reduced bait (esca) The Marble-Mouthed Frogfish (*Lophiocharon lithinostomus*) doesn't have a bait at all but instead has a relatively thick stiff rod and attracts its prey mainly by vibrating the rod.

Frogfishes even lure in the dark. Although the lure and bait can't be seen during night, the potential prey can feel the vibrations and shaking that are transmitted through the water, and they follow what seems to be an incautious animal. They attack and thus enter the strike zone of the frogfish and become prey themselves. The esca of one frogfish species, *A. hispidus*, has been discovered to harbour bioluminescent bacteria, causing the bait to glow in the dark with a greenish light.

When not in use, the rod is lowered and laid back onto the head, where it is somewhat protected. A lot of frogfish species have a narrow groove situated either to the left or right side of the second dorsal spine. Some frogfish species have a pocket-like aperture formed by the membrane between the second and third dorsal spine. Here the bait is protected and is only displayed when actually luring.



Randall's Frogfish (*Antennarius randalli*) with pocket-like aperture to protect the lure

2.3 Bait and Prey

Frogfishes mimic food animals like worms, small shrimps, squids or small fish with their bait (esca). Some fish species specialize in eating certain prey, for example worms. A frogfish with a worm-shaped lure should therefore more easily attract and catch these species.

However, examinations of the stomach contents of frogfishes haven't shown any correlation between the shape of the lure and the preferred prey animal. Frogfishes use several strategies to find enough food, and actively luring with the help of the esca is just one of them. Frogfishes are voracious and eat about anything that happens to swim close to their mouth!

If the lure looks like a fish, it is also often perceived as a rival and not so much as potential food. Some species like damselfishes, which have a territory and fiercely protect it against other fishes, will swim aggressively towards their potential rival and are immediately eaten by the frogfish.



Striped / Hairy Frogfish (*Antennarius striatus*) with its worm-shaped lure



Striped / Hairy Frogfish (*Antennarius striatus*) with a rod that lacks a lure

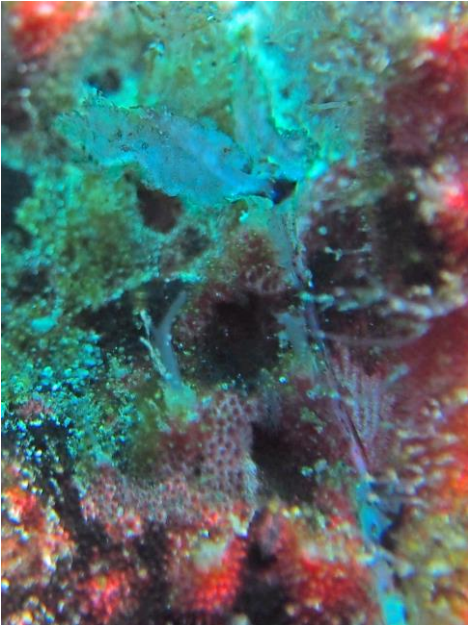
Sometimes you find a frogfish without a lure or with a crooked fishing rod, or the rod is much shorter than normal for that species. Because the esca acts as bait, it is obviously highly susceptible to loss or damage through attacks or nibbling from both potential prey and predators.

Frogfishes can regenerate their lure after a loss. Laboratory experiments where the lure was amputated have shown that the structure (morphology) of the regrown lure stays the same. It takes about 4 to 6 months to fully regenerate the bait. During this time it is much tougher for a frogfish to attract prey. It can still move and vibrate the rod, but without the lure it is much more difficult to hunt successfully, so the frogfish might fall on lean times until complete regeneration.

Frogfishes can also regenerate the rod. If the rod is damaged behind the lure with the original lure still intact, the result might even be a forked rod with two lures. When identifying a specimen and the length of the rod or the shape of the lure doesn't concur with other characteristics observed in the frogfish, you must take into account that the lure or bait might be damaged.

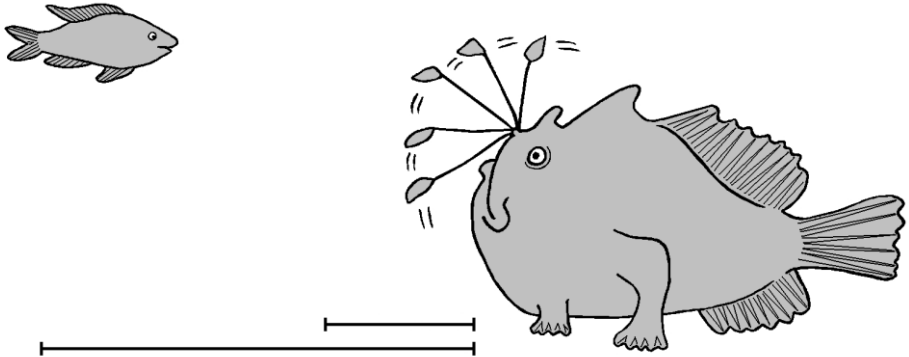


Frogfishes with special lures. Images above: A Clown Frogfish which lost its lure (photos of the same specimen taken 3 months apart). Images below: The lure of a Giant Frogfish which was probably nibbled on and now is bifurcated (left). A Hairy Frogfish where the lure and skin is damaged and scarred over (right).



2.4 Gape and Suck

When a frogfish spots potential prey it first follows the prey's movement visually. When the prey approaches to about seven body lengths, the frogfish starts luring. If the prey is not responding to the movement of the luring apparatus, the frogfish starts to slowly stalk its intended victim. While approaching, it keeps its body low and pressed to the ground. When the intended prey is only a short distance away, the frogfish orients itself so the head points towards the prey and then adjusts its mouth angle. When the prey approaches to less than one body length, the frogfish strikes. This area is called the *strike zone*.



Strike zone is about one body length / Zone for swallowing is about the length of the head

Now the frogfish opens its mouth, the lower jaw drops, the upper jaw moves out, and the mouth cavity is forcefully expanded. The oral volume is increased twelve-fold, which creates an enormous negative suction pressure inside the mouth. The prey is swept along with the inflowing water, sucked in and engulfed whole. The frogfish has the fastest gape-and-suck feeding of any fish: it takes only 6 milliseconds, which is faster than a scorpionfish or a stonefish (15 milliseconds).

Immediately the mouth is shut completely, the sphincter muscle of the esophagus contracts, and the swallowed water is expelled through the gill openings at the base of the pectoral fins. This expulsion of water often causes the frogfish to make an abrupt movement forward.

Tropical frogfishes have tiny (5mm) palatal teeth (pharyngeal teeth) that help deglutition. The esophagus and stomach are extremely flexible, so frogfishes can swallow items of prey that are twice their size. However, if a frogfish tries to swallow an oversized prey animal, it has to spit it out by a quick compression of the oral cavity since it can't rend the morsel into smaller pieces.



Small Painted Frogfish (*A. pictus*) eats a cardinalfish / Next page: *A. maculatus*



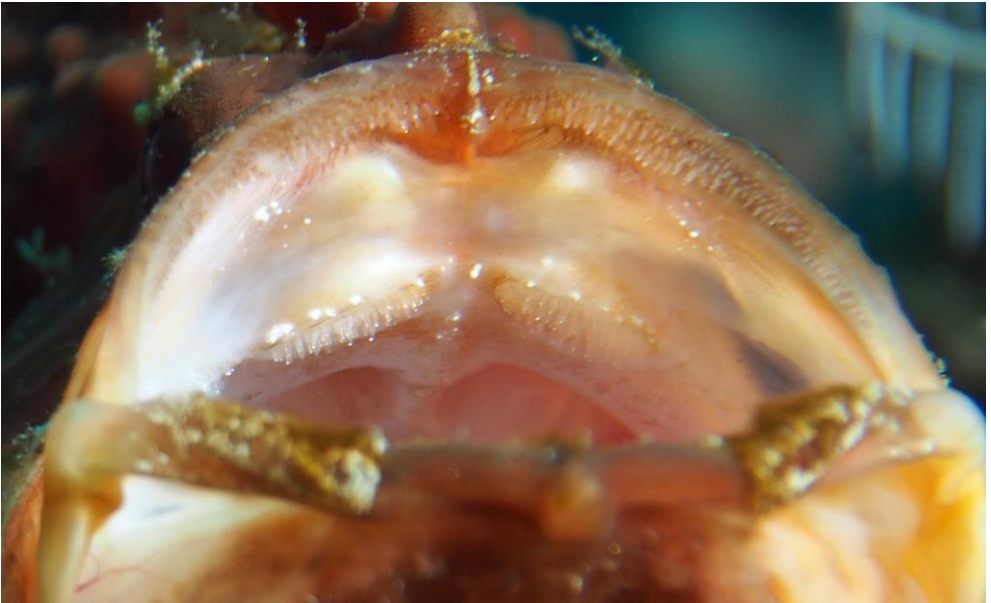
Above: *A. striatus* grabs its prey, turning around its axis. Now it can swallow the fish as a whole without chewing it. Below: *A. striatus* with a mantis shrimp in its mouth







Open jaw with pharyngeal teeth (roundish white structures inside the mouth) and gill arches that also have slightly serrated edges.



Recurved conical teeth of the dentaries and rows of small teeth on the upper palate of the mouth (premaxillae).



Frogfishes often make a series of cough-like movements which look like yawning. These movements force water out of the oral cavity and help to expel bits of the prey such as fish scales or shrimp antenna. Probably the yawn also helps to realign the tissue and bones of the jaw so the frogfish is ready for the next strike.





3. Defensive behaviour

Frogfishes are normally solitary, so if two frogfishes are found close together it is quite possible that they are a female ready to mate and a male following and guarding her.

Frogfishes defend their hunting grounds. If a conspecific approaches, the frogfish moves slightly so it can position itself between the intruder and its territory. If the intruder approaches to within a body length, the frogfish raises its body and its colour intensifies. It spreads its fins and opens its mouth so it looks much bigger and more threatening. Then it starts shrugging and bending its body towards the intruder. This threatening behaviour usually causes the intruder to withdraw.

On a large piece of floating Sargassum weed several Sargassum Frogfishes (*Histrio histrio*) may live together. Observations have shown that they often fight among themselves, and when defeated some are injured or even eaten. Up to a dozen smaller specimens were found in the stomach contents of larger animals.



Warty Frogfish (left) is chased away by a Painted Frogfish (right)



Striped / Hairy Frogfish (*A. striatus*) swallows a poisonous devilfish (*Inimicus didactylus*).

Other lay-in-wait predators like scorpionfishes, eels and lizardfishes are the natural enemies of frogfishes. However, sometimes they themselves also fall victim to a frogfish. Frogfishes have been observed to swallow lionfishes and scorpionfishes with no injury or discomfort as a result. Frogfishes are not venomous, but if attacked they can swallow water and inflate their body, so the increased girth makes it impossible to engulf them. The lizardfish on the image below couldn't swallow the frogfish, although it kept it trapped in its mouth for nearly half an hour.



Lizardfish (*Synodus sp.*) with inflated frogfish in its mouth

4. Camouflage

Camouflage is a way to mislead the sense organs like eyes, nose, or tongue into perceiving something different. Most animals use camouflage to hide from possible predators (protective resemblance).

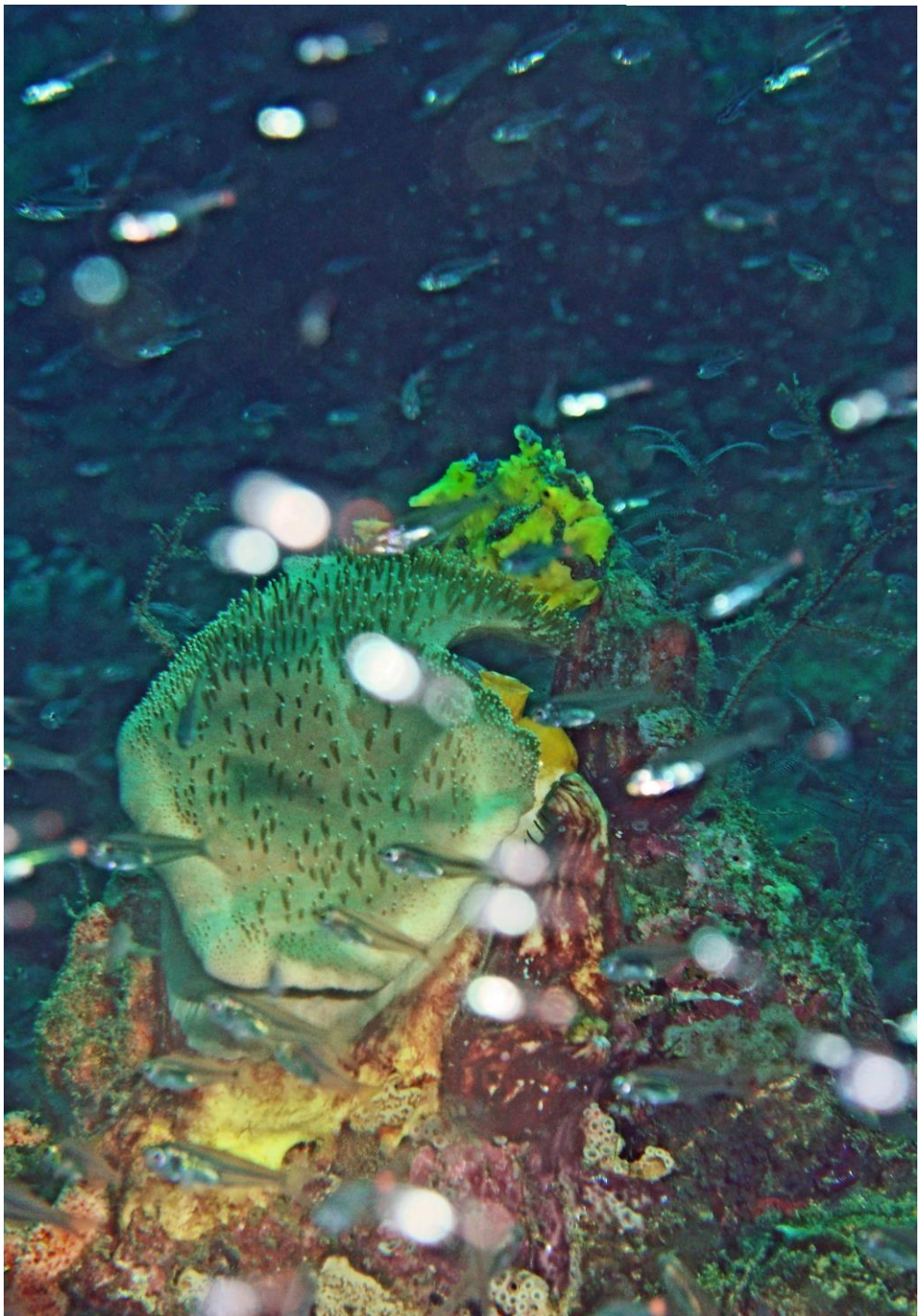


Striped / Hairy Frogfish (*A. striatus*) under a sea cucumber (*Neothyonidium magnum*)

The frogfish is a master of camouflage. Its body is often covered with spots, stripes, lines, warts, skin flaps, or filaments. The frogfish mimics substrate and structures like algae-covered rocks or rubble; plants like Sargassum weed or algae; and animals like tunicates, corals, or sponges. To achieve this deception, the frogfish uses different tricks such as breaking up the body's contour with stripes or lines and changing its colour to match its surroundings. Round dark spots, fake eyes on its body, or long hairy skin appendages add to this effect.

Motionless and camouflaged like this, the frogfish often goes undetected, not only by its intended prey or a passing predator but also - unfortunately - by divers and snorkelers.

Next page: Clown Frogfish (*Antennarius maculatus*) and a group of glasfishes





Giant Frogfish (*A. commerson*) / Three Coinbearing Frogfishes (*A. nummifer*)





Painted Frogfish (*A. pictus*) / Hairy Frogfish (*A. striatus*)



4.1 Breaking up the body's contour (disruptive camouflage)



Warty Frogfish (*Antennarius maculatus*)

An excellent method of camouflage is to break up the contour of the body and subdivide it into individual components. Stripes, spots, or irregular areas in a different colour can make the eye fail to discern the body as a whole. However, this kind of camouflage only succeeds if the animal is not moving at all or if it is swimming in a large aggregation of other identical-looking animals (e.g., schooling fishes).

4.2 Changing colours

Observations of frogfishes in captivity have shown that many frogfish species of the subfamily Antennariinae can change their colour in a matter of days or weeks. This change can occur in a light phase (white, yellow or orange to beige) or a dark phase (dark red or brown to black) but can also be quite radical, for example, from yellow to jet black or from cream to dark red. In the wild, if a frogfish moves into an area with sponges of a predominant colour, it can slowly adapt its colour until it completely blends in.



Both tiny Warty Frogfishes (*A. maculatus*) seem to be somewhere between colour phases



During the process of changing colours the Frogfish can be any colour between and some parts of the body can be ahead or behind of the overall colour change.

Image next page: Painted Frogfish with black lips, the overall body colour is brown



4.3 False eyes (ocelli)

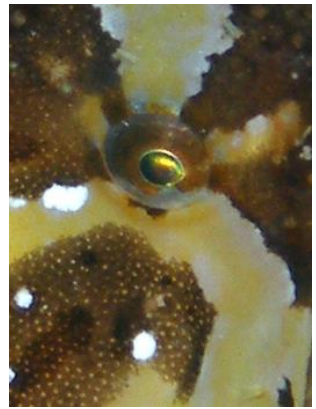
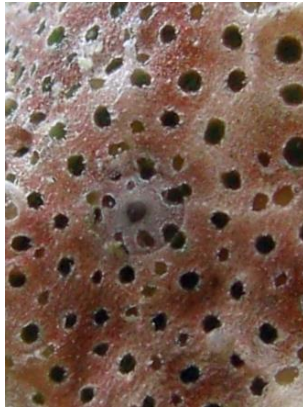
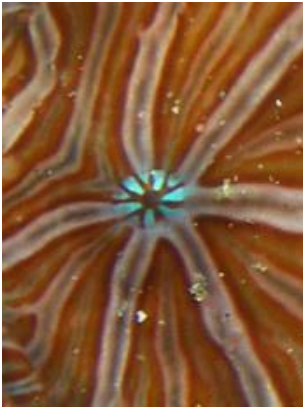


Not so obvious on first sight, if the eye is on the right or on the left (*N. subteres*)

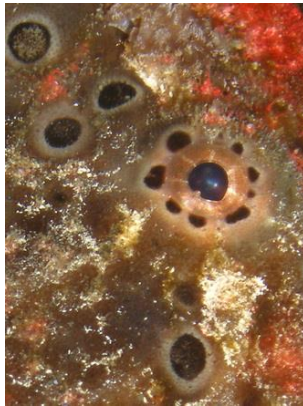
The eye is distinguished by its round shape and shiny black colour and can be extremely treacherous. Predators have to get a fix on their prey, and they can do so by focusing on the eyes. Fishes can't close their eyes and hide them, so they must use a different technique.

Some fishes have, mostly on the back of their body, two large dark spots that look like eyes. These false eyes make a predator perceive a much larger and more dangerous animal, so the fish might decide not to attack. If it attacks anyway, the fake eyespot near the tail might confuse it so much that it goes for the less vulnerable rear of the animal instead of the head with the real eyes. The fish is then able to swim away from the predator as fast as possible.

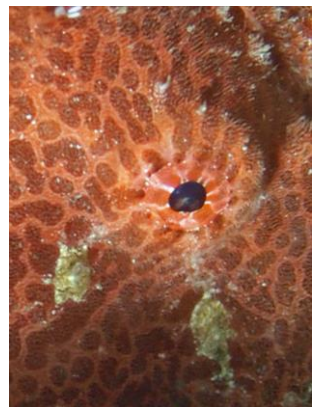
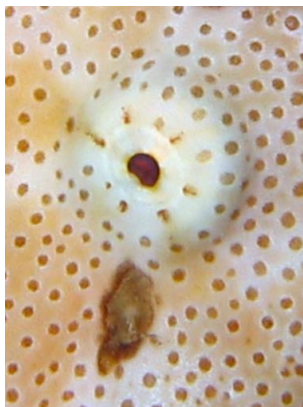
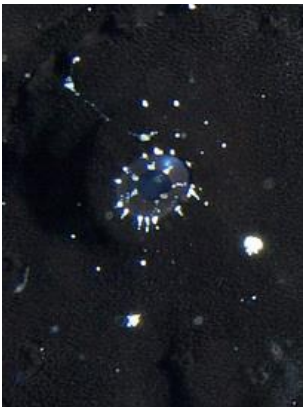
To this end, some frogfish species have large and conspicuous eyespots (ocelli) on their dorsal fins. Other species have brightly framed round spots on the top of the head while their real eyes are small and well camouflaged.



Patterns from the surrounding skin continue through the eye



The eye is hidden between round spots and lichen-like skin growth



The eye has the same colour and pattern like the surrounding skin

Next page: Painted Frogfish (*A. pictus*) with two large spots on the top of the head



4.4 Mimesis

Some animals gain protection because they look like something else, something inedible like a rock, sponge, leaf, or frond of seaweed. The mimic takes on the properties (e.g., colour, shape, form, and even movement) of a specific object or organism, but one to which the dupe is indifferent. This is called *mimesis*. Some frogfishes imitate inanimate objects like algae-covered stones or rubble (allomimesis), and others imitate plants such as algae or leaves swaying in the current or Sargassum weed (phytomimesis) or animals such as tunicates, corals, sea urchins or sponges (zoomimesis).

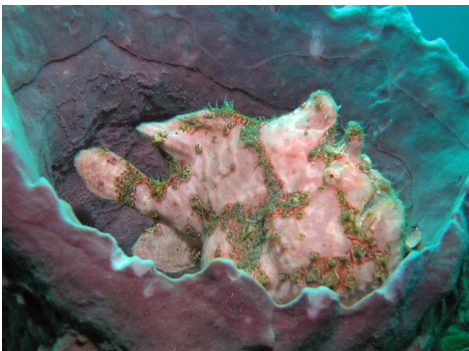
Some of the larger and more colourful frogfish species (of the *Antennarius pictus* group) look like sponges, down to the water intake and outlet openings they imitate with dark spots on their skin. These species also prefer to sit on sponges when luring. A few species look like stony or soft corals, for example, the Psychedelic Frogfish (*Histiophryne psychedelica*), which has lines all over its body reminiscent of the patterns found on stony corals or bryozoans.



Allomimesis: Rock with algae (*L. trisignatus*)



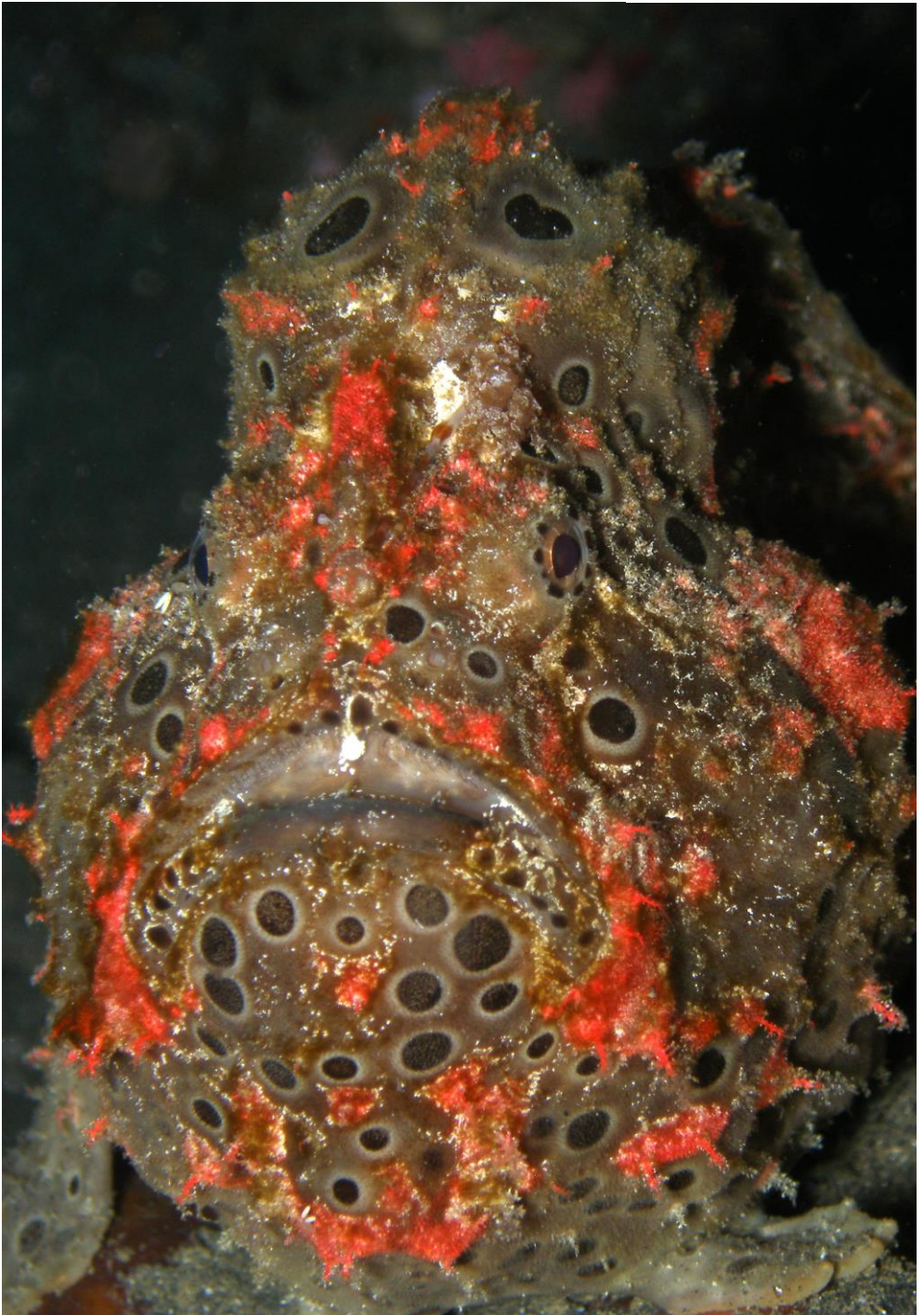
Phytomimesis: Dead leaf (*A. randalli*)



Zoomimesis: Sponge (*A. commerson*)



Zoomimesis: Tunicate (*A. tuberosus*)



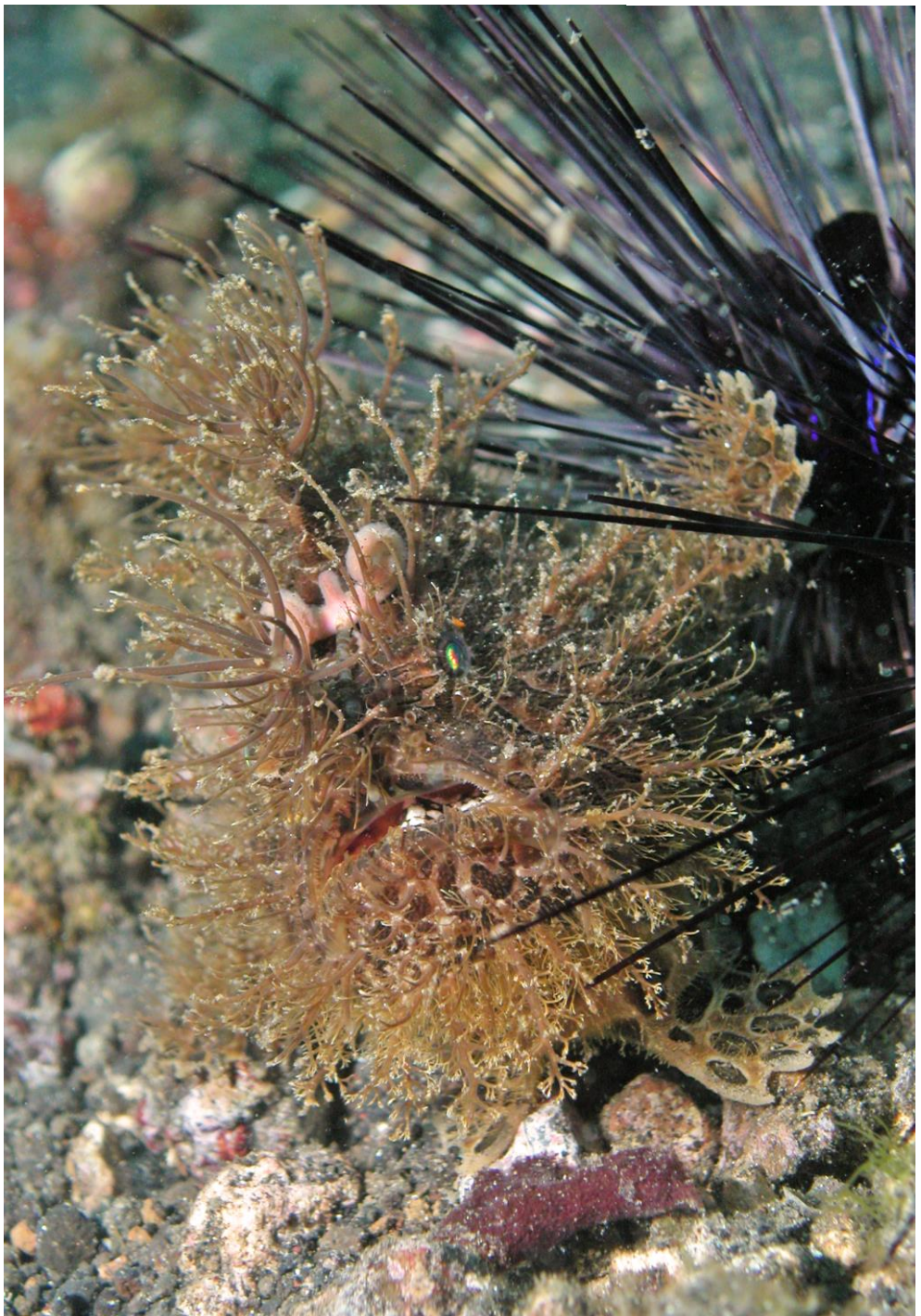


Striped / Hairy Frogfish (*A. striatus*) hidden between algae¹⁶

Some frogfish species look like algae covered rocks. In coral reefs there isn't a plentiful supply of algae for herbivore fishes. These fishes will approach what they perceive as a good feeding ground, but is actually a well-camouflaged frogfish, and are devoured. Because they all get caught, no herbivore fishes can eat the plants surrounding the frogfish so these plants grow extensively and even more fishes are attracted to the ambush site.

Other frogfish species, for example the Giant Frogfish (*A. commerson*), imitate in some areas mostly colourful sponges (zoomimesis) but in others mostly algae-covered rocks (allomimesis).

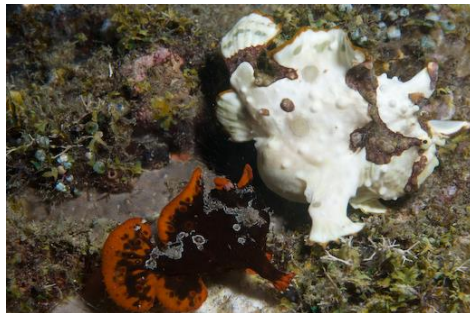
An other species, the Striped Frogfish (*A. striatus*), is at various times greenish brown with a lot of skin appendages (reminiscent of algae), black with thick skin appendages (where there are a lot of sea urchins), white without skin appendages (like coral rubble or a dead heart sea urchin), and brownish red with oval spots (like a sponge). Studies have shown a correlation between the dominant vegetation in a habitat and the increased occurrence of a particular colouring.



5. Reproduction

5.1 Courtship and spawning behaviour

There are no means to differ the male and female of tropical frogfishes, for example by colouration or size, except by examining the gonads by dissection. Images of mating sequences show that the male usually is smaller than the female.



Mating behaviour of the Warty Frogfish (female = white, male = black)

With frogfishes of the subfamily Antennariinae about 8 to 12 hours prior to spawning the female begins to fill up with eggs (40,000 to 180,000). The eggs measure around half a millimetre. This egg formation proceeds at a rapid rate so that shortly before spawning the female frogfish is so distended that it is hard for her to maintain her position on the bottom. She becomes buoyant, tail up, and is followed around closely by one or more males. The male continues to nudge the female in the abdomen, and they move quickly to the surface, where spawning occurs (see the following pages).

The thousands of eggs are expelled from the body encapsulated in a ribbon-like buoyant mass of mucus known as an *epipelagic egg raft*, and the male fertilizes them immediately. This happens extremely fast.

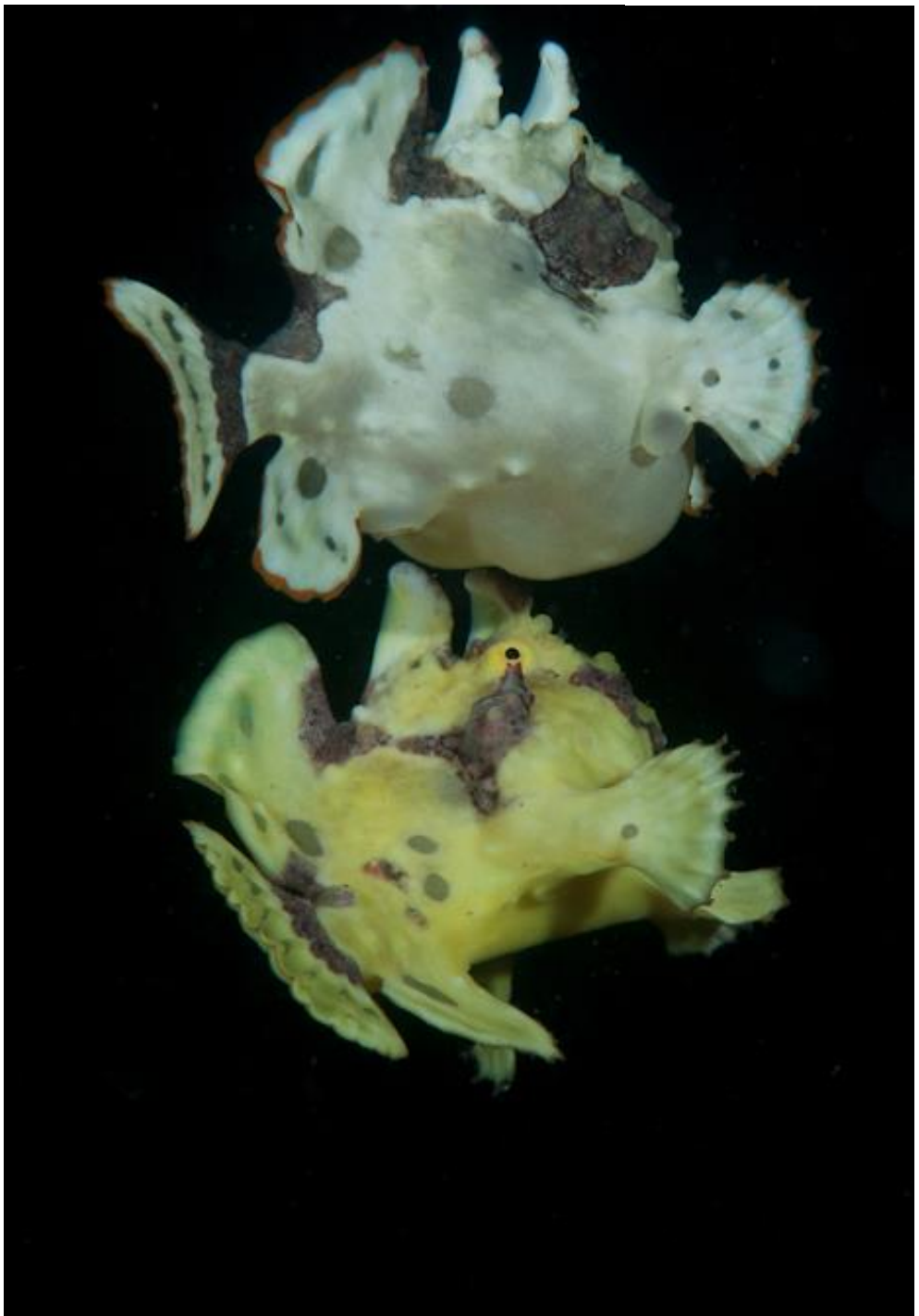


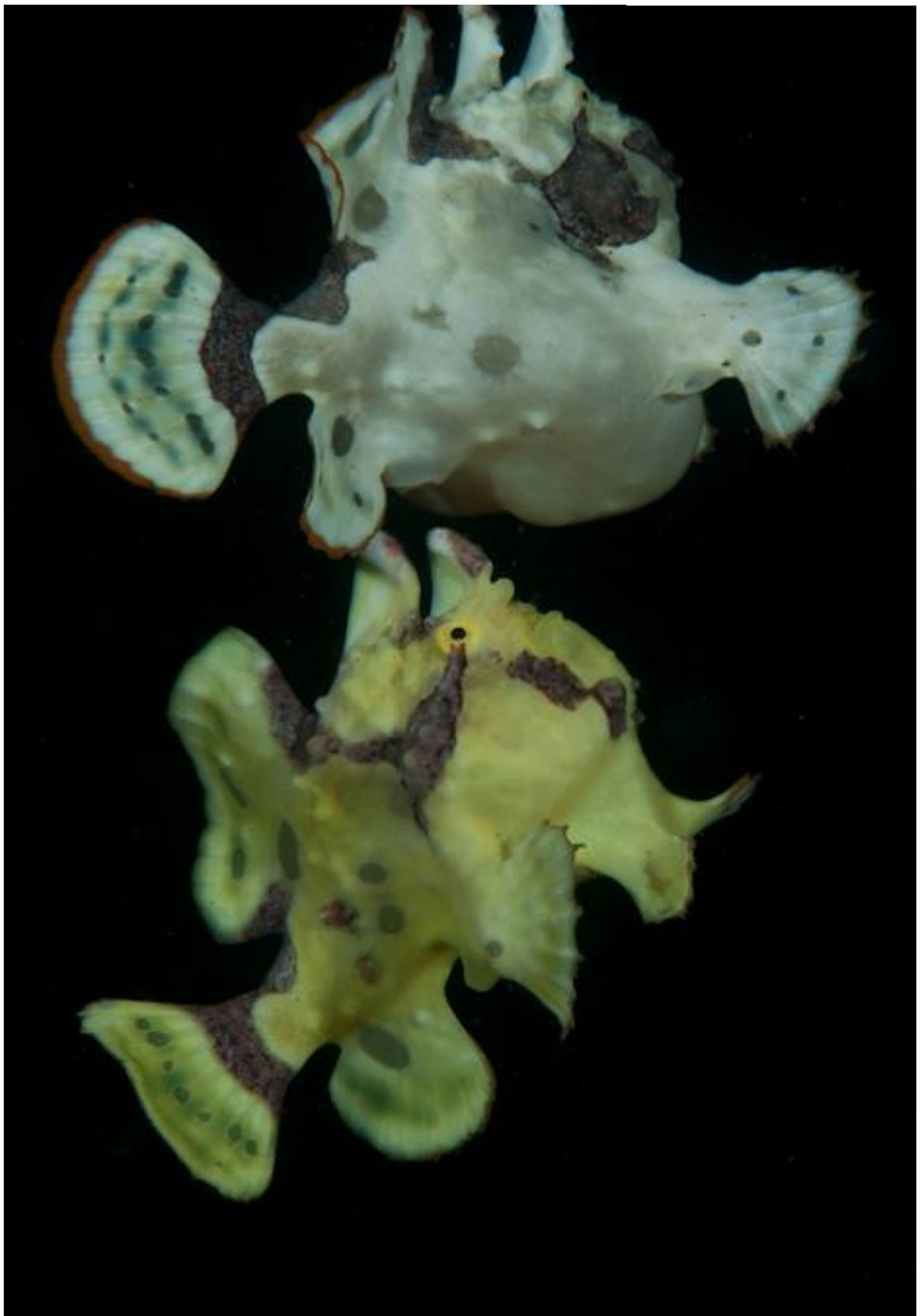
Hairy Frogfish (*A. striatus*): The bloated female at the front and three smaller males following her until she is ready to mate.



Divers report that sometimes the female is barely able to stay on the ground. Several times she would take off towards the surface with the males following her, but not always an actual mating would take place.





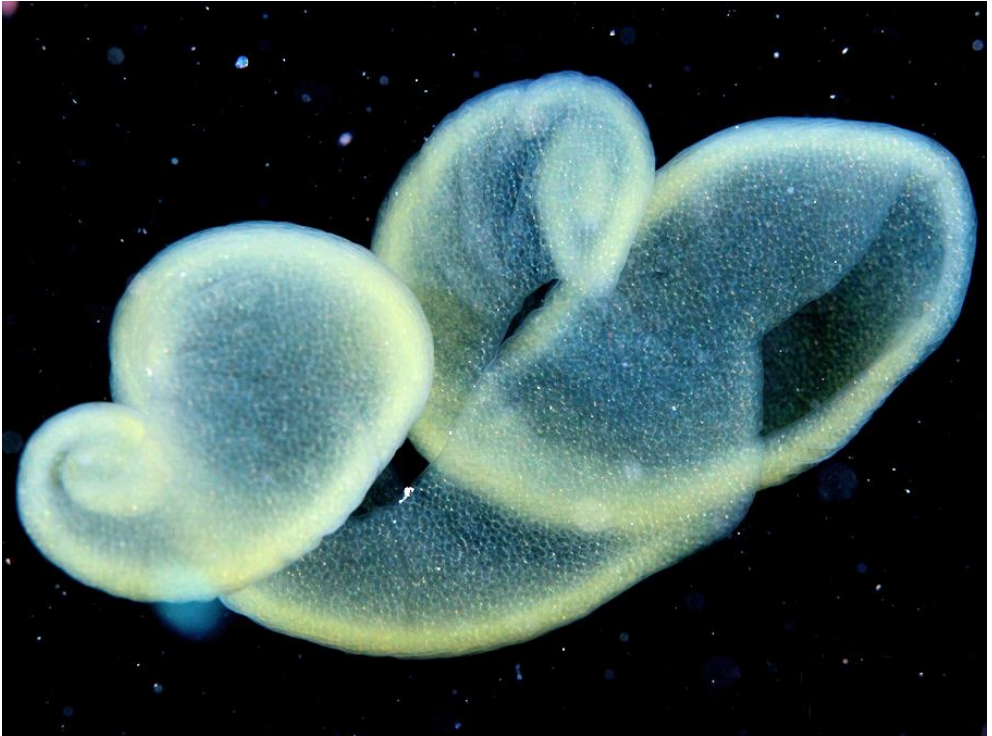


Now the gelatinous egg raft unfolds and floats on the surface of the water. It consists of several layers of the tiny eggs, each surrounded by a layer of mucus. This veil either is a double scroll-shaped sheath in the shape of the ovaries of the female or it is formed like a balloon with a single entrance hole at its base.

The male continues to guard the fertile female and follows her everywhere because, she spawns repeatedly over several weeks.



Female (large) releases the eggs, the male (small) fertilizes them (*A. multiocellatus*)

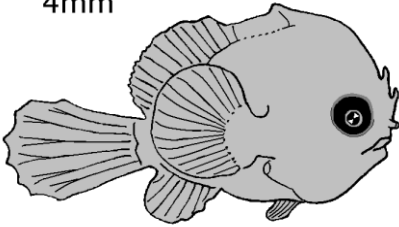


Egg raft of the Clown Frogfish (*Antennarius maculatus*)

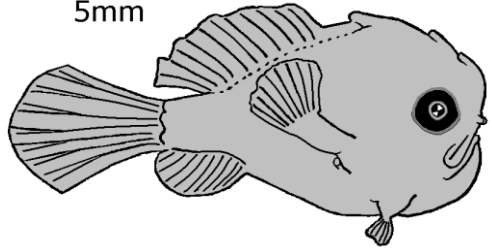
5.2 Larval development

The epipelagic egg raft drifts in the water for several days, crossing large geographical distances. After the embryos hatch the empty raft sinks to the bottom.

4mm



5mm



Larvae where the lure is not yet very developed

The planktonic stage lasts one to two months. Larvae are typically deep bodied and have a large head and large fins. Small larvae of 5mm already have a tiny lure. When the larvae settle out as juveniles they first live cryptic on sand or hidden under corals and rubble.



Tiny baby frogfish (probably *Antennarius pictus*) on sand

Protected coastal reefs and mangrove forests are the nursery grounds for a lot of fish species, including many frogfish species. While growing, juvenile frogfishes are very vulnerable and quickly become victims of predators. This is the reason why most juvenile frogfishes are extremely well camouflaged in brown and green colours and live hidden in crevices, between algae and beneath rubble.

5.3 Brood care

For frogfishes of the subfamily Antennariinae parenting ends with mating. However, many frogfishes of the subfamily Histiophryninae have fewer but larger eggs (3-4mm) and carry them around attached to their body or guard them in an egg cluster.

The young hatch when they are already well-developed and look like a small adult version. Because they lack a pelagic larval stage, these species are not distributed much by currents to other habitats. Therefore these frogfish species are often endemic and their range is restricted to a limited geographical area.



Psychedelic Frogfish (*Histiophryne psychedelica*) with egg cluster under the caudal fin



Three-Spot Frogfish (*Lophiocharon trisignatus*) with an egg clutch attached to its left

Frogfishes of the genus *Histiophryne* protect their eggs (about 120) in a brood pouch, which is formed by the pectoral and dorsal fins and the folded tail. Females of the genus *Lophiocharon* attach the eggs (about 650) with a thread-like extension to the skin surface on the side of their body and protect them by folding the tail fin. Some South Australian species produce numerous egg strings forming a mass containing about 5,000 eggs. The egg cache is spread out on the ground and protected by the female until the young hatch.



Eggs of the Marble-Mouthed Frogfish (*Lophiocharon lithinostomus*) about 3mm



5.4 Batesian mimicry by juvenile frogfishes

While most juveniles are well-camouflaged, the juveniles of the *Antennarius pictus* group are coloured conspicuously in white-orange to black-orange. When making undulating movements with their dorsal fins and slightly swaying in the current, they look exactly like flatworms or nudibranchs. This kind of mimicry is called *Batesian mimicry* and can also be found with juveniles of other fish species, for example sweetlips, flounders or spadefishes.

Mimicry is a type of protective adaptation. An edible animal imitates and falsifies the signals of an inedible or well-fortified animal. Flatworms have a nauseous taste and show this to potential predators by displaying orange, white, and black warning colours. Fishes living in shallow water can perceive colours, and they respond to these warning colours by not attacking those animals. Therefore, flatworms and nudibranchs are some of the animals most often imitated.



Juvenile of Warty Frogfish (*A. maculatus*)



Flatworm (*Pseudoceros lindae*)



Juvenile of Warty Frogfish (*A. maculatus*)



Nudibranch (*Chromodoris fidelis*)

Next page: Well-camouflaged juvenile (probably *Antennarius pictus*) on sponge



5.5 Luring techniques of juvenile frogfishes

Very tiny juveniles swim around a lot and have a more fish-like body form. Not much is known about their feeding behavior. They may already attract prey by luring, or they may just eat small animals like shrimps that happen to approach close enough to be swallowed.

Somewhat larger juveniles look like small versions of an adult, but in comparison with their body size the luring rod is longer and the bait larger. Probably the juvenile frogfishes are too small to be mistaken by their prey for a place of shelter like a sponge or an algae-covered stone. Therefore they have to be much more active in luring, and potential prey will only be attracted by bait of a certain size.

The luring techniques employed by juveniles are similar to those of small-sized frogfish species - they hide in crevices, among sponges, or under overhangs and lure. Even juveniles of a species like the Striped Frogfish (*A. striatus*), which normally walks around a lot, rather hide and don't move much. Their prey consists of small fishes or shrimps.



Juvenile Spotfin Frogfish (*A. nummifer* 1cm) while luring (photomontage from 3 shots)

Juveniles of the Warty Frogfish use an interesting luring technique. Sometimes they move their erect second dorsal spine hectically back and forth. The spine of this species is quite large and attached to the head with only a thin membrane and therefore very mobile. Prey responds to the vibrations and approaches. There are no scientific studies about this behaviour, but it would be interesting to find out whether it supports the use of the luring rod or even replaces it.



Warty Frogfish (*A. maculatus* 7mm) walks around and moves its second dorsal spine

6. Locomotion

Frogfishes swim rarely, and when they do, they mainly use their tail fin while folding their other fins flat to the body. Most frogfishes lack a swim bladder, though the Sargassum Frogfish (*H. histrio*) who lives pelagic on floating Sargassum weed is an exception.

Frogfishes use several modes of locomotion, but the most common way for them to move is a forward jet-like thrust and then a glide a few centimetres above the ground. This movement is achieved by sucking in water through the mouth and expelling it through the small gill openings behind the "legs" (jet propulsion). To cross small distances, the frogfish may also walk or even gallop with the aid of its pectoral and pelvic fins.



The Psychedelic Frogfish (*Histiophryne psychedelica*) uses a unique method of locomotion not found in any other species of the genus. It makes a series of short hops or bounces, pushing off from the bottom with both pelvic fins at once. The tail is folded to the side, and the dorsal fin is bent to one side so it looks like a small ball. In this balled position it can also sail down a slope without bouncing or using its fins.



If a frogfish is actively stalking a prey animal, it is walking forward as if in slow motion, always waggling its bait over or in front of its head. One pectoral fin after the other is moved in such a way that it looks like the gait of a land animal. It is interesting to note that frogfishes have reversed the order of their breast and belly fins. The powerful rear feet are in fact their pectoral fins. The smaller pelvic fins support the massive head with its huge jaw.

Above: Hairy Frogfish / Next page: Sargassum Frogfish which has a swim bladder



7. Habitats

To find a frogfish one needs to know where to go looking for it. Contrary to popular belief, there are actually more species living close to reefs or on sand than in the coral reef itself.

Exposed sponges, outer reefs: The Giant Frogfish (*A. commerson*) lives on drop-offs and on barrel sponges. It perches quite openly on the sponge. This species also likes to perch on anchoring ropes.

Between corals: Hidden in crevices and under corals live many smaller frogfish species such as the Spotfin Frogfish (*A. nummifer*), the Freckled Frogfish (*A. coccineus*), and the Bandfin Frogfish (*A. tuberosus*). They often leave their hiding place at night and go hunting.

Sandy reef flats with algae and seaweed: Here live the Striped Frogfish (*A. striatus*), and in places where the water is more turbid the Hispid Frogfish (*A. hispidus*). They hide among algae and seaweed.

Sandy areas with coral blocks and sponges: The Painted Frogfish (*A. pictus*) is often found on or next to orange, yellow, or red sponges. The Warty Frogfish (*A. maculatus*) hides between clumps of algae, sponges, and soft corals or perches on sponge-covered hydroids.

Rubble in crevices beneath stones: Some small species like *Histiophryne* or *Tathicarpus* are extremely cryptic and can only be found when you turn pieces of rubble around and search underneath.

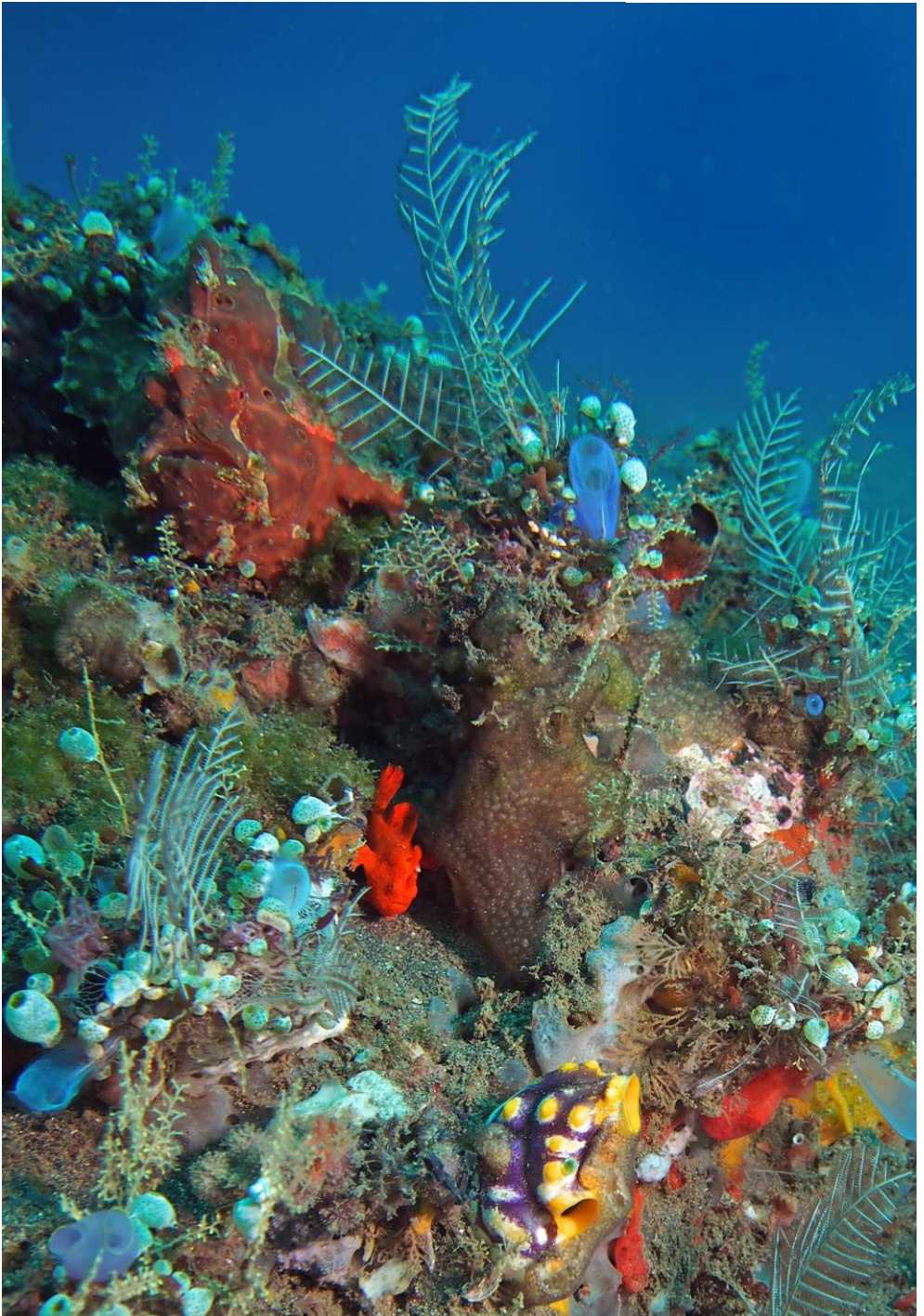
Shallow water: Some species are never found in deeper water but only in the upper two to four meters. E.g., Randall's Frogfish (*A. randalli*), the New Guinea Frogfish (*A. dorehensis*) and most *Histiophryne* species.

Brackish water, freshwater: Only the Brackish-Water Frogfish (*A. biocellatus*) lives in estuarine areas where rivers meet the sea.

Floating Sargassum weed: They often contain several Sargassum Frogfishes (*Histrio histrio*) from small (5mm) to large ones (15cm).

Between garbage, under piers, on wrecks: Garbage can be a good hiding place on otherwise empty sand. Litter such as large tins or old car tires are often inhabited by frogfishes. Open artificial reef structures and wrecks are also very popular with frogfishes.

Next page: Two Painted Frogfishes (*Antennarius pictus*)



8. Identification of frogfish species

For most fish species the overall colour and skin patterns are of importance if you want to identify them. Unfortunately with frogfishes a certain colour, such as bright red, can be found in very different species. In addition a single species, for example the Giant Frogfish can be yellow, orange, red, pink, brown, green, black, or white and everything between. That's why colours are always only an additional clue but can rarely be used as the main criteria when identifying a frogfish species.

8.1 Tips

In order to correctly identify a particular frogfish species it is crucial to take note of or take a picture of the following characteristics (in order of importance):

- 1. Where was the frogfish found?**
 - **Geographic area?**
- 2. Luring rod compared to length of second dorsal spine**
 - **Longer ? The same length? Shorter?**
- 3. Shape and form of the lure and bait**
- 4. Does the frogfish have**
 - **Ocelli (eye spots)? Round spots? Warts? Stripes? Lines?**
 - **Caudal peduncle (tail base) yes or no?**
 - **Other special characteristics?**
- 5. Size?**
- 6. Colours?**
- 7. What kind of habitat (e.g., sand, reef, seaweed)?**

Scientists also count the number of dorsal spines and the number of fin-rays and look the position of the gill openings, the position of the caudal peduncle, and the shape of the ovaries and note the size and shape of the dermal spinules. For this the frogfish is killed and dissected.

Photographs and detailed observations sometimes are not enough to ensure absolute certainty of identification.

8.2 The *Antennarius pictus* group

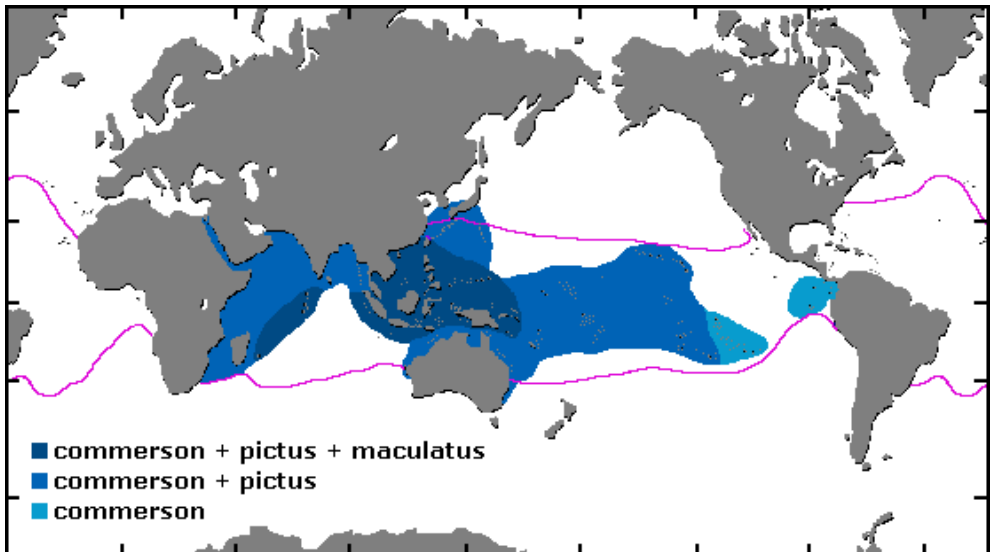
Frogfish species are divided into subgroups of species related closely to each other. The *Antennarius pictus* group encompasses **species with a lure that is about twice as long as the second dorsal spine**. All members of this group show a lot of colour variations and have round spots but never stripes or lines. They can change colours.

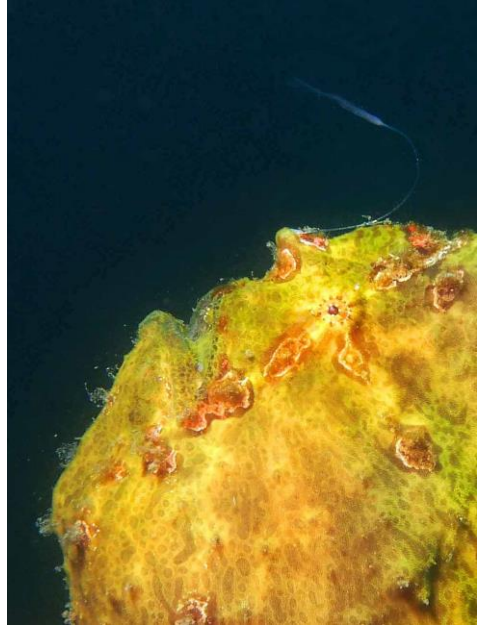
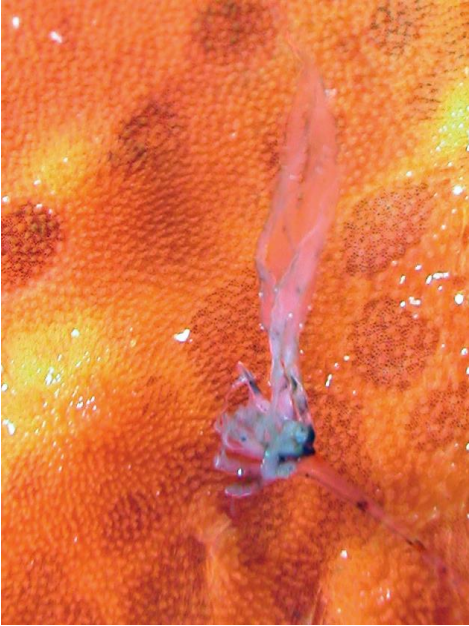
Three of the most common frogfish species found in the Indo-Pacific belong to the *Antennarius pictus* group. The Giant Frogfish (*Antennarius commerson*), the Painted Frogfish (*Antennarius pictus*) and the Clown Frogfish (*Antennarius maculatus*). Their distribution range overlaps in large parts. These are the three frogfish species most often found by divers, and unfortunately they are also the species most often confused with each other.

Juveniles of this group are specially difficult to distinguish. On first sight sometimes two of them seem almost exactly the same if you just look at their colour patterns and body form. Only by closely looking at the bait can you tell that they belong to two different frogfish species.

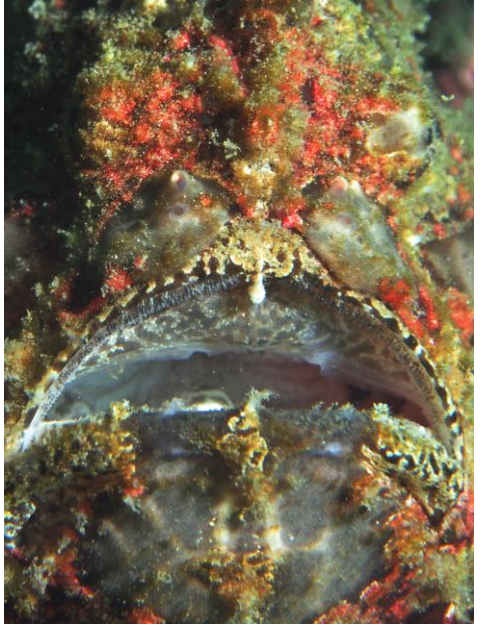
Distinguishing factors within the *Antennarius pictus* group:

- Form and size of the rod (illicium) and lure (esca)
- Body size
- Round spots
- Warts (pronounced or weak)



Giant Frogfish (*Antennarius commerson*), up to 30cm

Very long thin lure, bait that is bushy below with fine long filaments.



Second and third dorsal spines are thick and bulb-like. Sometimes covered with wart-like swellings. Often white skin flap on middle of upper jaw. Largest frogfish of the group.

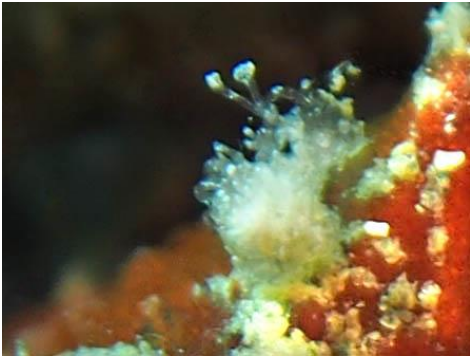
Colour variations *A. commerson*



This frogfish lives in coral reefs and is usually found perching on large sponges. It likes outer reefs and drop-offs where there is some current or sits on anchoring ropes. As a juvenile, it lives on sandy reef flats with coral blocks. It has large colour variation and can change colours.



Painted Frogfish (*Antennarius pictus*), 10 to 16cm



Long lure, the bait is bushy below with some darker areas and has a compressed appendage. When the lure rests on the head it looks like a small ball. When the lure is moved downward the appendage is fluttering behind like a banner. When the lure is moved upwards again the bait looks like a bush.



Two tiny white shrimps are perching on the left of this lure of a Painted Frogfish (*Antennarius pictus*) with a third one perching on the lower left.



This species nearly always has three light-edged spots on the tail fin and many smaller and darker round spots on the body as well as some wart-like swellings on the body.

Colour variations *A. pictus*



Juvenile approx 10mm



Juvenile approx 20mm

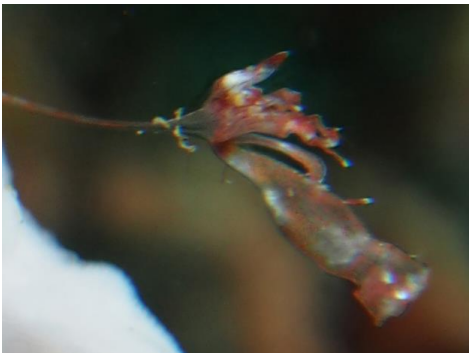


This frogfish is found in sandy reef flats with a covering of sponges or algae but also in coral reefs. It has a large colour variation and can change colours.

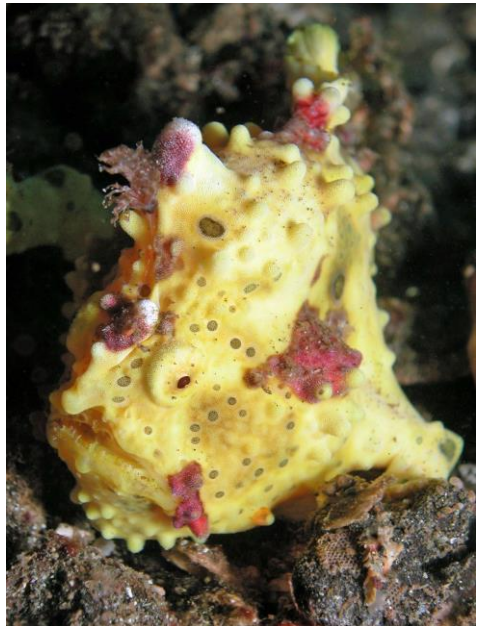


Warty or Clown Frogfish (*Antennarius maculatus*), 8 to 10cm

The Warty (or Clown) Frogfish has a long lure and a large esca that is flat like a leaf and mottled brown-white and with vertical bands. The frogfish moves it like a pennant or banner.



The esca looks like a small fish or shrimp, and it even has an "eye spot" and luminous edges at the tip of the appendages.



Dorsal spines very flexible. The second and third dorsal spine end in bulbous protrusions and are connected to the head with a thin membrane. Skin very warty.

Colour variations *A. maculatus*



Juvenile approx 30mm

Juvenile approx. 15mm



This frogfish lives on shallow reefs between algae, sponges and soft corals. It is multicoloured and complexly patterned. A dark patch in the shape of a triangle connects the eye to the dorsal fin and forms a saddle.

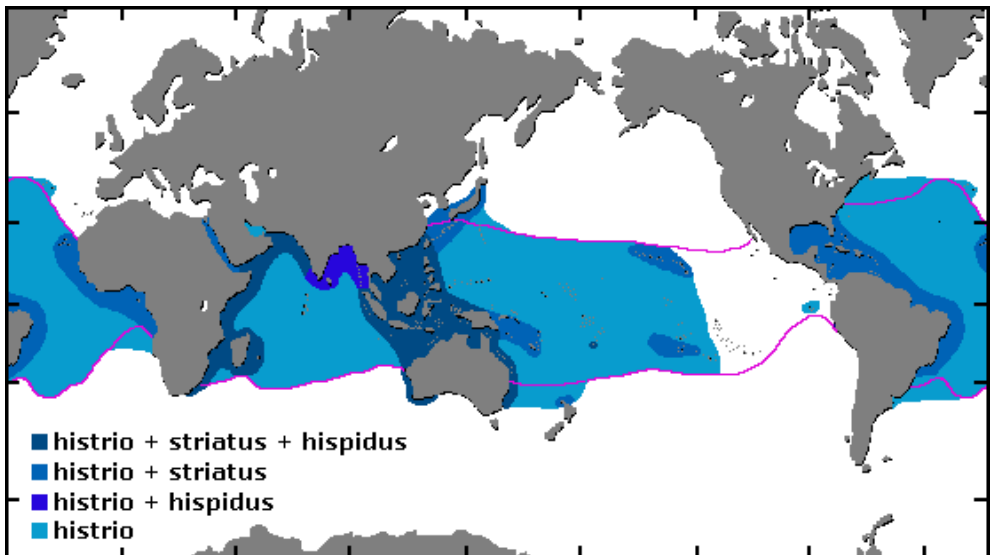


8.3 Frogfish species with stripes on their fins

Striped frogfishes mainly live among algae and seaweed or other marine plants like Sargassum weed. Stripes are an adaptation that enables animals to blend into their environment. The stripes mirror the light and shadowy areas of their surrounding and also effectively break up the shape of a fish, making it hard for a predator to pick it out from the background. Some species also have so-called "eyebars" across their eyes. These are dark stripes that make the eyes less obvious to predators.

Only four frogfish species living in the Indo-Pacific have stripes and they are easily distinguished from each other by the shape of their luring apparatus. Two striped species (*Antennarius striatus* and *Histrio histrio*) are found nearly worldwide - they live in all tropical oceans and even have occasionally been spotted in the East Pacific. *Antennarius hispidus* ranges from the Red Sea to Southeast Asia and *Antennarius indicus* is endemic to the Indian Ocean.

New DNA tests have shown that the three striped frogfish species of the genus *Antennarius* are closely related to each other.



There are also several frogfish species with fine light and dark lines on their body instead of stripes (e.g., *Fowlerichthys scriptissimus*, *Antennatus linearis*, and *Histiophryne psychedelica*). They mimic the patterns found on stony corals or ascidians.

Hispid or Shaggy Frogfish (*Antennarius hispidus*), 15 to 20cm

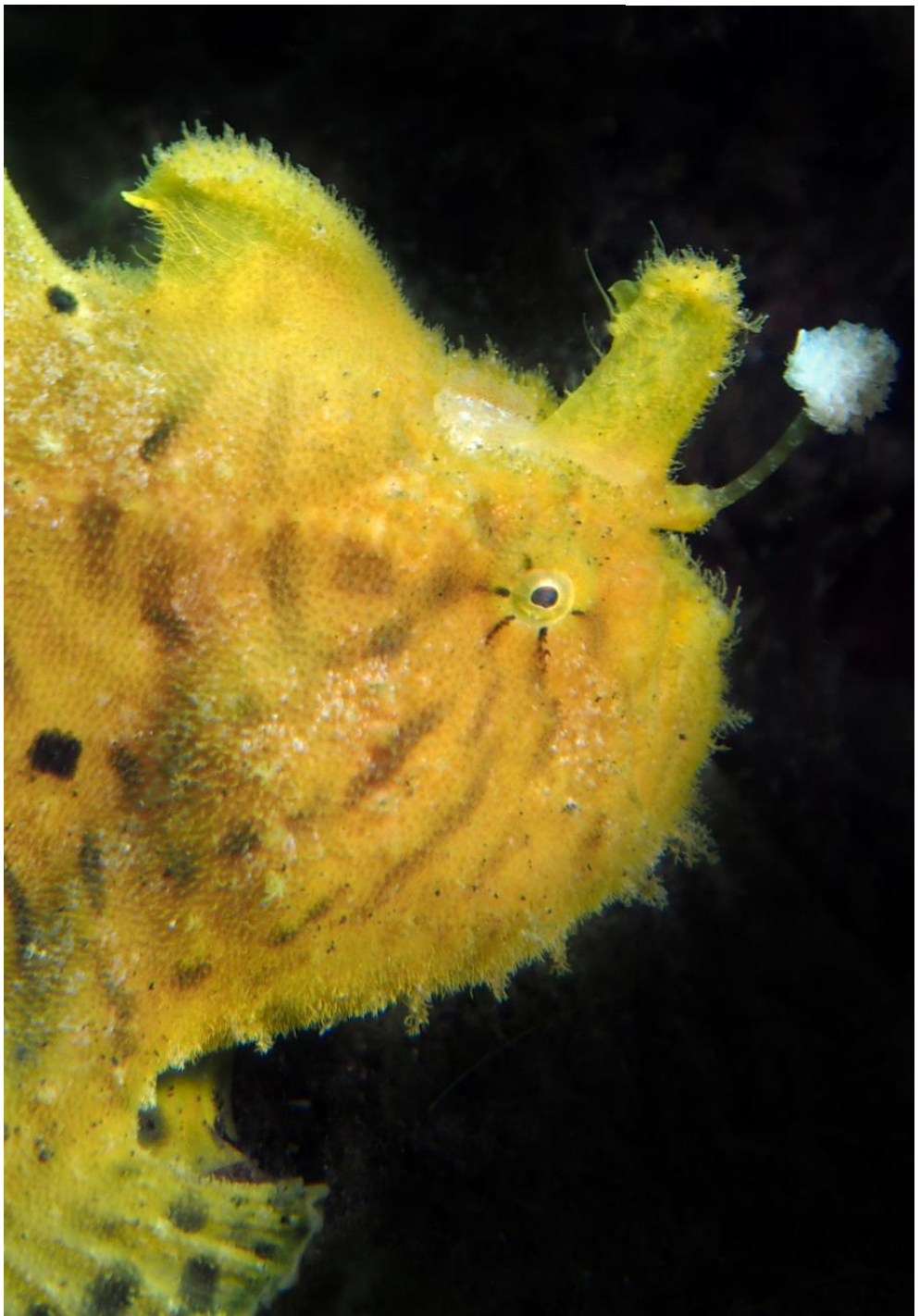


Illicium (rod) striped, about the length of 2nd spine. The esca (lure, bait) is a large oval-shaped tuft with slender filaments and looks like a pom-pom. Stripes not very pronounced.

Colour variations *A. hispidus*



This frogfish likes sandy areas and sits among clumps of algae and withered leaves and twigs swept into the sea. The Shaggy Frogfish likes to lean motionless against small rocks. It often tilts its rod and lure back and forth, which looks like a filtering tube worm in the current.



Striped or Hairy Frogfish (*Antennarius striatus*), up to 22cm

Esca (lure, bait) with two to seven thick worm-like appendages that engorge, when the frogfish starts luring. The rod and lure are very flexible.



Brown-black stripes and sometimes longish circular blotches all over the body.

Colour variations *A. striatus*

This frogfish lives on sand, in rubble and between algae and seaweed. It feeds on other benthic fishes like flounders or gobies. It is often entirely covered with filamentous skin appendages that look like hair.



Juvenile of *Antennarius striatus*, about 20mm (above) and 15mm (below)



While most Striped Frogfishes are brown-green coloured and look like algae, some specimens are of a very bright yellow or orange colour. They probably mimic sponges, and accordingly they often have fewer pronounced stripes and more often oval dark blotches.



Indian Frogfish (*Antennarius indicus*), up to 19cm



Antennarius indicus mostly has stripes on the dorsal, anal, and caudal fins but not on the rest of the body. It differs from other striped frogfishes in that it has two dark round spots encircled by a light ring. One below the dorsal fin and in mid body, sometimes a third spot above the anal fin. The rod is about the length of the second dorsal spine, the lure is large with flat leaf-like appendages. There is very little known about the habitat this frogfish species lives in. You can find it in coastal areas on coral reefs to 25m depth.

This frogfish species is endemic to the West Indian Ocean, the Gulf of Aden, Zanzibar, the Seychelles, and Sri Lanka. Its distribution is restricted to this geographic area, and only there you have to be careful, so you don't confuse it with other striped frogfish species like *Antennarius striatus* or *Antennarius hispidus*.

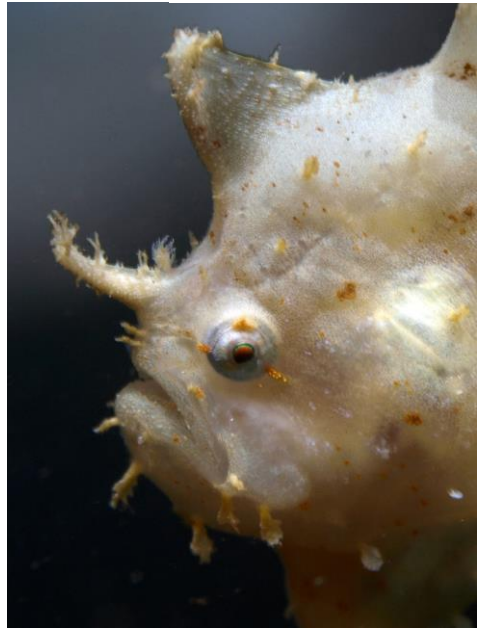
Colour variations



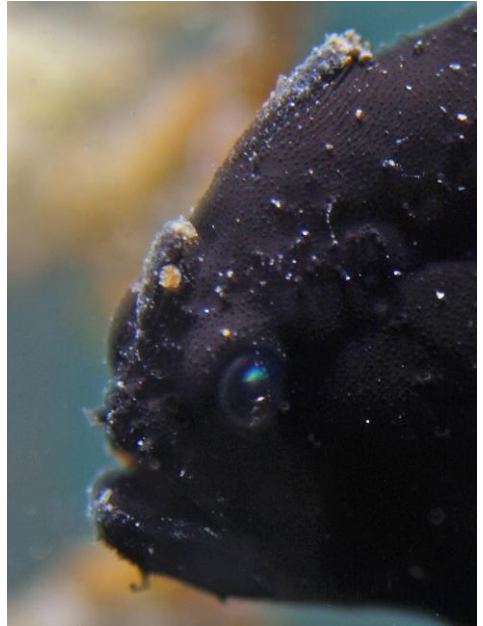
Sargassum Frogfish (*Histrio histrio*), up to 15cm

The Sargassum Frogfish is distinguished from all other frogfish species by its very large pelvic and breast fins. This frogfish is mottled with darker stripes on the fins and lots of fleshy, leafy appendages. Some specimens are plain-coloured, brown, creamy to white, or black.

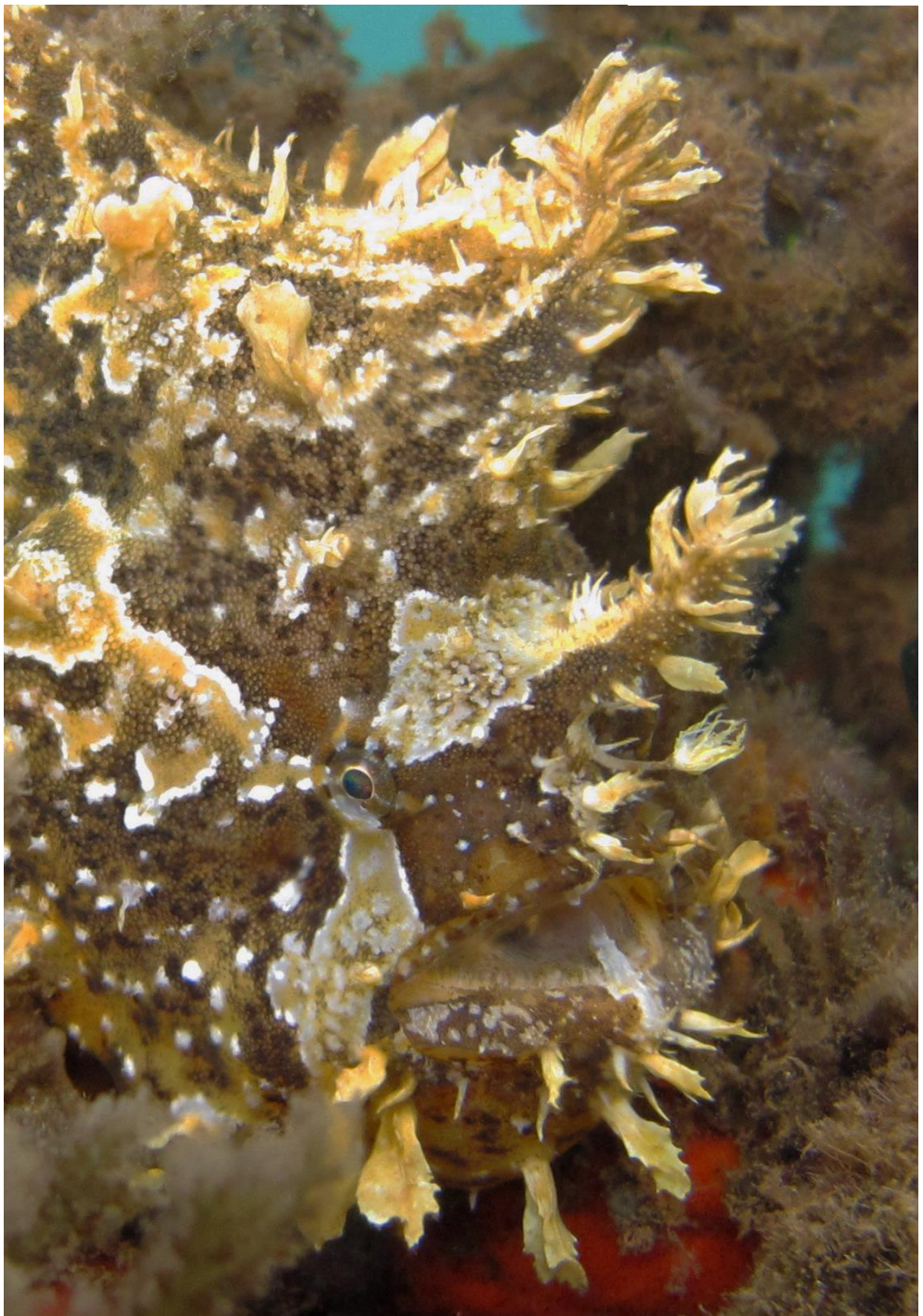




There are always two skin flaps on the snout just above the lips



Illicium (rod) is short. Small esca (lure, bait) with folds.



8.4 Identification key for small frogfish species

If you want to identify small-sized frogfishes (under 12cm), you need a good selection of photos or observations of the corresponding frogfish and must have a high tolerance for frustration. While some small species are fairly easy to determine, other small species can prove hard nuts to crack! The fact that a small-sized frogfish can also be the juvenile of one of the larger-sized species further exacerbates the identification problems.

Using this identification key

This identification key uses characteristics simple enough for the layman to apply, but it can't be compared with a scientific identification key (e.g., Pietsch and Grobecker, 1987). Although it may not always be possible to determine the exact species, it should be possible to at least narrow down the choice to two or three species.

Stipulation

The frogfish being identified doesn't belong to the *Antennarius pictus* group, see chapter 8.2, and the dorsal fins are not striped, see chapter 8.3.

Southeast Asia - start with step 1.

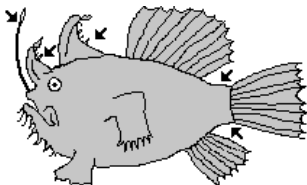
This identification key should be entered from the beginning with step one and then be completed without leaving out any steps. Species are eliminated one by one until an identification is possible.

Red Sea and Indian Ocean - start with step 5.

Frogfish species only found in Southeast Asia are skipped.

1. Transparent membranes

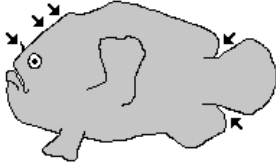
- Transparent membranes between the dorsal and tail fins and behind the second and third dorsal spine. Exceptionally long fin rays. Distinct caudal peduncle.
- ***Tathicarpus butleri*** (Butler's Frogfish), 10-12cm



2. Tiny or nearly not visible rod, rather flat head

→ Genus *Histiophryne*

Typically there is no visible esca (lure, bait) and the second and third dorsal spines are laid back and bound on the surface of the head by thick skin and can be discerned only as a slight ridge. Quite small and cryptic species.



- Entire body covered with brown-white-grey lines that look like the patterns found on stony corals. Very flat face with eyes directed forward. Meaty fins. Only Moluccas.
- ***Histiophryne psychedelica*** (Psychedelic Frogfish), 6-9cm
- Fine brown-white honeycomb pattern
- ***Histiophryne sp.1***, 8-9cm
- Small close-set white-edged red-brown ocelli all over the rosy body
- ***Histiophryne pogonius***, 5-6cm
- Creamy, green to purple. Areas with greenish blotches on body.
- ***Histiophryne cryptacanthus*** (Cryptic Frogfish), up to 9cm

3. Eyespot (ocellus) on dorsal fin

Several frogfish-species have a so called eyespot (ocellus) on their body. This is a large dark spot with a lighter and then with a dark ring around it. They should not be confused with dark round spots that are very common with frogfishes of the *Anntenarius pictus* group. See chapter 8.2.

- Rod shorter than second dorsal spine. Lure small, conical and bushy. Black basidorsal ocellus surrounded by a narrow pale and a black-edged ring. Second spine not connected with membrane to the head.
- ***Antennarius biocellatus*** (Brackish-Water Frogfish), 12-14cm



→ Short thin rod, bait round with short filaments. Second spine unusually long and narrow. Large pale edged ocellus (sometimes several) on the dorsal fin. Only Philippines and Indonesia.

→ ***Nudiantennarius subteres*** (Lembah Frogfish), 5-6cm



→ Long rod, dorsal spot surrounded with yellow ring.

→ *Antennarius rosaceus* go to **step 9**.

4. Rows of nearly transparent ocelli on dorsal fin

Rows of two to four nearly translucent to transparent ocelli (eye spots) on the membrane between the caudal fin.

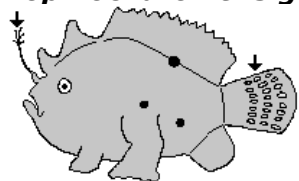
→ Nearly no esca. Long rod covered with dermal spinules.

→ ***Lophiocharon lithinostomus*** (Marble-Mouthed Frogfish), to 9cm



→ Large and distinct esca, long twig-like rod.

→ ***Lophiocharon trisignatus*** (Three-Spot Frogfish), 14cm (18cm?)



5. Small round white spots

→ Very small, flat body. White spot on caudal fin, one near upper, one near lower edge of fin. One white spot behind eye, one on dorsal fin, one above pectoral fin. Looks like dead leaf or piece of crusty alga.

→ ***Antennarius randalli*** (Randall's Frogfish), 1.5-2cm



6. Uniformly brown, black, white, cream coloured

- Large pelvic- and breastfins → uniformly coloured ***Histrio histrio***
- Worm-shaped lure, some stripes → uniformly coloured ***A. striatus***
- See chapter 8.3.

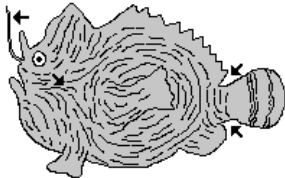
7. Long rod, no lure

- Roundish body, marbled patterns on its skin. The third dorsal spine is thick and immobile. No caudal peduncle (dorsal and anal fins end at base of tail fin). Banded tail.
- ***Antennatus tuberosus*** (Tuberculated Frogfish), up to 7cm



8. Linies on the whole body

- Close-set, curving dark lines with superimposed fine white lines on head and body. Caudal peduncle present. Dark-brown band on tail.
- ***Antennatus linearis*** (Pygmy Frogfish), 6-7.5cm



- Green-brown with lighter lines, dorsal spot. Long rod and small lure.
- A juvenile of ***Fowlerichthys scriptissimus*** (Scripted Frogfish). Adult size 28-50cm

9. Long rod with lure

- Does it belong to the *Antennarius pictus* group? For example *Antennarius maculatus* (8-10cm) or a juvenile? See chapter 8.2.

→ **Five species of the genus *Abantennarius* are left**

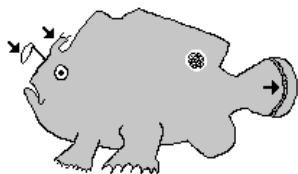
These five species often but not always have a round spot on their dorsal fin, and widely distributed. These species were previously assigned to the genus *Antennarius*. DNA tests have shown that they are closely related to frogfishes of the genus *Antennatus* but differ enough to be a separate genus: *Abantennarius*. Even for ichthyologists these species are difficult to differentiate and more so for the layman. Without a close look at the rod, lure, and tail no accurate identification is possible.

- The gill opening lies adjacent to the anal fin instead of the base of the pectoral fins. Long rod with lure. Very uncommon!
- ***Abantennarius analis*** (Tail-Jet Frogfish), 3-7cm
- Long rod, lure with filaments. Second spine is very long and slender with small clusters. Dorsal spot encircled with yellow ring.
- ***Abantennarius rosaceus*** (Spiny-tufted / Rosy Frogfish), up to 4cm



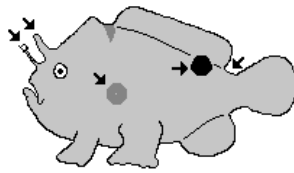
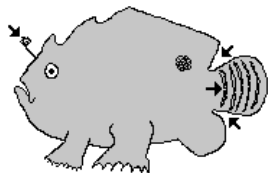
10. Rod same length or shorter than second spine

- Short rod. The esca points towards the belly and is very small. Second dorsal spine is bent backward. Sometimes round spot on dorsal fin. Often stripes on tail.
- ***Abantennarius dorehensis*** (New Guinea Frogfish), 2.5-5cm



11. Caudal peduncle

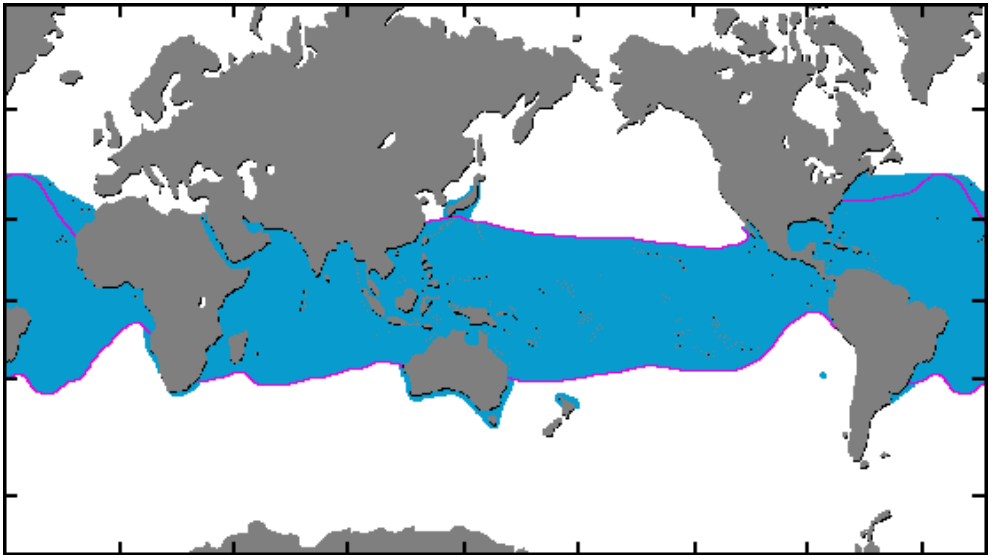
- Lacks distinct caudal peduncle (dorsal and anal fins end at base of tail fin)
- ***Abantennarius coccineus*** (Freckled Frogfish), 9-13cm
- Well defined caudal peduncle. Rod about equal to length of second dorsal spine. Esca small and often round.
- ***Abantennarius nummifer*** (Spotfin Frogfish), 5-10cm



9. Distribution of species (zoogeography)

Frogfishes are strictly marine fishes and are found in all tropical oceans of the world, but not in the Mediterranean Sea. They prefer water temperatures of 20° C or more so their range lies almost exactly between the two 20-degree isotherms.

We differ frogfish species that are adapted to continental conditions, and those that prefer island habitats. On continental slopes and around large islands there are more pronounced seasonal temperature differences, and rivers cause turbidity and change the salinity of the water. These environmental conditions demand a higher degree of adjustment from a species than, for instance, the clear waters around oceanic islands.



Five frogfish species are found nearly circumglobally. The range of the Striped Frogfish (*A. striatus*) and the Sargassum Frogfish (*Histrio histrio*) extends from the Atlantic into the Indo-Pacific to Hawaii with a few sightings of the Sargassum Frogfish in the Galapagos. The range of these widespread species also extends along the continental margins into colder waters to the north and south of the 20-degree isotherms.

Apart from the Giant Frogfish (*A. commerson*), which lives in an area extending from the Red Sea to the coast of South America, there are also two small species, the Spotfin Frogfish (*A. nummifer*) and the Freckled Frogfish (*A. coccineus*), which are widespread, the Spotfin Frogfish even lives in the Atlantic.

9.1 Species of the Red Sea, Maldives, and Indian Ocean

	Red Sea	South and East Africa	Seychelles Madagascar Mauritius	Maldives	Andaman Sea*
Abantennarius					
<i>A. coccineus</i>					
<i>A. dorehensis</i>					
<i>A. nummifer</i>					
<i>A. rosaceus</i>	a)				
Antennarius					
<i>A. commerson</i>					
<i>A. maculatus</i>					
<i>A. pictus</i>					
<i>A. randalli</i>	d)				
Antennatus					
<i>A. linearis</i>					
<i>A. tuberosus</i>				c)	
Striped frogfish species					
<i>A. hispidus</i>					
<i>A. indicus</i>				b)	
<i>A. striatus</i>					
<i>H. histrio</i>					

a) A single sighting b) Laccadive Islands c) Chagos Archipelago d) From photographs
* Eastern Indian Ocean (incl. Nicobar Islands, Burma, Thailand, Malaysia, North-Sumatra)

Red Sea

The Red Sea is isolated from the Indian Ocean by the Bab al-Mandab Strait. This threshold constitutes a biological barrier for some species because cool water from the Gulf of Aden wells up when hitting the shelf. This barrier constrains the mingling of water enormously, which together with high evaporation and very little precipitation results in the Red Sea having an unusually high salt content. For this reason only eight frogfish species occur here, most of them species with a large range and which are used to difficult environmental conditions.

Maldives, Indian Ocean

The Indian Frogfish (*Antennarius indicus*) is the only frogfish species endemic to the Indian Ocean. Frogfishes in the Indian Ocean are mostly found along the coast and around larger islands off the east coast of Africa, including Madagascar, Mauritius and the Seychelles. Another area extends from Southern India and Sri Lanka to the Maldives. These isolated atolls and oceanic islands often have a lower number of species because fewer larvae are swept there by ocean currents.

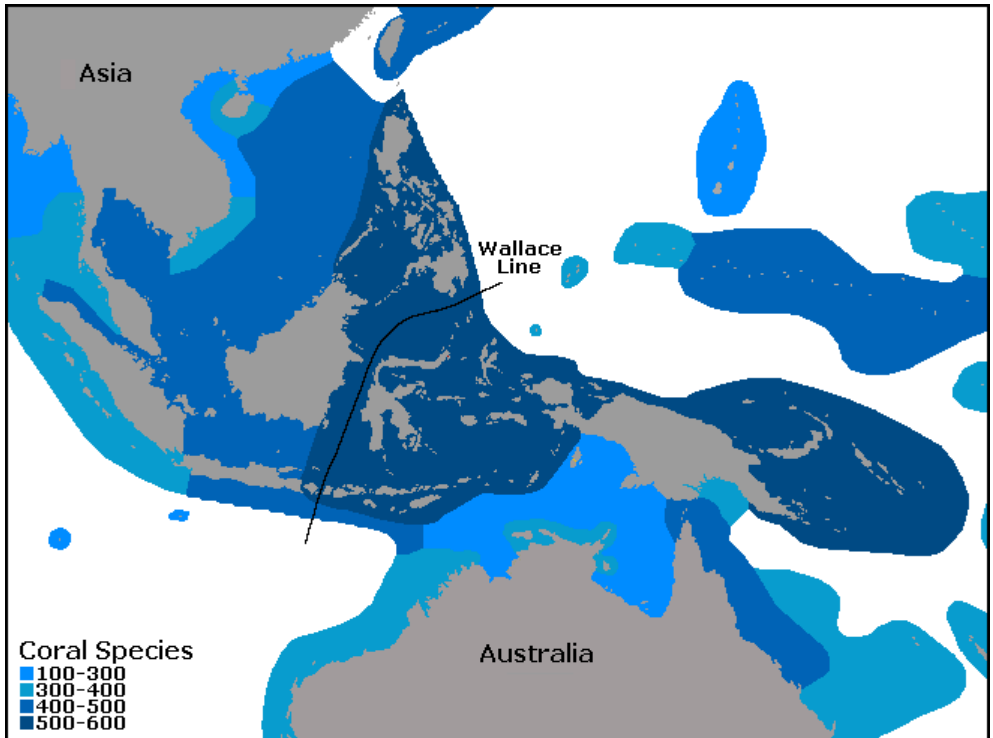
9.2 Species of Southeast Asia, Taiwan, Japan

	Borneo	Indonesia	Papua New Guinea	Philippines	Taiwan Japan
Antennarius pictus group					
<i>A. commerson</i>					
<i>A. maculatus</i>					g)
<i>A. pictus</i>					
Antennarius					
<i>A. biocellatus</i>	f)				h)
<i>A. randalli</i>					g)
Striped frogfish species (<i>Antennarius</i>)					
<i>A. hispidus</i>					g)
<i>A. striatus</i>					
<i>H. histrio</i>					
Abantennarius					
<i>A. analis</i>		a)			
<i>A. coccineus</i>					g)
<i>A. dorehensis</i>					g)
<i>A. nummifer</i>					
<i>A. rosaceus</i>	?		i)		g)
Antennatus					
<i>A. flagellatus</i>					
<i>A. linearis</i>		c)	f)		g)
<i>A. tuberosus</i>					g)
Histiophryne					
<i>H. cryptacanthus</i>					
<i>H. pogonius</i>					
<i>H. psychedelica</i>		c)			
<i>H. sp.1</i>					
Lophiocharon					
<i>L. hutchinsi</i>		d)			
<i>L. lithinostomus</i>			f)		
<i>L. trisignatus</i>		e)			
Nudiantennarius					
<i>N. subteres.</i>					g)
Tathicarpus					
<i>T. butleri</i>		c)			

- a) Christmas island (south of Java) b) A single sighting c) Moluccas d) Aru Island
e) To Singapore f) From photographs g) Kanagawa Prefectural Museum h) Taiwan
i) Sighting of the author ? No known sightings, but part of distribution range

References: Pietsch & Grobecker, Pietsch & Arnold, FishBase.org, AquaMaps.org, photos

The so-called Coral Triangle lies in Southeast Asia and is the area with the most marine species on earth. This large area encompasses an extraordinary range of habitats and environmental conditions and is a key region (hotspot) with very high biological diversity but which unfortunately is also under threat from human activities.



In the north the Coral Triangle extends to the Philippines. The western boundary coincides with the extent of the Asian continental shelf with the rather shallow Java Sea. Along the shelf also runs the so-called Wallace Line, a biogeographic dividing line between the Asian and Australian flora and fauna. The land masses of Australia and Papua New Guinea with the shallow Arafura Sea in between form the southern border. To the east the Coral Triangle expands to the Solomon Islands.

In the waters around the island nation of Indonesia live over 2,000 species of reef-associated fishes, including nine genera of frogfish (*Antennarius*, *Abantennarius*, *Antennatus*, *Fowlerichthys*, *Histiophryste*, *Histrio*, *Lophiocharon*, *Nudiantennarius*, *Tathicarpus*) with at least 25 species of frogfishes. The remaining six frogfish genera are endemic and occur only in the waters of southern Australia.

10. Frogfish species of Southeast Asia, Indian Ocean, Red Sea

10.1 Systematics

Common to all species of the order Lophiiformes (anglerfishes) is their unique nature of luring, where they use the converted first dorsal spine as a luring apparatus. The Lophiiformes order is divided into three sub-orders, one of them Frogfishes (Antennarioidei). New DNA tests have shown, that the family of frogfishes (Antennariidae, which means *antenna bearers*) comprises 14 genera and 49 species. It is quite possible that there are more tropical frogfish species, for example from the genus *Histiophryne*.

Phylum	Chordata	Chordates
Subphylum	Vertebrata	Vertebrates
Superclass	Osteichthyes	Bony Fishes
Class	Actinopterygii	Ray-finned Fishes
Subclass	Neopterygii	Neopterygians
Infraclass	Teleostei	Teleosts
Order	Lophiiformes	Anglerfishes
Suborder	Antennarioidei	Anglers
Family	Antennariidae	Frogfishes
Subfamily	Antennariinae	
Genus	<i>Abantennarius</i>	9 species
Genus	<i>Antennarius</i>	12 species
Genus	<i>Antennatus</i>	..4 species
Genus	<i>Fowlerichthys</i>	5 species
Genus	<i>Histrio</i>	1 species
Genus	<i>Nudiantennarius</i>	1 species
Subfamily	Histiophryninae	
Genus	<i>Allenichthys</i> *	1 species
Genus	<i>Echinophryne</i> *	3 species
Genus	<i>Histiophryne</i>	6 species or more
Genus	<i>Kuiterichthys</i> *	2 species
Genus	<i>Lophiocharon</i>	3 species
Genus	<i>Phyllophryne</i> *	1 species
Genus	<i>Porophryne</i> *	1 species
Genus	<i>Rhycherus</i> *	2 species
Genus	<i>Tathicarpus</i>	1 species

* Endemic to Southern Australia

Remark

These following uncommon species are not described in detail in this chapter:

- *Abantennarius analis* (Tail-Jet Frogfish), Schultz, 1957
Range: Christmas Island (Indian Ocean, south of Java) to Hawaii (3-7cm)
- *Antennatus flagellatus* (Whip Frogfish), Ohnishi, Iwata and Hiramatsu, 1997
Range: South Japan (6cm)
- *Histiophryne sp2* (Taiwan Frogfish), yellow coloured frogfish with whiskers on chin
Range: only known from images from Taiwan
- *Lophiocharon hutchinsi* (Hutchins' Frogfish), Pietsch, 2004
Range: Aru Islands (Southeast Indonesia), Northwest Australia (less than 5cm)

10.2 Subfamily Antennariinae

Antennarius biocellatus (Cuvier, 1817)

Twinspot / Brackish-Water Frogfish



Illicium



Characteristics: Illicium (rod) is shorter than second spine. Esca (lure, bait) is small, conical and bushy. The second spine not connected with a membrane to the head. Black basidorsal ocellus is surrounded by a narrow, pale, black-edged ring. Dark streaks radiate from eye. It has a high back and flattish body profile. Belongs to the *Antennarius biocellatus* group, which consists of a single species (Pietsch and Grobecker, 1987, p.174).

Size: 12-14cm (4.5-6in.)

Habitat: Only frogfish species also found in brackish water close to rivers, sometimes even in freshwater, mangrove swamps. Mostly in shallow water.

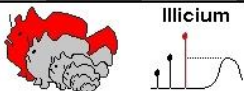
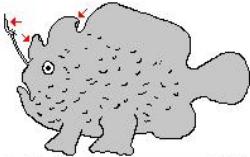
Range: Taiwan (and perhaps Southwest Japan), Philippines, Indonesia, Papua New Guinea, Solomon Islands. Rarely found, cryptic.

Colours: Is often mottled with darker spots.





***Antennarius commerson* (Latreille, 1804)**
Giant / Commerson's Frogfish



Characteristics: Illicium (rod) very thin and longer than second spine. Esca (lure, bait) bushy below with fine long filaments. Typically the second and third dorsal spines are thick and bulb-like. Body is sometimes covered with wart-like swellings (but nothing like warts of *A. maculatus*) and lichen-like growth. Belongs to the *Antennarius pictus* group and can easily be confused with other members of the group. This species is one of the largest in the Indo-Pacific and probably the one most often found by divers (Pietsch and Grobecker, 1987, p. 92).

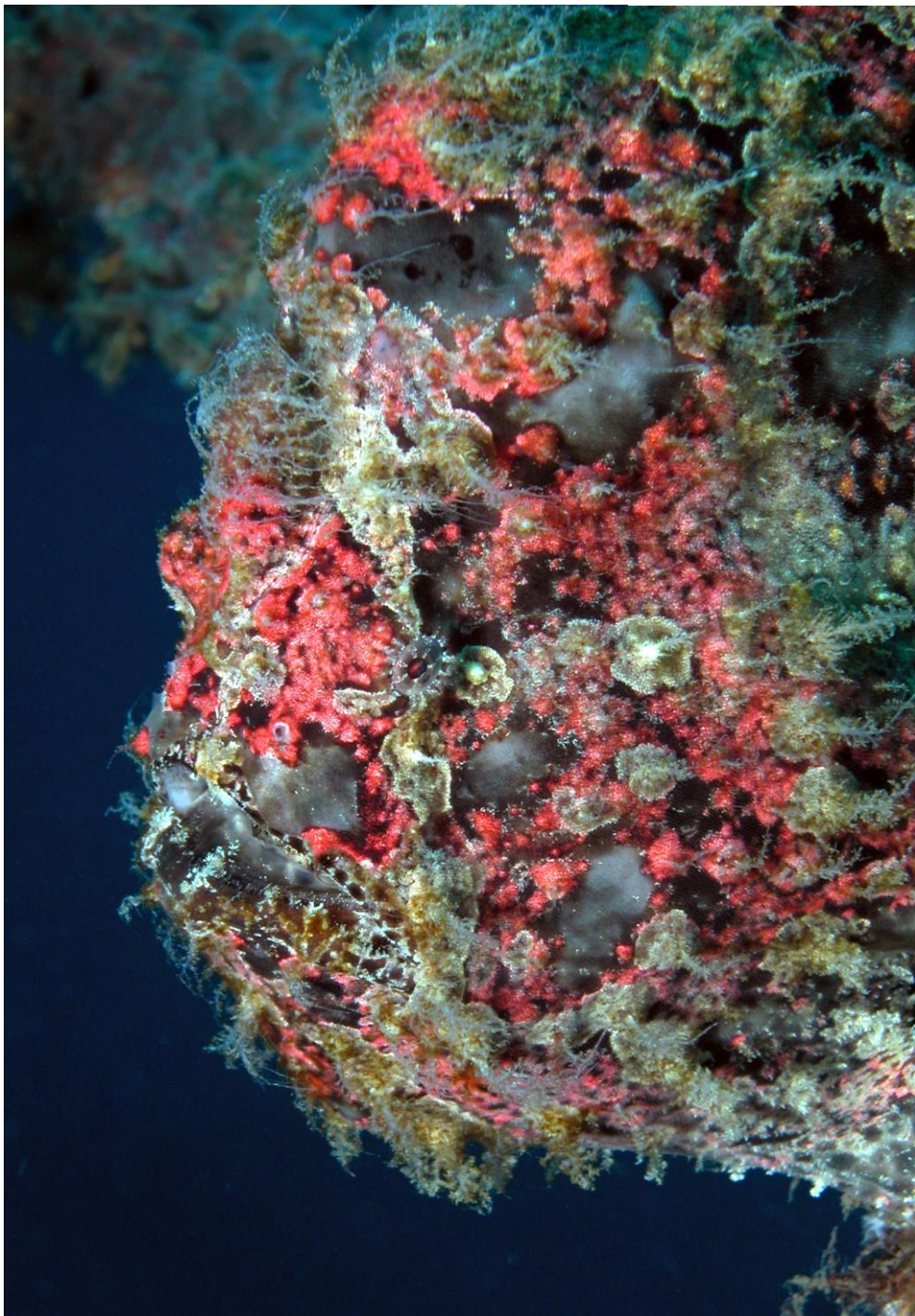
Size: Up to 30cm (12in.)

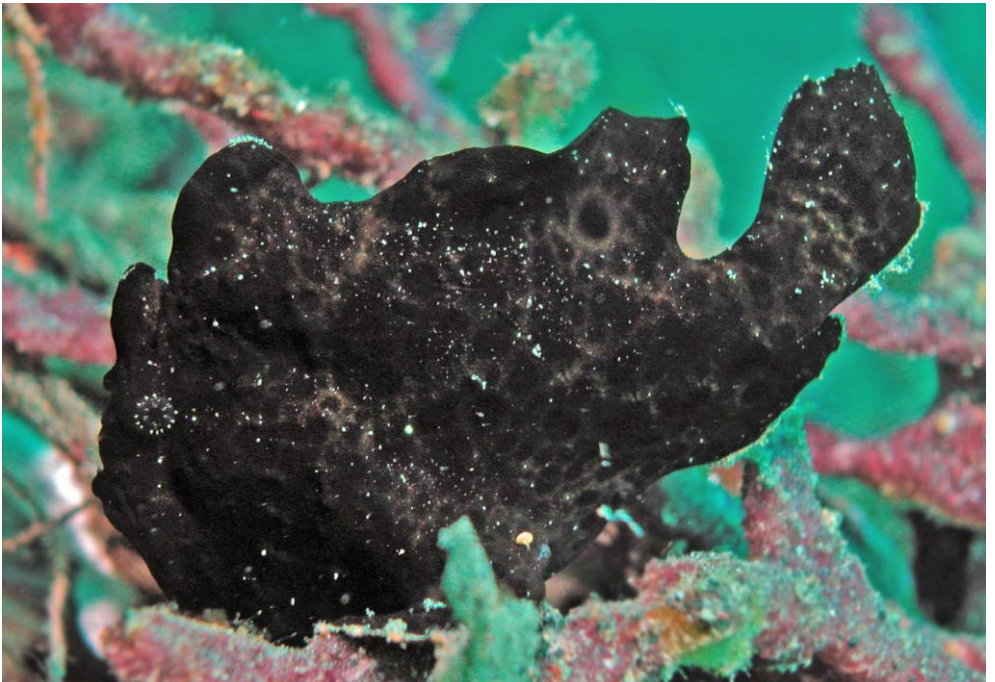
Habitat: Coral reefs, lagoons and seaward reefs down to 30m depth (100ft.). This frogfish usually perches on large sponges. Likes exposed areas where there is also some current.

Range: Red Sea, Indian Ocean, Maldives, Southeast Asia, Indo-Pacific to Society Islands, Japan, East Pacific. Wide spread and common.

Colours: Large colour variation, can change colours.

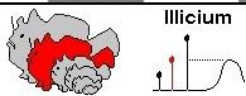
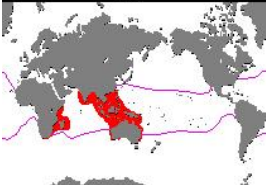
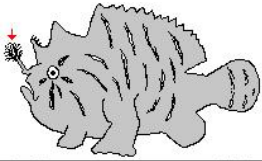






Young Giant Frogfish (*Antennarius commerson*) 5mm above, 60mm below

***Antennarius hispidus* (Bloch and Schneider, 1801)**
Hispid / Shaggy Frogfish



Characteristics: Illicium (rod) striped, about the length of second spine. Esca (lure, bait) with large oval-shaped tuft with slender filaments. Moves its esca so it looks like large tube worm in the current. Covered with roughly parallel dark stripes, some extending from the eye. Belly mostly without stripes. Belongs to the *Antennarius striatus* group. *Antennarius striatus* looks very similar but has a worm-shaped lure (Pietsch and Grobecker, 1987, p. 71).

Size: 15-20cm (6-8in.)

Habitat: Sandy areas, shallow rocky and coral reefs to 90m (300ft.). It squats hidden among algae, leaves and twigs swept into the sea or leaning

against rocks. Doesn't move around much. It is sometimes found in groups containing 5 to 6 individuals.

Range: East Africa, Southeast Asia, Japan to Australia. Some sightings in Fiji, Tonga and Cook islands. Wide spread but difficult to find.

Colours:

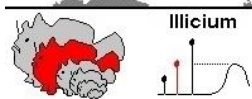
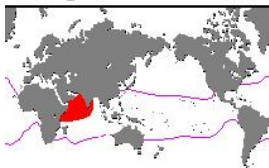






Several males surrounding a bloated female / Baby Hispid Frogfish (*A. hispidus*) 10mm

***Antennarius indicus* (Schultz, 1964)**
Indian Frogfish



Characteristics: Illicium (rod) is about the length of the second spine. Large esca (lure, bait) has flat leaf-like appendages. Body has two or three dark round spots encircled by a lighter coloured ring on the side. Black stripes appear on the fins and sometimes also on the body. Based on new DNA tests, this species is also placed into the *Antennarius striatus* group (Pietsch and Grobecker, 1987, p. 115; Arnold, 2012).

Size: Up to 19cm (7.5in.)

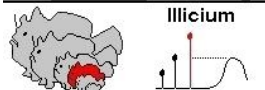
Habitat: Coral reefs to about 25m (80ft.). Perhaps this species lives in habitats similar to those of other striped frogfishes such as sandy areas with algae and seaweed.

Range: Endemic to the West Indian Ocean, Zanzibar, Seychelles, Gulf of Aden and Oman, Sri Lanka, Laccadives. Restricted to this area, uncommon. This is the only species listed in this book that is not found in Southeast Asia.

Colours:



***Antennarius maculatus* (Desjardins, 1840)**
Warty / Clown / Wartskin Frogfish



Characteristics: Illicium (rod) longer than second dorsal spine. Esca (lure, bait) is rather flat, mottled white and brown with vertical bands. Bait looks like a small fish or shrimp, it even has an "eye spot". Second and third dorsal spines connected with thin membranes to the head. Skin is very warty. Brown or black round, light-edged spots in different sizes. Irregular patches radiate from the eye, and there is a saddle on shoulders and the caudal peduncle. Belongs to the *Antennarius pictus* group. *Antennarius maculatus* is the smallest frogfish of the group (Pietsch and Grobecker, 1987, p. 87).

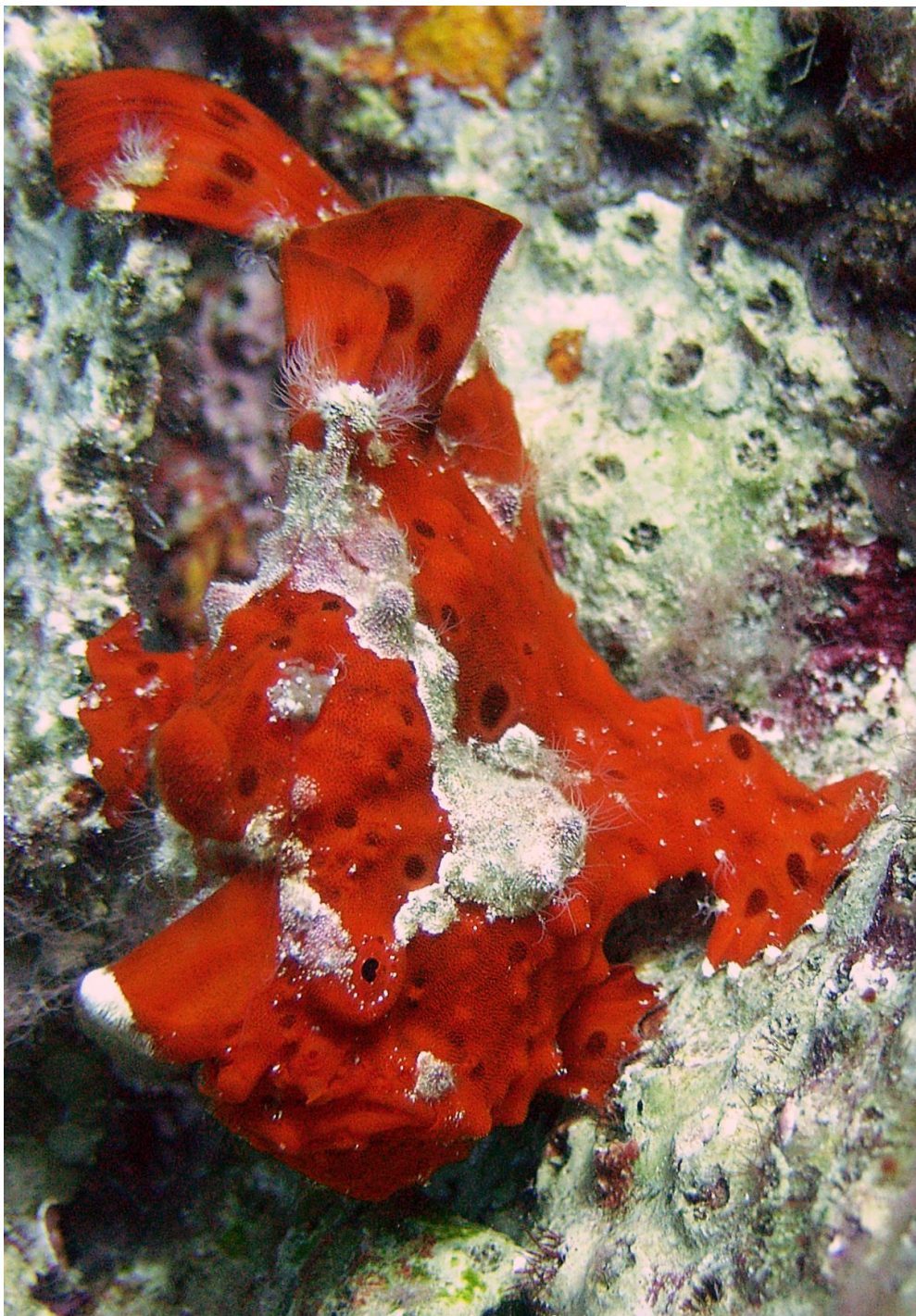
Size: 8-10cm (3-4in.)

Habitat: Shallow sheltered reefs, among algae, sponges and soft corals. To 20m depth (65ft.).

Range: Mauritius, Maldives to Solomon islands, Japan, Papua New Guinea, New Caledonia, mainly Philippines and Indonesia. Common.

Colours: Large colour variation, can change colours. Juveniles are white and orange coloured, mimicking flatworms.



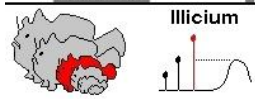
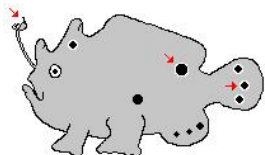




Young Clown Frogfish (*A. maculatus*) 15mm above, 40mm below, 50mm overleaf



Antennarius pictus (Shaw, 1794) Painted Frogfish



Characteristics: Illicium (rod) twice as long as second spine. Esca (lure, bait) bushy below, broad with compressed appendages. There are nearly always three light-edged spots on the caudal fin. The body may have some wart-like swellings and numerous small round darker spots on body. Can easily be confused with other members of the *Antennarius pictus* group like *A. commerson* or *A. maculatus* (Pietsch and Grobecker, 1987, p. 79).

Size: 10-16cm (4-6.5in.)

Habitat: Shallow sheltered reefs, lagoons, sandy areas covered with algae and sponges. Likes to live on or close to colourful sponges and adjust its skin colouring to the surroundings. Lives mostly around 10-20m (30-60ft.) depth, can be found to 70m (200ft.).

Range: Red Sea, East Africa, Maldives, Southeast Asia to Hawaii, South Japan to Australia. Widespread.

Colours: Large colour variation, can change colours. Juveniles can be black with orange spots and blue areas on fins.

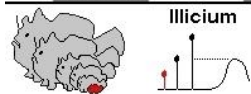
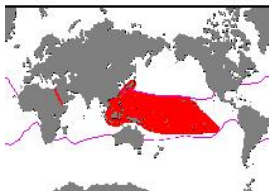
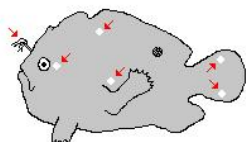
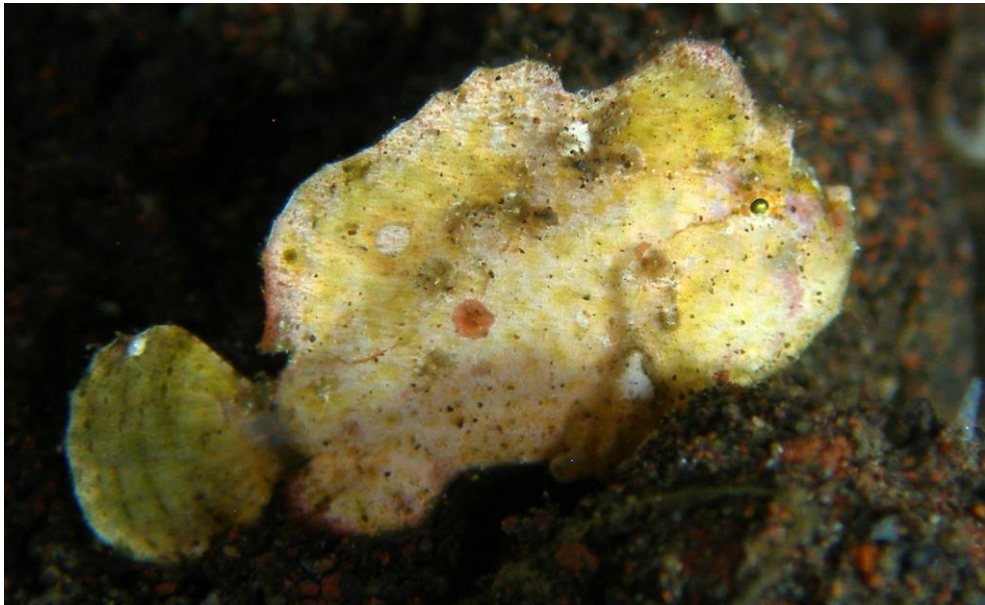






Juvenile frogfishes (*A. pictus*) approx. 5mm above and 10mm below

***Antennarius randalli* (Allen, 1970)**
Randall's Frogfish



Characteristics: Short illicium (rod). Esca (lure, bait) split into two with several slender filaments. Esca looks like a small cuttlefish. White spot on caudal fin, one near upper, one near lower edge of the fin. One white spot behind eye, one on dorsal fin, one above pectoral fin. Second and third spines connected by membrane, forming a small aperture to protect esca. The body is rather flat. Dorsal spot. Belongs to *Antennarius pauciradiatus* group (Pietsch and Grobecker, 1987, p. 178).

Size: 1.5-2cm (0.5-1in.)

Habitat: Rocky and coral patch reefs, sandy areas, mostly shallow water. This frogfish is very small, and since it is mostly brown to yellow it is

difficult to distinguish from the rubble or coral pieces it is hiding among.

Range: Red Sea, West Pacific, Japan, Taiwan, Philippines, Indonesia to Hawaii and Easter Islands. Not commonly found, very small.

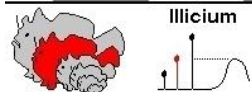
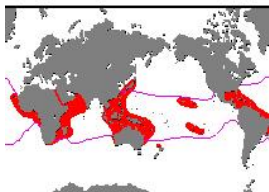
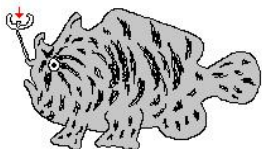
Colours: Looks like a crusty Halimeda alga or like a withered leaf.





Two colour variations of Randall's Frogfish

***Antennarius striatus* (Shaw, 1794)**
Striped / Hairy Frogfish



Characteristics: Illicium (rod) is thick and about the length of the second spine. The esca (lure, bait) is very flexible with two to seven thick worm-like appendages. This species belongs to the *Antennarius striatus* group and is closely related to *Antennarius hispidus*, but that frogfish has a very bushy lure (Pietsch and Grobecker, 1987, p. 54).

Size: 18-22cm (7-8.5in.)

Habitat: Sand, rubble and mud, between algae. Can also live at great depths (to 200m or 650ft.). Likes to walk around and actively stalk its prey.

Range: Red Sea, East Africa, Southeast Asia to Society and Hawaiian islands, Japan to New Zealand, West and East Atlantic. Not found in the An-

daman Sea. Wide spread but difficult to find.

Colours: Especially when living in areas with filamentous algae, some individuals are covered with numerous long skin appendages, hence the name "Hairy" Frogfish. Brown-black stripes. Juveniles often also have dark oval blotches (see next page)



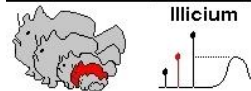
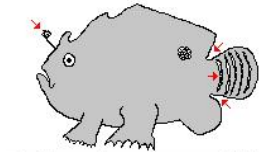


Young Hairy Frogfishes (*A. striatus*) 10mm above and overleaf / 40mm below





***Abantennarius coccineus* (Lesson, 1831)**
Freckled / Scarlet Frogfish



Name: Based on genetic studies, *Antennarius coccineus* has been newly assigned to the genus *Abantennarius* (Pietsch & Arnold, 2020).

Characteristics: Illicium (rod) is about the length of the second spine. Esca (lure, bait) looks like a small tuft, sometimes with dark swellings at the base. Dark basidorsal spot is not very pronounced. This species lacks a distinct tail base (dorsal and anal fins end at base of tail fin) which distinguishes it from the similar looking *Ab. nummifer*. Similar species *Ab. drombus* lives only in Hawaii (Pietsch & Gro-becker, 1987, Pietsch & Arnold, 2020).

Size: 9-13cm (3.5-5in.)

Habitat: Intertidal areas, lagoons and seaward reefs. Mostly shallow water (less than 10m or 30ft.). Cryptic, likes to hide in crevices and among coral rubble.

Range: Red Sea, West Indian Ocean, Maldives, Southeast Asia to East Pacific, Southwest Japan to Australia. Wide spread but difficult to find.

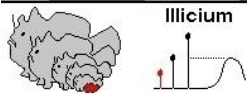
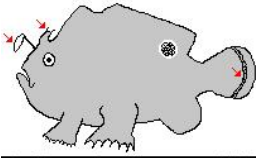
Colours:







***Abantennarius dorehensis* (Bleeker, 1859)**
New Guinea Frogfish



Name: Based on genetic studies, *Antennarius dorehensis* has been newly assigned to the genus *Abantennarius* (Pietsch & Arnold, 2020).

Characteristics: Illicium (rod) is distinctly shorter than second spine. Esca (lure, bait) is simple and oval shaped. This is the only species with the lure pointing towards the belly (ventrolateral) and with the second spine bent backwards. Sometimes there is a weak spot on the dorsal fin. Often there are bands on the tail (Pietsch and Grobecker, 1987, p. 166).

Size: 2.5-5cm (1-2in.)

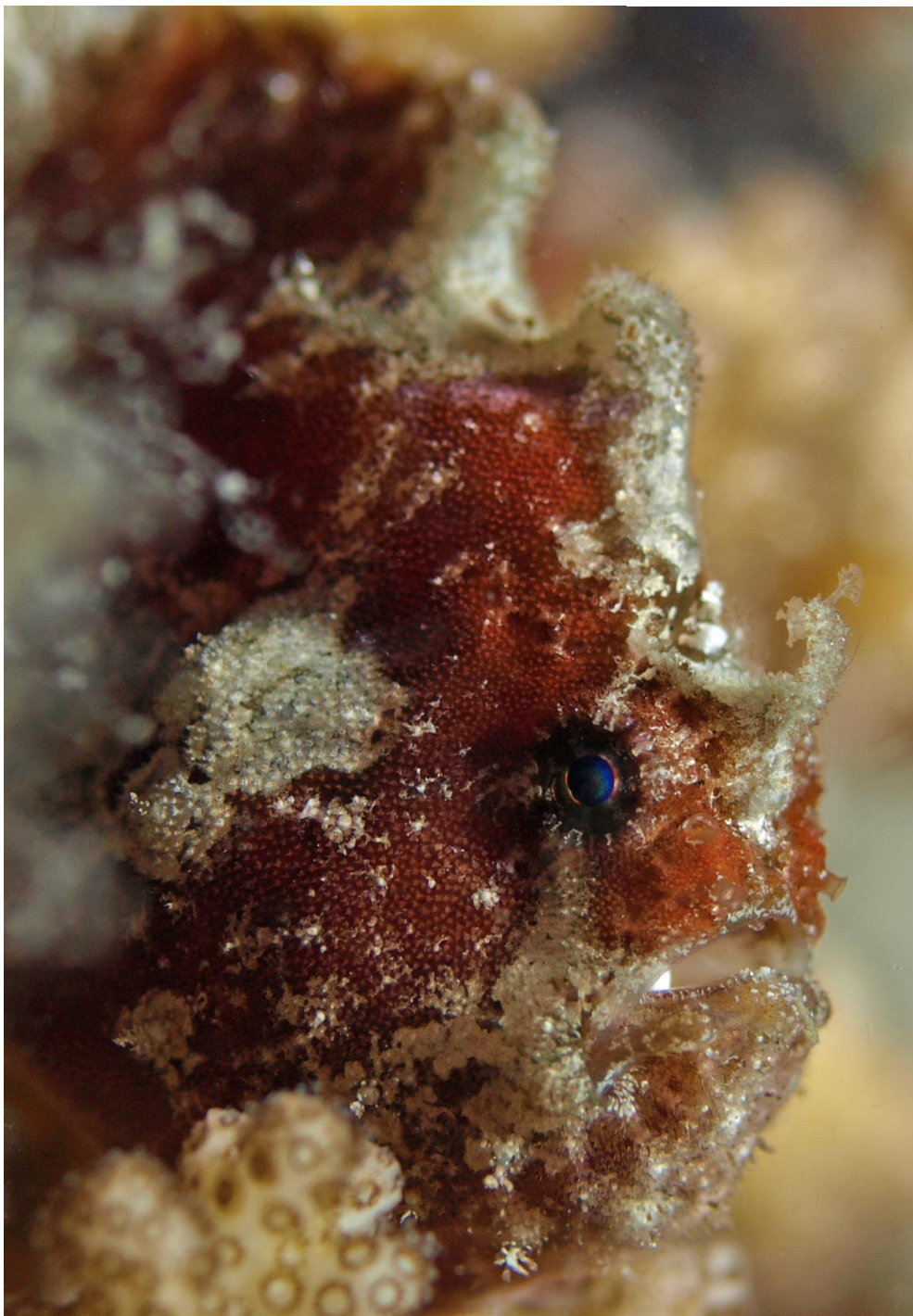
Habitat: Lives close to the surface in shallow water (1-3m or 10ft.) on sandy reef flats. Because

this frogfish is very small, it is very difficult to find.

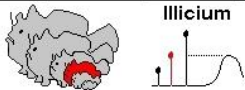
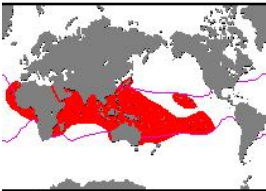
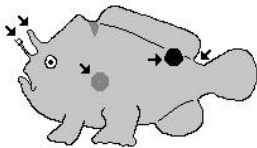
Range: East Africa, Southeast Asia to Tahiti and Society Islands, Taiwan, Southwest Japan to Australia. Wide distribution, but cryptic.

Colours:





***Abantennarius nummifer* (Cuvier, 1817)**
Spotfin / Coinbearing / Whitefingered Frogfish



Illicium



Name: Based on genetic studies, *Antennarius nummifer* has been newly assigned to the genus *Abantennarius* (Pietsch & Arnold, 2020).

Characteristics: Illicium (rod) about equal to length of second dorsal spine. Esca (lure, bait) small and often round and sometimes with filaments and dark swellings. Large dark basidorsal spot and orange-brown round spot on the side (hence the name "Coinbearing" Frogfish). This species has a distinct tail base which distinguishes it from the similar looking *Ab. coccineus* (Pietsch & Grobecker, 1987, p. 138).

Size: Up to 10cm (4in.)

Habitat: Lagoons and seaward reefs, seaweed areas. Lives hidden in crevices and below corals. Found most of the time in less than 20m (60ft), up to 170m (550feet).

Range: East Atlantic, Red Sea, East Africa, Maldives, Southeast Asia to Society islands, Southwest Japan to Australia and New Zealand.

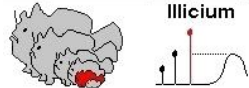
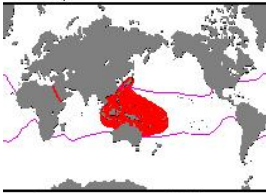
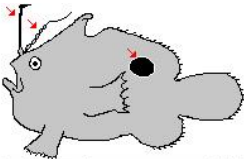
Colours:







***Abantennarius rosaceus* (Smith and Radcliffe, 1912)**
Spiny-tufted / Rosy Frogfish



Name: Based on genetic studies, *Antennarius rosaceus* has been newly assigned to the genus *Abantennarius* (Pietsch & Arnold, 2020).

Characteristics: Typically the second spine is very long and slender with small clusters. Illicium (rod) is distinctly longer than the second spine. Esca (lure, bait) is elongate with long filaments and dark swellings at the base. Dorsal spot is dark and encircled with a yellow ring (Pietsch and Grobecker, 1987, p. 170).

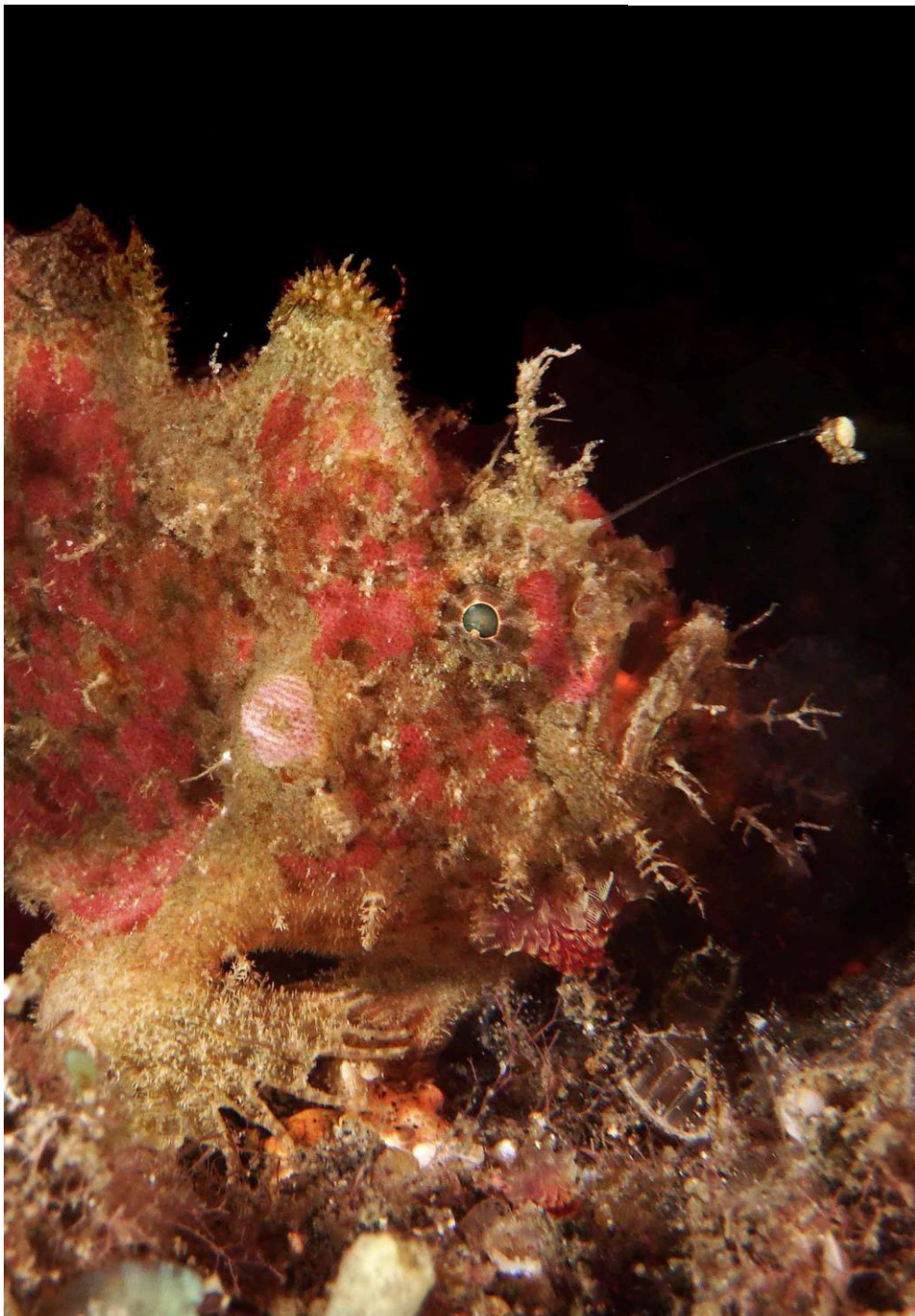
Size: Up to 4cm (1.5in.)

Habitat: Close to coral reefs. Found in surface water down to 130m, average around 30m.

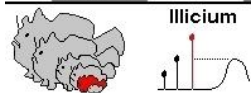
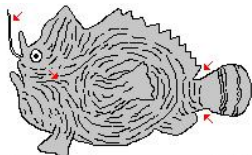
Range: Red Sea (one sighting), Southeast Asia, West Pacific to Samoa, Japan. Not well known.

Colours: This frogfish is not rose-coloured like the common name suggests but dark red, violet to brown with brown spots on body and fins, except on belly.





***Antennatus linearis* (Randall and Holcom, 2001)**
Pygmy Frogfish



Characteristics: Illicium (rod) longer than second spine. No distinct esca (lure, bait). A typical pattern of close-set, curving dark lines on the head and body with a lace-like pattern of fine white lines superimposed on the linear patterns. Blackish blotches are sometimes present. Dark bands on tail, the caudal peduncle is present. Although it lacks an obvious esca, it uses its illicium as a lure, attracting prey with vibrations. Closely related to *Antennatus tuberosus* (Randall and Holcom, 2001)

Size: 6-7.5cm (2-3in.)

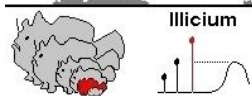
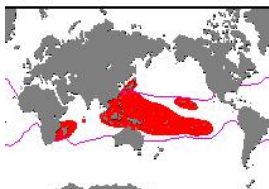
Habitat: Hides between rubble and rocks. Found at 4-33m (to 100ft.).

Range: Indo-West Pacific (South Africa, Natal, Mozambique, Aldabra, Molucca Islands, Japan, Papua New Guinea, Hawaii). Very uncommon.

Colours: Uniform brown colouring with lighter or darker areas and white lines superimposed. The colour patterns are reminiscent of some sponges and tunicates.



***Antennatus tuberosus* (Cuvier, 1817)**
Tuberculated / Bandfin Frogfish



Characteristics: Illicium (rod) is twice the length of the second spine. The rod tapers to a fine point, and there is no esca (lure, bait). Conspicuous dark-brown band on tail and no caudal peduncle. Typical red-brown marbled patterns on the skin, which is cream yellow with pink on the head. Closely related to *Antennatus linearis* (Pietsch and Grobecker, 1987, p. 192).

Size: Up to 7cm (3in.)

Habitat: Coral reefs, mostly at a depth of less than 6m (20 ft.), but it has been found down to 70m (230ft.). Often hides among hard coral, very cryptic.

Range: East Indian Ocean, Chagos Archipelago, Southeast Asia, Japan to Hawaii. Widespread but difficult to find.

Colours: Marbled with sometimes a bit lighter or darker overall colouring. A few specimens are overall cream coloured or only with red patterns but with the typical dark-brown band on the tail. Some individuals have pink patches. The image next page shows a juvenile.



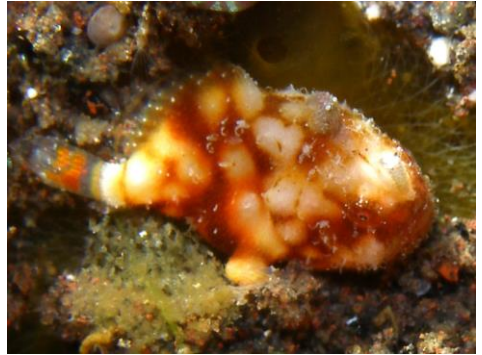
Colour variations *A. tuberosus*



Different colours but the tail always has dark-brown bands



Juveniles

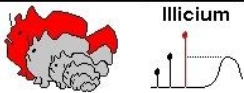
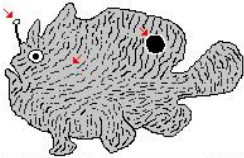


Some specimens show characteristics of both the Tuberculated Frogfish (*A. tuberosus* - left) and the Pygmy Frogfish (*A. linearis* - right), like the superimposed lines on the head.

Next page: Baby Tuberculated Frogfish (*A. tuberosus*) 10mm



***Fowlerichthys scriptissimus* (Jordan, 1902)**
Scripted / Calico Frogfish



Name: Based on genetic studies, *Antennarius scriptissimus* has been newly assigned to the genus *Fowlerichthys* (Arnold, 2012). *Antennarius sarasa* is a junior synonym of this species.

Characteristics: Illicium (rod) is long and the esca (lure, bait) small, white and bulbous. The triangular second spine is connected to the third spine by a skin flap. Dark spot on the dorsal fin (Nakabo, 2002).

Size: 28cm-50cm (very large specimen from the Cook islands) 11-19in.

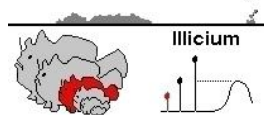
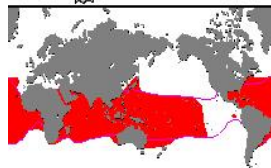
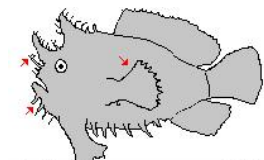
Habitat: Lives on rocky coastal reefs at a depth of up to 185m (600ft.).

Range: West Indian Ocean, South China Sea, Japan, Taiwan, Philippines, Tahiti, New Zealand. Most known sightings are from Japan. This species is very uncommon in Southeast Asia

Colours: Green-brown with lighter lines on the whole body.



***Histrio histrio* (Linnaeus, 1758)**
Sargassum Frogfish / Sargassumfish



Characteristics: Illicium (rod) short. Small esca (lure, bait) with folds. Very large pelvic and breast fins. Two conspicuous cutaneous appendages on mid-dorsal line of snout. Body covered with fleshy and leafy appendages. Has a swim bladder. Genus consists of a single species. Based on genetic studies, *Histrio histrio* is closely related to frogfishes of the genera *Antennarius* and *Antennatus* (Pietsch & Grobecker, 1987, p.199; Arnold, 2012).

Size: 15cm (6in.)

Habitat: Surface waters among Sargassum seaweed. Can also be found close to coral reefs, having drifted there.

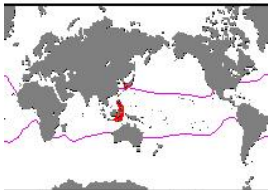
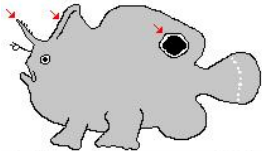
Range: *Histrio histrio* has a very large dispersal area. Found in all tropical seas (sightings even in the East Pacific and in colder water to 40-degree latitude north and south) in open water.

Colours: Highly variable, consisting of stripes, streaks, spots, and mottling of brown, olive, and yellow. Some are plain-coloured, only brown, creamy, or black. They resemble floating Sargassum weed.





Nudiantennarius subteres
Lembeh / Ocellated Frogfish



Illicium



This species has long been known as the Lembeh Frogfish (*Antennatus sp.*), an undescribed frogfish species which was found by divers around Indonesia and the Philippines. It has been identified and redescribed as *Nudiantennarius subteres* (Pietsch & Arnold 2017)

Characteristics: Illicium (rod) thin and slightly smaller than the second spine. The esca (lure, bait) is small, white and round with short filaments. The second spine is unusually long and thin and not connected to the head with a membrane. Large pale edged eye spot (ocellus) on dorsal fin, sometimes more than one. Membranes between rays of fins deeply incised.

Size: 5-6 cm (2-2.5in.)

Habitat: Sandy area with algae and rubble. Sometimes found hidden between sea urchins. Often found by night. 5-10m (15-30ft.) depth.

Range: Indonesia (Sulawesi, Bali, Alor), Philippines, Japan

Colours:

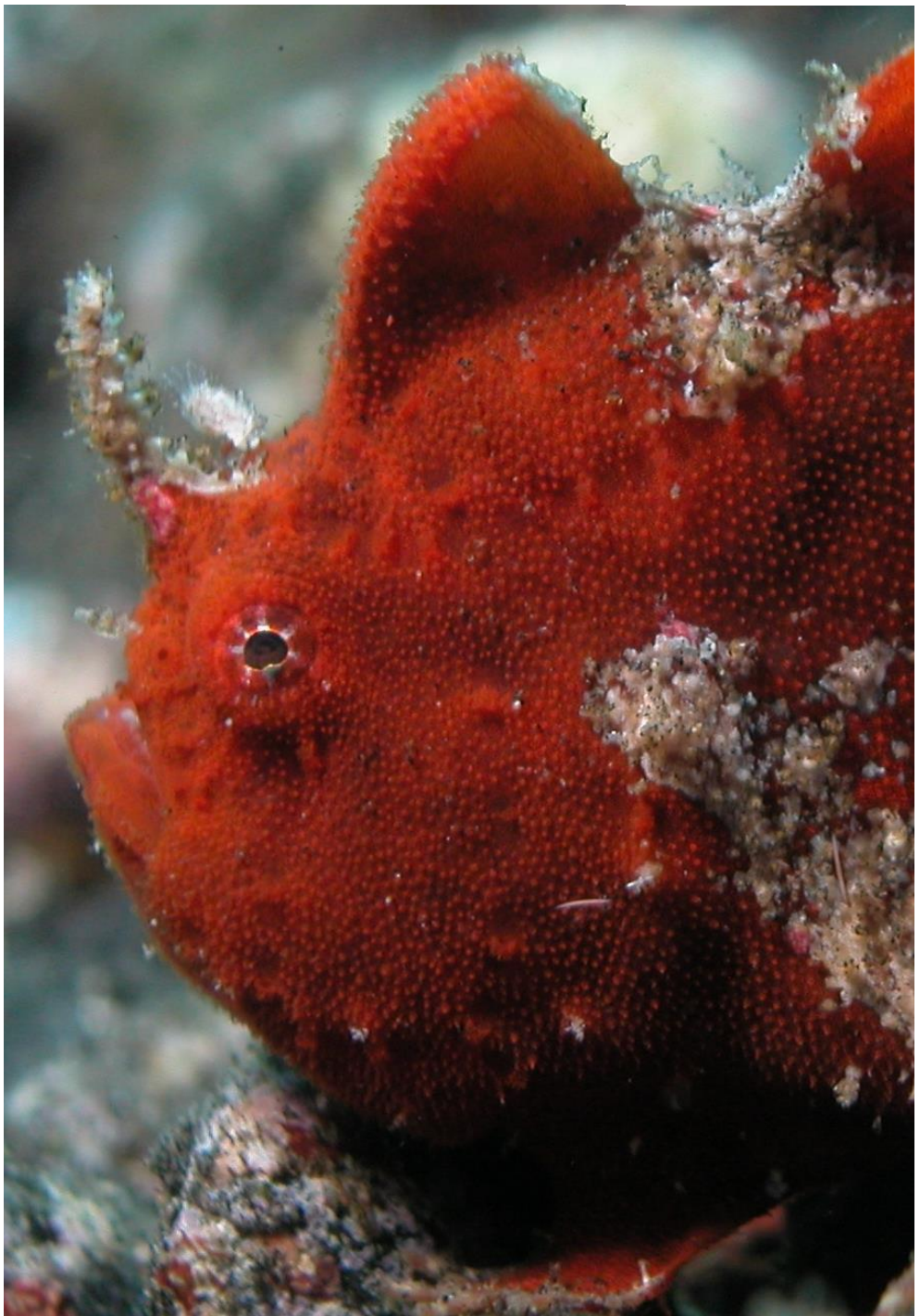


Colour variations *N. subteres*



Lure (esca)



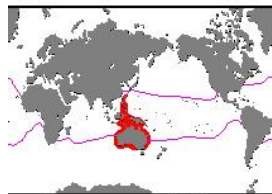




10.3 Subfamily Histiophryninae

Histiophryne cryptacanthus (Weber, 1913)

Cryptic / Rodless Frogfish



Characteristics: Very small illicium (rod) and tiny esca (lure, bait), nearly always hidden in a groove that lies about on the midline of the snout anterior to the eyes. Second and third dorsal spines are laid back and bound on the surface of the head by thick skin. Females hide a cluster of eggs (about 120 eggs, measuring 3-4mm) in a pocket formed by the pectoral fin and the tail (Pietsch and Grobecker, 1987, p. 255).

Size: Up to 9cm (3.5in.)

Habitat: Hidden under and inside coral rubble, mostly in shallow water sometimes to a depth of 130m (about 400ft.).

Range: West Pacific, Taiwan, Indonesia, Papua New Guinea and Philippines to subtropical Australia, except Tasmania. Rarely found.

Colours: Green-white areas and patches on skin that look like lichen.





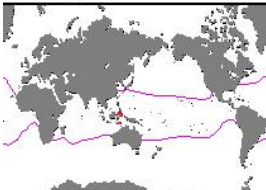
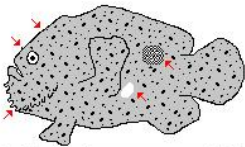
Juvenile of *Histiophryne cryptacanthus*, about 12mm (above) and 25mm (below)



As a juvenile, this frogfish looks like one of the abundant sea squirts (*Didemnum molle*), especially with the mouth open, and it has also been found on coral rubble with sea squirts. As an adult, it resembles greenish to purple sponges. It has green areas behind the pectoral fins.



Histiophryne pogonius (Arnold, 2012) Bearded Frogfish



Characteristics: Minute illicium (rod) and esca (lure, bait). The second and third dorsal spines lie flat on the surface of the head, attached with a thick layer of skin. This species has a flat face with small forward-facing eyes, cheeks with shallow depressions and a relatively small and nearly vertical mouth. Whisker-like skin appendages grow below the lips and on the chin. It has a stocky body with fleshy fins and no caudal peduncle. Closely related to *Histiophryne cryptacanthus*.

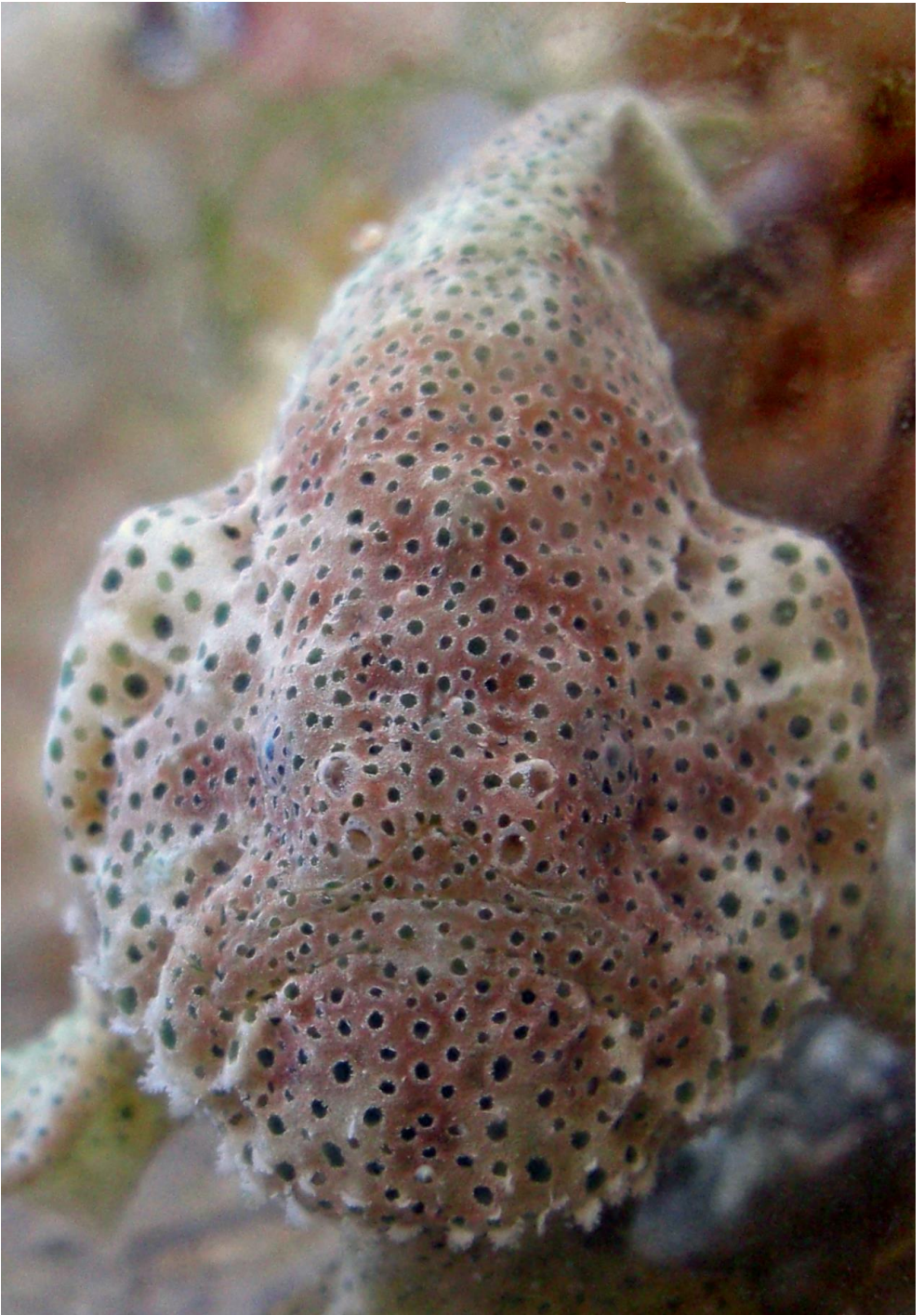
Size: 5-6cm (2in.)

Habitat: Found in shallow inshore waters, hidden in crevices under corals.

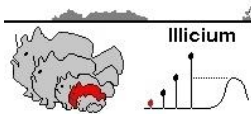
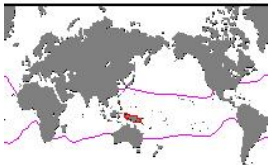
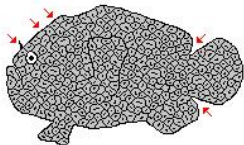
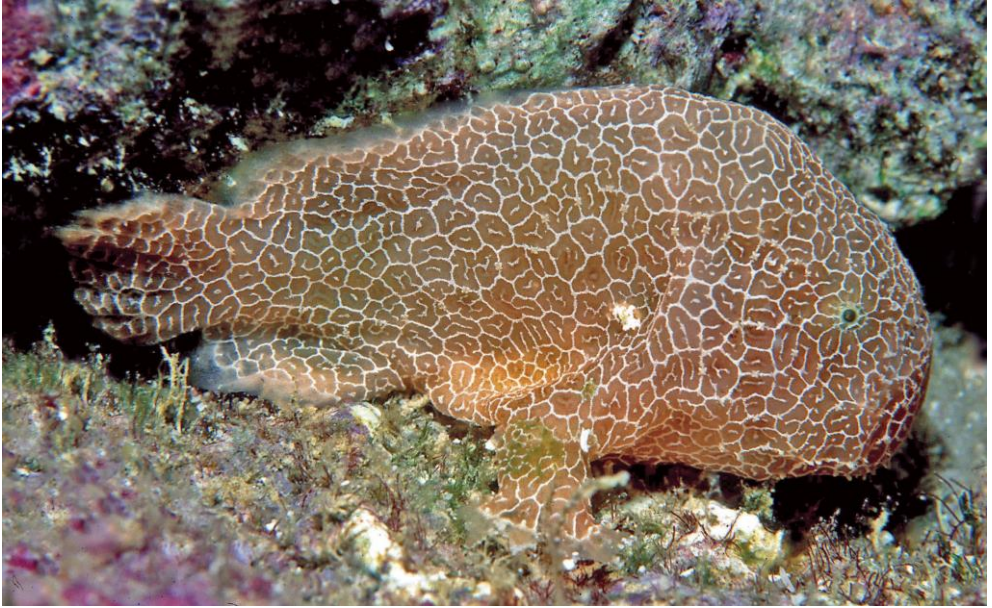
Range: Has been found in Southern Lombok and the Komodo islands (Indonesia), reportedly also in Cebu (Philippines).

Colours: Rose coloured with small dark red-brown to green-black round spots that are surrounded by a thin white ring. White encrusted patch behind the pectoral fins. Darker spot below the dorsal fin.





Histiophryne sp.1
Honeycomb / Paisley Frogfish



This frogfish with the brown-white honeycomb pattern is a new but not yet formally described and named species.

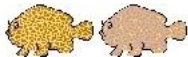
Characteristics: Shape and size of illicium (rod) and esca (lure, bait) unknown. The second and third dorsal spines lie flat on the surface of the head, attached with a thick layer of skin. It has a flat face with small forward-facing eyes and a relatively small and nearly vertical mouth. This frogfish is sometimes identified in books as *Histiophryne cryptacanthus*, but the scientific description of this species (Pietsch and Grobecker, 1987) doesn't mention this kind of pattern.

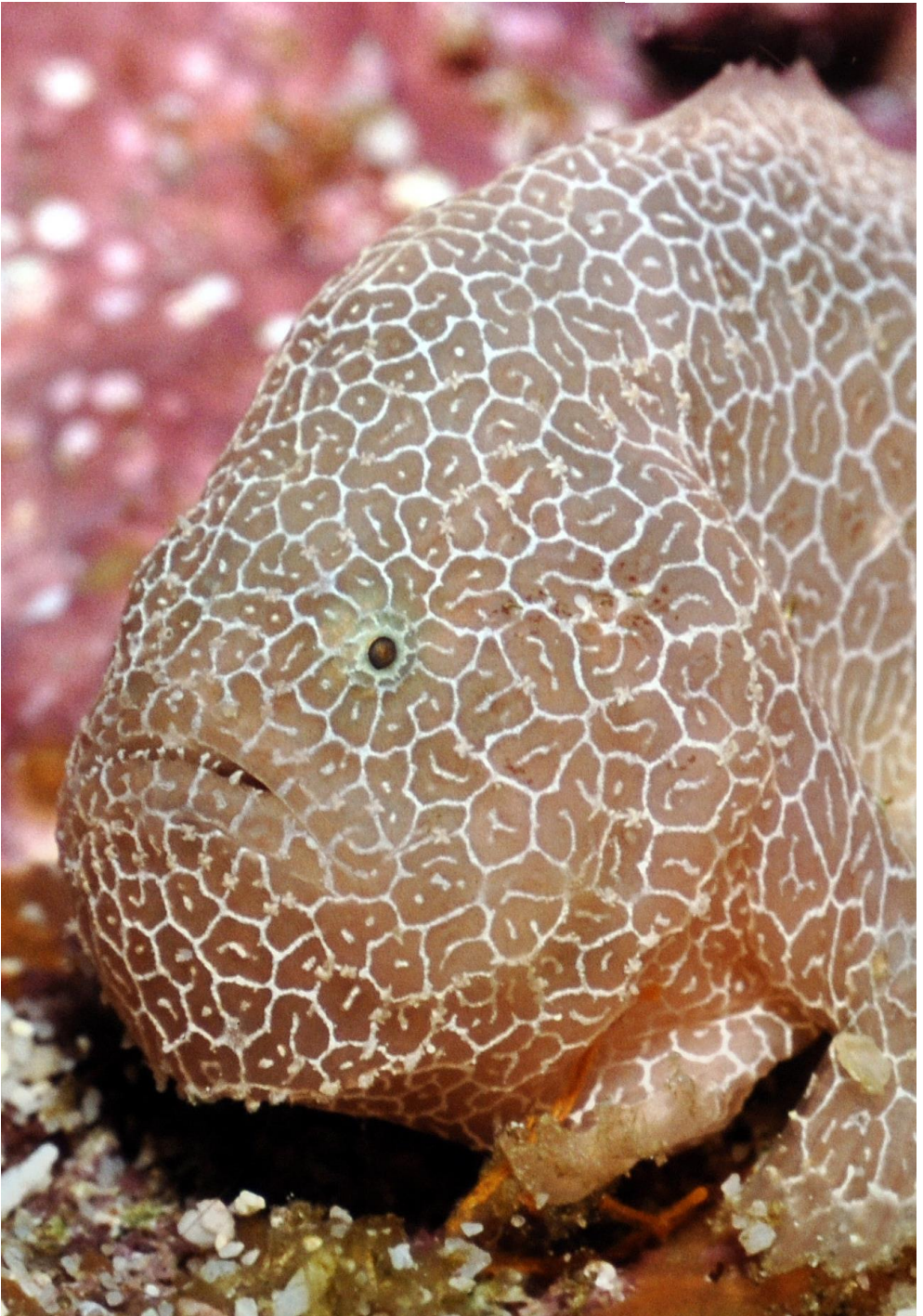
Size: Approx. 8-9cm (3-4in.)

Habitat: Coastal reefs.

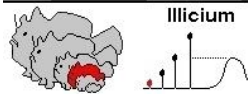
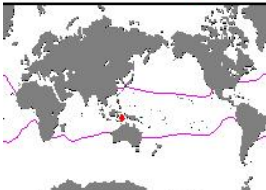
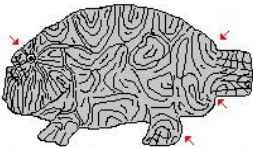
Range: So far only known from Papua New Guinea.

Colours: This frogfish is brownish to light pink with a honeycomb pattern reminiscent of the patterns on stony corals or tunicates. A white encrusted patch behind the pectoral fins.





***Histiophryne psychedelica* (Pietsch, Arnold, and Hall, 2009)**
Psychedelic / Ambon Frogfish



Characteristics: Illicium (rod) minute, no esca (lure, bait), second and third dorsal spines laid back and bound on the surface of the head by thick skin. Entire body covered with lines. The face is very flat with the eyes directed forward. The dorsal, anal, and caudal fins are thick and fleshy and covered by loose skin. No caudal peduncle. Small swim bladder present. These frogfishes might live in deeper water and move to shallow waters for mating. The female protects her eggs within a fold between the body and the caudal fin. This frogfish moves with a series of short hops, pushing off from the ground with its pelvic fins (Pietsch, Arnold, and Hall, 2009).

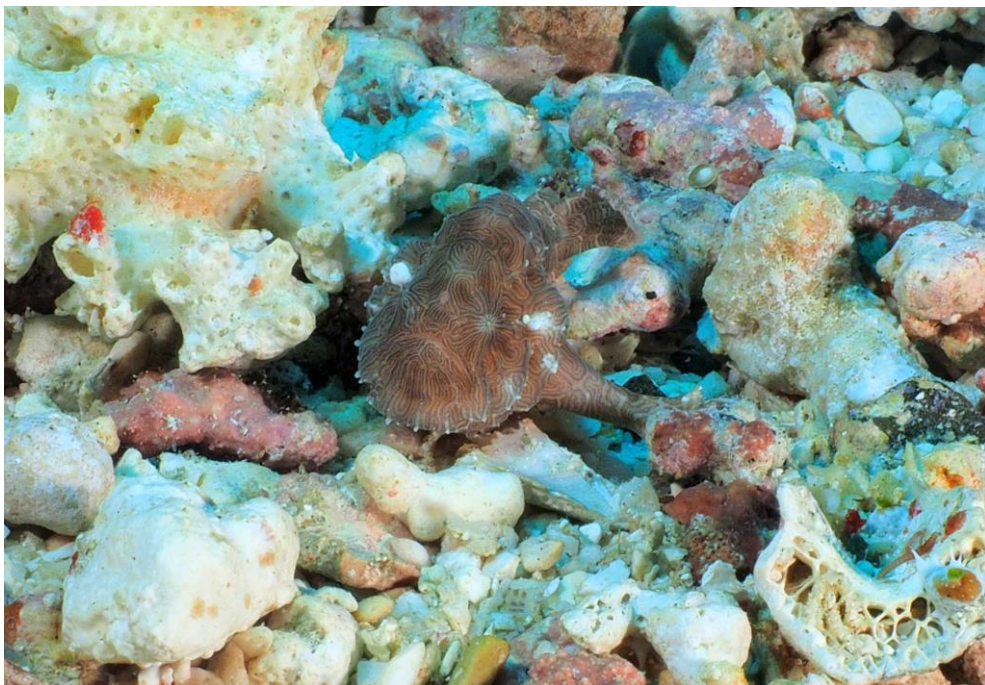
Size: 6-9cm (2-3.5in.), perhaps up to 15cm (6in.)

Habitat: 5-7m depth (to 20ft.), hide among rubble and in small holes.

Range: Endemic to the Moluccas (Indonesia). Very uncommon.

Colours: The Psychedelic Frogfish has white-brown-grey lines like the patterns found on stony corals.



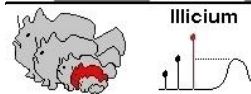
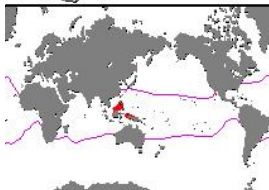


A few specimens with finer, dark lines have been found in the northern Moluccan islands.





***Lophiocharon lithinostomus* (Jordan and Richardson, 1908)**
Marble-Mouthed Frogfish



Characteristics: Long twig-like illicium (rod) covered with dermal spinules, esca (lure, bait) not very distinct. Large cone-shaped nostrils. Rows of two to four nearly translucent to transparent ocelli (eye spots) on the membranes between the caudal fin rays. The female is carrying a clutch of eggs (about 650 eggs of about 3mm diameter) attached with thread-like structures to the skin surface on the left side of her body. She protects them by folding the tail fin. This species can easily be confused with *Lophiocharon trisignatus*, but it can be distinguished because it has no distinct lure (Pietsch and Grobecker, 1987, p.229).

Size: Up to 9cm (3.5in.)

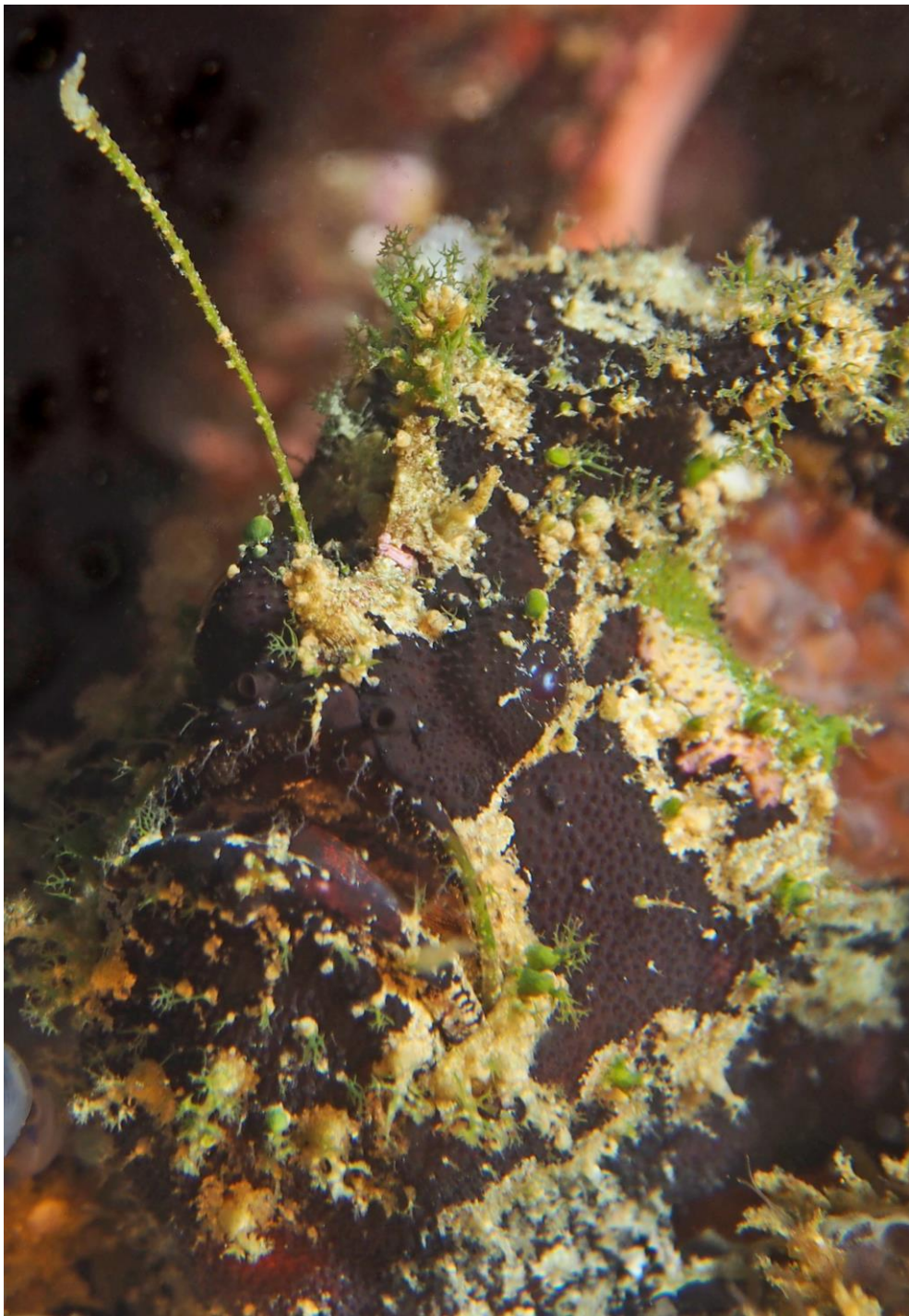
Habitat: Shallow reef flats, seaweed beds, sandy areas.

Range: Philippines, North Borneo, Papua New Guinea. Restricted to this area, uncommon.

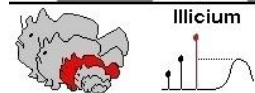
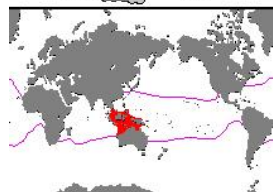
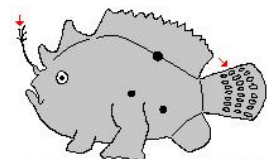
Colours: This species has a mottled body; even the inside of the mouth is mottled. It looks like an algae-covered stone.







***Lophiocharon trisignatus* (Richardson, 1844)**
Three-Spot / Spotted-Tail Frogfish



Characteristics: Illicium (rod) long. Large complex esca (lure, bait) that looks like a spider crab or like a tube worm. Rows of two to four nearly translucent to transparent ocelli (eye spots) on the membrane between the caudal fin rays. The female carries around an egg cluster attached to the left side of the body. The hatchlings are well developed, like a miniature version of the adult. This species differs from *Lophiocharon lithinostomus* in that it has a more complex lure (Pietsch and Grobecker, 1987, p. 224).

Size: 14-18cm (6-7in.)

Habitat: Coastal reefs, on shallow reef flats and under wharf pilings at a depth of 2-20m (to 65ft.).

Range: Singapore, Borneo, Philippines, Indonesia, Papua New Guinea to tropical Australia. This species is rarely found.

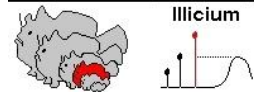
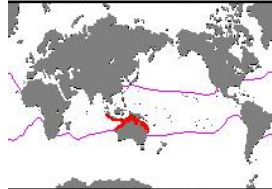
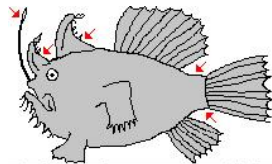
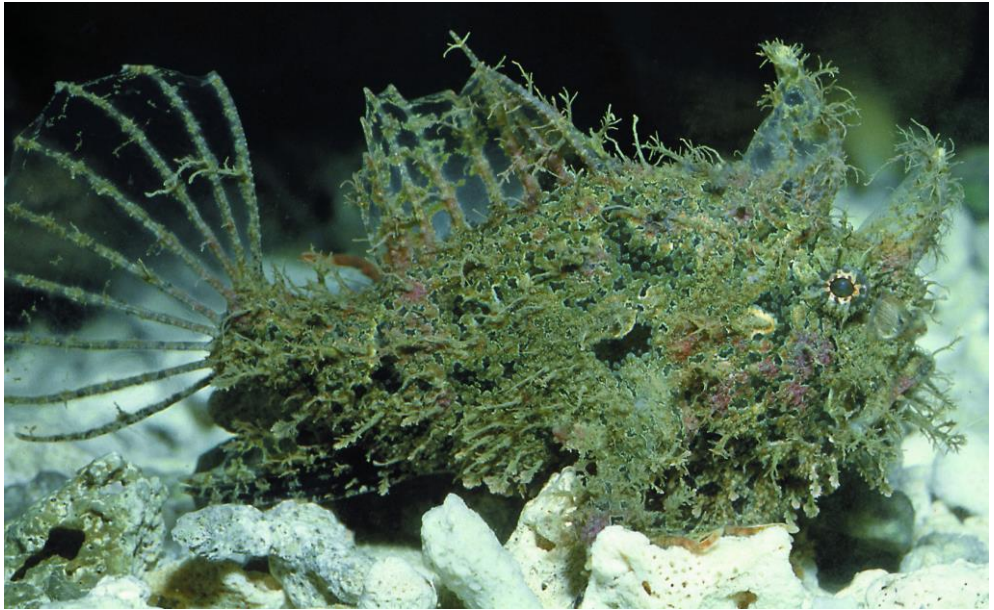
A related species *L. hutchinsi* has a short lure. Aru island, Indonesia

Colours:





***Tathicarpus butleri* (Ogilby, 1907)**
Butler's Frogfish



Characteristics: Illicium (rod) extremely long, up to half body length. Esca (lure, bait) broad and long with one or two eye spots at the bottom. Typically this species has transparent membranes between the exceptionally long fin rays. Small skin flaps on the body. Distinct caudal peduncle (dorsal and anal fins attached to the body distinctly anterior of caudal fin). Gill opening tube-like, extending out from the surface of the body. Has been observed to attach a mass of eggs to rocky substrate. Closely related to the genera *Lophiocharon* and *Histiophryne*. Genus consists of a single species (Pietsch & Grobecker, 1987, p. 259).

Size: 10-12cm (4-5in.)

Habitat: Lives among rubble and seaweed and in coastal reefs to a depth of 140m (450ft.) but usually shallower than 25m (80ft.).

Range: Tropical Australia, Papua New Guinea, Moluccas.

Colours:



11. References

Identification of frogfishes from photos

I have identified the frogfishes in this book to my best knowledge and with the help of the following references. Mistakes are still possible.

Frogfishes

- Theodore W. Pietsch, Rachel J. Arnold: Frogfishes, John Hopkins University Press 2020
- Theodore W. Pietsch, David Grobecker: Frogfishes of the world, Stanford University Press, 1987

Frogfish species

- Rachel J. Arnold, Theodore W. Pietsch: Evolutionary History of Frogfishes (Teleostei: Lophiiformes: Antennariidae): A Molecular Approach, 2012
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- *Antennatus linearis* - John E. Randall, Ron R. Holcom: *Antennatus linearis*, a new Indo-Pacific species of frogfish, 2001
- *Fowlerichthys scriptissimus* (*Antennarius sarasa*) - Tetsuji Nakabo: Fishes of Japan with pictorial keys to the species, Tokai University Press, Japan, 2002
- *Histiophryne pogonius* - Rachel J. Arnold - A new species of frogfish of the genus *Histiophryne* (Teleostei: Lophiiformes: Antennariidae) from Lombok and Komodo, Indonesia, 2012
- *Histiophryne psychedelica* - Theodore W. Pietsch, Rachel J. Arnold, David J. Hall: A Bizarre New Species of Frogfish of the Genus *Histiophryne* (Lophiiformes: Antennariidae) from Ambon and Bali, Indonesia, 2009.
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- *Nudiantennarius subteres* - Theodore W. Pietsch, Rachel J. Arnold: The "Lembeh Frogfish" Identified: Redescription of *Nudiantennarius subteres*, Copeia 2017
- Integrated Taxonomic Information System ITIS.gov

Behaviour

- Rachel J. Arnold: Evolutionary History of the Teleost Family Antennariidae (Order Lophiiformes) Evidence from DNA, Reproduction, and Geographic Distribution, with Notes on Conservation Implications, 2011
- Scott W. Michael: Reef Fishes Vol. 1, Microcosm Ltd. Shelburne, 1998
- N. Ramaiah, D. Chandramohan: Occurrence of *Photobacterium leiognathi* as the bait organ symbiont in frogfish *Antennarius hispidus*, 1992
- Observations by Teresa Zuberbühler

Zoogeography

- AquaMaps.org (range)
- FishBase.org (number of fishes in Indonesia)
- Roland Fricke: Fishes of the Mascarene Islands (Réunion, Mauritius, Rodriguez), 1999
- Global Biodiversity Information Facility
- Kanagawa Museum of Natural History, Japan (fishpix)
- Sightings (including images) by Teresa Zuberbühler and divers

Systematics

Scientific names used in this book are according to Pietsch, Arnold, 2020.

12. Photo credits

A large thank-you to all photographers who have been so generous with their photos! All pictures were taken in the sea, except those tagged with a star which were taken in an aquarium. Nearly all images were taken in Southeast Asia (except p. 46 Caribbean / p. 130 Japan).

- Adams, Mary Jane: 49t
- Allen, Gerald: 143 / 153
- Arnold, Rachel: 141*
- Auer, Barbara: 145t / 145b
- Bailliez, Stephane: 26bl / 26br
- Bartick, Mike: 7mr / 7ml / 41 / 43 / 44 / 45 / 46b / 72 / 111 / 115 / 127tr / 128ml
- Braun, Ralf: 32t
- Bruner, Jayne: 128tl
- Buschenreithner, Martin: 26t / 31 / 71mr / 78t / 78b / 81br / 81bl / 113 / 157
- Dauer, Christian: 7tr / 74tr / 94 / 99
- Eckhardt, Marcel: 48
- Erdmann, Mark: 148
- Gawron, Johanna: 12 / 14 / 17br / 19 / 33 / 36 / 37tr / 37br / 38 / 39 / 52 / 66bl / 67mr / 68 / 71ml / 77tr / 95 / 110 / 118 / 119 / 128mr / 132 / 134tr / 134ml / 134mr / 136 / 144 / 147
- Groomer, Jessica: 80* / 102*
- Henshaw, Dave: 100
- Isley, Jason: 49br / 49bl
- Kanat, Zane: 128br
- Kozuka, Eiji: 130 Kanagawa Museum of Natural History (KPM-NR0094349)
- Mattke, Volker: 32b / 128bl / 137
- Muller, Ellen: 46tr / 46t
- Nagareda, Bronson: 126* / 140*
- Schwarz, Tom: 29t / 29b / 30t / 30b / 42t / 42b / 62 / 67ml / 74br / 121 / 125 / 128tr / 134tl / 146 / 149 / 156
- Shafer, Bruce: 55br / 55bl
- Steene, Roger: 142
- Sukirman, Kermi: 17tl / 104
- Taylor, Warren: 7br* / 37tl* / 151* / 152*
- Weidinger, Niki: 20tl / 20tr / 20ml / 20mr / 20b / 21 / 101t / 134bl
- Weigel, Heinz: 17tr / 71tl / 82bl / 83

All other images and illustrations

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Thanks

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Teresa (Zubi) Zuberbühler 2014/18/21 www.frogfish.ch



