

Ghosts on the Reef

by Klaus M. Stiefel

The Philippines are a curious country, full of striking contrasts. The island nation is torn between a fast-forward version of modernity and a mindset grounded in traditional spiritual thinking. While Manila has universities with cutting-edge computer science and marine biology departments, the people on the small islands in the provinces believe in an assortment of ghosts such as the white lady, the sigbin and the manananggal, a particularly vile creature which preys on pregnant women and feeds on their unborn children!

While these ghosts only exist in people's heads, there are also real ghosts in the Philippines, on the reefs just a few meters off those rural island villages. These are the ghost pipefishes, a family of fishes certainly among the most unusual vertebrates on the planet. Their highly modified bodies make them look more SciFi than all those aliens in your favorite SciFi movie. Few fishes have diverged as much from the standard fish-shape. The unusual bodies of the ghost pipefish did not evolve to delight us with their bizarre aesthetics, but for the sake of camouflage, and the six ghost pipefish species use different visual tricks to evade predators.

The most common (but still rather rare) ghost pipefish is the ornate ghost pipefish (*Solenostomus paradoxus*). Up to eleven centimeters long, it is a laterally compressed fish with a big head composed mostly of a long snout. It is covered in pointy fleshy appendages which make it look like a crinoid, an echinoderm distantly related to the seastars and sea urchins. These crinoids are filter-feeders, and collect plankton by swaying their arms back and

forth in the current. The ornate ghost pipefish don't just look like crinoid arms, but also move like them, peacefully rocking back and forth while hovering in-between the echinoderm's real appendages. When a diver approaches, the ghosts carefully move to the other side of the crinoid, mindful not to break camouflage by moving too swiftly or un-crinoid like. You will not see a power-stroke like that of an accelerating tuna from a ghost pipefish! Crinoids come in several different colors, and so do the ornate ghost pipefish: red, yellow, white and black forms can be seen. The ornate ghost pipe fish match their host's colors.

The robust ghost pipefish, *Solenostomus cyanopterus*, the halimeda ghost pipefish, *S. halimeda*, and the roughsnout ghost pipefish, *S. paegnius*, all seek safety by looking like marine plants and algae. There are, of course, many different kinds of marine plants and algae, which gives the ghost pipefishes many kinds of options in their quest for camouflage. Evolution has formed the bodies of each species to resemble one kind of marine plant. For instance, the halimeda ghost pipefish looks like a chain of halimeda algae. The robust ghost pipefish resembles a leaf of sea grass. The roughsnout ghost pipefish looks like a piece of seagrass overgrown with filamentous algae. This coarse genetic tuning of ghost pipefish camouflage (each species resembling one type of invertebrate, algae or plant) is further augmented by a fine-tuning of their looks, adjustable during the life-time of an individual fish. When transferred from a brownish rubble-substrate to a background



An ornate ghost pipefish in front of a crinoid. Dauin, Philippines. Canon EOS 5D Mark II, Hugyfot housing, Inon 240 strobe, Canon EF100mm f/2.8 Macro USM, f22.0, 1/125, ISO400

composed of greenish-yellow algae, color change from brown to yellow took 36 hours in a robust ghost pipefish observed by Gerlach (2009). Within less than 2 days, the ghost pipefish matched the new environment's color again.



(Above) A pair of robust ghost pipefish. Dauin, Philippines. Canon EOS 5D Mark II, Hugyfot housing, Inon z240 strobe, Canon EF50mm f/2.5 Compact Macro, f25.0, 1/125, ISO320

A roughsnout ghost pipefish, S. paegnius. Dauin, Philippines. Canon EOS 5D Mark II, Hugyfot housing, Inon z240 strobe, Canon EF50mm f/2.5 Compact Macro, f25.0, 1/160, ISO200

(Left) Halimeda ghost pipefish among halimeda algae. Dauin, Philippines. Canon EOS 5D Mark II, Hugyfot housing, Inon z240 strobe, EF100mm f/2.8 Macro USM, f20.0, 1/160, ISO320

The fifth known ghost pipefish species is the delicate ghost pipefish (*S. leptosomus*), which looks somewhat like a puny version of the ornate ghost pipefish. Several variants of this fish exist, some seem to be mimicking a crinoid, while others are more reminiscent of a piece of sea weed or a twig. The armored ghost pipefish is very rare and found on deep, rocky reefs.

Given how rare ghost pipefish are, it is quite possible that additional ghost pipefish species exist,

which have not been described yet. What is usually called ‘hairy’ or ‘velvet’ ghost pipefish (mimicking chunks of filamentous algae) seem to be variants of *S. paegnius* (mostly) or *S. halimeda* (see Kuitert, 2006, p109-110). It is not unusual even for experts to be confused about the species of ghost pipefish they are looking at - note the question mark under the picture of the hairy variant of *S. halimeda* on page 110 of Kuitert’s excellent book on the seahorse relatives. Without counting fin rays & spines and other anatomical features under a microscope, no one can be sure which kind of *Solenostomus* they are really dealing with.

When it comes to feeding themselves, the

ghost pipefish suck - literally! They hunt by sucking up minute invertebrates like tiny shrimp with their pipette-like jaw. If you are lucky enough to see a hunting ghost pipefish, you will notice how they seem to intensely concentrate, and fixate a diminutive crustacean, often with one eye. They twist their bodies slightly to have a better view of their prey. Then, a quick darting-sucking movement follows and the unsuspecting shrimp is on its way to the ghost pipefish stomach. What stands out when watching this feeding behavior is the action of the suction jaw. The presence of such a specialized jaw puts the family of the ghost pipefishes in the order of the Syngnathiformes (Syn - together; gnathos - jaw; the fused jaw fishes). Other families in this order of fishes are the seahorses & non-ghost pipefishes, the trumpetfishes, cornetfishes and shrimpfishes.

While it’s spectacular to see a ghost pipefish decimate the shrimp population for lunch, it takes



Roughsnout ghost pipefish jaw. Dauin, Philippines. Canon EOS 5D Mark II, , Hugyfot housing, Inon z240 strobe, Canon EF100mm f/2.8 Macro USM, f20.0, 1/200, ISO200



A trumpetfish mouth, very similar in anatomy and function to the ghost pipefish jaw. Okinawa, Japan. Canon EOS 5D Mark II, Hugyfot housing, Inon z240 strobe, Canon EF100mm f/2.8 Macro USM, f11.0, 1/200, ISO320

quite a bit of luck to encounter this behavior. Additionally, ghost pipefish are small and hence the workings of their jaw are not so easy to observe. It is usually easier to observe a syngnathid jaw at work on a trumpetfish. They are not particularly rare in many tropical waters, and on this much larger fish the very specialized suction jaw is easier to observe in action. If you patiently follow such a trumpetfish on its hunting trip over the reef you will likely see it suck up a careless

damsel fish after a while. The jaw mechanics of this larger predator are very similar to those of the ghost pipefish.

The way ghost pipefish reproduce is only superficially similar to the way their cousins, the seahorses, produce offspring. In seahorses and non-ghost pipefishes the male fish takes care of the eggs, either by keeping them in a brood pouch on its belly (seahorses) or by gluing them to its abdomen (pipefishes). In contrast, in the ghost pipefish the larger females keep the

fertilized eggs near its body, carrying them in a brood pouch formed by its pelvic fins.

Ghost pipefish often travel in pairs of a larger female and a smaller male fish. Before mating the male ghost pipefish courts the female. This is rarely seen and was first described by Fishelson in 1966:

When courting, the male circles around the female at a distance of 8 to 10 cm, approaching her and swimming forwards and backwards. Concomitantly the first dorsal fins

are alternately quickly spread and folded, displaying the conspicuous colouration which is due especially to the black ocelli. The female reacts to this display of courtship by turning her body towards the male and pointing her head sharply downwards. During this his yellow-black pattern becomes very conspicuous. The courtship is interrupted at night but on one occasion was observed to continue for three days.

Three days of courtship is a long time for such a short-lived species!



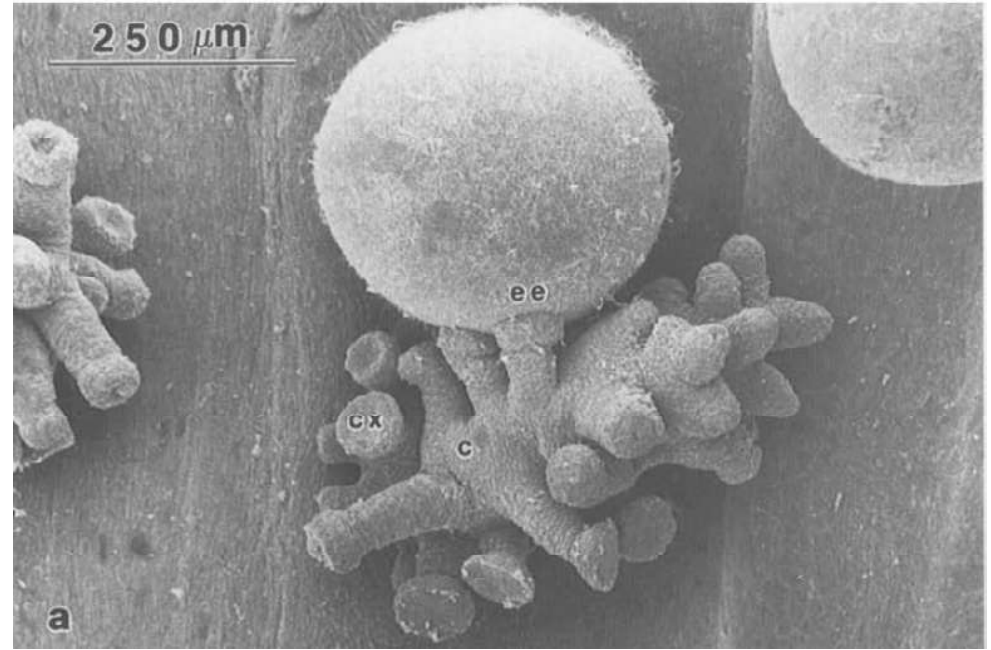
Ornate ghost pipefish brood pouch. Dauin, Philippines. Olympus E-M1, Olympus housing, Inon z240 strobe, Olympus M.60mm F2.8 Macro, f18.0, 1/200, ISO250

What signals does the female ghost pipefish react to? Based on which criteria does she select a mate? There is still insight to be gained into ghost pipefish courtship if lucky underwater videographers manage to capture more of this behavior!

After insemination, the female pulsates her brood pouch, possibly to enhance fertilization of her eggs. You can admire a great video of this behavior on Anna DeLoach's Blennywatcher Youtube channel.

Once fertilized, the eggs develop in the brood pouch. There,

they are anchored to the skin of the female via specialized structures, called cotylephores. Blood vessels run through the stalks of the cotylephores to the developing embryos, likely providing them with nutrients and oxygen. Here we see a case of convergent evolution: the cotylephores are similar in function to a mammalian placenta in that they nourish the developing embryo. This similarity exists even though both organs developed in only very distantly related animals, originating from different bodily tissues. In



Electron microscopical image of a branched cotylephore attached to an egg. Image from Wetzel and Wourms, 1995

retrospect it is not surprising that such structures independently evolved more than once. It makes sense to support the metabolism of your developing eggs!

It seems that ghost pipefish can change sex, like a number of fish species are capable of; this has been observed in aquaria when captured specimen switched from male to female. It is not clear if this happens in nature as well; however it would make sense in a rare and short-lived species, where it is rare to encounter conspecifics to begin with; and in

those rare encounters, the conspecific might by chance not be the right sex for reproduction. In such a situation a strategic sex change might turn two frustrated male ghost pipefish into a female - male couple, ready to reproduce.

I am privileged to live in Dauin, on the Philippine island of Negros, one of the prime destinations in the world for 'muck diving' (diving with the goal of observing small & unusual marine animals). Here we see ghost pipefish regularly, but not all throughout the year.

Occasionally, for a few weeks the dark volcanic sand on the underwater slopes of Negros is teeming with ghost pipefish, and we see them on every dive. On one occasion I spotted a crinoid with eleven (!) individuals of the ornate ghost pipefish. These episodes of ghost pipefish abundance don't last very long, though. After a few weeks, the Solenostomidae are all but gone. This cyclic pattern of occurrence is due to the peculiar life cycle of *Solenostomus*: They spend a large part of their lives as pelagic larva, floating through the open ocean, only to settle for the last few months of their life-span on a reef or in a coastal sandy region. There they still hunt and grow, but their main aim is to reproduce. They seem to die briefly afterwards - and then sadly leave the reef ghost pipefish free for the following few months. To my knowledge, no study has looked at the pelagic part of ghost-pipefish life in any detail yet. How the larvae grow and feed during their mid-water time is one of the most interesting un-answered questions of ghost pipefish biology.

As I am writing this in the year 2018, I have to mention that many ecosystems on Planet Earth are stressed, and that the populations of many animals are in danger. The ghost pipefishes are not listed as endangered; the conservation status of the different *Solenostomus* species is either listed as 'least concern', 'data deficient' or 'not evaluated'. But they live in tropical coastal waters, many of which feel the stress of human activity. Healthy tropical coastal ecosystems are declining, and the ghost pipefish are rare inhabitants of these shrinking ecosystems. Protecting the coastlines in the tropics from runoff, pollution and 'development' also protects the ghost pipefish.

Finally, we should discuss the most important



Close up on an eye of an ornate ghost pipefish. Dauin, Philippines. Olympus E-M1, Olympus housing, Inon z240 strobe, Olympus M.60mm F2.8 Macro, f18.0, 1/200, ISO250

question of all things ghost pipefish - how to photograph them! In brief, this needs to be done with patience, and carefully. It will probably take you quite some dive time to find a ghost pipefish, or a pair of them. Even in Dauin, with a really high likelihood of encountering these fish, we might spend the first half hour of a dive checking crinoid after crinoid before we succeed in finding a *Solenostomus*. Don't despair, go slow, and look closely!

Once you have spotted a ghost, don't stress the animal out. A recent study has shown that the strobes of underwater cameras do not harm the seahorses (Harasti & Gladstone, 2013), so I wouldn't think that firing strobes at a reasonable rate would significantly harm the related ghost pipefishes. But make sure your buoyancy is good, and you don't stir up sediment, or disturb the



A male and a female ghost pipefish swimming as a pair. Dauin, Philippines. Canon EOS 5D Mark II, Hugyfot housing, Inon z240 strobe, Canon EF100mm f1.8 Macro USM, f13.0, 1/200, ISO320

ghost pipefishes on their crinoid home with hectic movements. Besides stressing the animals this looks undignified and makes it harder to get good photographs.

As mentioned above, the ghost pipefish will rarely break camouflage and try to escape from you in a quick burst - they are simply not equipped with the swimming musculature and fins to do that. But they seem to know exactly where you are, and will slowly hover away from you when disturbed. They will cleverly move so that a crinoid or a piece of algae is between you and them. If you move and breathe calmly, they are less likely to show this very subtle escape behavior.

But even when you as an underwater photographer approach a ghost pipefish carefully, it's still a surprisingly tricky photographic subject, given that it's such a slow-moving fish. The reason



Three ornate ghost pipefishes hiding, somewhat unusually, in-between hydroids. Tulamben, Bali, Indonesia. Canon EOS 5D Mark II, Hugaflot housing, Inon z240 strobe, Canon EF100mm f/2.8 Macro USM, f/18.0, 1/200, ISO320

show an eye, like we know it from other fishes, placed on the head of a bizarrely looking animal barely recognizable as a vertebrate - stunning!

I also like to photograph ghost pipefish in the context of their environment, the ornate ghost pipefish next to crinoids, and the others in-between the vegetation which they mimic. This nicely shows the type of camouflage these fishes employ for survival. It's a real challenge to photograph the developing eggs in a gravid female's brood pouch. It's difficult to get just the right angle, and with breeding females the responsible underwater photographer should be extra careful - we don't want to play the role of the aforementioned manananggal and harm unborn life.

A photographic technique I want to explore more in the future with ghost pipefish is close-up wide-angle. There is still lots to do when it comes to ghost pipefish biology and photography!

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is that they like to twist and turn their oddly-shaped bodies, possibly to get a good view of their surroundings with their laterally placed eyes. I found that they would frequently twist themselves out of the plane of focus of my camera. The remedy for this problem is more patience; you will simply have to wait until your ghost is in the right position, and then quickly press your camera's shutter.

Close ups on the eyes of ghost pipefishes often make for impressive photographs. Shots like that