## FEATURE: Arrival of the Fittest – Hiding in the Light

PROF.: Here's an unusual strategy – hiding by turning on a light!

VOICE: Did you say something can ***hide*** – by ***turning on a light?***

PROF.: Yes. Many species of fish and sea animals do it every day. And it saves their lives.

Let's talk about "light as camouflage."

FORMAT: THEME AND ANNOUNCEMENT

VOICE: Professor, were you joking when you said some sea animals hide from predators, by turning on a light?

PROF.: No. I was serious.

Between the bright sunlight at the top of the ocean, and the darkness at the ocean bottom, is the "twilight zone" – the half-lit mid-water region. That's a hazardous area for a fish or sea animal to swim, if it wants to stay alive.

VOICE: That makes sense. A hungry predator swimming underneath, can easily see the animal's dark silhouette against the light background.

PROF.: So it knows immediately where to find its next meal.

VOICE: So how can a fish or sea animal avoid being eaten, by turning on a light? Do you mean some of them make themselves invisible by generating light, so they can blend into the light background near the top of the sea or ocean, to avoid being detected?

PROF.: Yes, by a process called bioluminescence.

VOICE: Is that the process that makes a glowworm or firefly glow?

PROF.: Yes, except that the underwater version of bioluminescence is more complicated.

Marine biologists Richard Young and Alyde Roper discovered that 99 per cent of the animals in the ocean's twilight zone have light-emitting organs called photophores in their bodies. Young says, quote, "These organs are less than two tenths of a millimeter in diameter; but they are probably as complex as the eye.

VOICE: What do they do?

PROF.: Young elaborates, "They control the direction, color, and intensity of the light. They have an interference filter and an interference reflector, like a little mirror, and at the focus of that mirror is a crystal of the protein luciferase. The photophores are so small, so numerous, so close together that at a distance their combined glow looks like one continuous light."

VOICE: But wouldn't that create another problem? These animals glow to blend with the brightness of the water, ***as seen from underneath.*** But couldn't a smart predator swim ***above*** the animal in the twilight zone? That way, it would see the water underneath it as a ***dark*** mass, and the glowing fish and squid would be obvious to it.

PROF.: That was another point that amazed Young and Roper. The light-generating organs are highly ***directional.*** They can be ***aimed*** like a bank of tiny flashlights.

So these animals emit light from the underside of their bodies, where light blends with the surroundings. Yet they remain dark on the top and edges of their bodies.

VOICE: So when a predator swims ***above*** these animals, it can't see them because they blend inconspicuously with the darkness ***underneath***.

PROF.: But when a predator swims ***below***, it can't see animals because they blend inconspicuously with the light ***above*** it.

VOICE: But the ocean environment is more complex than that. The brightness of the light varies greatly at various depths – and at various times of day and night.

PROF.: That's right. So just turning a light on or off wouldn't be enough. If the animals had to choose between light that was full brightness or light that was off, they wouldn't camouflage well in most lighting conditions.

VOICE: Then what happens if the squid moves upward, closer to the ocean surface? There's more sunlight there. So the light that the squid produces would be less than the brightness of its surroundings. Wouldn't the animal lose the camouflage effect of blending into its environment, and be eaten by a predator?

And what happens when the sun sets? Do bioluminescent animals continue to glow?

PROF.: They have more lighting choices than just on and off. Dr. Young wrote, "As we adjusted the light in our laboratory, one squid ***varied*** the intensity of its luminance over a range of about 16,000-fold…"

VOICE: (SURPRISED) A ratio of ***16,000 to one?*** Do you mean the squid could adjust its glow to shine 16,000 times as brightly on some occasions as on others?

PROF.: Right. It doesn't just have an on-off switch.

VOICE: It sounds as if it has a dimmer switch.

PROF.: That's a good description. Dr. Young explains that this ability enables the squid to match downward light with a high degree of accuracy, while it moves through a depth range of about 300 meters.

He discovered the eyes coordinate with the light-making organs, the eyes and additional light receptors on the upper surface of the squid's head.

VOICE: In other words, the squid uses ***feedback*** among its eyes, its light-making organs and its light receptors.

PROF.: Yes. And in addition, those researchers discovered receptors on the underside, arranged so that some of the light-making organs shine directly on them. The squid's nervous system monitors the intensity of the light in the sea. Then it adjusts the brightness of the animal's glow, until it very accurately matches the intensity of the surrounding light.

VOICE: The ***color*** of the light also varies with the time of day. It also changes at various depths in the water.

PROF.: The squid adjusts the color of its light, to match the light around it. Only a predator with extremely good eyes can distinguish the squid from the sea.

VOICE: That's really impressive! Some of these undersea animals are smarter than I had realized. Is that why we eat fish for brain food?

PROF.: (LAUGHS) Researchers disagree about whether eating seafood improves our mental performance. Some think the specialized proteins in fish and other sea animals may make our brains work better, but others question that.

Whether it's true or not, I don't believe that these animals designed and built these complex organs by themselves.

Many scientists are having serious doubts about whether the random processes of natural selection could originate complex organs like these.

VOICE: But "survival of the fittest" is one of the most widely-accepted ideas in biology.

PROF.: Survival of the fittest is one thing. But ***arrival*** of the fittest[1] is very different from that.

VOICE: What do you mean?

PROF.: When a faster animal and a slower animal race, the faster will win. When a smarter person and a less intelligent person compete, the smarter usually excels. So the survival of the fittest isn't what I'm questioning.

VOICE: Then what is "arrival of the fittest"?

PROF.: I mean, where did these complex animals and complex organs come from? For natural selection to function, there must be at least two rival organisms. Natural selection needs to ***select between*** things that ***exist***.

VOICE: In other words, there can be no "struggle for survival," until at least two combatants are alive.

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1 TRANSLATOR: Please try to find a word for "arrival" that rhymes with "survival." Arrival is used in the sense of origination, source or coming into existence.

PROF.: Exactly! Until the "more fit" and the "less fit" both exist, there is no struggle to see which one will survive. There can be no life-and-death contest for the survival of the fittest, until there is the arrival of both the fittest and the less fit.

VOICE: Natural selection destroys the weak members of an animal population. Crippled animals starve, and those suffering from genetic defects reproduce less than their able-bodied peers.

PROF.: But natural selection is ***not a creative mechanism.*** As scientists study more deeply, they discover complexities that genetic mutations simply don't explain satisfactorily.

VOICE: So you're saying natural selection doesn't create anything.

PROF.: Right! Survival of the fittest doesn't explain ***arrival*** of the fittest.

VOICE: Then how do new species "arrive"? And how do new organs – like those that enable "twilight zone" sea animals to camouflage themselves – arrive?

PROF.: An increasing number of scientists are reasoning that there must be some kind of intelligence that is above nature.

VOICE: Some kind of intelligent God?

PROF.: Some call it God; others don't. But a growing number of scientists realize that nature is not likely to produce living organisms, ***by itself***.

VOICE: In the case of the squid, the principles of genetics say it would have to ***inherit*** its light-making apparatus from an animal that had similar organs. Yet that light-***directing*** mechanism contains mirrors and filters. It is so different from anything else known in nature, that it's difficult to imagine any other species from which it could have inherited it.

PROF.: That's the way I see it. Most bioluminescent animals have their light-producing organs at a fixed position in their bodies. Squids ***move theirs*** – to keep the light always beaming ***downward,*** no matter at what angle the organism moves or tilts.

It seems logical to me that the squid received that ability as a unique feature, from God.

VOICE: I can see why scientists are finding it harder to believe that random evolutionary processes made organisms that are so complex and so precise.

PROF.: I agree with the sage who said, "If you think hard enough, you are forced to believe in God!"

FORMAT: THEME AND ANNOUNCEMENT