

**APICULTURE AND AQUACULTURE WEEK 9: BIOLOGY AND
BEHAVIOUR OF FISH SPECIES AND IDENTIFICATION OF
COMMONLY FARMED FISH SPECIES**

BY

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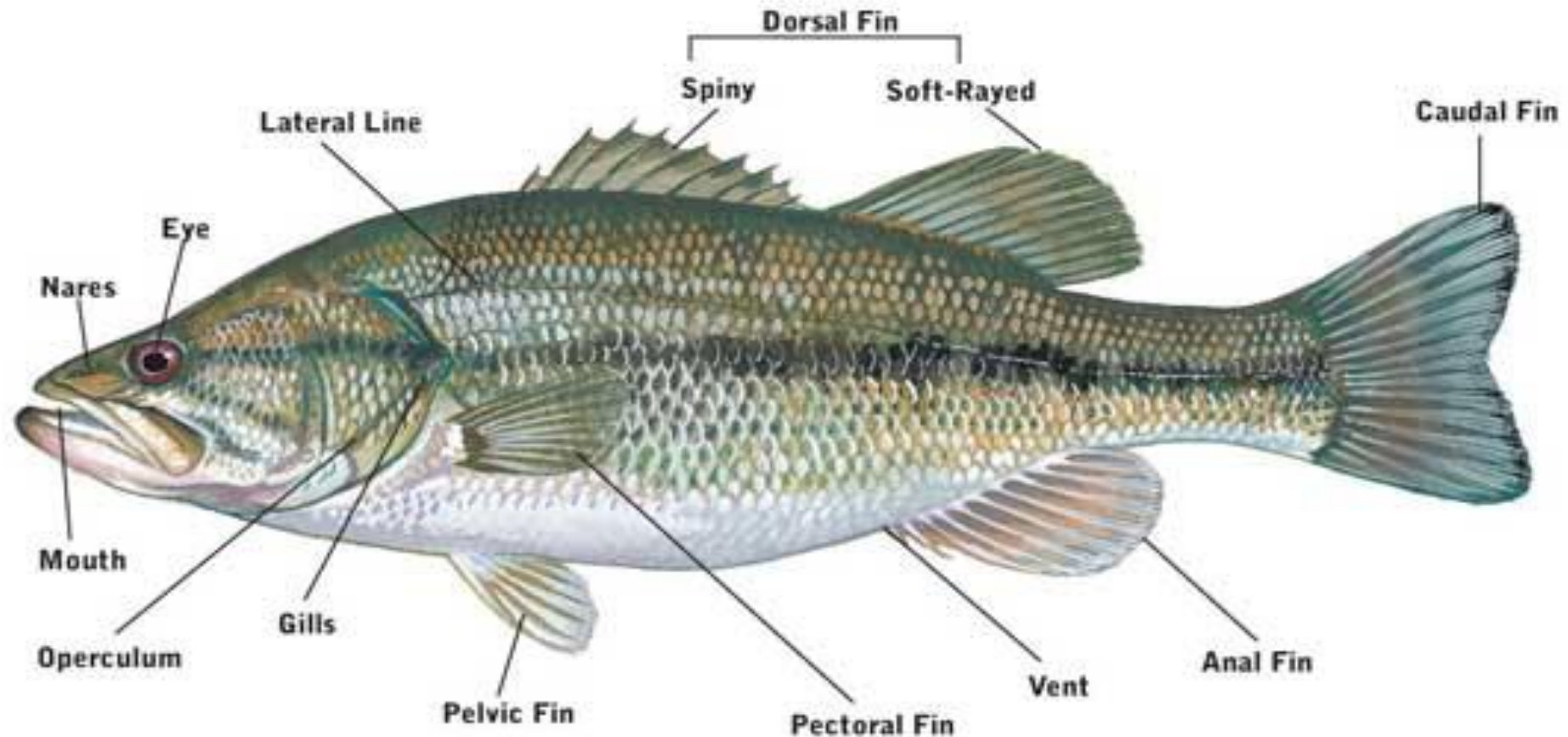
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EXTERNAL ANATOMY OF FISH

Source: <http://www.animalsworlds.com/internal-anatomy.html>

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Parts of external fish anatomy

- **Eyes:** Used for sight, fish can detect colors and see short distance with their eyes. They use their vision to escape predators and find food.
- **Nares:** Similar to nostrils, except nares are used for smelling only (nostrils are used for both smelling and breathing).
- **Mouth:** The mouth is used to consume food.

Parts of external fish anatomy continue ...

- **Operculum:** The operculum is the bony flap that protects the gills from harm. It opens and closes to allow water to pass over the gills.
- **Pectoral Fin:** The pectoral fin allows for abrupt changes in side-to-side direction and speed. It also acts as a brake to decrease speed while swimming.
- **Pelvic Fin:** The pelvic fin stabilizes the fish while swimming and allows for up-and-down movement in the water.

Parts of external fish anatomy continue

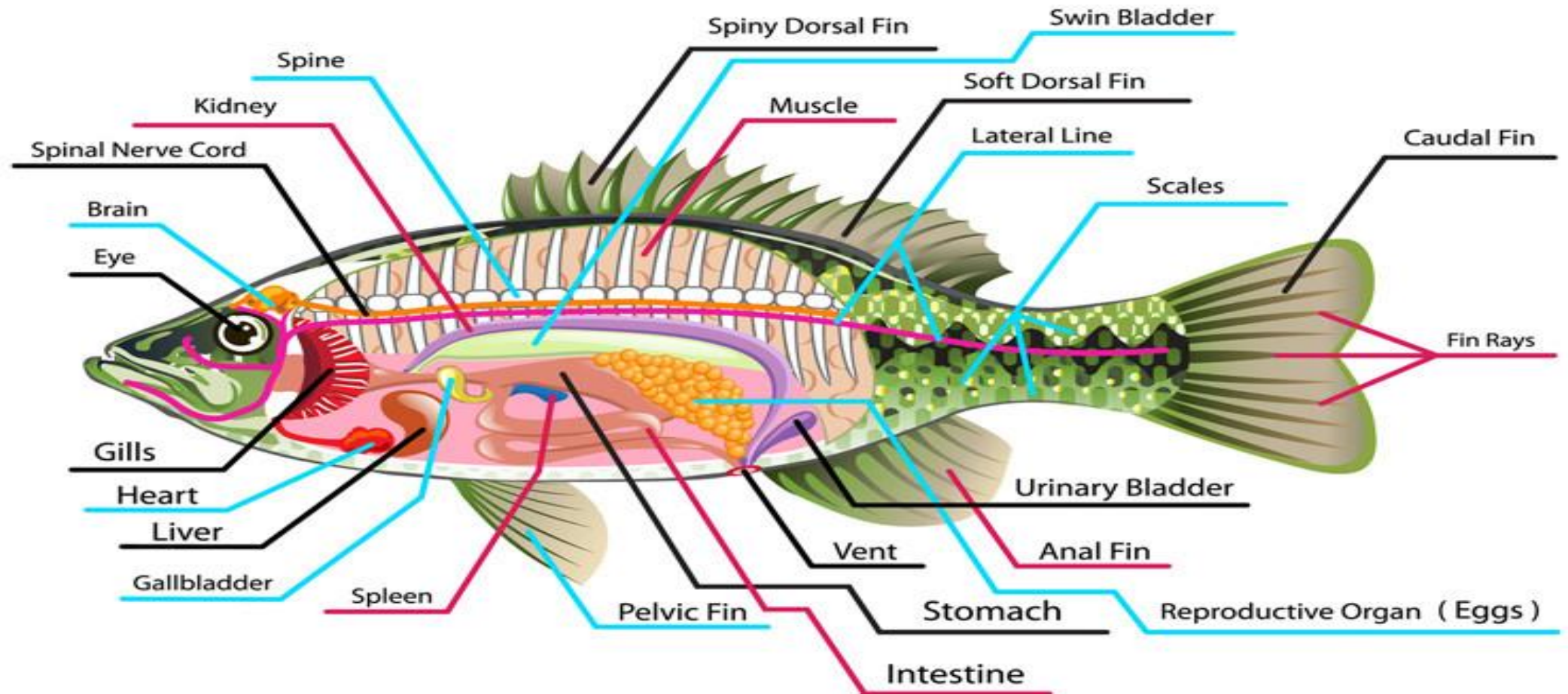
- **Vent:** The vent removes waste and extra water. It is also the outlet for eggs or milt (sperm) during spawning.
- **Anal Fin:** The anal fin stabilizes the fish while swimming.
- **Caudal Fin:** The caudal fin moves, propels or pushes the fish through the water.
- **Adipose Fin:** The adipose fin is not pictured; it is not present on a lot of fish species. Its purpose is unknown. Trout, salmon and catfish have an adipose fin. It is the small, thick, fleshy fin located between the dorsal and caudal fins.

Parts of external fish anatomy continue ...

- **Dorsal Fin:** The dorsal fin helps maintain balance while swimming.
- **Scales:** Scales protect the fish from injury.
- **Barbels:** Barbels are not pictured. They are the "whiskers" found on the head area of fish such as catfish or bullheads. On the catfish and bullheads, barbels are thought to be a sensory organ to help track down prey or food. Sturgeon also have barbels.

Internal anatomy of the fish

Source: Animalworlds.com - free



Internal anatomical parts of the fish

- **Urinary orifice:** opening for eliminating urine.
- **Genital Orifice:** opening related to the genital organs.
- **Anus:** end of the digestive tract.
- **Gonad:** hormone-secreting sexual gland of a fish.
- **Intestine:** last part of the digestive tract.

Internal anatomical parts of the fish continue ...

- **Pyloric ceacum:** cul-de-sac related to the intestine.
- **Gall bladder:** small sac containing the bile.
- **Liver:** bile-producing digestive gland, among other roles.
- **Heart:** blood-pumping organ.
- **Gills:** respiratory organ of a fish.

Internal anatomical parts of the fish continue ...

- **Tooth:** hard organ of a fish used to shred food.
- **Eye:** sight organ of a fish.
- **Olfactory bulb:** bulging part of the smell organ of smell of a fish.

Life cycle of fish

- **Egg Stage:** It all begins when a fish lays eggs. These eggs are tiny and often stick together in groups called “clutches.” The eggs are usually laid in a safe spot, like underwater plants or rocks. The eggs are protected by a jelly-like substance.
- **Embryo Stage:** Inside each egg, a tiny fish called an embryo starts to develop. The embryo gets oxygen from the water through a thin membrane that surrounds the egg.
- **Larva Stage:** When the embryo grows big enough, it hatches from the egg as a larva. Larvae are very small and look different from adult fish. They might have a big yolk sac attached to their bellies, which provides them with food.

Life cycle of fish

- **Fry Stage:** As the larva grows, it becomes a fry. Fries look more like adult fish, but they are still quite small and might not be able to swim very well yet. They continue to feed on their yolk sac or tiny organisms in the water.
- **Juvenile Stage:** The fry gradually becomes a juvenile fish. At this stage, they have developed scales and can swim better. They start to hunt for food on their own, eating small insects, plankton, or other small creatures.
- **Adult Stage:** After some time, the juvenile fish grow into adult fish. They are now fully developed and can reproduce, continuing the cycle by laying their own eggs. Adult fish come in various sizes, shapes, and colors, depending on their species.

Adaptations of fish to live in water

- **Gills for Respiration:** Fish have specialized respiratory organs called gills, which allow them to extract dissolved oxygen from water. Gills consist of filaments covered with tiny, blood-rich lamellae that provide a large surface area for gas exchange. As water flows over the gills, oxygen diffuses into the blood, and carbon dioxide is expelled, enabling fish to breathe without surfacing.
- **Streamlined Body Shape:** Most fish have a streamlined, torpedo-shaped body that minimizes drag as they swim through water. This shape allows them to cut through the water smoothly, reducing energy expenditure and increasing swimming efficiency. The streamlined form is particularly evident in fast-swimming fish like tuna and sharks.

Adaptations of fish to live in water continue ...

- **Fins for Propulsion, Steering, and Stability:** Fish have multiple fins (pectoral, dorsal, caudal, pelvic, and anal) that serve different functions. The caudal (tail) fin provides thrust, propelling the fish forward, while pectoral and pelvic fins aid in steering and stabilization. Dorsal and anal fins help maintain balance, preventing rolling and enabling agile movement in water.
- **Swim Bladder for Buoyancy Control:** The swim bladder is an internal, gas-filled organ that allows fish to control their buoyancy. By adjusting the amount of gas in the bladder, fish can rise or sink without expending energy swimming. This adaptation is crucial for maintaining depth and position in the water column, especially for fish that need to hover at specific depths.

Adaptations of fish to live in water continue ...

- **Scales for Protection and Streamlining:** Fish scales act as a protective layer, shielding the fish from injury, parasites, and infection. They also reduce water friction, allowing the fish to move more smoothly. Scales are often covered with a thin layer of mucus, further minimizing resistance and helping fish glide through water with ease.
- **Mucous Coating for Disease Resistance and Reduced Drag:** A layer of mucus covers the fish's body, serving multiple purposes. It creates a barrier against pathogens and parasites, helping prevent infections. Additionally, the mucus layer reduces drag as the fish swims, conserving energy and aiding in faster, more efficient movement through water.

Adaptations of fish to live in water continue ...

- **Lateral Line System for Sensory Perception:** The lateral line is a unique sensory organ that runs along the sides of fish, detecting vibrations, pressure changes, and movements in the surrounding water. It helps fish sense nearby objects, locate prey, avoid predators, and stay oriented within a school. This adaptation is particularly valuable in dark or murky water.
- **Osmoregulation to Balance Salt and Water Levels:** Fish live in environments with varying levels of salinity and have evolved osmoregulation mechanisms to maintain internal balance. Freshwater fish actively absorb salts through their gills and excrete large amounts of dilute urine. Saltwater fish, on the other hand, drink seawater and excrete excess salt through specialized cells, maintaining their internal balance.

Adaptations of fish to live in water continue ...

- **Countershading Camouflage for Concealment:** Countershading is a form of camouflage in which a fish's dorsal (top) side is darker, blending with the darker water or seafloor below, while the ventral (bottom) side is lighter, matching the brighter surface above. This color gradient helps fish avoid detection from both predators and prey, making them harder to spot from different angles.
- **Adapted Vision for Low Light Conditions:** Fish eyes are adapted to see well in low-light environments, with a high density of rod cells that are sensitive to light. This adaptation allows them to detect movement and navigate in murky waters, deep-sea regions, or at night. Some fish also possess a reflective layer, the tapetum lucidum, which enhances their vision by reflecting light through the retina.

Adaptations of fish to live in water continue ...

- **Flexible Fins and Tails for Varied Swimming Styles:** Fish have flexible fins and tails that adapt to different swimming speeds and styles. For instance, some fish have long, narrow fins for rapid acceleration, while others have more rounded fins for maneuvering in tight spaces. The shape and flexibility of fins and tails enable fish to adapt to various environments, from fast currents to complex reef structures.
- **Efficient Excretion of Nitrogenous Waste:** Fish excrete ammonia directly into the water through their gills, allowing for immediate removal of toxic waste products. This adaptation is highly efficient in aquatic environments where water constantly flows over the gills, preventing the accumulation of harmful substances in the fish's body. This simple, continuous excretion process helps fish maintain a stable internal environment.

Factors which affect fish growth and development

- 1. Water Temperature:** Fish are ectothermic, meaning their metabolic rates depend on water temperature. Optimal temperatures speed up metabolism and growth, while too cold or too hot conditions can slow growth or cause stress.
- 2. Dissolved Oxygen Levels:** Sufficient oxygen is crucial for respiration and metabolic activities. Low oxygen levels can reduce growth rates and may even be lethal if severely deficient.
- 3. Water Quality:** Clean water with low levels of toxins, ammonia, and nitrates supports better growth. Polluted water can stress fish, weaken immunity, and hinder growth.

Factors which affect fish growth and development

4. Diet Quality and Nutrition: Balanced diets with adequate protein, vitamins, and minerals are essential for healthy growth. Malnutrition or nutrient imbalances slow growth and may cause health issues.

5. Stocking Density: Overcrowding increases competition for resources, raising stress levels and slowing growth. Optimal stocking densities reduce competition and promote growth.

6. Genetics: Genetic makeup determines growth potential, with certain fish strains or breeds genetically predisposed to faster growth under optimal conditions.

Factors which affect fish growth and development

7. Light Exposure: The photoperiod (duration of light exposure) affects feeding, activity, and growth. Proper light cycles can improve feed intake and encourage healthy growth rates.

8. Water pH Levels: Fish thrive in specific pH ranges, depending on the species. Extreme pH levels can stress fish, disrupting their metabolism and slowing growth.

9. Presence of Parasites and Diseases: Health challenges like parasites or infections reduce growth by diverting energy from growth to immune response and may require medication that impacts feeding.

Factors which affect fish growth and development

10. Ammonia and Nitrate Levels: High concentrations of ammonia and nitrates are toxic to fish, hindering growth and weakening the immune system. Regular water monitoring is needed to prevent accumulation.

11. Salinity Levels: For fish in brackish or saltwater environments, salinity balance is crucial. Incorrect salinity levels can stress fish and reduce growth.

12. Social Interactions and Hierarchies: Dominance behaviors and aggression can lead to unequal access to food, especially in competitive environments, slowing growth for some fish in the group.

Mating mechanisms and behaviours in fish

- ✓ **Roadcast Spawning:** In broadcast spawning, fish release eggs and sperm directly into the open water for external fertilization, often synchronizing with environmental cues like lunar cycles or tides. This strategy is common in pelagic fish like tuna, cod, and groupers. These species release large quantities of eggs, increasing the chances that some will survive in open waters.
- ✓ **Nest Building:** Some fish construct nests to protect their eggs. Males often build and guard these nests, courting females to lay eggs there. Bluegill sunfish males create depressions in the substrate, while sticklebacks use plant material to build complex nests.
- ✓ **Mouth brooding:** In mouth-brooding species, one parent (often the female, but in some species, the male) carries the fertilized eggs and sometimes young fry in their mouth for protection until they are ready to survive on their own. Examples include tilapia, betta fish, and some African cichlids like *Aulonocara* and *Pseudotropheus* species.

Mating mechanisms and behaviours in fish continue .

- ✓ **Internal Fertilization:** In some species, males use specialized organs to transfer sperm directly to the female, allowing fertilization to occur internally. This method is common in livebearers like guppies, mollies, and swordtails, where females give birth to live, free-swimming young. Sharks and rays also exhibit internal fertilization through claspers.
- ✓ **Hermaphroditism (Sex Changing):** Certain fish can change sex to maximize reproductive success. Clownfish are sequential hermaphrodites, starting as males and changing to females if the dominant female dies. In wrasses and groupers, individuals can change from female to male to control group dynamics and enhance breeding opportunities.
- ✓ **Parental Care (Biparental or Uniparental):** Some fish exhibit parental care behaviors, where one or both parents actively guard and tend to the eggs. Cichlids like Oscars and Angelfish protect their eggs and young. Seahorses are unique as males carry fertilized eggs in a specialized pouch, nurturing them until they hatch.

Mating mechanisms and behaviours in fish

- ✓ **Lek Mating (Territorial Display):** In lek mating systems, males gather in a specific area (lek) to display for females, often through color changes, posturing, or sound production. African cichlids and certain wrasses exhibit this behavior, with males defending small territories to impress females with their display and habitat-building skills (Amorim et al., 2015).
- ✓ **Sneaker Males and Satellite Males:** In some species, smaller "sneaker" or "satellite" males employ alternative strategies to fertilize eggs, bypassing courtship with the female. For example, bluegill sunfish have sneaker males that quickly dart in to release sperm near a mating pair's nest. Salmon and trout also have sneaker males competing to fertilize eggs during spawning events.

Mating mechanisms and behaviours in fish

- ✓ **Migratory Spawning:** Some fish undertake long migrations to specific spawning grounds, ensuring optimal conditions for egg-laying and fry survival. Salmon famously migrate from the ocean to freshwater rivers to spawn. Eels also migrate thousands of miles to the Sargasso Sea for spawning, with both species often dying after this long journey.
- ✓ **Pair Bonding:** Pair bonding involves monogamous or semi-monogamous relationships where a male and female form a pair to mate and care for offspring together. In seahorses, pairs form lifelong bonds, engaging in daily courtship rituals to reinforce their bond. French angelfish pairs often share territories and work together during spawning, while clownfish form stable pairs within their anemone homes.

Types of social behaviours and communication in fish

1. Schooling

- **Description:** Schooling is the behavior of fish swimming in coordinated groups, often moving in synchronized patterns. This provides protection against predators (as there is safety in numbers), enhances foraging efficiency, and improves hydrodynamic efficiency, helping fish save energy.
- **Examples:**
 - **Sardines** form large, densely packed schools called “bait balls” when threatened, confusing predators and making it difficult for them to target individual fish.
 - **Herring** exhibit schooling to avoid predators like dolphins and seabirds. Their tight, synchronized movements help avoid attacks.
 - **Yellowtail fish** school together in coral reefs, enhancing their chances of detecting predators and locating food sources.

Types of social behaviours and communication in fish

- **Territoriality**

- **Description:** Territoriality involves fish establishing and defending specific areas or territories from intruders. Territorial fish are often highly aggressive in protecting their space, particularly during mating or nesting periods.

Examples:

- **Damselfish** aggressively defend territories on coral reefs, particularly guarding patches of algae they cultivate as a food source.
- **Cichlids** such as **Oscars** and **Convict cichlids** establish territories around nesting sites, especially during breeding, defending against other fish that may threaten their young.
- **Betta fish** (Siamese fighting fish) are extremely territorial, often attacking other males that invade their space.
- **Gobies** defend small territories in sandy or rocky areas, where they burrow and protect food sources from competitors.

Types of social behaviours and communication in fish

- **Courtship**

- **Description:** Courtship behaviors in fish are often complex and involve displays of color, movements, and rituals designed to attract mates and establish reproductive compatibility. Courtship is essential for successful mating, especially in species where pairing is selective.

- **Examples:**

- **Male guppies** use bright colors and rapid movements to attract females, often engaging in elaborate “dance” displays.
- **Sticklebacks** build nests and perform a zig-zag dance to attract females. The males will then lead the females to the nest for egg laying.
- **Cichlids** exhibit unique courtship rituals where males display intense colors and engage in a “circle dance” to encourage females to lay eggs.
- **Seahorses** perform courtship dances that involve synchronized swimming and color changes. Pairs often wrap tails together, forming a bond before the female transfers her eggs to the male’s pouch.

Types of social behaviours and communication in fish

- **Visual Signals in Communication**

- **Description:** Fish use visual signals, including color changes, body posturing, and fin displays, to communicate with each other. Visual cues can indicate mood, reproductive readiness, aggression, or submission.

- **Examples:**

- **Clownfish** display aggressive body language, such as fin extension and jaw gaping, to establish dominance in an anemone.
- **Parrotfish** change colors to communicate social status, especially when establishing dominance or during mating.

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- **Parrotfish** change colors to communicate social status, especially when establishing dominance or during mating.
- **Angelfish** use color intensity to display aggression or courtship intentions, particularly in competitive reef environments.

Types of social behaviours and communication in fish

- **Chemical Signals (Pheromones) in Communication**
- **Description:** Fish release chemical signals or pheromones to communicate, often related to reproduction, alarm responses, or marking territory. These chemical signals can convey information about species identity, sexual readiness, or danger.
- **Examples:**
 - **Salmon** use pheromones to identify and locate their native spawning streams, navigating over long distances to reach their birthplace.
 - **Minnows** release alarm pheromones when injured, alerting nearby fish to the presence of a predator.
 - **Tilapia** release pheromones in the water to attract mates, helping synchronize reproductive activities.

Types of social behaviours and communication in fish

- **Sound Signals in Communication**

- **Description:** Some fish produce sounds to communicate, often using specialized muscles or body parts, like their swim bladder or grinding teeth. Sound communication is often used in mating calls, territorial defense, and social interactions, especially in murky or dark environments.

- **Examples:**

- **Drums and croakers** (family Sciaenidae) produce “drumming” sounds by vibrating muscles against their swim bladders, typically for mate attraction or territorial display.
- **Clownfish** produce popping or clicking sounds during social interactions, especially when asserting dominance within their anemone homes.
- **Toadfish** emit grunts and hums, often as part of their courtship calls or to signal their presence in rocky or estuarine environments.
- **Damselfish** produce chirping or clicking sounds to communicate during courtship or when defending their territory against intruders.

Examples of farmed fish species in Uganda

- **Tilapia** (*Oreochromis niloticus*).

Local name: Ngege.

Features:

It grows quickly on ponds and is resistant to many diseases.

Prefers shallow water with good aquatic weed cover.

Has a better taste compared to other fish species.

It is deep bodied and laterally flattened.

Examples of farmed fish species in Uganda

- **Cat fish.**
- **Features:**
 - Have no scales on the body.
 - Possesses a long adipose dorsal fin.
 - Can grow well in both deep and shallow water.
 - Prefer free flowing water.
 - Can withstand the high temperature in the water.
 - They have eel-like body shapes. (i.e. elongated bodies).

Examples of farmed fish species in Uganda

- Nile Perch. (*Lates niloticus*).
- Local name: Mputa
- **Features:**
 - It is a very large fish, attaining a maximum weight of 200kg.
 - Reaches a maximum length of about 2m.
 - It is a predatory fish.
 - Requires deep water which is clear.
 - It is also deep bodied and laterally flattened.

Examples of farmed fish species in Uganda

- **Lung fish (*Protopterus aethiopicus*).**
- Local name: Mamba.
- **Features:**
 - Has simple lungs and can breathe in air because of this.
 - Can live in water with little oxygen supply.
 - Have elongated body (i.e. eel-like).

References

Animalworlds.com (2024). <http://www.animalsworlds.com/internal-anatomy.html>

Amorim, M.C.P., Vasconcelos, R.O., Fonseca, P.J. (2015). Fish Sounds and Mate Choice. In: Ladich, F. (eds) Sound Communication in Fishes. Animal Signals and Communication, vol 4. Springer, Vienna.
https://doi.org/10.1007/978-3-7091-1846-7_1