Chronicle of Aquatic Science
Open Access Peer Reviewed Journal
Vol. 1, Issue, 9
https://chronicleofaquaticscience.in/
Mini-review
Kashyap et al. (2024)
Manuscript ID: CoAS_V1IS9_09

OPEN ACCESS

Harmonizing Underwater: Exploring the Influence of Pheromones on Fish Communication and Behaviour

Narsingh Kashyap*[1], Suresh Eswaran[1], Jaiswar Rahul Ramasre[1], Sanjay Chandravanshi[2] and Chetna Kashyap[3]

[1]*TNJFU-Institute of Fisheries Post Graduate Studies Vaniyanchavadi, Chennai-603103, Tamil Nadu, India*
[2]*Fisheries College and Research Institute, Thoothukudi-628008, Tamil Nadu, India*
[3]*Mahatma Gandhi College of Horticulture and Research Station -MGUVV Sankara Patan 491111, Chhattisgarh, India*

Corresponding Author
Narsingh Kashyap
Email: narsinghk307@gmail.com

(Received- 16.02.2024, Revised- 21.02.2024, Accepted- 27.02.2024, Published:29.02.2024)

How to cite this article:

Kashyap, N., Eswaran, S., Ramasre, J.R., Chandravanshi, S. and Kashyap, C. 2024. Harmonizing Underwater: Exploring the Influence of Pheromones on Fish Communication and Behaviour. *Chronicle of Aquatic Science* 1(9): 67-72

ABSTRACT

Fish communication and behavior are intricately linked to the influence of pheromones, chemical signals that play a vital role in social interactions among fish species. This review delves into the significance of pheromones in shaping fish behavior and communication patterns. Pheromones serve as powerful cues that facilitate various behaviors such as mating, territorial marking, and alarm responses. Understanding how fish perceive and respond to these chemical signals provides valuable insights into their social dynamics and ecological interactions. By exploring the intricate world of pheromones in fish communication, this research sheds light on the fascinating mechanisms that govern social behavior in aquatic environments.

KEYWORDS

Phenomenon, Communication, Aquatic ecosystem, aquaculture

Introduction

Pheromones are organic compounds found in nature that are mostly utilised in animal communication. It is secreted by an individual and received by another individual of the same species, serving as stimuli for various behavioural responses. Aquatic organisms use soluble pheromone molecules. These molecules diffuse ten thousand times slower than air, allowing for more accurate and targeted signaling in water conditions. Pheromones can be categorized into different types like releaser pheromones that prompt immediate behavioural reactions, signaller pheromones providing information about the individual or hierarchy, modulator pheromones affecting mood and emotion, and primer pheromones influencing endocrine systems over time.

For many fish, pheromones are essential to their existence. They provide numerous options for managing both native and exotic fish because they are strong, safe for the environment, species (or taxon) specific, and simple to add to the water. Animals need their chemical senses, or chemoreception, to survive. Animals must synchronise their reproductive cycles, locate food, and escape predators by coordinating their biological activities with environmental cues. Aquatic species identify and select food, partners, and habitat by using chemical cues from other organisms. They also use this information to avoid potential threats like infection and predation. Pheromones are chemical signals produced and released by animals to communicate with others of the same species. These chemical molecules are essential for a various social and reproductive behaviours such as mating, territorial marking, and signalling alarm or attraction. Pheromones can be detected by the olfactory system in animals, triggering specific behavioural responses. The study of pheromones and their effects on behaviour has significant implications for understanding animal communication and social interactions. Furthermore, researchers are also exploring the potential applications of pheromones in various fields, including agriculture and pest control. An increasing demand has been seen for utilizing pheromones in agriculture to manage pests over the past few years. By understanding the chemical signals that insects use for mating and communication, researchers have developed pheromone-based traps and mating disruption techniques to manage insect populations in an Eco-friendlier manner. Moreover, the potential applications of pheromones extend beyond pest control. In the field of animal behaviour, scientists are delving into the use of synthetic pheromones to manipulate social behaviours in animals, which could have implications for animal welfare and conservation efforts.

Different types of pheromone are used in aquatic ecosystem

Migratory Pheromones: These animals find their way by employing a range of techniques, such as identifying chemical signals in water. This form of communication, known as chemoreception, allows organisms to detect pheromones released by other members of their species or to sense changes in their environment. Salmon must travel great distances to return to their home streams in order to spawn (Ueda and Shoji 2002). The orientation mechanism of salmon migration may be based on olfactory imprinting. Adult sea lampreys (*P. marinus*) use a pheromone generated by larvae in the stream to find spawning sites (Sorensen et al., 2003). Larval petromyzontid lampreys frequently manufacture and release alcoholic acid and petromyzonol sulphate, which are probably utilised as a part of a shared evolutionary conserved phenotype. Some fish species use nonspecific fragrance for tracking to find their feeding and/or spawning environment. These attractants can work as short-range attractants in certain cases, like the freshwater eel *Anguilla rostrata*, where they are present among a variety of other stimuli.

Sex Pheromones: Sex pheromones are mostly used by a number of animals in reproductive seasons for synchronization of spawning. Many organisms depend extensively on sex pheromones to regulate their reproduction. One individual release these chemical signals to attract another of the same species for mating. In some species, the pheromones released by females can signal their readiness to mate, while in others, males release pheromones to attract females. Understanding the role of sex pheromones in

different species has significant implications for pest control, animal behaviour studies, and even human attraction research.

Recent research has shown that the use of sex pheromones in pest control has been particularly successful. By synthesizing and releasing large quantities of the pheromones, researchers have been able to disrupt the mating patterns of pests and reduce their populations without the use of harmful chemicals. This innovative approach has great potential for reducing the environmental impact of traditional pest control methods. In addition to pest control, the study of sex pheromones has also shed light on the intricacies of animal behaviour. For instance, the complex interplay of pheromones in social insects like ants and bees has provided valuable insights into their communication and reproductive strategies.

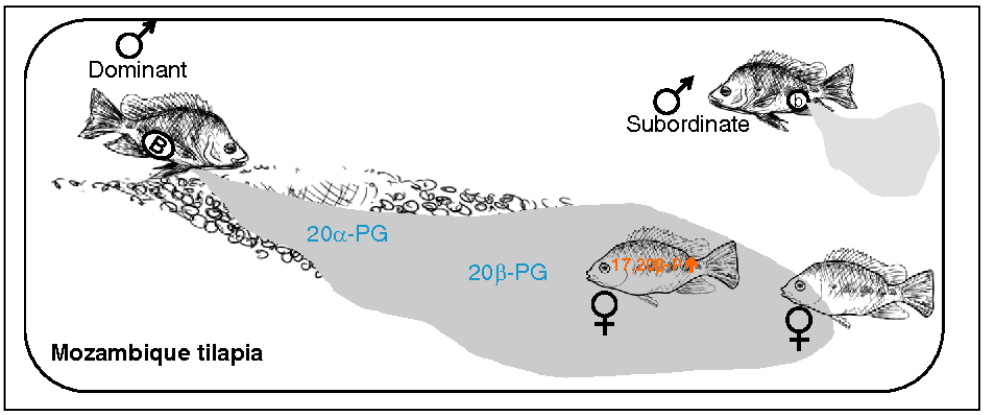


Fig 1- Releasing of male priming pheromone (20α-PG, 20 β-PG)

Several experimental techniques have been used to determine the pheromone chemicals in fish pheromone studies. The first strategy is based on the understanding of the reproductive endocrinology of the selected species and is motivated by the hormonal pheromone hypothesis. To validate a hormone molecule's pheromonal activity, it is usually hypothesised and investigated using EOG and/or behavioural testing.

Employing Pheromones to Eliminate Nuisance Fish in Bulk: Many aquatic animals use different types of pheromones for shoaling, migratory, and reproduction to find each other throughout their lives. Fishe that migrates or engage in reproductive activity depend significantly on these kinds of pheromones, which are typically species- or taxonomic-specific. Several hundred fish species migrate throughout their spawning season in response to fragrances, which are called pheromones. Sex pheromones is playing a crucial role in most of the animals for a synchronization. Still, the majority of vertebrate sex pheromones are unknown.

Locating and recognizing foodstuff

Marine organisms use different chemical detectors to locate and recognize their food, as well as to choose a feeding area. In fisheries and aquaculture, the development of synthetic foods and stimulants involves the use of multiple chemical signals for detecting food (Kamio and Derby, 2017). Feeding strategies can be developed with the help of chemosensory biology. Nucleic acids, organic acids, and amino acids all have been shown to stimulate marine animals' appetites. Typically, the most prevalent chemicals in crustacean are betaine, taurine, trimethylamine oxide, glycine, and alanine. Commercial fishing may utilise baited traps to use artificial chemoattractant. It has been demonstrated that using sugarcane and fish together as an attractant in basket traps for Asian paddle crab (*Charybdis japonica*) and blue swimmer crab (*Portunus armatus*) works better than using fish bait alone.

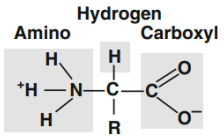
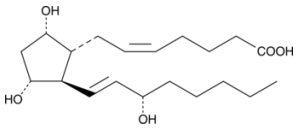
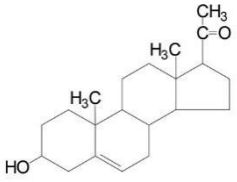
Chemical defence: Insects and sessile organisms may perceive defensive molecules released by organisms as chemical cues, resulting in unsuccessful feeding and settlement. Distasteful chemicals,

known as deterrents, are a well-known chemical defence mechanism that lowers the feeding activity of plant consumers.

Species Specificity: It is widely recognized that fish species which are closely related have similar pheromone systems, meaning they have similar chemicals and effects, whereas species that is distantly related have different ones. Sex pheromones are employed in mate choice to entice or discriminate between possible nonspecific partners. Moreover, heterospecific mates may also be attracted to one another and result in hybridization if two species have extremely similar sex pheromones. Interbreeding is observed among numerous freshwater fish species. This phenomenon may be because both species respond to a similar pheromonal mechanism during breeding (Hanfling et al., 2005; Irvine & Sorensen, 1993).

In Fishery Conservation: Furthermore, pheromones are essential for the migratory and reproductive biology of many native fish species that are threatened or endangered and that type of pheromone are play crucial role for breeding & conservation of endangered fish species. Pheromones released by fish can signal important information to another individual of the same species, such as the presence of predators or the location of spawning grounds. This communication can help in avoiding predators and finding suitable areas for reproduction, thus contributing to the conservation of fish populations (Unfer & Pinter, 2017). Additionally, understanding how pheromones influence fish behaviour can also aid in the development of more effective conservation strategies and management practices. Further research into the specific pheromones involved and their effects on fish behaviour could provide valuable insights for the sustainable management of fisheries.

The chemical composition of pheromones: Chemical signals have a broad variety of molecular weights. Marine organisms create and consume a wide range of organic molecules as part of the carbon cycle, along with other biogenic molecules such as compounds of phosphorus, sulphur, and nitrogen. Marine species use very tiny organic molecules, less than 1.5 KDa, known as metabolites, to identify and select food. They also use peptides (7–11 KDa) to locate potential partners, proteins (between 30 and 200 KDa and their dimers) to locate particular prey, and protein complexes to establish gregarious settlements.

Amino Acids	
Prostaglandin F2a	
Steroid Hormones	

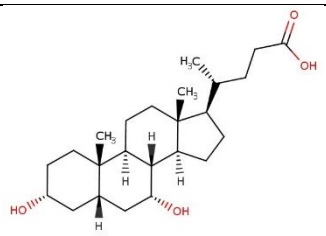
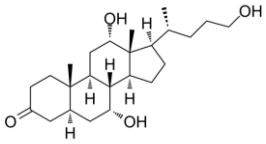
Bile Acids	
	

Fig 2. Chemical structure of sex pheromones in fish.

Conclusion

Pheromones plays in the life cycles of numerous fish species. Now that many of these cues have been identified, research in the lab has shown that they significantly impact fundamental biological and psychological mechanisms that pertain to the fundamentals of fish biology. Aquatic organisms' pheromone communication is an example of how they have adapted to the needs and opportunities of their surroundings.

References

Falewee, C., Gaultier, E., Lafont, C., Bougrat, L., & Pageat, P. (2006). Effect of a synthetic equine maternal pheromone during a controlled fear-eliciting situation. Applied Animal Behaviour Science, 101(1-2), 144-153.

Kamio, M., & Derby, C. D. (2017). Finding food: how marine invertebrates use chemical cues to track and select food. Natural Product Reports, 34(5), 514-528.

Kobayashi, T., Kiyokawa, Y., Arata, S., Takeuchi, Y., & Mori, Y. (2013). c-Fos expression during the modulation of sexual behavior by an alarm pheromone. Behavioural brain research, 237, 230-237.

Li, W., Siefkes, M. J., Scott, A. P., & Teeter, J. H. (2003). Sex pheromone communication in the sea lamprey: implications for integrated management. Journal of Great Lakes Research, 29, 85-94.

Moore, A., & Waring, C. P. (1996). Electrophysiological and endocrinological evidence that F-series prostaglandins function as priming pheromones in mature male Atlantic salmon (Salmo salar) parr. Journal of Experimental Biology, 199(10), 2307-2316.

Murphy, C. A., & Stacey, N. E. (2002). Methyl-testosterone induces male-typical ventilatory behavior in response to putative steroidal pheromones in female round gobies (Neogobius melanostomus). Hormones and Behavior, 42(2), 109-115.

Murphy, C. A., Stacey, N. E., & Corkum, L. D. (2001). Putative steroidal pheromones in the round goby, Neogobius melanostomus: olfactory and behavioral responses. Journal of Chemical Ecology, 27, 443-470.

Ogata, H., Kitamura, S., & Takashima, F. (1994). Release of 13, 14-dihydro-15-keto-prostaglandin F2α, a sex pheromone, to water by cobitid loach following ovulatory stimulation. Fisheries science, 60(2), 143-148.

Sorensen, P. W., & Stacey, N. E. (2004). Brief review of fish pheromones and discussion of their possible uses in the control of non-indigenous teleost fishes. New Zealand Journal of Marine and Freshwater Research, 38(3), 399-417.

Sorensen, P. W., & Stacey, N. E. (2004). Brief review of fish pheromones and discussion of their possible uses in the control of non-indigenous teleost fishes. New Zealand Journal of Marine and Freshwater Research, 38(3), 399-417.

Stacey, N. (2011). Hormonally derived sex pheromones in fishes. In *Hormones and reproduction of vertebrates* (pp. 169-192). Academic Press.

Ueda, H., Yamamoto, Y., & Hino, H. (2007). Physiological mechanisms of homing ability in sockeye salmon: from behavior to molecules using a lacustrine model. In American Fisheries Society Symposium (Vol. 54, pp. 5-16). American Fisheries Society.

Unfer, G., & Pinter, K. (2017). Fisheries management of stream-resident brown trout populations–possibilities and restrictions. Brown trout: Biology, ecology and management, 649-665.