Wayward Inkblots: An Overview of the Behavior in the Mimic Octopus (*Thaumoctopus Mimicus*)

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Abstract

The mimic octopus (*T. mimicus*) is a peculiar species of octopus with extensive mimicry ability, which accounts for not only visual elements of the model, but also behavioral elements. Described in 2005 by Norman and colleagues after a few decades of popularity amidst photographers and divers, these octopuses have undergone numerous studies to show their immense polymorphic abilities and how their high-fidelity mimicry is needed in their high-risk environment. More octopuses would turn out to be related (and frequently mistaken) to the mimic octopus, and mapped onto phylogeny with their relatives. Zoosemiotic researchers would also become interested in *T. mimicus*, authoring numerous papers on the possibility of higher levels of consciousness behind their deceptive behavior, and applying concepts such as image schema, cognitive empathy, and Cognitive Metaphor Theory (CMT). Gómez-Moreno (2019) argues it may even be appropriate to rename *T. mimicus* from mimic octopus to mimetic octopus based on the findings of body image within the paper. Whether or not these concepts can apply is still up to future researchers. My questions for this paper are as follows: How much of mimicry is learnt? Can the concept of image schema be applied to the mimic octopus? What other psychological or social factors play into mimicry? Furthermore, how can these findings be applied phylogenetically to other related octopuses?

Introduction

Sometime in the mid 1980s, underwater photographers Roger Steene and Rudie Kuiter reported an enigmatic long-armed octopus traversing the soft-sediments of Indonesia in broad daylight. The creature exhibited a propensity for dynamic and diverse mimicry of other animals,

particularly venomous ones, which Steene would publish many photographs in a tropical marine life book, *Coral Seas*, in 1998. Steene's full color 35mm photography captured the unprecedented forms of "Wonderpuss the Octopus," or as the caption states, the "Mimic Octopus," with mimicry ranging from ghostly-white eight-fold structures ("as a jellyfish"), benthic flatfish ("as a flounder"), or amorphous red masses resting in the sand ("as something unrecognizable") (Steene, 1998). As Steene (1998) noted, "its deception is further enhanced by copying the exact movements of the mimicked subjects." One year later, BBC and Discovery would fund a natural history documentary inspired by the mystery caught on film by Steene (see Note 1). They would employ Mark D. Norman, a marine biologist from the University of Melbourne and curator of Museum Victoria, on the search for the supposed "mimic octopus." With numerous co-authors throughout the years, Norman has described 150 octopus species, but this animal would show unique behavior compared to all other octopodes. This production would lead to a large amount of photographic and video data on the octopus, which would be described in the 2001 publication "Dynamic Mimicry in an Indo-Malayan Octopus" by Norman and colleagues. The article outlines the observed behaviors of the mimic octopus: a distinctive, long-armed octopus that occupies shallow river mouths in the Indo-Malayan archipelago. The authors were still unsure of pinning specific forms onto specific animal models with certainty (as they were only certain of the forms of soles, sea snakes and lion fishes), and they conclude it is likely to be a Batesian mimic, but it was not until 2005 that the species was officially described as *Thaumoctopus mimicus* (Norman & Hochberg, 2005), or common name, mimic octopus. Opportunism was later observed in a species of jawfish (*Stalix* cf. *histrio*) using the high-contrast patterns of *T. mimicus* to match colors and hide from predators (Rocha et al., 2012); an interesting pairing since *T. mimicus* has been observed in Steene (1998) wrapping a tentacle

around its pointed eyes to mimic the form of the jawfish. New research and reports would show the species also inhabits the coasts of Thailand (Nabhitabhata & Sukhsangchan, 2007), Australia (Coker, 2013), the Arabian Sea (Sajikumar et al., 2020), and reported all along the western Pacific and Indian Ocean thanks to predominantly citizen science data, mostly from iNaturalist (GBIF.org User 2025).

Beginning with the paper "The Role of Image Schemas and Superior Psychic Faculties in Zoosemiosis" by José Manuel Ureña Gómez-Moreno, the question of applying the cognitive psychological concept of image schemas was raised in relation to the mimicry behavior of *T. mimicus*. In 2019, Gómez-Moreno would revisit the topic with perspective further into cognitive-semiotics in "The 'Mimic' or 'Mimetic' Octopus? A Cognitive-Semiotic Study of Mimicry and Deception in *Thaumoctopus Mimicus*," and in 2025, Schumann would extensively call upon the research of Gómez-Moreno in her study proposing the use of Conceptual Metaphor Theory to explain the potential of meaning-making within *T. mimicus* (Schumann, 2025). The body of research that exists leads me to the following questions: How much of mimicry is learnt? Can the concept of image schema be applied to the mimic octopus? What other psychological or social factors play into mimicry? Furthermore, how can these findings be applied phylogenetically to other related octopuses?

Methods

Primary literature searching began with the EBSCO proxy provided by the Hampshire College Library, and a few other biological databases provided by the Holyoke Community College Library (Science Direct, JSTOR, etc.). The search term "mimic octopus" showed mild

success, but “Thaumoctopus mimicus” bore far more results. The search terms “white V octopus,” “blandopus” (see Note 2), and “long-armed sand octopus” bore no results on the Hampshire EBSCO proxy. Additional research was done through following references cited in the initial selection of papers, Ecosia searches about Mark D. Norman, Christine L. Huffard, and following Wikipedia citations on the pages “Mimic octopus,” “Wunderpus,” and “White V octopus.” Searching through iNaturalist for research-grade occurrences of *T. mimicus* led me to GBIF.org, which included a proper compilation of all sightings along with other databases’ reports.

Discussion

The mimic octopus (*Thaumoctopus mimicus*) occupies an interesting nexus between behavior and adaptation, which leaves many questions on how an animal dependent on the appearance of others comes to existence through a mixture of learning and evolution. *T. mimicus* belongs to the class Cephalopoda, a group of mollusks, named for the Latin *mollis*, meaning soft (Oxford University Press, 2023). Most mollusks have some type of calcified protection to protect their soft bodies, like bivalves, gastropods, or even cephalopods like nautiluses, but most extant cephalopods, the coleoids, have internalized their shells, such as the gladii of squids or the cuttlebones of cuttlefish. Incirrate octopuses are a less-protected offshoot of the coleoid division, which have no hard shells or calcified parts to protect themselves against prey, beyond some species having stylets, which are internalized vestigial remnants of an ancestral gladius (Fuchs et al., 2007). As Godfrey-Smith states in *Other Minds*, it is a very unusual evolutionary route for a group of such complexity, but ultimately opened it to “a body of pure possibility” (Godfrey-Smith, 2016, pp. 43-45). Imagine this squishy, near-defenseless mass crawling across

the daylit sands of Indonesia in waters teeming with predatory pelagic fish: this is the life of a mimic octopus. The mimic octopus takes great advantage of its pliable body plan to mimic the appearance, motions, and behavior of other animals, the majority of which are venomous, causing predators to avoid them. According to Tom Tregenza, co-author of the 2001 paper that observed the behavior of *Thaumoctopus mimicus*, "the octopus badly needs its mimicry… because unlike other octopus species, it forages by day over open sandy bottom in full view of its fish predators. 'It's such an exposed habitat that camouflage just isn't good enough'" (Withgott, 2001).

The initial article which goes over the at-the-time undescribed mimic octopus, "Dynamic mimicry in an Indo-Malayan octopus" by Norman et al. (2001) questions the possibility of convergent evolution of black-and-white bands (later called high-contrast dark-brown and light body, or HCDL in Huffard et al. (2010) in *T. mimicus*, in essence, meaning the same selective pressures may have faced both *T. mimicus* and the venomous sea-snakes that they resemble. Norman et al. (2001) posits *T. mimicus* is likely a Batesian mimic since it is not believed to be venomous hence making the display a 'dishonest' signal. At the time of both Norman et al. (2001) and Norman & Hochberg (2005), there is no evidence to confirm or deny the presence of venom in *T. mimicus*. According to Fry et al. (2009), cephalopods seem to share a single origin in the molecular evolution of venom. Norman & Hochberg (2005) does show the same glands used in the study that are present among cephalopods ancestrally, but this is not a confirmation of their status as a venomous species, and sampling these organs is yet another point of future research for *T. mimicus*. With this uncertainty aside, it is safe to conclude for now that *T. mimicus* is Batesian in nature. Furthermore, it is rare for a Müllerian mimic to exhibit the polymorphism of *T. mimicus*, since Müllerian mimics aim to co-evolve to a similar signal, and it would be

theoretically disadvantageous to evolve dissimilar signals for the same contents (Turner, 1989). The idea of a "dishonest" or "honest" signal quite obviously comes with loaded anthropocentric implications, but this is what biosemiotic researchers attempt to tackle by beginning to peel away the human-centricity of semiotic analysis itself.

In the following years, more related octopuses would turn up in academic literature showing mimicry abilities of varying fidelity and similarity to *T. mimicus*. In 2006, Norman & Hochberg described a relative of *T. mimicus*, and one that was also reported in the 1980s off the coast of Indonesia: *Wunderpus photogenicus*, or common name, wunderpus (Hochberg et al., 2006). During the description of the mimic octopus, they were frequently confused with the wunderpus as related long-armed octopus with mimicry behavior, the confusion seeming to even slip into in Steene (1998), with the title "Wonderpuss the Octopus" emboldened at the top of the page. The wunderpus began to populate the aquariums of collectors throughout the mid 1980s, until Norman & Hochberg finally collected enough specimens to describe (four of the specimens in Hochberg et al. (2006) were obtained from commercial aquarium trade). A helpful webpage from the University of California Berkeley shows the numerous visual differences between *T. mimicus* and *W. photogenicus*, most notably, the lighter hue of brown, more defined blotches of white, and longer eyestalks in *W. photogenicus* compared to *T. mimicus* (*Wunderpus vs Mimic*, n.d.).

Huffard et al., 2010 explores the morphological and behavioral traits of *W. photogenicus* and *T. mimicus*, namely the dorsoventrally compressed swimming (DVC swimming), and in particular, the more specialized "flatfish swimming" seen in *T. mimicus*, as DVC swimming does not necessarily include fin undulation and flattening of head and mantle. Huffard et al., 2010 constructs a phylogenetic tree of the related octopuses, in particular, the "Long-Armed Sand

Octopuses," or "LASO," which the paper proposes as a new clade. At the time of Huffard et al., 2010, there had been no other constructions of the phylogenetic relationships of *T. mimicus*, and it would appear the analysis of shallow-water octopus mitochondrial DNA may still be the latest to include *T. mimicus* and relatives. LASO includes another two similar octopuses, both of which are yet to be described as of writing, with the recommendation that LASO itself be considered a synonym of the *Thaumoctopus* genus, making *Wunderpus* a junior synonym. These two other mimics in LASO are the "White V" octopus, and the "Hawaiian Long-Armed Sand Octopus." The article asserts *T. mimicus* blurs crypsis (camouflage) and mimicry across its vast polyphenism since some of its forms seem intended to draw attention rather than to obscure. Flatfish swimming was observable in all LASO octopuses besides *W. photogenicus*, HCDL in *T. mimicus* and *W. photogenicus*, and all LASO species plus *Abdopus aculeatus* have long arms and exhibit DVC swimming. Huffard et al. (2010) asserts with mDNA evidence that *Adbopus* is a sister clade to LASO, and the LASO + *Abdopus* clade is a sister to the reef-dwelling *Octopus cyanea* clade. Huffard et al., 2010 further points out that behaviors such as those found in *T. mimicus* and *W. photogenicus* are entirely heritable traits, and this may point to an hypothetical ancestor with overlapping mimicry capacity, postulating that DVC and flatfish swimming may have evolved in conjunction with the especially long arms. The article points to a study by Hanlon, et al. (2010), which found that a laboratory-reared specimen of *Macrotritopus defilippi* was observed flatfish swimming, despite having never seen a flatfish.

Conversely, the possibility of social mimicry playing a role in the traits of LASO octopuses is present, since Krajewski et al. (2009) found 33 individuals of *Octopus insularis* imitating *Cephalopholis fulva*, a grouper species, out of 39 total observed individuals throughout 100 hours of diving. 12 of these individual octopuses were recorded on the seafloor, where they

remained camouflaged to the background, until joining schools and gaining the coloration of foraging *C. fulva*, which reinforces the previous statement of Huffard et al., 2010, being that *T. mimicus* and *W. photogenicus* are unique in the goal to appear conspicuously amidst the environment they inhabit. Despite this, it is important to note that any species of octopus holds the capacity for social mimicry or "schooling mimicry" (Krajewski et al., 2009), and that this may be applicable in further research. As Norman et al. (2001) states, the dynamic mimicry ability of *T. mimicus* allows some degree of separation from genetic restraints, and that based on the observations of the authors, *T. mimicus* was able to make decisions based on the appropriate actions in a given situation.

The question remains of whether or not mimicry in *T. mimicus* is entirely "hard-wired" for mimicry, but the evidence is strong in Huffard et al. (2010) that some degree of neurological and morphological equipment of mimicry is present in the common ancestor of the LASO clade, and Norman et al. (2001) supports a certain flexibility in the polymorphic form of *T. mimicus*. Though it opens more questions for the implications to the rest of LASO phylogeny, Gómez-Moreno brings *T. mimicus* to the aforementioned biosemiotic lens for investigation, much of which reinforces the claims of decision-making in Norman et al., 2001. Beginning with Gómez-Moreno (2014), or "The Role of Image Schemas and Superior Psychic Faculties in Zoosemiosis," it is first asserted that image schemas are "highly instrumental" to mimicry in two animals being studied: *T. mimicus* and the Gibb's sea spider crab (*Pisa armata*). For obvious reasons, I will not be focusing much on *P. armata* for this study, but Gómez-Moreno makes a compelling case for the application of image schemas to both subjects in a way that invites comparison between species.

Gómez-Moreno (2014) mentions the study on macaque monkeys done by Rizzolatti and Craighero (2004) in which visual perception of grasping in other monkeys activated the same sensorimotor schemata in the somatomotor cortices as performing a grasping action by itself (as cited in Gómez-Moreno, 2014). Gómez-Moreno (2014) compares the dynamic mimicry of *T. mimicus* with the fixed-imitation of the barreleye fish *Macropinna microstoma*:

> "These modifications are independent of the interpretive brain, which results from a more sophisticated type of organic coding… In other words, the fake eyes are not part of a dynamic survival strategy consciously deployed and controlled by *Macropinna microstoma*. In fact, we do not even know whether the barreleye fish is aware of its peculiar anatomic structures."

Unconstrained by a single genetic path to mimicry, *T. mimicus* can employ a wide range of techniques behaviorally and morphologically, and Gómez-Moreno (2014) considers creative reasoning in an animal to be evidence of "superior psychic faculties." *P. armata* evolved with image schemas such as VERTICALITY and BALANCE in its repertoire of algae-swaying iconography for communicating deceptive signs, or interspecific semiosis, and similarly, *T. mimicus* uses the COMPULSION schema to enact self-instigated motion along the seafloor during flatfish swimming, including lower categories RESISTANCE and ATTRACTION (Gómez-Moreno, 2014). The RESISTANCE schema allows upward force in the octopus' muscles against gravity, and the ATTRACTION schema is enacted when giving way to gravity as the force acts to pull the octopus to the seafloor. The SURFACE and PATH schemata complement ATTRACTION and RESISTANCE, allowing conceptualization of the environment. While there is neurological evidence of image schemata in other animals, the work done by Gómez-Moreno (2014) is yet to be supported by neurological research.

While the cognitive abstraction of algae mimicry in *P. armata* may be enough for blending in with marine benthos (Gómez-Moreno, 2014), the high-risk-low-protection lives of *T. mimicus* have much higher requirements (Withgott, 2001). The semiotic novelty of *T. mimicus* lies in the claim of dynamic mimicry in Norman et al. (2001), and is further explored in Gómez-Moreno (2019), which raises the possibility of bodily self-awareness, cognitive empathy, and the ability to optimize standard imitation into partial forms based on situation appraisal. Gómez-Moreno (2019) based the analysis on observations of *T. mimicus* in Mitchell's typology of deceptive acts (as cited by Gómez-Moreno, 2019), Zlatev's Mimesis Hierarchy (2008), and types and levels of consciousness (2018). The article notes that behavioral complexity alone is not the indicative of self-consciousness, but may suggest it, and their advanced deception abilities show some level of cognitive sophistication worthy of cognitive-semiotic research (Gómez-Moreno, 2019). In analyzing footage of a *T. mimicus* specimen performing sea-snake mimicry, Gómez-Moreno, 2019 argues that this mimicry form succeeds the lionfish and flatfish forms in complexity since lionfish and flatfish mimicry do not require close octopus-antagonist interaction, and though not unique to *T. mimicus*, the species is capable of assessment of perceived threats with appropriate mimicry forms, which may be indicative of higher cognition. With the adjustment of full to partial mimicry, Gómez-Moreno (2019) offers a minimal and a richer explanation for this phenomenon. The minimal explanation of partial mimicry from Gómez-Moreno (2019) is that this is a reflexive (non-reflective) enactment in response to the danger of the nearby damselfish in the footage, while the richer explanation states its mimicry works tightly with its own body image and cognitive empathy to understand optimal deception. The latter interpretation would place *T. mimicus* at dyadic mimetic on Zlatev's Mimesis Hierarchy, and reflectively conscious on Zlatev's Semiotic Hierarchy, leading Gómez-Moreno

(2019) to the assessment that it can be argued that the more appropriate common name for *T. mimicus* is not mimic octopus, but rather, the mimetic octopus.

Schumann (2025) further uses zoosemiotic evidence from both Gómez-Moreno (2014) and Gómez-Moreno (2019) to apply Conceptual Metaphor Theory (CMT) to *T. mimicus*, postulating that pre-linguistic mental constructs used for comparison (cross-domain mappings), or metaphors, inform the decisions of not just infant children incapable of speech, but other members of the animal kingdom incapable of speech entirely. Since metaphors by definition draw attention to the similarities between two concepts, the central claim of Schumann (2025) is bodily reflection in *T. mimicus* that allows for the drawing of comparisons between itself and surrounding organisms.

Conclusion

When describing the mimicry of *T. mimicus* in comparison to other octopuses, or any other animal, one needs to look no further than the title of the very first paper published on the organism: dynamic mimicry (Norman et al., 2001). While it was a clear fact that *T. mimicus* was an unusual form even for the already unusual octopus fact from the beginning of the mimic octopuses' foray into print with Steene's *Coral Seas* (1998), the studies on *T. mimicus* shows there is not only an incredible wealth of information ranging from phylogeny (Huffard et al., 2010) to zoosemiotics (Gómez-Moreno, 2014; Gómez-Moreno; 2019; Schumann, 2025), but an exhaustive amount of research that is yet to be done.

Neurological research is yet to have supported the claims of image schema in *T. mimicus* as claimed by Gómez-Moreno (2014). Research of this sort could involve searching for localized neurological regions associated with specific activities and concepts in *T. mimicus*.

Gómez-Moreno (2019) utilizes Zlatev's Semiotic Hierarchy (Zlatev, 2018) to show from existing footage and data that *T. mimicus* is reflectively conscious in its conspicuous mimicry, possibly justifying the replacement of the name mimic octopus with mimetic octopus. Acknowledging this new title in the biological sciences could open possibilities with dialogue between the fields of biology and cognitive linguistics, and make for novel insights on where they intersect.

As stated in Huffard et al. (2010), there is insufficient evidence to suggest that DVC may be an efficient mode of swimming for long-armed octopuses, but it is a possibility since the streamlined form may incorporate lift to increase biomechanical efficiency and combat the inefficiency of typical jet-propulsion seen in other octopus species. Further research, potentially through simulation, could be performed to determine the biomechanical features of long-armed octopuses. The co-evolution of behavior, morphology, and zoosemiotics in the LASO clade also calls for further research. In tandem with this research, further efforts should be made to describe the "Hawaiian Long-Armed Sand Octopus" and the "White 'V' Octopus." The perspective of developmental or evolutionary-developmental biology could be applied to study of *T. mimicus* to ask questions about what developmental milestones must be met for mimicry to occur.

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Notes

[1] The documentary in question seems to be partially lost as of writing, and there appears to be evidence of three separate documentaries featuring Mark D. Norman from roughly the same time. Firstly, *Mimic Octopus: An Incredible Imposter* from the "Wild Discovery" series (Mimic Octopus: An Incredible Imposter. (n.d.)), and secondly, "Octopus Hunter," which Withgott, 2001 claims is the film that led up to the creation of Norman et al., 2001. Thirdly, the closest lead I have found is a documentary from 2000 labeled "Underwater Wonderland," part of the "Wild Indonesia" series from BBC, which can be accessed here: https://archive.org/details/BBCNaturalWorld180EpisodeCollection/BBC+Natural+World

+2000+-+Wild+Indonesia+02%2C+Underwater+Wonderland.mpg. The credits list a special thanks for Mark D. Norman, Julian Finn, and Roger Steene, and shows the mimic octopus from 41:11-44:04. It appears to use the same shot as what Gómez-Moreno, 2019 cites in Fig. 1 (sea-snake mimicry) as footage from Norman et al., 2001, which uses the footage from this initial documentary. To summarize, if "Underwater Wonderland" is not the same as "Octopus Hunter," then it at least uses the same footage.

[2] For simplicity's sake, I have only mentioned the undescribed Indonesian species in this paper as "White 'V' octopus," but it may also be referred to as the "blandopus" or "Octopus sp.18" (Hanlon et al., 2008).