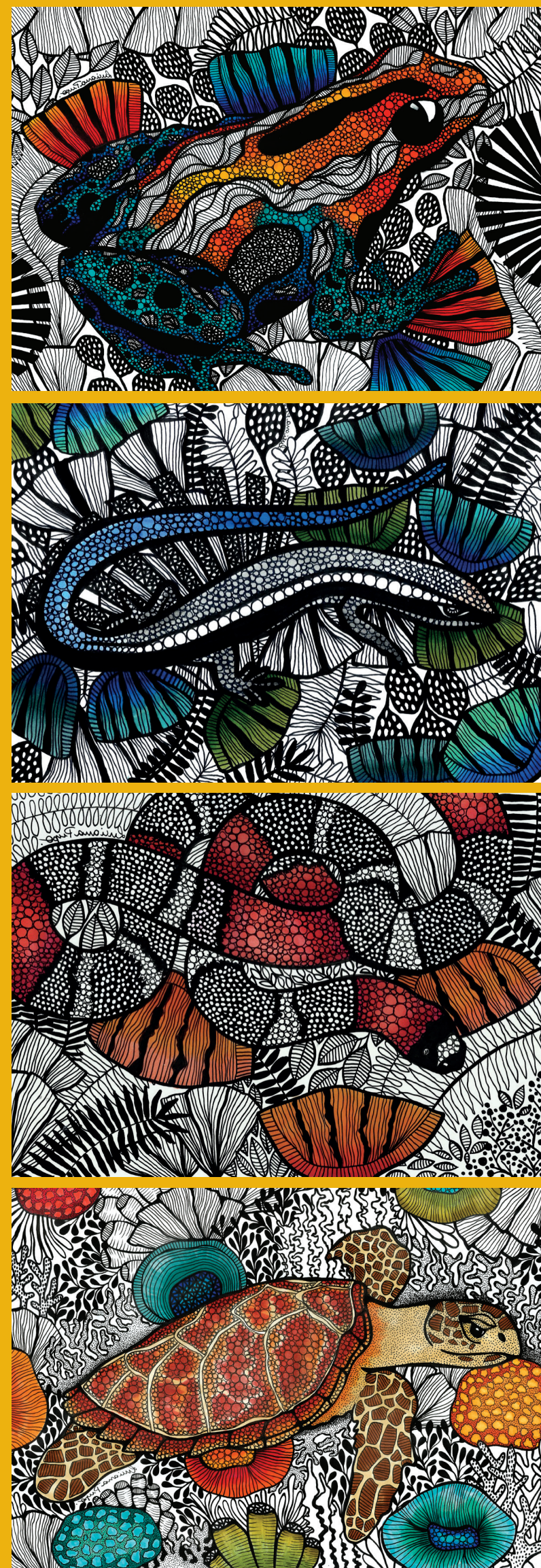




A **herpetologia** é um ramo muito ativo da ciência nacional e atualmente destaca-se em cenário internacional com a grande produção de conhecimento. Nesta obra reunimos um pouco desta riqueza em 18 revisões temáticas que protagonizaram o **IX Congresso Brasileiro de Herpetologia**. Os capítulos abordam temáticas contemporâneas e não se restringem apenas ao estudo dos anfíbios e répteis, mas também incorporam aspectos ambientais mais amplos e aqueles socioeconômicos atuais. Esta é uma leitura obrigatória não só para qualquer herpetólogo brasileiro, mas também a todos aqueles interessados em Zoologia, ciência e cultura geral.



Herpetologia **BRASILEIRA** contemporânea



**LUÍS FELIPE TOLEDO**  
Organizador



# Herpetologia **BRASILEIRA** contemporânea





# HERPETOLOGIA BRASILEIRA CONTEMPORÂNEA







# HERPETOLOGIA BRASILEIRA CONTEMPORÂNEA

Luís Felipe Toledo, Org.



2021



# **HERPETOLOGIA BRASILEIRA CONTEMPORÂNEA**

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*cinerascens*,  
L. F. Toledo



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◀ *Proceratophrys laticeps*,  
L. F. Toledo

# QUEERING HERPETOLOGY: ON HUMAN PERSPECTIVES AND THE STUDY OF DIVERSE ANIMALS

Karen Warkentin (Boston University & the Smithsonian Tropical Research Institute, USA)

**Resumo:** A compreensão da vida por biólogos e outros humanos sempre foi moldada pela nossa história social e biologia mamífera, as quais embasam as perguntas que fazemos. Comparativamente com outros tetrápodes, anfíbios e répteis possuem uma extraordinária diversidade em biologia reprodutiva e história natural. A herpetologia revela esta variação, expandindo o que conhecemos ser possível e permitindo que façamos novas perguntas. A perspectiva *queer*, informada pela vida de diversos biólogos, influencia o que percebemos, perguntamos e investigamos. Assim, combinando diversidade humana e herpetológica, e atento às observações *queer*, revela-se um grande potencial para descobertas inovadoras.

**Abstract:** How biologists and other humans understand life has been shaped by our social history and mammalian biology, which inform the questions we ask. Compared with other tetrapods, amphibians and reptiles show amazing diversity in reproductive biology and life history. Herpetology reveals this variation, expanding what we know as possible and enabling us to ask new questions. Queer perspectives, informed by the lives of diverse biologists, influence what we notice, ask, and investigate. Combining human and herpetological diversity, and attending to queer observations, offers great potential for transformative discoveries.

"Queer" is an unstable, multifaceted concept. It first appeared in the 16<sup>th</sup> century (Sayers 2005) as an adjective for odd, unusual, deviant, suspicious, or slightly unwell, in opposition to ordinary and normal. As a verb, it meant to spoil, disrupt, or undermine. It was later applied to people as an adjective or noun meaning homosexual or, more generally, outside



accepted norms of sexuality and gender. In this sense it has been used as a slur, and some people find it offensive. As a biologist interested in variation, the old meanings of unexpected and perplexing suggest to me that queer observations may particularly reward investigation.

My own queerness has shaped many aspects of my career, including in ways I see only in hindsight. Starting in the 1980's, when I came out as a lesbian, the word queer was reclaimed to celebrate human diversity, positively claim non-normative or marginal desires, and make space for variant sexual perspectives. This occurred as what had begun as the gay liberation movement, aiming for social transformation, increasingly focused on obtaining rights such as marriage for gays and lesbians who might fit into slightly expanded social norms (Warner 1999). Queer still has this non-normative meaning.

In addition, queer is now used as an umbrella term for gender and sexual minorities—lesbian, gay, bisexual, transgender, intersex, asexual, pansexual, non-binary, gender-nonconforming, and others. As a verb, queer can mean to apply non-normative perspectives, particularly the critical methods of queer theory, to concepts or academic fields (Barker & Scheele 2016). It can also mean to integrate gender and sexual minorities into, for instance, a field and the changes that result from such integration. Here I will use queer broadly to include gender and sexual minorities, noting that we sometimes restrict queer to sexualities and use trans as an umbrella term encompassing gender minorities.

It is relevant that “normal” also has a variety of common meanings, from ordinary and conventional to healthy and natural. However, norms are fundamentally contextual; our native languages and the cultures we live in deeply shape our perceptions (Henrich et al. 2010). Biologists often think of normal as a distribution, not a property of individuals, and design experiments and statistical analyses to avoid potential biases. However, in choosing questions to investigate we apply entirely different criteria, which may often reinforce the status quo (Gowaty 2018; Tang-Martínez 2020a).

The questions we ask today build on questions asked and hypotheses tested through the history of biology (Tang-Martínez 2020b). However, what our intellectual ancestors imagined as possible was shaped by their social context. For instance, when Darwin proposed sexual selection as a mechanism to explain the origins of male traits disfavored by ordinary natural selection, other Victorians accepted the idea that males compete for females and winners pass on their competitive traits, but the idea that



▼ *Agalychnis callidryas*,  
K. M. Warkentin

females actively choose mates, and their aesthetic preferences drive the evolution of male displays, was hard to imagine (Tang-Martínez 2016). After Trivers (1972) proposed parental investment theory in a much different social context, biologists increased efforts to test for sexual selection by female choice. Then, the paradigm of eager/undiscriminating males and coy/choosy females was overgeneralized, despite evidence to the contrary. In the same era, women field biologists noticed that their study species did not fit this expectation (Tang-Martínez 2020a). Incorporating feminist perspectives into evolutionary biology transformed the field and continues to change how we understand ourselves and other animals (Gowaty 1997; Hayssen & Orr 2017). Despite this, we still grapple with a legacy of oversimplified, binary sex roles that impact biological research (Tang-Martínez 2016). The mutually reinforcing resonance between social context and research efforts can block,

but sometimes accelerates, scientific and social progress.

The 2019 Brazilian Herpetology Congress, with its theme of Inclusive Herpetology, coincided with the 50<sup>th</sup> anniversary of the Stonewall uprising. In June 1969, when queer people in New York City fought back against a routine police raid at the Stonewall Inn, same-sex relations were illegal in the USA; gender conformity was actively policed and people could lose their jobs for being gay (Canaday 2009). In Canada, where I was born, Pierre Trudeau's

government had just decriminalized same-sex relations, along with contraception and abortion, declaring "there's no place for the state in the bedrooms of the nation" (CBC Archives 2020). The Stonewall uprising was a catalyst and a turning point for public organizing against gay oppression. In the half-century since, in many countries, sexual minorities have gained a diverse range of legal protections, including constitutional protection in 11 countries (Ramon Mendos 2019). However, other countries mandate a range of penalties, including long prison sentences and even death; these sanctions have recently increased in some places (Ramon Mendos 2019). Social acceptance of and sanctions against trans and gender-diverse people also vary greatly today (Chiam et al. 2017), as they have historically across cultures (Vasey & VanderLaan 2015)

The criminalization of same-sex sexual interaction privileges heterosexuals and discriminates against sexual minorities, creating



▲ *Cochranella granulosa*,  
J. Delia



legal inequity. The term “heterosexism” includes such clear structural inequalities as well as more subtle ones, as occur when well-meaning people act on unconscious biases. I find “heteronormativity” a useful concept; this is the routine assumption of heterosexuality and associated behaviors, family structures, life history attributes, etc. Heteronormativity makes certain kinds of variation invisible and marks visible differences as queer, needing explanation, while normative traits are naturalized, unquestioned, and unexamined. Clearly this affects how we see—or often fail to see—queer families, but it also affects many other families. In my family, both my same-sex partner and my adopted brother may go unrecognized in contexts where a heterosexual partner or genetic sibling would not. Heteronormativity also affects our biological observations of other species, including what we notice, what we record, and how we interpret what we see. We often assume courting or mating animals are male and female, but they may not be. For instance in garter snakes, *Thamnophis sirtalis*, cold males emerging from hibernacula temporarily release female pheromones, attracting courtship by warmer males, which helps the cold ones warm up and protects them from predatory birds (Shine et al. 2012). When phenomena like this go unrecognized, their apparent absence reinforces heteronormative notions of biology.

Conversely, the discovery of sexual behavior in same-sex contexts, where its function cannot be fertilization, creates opportunities for research that can improve our understanding of sexual behavior more generally (Crews 2012). After noticing extensive courtship and copulatory behavior in the all-female lizard *Cnemidophorus uniparens*, Crews and collaborators documented that this increases fecundity, and conducted an elegant series of experiments with *C. uniparens* and their sexually reproducing relatives (Crews 1987). These revealed evolutionary changes in neuroendocrine mechanisms of behavior and reproduction with broad implications for understanding vertebrate sexuality (Woolley et al. 2004; Dias & Crews 2008; Crews 2013).

Same-sex sexual behavior has now been documented in hundreds of species, typically by individuals that also mate heterosexually (Poiani 2010). It is estimated to occur in about 15–30% of mammal and bird species (Bagemihl 1999), but we still lack good estimates of its distribution and prevalence in reptiles and amphibians. There can be non-adaptive reasons for any behavior, so same-sex mating could occur as an incidental side-effect of adaptive traits (Bailey & Zuk 2009) or sexual nondiscrimination could be ancestral (Monk et al. 2019). However, once any trait is expressed, it is available for selection, and traits that evolved in one context can later gain new functions (Gould

& Vrba 1982; Prum 2005). Indeed, there is substantial evidence for non-reproductive functions of sexual behavior, including in same-sex contexts (Wolff & Macdonald 2004; Lukas & Huchard 2014; Young & VanderWerf 2014; Moscovice et al. 2019; Barron & Hare 2020). Same-sex sexual behavior is, however, only one part of the queer diversity of life, and may not be where herpetology has the most to contribute.

Human reproductive biology—as viviparous, placental, internally fertilizing gonochorists with chromosomal sex determination and female lactation—probably biases our broader understanding of sexual and reproductive biology. Most mammals share these traits, offering limited material for comparative analysis. Similarly, many aspects of sex and reproduction are shared ancestral traits in birds. Reproductive diversity among amphibians and reptiles is higher, but less studied. For instance, parental care is estimated to occur in 10–20% of frogs and has evolved many times, offering excellent opportunities for comparative work (Vági et al. 2019). Male, female, and biparental care are widespread, especially in terrestrial breeders. Male care evolved as often as female care, and there is no sex bias in care duration or level of protection (Vági et al. 2019). This clearly opposes simplistic notions that anisogamy leads to female care. Nonetheless, for many frogs we still know very little, and fieldwork will continue to change our understanding.

For instance, when Jesse Delia started his PhD research with me in 2011, we thought about 20% of glassfrogs had parental care, always by fathers. Then, on a stream in Panama late at night, Jesse and Laura Bravo-Valencia noticed females sitting on eggs, just for a few hours. Through lab and field experiments, they determined that this brief period of egg-hydration provides essential protection from predation and drying (Delia et al. 2017). Their extensive fieldwork transformed our understanding of glassfrog reproduction, suggesting that all species require, and provide, egg care. Male care evolved from female care three times, and care duration and behavior was elaborated each time; males care the longest in lineages where they mate multiply (Delia et al. 2020). Minimalist maternal care and elaborate paternal care oppose conventional sex-role theory; thus, the newly evident variation in glassfrog parenting opens new research questions.

Frogs evolved terrestrial eggs over 50 times (Gomez-Mestre et al. 2012), but intraspecific variation that would enable such change was unknown. Then, midway through his PhD research on *Dendropsophus ebraccatus*, Justin Touchon searched for their terrestrial egg clutches at a new study pond with a great chorus. Frustratingly, he found none. Motivated by this queer observation, we returned at night to follow amplexant pairs and saw these “terrestrial-breeding” frogs laying eggs



in the water. This simple observation opened new research possibilities. In experiments, Justin found that *D. ebraccatus* pairs assess local conditions and make plastic, behavioral choices between terrestrial and aquatic oviposition (Touchon & Warkentin 2008; Touchon & Worley 2015). Selection pressures vary among ponds, so eggs survive better on land in some places, and better in the water in others (Touchon 2012). In further comparative work (in preparation), Justin found 5 other species of *Dendropsophus* that show similar plasticity; their phylogenetic placement supports that plasticity may play a role in transitions from aquatic to fixed terrestrial egg-laying. He also found variation among *D. ebraccatus* populations, including localities where they only lay terrestrial eggs, and individual variation within a population that he is now using for a selection experiment to study genetic changes during the evolution of terrestrial reproduction (J.C. Touchon, pers. comm.).

Compared with the less diverse birds and mammals, less effort has been invested to understand reproduction, life history, sex determination, and sexual development in amphibians and reptiles. Thus, substantial diversity likely remains undiscovered. Even in relatively well-studied areas, such as sex determination in reptiles, there is much to learn. The many origins of different forms of genetic and environmental sex determination in reptiles, including recent evolutionary transitions, offer excellent research opportunities. For instance the discovery of adaptive divergence in sex determination mechanisms between high-altitude GSD and low-altitude TSD populations of snow skinks (Pen et al. 2010) enabled comparisons to determine the underlying genomic changes (Hill et al. 2018). Similarly, the discovery of widespread sex reversal of ZZ males to females in bearded dragons (Holleley et al. 2015) opened new opportunities to examine the role of sex reversal in evolutionary transitions between sex determination systems (Holleley et al. 2016; Deveson et al. 2017) and the process of sexual development (Whiteley et al. 2018).

Understanding why sexual reproduction is so common, given the immediate advantages of asexuality, is a longstanding problem in evolutionary biology (Otto 2009). There are over 40 origins of obligate parthenogenesis in squamates, most—but not all—involving hybridization (Kearney et al. 2009). The all-female *Ambystoma* have persisted for 5 million years reproducing by gynogenesis, using heterospecific sperm to activate their eggs, and occasionally incorporating sperm DNA (Bi &

▼ *Imantodes inornatus*,  
K. M. Warkentin





▲ *Agalychnis callidryas*,  
K. M. Warkentin

Bogart 2010; Gibbs & Denton 2016). Since 1997, reports of sporadic parthenogenesis in normally sexual species have accumulated, most with loss of heterozygosity but possibly also clonally (Neaves & Baumann 2011), most in captivity but also from the wild (Booth & Schuett 2016). Thus, the boundary between sexual and asexual reproduction now seems more permeable than we used to think.

Considering our own evolutionary history, comparative primatology suggests about a 45 million year history of non-reproductive, social functions of sexual behavior in anthropoids, and a 30 million year history of bisexual capacity and behavior in catarrhines (Dixson 2012). All the great apes—not just bonobos—show both same-sex and heterosexual sexual behavior (Dixson 2012). Thus, we inherited an ancient capacity to use sexual behavior in many different ways, for different reasons, and with different kinds of partners. Then our ancestors evolved cooperative breeding, involving shared childcare of very needy young, dramatically changing both environmental effects on development and natural selection on human variation (Blaffer Hrdy 2009). As well as diversifying family structure and the organization of childcare, cooperative breeding probably contributed to increase genetic and phenotypic diversity in gender and sexuality, via higher potential for kin selection (VanderLaan et al. 2017) as well as socially contingent costs and benefits of individual reproduction (Blaffer Hrdy 2009). While other apes, and catarrhines more broadly, have an expansive capacity for diverse sexual behavior, humans show more variation in gender

and sexuality traits among individuals and also more variation among cultures (Dixson 2012); this is part of the richness of human diversity.

Although mammalian biases and effects of human social history on biological thought have slowed our discovery of reproductive, sexual, and life history diversity in other species, I suggest that active inclusion of human diversity among scientists might accelerate our progress. Specifically, we could take advantage of some ways that humans vary more than most mammals. Social science has shown the value of diversity within working groups. In science, citation rates are higher for papers by mixed-sex teams versus all-male teams (Campbell et al. 2013), for ethnically diverse teams (Freeman & Huang 2015), and for international collaborations (Adams 2013). Scientists who have lived in different countries have higher impact

factors—even people who moved with their families as children (Franzoni et al. 2014). Innovation rates are also higher for gender and ethnic minorities (Hofstra et al. 2020). There are benefits of diversity among people, such as gender and race, and within individuals, such as international experience and bicultural heritage (Galinsky et al. 2015). Diversity in groups improves creativity, complex thinking, and problem solving, and interacting with people unlike yourself improves performance for both majority group members and minorities (Galinsky et al. 2015). However, these positive synergies can be blocked by overt inequalities or more subtle, unconscious biases (Galinsky et al. 2015). Thus, token diversity without real integration, or the presence of people whose differences are invisible or suppressed to fit in with group norms, is of limited value compared to open interaction among people free to be themselves.

We know women and racial and ethnic minorities are underrepresented in STEM fields, and there are efforts to improve equity and inclusion (e.g., Roper 2019; Mehta et al. 2020; Segarra et al. 2020). Gender and sexual minority experiences in STEM are less studied, but a large study of US federal agencies, where LGBT employees are legally protected from discrimination, found STEM-related agencies have 18–20% fewer LGBT employees than expected from population estimates and 13% fewer than non-STEM federal agencies (Cech 2015). This discrepancy may reflect work experiences, as these employees reported worse perceived treatment and less job satisfaction, compared to both straight colleagues in the same agencies and LGBT employees in non-science agencies (Cech & Pham 2017). It may also reflect a leaky pipeline. In a broad national survey of students who began college in 2011 as STEM majors, the 4-year retention rate was 7% lower for sexual minority students than for heterosexuals (Hughes 2018).

I started college just 10 years after Stonewall, but some factors affecting my persistence in STEM are likely still relevant today. While the heteronormativity of some biology courses was alienating, I loved both plant physiology and my part-time job as a naturalist. Still, when my botany professor said I was “wasting my talents” on environmental education I stopped considering graduate work with plants. I was also a feminist activist and took women’s studies courses, considering that career, but one summer of indoor work was enough to dissuade me. I could see no way to combine my interests in biology with gender and sexuality studies. So, after graduating, I continued working in nature interpretation.

As a naturalist, I loved working with snakes. Their alien elegance and misunderstood nature appealed to my queer sensibilities and helping people overcome—or at least not act out—their fear and revulsion



was rewarding. Thinking I might study snakes, I took Jim Bogart's herpetology course, but it was his lecture on reproductive diversity in frogs that blew my queer Canadian mind. I had no idea that much variation was possible in a single vertebrate order. The Canadian frogs I knew just lay eggs in water and leave them but, in the tropics, frogs have an amazing variety of reproductive modes and lifestyles. Looking at my career now, that lecture was possibly the most impactful hour of my life, and it gave me a path to continue in biology. By queerly conjoining the study of amphibians and non-avian reptiles, herpetology allowed me to work with both frogs and snakes. As a student, the weirdness of this mix seemed to me to enable, or require, an appealing diversity of thought—a kind of interdisciplinarity internal to the field—that had not been evident in my more phylogenetically coherent mammalogy course.

In my masters research with Richard Wassersug, I studied behavior in a morphology lab and tadpoles in a medical school (Warkentin 1992a; b). My science was a bit disjunct from what I saw around me, but I was used to that from my personal life. I also contributed to a groundbreaking anthology, *Bi Any Other Name* (Hutchins & Kaahumanu 1991), now considered a catalyst for the bisexual rights movement but—because US immigration was denying entry to queer activists—I used a pseudonym to avoid jeopardizing my PhD opportunities. I chose Mike Ryan's lab at the University of Texas for the opportunity to do Neotropical field research on the behavior and integrative biology of frogs. Somehow, I overlooked the entire lab's focus on sexual selection; I had zero interest in studying frog heterosexuality.

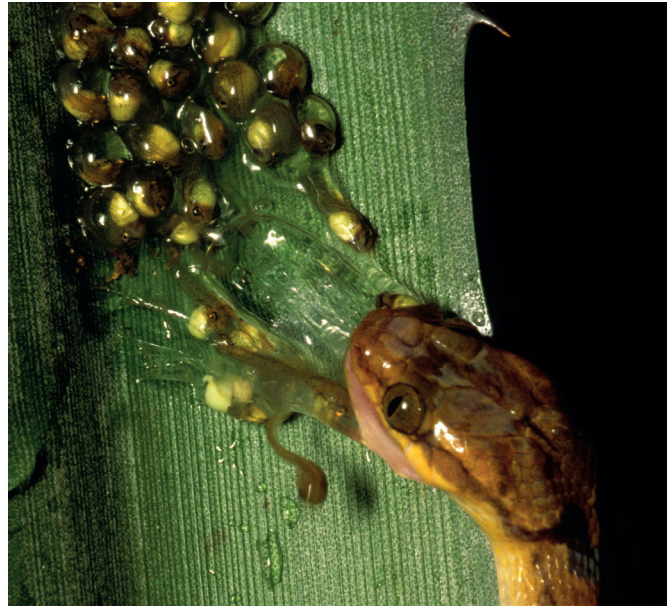
Fortunately, I received an NSERC fellowship from Canada that gave me the freedom to choose my own questions. I wanted to focus on natural selection and to work with early life stages whose sex was unknown and arguably irrelevant. So I went to Costa Rica on a field course, looking for a frog with interesting eggs or tadpoles and a question for my research. Larry Gilbert introduced me to the arboreal eggs of *Agalychnis callidryas*, hanging ornamentally on leaves over a pond full of tadpoles. In my initial natural history observations, snakes ate half of my monitored eggs. Then, I accidentally bumped into a well-developed egg clutch; a few embryos hatched and fell into the water. I did not know that frogs were not “supposed” to hatch rapidly so, based on what I had seen, I hypothesized adaptive plasticity in hatching timing. I wondered if embryos might escape from snakes by hatching early, and if aquatic predators of tadpoles might select for later hatching. At a herpetology conference before my next field season, I presented my egg-predation data, hatching plasticity hypothesis, and the experiments I had planned. Some senior herpetologists told me that frog embryos

could not possibly hatch fast enough to escape from snakes, nor could a few days of development affect tadpole survival in the water, counselling me against wasting time testing my “misguided” hypothesis. With a well-developed stubbornness about testing ideas for myself and a healthy skepticism of authority figures’ advice on what was best for me, honed by my queer life, I returned to Costa Rica.

I saw embryos hatch and escape during snake attacks in my cages and gathered evidence corroborating that this also occurs in nature. I ran experiments with predatory shrimp and fish, in which older hatchlings survived better. Then, with data supporting the existence of escape-hatching and a predation risk trade-off, I submitted my work for publication. One reviewer wrote “Every herpetologist knows that if you jiggle well-developed frog eggs they hatch.” They apparently thought the snakes were inadvertently breaking weakened egg capsules, releasing passive embryos, and I had simply misinterpreted a trivial observation. They were wrong.

My PhD work documented that *A. callidryas* embryos can hatch to escape from predators (Warkentin 1995), providing proof-of-concept for a previously unimagined phenomenon and motivating further research. As evidence for embryo responses to predators and pathogens accumulated, earlier studies of hatching responses to abiotic and host cues took on new importance. What initially seemed to be isolated special cases increasingly appeared as examples of a widespread general phenomenon (Warkentin 2011a; b). Environmentally cued hatching is now part of the foundational knowledge (Gilbert 2010; Gilbert & Epel 2015) that young scholars are using to ask questions I would never have imagined (Guevara Molina et al. 2020). Indeed, the possibilities inherent in nature exceed the limits of imagination of any one human. Thus, as an advisor, I try to focus on the feasibility and value of students testing their hypotheses and not to reject hypotheses prematurely based on my *a priori* assessment of their likelihood.

The scientific trajectory of predator-cued hatching—from unasked question and impossible concept, through isolated weird case and motivating possibility, to exemplar in a newly appreciated general phenomenon, which becomes foundational knowledge—is probably not unusual for novel ideas. It highlights the importance of unasked



▲ *Agalychnis callidryas* hatching to escape *Leptodeira septentrionalis*, K. M. Warkentin

questions in ‘epistemologies of ignorance’ (van Anders 2014) as well as the fact that one person’s impossible concept is another’s motivating possibility.

I cannot have been the first herpetologist to bump into an *A. callidryas* egg clutch and see a few embryos hatch, and the fact that some terrestrial amphibian eggs hatch when flooded has been known for a long time (Harrison 1922). Why did I hypothesize escape-hatching in *A. callidryas* where others had not? Why did I pursue environmentally cued hatching as a potentially general phenomenon, where others saw isolated cases? I think my experience as a queer and migratory person contributed to this. Many times, I have left a familiar but in some ways constraining environment, traversing social, geographic, and linguistic barriers to enter a novel environment, facing unknown risks for new opportunities. This has given me what my partner Ondine calls “imaginative micro-empathy” for the conceptually similar process of hatching. This both motivates my study of hatching and generates testable hypotheses.

Herpetology still harbors unexplored mysteries, including isolated studies reporting unexplained phenomena that may serve as motivating possibilities. Natural sex change in frogs is one such case. In a laboratory study of individually identifiable *Hyperolius viridiflavus*, 7 of 24 females became males (Grafe & Linsenmair 1989). These individuals laid viable eggs, then developed vocal sacs, called, fought

with primary males, amplexed females, and fertilized eggs. All seven sex-changing individuals were in terraria with few or no primary males, suggesting socially-dependent sex change as has evolved many times in fishes (Erisman et al. 2013). “No further examinations were published” (Hayes 1998), but absence of evidence is not evidence of absence. The abundance of species, diversity of forms, and number of evolutionary origins of hermaphroditism in fishes (Erisman et al. 2013; Kuwamura et al. 2020), combined with the ancestral

▼ *Dendropsophus*  
*ebraccatus*,  
K. M. Warkentin





reproductive similarities of anamniote lineages, makes the apparent absence of hermaphrodite frogs a puzzle. The evolutionary or physiological reason for their absence is not yet clear, especially given our increasing understanding of the plasticity and evolvability of sexual systems (Leonard 2018). Much work would be necessary to determine the existence and relevance, or true absence, of natural functional hermaphroditism in frogs. However, Grafe and Linsenmair's (1989) *H. viridiflavus* came from Tanzania, where changing one's legal name and gender is impossible and consensual same-sex sexuality is punishable by life in prison (Chiam et al. 2017; Ramon Mendos 2019). Such state-sanctioned discrimination means that queer scientists, who might be particularly motivated to study frog sex-change in nature, face personal risks in pursuing this initial finding. Still, there might be other hermaphrodite frogs, in countries where diverse people could study them in relative safety. The recent discovery of frequent discordance between genetic and phenotypic sex in *Rana clamitans*, uncorrelated with human land use (Lambert et al. 2019), suggests we have much to learn about natural variation in sexual development, even in well-studied temperate frogs.

Herpetology has revealed substantial sexual and life history diversity in nature, but without a doubt undiscovered diversity remains. Some things we now think we know will be wrong and some unasked, unimagined questions will be transformative. I suggest we not underestimate the value of weird observations, from the field or lab. They can lead to testable hypotheses and bodies of work that transform our understanding of nature. In some research on humans, trusted access to research subjects may be contingent on an investigator's identity. In contrast, within herpetology—despite continuing inequities (Salerno et al. 2019)—anyone potentially could investigate any question. However, life experience affects our interests and perspectives, what we notice and imagine, and what motivates us. This likely contributes to higher measured rates of scientific innovation among minorities (Hofstra et al. 2020). Including diverse human perspectives in science facilitates new discoveries, in part, because different people ask different questions (Haines et al. 2020; Tang-Martínez 2020a). Nonetheless, both minority scientists and novel, non-mainstream ideas often face a higher burden of proof. For some scientists, non-normative lives may help prepare us to pursue research outside the realm of prevailing ideas. In addition, support networks are critical. My own career has benefitted from the support, mentorship, and advocacy of many people, very few of whom share my queer female identity. Their confidence in me, the early independence

they allowed me, and the help they provided have been crucial in my development and discoveries. By supporting students and colleagues whose lives and perspectives are unlike our own, we can all contribute to help diversify science and enrich our collective understanding.

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