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Q & A

Adriana Briscoe

Born in Honolulu, Hawaii, Adriana D. Briscoe grew up in Colton, California. She received a BA in Philosophy, a BS in Biological Sciences, and an MA in Philosophy from Stanford University and a PhD in Biology from Harvard University, working with Naomi Pierce and Richard Lewontin. She is a Professor in the Department of Ecology and Evolutionary Biology at the University of California, Irvine. Briscoe is known for studies of how color vision mediates ecological interactions between butterflies, host plants, and the environment, in the context of mimicry and species recognition. Her discoveries have been featured on television and in museums both in the USA and in Europe. She has written and spoken about the importance of teachers in developing future scientists and the need for increased funding for Black, Indigenous, and people of color (BIPOC) teacher training in science, technology, engineering, and mathematics (STEM) in order to create a more just and diverse scientific workforce. She is a member of the nascent California Consortium for the Earth BioGenome Project where she is leading the sequencing of several butterfly genomes for conservation purposes. Briscoe is an elected Fellow of the American Association for the Advancement of Science and the California Academy of Sciences, and she was honored with the Distinguished Scientist Award from the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science, the first woman and third person overall to have been given all three of these awards.

Photo: Courtesy of Wes Koseki/UCI School of Biological Sciences (CC-BY-SA).

What turned you on to biology in the first place? I grew up in a Mexican-American community in California in a valley set below the San Bernardino mountains near the intersection of the Southern Pacific and Santa Fe railroads, an area that was once filled with orange groves in which my maternal grandfather, Sebastian Mejía, had worked but is now filled with Amazon warehouses, smog, and urban sprawl. In the summers, my family took me on long camping trips to the deserts of southwestern USA, Baja California, and Mexico, places of great natural beauty, and this is how I developed a love for plants, rocks, and fossils. As a middle school student, I was sent by my mother to the San Bernardino County Museum for summer camp where I had the unforgettable experience of dissolving accretions containing fossilized insects in dilute acid and visualizing them under a dissecting scope. These fossils were so perfectly preserved that I could even see individual facets of their compound eyes.

I remember watching episodes of *The Undersea World of Jacques Cousteau* on television growing up, and as an eighth grader I was invited to participate in a Youth Science Program at the World Life Institute, a private zoological research institute led by Bruce Halstead, who had accompanied Cousteau on some of his voyages. My first introduction to research occurred when Halstead had me investigate the geographical localities of marine organisms for a book that he was writing entitled *A Color Atlas of Dangerous Marine Animals* (1990).

And what drew you to evolutionary biology? Raised Catholic, I grew up with the idea that the theory of evolution by natural selection was not incompatible with religious belief. As a freshman in college, I took a seminar on the book *Christianity and Evolution* by Pierre Teilhard de Chardin (1971, translated by René Hague), a Jesuit priest and paleontologist, and this ended up being a kind of bridge between my high school catechism studies and my university philosophy studies. As a junior and senior, I took history and philosophy of science courses with Peter Godfrey-Smith, Peter Galison, and Hasok Chang. I became interested in epistemology, or how it is that we think we know something about the world, and also in the Darwinian Revolution. Evolutionary biology intrigued me because it uses mathematics and statistics to reconstruct the history of life on Earth. I saw it as a way of explaining the weird desert plants, mysterious archeological sites, geological formations, and fossils that I had encountered as a child. In my junior year I joined Ward Watt and Carol Boggs, evolutionary biologists, for a summer of fieldwork at the Rocky Mountain Biological Laboratory, which introduced me to population genetic studies.

Who were your key early influences? I grew up in a family of readers. My father, Peter Michael Briscoe, an academic librarian who's read thousands of books, would talk about them every night at the dinner table. My mother, Loretta Olympia Briscoe (née Mejía), a schoolteacher, instilled in me an early interest in social justice. My paternal grandfather, Louie Howard Briscoe, was a gifted and largely self-taught machinist who subscribed to *Popular Mechanics* and *National Geographic*. He was always building things in his home workshop. For instance, he built a motion detector, which made an alarming sound when you waved your hand in front of it. As a child, I found his hand-made toys and wooden machines quite magical.

You have a faculty position in a biology department but seem pretty interested in the history and philosophy of science. Why did you give this up? When I was trying to decide in what direction to go for graduate school, I went to speak with Peter Galison, one of my professors at Stanford. Galison told me to think about whether I preferred working in the library or in the lab — I had worked in both as an undergraduate — and to base my decision on that. In the end, I think that I chose lab work because I enjoy the collaborative nature of biology. Historians are often solitary scholars and, while I probably could have sustained the individual drive needed to become a historian, I think that I would have ended up lonelier over the long term. Nonetheless, I do think that science and scientific societies are in great need of historians, for example, to shine a light on our connections with eugenics, racial biases in medicine, and our complicity in the degradation of the environment.

Do you have a favorite science book? As a graduate student in the mid-1990s, I borrowed Philip Sheppard, John Turner *et al.*'s 'Genetics and the evolution of Muellerian mimicry in *Heliconius* butterflies' (Philos. Trans. R. Soc. Lon. B (1985) *308*, 433–610) from the Museum of Comparative Zoology's library and, after reading it, felt perplexed by the dizzying array of wing color patterns that segregated in their genetic crosses. Gobsmacked by the variation, I wanted to study wing color patterns; however, the scientific community didn't have any idea what genes were responsible for this riot of color, or where to start, so I gave up that idea. With this background in mind, it was very satisfying to read Chris D. Jiggins's book *The Ecology and Evolution of Heliconius Butterflies* (2017) because he does a marvelous job of making sense of this old genetic literature by pairing it with modern discoveries of the genes involved in determining wing color patterns. There is a richness to studies of *Heliconius* butterflies that have been summarized in this book, including speciation and co-evolution with their host plants, and this should be of interest to biologists studying a wide range of organisms. If I were a graduate student now, I would be reading it for inspiration.

What is your favorite experiment? Every so often in the news someone reports the discovery of a new organism such as a bird or a frog or a mushroom that fluoresces under a black light. My favorite experiment started when someone in my lab — unfortunately I don't remember exactly who; it was probably C.C. Chiao, who briefly visited in 2008 — was playing around in a dark room and noticed that the yellow patches on *Heliconius* butterfly wings are fluorescent. When this was brought to my attention, I too thought, wouldn't it be marvelous if the fluorescence is part of a visual signal that butterflies use to communicate? It wasn't until much later that I set about testing this hypothesis with Susan Finkbeiner, my graduate student, Daniel Osorio, and Dmitry Fishman (J. Exp. Biol. (2017) *220*, 1267–1276). We performed a number of control experiments not usually included in reports of biological fluorescence and found sadly that the butterfly fluorescence was too weak to contribute to a visual signal under natural conditions.

I love this study because it illustrates an epistemological problem: namely, how can we know whether or not something is true when even our eyes can deceive us? Sometimes your interpretation of what you see is just flat out wrong and you need careful experimentation to figure out why. After I presented the results of this study at a meeting, a physicist came up to me quite upset: he said that the fluorescence "had to be there for a reason," whereas I'd concluded that the butterfly fluorescence was in fact an epiphenomenon.

What is the reason for your butterfly obsession? The biology of butterflies is fascinating. For example, some butterflies exhibit sex-role reversal, meaning that genetic males assume the behavior and reproductive biology of females when infected by *Wolbachia* or other endosymbionts (Heredity (2017) *118*, 284–292). Other butterflies have evolved wing color patterns that resemble the ant species that tends their larvae (J. Lepidopterists' Society (2016) *70*, 130–138). Lepidopteran chromosome evolution is also wild. The genus *Agrodiatus*, for example, has a haploid chromosome number ranging from n = 10 to n = 134 that is the result of chromosomal fusion and fission (Nature (2005) *436*, 385–389).

What is the best advice that you've been given? One of the most useful pieces of career advice that I've heard comes from Daniel Osorio, who noted that it is good to have a trade if you are going to pursue academic biology. Daniel probably had a specific skill set in mind when he said this, such as being able to record from single neurons using electrophysiology or being able to make and image cryo-EM sections. I also interpret Daniel's advice more broadly to mean that it is good to be known for something. For graduate students and postdocs especially, it's critical to identify an area for which you want to be known and to do your best to learn as much about it as possible.

You've written about the need for more government funds for teacher training in STEM subjects, particularly for Latino teachers (*Gender, Race and Class in the Lives of Today's Teachers: Educators at Intersections*, Lata Murti and Glenda M. Flores, eds). Why have you taken this up? My mother was a bilingual elementary school teacher who taught in English and Spanish, so I developed an early appreciation for the essential work that teachers do. BIPOC are disparately affected by income, wealth, and health inequalities in the USA — and this, in addition to police brutality and anti-Black and anti-Brown racism, is an underlying cause of the widespread protests that we've seen this year. Native American, Black, and Latino people are underrepresented in the STEM workforce, and STEM-related jobs pay higher-than-average wages. As scientists and educators, we can do something about this. In California where I live, about 54% of K-12 students and 20% of K-12 teachers are Latino. Given how few Latino students I noticed were taking my upper-division biology courses, I wondered: how many K-12

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teachers are Latino and also teach science or math? I couldn't find this information anywhere. Curious to figure this out, Dylan Rainbow and I examined more than one million 2017 to 2018 California Department of Education records, and we found that, while about 17% of K-12 teachers teach science, math, or computer science, only 3% of K-12 teachers in California are Latino and teach these subjects, evenly split between men and women. This means that most Latino students in California will never have a Latino teacher as a role model in a STEM subject, and this is unfortunate because research has shown that having a teacher of the same race/ethnicity can have a positive impact on student achievement. For instance, Black male students are 39% less likely to drop out of high school if a single Black teacher in the third, fourth or fifth grades teaches them. Providing paid research internships in our labs and student loan forgiveness to BIPOC who are interested in becoming science and math teachers is a critical part of closing this gap.

What do you think is the biggest problem that science and society as a whole is facing today? Unquestionably, the biggest problem we are facing is climate change. This summer we've been having heat waves, with records broken for the hottest temperature in cities across California, and this has fueled massive fires — the largest in California recorded history — prompting evacuations. The fires have only exacerbated the terrible air quality in Los Angeles, Riverside, and San Bernardino counties, places where millions of people live. I also worry about the farmworkers, a majority of whom are Indigenous migrants from Mexico and Central America, who are working through the smoke, ash, and intense heat to pick the food that is feeding US Americans during the COVID-19 pandemic. Many of these people come from impoverished communities where extreme weather and drought have made making a living impossible. The pressure to migrate is only going to intensify as the planet heats up.

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Quick guide

Same-sex sexual behaviour

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What is same-sex sexual behaviour? Same-sex sexual behaviour is behaviour that is usually performed at some stage during reproduction with a member of the opposite sex, but which is instead aimed towards members of the same sex. These behaviours can include courtship, mounting, genital contact, copulation and even pair bonding and the raising of offspring together.

Isn't this something that only happens in humans? No! There is now considerable evidence for same-sex sexual behaviour across a whole range of animals.

Is this different from same-sex sexual preference and orientation? To some extent yes. Same-sex sexual preference is when, given a choice, an individual chooses to engage in reproductive behaviours with an individual of the same sex rather than an individual of the opposite sex. Same-sex sexual orientation is a step further, suggesting an unchanging life-long preference for same-sex partners. This is particularly difficult to measure in animals, given that we are unable to ask them what they desire. One exception to this may be in domestics rams in which around 8% of males are thought to be same-sex-orientated throughout their lives.

Are same-sex sexual behaviours common? Same-sex sexual behaviour, in wild and captive settings, has been documented in mammals, birds, reptiles, amphibians, fish, insects, spiders and other invertebrates (Figure 1). In some species, same-sex sexual behaviours are as frequent as opposite-sex sexual interactions, as in bottlenose dolphins for example. Moreover, same-sex sexual behaviour might be underreported, in particular in species where both males and females look the same.

What is the mechanistic basis of same-sex behaviour? In many cases we don't know, not least as often same-sex sexual behaviour has only been recorded anecdotally. However, in fruit flies mutations leading to same-sex interactions have been well-studied and helped unravel the neurogenetics of courtship and mating behaviour. Unsurprisingly, a key feature is a failure to discriminate sex, but it remains unclear how such mutations and pathways speak to same-sex sexual behaviour more broadly.

Why would animals do this? Same-sex sexual behaviour is often considered an evolutionary paradox because we should expect animals to be naturally selected to maximise their fitness by having as many offspring as possible. So why would animals engage in sexual activities that result in no offspring? Typically, it is assumed that such behaviours must, therefore, be costly. Of course, sexual interactions with members of the opposite sex are typically costly and can even result in injury or death. Sexual interactions with members of the same sex are, therefore, expected to have similar costs, along with the additional cost of not producing offspring. However, individuals that engage in same-sex sexual behaviour can still have sex with members of the opposite sex and reproduce.

What benefits might there be to same-sex sexual behaviour? There have been many hypotheses proposed to try and explain the occurrence of same-sex sexual behaviour. These fall into two categories: adaptive hypotheses and non-adaptive hypotheses. When same-sex behaviours were first observed, they were typically thought to be maladaptive, but now many evolutionary reasons for their existence have been suggested.

What are the adaptive explanations for same-sex sexual behaviour? Many of the adaptive hypotheses suggest that these behaviours have some sort of social function, beyond a purely reproductive context. For example, same-sex sexual behaviour might be used to communicate social status. Dominant individuals may express their social status by mounting subordinate individuals or *vice versa*. Same-sex sexual behaviour may also be used to manage conflict, as in female bonobos who are able to improve their chances of attaining food when entering a food patch by engaging in genito-genital rubbing