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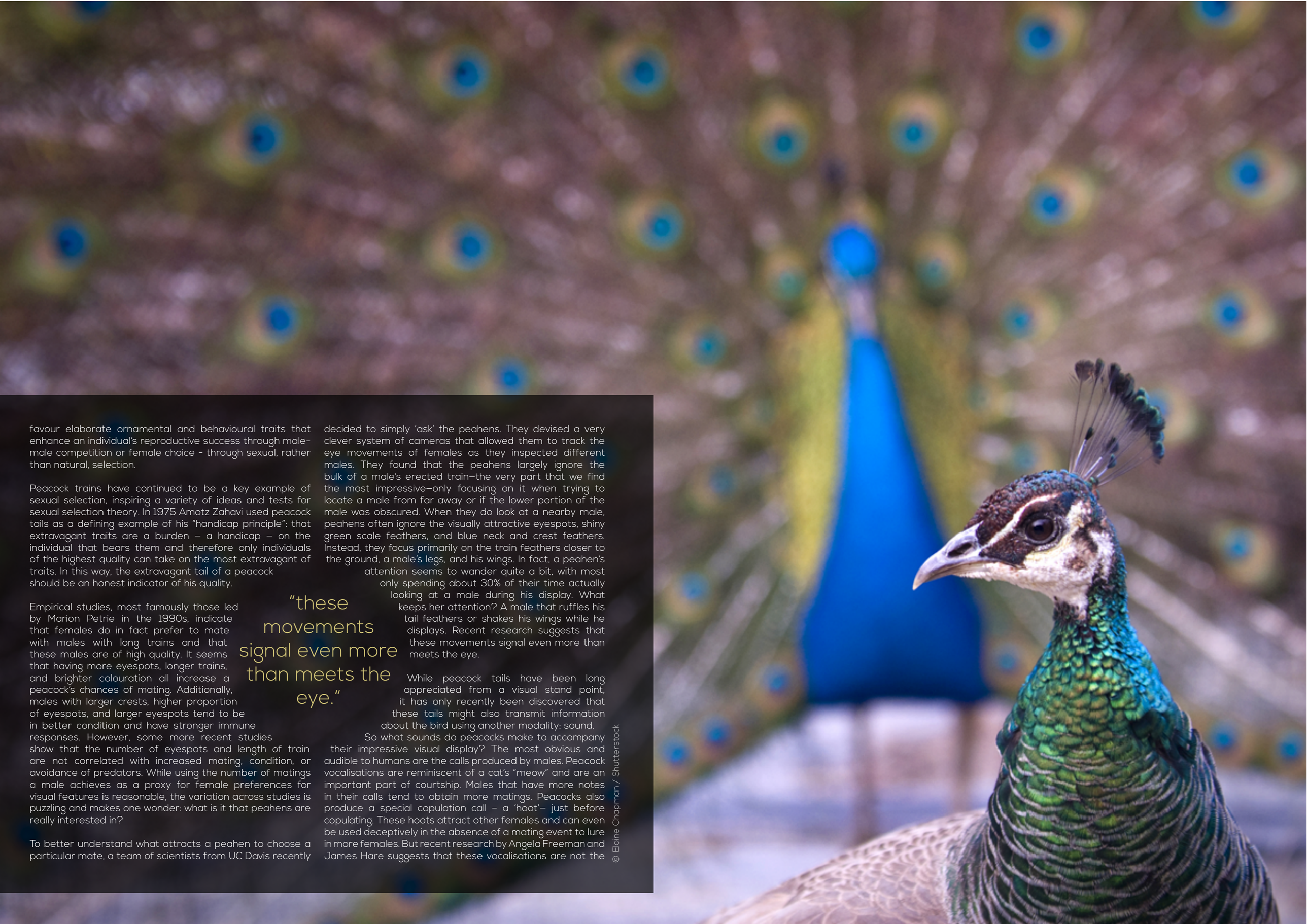
IT'S NOT ALL IN THE EYES

*The wonders of the world are not limited to what humans can see with their eyes. Peacocks join a select group of animals who can communicate using infrasound. **Nora Carlson** and **Christopher N Templeton** investigate the new research.*

Male peafowl, or peacocks, have elaborately ornamented plumage and their beautiful train feathers have become a classic example of the complex and visually stunning extremes produced through the process of sexual selection. Peacock tails are long, sometimes reaching nearly two meters, and typically account for more than 60% of a bird's body length. They are colourful, showcasing nearly every colour under the rainbow and using iridescent structural pigments that allow the colours to shift and change as the feathers move and reflect sunlight. And, to top it all off, the tips of their tail feathers have dazzling eyespots that draw attention during the amazing weaving and shaking the feathers undergo during the male's display.

The elaborate train of the peacock presents a puzzle that has inspired generations of evolutionally biologists and helped sculpt and refine theories of sexual selection. When Charles Darwin first encountered peacocks, he found it difficult to envision a survival advantage the peacock's train could provide, stating in 1860 that the very sight of such a seemingly confusing trait made him 'sick'. But ultimately, peacocks helped inspire Darwin's idea that evolutionary processes might also



favour elaborate ornamental and behavioural traits that enhance an individual's reproductive success through male-male competition or female choice - through sexual, rather than natural, selection.

Peacock trains have continued to be a key example of sexual selection, inspiring a variety of ideas and tests for sexual selection theory. In 1975 Amotz Zahavi used peacock tails as a defining example of his "handicap principle": that extravagant traits are a burden – a handicap – on the individual that bears them and therefore only individuals of the highest quality can take on the most extravagant of traits. In this way, the extravagant tail of a peacock should be an honest indicator of his quality.

Empirical studies, most famously those led by Marion Petrie in the 1990s, indicate that females do in fact prefer to mate with males with long trains and that these males are of high quality. It seems that having more eyespots, longer trains, and brighter colouration all increase a peacock's chances of mating. Additionally, males with larger crests, higher proportion of eyespots, and larger eyespots tend to be in better condition and have stronger immune responses. However, some more recent studies show that the number of eyespots and length of train are not correlated with increased mating, condition, or avoidance of predators. While using the number of matings a male achieves as a proxy for female preferences for visual features is reasonable, the variation across studies is puzzling and makes one wonder: what is it that peahens are really interested in?

To better understand what attracts a peahen to choose a particular mate, a team of scientists from UC Davis recently decided to simply 'ask' the peahens. They devised a very clever system of cameras that allowed them to track the eye movements of females as they inspected different males. They found that the peahens largely ignore the bulk of a male's erected train–the very part that we find the most impressive–only focusing on it when trying to locate a male from far away or if the lower portion of the male was obscured. When they do look at a nearby male, peahens often ignore the visually attractive eyespots, shiny green scale feathers, and blue neck and crest feathers. Instead, they focus primarily on the train feathers closer to the ground, a male's legs, and his wings. In fact, a peahen's attention seems to wander quite a bit, with most only spending about 30% of their time actually looking at a male during his display. What keeps her attention? A male that ruffles his tail feathers or shakes his wings while he displays. Recent research suggests that these movements signal even more than meets the eye.

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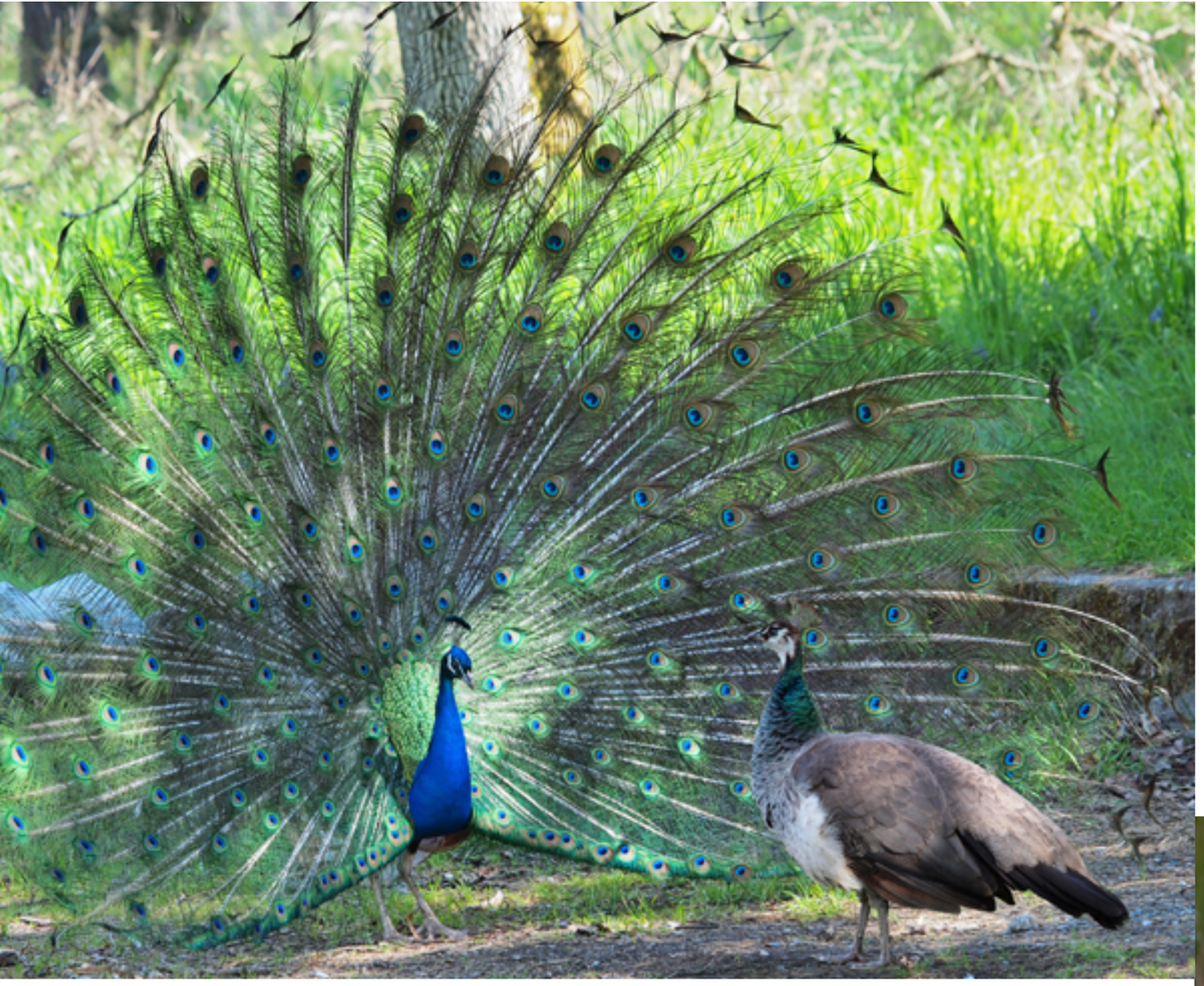
While peacock tails have been long appreciated from a visual stand point, it has only recently been discovered that these tails might also transmit information about the bird using another modality: sound.

So what sounds do peacocks make to accompany their impressive visual display? The most obvious and audible to humans are the calls produced by males. Peacock vocalisations are reminiscent of a cat's "meow" and are an important part of courtship. Males that have more notes in their calls tend to obtain more matings. Peacocks also produce a special copulation call – a 'hoot'– just before copulating. These hoots attract other females and can even be used deceptively in the absence of a mating event to lure in more females. But recent research by Angela Freeman and James Hare suggests that these vocalisations are not the



only sounds that peacocks make. As they display, peacocks intermittently ruffle their train and feathers – a behaviour that we now know seems to help keep the attention of the females – and it turns out that it also makes noise. When one thinks of charismatic bird sounds they probably think first of a chaffinch, robin, or wren, rather than the sounds made by the tail of the peacock. There is a good reason for this: the sounds made by a peacock's tail are infrasonic – sounds below 20 Hz in frequency – and therefore below the hearing abilities of most humans. But these sounds may be an important part of peacock's impressive train display that has been completely overlooked until now.

Peacocks produce noise with their trains in two main ways: the 'shiver train' where the males will shake their train feathers vigorously rattling them, or the 'pulse train' where they pulse their train towards the female while vibrating the base of the train feathers. To produce noise with their wings, peacocks shake their wing feathers vigorously during the part of the display where their back is presented to the female. The unusual parabola-like shape produced by an erect tail led Freeman and Hare to question if the train itself was producing sounds that we simply cannot hear. While many bird species, like kakapo, cassowaries, and houbara bustards, produce low-frequency sounds, there are no known birds that communicate using infrasound. Peafowl ear morphology suggests that they might be able to hear the low frequency sounds produced by the moving trains.

The next question is - can peafowl can extract information from these infrasounds? To test this question the authors played back recordings of these sounds to see if peacocks alter their behaviour in response to these sounds, and they did. Both male and female peafowl respond to these infrasounds, suggesting that they glean biological information from them. Birds become more alert or increase their walking/running behaviour in response to playbacks of infrasounds recorded during pulse train and wing shaking displays respectively. Males also increased calling behaviour in response to infrasound playbacks produced during both shiver train and calling displays. Thus, peafowl seem to produce and respond to infrasound during courtship displays, suggesting that they might function as social signals. So, it appears that these sounds successfully transmit some sort of information to other individuals, but why are they infrasound?

One of the characteristics that makes infrasound unique is its ability to travel through dense foliage and over long distances largely unaltered. While high pitch sounds lose their potency over very short distances, a process known as attenuation, low frequency sounds attenuate much more slowly. The habitat of peafowl in their native India is primarily dense vegetation and thus using infrasound could be beneficial for transmitting long distance signals through this complex habitat.

While the acoustic properties of infrasound seem like something many animals would take advantage of, there are few other examples thus far discovered in the animal world. These are mainly large animals that use infrasonic signals to communicate across vast distances or through substrates other than air. For example, elephant groups are often dispersed across large distances, sometimes in dense vegetation that further restricts visual contact, making infrasound particularly beneficial. They produce infrasonic calls, often referred to as 'rumbles', that travel through the ground to maintain contact with other members of their social groups and can use these sounds to recognize individuals up to 2.5 km away. Ovulating female elephants may also use infrasonic calls to advertise their position to males in musth, thus allowing males that are scattered over large distances to locate the females during the female's short receptive window.

Like elephants, blue and fin whales both produce infrasonic vocalizations that can travel across vast distances–over 1,000 miles–allowing widely dispersed individuals to communicate, though little is known about their purpose. These infrasonic 'songs' are thought to be used for breeding since only males are known to produce them but whether they are for female attraction or male-male competition is still unknown.

Infrasonic signals are produced by some Crocodilians (alligators and crocodiles), and like in peacocks, these were only discovered after observations of accompanying visual traits. Males of some Crocodilian species produce infrasonic calls as part of their territorial and mating displays. Infrasound accompanies a male's bellowing and headslapping display. The by-product of these sounds is commonly referred to as 'water dancing', where males vibrate their trunk muscles to produce infrasounds, producing such powerful vibrations that they cause the water on top of the male's back to 'dance'. These signals are only produced by males and so it is thought that they are an important sexual signal involved in mate choice, though again there is still very little known about the function of these sounds.

Infrasounds are a remarkable example of the great variety ways that animals can communicate with each other, often right under our noses. As humans, we are constrained to observe the world through our own sensory organs and so often miss levels of communication other organisms produce. The discovery of infrasonic signals produced by a peacock's tail highlights the amazing diversity in perception within the animal kingdom that we often miss. In all of the species of animals that we have discovered to produce infrasounds, each one was studied extensively before we began to realise that they produced infrasound. This highlights our bias in research towards what we can perceive, often not looking deeper into modes of communication we may not be able to easily observe. As scientists, we need to remember to always search beyond what we can see, hear, smell, and taste and try to view the world from different animal's perspectives, if we are to truly understand the world around us.

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Freeman, A. R., & Hare, J. F. (2015). Infrasound in mating displays: a peacock's tale. *Animal Behaviour*, 102, 241-250.