

How Musical Are Animals? Taking Stock of Zoömusicology's Prospects

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ABSTRACT: This article surveys zoömusicology, the study of music in animal culture. Discussing the field's multidisciplinary intellectual history, its current state of research, and future opportunities and challenges, the article draws together ancient and recent literatures on human exceptionalism and the definition of music, and it critiques the role that consciousness, intentionality, language, and function play in discussions of animal capacities, particularly vis-à-vis music. Theories about the origins and evolution of music serve to link cross-cultural comparisons (often produced in the search for music universals) to cross-species comparisons. The article considers birdsong (including early recordings, birdsong transcription, and sonographic analysis), whale song, insect sonification, and other forms of animal music, as well as animals who seem to appreciate human music. It also catalogs related endeavors that bridge musical, ecological, and epistemological issues. Profiles of key zoömusicologists open a window onto the diversity within the field. The article argues for zoömusicologists to participate in performances based on the species they research. One open question is whether fieldwork should be mandatory in zoömusicology or whether relying on other researchers' recordings and fieldnotes could suffice. In imagining multidisciplinary collaborations, the article explores how zoömusicologists might navigate between the approaches of the sciences, which deal with generalities and replication, and those of the arts and humanities, which incline towards particularities and one-offs. It unsettles the implications of prestige differentials inherent in hard/soft, science/humanities, and human/animal binaries, and proposes that a zoömusicologist-in-residence be appointed for all major science laboratories that study animal sonic phenomena.

KEYWORDS: zoömusicology, musicality, birdsong, whale song, ethnomusicology

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"It seems to me that the commonsense view of music is to approach all of the world's available music with an open mind." (Grainger 1987, 151)

What is music? What does it mean and do? What are its origins? Is musicality an instinctive or acquired skill, or both? Are there music universals? Behind such a deceptively simple line of inquiry looms yet another question: is musicality an exclusively *human* trait? Through diverse aims and methods, scholars scattered throughout the humanities and the natural and social sciences have engaged with these core problems.

Despite progress, insights are typically partial, speculative, and even conflicting. In the belief that the search for musicality, its nature, and its origins demands an approach *across species* and not just across disciplines, this article reflects on the potential for these topics to be addressed by zoömusicology, which I define as "the study of music in animal culture" (Taylor 2017b, 4). After examining the field's broad intellectual history and current state, the article charts zoömusicologists' future opportunities and challenges in understanding and celebrating animals' acoustic constructs.¹

THE INTELLECTUAL HISTORY OF ZOÖMUSICOLOGY

The musical properties of animal sounds have been lauded throughout the centuries by writers, musicians, philosophers, and everyday people.² Songbirds in particular played a key role in ancient debates on the status, in-

telligence, and competences of animals (Arbo and Arbo 2008, 264).³ The Pythagoreans claimed to have learned all their musical skills from animals (Arbo and Arbo 2006, 214). The pre-Socratic philosopher Democritus (c. 460–c. 370 BCE) was perhaps the first to document a theory that placed birdsong upstream from human music (Arbo and Arbo 2006, 213), a notion seconded by poet and philosopher Titus Lucretius Carus (94–56 BCE) who, in his poem *On the Nature of Things* (Titus Lucretius Carus [1st century BCE] 1910, 231), extolled “the liquid notes of birds” as the potential origin of human music.

To take a few snapshots of just one species, Homer (c. 800–c. 701 BCE) and Virgil (70–19 BCE) join a long history of poets who praised the vocalizations of the nightingale (*Luscinia megarhynchos*; see Arbo and Arbo 2006, 230). In his encyclopedic *Naturalis Historia*, the natural philosopher Pliny the Elder (23–79) upheld this species’ grasp of music theory, evidenced by singing that he believed conforms to “the one perfect Science of Music” (Pliny the Elder [77] 1847, 217).⁴ In his dialogues devoted to animal talents (*De sollertia animalium* and *Bruta animalia ratione uti*), the essayist Plutarch (c. 46–c. 120) maintained that nightingales sing with passion and for pleasure, and that they esteem beauty over utility (Arbo and Arbo 2008, 262).

Composers and musicians have also celebrated nightingales. As philosopher Kathleen Marie Higgins has observed, “[c]lassical Persian musicians take the song of the nightingale as a model for music-making” (2012, 24). The second movement of Ludwig van Beethoven’s 1808 Symphony No. 6, the *Pastoral*, incorporates flute imitations of a nightingale. A recording of their song is featured in the third movement of Ottorino Respighi’s 1924 symphonic poem *Pines of Rome*, and in the same year, the BBC broadcast cellist Beatrice Harrison performing in her Surrey garden alongside a singing nightingale.⁵ Many more examples could be listed.

Composer Olivier Messiaen declares birds to be “the greatest musicians existing on our planet” (Messiaen and Samuel 1994, 85). His student, composer François-Bernard Mâche, coined the word *zoomusicologie* in 1983, devoting a lengthy chapter to the subject in his book *Music, Myth and Nature* ([1983] 1992).⁶ In imagining the field’s potential, Mâche emphasizes the value of musical training for students of animal sounds, suggesting that musicians will hear them differently from ethologists ([1983] 1992, 97). He then unfurls a series of analyses of avian songs. Mâche favors distributional analysis but does not limit himself to this approach; he links his examples to Beethoven’s truncation of a theme in recapitulation, Messiaen’s “chromaticisms of durations,” and Stravinsky’s repetitive yet irregular rhythms, among others (Mâche [1983] 1992, 127–128, 116–124, 134–135). Rather than dismissing repetition as signaling various birds’ lack of creativity, Mâche regularly praises instances of redundancy, which he regards as an essential musical tool. Other songbirds earn his praise for their “concern for development” and “sense of sound architecture” ([1983] 1992, 130, 141). Further overlaps and mutualisms that he identifies include an avian melodic-rhythmic *ritornello* here and a hocket there, as well as *ostinati*, *rubati*, chromatic staccatos, appoggiaturas, *glissandi*, transpositions, and descending chromatic scales.

The result of Mâche’s careful analysis was to reveal the poverty of the scientific vocabulary in the study of animal music. Taken together, his analyses support the hypothesis that “basic innate schemes” underwrite sound cultures across species (Mâche 2000, 473). In this context, Mâche urges scholars to abandon the practice of placing quotation marks around the phrase *animal music*, which in his view signals that animal sounds should only be considered music in a metaphorical sense and are not the genuine article ([1983] 1992, 114). This, he believes, will encourage scholars to study animal sounds without the distraction of their assumed functions—to understand them, in other words, as “beautifully functional” (Davies 2012a, 21). However, the acceptance of animal acoustic constructs as music is far from unanimous, as is evidenced by the many definitions of music that are crafted and read from an essentially humanist position.

HUMAN EXCEPTIONALISM AND THE DEFINITION OF MUSIC

As a starting point for its investigations, zoömusicology acknowledges that animals can have meaningful—and musical—lives, and this leads to a series of fundamental questions. Is it enough for zoömusicologists to ask

who sings, when, and where, as well as how, with whom, and to what effect? Or, in creating room for animals' sonic productions to be the object of scrutiny, should the field seek a new definition of music? If it does, should zoömusicology endorse an extant, inclusive definition of music, or should it propose one of its own? Since great scholarly debate accompanies the sonic products created by humans, broadening (or bursting open) such definitions to include the music of animals poses significant challenges.

The Grove Dictionary of Music (the discipline's benchmark reference work, which has recently been subsumed into *The Oxford Dictionary of Music*) offers no definition of its subject. In its "Music" entry, ethnomusicologist Bruno Nettl notes that "[i]mposing a single definition [of music] flies in the face of the broadly relativistic, intercultural, and historically conscious nature of this dictionary" (Nettl 2001). Further, philosopher Stephen Davies argues that definitions of music are rare because "we are usually highly successful in identifying music as such, and don't feel the need of a definition" (2012b, 535). Even putting aside controversial borderline cases, Nettl and Davies agree that the vantage points, properties, uses, and meanings of music are simply too numerous to accommodate a satisfactory definition. Nonetheless, when our subject must be fixed into a simple declarative sentence, a human-specific characterization is frequently proposed; many have argued (and continue to argue) that music is uniquely human.

Notable among human exceptionalists are the composers Roger Sessions (1950, 11), Wilson Coker (1972, 24), and Igor Stravinsky (1947). Stravinsky, for example, allows that while a breeze in a tree, a rippling brook, or a bird's song may delight us and even suggest music, such items are mere "promises of music" that require "a human being to keep them" (Stravinsky 1947, 24). Musicologists who cleave to music as an area of human uniqueness include Wayne D. Bowman (1998, 69), Nicholas Cook (1998, 4), Ian Cross (2003, 109–110), and Lawrence M. Zbikowski (2009, 99), as well as ethnomusicologists Charles Seeger (1963, 215), Alan Merriam (1964, 6), Mieczyslaw Kolinski (1967, 1), Frank Harrison (1977, 30), Bruno Nettl (1983, 24), John Blacking (1995, 10), and many others.⁷ Music theorist Edward Hanslick also contributes to this exclusionary zone, rejecting any prospect of music in a bird's song: "Not the voices of animals, but their gut is of importance to us; and the animal to which music is most indebted is not the nightingale, but the sheep" (string players at this time performed on gut strings) (1891, 151). Such judgments often manifest as blanket dismissals that depend upon circular reasoning (i.e., defining music as a uniquely human phenomenon assures that only humans make it). Others, however, have proposed more specific objections to considering animal sound patterns and practices as music.

CONSCIOUSNESS, INTENTIONALITY, LANGUAGE, FUNCTION, AND OTHER BASES FOR OBJECTIONS TO ANIMAL MUSIC

Due to their intensely multidisciplinary borrowings and engagements, scholars in zoömusicology must read widely. In so doing, the zoömusicologist is often struck by the exaggerated sense of importance that consciousness, intentionality, language, and function play in discussions of animal music and other animal activities. Marian Stamp Dawkins joins a number of other ethologists who believe that it is "simpler and more plausible to think that many other species do have conscious experiences than that they do not" (1993, 2; also see de Waal 2016). Similarly, philosopher Hugh Wilder urges an openness to the possibility of animals' "rich intentional lives" (1990, 357), and intentionality has even been proposed for plants (Brisini 2018). As research progresses, "animals are increasingly recognized as having concepts and intentions" (Scharff and Petri 2011). Nonetheless, an immense amount of argumentative weight has rested on these contested areas for centuries.

In the West, ancient models often privileged music theory over music performance, and disinterested contemplation and eternal truths over things situated and sensorial. Sounded music (including dance, theater, and poetry) was often set in opposition to inaudible "music" and a concern for theories on aesthetics, ethics, truth, number, and harmony. Pythagoras's (c. 570–c. 495 BCE) unheard "harmony of the spheres" is a case in point (Taylor 2017b, 193). Building on Pythagorean theory, the dialogues of Plato (c. 428–c. 348 BCE) evince how he

was troubled by the way that music's seductive power and irrationality contradicted his idealized mathematical theory of cosmic harmony and the human soul (Bowman 1998, 20–56; Taylor 2017b, 206–207n38).

This separation of theory and practice in human music impacted the reception of animal music. At the end of Antiquity, for example, Saint Augustine of Hippo (354–430) penned a treatise entitled *De musica* ([1491] 2006); in it, he grants that animals like the nightingale do make pleasing music, but this is not a commendation. Augustine understands music principally as an intellectual activity that resides in the mind and brings with it ethical concerns. Since he believes animals lack rational knowledge, Augustine diminishes them to the level of human musicians, whose performances for the people's applause lack grounding in reason and who would, Augustine supposes, immediately give up their performance practice if they understood the situation as he does ([1491] 2006, 192–193).

Treating human rationality as a defining feature of music continued into the Middle Ages (and beyond), where birdsong was not formally accorded the status of music. Nonetheless, the first written evidence of birdsong being incorporated into human musical practice is found at this time, with “poetic texts of a number of songs” charging “singers [to] imitate birdsong or voice the speech of birds” (Leach 2007, 3). In another approach, Jesuit polymath Athanasius Kircher searched for the proportions of the universe in music, which he believed was composed by God and revealed in the songs of birds (Knobloch 1979; Tammereau 2000). In his monograph *Musurgia Universalis*, Kircher was likely the first European to present birdsong transcriptions ([1650] 2012).⁸ While the images are well-known and striking, they have been critiqued as reductive. A single transcription fails to represent inter-individual variability (Whidden and Shore 2019). In addition, while music historian John Hawkins praises these early transcriptions as the product of Kircher's “great ingenuity and industry” ([1776; 1853] 1963, 2), Szöke, Gunn, and Filip (1969) characterize them as naïve and primitive. It remains unresolved whether their simple nature merely reflects the shortcomings of their human transcriber or a lack of technology (or both), as well as whether Kircher held that avian song was music full stop or was instead proto-music in need of a human mind to raise it to the level of music proper.

These ideas about rationality and the human/animal divide shaped modern thinking about the question of whether animals make music. In the eighteenth century, for example, the composer Jean-Benjamin de La Borde acknowledged that a bird's song could please the human ear, but he argued that human rationality was necessary for a being to have a concept of music (1780, vol. I, Ch. 4, 8). More recently, the philosopher of music Peter Kivy argued that “[A]s soon as we take being able to hear bird noises *as* music to imply that therefore they *are* music, we are saying that they *literally* have syntactic properties; and *that* is a conceptual impossibility. A natural object *cannot*, as a matter of logic, have syntactic properties, whether it is a bird's ‘song’ or anything else” (1990, 24–25, emphasis in the original). By taking the simplistic position that music is human, and birdsong is noise, Kivy parts from Charles Darwin who, in acknowledging our continuity and connectivity with the natural world, never used scare quotes when referring to animal mentality or behavior (Darwin [1871] 1981; Crist 1996, 40). (It should be noted that ethologists *do* credit birdsong with syntax, e.g., Balaban [1988].) Other contemporary scholars who deny animals the mental wherewithal or moral virtue necessary for music include Colin Radford (1989, 74), Gordon Graham (1995, 150), Roger Scruton (1997, 160), and Francis Wolff (2015). The belief that animal song cannot be the product of higher-order thought suggests that every music performance is consciously theorized. However, philosopher of mind Peter Carruthers argues that many differences in mental processes between humans and other animals are trivial (2004, 83). Lacking a unified, uncontested theory of mind even for humans, many scientists of animal behavior avoid this contentious subject.

Philosopher Theodore Gracyk takes the convoluted position that a nightingale's song might sound musical to humans because it exploits aspects of melody, rhythm, and timbre in familiar ways; however, he argues it is not music because it fails to be the product of a cultural tradition. This is factually wrong, as ethologists have identified cultural transmission in numerous species (e.g., P. B. J. Slater 1986; Krützen, Mann, Heithaus, Connor, Bejder, and Sherwin 2005; Garland, Goldizen, Rekdahl, Constantine, Garrigue, Hauser, Poole, Robbins,

and Noad 2011). (Such a passage of traits across generations outside of the biological mechanism of inheritance erodes the nature/culture divide, which so often is used to distinguish humans from animals. Notwithstanding this evidence, Gracyk claims that nightingales are not “conceptually informed” (2013, 63) and sets great store in language as a critical tool for forming judgments about aesthetic experiences (2013, 60).)

Such a position is disputed by ethnomusicologist Timothy Rice, who describes instances of “highly sophisticated nonverbal musical understanding” among humans (1997, 115), and while he does not extend this to animals, others have (e.g., Craig 1943; Sotavalta 1956; Szöke et al. 1969; Rothenberg 2005, 2008, 2013; Taylor 2010, 2016, 2017b; Roeske, Kelty-Stephen, and Wallot 2017). In a related vein, Higgins cautions that the dominance of the linguistic model in philosophy obscures the contributions music makes to human life (2012, 79). She pushes back on “philosophical models that see the structure of language as the structure of thought” and argues for music’s place in the philosophy of mind (2012, 9).

Drawing the distinction between music and language is a key challenge in defining animal music, especially in light of projects that offer linguistic-analytical explanations of music (Lerdahl and Jackendoff 1983; Nattiez 1990; Marler 2000). Even when considering only human music, the relationship between music and language is complex. Tonal languages, poetry, recitative, *Sprechgesang*, and parentese complicate definitional efforts, as do phenomena like keening, chanting, rapping, and auctioneering (Wachsmann 1971; Staal 1985; Rohrmeier, Zuidema, Wiggins, and Scharff 2015); some scholars have argued that applying linguistic-analytical models to music has been less than fruitful (Lidov 1997; Fink 1999). Musicologist Elizabeth Hellmuth Margulis argues that since repetition is omnipresent in music, its main purpose cannot be understood as information-carrying (2014, 13), and she uses this distinction to differentiate music and language. Cognitive scientist Catherine Stevens argues that although consensual agreement about musical *genres* determines how certain musics should sound and the conventions surrounding them, musical *meanings* are non-propositional and open to interpretation, with no fixed reference (Stevens 2004, 433). Ambiguity can thus be an asset in the making of music. Ultimately, appreciating the differences between language and music will allow scholars to have a more straightforward discussion of animal participation in the music realm.

Other objections pile up around animal music’s lack of one or another attribute, such as a lack of hierarchical structure, diversity, and/or complexity.⁹ While this could be true for some species, I would suggest that these critics are selectively choosing examples to justify their positions, comparing simple examples of animal music to complex examples of human music. Many human genres lack complexity in the contrapuntal and harmonic realms; indeed, much human music sounds simple, repetitive, and formulaic. Moreover, complexity of an unfamiliar type runs the risk of being mistakenly dismissed as “primitive.”

Finally, issues of function typically bear the principal explanatory burden of animal music, often paired with the erroneous corollary that human music has no function. For instance, despite much ink having been spilt by musicologists to itemize human music’s functions and uses (e.g., Goehr 1992; DeNora 2000; Clayton, Herbert, and Middleton 2003, 1–15; and Kramer 2003), evolutionary biologist Marc D. Hauser and neuroscientist Josh McDermott deliver the outdated verdict that unlike animal music, human song is “produced for pure enjoyment” (2003, 667).¹⁰ Psychologist of music John A. Sloboda concedes that human music has utility but claims that “the functions of music for man find no parallel in the animal world,” arguing that the *purpose* of animal music is more limited and monodimensional (1985, 18). In animal studies, however, scholars are more and more allowing that the functional and the aesthetic are not mutually exclusive and even work in tandem. In “The Aesthetic Content of Bird Song,” pianist and ornithologist Joan Hall-Craggs critiques the practice of adding the qualifier “human” to definitions of music and writes that “If...art music should become totally divorced from function it will cease to communicate and will, therefore, cease to exist” (1969, 380). In any case, proof of function should have no bearing on how the quality of a musical outcome is judged.

Rather than concentrating on naysayers while we wait for new evidence to come to light (or, indeed, for scholars to avail themselves of current evidence), one could instead seek those with a history of guiding us out of

the gated communities in which speciesism and anthropocentrism, as well as Eurocentrism and linguocentrism, dominate discourse.¹¹ Primatologist Frans B. M. de Waal claims that “efforts to single out distinctly human capacities have rarely held up to scientific scrutiny for more than a decade” (2009, 175). The natural sciences offer good reads about ants that learn geometry, fish that decorate, dolphins that give gifts, ravens that can imagine being spied upon, and horses that can read human emotions from photographs.¹² We now know that cognitive abilities are supported in species with substantially different brain structures from our own, with research on animal cognition bringing to light animals using mirror images, extracting and representing rules, problem solving, a priori planning, and employing artificial languages to dialog with experimenters, as well as cases of cooperative intention and self-recognition.¹³ This prompts the question of whether animal music is more likely to be accepted as such if deliberations are evaluative and not merely classificatory.

CROSS-CULTURAL COMPARISONS IN THE SEARCH FOR MUSIC UNIVERSALS

Contemplating what criteria an animal’s sonic constructs would need to meet in order to find acceptance as music returns us to the zone of definitional contestation. Although heritage Western art music constitutes a very small subset of musical phenomena, it dominates theory and skews debates. As I observed above, there is no universal definition of music. In this context, zoömusicologists who compare human and animal acoustic objects must recognize that some (and perhaps many) features of human music are culture-specific. Doing so will avoid partiality to a single but persistent point of reference.¹⁴ Music extends across but is also constrained by culture, with each musical event comprised of the assorted uses, participants, materials, and traditions specific to that one time and place (Seeger 1971; Taylor 2017b, 188). Ethnomusicologist George List, for example, strongly criticizes the search for regularities or laws in music research: “To my mind the most universal characteristic of music is its non-universality as a means of communication. Whatever it communicates is communicated to the members of the in-group only, whoever they may be” (List 1971, 399).

Many languages lack a word for music, and many social worlds have no concept that corresponds to the Western notion of music. So, while Western scholars might find something that fits their intuition of what music is in any corner of the world, ethnomusicologists today are cautious about making claims of a universal human sonic experience. Nonetheless, as surveys of the world’s music have proceeded, a minority of scholars who cling to a universalist agenda have begun to settle for “statistical universals” rather than unambiguous ones.¹⁵ For example, Higgins (2012) distinguishes three types of common denominators: universals of musical perception, musical structure, and musical evaluation. Universals aside, melodic contour, the sense of a tonic, consonance and dissonance, phrase endings, pitch hierarchies, scales, internal repetition, rhythmic patterns constructed in twos and threes, small intervals—these and many other components have been studied for cross-cultural regularity in human music. Examinations of these components in animal music might shed light on the biological basis of music and musicality.

ORIGINS AND EVOLUTION

The question of music universals is directly related to the question of music’s origins (Mâche 2000, 476), and in the study of both topics, there is a long history of researchers weaving animal practices in and out of their narratives and conjectures. As with language, the origins of music remain unknown, although there is abundant speculation. For instance, Darwin proposed in *The Descent of Man and Selection in Relation to Sex* that music preceded articulate language ([1871] 1981, 1:56; see also Kivy 1959). Philosopher and biologist Herbert Spencer arrived at a different conclusion, refusing to pre-date music and instead advancing the theory that music developed out of emotive speech ([1857] 1966; Francis 2007). According to musicologist Bennet Zon, Spencer believed that “[s]avages may have their generic dance-*chants*, but when chant becomes

music (when it is civilized) it acquires the individuality and complexity of a song, chorus, concerto, symphony and opera" (2017, 92).

Theories about the origins of human music that emerged in the late 1800s tend to fall under the shadow of Spencer's Social Darwinism and the movement in the anthropology of this period known as "cultural evolutionism."¹⁶ Refusals to credit some humans with even "primitive" music is not uncommon in this era, with much of the argument hanging on the colonial and racist assumption that cultural evolution marched European music forward, just as biological evolution supposedly did with our biology.¹⁷ A case in point: "The examination of the music of savages shows that they hardly ever succeed in making orderly and well-balanced tunes, but either express themselves in a kind of vague wail or howl, which is on the borderland between music and informal expression of feeling," writes composer, conductor, and musicologist C. Hubert H. Parry, "or else contrive little fragmentary figures of two or three notes which they reiterate incessantly over and over again" ([1896] 1950, 6). Parry concludes that "it was not till special races had arrived at an advanced state of intellectuality that men began to pay any attention to the relations of notes to one another" ([1896] 1950, 7). I offer this quote as an illustration of the defective thinking of the period.¹⁸

While nineteenth-century cultural evolutionism has been fully discredited in anthropology, contemporary scholars continue the crowded debate about musical origins. Archaeologist Steven Mithen describes the sonic communication of *Homo neanderthalensis* as a musical protolanguage but stops short of identifying it as music (2006). Psychologist Steven Brown's "musilanguage" theory proposes a chronology in which singing and speaking are "reciprocal specializations" that hail from a common ancestor (2000, 271). Among those who credit the capacity of language as an adaptation, while withholding this label from the capacity of music, is cognitive psychologist Steven Pinker. He believes music is "useless" in terms of conferring survival advantage and characterizes it as "auditory cheesecake" (1997, 528, 534). Others, like cognitive psychologist and neuroscientist Daniel Levitin, refute Pinker's notion, identifying the significant role music has played in the development of human cognition, including the adaptive advantages of social bonding and cohesion (Levitin 2006; see also Carroll 1998; Huron 2001; Abbott 2002). Levitin also holds open the possibility that music is the progenitor of language.¹⁹ An alternative biocultural proposal attempts to dispense with the nature vs. culture (or adaptation vs. non-adaptation) dichotomy, seeking to integrate cultural and biological dimensions into the same system (van der Schyff and Schiavio 2017, 1).

Neuroscientist Björn Merker places human song in "a superordinate strategic position in the study of language origins," and presents a speculative history of the conversion of human song into language that spans a million years (2012, 233). He believes the vocalizations of birds and cetaceans have a direct parallel in the vocalization of humans (2012, 217). In *A Million Years of Music: The Emergence of Human Modernity*, musicologist Gary Tomlinson presumes no analogy between, on the one hand, human music and, on the other, bird and whale songs since, in his view, "[m]odern musicking and language, in a real sense, did not develop at all. Instead they fell out, as belated emergences, from patterns of sociality and communication" (2015, 12). Nevertheless, animal communication systems may be more complex than many assume: a recent analysis of the vocalizations of seven species of mammals and birds found unpredictable language-like complexities adhering to statistical processes similar to those in human language (Kershenbaum, Bowles, Freeberg, Jin, Lameira, and Bohn 2014).

Evolutionary psychologist Geoffrey Miller also takes an adaptationist approach to music, underlining the crucial importance of the evolutionary process of sexual selection for humans (2000). Another adaptationist agenda finds weaknesses in both the sexual selection and social bonding hypotheses, drawing the distinction that "music and dance do not *cause* social cohesion (as in the social bonding hypothesis); rather, they *signal* social cohesion" (Hagen and Bryant 2003, 30). In "Music and Dance as Coalition Signaling System," Edward H. Hagen and Gregory A. Bryant argue that these expressive forms evolved as a means for indicating and maintaining group cohesion, suggesting that early humans perceived "a correlation between music quality and coalition quality" (2003, 37). Ethnomusicologist Joseph Jordania believes that music served several crucial adaptive func-

tions, including the use of loud, rhythmically-precise singing and drumming to ward off predators, which he calls “Audio-Visual Intimidating Display” (2009, 272). Other more general approaches to adaptation attribute the origins of music to our switch to bipedalism (Larsson 2014) or to “affective engagement,” a type of Theory of Mind that sees music emerging from “the mirror neuron system of empathy and imitation” (Livingstone and Thompson 2009). One wonders how this crowded field of theories might be adjusted, and with what gain in explanatory power, if scholars were to acknowledge that music is trans-specific.

Although the capacity for music-making emerged in the evolutionary history of animals and humans, there is no agreement from evolutionary biology that culture follows an evolutionary path. Art renews and transforms itself, argues neuroscientist Jean-Pierre Changeux, but we cannot say that it “evolves,” if we use that word in the sense that biologists do (2012, 315). Music historian William Austin also interrupts the narrative of musical progress: “Music itself does not evolve from one composition to another or one style to another” (1953, 27). Other humanities scholars have joined him in sounding the alarm about theories of evolutionary biology intruding into cultural domains (Kozbelt 2017; Rampley 2017). Social scientist Pierre Bourdieu also weighed in, correlating musical proficiency and taste to social class and trajectory, not biology (1980, 1984). In short, there is no single, uniform history of music and its origins, nor is there a formula for how it transforms, even in hindsight. Nonetheless, many of these theories are deployed to deny the richness of animal music and animal lives.

CROSS-SPECIES COMPARISONS

Scientists specializing in music cognition generally understand music as an acquired competence based on musicality: a natural, spontaneously developing but multifaceted trait. However, the two are not easily isolated from each other (Marcus 2012; Honing, ten Cate, Peretz, and Trehub 2015). The human brain lacks a dedicated “music center”; as in vision, humans draw on a suite of cognitive capacities (likely with distinct evolutionary histories) to process music component by component (Levitin 2012). While scholars like List question whether even *intra*-specific understandings of music are possible, others have called for comparative, multicomponent studies across species to probe the biological basis of musicality.²⁰

“Stable distinctions of insider and outsider, Self and Other, emic and etic are no longer embedded in either musicological or ethnomusicological practice,” asserts musicologist Nicholas Cook, who terms these binaries “residues of colonialism” (2008, 63). Despite his optimism that such dividing lines are passé, potentially fruitful cross-species comparisons are often sidelined by the human exceptionalism inherent in received definitions of music, whether overt or veiled. However, studies have described the role of music in the cosmologies of Indigenous peoples who listen carefully to birds (Feld 1990; Brabec de Mori and Seeger 2013; Descola 2013). In related work, philosopher and ethologist Roberto Marchesini’s version of posthumanism debunks the misconception that humanity is separate from animality; he draws our attention to the “extensive animal loans [made to]...human culture in terms of activities, behaviors, and skills,” including music (Marchesini 2016b, 113). Despite widespread suggestions that cross-species comparisons will be fruitful (Hartshorne 1953; Hall-Craggs 1969; Mâche [1983] 1992, 2000, 2001; Margoliash and Nusbaum 2009; Taylor 2017b), claims or denials of human uniqueness in aspects of music or musicality are contingent upon scholars cataloging other species’ musical capacities, and the greater part of this task remains to be taken up.

Birdsong. Few topics bridge the divide between the natural sciences and the humanities more compellingly than the quest to understand the origins of culture. Human music, which presumably began in song, plays a special role here, since we are the only primates with the cerebral capacity for vocal learning. Aside from us, to date this capacity appears limited to songbirds (who comprise about half of the world’s approximately 10,000 bird species), parrots, and hummingbirds, as well as elephants, bats, and some marine mammals. One of the first observations we have that songbirds learn their songs was made by Aristotle (350 BCE) (Arbo and Arbo 2008, 262), and this was later confirmed in key ethological studies in the 1950s and beyond (Koehler 1951; Thorpe

1954).²¹ Several early music books capitalized on this faculty, offering instructions on how to teach tunes to captive birds (Godman [1717] 1955; Beeton 1860; Stainer 1899).

By the Romantic era, birdsong had been upgraded to either an origin for human music or something on par with the music of non-Western cultures (Leach 2007, 284). Several nineteenth-century monographs were motivated by birdsong boosterism and the belief that song was the best way to identify birds.²² In 1871, Darwin built his evolutionary theory of music based on birdsong, crediting birds with “strong affections, acute perception, and a taste for the beautiful” and thereby suggesting that birdsong and human music are evolutionary analogs ([1871] 1981, 2:108). However, he did not limit his attention to birds, crediting all animals with the “perception, if not the enjoyment, of musical cadences and of rhythm” ([1871] 1981, 2:333).

Like Darwin, early to mid-twentieth-century authors of scholarly articles (including those publishing in science journals) often wrote in an accessible style, adopting a personal voice and infusing their texts with colorful descriptions and human-animal metaphors that did not place animal music in scare quotes.²³ While some of these articles included music notation of birdsong, graphic and mnemonic options competed for its representation, which read quite differently from conventional notation's near-exclusive monopoly in Western music practice.²⁴ Favorable comparisons with human music were common. The ornithologist Richard Hunt, for example, argued that a mockingbird's “interest in his own mimicry is ‘artistic’” (1922, 198).²⁵

Early Birdsong Recordings. In a recent article, radio producer and sound recordist Craig Eley describes the use of whistling to imitate birdsong. Focusing on the Western world and the period from the 1890s to the 1930s, Eley suggests that this practice could be categorized as a kind of field recording, one that pre-dates machine-made ones (2014). He argues that bird whistling critically disrupts dominant narratives in the history of sound technologies and emphasizes that “environmental recording practices are always imitations, and their meaning is only made within historically specific representational systems” (2014, 5).²⁶

Wax cylinders, shellac discs, and magnetic tape each had their turn. Early recordists included the European pioneer of recording wild birds, violinist and singer Ludwig Koch (Nicholson and Koch 1936; Koch 1956), and Albert Brand, a businessman turned ornithologist who was affiliated with the Cornell Library of Natural Sounds (Brand 1932; 1934).²⁷ Brand produced an extensive birdsong field guide, *American Bird Songs*, featuring seventy-two feathered choristers (see Glass 1945). Brand was also at the forefront of efforts to use motion picture film to photograph avian vocalizations for study, believing that conventional methods did not always serve the birdsong project (1937).

Sonograms Versus Notation in Songbird Studies. As technological advances progressed, research began to focus on vocal learning in a few species easily accommodated in a laboratory, such as zebra finches, chaffinches, and canaries. The mid-twentieth century saw an increasing search for and, ultimately, a reliance on “objective methods” to settle longstanding debates about how to represent recorded birdsong. Bell Telephone Laboratories introduced the sonogram, or sound spectrogram, during World War II; this graphic representation of sound plots time on the x-axis, frequency on the y-axis, and relative amplitude as a gray scale. Sonograms were in widespread use by the end of the 1950s, led in large part by ethologist William H. Thorpe's historic study of chaffinch song (1954).²⁸ As late as 1975, his articles continued to use music notation, along with sonograms, though the two were not paired together (Thorpe 1975).

Classic articles by zoologist Olavi Sotavalta (1956), pianist and ornithologist Joan Hall-Craggs (1962), Péter Szöke (Szöke, Gunn, and Filip 1969; Szöke and Filip 1977), and composer David Hindley (1990) are notable for their sophisticated transcriptions of birdsong and sensitivity to nuances of sound, with or without sonograms. Other key texts investigating the musicality of birdsong incorporate a mixture of sonograms and notation, including those by philosopher Charles Hartshorne (1953; 1956; 1973), poet and ornithologist K. C. Halafoff (1961), ornithologist Edward A. Armstrong (1973), naturalist Rosemary Jellis (1977), musicologist Patricia Gray and her colleagues (2001), ethologists Peter Marler and Hans Slabbekoorn (2004), ornithologist Donald E. Kroodsma (2005), philosopher and clarinetist David Rothenberg (2005), neuroscientist Gisela Ka-

plan (2009), musician and soundscape ecologist Bernie Krause (2012), and myself, ornithologist and violinist/composer Hollis Taylor (2017b).

Whale Song. The ethereal beauty and runaway success of the 1970 record *Songs of the Humpback Whale* (produced by bio-acoustician Roger Payne) are epic. The album changed human cultural consciousness about these large (but largely unknown) creatures of the deep, who were suddenly transformed into “musical friends of humanity, symbols of ecological holism, bellwethers of environmental welfare, and even totems of a movement to transform the world and our attitude toward it” (Burnett 2012, 2). *Save the Whales!* became an omnipresent slogan, which resulted in a global ban (observed by most nations) on whale hunting (O’Dell [1970] 2010). Reflecting on his seminal recording, Payne later wrote that whales “give the ocean its voice” (1995, 145). In his fieldwork, Payne recorded the whales with a hydrophone (an underwater microphone designed to capture aquatic soundscapes). His subsequent sonographic analysis (Payne and McVay 1971) was complicated by the fact that a single whale song can last up to twenty-three hours (R. Payne 1995, 144).

Like songbirds, whales learn their songs via cultural transmission. In a markedly different approach from that of other species, each group of whales sings the same highly structured song, although that song evolves continuously and rapidly on multiple levels of structure (Payne and Payne 1985; K. Payne 2000). Studies have continued to produce new insights into this complex oral culture and how to quantify song units.²⁹ For instance, one study argues “that some singing humpback whales not only produce sounds conducive to long-duration reverberation, but also may sequentially structure songs to avoid spectral overlap between units and ongoing reverberation” (Mercado 2016, 1). Meanwhile, researchers in Australia report that humpbacks “picked up a catchy tune sung by [whale] immigrants from a distant ocean.” Analyzing this phenomenon, the researchers claim that “the rapid and complete replacement of a complex song over a period of less than two years is revolutionary rather than evolutionary and suggests that novelty drives changes in humpback whale song” (Noad, Cato, Bryden, Jenner, and Jenner 2000, 537). Another study, based on a large sample size, finds that bowhead whale (*Balaena mysticetus*) songs vary significantly from one whale to the next, even within the same year (Stafford, Lydersen, Wiig, and Kovacs 2018).

Even more than biologists, musicians played a notable role in echoing the sense of wonder at whale song, which Roger Payne and McVay first described in the pages of *Science*, writing that the humpback whale “emits a series of surprisingly beautiful sounds” (1971, 585).³⁰ The monographs *The Charged Border: Where Whales and Humans Meet* (Nollman 1999) and *Thousand Mile Song: Whale Music in a Sea of Sound* (Rothenberg 2008) bridge this gap, as do the humans who stepped in to extend and celebrate the ocean’s voice, from classical composers like Alan Hovhaness, George Crumb, and Toru Takemitsu to folksingers Judy Collins and Pete Seeger, and musicians like Paul Winter, Lou Reed, Charlie Haden, Don Cherry, and others (Rothenberg 2008, 25–49).

Insect Sonification. The biologist Phil Senter has observed that “[s]tridulating insects, including crickets, performed the first terrestrial twilight choruses during the Triassic,” which occurred some 200–250 million years ago (2008, 255). Beyond crickets, a range of insects from scorpions and butterflies (A. J. Alexander 1958; Baird 1878, 282, 309) to grasshoppers, locusts, cicadas, leafhoppers, and katydids (R. D. Alexander 1956) all have been observed to stridulate (make sound by sliding or rubbing one body part against another). Having left behind the songs of birds and whales, one might expect descriptions of sonification in insects to read like a report; often, the case is quite the opposite. Again, the writing follows in the rich tradition of natural historians, revealing the signal importance of fieldwork to capture dimensions of animal life not available in the laboratory.³¹

Cross-cultural comparisons are common in insect studies, with frequent suggestions that rhythm in human music might have been influenced by them, and studies of this topic often use musical terminology. In his description of insect sounds, the nineteenth-century entomologist Samuel Hubbard Scudder employs the words *trill*, *crescendo*, *staccato*, *note*, *choir*, *discord*, *harmonize*, and *song* (but not *music*), and he notates detailed rhythms, some with articulation markings (e.g., *staccato*) or mnemonic words (1868). Similarly, Orthoptera (grasshoppers, katydids, and crickets) are “instrumental musicians of the highest stamp” and “profoundly musical,” claims the

early twentieth-century naturalist Harry A. Allard in his detailed study of this topic (1928, 81). He contrasts “the angular-winged katydids, *Microcentrum*, [who] have introduced new trends of composition and variety into their songs” with the crickets, who “have seemingly established their distinctive genius on the basis of tonality alone,” in his analysis of insect technique, rhythm, tonality, and timbre (Allard 1929, 569). Allard concludes: “I am better, broader, wiser, happier for having heard the crickets and katydids, for somehow there are points of kinship in our lives, even though our magnitudes and roles of living seem so far apart” (1929, 591).³²

In his study of sound production in insects, the mid-twentieth-century entomologist Richard Dale Alexander uses the word *music* or *musical* twelve times, while the phrases *almost musical*, *not very musical*, *slightly musical*, and *less musical* each appear once (1956). Five appearances of *non-musical* refer variously to chirps, buzzes, lisps, “noisy” sounds, and other broad spectrum sonic phenomena, which are now regularly appreciated in contemporary music. In *Bug Music: How Insects Gave Us Rhythm and Noise*, Rothenberg writes: “Music is immediately meaningful even if we cannot translate it, so once heard as music, the world of animal communication is immediately accessible, emotional, and interesting” (2013, 11). He traces the relevance of techniques of entrainment, groove, meter, phase shifting, polyrhythms, quantization, and quasi-periodicity to insect musicians.

Other Animal Music. In his monograph *The Music of Nature*, composer William Gardiner presents only short, basic transcriptions of animal sounds. This is due to the fact that, like Stravinsky, he believed that nature’s musical hints require a human touch to bring them to their fullest realization: “From these natural exclamations [birdsongs], the musician draws the vivifying strokes of his art, and from these fragments of rhythm and melody, he forms the motives of the most pleasing and diverting compositions” (1832, 183). Despite such attitudes, many other authors have credited non-human species with musical behavior. Singing mice find anecdotal praise (Lockwood 1871; H. H. Slater 1877), as do whistling woodchucks and singing rats, as well as rabbits, gray squirrels, flying squirrels, and chipmunks (Slater 1877, 769). In philosopher James Sully’s 1879 review of animal music, he pushes back against the notion that we should not judge animal music by a human standard (1879, 606). Not unlike Mâche, Sully’s aim is “to vindicate the musical capabilities of animals without resorting to the fanciful hypothesis that their systems and standards are wholly unlike our own” (Sully 1879, 606–607). In working his way through evolutionary musicology, Sully speculates that “[p]rimitive human melody was probably inferior to that of many birds” (1879, 619).³³ In *The Music of the Wild*, writer Gene Stratton-Porter takes us out to hear nature’s musicians in the forests, fields, and marshes; her descriptions are chock-a-block with religious references and sentimental anthropomorphism (1910). One aspect of her work, however, is not outmoded: in an approach that encourages conservation, she urges her readers to directly experience nature but to eschew the practice of mass specimen collection so common at the time. Sound also plays a significant role in the lives of fish, who “are known to vocalize while defending their territory, feeding, and spawning” (Pagniello, Cimino, and Terrill 2019, 1). Recent studies have catalogued a diversity of sounds among vocal species of fish, as well as changes in performance across the diurnal cycle, such as dawn and dusk choruses (Parsons, Kent, Recalde-Salas, and McCauley 2017; Pagniello, Cimino, and Terrill 2019).

Others have written about (and recorded) the way animals act musically together in an ecological, orchestral way. Musician and wildlife recordist Bernie Krause’s *acoustic niche hypothesis* predicts that in the collective sonic output of a habitat, species will avoid sonic competition to ensure they maintain unique, partitioned sound signatures (1987; 2012, 99). Insisting on the significance of recording and listening to the *entirety* of an acoustic fabric, Krause recorded more than 15,000 species in their ecological soundscapes over the last 40 years, including many who live in habitats now deteriorated (2012). Acoustic ecologist and recordist Gordon Hempton similarly documented vanishing wild soundscapes. In *Earth is a Solar Powered Jukebox*, Hempton describes how the pitch produced by grasses and needle-leaved plants is determined by the length of their leaves, how stones are musical notes sounded by flowing water, and how “the presence of a healthy songbird community ranks number one” as an indicator of an environment’s health (2016, 65). “Birds,” he writes, “are your muses, your messengers, your angels” (2016, 66). Another deep listener of nature is sound recordist Lang Elliott, who, in addition to recording

and filming specific frogs and toads, insects, birds, mammals, and reptiles, also records immersive soundscapes like *Insect Lullabies* and *Birds and Brooks*.³⁴ Taken together, his work both deconstructs nature and puts it back whole again.

Animals that Appreciate Music. While animals may appreciate and enjoy the sounds they (or their mates and other conspecifics) produce, their interest apparently extends to other species' music as well. In this, the human examples are the most frequently catalogued,³⁵ and anecdotal evidence of these phenomena has a long history. Dolphins' sensitivity to human music was well known in Antiquity (Arbo and Arbo 2006, 213n12). In the medieval period, Muslim scholars "reported that animals were emotionally effected by [human] music," including dolphins, whales, and camels (Higgins 2012, 28). In a section of the *Descent of Man* titled "Voice and Musical Powers," Darwin details ample evidence of animals who were responsive to music; the text discusses insects, spiders, crustaceans, and a number of species of vertebrates, including fish, alligators, gibbons, and seals ([1871] 1981, 2:330–337). Musicologist W. J. Treutler gathered anecdotes of seals, flies, bees, and snakes, as well as a cat, a dog, and even a pet lobster, all with an apparent fondness for music (1898). In defining *music* as "a succession of sounds so combined and modulated as to please, not only the ear—our ear—but some ear," Treutler identifies music's essential purpose as "the gratification of the sense of hearing" (1898, 72). Similarly, the article "Music for Animals," which was published in *The Musical Times and Singing Class Circular* by an uncredited author, recounts how a wealthy nobleman in the Low Countries "regaled all his horses—and he kept a large number—with a [monthly] concert of orchestral music performed by his private band." The text gives no report on how the animals responded ("Music for Animals" 1879, 162). It also describes a lion who left his prey to listen to music and a "herd of stags who were brought all the way out of Yorkshire to Hampton Court by two men who played the bagpipes and the violin" ("Music for Animals" 1879, 163).

More recently, evidence has appeared online that the genre of concerts for animals is flourishing, including Paul Barton's piano concert for a blind elephant (framed as an apology for the crimes of humanity) and Laurie Anderson's concert for dogs, which was performed at a frequency that best suited canine hearing.³⁶ Further, science has begun to offer more than anecdotal evidence to support the claim that animals appreciate music. For instance, a recent article in *Applied Animal Behaviour Science* shows that certain kinds of music uniquely appeals to cats. The article also reviews studies of the effects of human music on gorillas, lar gibbons, chickens, dogs, elephants, lambs, horses, fish, laying hens, and more (Snowdon, Teie, and Savage 2015; see also Kaplan 2009).

THE CURRENT STATE OF ZOÖMUSICOLOGICAL RESEARCH

ZOÖMUSICOLOGY AND ITS OTHERS

Zoömusicologists make connections and reveal continuities obscured by outdated understandings of human music and animal capacities. They approach their subject with a trained ear (granted, one trained in human genres) and alter the contour of inquiry in animal music studies by posing questions that other specialists do not. I summarize the field like this:

[Z]oömusicology allows for unapologetically bringing musicological tools and ways of knowing to the project, for honoring painstaking long-term field observation (well-known in ethnography and the natural sciences), for giving a place to thick description and the materiality of the experience of music, and for allowing the exceptional and mysterious to play a part in shaping a species' depiction. With no standardized methodology or fixed research questions, work under this umbrella is best considered a mixed-methods, multiperspectival field rather than a discipline. (2017b, 4–5)

Zoömusicology is not alone in seeking to bridge the gap between the arts and sciences through intermingled investigations of musical, ecological, and epistemological issues. *Acoustic ecology*, for example, is concerned with the relationship between listeners and their sonic environment, including artistic and activist responses (Schafer 1977; Truax 1984, 1996; Krause 2002, 2012), while *soundscape ecology* is a field that assesses the biodiversity of an environment by studying its acoustic footprint (Pijanowski, Farina, Gage, Dumyahn, and Krause 2011; Farina 2014). Soundscape composition seeks not merely to entertain listeners but to increase their consciousness of the sonic environment (Martin 2017, 20). Additionally, *biomusicology* studies the biological and evolutionary origins of human music-making (Wallin 1991; Arom 2000; Bickerton 2000; Fitch 2015), while *biomusic* may refer to music that draws on samples of animal sounds (Brumm 2012) or on biofeedback sourced from human or animal physiological states like brainwaves or heartbeats (Eaton 1973; Rosenboom and Paul 1986). *Ecomusicology*, “the critical study of music/sound and environment,” often shares acoustic ecology’s activist goals (Allen and Dawe 2016, 2).³⁷

MAPPING PRACTICES, DOCUMENTING PROCESSES: PROFILES IN ZOÖMUSICOLOGY

Practitioners in zoömusicology are united in their belief that music-making is a shared capacity across species, but they diverge in their research themes, methodologies, theories, and collaborations. This contrasts with ethnomusicology, which tends to be defined not by its object of study but its methodology (Stobart 2008, 3). Therefore, this section describes the work of individual researchers so as to do justice to the field’s width and breadth.

In his monographs *Music, Myth and Nature* ([1983] 1992) and *Musique au singulier* (2001), François-Bernard Mâche urges us to cast aside anthropocentric prejudice and simply judge animal music by its sonic achievement—and his analyses prove this point. He is a key point of reference for scholars in zoömusicology, but his primary vocation is composition. His portfolio includes a number of works based on, and even incorporating recordings of, animal songs, and it is at the intersection of zoömusicology and composition that he has produced some of his most profound analytical writing:

If I acknowledge that the analysis of birdsong is a help in my reflexion as a composer, I will soon be suspected of being more imaginative than a scientist should be. Where I think I encounter refrains, anticipations, reminiscences etc., the biologist is satisfied with classifying equivalent signals. At the most, he will sometimes condescend to interpret the riot of individual sonic inventions, by looking for some utilitarian aspects for the benefit of the species, as if the gra-tuity of musical play was a human privilege, and no similar freedom could be imagined for the animal....Meanwhile, musicians’ attempts to analyze animal signals will reveal a matter for amazement and reflexion, and it will be a long time before this is exhausted. That is why, instead of being criticized as an anthropocentric biologist, I hope to be accepted as a zoocentric musicologist. (1997, 77–78)

Three recent chapters detail his contributions to zoömusicology (Arbo 2018; Martinelli 2018; Taylor 2018).³⁸

In addition to teaching university-level courses on the subject, semiotician, musicologist, and composer Dario Martinelli has published prolifically on zoömusicology and written musical works based on animal songs. Further, he points to ethnomusicology’s successes and challenges as providing a significant guide to zoömusicology’s development (2002, 89–103, 308–309; 2018, 109). On the debate of whether animal music is homologous or analogous to human music, Martinelli casts his vote with homology, arguing that “a concept of music (or aesthetics, more generally) exists in non-human animals as well as in human ones” (2002, 106–107). Devoting a chapter of his *Zoosemiotics: Proposals for a Handbook* (2007) to the topic of zoömusicology, Martinelli sees these two fields as

tightly linked (see also Martinelli 2001). A 2005 article investigates the question of whether musical structures may be found universally in all music, human and animal, a topic he covers exhaustively in *Of Birds, Whales, and Other Musicians* (2009, 133–214). In 2008, he and David Rothenberg convened the First International Conference on Zoömusicology. Subtitled “NightinGala,” the conference took place in Jäärvenpää, Finland, and assembled musicians, musicologists, biologists, and other researchers from three continents. That same year, he curated the first collection of journal articles on zoömusicology (Martinelli 2008).

In addition to a co-authored review essay on zoömusicology (Doolittle and Gingras 2015) and an article on the history of animals who feature in Western music (Doolittle and Brumm 2008), Emily Doolittle’s key contribution to the field involves collaborations with scientists. These display the distinct advantages that come from working across disciplines. Using “music theoretical, bioacoustic, and statistical analysis,” Doolittle and behavioral biologist Henrik Brumm find “some striking similarities in interval selection and structure between musician wren song and some human music” (Doolittle and Brumm 2012, 55). Another article on hermit thrush song seeks to understand the role that nature and culture play in the origin of scales in human music (Doolittle, Gingras, Endres, and Fitch 2014, 16616). The study finds that the scale construction of human and thrush music are similar in significant ways. Both papers have significant implications for debates on the origins of music and contentions of human exceptionalism.

A Canadian by birth, Doolittle taught in the United States before taking up a position in Glasgow, a move which has facilitated her work in zoömusicology. In her experience, composition is more likely to be considered research in the UK than in North America (E. Doolittle, email to author, 27 March 2019). Her compositional portfolio includes a host of birdsong-based works, as well as pieces based on seal and whale song. She describes her approach like this:

I always transcribe and play animal songs when I’m using them in my compositions. It’s a way of trying to internalize the song—trying to understand its rhythms and patterns and energy. In my pieces, I’m not usually trying to represent the animal song exactly. (If I were, I’d just use a recording!) It’s more about trying to find areas of overlap and areas of difference between that animal’s musicality and my own. (E. Doolittle, email to author, 27 March 2019)

Doolittle has taught university-level courses on zoömusicology and is co-supervising clarinetist Alexander South, a PhD student who studies humpback whale song from an interdisciplinary perspective. His research involves fieldwork; sonograms, abstract symbols, and conventional notation; musicological analysis; and much more, all founded on musical training and “immersive and detailed listening” (A. South, email to author, 31 March 2019). South also plans to look at “song as an embodied and social process” and to use musical performance as one mode of disseminating his research results (A. South, email to author, 31 March 2019).

As a professor of both philosophy and music, David Rothenberg is well placed to pose questions about animal aesthetics, and he regularly does. Four monographs, one on birdsong (2005), one on whale song (2008), one on insect sonification (2013), and one on nightingale song (2019) demonstrate his penchant for going to the source. Rothenberg corresponds directly with scientists and often conducts face-to-face interviews with them about their latest research. While acknowledging that art and science have divergent criteria for truth, Rothenberg likes to frequent the border territory.³⁹ His 2014 interview with ethologist Peter Marler uses the study of birdsongs to provide a window onto what C. P. Snow called “the two cultures” ([1959] 1964) of the sciences and the arts. With their emphasis on reproducible results, large data sets, and broad explanatory principles, scientists are expected to sidestep troublesome details: “You have to pretend when you present a generalization, that things are much clearer than they really are,” Marler confesses (Rothenberg 2014, n.p.). Suffice it to say there is a feeling among many zoömusicologists that scientific studies too often restrict themselves to those phenomena that can be more easily explained through empirical evidence, leaving significant

gaps in our understanding.⁴⁰ For instance, the most complex and inventive birdsongs are, according to Marler, “understudied, very difficult to study, and I’m quite convinced that the possibilities are remarkable if you could only document them convincingly” (Rothenberg 2014, n.p.). Like interspecies musician Jim Nollman (1999), Rothenberg seeks out opportunities to perform (on clarinet) alongside animal musicians—birds, whales, insects, and others—directing a close ear to how they respond, and sometimes inviting the public.

Fundamental to my research as a violinist/composer has been the months of fieldwork I spend each year in Australia’s outback recording the songs of birds, especially the pied butcherbird (Taylor 2008; 2010; 2011a; Taylor and Lestel 2011) and the superb lyrebird (Curtis and Taylor 2010; Powys, Taylor, and Proberts 2013; Taylor 2016; Taylor, Powys, and Proberts 2018). “As a zoömusicologist,” I explain, “I unapologetically embrace musicological tools and insights (including a trained ear and a musician’s hunch), honor knowing but neglected voices from multiple species, and allow for rarities, one-offs, and anomalies inaccessible (or ignored) in the laboratory to play a part in investigations of animal capacities” (2017a, 41).

In a recent multidisciplinary collaboration, my colleagues and I demonstrate how pied butcherbirds follow musical principles also used by human musicians (Janney, Taylor, Scharff, Rothenberg, Parra, and Tchernichovski 2016). Based on my field recordings, the article also features my birdsong transcriptions, which are paired with sonograms. Other topics I have studied include human exceptionalism in music (Taylor 2013), Olivier Messiaen’s transcriptions of Australian songbirds (Taylor 2014), and the multifaceted aesthetics of Australia’s bowerbirds (Taylor 2011b; 2015a). My major work is the monograph *Is Birdsong Music? Outback Encounters with an Australian Songbird* (Taylor 2017b), and I am the webmaster for the zoömusicology.com website. My composition portfolio features pieces that cleave closely to my birdsong transcriptions: “I do not set out to improve on pied butcherbird songs—that is the birds’ task—but rather to commend and showcase them,” I explain. “Thus, it is key that my (re) compositions of pied butcherbird vocalizations maintain a close connection to the original” (2017b, 248).

Composer and musicologist David Hindley credits transcription and composition as crucial steps in music analysis, noting: “It is *through the process* of recreation of a bird’s song via its symbolic representation that I hope to find the answers to fundamental questions about that bird’s song” (1995, 12, emphasis in the original). The texts that supplement his birdsong analyses benefit from his composer’s sensitivity to the nuances of sound. In one text, he compares how a nightingale changes its vocal timbre, just as a human musician might toggle stops on an organ, “to provide an ‘edge,’ a nasal quality” (1990, 30), an approach that we might label *spectralism*. Hindley’s methodology deserves special attention. In his work, he slows down birdsong recordings in order to craft highly detailed, yet eminently legible, transcriptions, and he supplements his notations with sonograms and spectral analyses (1995, 20).⁴¹ In other publications, Hindley has reconstructed the song of the New Zealand huia (which became extinct circa 1907) based on whistled imitations and a few written descriptions. He then set the imagined huia song into a synthesized composition along with soundscape recordings of the bird’s territory (Hindley 1992).

Composer and musicologist Michael Hannan prefers listening to birdsong over music made by humans (M. Hannan, email to author, 1 April 2019), and he has penned dozens of birdsong-inspired pieces. While he sometimes draws on the field recordings of other recordists, his process emphasizes personal experience: he wakes early each morning to attend to the local avian counterpoint, records in the field, and may transcribe birdsong directly, without first recording it (Taylor 2011c, 19). Like Hindley, Hannan finds composition to be part and parcel of his analytic process, rather than simply a step that precedes or follows it. “In trying to incorporate [birdsong] material into my compositions,” he writes, “it was necessary to do detailed analyses of...[their] micro- and macro- structures; and the pied butcherbird accordingly influenced the development of the details of my harmonic language and its variety” (M. Hannan, email to author, 1 April 2019). His work parallels the movement by many contemporary composers away from mere melodic imitation of birdsong (often for a programmatic purpose) to a fuller exploration of avian idioms (Taylor 2011c, 21). A case in point is his composition *13 Ways of Looking at a Butcherbird* (2005), which is based on his transcriptions of commercial field recordings and recordings he made in six different locations. His solution to writing harmonic accompaniments to various avian melodies fluctuates from movement

to movement. In Movement V, for example, a bird who employed the whole-tone scale “inspired a simple parallel chord accompaniment in the same scale” (Hannan 2005, n.p.).

As much as possible, Hannan cleaves to the original musical achievement of his birds and their circumstance, so he conceives the subsequent composition as more an enhanced translation than an upgrade. In *Resonances I–IV* for piano (1987–97), which also incorporates his transcribed birdsong, the piano’s sustain pedal is constantly depressed—a reminder that birds share their acoustic space with numerous other species. As a result, “any new material has to blend harmonically with what has gone before” (Hannan 1995, n.p.).

Neuroscientist and trained musician Gisela Kaplan proves that contemporary science writing need not be stripped of words like *musical*, *dazzling*, or *remarkable*. Her openness to surprise and beauty makes her a popular science communicator. She is also active in native wildlife protection and animal welfare in Australia, and her texts recount birds she has nursed back to health or has become close to in some other way.

Kaplan’s monographs (Rogers and Kaplan 2000; Kaplan and Rogers 2001; Kaplan 2004; Kaplan 2015) and articles (Kaplan 1999; Kaplan 2009; Suthers, Wild, and Kaplan 2011) discuss both general subjects, such as avian cognition and behavior, as well as present focused investigations of particular species, such as the Australian magpie. “Humans that lack musical ability are not able to reproduce tunes accurately, let alone arrange them in a composition,” she explains in a passage that makes the case for musicality in songbirds. “Hence, expressed positively, the ability to do so should be regarded as evidence of musicality. We would certainly not hesitate to call the ability to produce a song in pitch musical ability if a human had done so” (2009, 91). Kaplan’s work sheds light on the question of whether animals only make music to serve a biological purpose. Writing about Australian magpies, she states: “Here is a bird exceptionally endowed for song and yet so much of what is produced [by them] seems to have no easily identifiable function” (2015, 116). Although male seasonal singing occurs in many avian species, the Australian magpie joins a growing list of birds that appear to develop and sing songs outside the breeding season for their own sake (2009, 91). Since magpie song is neither motivated by reproduction nor sung in the breeding season, Kaplan boldly proposes magpies as an alternative (and more representative) species for research into songbird vocal behavior than models currently favored in laboratory settings (2008, 51).

Each of these brief profiles highlights different aspects of the field of zoömusicology by tracking how an individual scholar shapes their research agenda. Collectively, these profiles take the field’s temperature. It is notable that the majority of individuals active in zoömusicology more often identify as composers and/or performers, rather than as musicologists. The remainder of this article focuses on how zoömusicology can create new modes of aesthetic experience based on animal song, imagine new paths of research, and negotiate disciplinary politics.

OPPORTUNITIES AND CHALLENGES FOR FUTURE WORK IN THE FIELD OF ZOÖMUSICOLOGY

The acquisition and application of musical knowledge are the foundational tasks for researchers in zoömusicology. Beyond doing this kind of work, navigating the field is not straightforward. What, then, are the opportunities and imperatives for zoömusicologists? What departments will host them, and which journals will publish their articles? To whom will they apply for grants? How can they stay true to their roots but still profit from the benefits of multidisciplinary research?

COMPOSITION, SOUND ART, AND PERFORMANCE

Musicologists and ethnomusicologists often learn the music of the cultures they study and participate in performances; zoömusicologists have the same opportunity and responsibility.⁴² The focus of this section, therefore, is not whether or not zoömusicologists should respond to animal music through creative engagement, but how they can do so. In performance, for example, a zoömusicologist must choose among various modes of musical

imitation (i.e., by vocal or instrumental means). An alternative to imitation is dialog, with performance framed as conversation with animal music, whether improvised or composed. Those whose proficiency or inclination may not run to performance may instead turn their attention to new media arts, involving field recordings and studio production, mounting a sound art installation, or creating outcomes for radio or the Internet. Lectures/concerts are another prospective outcome to disseminate research findings to the broader public. Performance keeps the emphasis on, and returns the emphasis to, sound. This feedback loop echoes what John Baily, building on the work of Elaine Goodman (2000), argues is “mainstream musicology’s recent concerns with performance practice, and particularly with the relationships between analysis and performance” (Baily 2008, 117).

In this vein, Richard O. Prum has argued that a “more inclusive, ‘post-human’ view of art” offers new opportunity for progress in aesthetics (2017, 337).⁴³ When creative practice is extended by animals’ sonic prowess, both composers and their audiences stand to benefit. This kind of *nature aesthetics* has particular cultural relevance in the Anthropocene. Following the work of Vinciane Despret (2012), one might argue that if zoömusicologists are successful in making animals interesting, people will be more interested in them. A number of authors observe that the climate crisis and decrease in the planet’s biodiversity are as much cultural as scientific in nature, with climate contrarians’ distrust mounting as scientific consensus solidifies. In this situation, facts are not enough to change human attitudes, behaviors, and institutions, but spaces energized by animal music do enjoy such potential.⁴⁴ Understanding that the success of a performance to deliver an environmental message and inspire change is not automatic, zoömusicologists are nonetheless ideally placed at this time to produce works that function in terms of artistic quality, while also being relevant—ecologically, ethically, and even politically.

FIELDWORK OR DESKWORK?

One of zoömusicology’s open questions is whether fieldwork is mandatory or if relying on existing recordings and fieldnotes will suffice. The fieldworker has the potential to be vulnerable, and this vulnerability can be desirable. In fieldwork, one must be open to surprises, setbacks, and encounters with everyday people and citizen scientists in order to draw on and profit from diverse perspectives. In addition, an immersive, situated, and holistic approach opens itself to a narrative-based engagement.⁴⁵ Although a fieldworker may be the beneficiary of the felt quality of an animal song, some scholars dismiss these experiences; they believe that the laboratory is a privileged site for uncovering truth about the natural world, since the field is fundamentally contaminated.⁴⁶ While I chose to mount a sustained, long-term engagement with the sonic constructs of another species, there is no agreement among zoömusicologists that fieldwork is imperative. Doolittle sees zoömusicology as a capacious source of insights not limited to those who conduct fieldwork, arguing that “one can...study the relationship between human and animal songs philosophically, or artistically, or anthropologically, or any number of other ways” (E. Doolittle, email to author, 27 March 2019).

Hannan urges zoömusicologists not to avoid cross-species contact zones. He sees the field as more than a place to make recordings; he also imagines it as a site for directly observing animals’ multimodal behavior. He draws an analogy with ethnomusicology:

The first “ethnomusicologists” were armchair researchers, analysing the recordings that were held in archives. This was a starting point for field studies that considered music in its cultural context. Similarly, zoömusicology needs to consider the sounds of animals in their biological and ecological contexts. (M Hannan, email to author, 1 April 2019)

Ethnomusicologist Marcello Sorce Keller extends the analogy, cautioning zoömusicology to avoid the early mistakes of his discipline, when fieldworkers often did little more than provide “mere description of specific cases, without comparative dimension and theoretical elaboration” (M. Sorce Keller, email to author, 30 March

2019).⁴⁷ In keeping with his concentration on theory, Martinelli underlines how fieldwork and theory feed one another: “now that there are more theories, more models, more methodologies to study zoömusicology, empirical scholars can go to the field with much more background information, so their work becomes less of a ‘wandering around in search of useful information’” and more of a focused attempt to answer specific questions (D. Martinelli, email to author, 3 April 2019).

Even those who conduct fieldwork will likely source existing recordings to supplement their research. This brings with it the requirement to investigate what to date has been noted about a species’ behavior by the recordist and others. More importantly, the research must inquire into a recordist’s collecting practices: whether the recordings are somewhat uniform (discrepancies will arise due to recording technique and equipment, audio format [analog or digital, compressed or uncompressed], and environmental conditions, for instance); and whether, or how and how well, they have been annotated and edited, including filtering and deletions. In comparing recordings and evaluating how they are used for the production of knowledge, anthropologist Gregory Bateson counsels that “no data are truly ‘raw,’ and every record has been somehow subjected to editing and transformation either by man [sic] or by his instruments” (Bateson 1972, xx). Nothing can be assumed.

THE QUALITATIVE/QUANTITATIVE DIVIDE AND THE PROBLEM OF EPISTEMOLOGY

No matter what other skills one brings to the study of animal music, the subject matter demands that researchers have music training and are adept in deploying musicological tools. As Cook and Eric Clarke observe, musicology has typically been a “data-poor” discipline, with “musicologists...build[ing] interpretations on very small data sets or even on single instances” (Cook and Clarke 2004, 4). “There may be many musicological certainties,” they argue, “that would not survive systematic engagement with the available data” (Cook and Clarke 2004, 4). Zoömusicologists will do well to heed this warning, especially when collaborating with or presenting their research to scholars in the natural sciences. Further, zoömusicology must address the problem of using ideas from music theory, which were designed to illuminate human musical traditions (especially the Western classical one) to understand animal song.

In examining the way sounds are aesthetically deployed by animals, zoömusicologists have the potential to make connections between diverse disciplines, as well as to invigorate ideas and techniques from those fields by setting them in a new disciplinary context. One could argue that in zoömusicology, methodological pluralism is *de rigueur*, with ample room for both comparative and “what makes it work?” approaches. Beyond simply *mixed* methods, music’s potential to profit from specifically *data-rich* methodologies could provoke a re-evaluation of the comparative method, which has been used only sporadically in ethnomusicology (Cook 2004, 103).

The “lure of numeracy” continues to influence scholars (Gourlay 1978, 26), and zoömusicological projects must come to terms with it—with the researcher either cultivating mathematical skills or consciously limiting themselves to the stock of interpretive techniques available in their musicological toolbox. (It’s worth noting that, in recent years, musicologists themselves have relied increasingly on advanced mathematics.) Nevertheless, data alone will fail to answer one of zoömusicology’s key questions: What is the surplus that is not captured in technical descriptions and functional accounts of animal music?

A field cultivates not just methodologies but also epistemologies. Zoömusicology starts with experience and sound.⁴⁸ Of course, in-the-moment lived experience is informed by past encounters and relies on implicit assumptions; no researcher experiences sound as unmediated knowledge, and species certainly differ in their auditory capacities. All that said, experience and sound are always the starting place for zoömusicological inquiry. Any desire to quantify animal music may bump up against sounds that do not lend themselves to scientific methods and quantitative analysis, and it is not only musicians and humanities scholars who hold this view. “Who are we humans to assume that birds don’t see their songs as musical?” asks biologist David E. Gammon. “As a scientist, I’m biased towards thinking about birdsong quantitatively, but as a musician I also appreciate that

some important concepts of birdsong do not translate easily into numbers” (D. E. Gammon, email to author, 30 March 2019)

Some observations are allowed to become *data* while others are anomalies that must be tidied up. Statistics, like science, deals with generalities and replication, while music inclines towards particularities and one-offs. “Works of art and culture are living experiences, not abstract doctrines. They are sensuous, delicate, uniquely individual,” writes literary theorist Terry Eagleton. “Theory is general,” he continues, “culture is specific” (2004, 74). Changing a note by a semitone within a single composition may have no impact on a statistical analysis but could have a huge musical effect (Nettheim 1997, 94).⁴⁹ Further, deviation from the exact, the precise, and the rigid is the starting point for creativity and communication, so studies that require animals to sing in time and in tune in order to make music “like humans” miss the nuanced story on the ground (Seashore 1927, 466). My intention here is not to revive debates about scientific versus humanistic research methods, but rather to sum up the existential dilemma of zoömusicology.

Space does not allow for a full consideration of the ontological assumptions that notation systems entail and how notation is embedded in discourses of authenticity, exoticism, and agency.⁵⁰ The decision to employ the notation of conventional music in addition to sonograms should depend on which tools are best able to respond to the complexity of specific animal songs. At a moment when some universities are dropping the requirement of musical literacy, even for music majors, one can page back to a time when a well-rounded education included the skill of transcription, and scientists were adept at this craft. Such skills are essential for the zoömusicologist. The case could be made that the less researchers are exposed to art and music (due in part to long-term defunding in many countries), the less equipped they are to navigate animal acoustic constructs, whether or not they term them *music*. Philosopher and ethologist Dominique Lestel believes the issue goes beyond a lack of formal training or deep knowledge in the arts; rather, some researchers are not even aware that the absence of these kinds of experiences are a problem at all (Lestel 2012, 174).

Sensitivity to musical diversity is essential for the zoömusicologist. A cursory understanding of nineteenth-century Western art and music, for example, cannot stand in for an appreciation of the width and breadth of human practice across time and space.⁵¹ While the sonogram has largely replaced the musical score as Latour’s *immutable mobile* (Mundy 2009, 220), some, like this author, continue to tout the power of notation, especially when paired with sonograms (Taylor 2017b, 41). No one discipline can provide comprehensive answers when the problems at hand are embedded in complex structures. If zoömusicology is to produce results with theoretical and empirical consequence, the repertoire of methodological skills and tools used in analysis may require software applications that cluster and visualize recordings, as well as spreadsheets that detail algorithmic approaches to analysis (Markov chains, network analysis, formal grammars, temporal structure, etc.).⁵² Towards this end, music notation can be exported as a MusicXML file, which opens up the data to bio-informaticians, who study the parallels in complexity among human music, language, and animal song. Some scholars are wary that new methods such as these might lead to reductionism or positivism. However, David Huron suggests a way to navigate between such difficulties: treat each new technique “as a *potentially useful strategy for discovery* rather than a *belief about how the world is*” (1999, 23, emphasis in the original).

CHALLENGES IN THE ACADEMY

Thinking with Aldo Leopold, musicology and the natural sciences can be taught separately, but they cannot be deployed separately to unravel questions of musicality in animal music. Consequently, this article has taken as its core mission to interrogate zoömusicology across species and academic boundaries. However, one cannot ignore the steep “prestige differentials” in operation in the culture of the academy and the broader societies in which universities are embedded, which are expressed in binaries such as hard/soft, sciences/humanities, and human/animal (B. H. Smith 2018, 100). Scientific legitimacy may not be possible for some projects, or may come at

too great a cost for others. Further, not all scientists agree with one another, and crossing disciplinary borders can find zoömusicologists importing scientific and technical materials without the comprehensive expertise “to assess experimental designs, statistical analyses, or the robustness of conclusions in those fields” (B. H. Smith 2018, 100). When zoömusicologists attempt to dismantle these *de facto* hierarchies through engagements with the natural sciences, they face the danger of feeling like a dilettante in another’s area of expertise.

Many obstacles hinder the study of animals by scholars from disciplines that historically have been theorized on the assumption of human exceptionalism, and musicology is very much included here. Ethnomusicologist Philip V. Bohlman famously stated in an article of the same name, we must understand “musicology as a political act” (1993, 436). Here, it is enough to note that zoömusicologists need to be part of the conversation with respect to the full enterprise of music. If animals’ sonic constructs are *not* understood as music (and thus their study is not accepted under the broader umbrella of musicology), the search for publication venues and grant sources will become complicated, at best.

We know that gaining a secure position in a music department is likely to depend on expertise in more traditional aspects of musicology. We also understand that while scientists are becoming more effective in communicating to the public, the involvement of artists in science research can make their outreach even more effective (Stevens and O’Connor 2017). A natural extension of this—a bold but promising way forward—would be for every science department that studies animal song to appoint a zoömusicologist to communicate aspects of their laboratory’s findings (and even to influence lines of questioning and methods). In this way, inquiries will unfold through performances, sound art, composition, and mixed-media installation, as well as the more traditional aspects of research and writing.

CONCLUSION

Zoömusicology puts forward new, expanded directions for musicology. Indeed, an inclusive notion of music, neither limited by the West nor by the human, demands investigations into the sound patterns and practices of animals. With its formidable inheritance from ethnomusicology in particular, zoömusicology will develop and extend border crossings; it will experiment with diverse methods; it will revisit overly hasty definitions, theories, and biases; and it will nudge us away from defining ourselves and our music as separated from and in opposition to animals. Poet, translator, and critic Stuart Cooke believes zoömusicology is “the most vibrant field for the study of non-human art as art.”⁵³ With so many species remaining to be canvassed, a cornucopia of low-hanging fruit awaits zoömusicologists, and failing to thoroughly investigate animal capacities would seem negligent.

Zoömusicological approaches could impact big-picture questions about music, musicality, and their origins. Even syntheses of the available empirical evidence by zoömusicologists could contribute new understanding. A site for interdisciplinary exchange, zoömusicology produces results relevant beyond academia as well, broadening the base of musicological (and environmental) discussions with animal song celebrations for concert audiences, citizen scientists, environmentalists, students, and everyday people. By prescribing sound and listening as forms of ethical invitation, zoömusicologists’ creative engagements have the transformative potential to extend our feelings of connectivity and kinship beyond the human.

NOTES

1. Though we are animals in denotation if not connotation, the word “animal” in this article refers to members of the kingdom Animalia other than humans.

2. Although this survey concentrates on Western culture, theories about the nature of music and the role of animals therein are also present in early Eastern philosophies, including those of China and India (Gracyk 2013, x).

3. While Aristotle (c. 384–322 BCE) acknowledged the remarkable talents of some birds, in general he did not compare animal sonic constructs to human music, focusing instead on issues of biological function (Arbo and Arbo 2006, 217–218; Arbo and Arbo 2013, 138).

4. Pliny continues: “there is not any manufacture of a Pipe so exquisitely contrived by the Art of Man that can accomplish such a Variety of Things as proceed out of that little Throat” ([77] 1847, 217). For more on Pliny and the musicality of animals in the ancient world, see Arbo and Arbo (2006, 2008, 2013).

5. A recording of this performance is provided on the BBC (2020) website.

6. One brief mention of *zoömusicology* pre-dates this: in 1969, biologist and musicologist Peter Szöke and his colleagues described a manuscript by Athanasius Kircher as a “zoomusicological representation of the cock-crow” (Szöke, Gunn, and Filip 1969, 426).

7. For more on human exceptionalism in music, see Taylor (2017b, 205n22).

8. An image of a page from this text that includes this transcription can be found on a blog post from the Special Collections of the University of St. Andrews (2020).

9. Scholars arguing that animal music lacks human music’s hierarchical structure and tonality include Lerdahl and Jackendoff (1983), Scruton (1997), and Ball (2010, 23). Problematising this critique are Narmour (1977; 1990, xi), Cohn and Dempster (1992, 156–181), Lidov (1997, 1–28), Rosen (1998), McClary (2007, 295), and Iyer (2002, 387, 388). Scholars arguing that animal music lacks complexity and/or diversity include Mynott (2009, 176), Patel (2008, 356), and Slater (2001). Problematising this critique are Catchpole (1976); Dowsett-Lemaire (1979); Todt and Hultsch (1998); Podos, Peters, Rudnicki, et al. (1992); and Payne (2000).

10. “Another difference is that in most nonhuman singing species,” Hauser and McDermott continue, “singing is predominantly male behavior, which is not true for humans. Animal song thus likely has little to do with human music” (2003, 667). However, their gloss ignores the prolific vocalizations of female songbirds, particularly in the Southern Hemisphere where birds are resident year-round (Taylor 2017b, 25, 225–226).

11. See, in particular, Carruthers (2004), Plumwood (2001, 2009), Hodgetts and Lorimer (2015), and de Waal (2016), as well as texts by Despret (2012), Haraway (1988, 2008), Lestel (2011, 2012), Marchesini (2016a), and Wemelsfelder (1997).

12. See Wystrach and Beugnon (2009); Milius (2003); Holmes and Neil (2012); Bugnyar, Reber, and Buckner (2016); and Smith, Proops, Grounds, et al. (2016), respectively.

13. See, for instance, Reznikova (2007) and Güntürkün (2012).

14. For more on cross-cultural studies of human music and the search for music universals, see Farnsworth (1948); List (1971); McAllester (1971); Blacking (1977, 1995); Harrison (1977); Hood (1977); Khe (1977); Lomax (1977); Nattiez (1977); Nettl (1977); Nketia (1984); Nettl (2000); Huron (2007); Higgins (2012); and Trehub, Becker, and Morley (2015).

15. See, in particular, Nettl (2001); Stevens and Byron (2009); Tan, Pfordresher, and Harré (2010, 298); Brown and Jordania (2011); Savage, Merritt, Rzeszutek, et al. (2012); Savage, Brow, Sakai, et al. (2015); and Tenzer (2015).

16. It should be noted that theories about the origins of culture (including music) developed by scholars in cultural evolutionism were fundamentally colonial and racist, and this school of thought has long been discredited in anthropology.

17. One finds a range of similar sentiments in Spencer ([1857] 1966, 420), G. Allen (1880), Wallaschek (1893, 230), and Gilman (1909). Composer Percy Grainger is a notable early exception: “While so many of the greatest musical geniuses listen spellbound to the unconscious, effortless musical utterances of primitive man, the general educated public, on the other hand, though willing enough to applaud adaptations of folk-songs by popular composers, shows little or no appreciation of such art in its unembellished original state, when, indeed, it generally is far too complex (as regards rhythm, dynamics, and scales) to appeal to listeners whose ears have been subjected to the ultra-refining influence of close association with the subtle developments of our latest Western art-music” (1915, 417). Also see Head (1997) on the origins of music in birdsong.

18. The antidote for such tracts is ethnomusicologist Judith Becker’s searing critique of those who champion the doctrine that Western art music is superior: “Otherwise intelligent and sophisticated scholars continue to use the word ‘primitive’ when referring to the music of Africa, American Indians, aboriginal Australians, and Melanesians, among others. A more subtle form of this dogma is the concept that Western art music is intrinsically interesting and complex, while other musical systems need their social context to command our serious attention” (1986, 341).

19. For more on this contested topic, see Wallin, Merker, and Brown (2000); Radick (2007); Patel (2008); Hallam, Cross, and Thaut (2009); Bannan (2012); Arbib (2013); Lawson (2014); Tenzer (2015); and Killin (2016).

20. See, in particular, Marler (2000); Gray, Krause, Atema, et al. (2001); Hauser and McDermott (2003); Fitch (2005); Cross (2009); Hoeschele, Merchant, Kikuchi, et al. (2015); Rohrmeier, Zuidema, Wiggins, et al. (2015, 1); and Spierings and ten Cate (2016, 345).

21. For more on birdsong in classical antiquity, see Arbo (2018, 142–144).

22. See, for instance, Harting (1866), Cheney (1892), and Witchell (1896), who distinguished himself with his inquiry into song evolution, song learning, musicality, and mimicry.

23. See, for instance, Moore (1913), Andersen (1926), and Miller (1952).

24. See in particular Mathews ([1921] 1967), Garstang ([1922] 1923), Hunt (1923), and Saunders (1915, 1951).

25. See also Oldys (1907), F. H. Allen (1923), Herzog (1941), Craig (1943), Tiessen (1953), Marler (1981, 92), Boughey and Thompson (1981, 65), and Baptista and Kroodsmá (2001, 11).

26. Similar to Western bird whistle imitation is the Australian Aboriginal use of the gumleaf to mimic birdsong. Used in hunting and musical performance, little is known about the (presumably) long history of this practice (Taylor 2015b).

27. For more on the evolution of birdsong recording and the sonogram, see Bruyninckx (2018) and Mundy (2018).

28. Despite the sonogram's seeming objectivity and widespread use, its computational basis has been challenged (Szöke and Filip 1977; Boucher, Jinnai, and Taylor 2010). The widespread reliance on visual modes of representation, which is one manifestation of the broader trend toward ocularcentrism in the sciences, is particularly problematical when the subject is sound.

29. See, for instance, Guinee and Payne (1988); Noad, Cato, Bryden, et al. (2000); Eriksen, Miller, Tougaard, et al. (2005); Au, Pack, Lammers, et al. (2006); Green, Mercado, Pack, et al. (2007); Garland, Goldizen, Rekdahl, et al. (2011); Allen, Murray, Noad, et al. (2017); Allen, Garland, Dunlop, et al. (2018); and Stafford, Lydersen, Wiig, et al. (2018). Also see Janik (2009) for an overview of whale song.

30. Thinking through these issues, Rothenberg has observed: “[Scientists] are [often] afraid to admit the beauty that leads us to be interested in the music of nature in the first place” (D. Rothenberg, email to author, 22 March 2019). Also see Rothenberg (2008, 133).

31. Against this backdrop, sociologist Eileen Crist identifies a deficit evidenced in much of today's academic science writing: “The truths yielded through detached, methodologically stringent, and quantitative analyses of animal behavior will distort the realities of animal life, if such analyses are taken to be exclusive truths, or fruit of a singularly privileged perspective” (1996, 35).

32. Allard's enthusiastic descriptions are consistent with the finding that the more time an ethologist spends in the field, the more likely they are to “anthropomorphize” the animals that they encounter there (Daston and Mitman 2005, 7–8). While claims about the musicality of animals may be criticized for attributing more than we ought to animals, scholar of literature and culture George Levine argues that anthropomorphism was crucial in Darwin's development of the theory of sexual selection (2006, 226). Further, research that does not appear to anthropomorphize animals is often based on anthropomorphic assumptions, such as the notion that human beings are the zenith of the knowing world. As a remedy to these ills, biologist Frans de Waal coined the term *anthropodenial* to underscore how avoidance of anthropomorphism sets off an underestimation of animal abilities, admonishing us to “admit that animals are far more like our relatives than like machines” (1997, 52).

33. Other writers from this period grapple with similar issues. In an article on animal music from the same year, naturalist Xenos Clark attempts to distance himself from “the world of sentiment, where poet-naturalists and nature-poets have culled a wealth of fancies that will endure as long as there is human emotion” (Clark 1879, 209). Despite his desire to avoid romanticism, Clark's simple musical notations of various animal sounds fall short of his stated goal of achieving a scientific account of animal music.

34. More information about Elliott's work can be found on his website (Elliott 2019). See also Honing (2019) and Rothenberg (2019, 73–81).

35. For additional sources on this topics, see Fennell (1841), Cornish (1895), and Gilliland (1944).

36. For a video of Barton's *Bach on Piano for Blind Elephant*, see Barton (2018). Bastien Inzaurrealde and Adam Gabbat (2016) provide a video of Laurie Anderson's concert for dogs in New York's Times Square.

37. See also Allen (2011), Pedelty (2012), and Titon (2013). On related work that connects music and the environment (e.g., environmental ethnomusicology, archaeomusicology, and studies of music as the commemoration or evocation of place), see Taylor and Hurley (2015).

38. See Taylor (2018) for a listing of Mâche's articles in French.

39. “As a musician,” Rothenberg writes, “I can record just *one* duet between my clarinet live with a humpback whale and find some beautiful synergy there. As a scientist, I would want to do it five hundred times, then statistically analyze all the data thus collected. It is boring to me, but I know it is important. I also know that mere statistical analysis does

not explain much about human music, so animal music ought to be taken seriously enough that more musical analyses can be applied to it" (D. Rothenberg, email to author, 27 March 2019).

40. "One of the reasons why normal science seems to progress so rapidly," writes physicist and philosopher Thomas Kuhn, "is that its practitioners concentrate on problems that only their own lack of ingenuity should keep them from solving" ([1962] 1966, 37).

41. The spectral analysis accomplished by Hindley's cumbersome "Janiform scores" spans many pages. In the twenty-five years since Hindley's early publications, researchers have been able to access significantly improved hardware and software for music analysis. I would suggest that, in this context, the significance of Hindley's research lies more in his resolve to reveal the nuances of a bird's song and in his certainty that there was much more to be elucidated in their music than anthropocentric critics would have suspected.

42. Performance is not only important for ethnomusicology and zoömusicology. Musicologist Madimabe Geoff Mapaya emphasizes how "entering the field [of musicology] without undergraduate musicological training or appropriate music performance experience undermines the study of the music" (2018, 115).

43. In his article "Coevolutionary Aesthetics in Human and Biotic Artworlds," Prum draws a clear line between "biotic advertisements (animal courtship displays, fruits, and flowers), which share with human art a common mechanism of coevolving with their evaluations" and things abiotic (2013, 813). For instance, the night sky or a rainbow arise from "abiotic optical physics alone," while animal courtship displays, fruits, and flowers are products of "functional organismal physiology resulting from millions of years of genetic and cultural evolution...." For Prum, this "distinction between the abiotic and the biotic" is "the most fundamental, aesthetically relevant ontological category in nature" (2013, 815).

44. For more on environmental aesthetics as well as art and activism, see Gablik (1991), Pedelty (2012), Stevens and O'Connor (2017), and Portera (2018).

45. On writing fieldnotes, see Emerson, Fretz, and Shaw (1995).

46. In ethnomusicology, scholars have confronted related issues. For methodological writings in ethnomusicology that highlight the importance of empathy in fieldwork, see Titon (2008) and Barz and Cooley (2008). For more on ethological fieldwork, see Lorimer (2010).

47. See also Sorce Keller (2012).

48. As musicologist Leonard B. Meyer observed: "[T]he critic does not, I think, begin with aesthetic principles and arrive at critical judgments. Quite the opposite. He begins with his own responses—his cognitive-affective sense of whether a composition is convincing and exciting, intriguing and entertaining. Then he attempts to find rational grounds for his judgment" (1973, ix).

49. Of course, science itself is not monolithic. As Gisela Kaplan has observed, some researchers put aside abstract, theoretical approaches in order to understand the concrete particulars of animals and their lives (2015, 121).

50. For more on notation, see Stockmann (1979), Agawu (1995), Marian-Bălașa (2005), and Taylor (2017b, 53–83).

51. A number of articles on animal song by scientists are marked by ethnocentrism and display a flawed assessment of both animal song and human music. See, for example, the discussion in Taylor (2017b, 215–217) of the contrast between the perspective of Araya-Salas (2012) and that of Doolittle and Brumm (2012).

52. For more on current research methods in zoömusicology across taxa and disciplines, see Kershenbaum, Bowles, Freeberg, et al. (2014).

53. "I can't wait for literary studies to catch up!" Cooke writes. "Most understandings of literature remain beleaguered by the spectre of semanticism. That is, most readers continue to focus on what texts might mean, so that the absence of obvious meaning makes us extremely uncomfortable (e.g., the common aversion to avant-garde and sound-based poetics)...For me, zoömusicology represents a delightful release from these strictures, because it has no problem with taking pleasure in sound-forms, and no problem with non-Western models of music and composition" (Cooke, email to author, 29 March 2019).

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