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Sconfinamenti tra i saperi umanistici e le scienze della vita
Crossing borders between the humanities and the life sciences

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Predictability and the Unpredictable

Life, Evolution and Behaviour

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Interspecific Cultural Convergences (ICC) and Interspecific Cultural Studies (ICS): From the Only Human Towards a Comparative History of Animal Uses and Traditions

MARCO CELENTANO

Predictability is a relational, historically and culturally shaped concept. A phenomenon can be defined as predictable in relation to the available knowledge, instruments and methods, as well as the epistemic horizons in which its explanation is located (E. FOX KELLER 2002). From this point of view, the last hundred years in the field of comparative study of animal behaviours and minds have led to radical changes in our epistemic horizon by extending our understanding of what we have to consider predictable or unpredictable in animal behaviours. Indeed, this historical phase has seen the discovery of entire classes of phenomena related to the expression of animal thought, languages, societies and cultures, which in the preceding decades would have been considered *impossible* within relevant scientific areas as anthropology, comparative psychology, theoretical and moral philosophy, linguistic and cultural studies.

For instance, new sound analysis technologies developed over the last decades have allowed a decoding of bird songs that, pushing the limits of our sensory and cognitive channels, allowed us to appreciate its syntactic complexity and the richness of its intraspecific differentiations (cultural traditions), radically modifying our views. In the last ten years, the analysis of the cerebral structures of birds has also demonstrated the presence of areas for processing and decoding acoustic communication similar to those found in our central nervous system. The brain of parrots, corvids and sparrows has been shown to have a higher neuronal density than that of mammals, including primates. Higher is also the percentage of neurons that are part of the brain areas destined to the so-called “superior functions” as the bark in mammals and the *Pallium* in birds. A research directed by Clifton W. Ragsdale, of the University of Chicago, has recently confirmed a close affinity between the mammal neocortex and the birds’ DVR, or ventricular backbone (J. DUGAS-FORD, J.J. ROWELL, C.W. RAGSDALE 2012). In the last fifty years,

the use of microphones suitable for recording in the deep sea, and the computerized analysis of sounds, made us begin to understand the complexity of whale songs, or the amazing analogies of the dolphins' whistling with human names. In the same span of time, progress in the techniques of brain analysis has shown that the cetacean's paralimbic system makes possible a very rapid integration of perceptions and a richness of information which is considered superior to the human one, and that cetacean such as humpback whales and dolphins have brains with even more cortical convolutions than humans (R. D. FIELDS 2008).

These developments open up new perspectives, making it necessary to overcome, both in scientific training and in research, classical dichotomies such as nature/culture, Natural Sciences/Humanities. They integrate the horizon of the foreseeable, including the expectation of a gradual extension of the class of organisms that we should recognize as "cultural animals", as well as of the phenomena to which this chapter is devoted: the cases of Cultural Convergent Evolution between different species.

From the discovery of animal cultures to the approach of contemporary philosophy of ethology

In the second half of the 20th century the developments of ethology led to one of the most revolutionary discoveries of contemporary science: the existence of animal cultures¹. It falsified, or empirically refuted, one of the fundamental assumptions of our philosophical and scientific tradition: man as the only "cultural animal". Therefore, it questioned *the very partition of science in Humanities, conceived as the sciences of culture, and Natural Sciences.*

Two field studies, which became known to the scientific community in the mid-1960s, prompted this discovery. The first, directed by J. Itani, S. Kawamura and M. Kawai, disciples of the Japanese ethologist K. Imanishi, began in 1948 on the island of Koshima, where a community of macaques (*Macaca fuscata*) lived then and still does today. The second, promoted by Louis Leakey, the most authoritative anthropologist of the time, began in 1960 and was carried on by J. Goodall, who was the first scholar to study

¹ Ethologists broadly agree nowadays on a trans-specific notion of "culture" that implies, as its necessary and sufficient conditions, the existence of systems of transmission of experiences and uses to other individuals and generations, through learning/teaching processes (F. DE WAAL 2001, p. 11; D. MARTINELLI 2011, p. 230).

the behaviour of chimpanzees in their natural environment, in the Gombe Stream Chimpanzee Reserve, in Tanzania.

The observation of macaques made Satsue Mito, an inhabitant aide to the three ethologists, the first human witness to the birth of a tradition within a community of non-human animals (DE WAAL 2001, pp. 179-211) in 1953. The Western scientific community became aware of this discovery in 1965, when Kaway published a paper on the scientific magazine *Primates* (M. KAWAY 1965). Meanwhile, in 1960, Jane Goodall had begun studying the chimpanzees at the Gombe Stream Chimpanzee Reserve². She was the first scholar to discover important aspects of the social life and material culture, and of the emotional and cognitive behaviour, of chimpanzees: their ability to build wooden tools and exploit them to obtain food; the techniques used to open coconuts by choosing, carrying and using different stones in the form of anvils and hammers; the existence of cultural differences between groups; the complexity of their social structures and the differences in sensitivity, intelligence, character and preferences in every single individual.

In the 1960s another sub-field of ethological research began to contribute to the birth of cultural ethology: the study of communicative systems in singing birds. It led to the discovery of the existence of “dialects”, which are regional and macro-regional differentiations of the songs within a same species. Marler and Tamura, pioneers of this turn, already in the early 1960s discussed «the Song Dialects» (P. MARLER and M. TAMURA 1962) and «culturally transmitted patterns of vocal behavior» in sparrows (P. MARLER and M. TAMURA 1964).

The debate on the philosophical and scientific consequences of such discoveries began to develop in the 1970s and intertwined with the discussions on animal minds aroused from some comparative psychologists who studied the ability of higher primates to learn man-made languages as the ASL (R. FOUTS 1997; F. PATTERSON 1999; H.L. MILES 1994) or other techniques of interactive use of human lemmas or symbols (D. PREMACK 1986; S. SAVAGE RUMBAUGH 1977), to recognize themselves in the mirror (G. GALLUP 1970; D.J. POVINELLI 1987), to solve cognitive problems (DE WAAL 2016).

Despite their methodology, based on observations in captivity and on anthropocentric assumptions which equated the intelligence of other animals to their ability to acquire and use human language or tools, these experiments

² The site, thanks to Goodall's efforts, has become a protected area since 1968.

opened up a window on a new territory: the translation of thought and experience of other animals, like apes and later parrots (D.K. PATTERSON and I. PEPPERBERG 1994), in human languages.

Between the '90s and the next decade a both anti-determinist and anti-anthropocentric oriented *philosophy of ethology* emerged, intersecting with the rising *Animal Studies*. Books like *Visions of Caliban* (D. PETERSON and J. GOODALL 1993) and *Species of Mind* (C. ALLEN and M. BEKOFF 1997) gave a first significant boost in this direction. Then, philosophers of ethology and zoo-anthropologists as MARCHESINI (1999), LESTEL (2001), DE WAAL (2001), WOLF (2003), DESPRET (2004), MARTINELLI (2007) contributed to set the comparative study of animal minds, cultures and societies on new both post-mechanistic and post-idealistic bases (M. CELENTANO 2000).

Ethno-ethology and Interspecific Cultural Studies

According to the approach of the contemporary philosophy of ethology, the discovery of animal thought and cultures required an overcoming of the division between Life Science and Humanities, as well as the development of a meta-disciplinary area able to combine biological, ethological and ecological skills with the methods of the modern comparative cultural studies.

This approach, that I will call hereafter *Interspecific Cultural Studies*, is oriented to a comparative study of cultural traditions, uses, expressions and developments that include not just the human, but *all the known and knowable animal cultures*. It can be consolidated only through a reallocation of cultural studies within an inter-specific perspective. To this aim, it is necessary to dispose of traditional mechanist and dualistic Cartesian models, but also of the “psycho-hydraulic” model of classical and early cognitive ethology (R. MARCHESINI 2016), as well as of the gene-centric “classical sociobiology” (DE WAAL 2001), and of the deterministic approach dominant in evolutionary psychology (P. LIEBERMAN 2013). The main tasks of *Interspecific Cultural Studies* will be the following:

To upturn traditional forms of human self-representation, and pave the way to post-anthropocentric forms of self-understanding, in which man is *only one of* the cultural animals, and to consequently re-found methodologies, epistemological references, and narrative background of the cultural studies with a post-anthropocentric and inter-specific setting.

To refocus ethology and behavioural science on a post-gene-centric, post-deterministic, and post-mechanist approach, which considers all the organisms, not only as products of an external selection, but also as selective agents, whose explorative activities are part of the driving forces of evolution through their cognitive and behaviour.

To form new generations of teachers and scholars equipped to compare human and non-human cultures and societies without falling into the traditional opposition between anthropomorphism and anthropodenial;

To collectively construct, through researches, comparisons and debates, a meta-disciplinary lexicon capable of attributing to concepts such as “culture”, “traditions”, “invention”, or “singing” meanings usable in reference not only to a human, but also to a non-human context;

To critically reframe the (chronologically) short history of human cultures into the big history of animal experiences, traditions and cultures which is hundreds of millions of years long.

These tenets appear to reflect the actual trend of ethology at large. Contemporary ethology, assimilating approaches and methodologies already in use in the ethnological field, is increasingly shaping itself as «animal ethnography» (D. LESTEL 2006). «The convergence between ethology and ethnography has significantly transformed studies of animal subjectivity and culture» and the future of both fields lies, according to Lestel, «in a cultural zoology that treats animals as subjects partaking in culture» (LESTEL 2006, p. 147). These developments have led to the birth of a new interdisciplinary field of research, ethno-ethology, which «can be described as a discipline that studies the dynamics of agents which combine actions and interpretations in an ecological, historical and individual perspective». It is «an ethnography of the way the individual beings perceive and conceive, in the course of their interactions, the behaviors of other living beings and the way they react to these behaviors» (D. LESTEL, F. BRUNOIS, F. GAUNET 2006, pp. 166-167). The etho-ethnologic approach aims at a comparative study of animal behaviours, minds, and cultures which considers each animal as «a coherent agent that interprets significations in a homogenous manner [...] and attempts to understand it in a historical (which calls on a temporal dimension) and social (an agent always acts in coordination with other agents) perspective» (*ibidem*). This approach implies the adoption of procedures and methods that allow distinguishing each individual as such, within an observed group, and

each observable local or regional intraspecific difference in the populations belonging to the same species.

Behaviour as a self-regulative interaction and a driving force of evolution

In the perspective of contemporary ethology, behaviour is framed as a *self-regulative* and *cognitive interaction* of organisms with their inter- and intra-specific environment body. “Self-regulative activity and interaction” means that all organisms, of every species, need at any time to maintain or restore internal processes and physiological states which allow them to stay alive, and perform this function through explorative and energy trading activities, absorbing and transforming matter and energy present in the external environment, and modifying both the latter and themselves.

What does “cognitive” mean here? In the perspective of contemporary ethology, we can call “cognitive” all the activities through which organisms explore their survival chances and test their ability to actively change their physiological and/or perceptual states. Each “cognitive” activity is in this sense a *production of behavioural forms*, or of *self-regulative internal and external interactions*, enabling the performance of the organism’s life cycle. In this perspective, cognitive activities are not a prerogative of animals, but of all organisms, because the simple fact that organisms are able to survive constitutes evidence of their ability *to make an object of knowledge out of their own living conditions* (K. LORENZ 1977; R. RIEDL 1980; M. CELENTANO 2000, 2017).

These self-regulating and cognitive activities are obviously channelled and limited through the constraints imposed by the anatomy and morphology of the species, of the intra-specific and inter-specific context, and of individual characteristics and contingencies. Nonetheless, framing behaviour in such terms allows us to understand both the history of each existed and existing species and group, and the history of each body as an active and selective exploration of the environment, and an active construction of the respective ecological and social niche.

This post-mechanical conception of behaviour has assumed, since the ‘90s, a relevant role in the renewal of models of evolutionary biology derived from the developments of epigenetics and from the introduction of the evo-devo perspective.

Two notions in particular, previously introduced by two scholars of the 20th century, C.H. Waddington and J. Piaget, began to find consensus and corroboration from experimental findings, and to take relevance in evolutionary studies: the notion of «behavior as motor of evolution» (J. PIAGET 1976), and of *non-genetic hereditary systems* – nowadays called *Epigenetic Inheritance Systems* (E. JABLONKA and M. LAMB 2005) –, able to produce phenotypic modifications much faster than genetic mutations (C.H. WADDINGTON 1975; PIAGET 1976).

What does it mean in this new context that behaviour is a “motor of evolution”?

To conceive behaviour as a driving force of the differentiation of organisms means that individuals, populations and species, when they encounter environmental changes that endanger their survival or offer them new growth opportunities, do not passively wait for a favourable genetic mutation that allows some of them to overcome those new obstacles or exploit those new resources. Organisms, in the face of any change, engage all the innate and/or learned cognitive and physiologic resources they possess, to take advantage of the new conditions. Under this perspective, evolutionary divergences start from the sphere of behaviours, from changes in the ethological attitudes, which are active responses to changes in the environmental, social or individual context. Significant genetic mutations, on the contrary, appear only rarely as self-sufficient causes of evolutionary change.

During the last decade, promising research developments made increasingly evident the close correlation between EIS (Epigenetic Inheritance Systems) and BIS (Behavioural Inheritance Systems), leading to the birth of two new interdisciplinary fields of inquiry: “behavioural epigenetics” (E. JABLONKA 2006, 2013; F.A. CHAMPAGNE and E.F. RISSMAN 2011; I. TAVORY, S. GINSBURG, E. JABLONKA 2012) and “cultural epigenetics” which include «the investigation of the role of behavior in shaping developmental-epigenetic states and the reciprocal role of epigenetic factors and mechanisms in shaping behavior» (E. JABLONKA 2017, p. 42).

Interspecific Cultural Convergences (ICC) or cases of Convergent Cultural Evolution (CCE)

In ethology, as in morphology, the cases in which, during phylogeny, different species have developed similar structural and/or functional traits that are not inherited from common ancestors are called *convergent evolutions*, *evolutionary convergences*, or simply *convergences* (A. HEYMER 1977, p. 74; D. MAINARDI 1992, pp. 221-222). A typical example is the wings in flying insects, bats and birds. I propose to extend the concept of *evolutionary convergence* to the phenomena inherent in *cultural evolution*, defining:

As *Cultural Convergences* or *Cultural Convergent Evolution* (CCE) all (and exclusively) the cases in which it is historically proven that a technique, an invention, a discovery or a use has been developed by different cultures and populations in reciprocal independence³;

As *Interspecific Cultural Convergences* (ICC) all (and only) the cases in which cultural convergences occur not only between populations of the same species, but also between *societies and traditions of different species*.

The concept of CCE so intended presents some differences from that of “convergent evolution” traditionally adopted in the evolutionary studies. «In the bio-ecological world the term convergence is used in reference to morphological, physiological, ecological and behavioral characteristics exhibited in an independent way by individuals belonging to different species» (G. PRGOZZI 1992, p. 221) united by the fact of colonizing «environments characterized by relatively similar ecological conditions» (*ibidem*). However, cases of CCE can also occur among species living in very *different* environments.

The case of singing is emblematic in this regard: from a taxonomic point of view, singing is a phenomenon widespread in very distant and different animal clades. It appears in species genetically, phylogenetically and ecologically as different from one another as cetaceans, monkeys as Hylobatidae, Tarsius, Indri and Callicebus, in all the human cultures spread over the planet, the mice, and thousands of species of singing birds (M. CELENTANO 2016).

The fact that singing is developed in species so distant from each other means that this convergence cannot be explained on the basis of “homologies”, understood as characteristics inherited by common ancestor. The ances-

³ This concept of CCE should not be confused with that of “Convergence Culture”, recently introduced by H. JENKINS (2006), which refers to the effects of interactions between the traditional and the new digital media.

tors common to birds and mammals did not sing, as well as those common to insects and birds did not have wings.

The diffusion of singing in so different clades and environments is the result of mutually independent, but in some aspects similar, evolutionary processes and selective pressures. It can be adequately understood only by identifying and comparing the *functions* that this kind of expression plays, and the *forms* it has assumed in all these animal societies, just as it is normally done in the comparison of the human singing traditions and performances. This approach can be extended to all the fields of the ICC.

The cataloguing of CCE cases and the research on the causes of these evolutionary convergences are still at an early stage. To deepen our knowledge of such phenomena we will need to integrate the methodologies of comparative study of customs and practices, communication systems and expressive forms, social regulation devices and material techniques, as developed by the Humanities, with the observation and intra- and inter-specific comparison methods of contemporary ethology. We also need to construct open databases to set a methodical comparison between products, forms and intra-specific differentiations of all the animal cultures.

I would like to conclude this section by proposing, in Figures 1 and 2, a first provisional mapping of the most common cases of ICC, or CCE, and of the factors that may have contributed to their genesis. It is of course only a first sketch that, with the contributions of other scholars, will be widened and further articulated.



Figure 1. most common cases of ICC or CCE

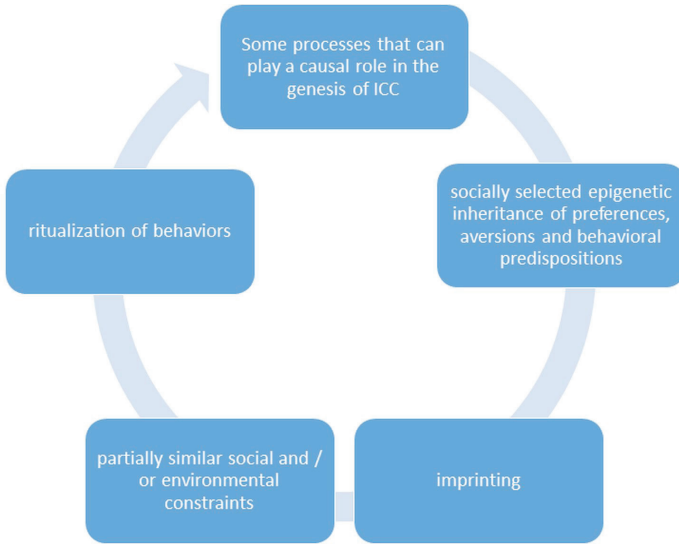


Figure 2. Factors that may contribute to ICC or CCE

CCE: the case of singing

In this final section I will illustrate the biological and social functions performed by singing in different animal species, and some converging aspects they present. I will borrow the method from a somewhat unorthodox source, the traveller, ethnologist and writer B. Chatwin. I will in fact start by comparing the functions of animal songs highlighted by ethologists with the ones that Chatwin ascribed to the «songs of the ancestors» of Australian Aborigines (B. CHATWIN 1987). In fact, although some biologically and socially important features of these songs, such as courtship, are not reflected in his descriptions⁴, Chatwin's analysis illuminates in a surprising way some characters and uses of songs which can be found also in other animal communities.

⁴ Chatwin privileges, within a rich set of local songs, only a few. He did not aim at an exhaustive cataloging of native songs, yet the existence of courtship serenades in aboriginal traditions is attested by other authors (D. LOCKWOOD 1962; G. ENGLARO 1998; T. GIOIA 2015).

Chatwin ascribes to the Australian songs of ancestors three different functions:

1. Totemic memories of the clan and documents for individual recognition. The songs tell of the familiar and mythical roots from which an individual comes, and thus allow the identification of each member of the group through his affiliation with his “totemic” ancestors (CHATWIN 1987, pp. 4, 12-13)⁵.
2. Melodic and vocal maps of a territory, travel guides for migration and occasional or cyclical displacements, providing information about territorial features and boundaries that cannot be crossed without risk (CHATWIN 1987, pp. 13, 14, 69, 134-135).
3. “Pass”: sound attestations that allow to recognize a person as «the owner of that path»; they feature as documents transmitted by cultural inheritance, in order to identify who has the right of transit in a given territory and the right to give or deny to others the transit permission (CHATWIN 1987, pp. 14, 70).

It is possible to find equivalents of these three functions in the songs of other species?

1. Songs as individual recognition “documents”, informing on the geographical and family roots from which an individual comes, allowing mutual recognition among members of a group or colony.

At the end of the 1950s, J.S. WEEDEN and J.B. FALLS (1959) interpreted some duets between male birds in neighbouring territories as exchanges aimed at making acquaintance, and P. MARLER (1960) suggested that melodies of birds could provide information for individual identification. A decade later, two studies conducted in different areas (W.L. THOMPSON and J. O’HARA RICE 1970; S.T. EMLÉN 1971), documented this functioning in the song of the male of *Passerina Cyanea*. In fact, in case of a sound intrusion of new neighbours, males modified their singing by adding to the specific sequence of their species some individually differentiated final parts. The songs of all the members of the group were so marked by a different ending. Further studies have shown that there are intermediate layers between the songs of a species and its individual variations. According to F. FEEKES (1977), the *Cac-*

⁵ Similar cases of anthroponymic functions of songs are reported by other scholars concerning Australian populations such as Warramunga (R. BOSI 1994, p. 116) and Aranda (BOSI 1994, pp. 95-96).

icuscela emits colony-specific songs that have the function of a colony password and similar functions are found (E.D. BAILEY and J.A. BAKER 1982) in Virginia quail (*Colinus virginianus*). MARLER and TAMURA (1962, 1964), W. THORPHE (1961, 1972), W. WICKLER (1988) and many others contributed to the discovery of local and regional dialects. The existence of this «micro-geographic (or local dialects) and macro-geographic differences (regional dialects)» (D. MARTINELLI 2011, p. 238) was also found in the communicative systems of other animals and it is now regarded as a phenomenon widespread in mammals and birds. For example, studying the songs of the *Batis molitor* in nine different regions of East Africa, ethologists and zoo-musicologists found two kinds of dialectal variations: the presence of a sequence of three descending sounds or of longer sequential sequences, and differences in the order of the three base sounds, in which the middle height may be in the second or third position (WICKLER 1988, pp. 76-77).

In many cases, the development of local song traditions is a prerequisite for the invention of personal songs and for their use for identifying individuals and reinforcing parental or couple ties. We find an interesting example thereof in the African *Lanarius aethiopicus major*: Here, the members of a pair learn to perform duets with one another and, while adopting certain phrases and rhythms which are characteristic of the locality, work out between themselves the duets which are sufficiently individualistic to enable the bird to distinguish and keep contact with its mate by singing duets with it – or, to be more exact, singing antiphonally with it – in the dense vegetation in which they usually live (THORPHE 1972, pp. 160–61).

These performances of Ethiopian shrikes revealed, in later studies, more complex interactions which include a dozen of different pair duets, and many duets between competing males and/or neighbours, both divisible, from a formal point of view, into two subgroups: unisons and antiphonal duets. The latter, in the case of male territorial duets, are, in turn, divided into exchanges of identical notes and varied exchanges. There are also cases in which an individual sings by issuing two different voices at the same time and cases where individuals who lost their companion, using this technique, run alone the sequence they used to do together (T. HARRIS 2000). Finally, there is evidence of the simultaneous running of two different types of duet, one of courting or strengthening the couple's tie, the other as a sort of duet/duel with a rival (WICKLER 1988, p. 33). Instances of songs that mix different dialects are also documented (WICKLER 1988, p. 43).

2. *Songs like melodic and sung maps of the territory, guides for migrations and occasional or cyclical displacements, which transmit information about resources and dangers and on “borders” that cannot be trespassed without risk.*

The cases of the Lira bird (*Menurana ovaehollandiae*), who includes in its own repertory environmental and animal sounds collected from the surrounding territory, thus offering an acoustic mapping of it (A.H. DALZIELL and R.D. MAGRATH 2012), and that of the Australian magpie which exchanges information on food sources and migratory routes with conspecifics through songs (L.J. ROGERS and G. KAPLAN 1998, p. 86) are well known. Well-documented is also the use of vocalizations with information and referential functions in birds such as the northern royal gull (*Larus argentatus*), or the *Indicator indicator*, that uses the song to locate food resources.

With regard to whales, R. Payne was the first to hypothesize that «the humpbacks use their songs a bit like Australian aborigines, whose songs contain descriptions of the road and the points where you are and tell about the characteristics of the scenery you are in» (R. PAYNE 1995, p. 165). In turn, Martinelli observed that «migratory species of cetaceans use songs as geographic maps, in a way that cannot help but think of Chatwin’s songs» (MARTINELLI 2011, p. 163). Stimpert, Peavey, Friedlaender, and Nowacek (A.K. STYMPERT *et al.* 2012), conducting a study on ten male individuals of megaptera provided with multisensors that allow deep recordings have reinforced this hypothesis. Their research led to the conclusion that the choir repertory of *Megapteran ovaengliae*’s male does not include only courtship songs and does not only appear in the breeding season. In the vicinity of the migratory season, the individuals they observed were leaving for food, and using songs that were significantly different from those of courtship, to communicate remotely.

3. *Songs as “pass” that allow to recognize an individual as “path owner”: a person who has “right” of transit on that path, can enjoy the resources that it offers, and can grant or deny to others the transit to such resources.*

The words “right” and “owner” that Chatwin chooses to describe this use of songs, and the reference to bargaining practices that take place through songs exchanges, would seem at first glance to preclude a comparison with non human cultures. However, we are here facing notions of “right” and “property” very different from those used for humans. In fact, they do not sanction the fixed property of a territory, and do not permanently interrupt the other’s right of

access or of usufruct of its products. They only attest that someone has the privilege of crossing it, practicing hunting, gathering or exchanging without being attacked, and receiving help when needed during this crossing. Sticking to this definition, this type of use of songs presents remarkable analogies with the “territorial” delimitation function that ethologists have found in the song of adult males of many of the singing birds. But, in order to determine whether we can detect analogies or convergences with this use of songs in other animal species, it is necessary to first ascertain whether other animals can, through variations in the intensity intense gradients or formal differentiations of their singing, not only signal the presence of a male x in a territory y , but also send a generic messages of transit prohibition or permit. We should therefore ascertain:

Whether resident male responses depend or not on the ability/inability of the intruder to be individually recognized through its song;

Whether or not we can find any differences in the songs that the resident male performs in presence of intruders depending on their being unknown individuals, new entries, or long-term frequentations;

Whether actual adjustments and bargaining occur between these animals through singing or not.

Recent observations indicate that generally both the bird that enters the territory of another and the one already located in it may adopt various communication strategies that reduce or intensify aggressive reactions. These choices are manifested by variations in the form and intensity of the song, or through options that consist in overlapping or not on the other's emissions. Recently, a study titled *The Social Interaction of Song in Song Sparrows* introduced the concept of «acoustic ownership marker» (J.M. BURT and M.D. BEECHER 2008). The study shows that the songs of resident males can perform the function of deterrent to many varying degrees of intensity, some of which seem to include the possibility of resolving controversies caused by small boundaries trespasses between neighbours without any physical clashes, only through exchange of songs. According to the authors, these interactions appear like a continuous strategic game of escalation and/or de-escalation of aggressive elements driven by different parameters such as overlapping or not of songs, and the repetition or variation of the verse performed. Different dynamics characterize the exchange of songs between «first-year neighbours» and «neighbours of long time» (*ibidem*). The authors suggest that the use of a kind of “conventional matching”,

which gives rise to an agreement on repertoires that can be paired or alternated (BURT and BEECHER 2008, p. 89), can be attested between long time neighbours.

Territorial defence and recognition of the con-specifics that occurs through the exchange of songs are closely linked to the last group of biosocial functions of singing we have mentioned: those related to courtship, mating, and strengthening of the couple's bond. The study on this kind of song functions has been conducted on two main groups: singing birds (P. MARLER and H. SLABBEKOORN 2004, pp. 39-78; M. NAGUIB and K. RIEBEL 2014) and mysticeti (PAYNE 1995; R. SUZUKI, J. BUCK, P. TYACK 2006). More recently, more model species have been added. For example, individual differences and local dialects have been identified in the male-female couple duets of the crested gibbon (T. GEISSMANN 2006, V. THINH *et al.* 2011). The courtship vocalization of the mice, brought to frequencies that are audible and distinguishable by human ears, revealed melodic qualities comparable, for beauty and complexity, to those of the birds (CHABOUT *et al.* 2015).

Among the mysticeti, the species whose song has been more studied is *Megapteranovaeangliae*. R. PAYNE and S. McVAY (1971) were the first to decode structures and functions of its songs. Thanks to their efforts, it has been ascertained that the males of humpback whale produce melodies that are differentiated by geographical area and are renewed year after year or, more drastically, in multi-year cycles. They have complex structures, composed by different parts or "themes", consisting of ascending and descending sounds, lasting between 20 and 30 minutes, and can be repeated several times. Recently, R. SUZUKI, J. BUCK and P. TYACK (2006), examining the songs of 16 male humpbacks and thanks to specially designed software, have analysed their basic structures. The algorithm has mathematically confirmed the hypothesis of Payne and McVay that humpback whales have their own syntax and their song, like human speech, is based on a hierarchical language, consisting of lengthy sound blocks with increasing complexity, inserted into each other as in a system of Chinese boxes. This syntactic system, in many respects analogous to human verbal language with its subdivisions in phonemes, phrases, words, propositions and periods, is actually found in an ever-increasing number of social mammals and birds. The same conclusions have led to the analysis of vocal languages of cetaceans such as dolphins and "killer whales", of mice, and especially of sparrows and other birds, such as the *Parus minor* (T.N. SUZUKI, D. WHATCROFT, M. GRIESSER 2016).

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