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The Marine Mammal Captivity Issue: Time For a Paradigm Shift

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Dolphin and whale (cetacean) captivity is one of the most contentious cultural issues of modern times. Neither the “anti-“ or “pro-“ captivity groups can be expected to concede to the other but neither is it entirely impossible to conceive of ways to bring the two together over shared interests and objectives. So, the issue is whether there is a way to move forward into the future by combining forces for the benefit of everyone involved. In order to consider that possibility, three questions must be addressed. First, who are cetaceans? Second, do cetaceans flourish (or, thrive) in captivity? Third, what should we do about what we know about the answers to the first two questions?

Scientific research done both in captivity and in the field has revealed much about who dolphins and whales are. There is no doubt that captive research has contributed substantially to our understanding of them. But that same empirical research leads to the inescapable conclusion that cetacean nature is fundamentally incompatible with captivity. Cetaceans cannot flourish in captivity. To flourish is to thrive and not simply exist or even live or reproduce. As Nussbaum

(2011) articulates: “Each creature has a characteristic set of capabilities, or capacities for functioning, distinctive of that species, and that those rudimentary capacities need support from the material and social environment if the animal is to flourish in its characteristic way.” (p.237). White (in press) states that flourishing is “Full, healthy growth and development of the traits, skills and dispositions that allow a being to have a satisfying and successful life as a member of that species.” These definitions point clearly to the basis of flourishing – *the characteristic nature of each species*. And the traits and characteristics of each species derive from evolution and adaptation. Therefore, the definition of flourishing anchors the issue of welfare in captivity squarely in species-specific evolutionary and adaptive history – and does not leave the issue up to anthropocentric opinion. The evidence, described below, shows unequivocally that flourishing is impossible for cetaceans in captivity. Cetacean nature and captivity are fundamentally incompatible.

Who are Cetaceans?

There are around 90 living species of dolphins and whales representing a range of behaviors and capacities, lifestyles, and morphologies. But there are some basic characteristics shared by all cetacean species, and, in particular, by those most commonly used in the captivity industry: bottlenose dolphins (*Tursiops truncatus*), beluga whales (*Delphinapterus leucas*), and orcas (*Orcinus orca*). These shared aspects of their nature include being wide-ranging, highly intelligent, socially complex, autonomous individuals possessing of large elaborated brains.

Moving and traveling

Cetaceans are typically wide-ranging and adapted to traveling long distances and diving to deep depths. Importantly, they live in all three spatial dimensions of their environment. Atlantic bottlenose dolphins (*Tursiops truncatus*) off southeast Florida often dive to the ocean bottom where they reach depths of 7 – 13 m and engage in “crater feeding”, i.e. burrowing into the sediment to catch fish hiding there (Stewart, 2009). Many bottlenose dolphin groups utilize the full water column when foraging, feeding at depths of 20-30 m and often dive from the surface to the sea bed and back again (Hastie et al., 2006). Many of the foraging habits of dolphin groups, such as sponge-carrying, in Shark Bay, Australia have become enriching cultural behaviors for them (Krutzen et al., 2005) and provide a way to exercise behavioral and social choice. Belugas in open water can cover thousands of kilometers over a few months and can swim at a rate of up to 6 km/hour and to depths of 600-1000 m (Lydersen et al., 2001; Richard et al., 2001). Orcas often swim in a consistent direction at a rapid pace when they are not foraging or hunting, and often engage in synchronized dives (Ford, 2009), suggesting an important social purpose for traveling independent of procuring food. Resident orcas have been measured traveling at a rate of over 20 km/hr (Ford, 1989) and off New Zealand dive to the ocean bottom (~12 m) to feed on stingrays (Stewart, 2009). There is, obviously, a wide range of ways different species, populations and groups of cetaceans utilize their three-dimensional environment. However, it is evident from all of the literature on wild cetacean foraging, traveling, socializing and cultural behaviors that they engage their environment in a way not physically possible in captivity.

Pro-captivity advocates often claim that the cetaceans they hold captive benefit from the lack of necessity to travel over long distances for food and to escape predators. But this claim demonstrates a profoundly anthropocentric view of cetacean evolution, adaptation, and nature. For cetaceans, moving is not only an important aspect of physical welfare but it is intimately tied to their psychological welfare as well. They need to be challenged by their environment while hunting, socializing, escaping predators, exploring, and just expending energy in the act of moving. Their entire adaptive history ensures, from a proximate mental point of view, that they are motivated to move around to problem-solve in their environment. They are deprived of this essential rewarding component of a natural life in captivity. Moreover, in the natural environment conflicts between individuals are often resolved or prevented from escalating by dispersal, something not possible when confined in a tank.

Large Complex Brains

As a group, cetaceans possess the neurobiological underpinnings of complex intelligence, which they demonstrate in their prodigious cognitive capacities both individually and socially. There are three aspects of cetacean, and particularly bottlenose dolphin, beluga and orca, brains which form the basis for their keen intelligence. First, their brains are large relative to their body size. Second, they possess a highly expanded neocortex, the evolutionarily newest part of the brain. Third, the cellular architecture of their neocortex is well differentiated, which forms the foundation for complex information processing.

Absolute brain size is related to some aspects of intelligence, but because there is a positive correlation between brain and body size, it is relative brain size which is thought to account for more of the variance in intelligence across species. Relative brain size is typically expressed as an Encephalization Quotient or EQ (Jerison, 1973) which is a value that represents how large or small the average brain of a given species is compared with other species of the same average body weight. Species with EQs of one have average brain sizes, greater than one, larger brains than expected, and less than one, smaller brains than expected. The cetacean suborder Odontoceti, and, in particular, the superfamily Delphinoidea (which includes all porpoises, oceanic dolphins, and toothed whales) is the most highly encephalized nonhuman taxonomic group to have ever evolved, with EQs ranging from 1.8 to 5.0 – significantly higher, as a group, than any other species except modern humans (who possess an EQ of 7.0). EQ values for bottlenose dolphins, beluga whales, and orcas are 4.2, 2.6, and 2.3, respectively. That is, they possess brains 4.2, 2.6, and 2.3 times larger than expected for their body size (Marino, 1998; Marino, 2009). Therefore, the brains of dolphins and toothed whales are exceptional in their relative size and, it turns out, in the level of expansion of the neocortex as well.

The neocortex is a part of the forebrain which serves as the substrate for some of the most complex cognitive capacities found in mammals, such as self-awareness, communication skills, sensory-perceptual integration, flexibility in problem solving, and innovation. Neocortex expansion is indexed by surface area; increasing surface area through convolutions is one way to increase total neocortical volume. The modern cetacean neocortex is among the most highly convoluted of all mammals, revealing that there was a substantial increase in neocortical surface area and volume over their evolutionary history. One measure of convolution is the ‘gyrification index’, which compares neocortical surface area to total brain weight. Gyrification indices for

odontocetes range from 2.4 – 2.7, substantially exceeding the value of 1.75 for modern humans (Ridgway & Brownson, 1984). The gyrification index is positively correlated with brain mass across the mammals and cetacean (as well as human) brains appear to be consistent with this pattern.

For several decades, the common view was that cetacean brains, though large, were fairly simple in structure (e.g., Kesarev, 1971) and not possessing of the level of differentiation in architecture and range of cell types typically correlated with complex cognitive abilities. But recent studies using more sophisticated histological and imaging techniques have refuted those early interpretations and, instead, reveal a very different picture, pointing to extensive neocortical complexity, laminar differentiation, and cellular variation (Hof et al., 2005; Hof & Van der Gucht, 2007; Oelschlager & Oelschlager, 2009). (More recent attempts to resurrect notions of the “primitive” cetacean brain [Manger, 2006] have failed [Marino et al., 2008]. The accepted modern scientific view is that cetacean brains, though varying in size and complexity across species, are characterized by a wide variety of neocortical features, such as columns, modules, layers, which underlie complexity in information processing, i.e. intelligence.

In addition to the outer neocortex, there are other cortical regions that are especially elaborated in cetacean brains. The cingulate and insular cortices (both situated deeper within the forebrain) are extremely well developed (Hof & Van Der Gucht, 2007; Jacobs et al., 1979) and the expansion of these areas in cetaceans is consistent with high-level cognitive functions such as attention, judgment and social awareness (Allman et al, 2005), Moreover, recent studies show that the anterior cingulate and insular cortices in larger cetaceans contains a type of projection neuron, known as a spindle cell or Von Economo neuron (Hof & Van Der Gucht, 2007)

considered to be involved in facilitating neural networks subserving aspects of social cognition (Allman et al, 2005) and thought to play a role in adaptive intelligent behaviour (Allman et al., 2005). Finally, Hof et al., (2005) concluded that the present evidence for complexity and large size in cetacean brains is entirely consistent with the evidence for behavioral and social complexity in cetaceans.

Intelligence and Autonomy

Most of the research on cognitive capacities in individuals has been done with bottlenose dolphins. But, based on brain size and complexity, as well as behavior in the natural setting and the (albeit more limited) findings of captive research studies of belugas and orcas, it seems clear that many of the cognitive capacities revealed in bottlenose dolphins are shared with these two species and other cetaceans.

As the most studied cetacean species, bottlenose dolphins have demonstrated a wide range of capacities. These include but are not limited to mirror self-recognition (Reiss & Marino, 2001), the comprehension of gestures as symbolic referents to their own body parts (Herman et al., 2001) and metacognition, i.e. the ability to report on one's certainty about the proper response to a task (Smith et al., 1995). Bottlenose dolphins exhibit sophisticated vocal imitation and vocal learning (Reiss & McCowan, 1993; Hooper et al., 2006) as well as imitation of arbitrary behaviors (Richards et al., 1984; Reiss & McCowan, 1993; Herman, 2002) and even innovated behaviors created by a conspecific (Herman, 2006 review.) They also understand human pointing (Pack & Herman, 2007), are sensitive to human visual gaze and attentional state

(Pack & Herman, 2007; Xitco et al., 2004) and show referential pointing themselves using their body position and rostrum (Xitco et al., 2001). Bottlenose dolphins are also well known for their prodigious comprehension of an artificial symbolic language with syntax (Herman et al., 1986, review). Finally, bottlenose dolphins plan ahead (McCowan et al., 2001) and use tools (Krutzen et al., 2005).

Beluga whales show exceptional communicative and mental representational abilities. Among other capacities, they are able to comprehend and produce symbolic lexigrams and sounds, demonstrating an understanding of the bidirectional relationship between symbols and the objects they represent (Murayama et al, 2012). And, a captive beluga whale named Noc demonstrated spontaneous imitation of human speech, i.e. voicing and creation of comprehensible words (Ridgway et al. (2012), adding to the body of evidence for sound mimicry in belugas (Fish & Mowbray, 1962; Schevill & Lawrence, 1949). Belugas are also capable of imitating novel natural and arbitrary computer-generated sounds (Murayama et al., in press).

Orcas, in captivity, have also demonstrated the sophisticated ability to imitate the novel actions of conspecifics (Abramson et al., 2013) and, like many other cetaceans, orcas are vocal learners (Foote et al., 2006). In studies of their responses to mirrors, orcas show contingency checking behavior - a correlate of self-directed responses exhibited by most individuals who demonstrate mirror self-recognition and one orca in this study showed behavior highly suggestive of self-recognition (Delfour & Marten, 2001).

The extraordinary cognitive abilities evinced by bottlenose dolphins, belugas and orcas in captivity are reflections of their complex behavior in the natural setting, and, in particular, their social complexity (see below). Moreover, the capacity for imitation, characteristic of many

cetacean species, relies upon a sense of self which underlies the key feature of autonomy.

Autonomy (sometimes called ‘practical autonomy’) is characteristic of beings who have desires and goals, engage in intentional behaviors to achieve those goals, and possess a sense of self that allows them to evaluate how their life is going (Wise, 2005). Autonomous individuals self-determine and have a vested interest in how their life turns out. Cetaceans, along with other highly intelligent animals like great apes, elephants, and others, are clearly autonomous individuals who have a well-developed sense of self and are, thus, keenly aware of how their life is unfolding in captivity. This awareness makes them especially vulnerable to the stresses of a captive life. Far from what might be argued by the captivity industry, intelligence and complex self-awareness are risk factors for doing poorly in captivity.

Social Complexity

Possibly the most important component of who dolphins and whales are is their level of sociality. Although not all cetaceans are highly social, those species kept in captivity, ironically, tend to be among the most socially complex. All three, bottlenose dolphins, beluga whales, and orcas, develop slowly with very long juvenile periods in which they learn the social and material skills needed in adulthood. Alloparental care in the wild is common in all three species (Leung et al., 2010, for review). Moreover, cultural traditions have been identified in many species of cetaceans, including the bottlenose dolphin and the killer whale (Rendell & Whitehead, 2001; Whitehead, 2011).

Bottlenose dolphins live in fission-fusion societies with strong mother-child bonds and learning of foraging strategies and social rules from mothers and other individuals in the group (Mann, et al., 2007; Sargeant & Mann, 2009). Social network analysis demonstrates that groups of dolphins form a social infrastructure with different social roles which vary in importance to the integrity of the group (Lusseau, 2007). Arguably, the most complex nonhuman social relationships described to date are among bottlenose dolphins in Shark Bay, Western Australia. Males in this population form two and possibly three levels of nested alliances within a social network numbering in the hundreds. Males cooperate in groups of 2-3 to form consortships and also hold membership in larger groups of 4-14 individuals that cooperate in competition with other groups over estrus females (Connor et al, 1992, 1996). Similar complex relationships are present in another bottlenose dolphin population in which males form groups and higher-order relationships, interacting in several social dimensions (Lusseau, 2007). Such ‘alliances of alliances’ are rare outside of our own species, even among great apes (Connor et al., 1999). There is also evidence that individual role-taking has emerged in dolphin societies to facilitate cooperative relationships (Gazda et al., 2005) and decision-making processes (Lusseau, 2007; Lusseau & Conradt, 2009).

Beluga whales live in small groups that join, from time to time, with larger aggregations of hundreds or thousands of individuals. Adult females are strongly bonded with their newborns as well as an older child. These triads stay together and join with others to form large nursery groups. Generally, group composition is fluid and underwritten by complex vocalizations, facial expressions, and a variety of other characteristics (O’Corry-Crowe, 2009).

Orcas are a cosmopolitan species possessing some of the most varied and complex social traditions known. Resident orcas in the North American Pacific Northwest live in matrilineal social units, which are themselves parts of pods, which are members of clans, and one to three clans form a community (Bigg et al., 1990). These nested levels of social units are distinguished by dialects and other behavioral traditions formed by social learning. For instance, dialect similarity is related to group closeness; dialect similarity decreases as one compares matrilineal groups within pods, pods within clans, clans within communities, and communities (Deecke et al., 2000; Ford et al., 2000; Yurk, 2003).

Orca groups can be extremely complex in terms of the roles families and individuals play in the group. For instance, many orca groups are matrilineal and rely on family relationships for survival. Moreover, within populations, some matrilineal play a more central role in the social network than others and are, therefore, critical for maintaining the group's integrity. Thus, individual orcas in a group are not generic or interchangeable and the effects of the removal of individual whales depends upon their role in the social network (Williams & Lusseau, 2006).

In summary, even this brief review of who cetaceans are provides an answer to the question: "What do cetaceans need in order to flourish?" Cetaceans need to move. They need to travel and to experience variety in their physical environment. They also need personal space so that they can spread out and avoid each other when conflict arises. As highly intelligent beings they need to be challenged by their physical and social environment. As autonomous beings, cetaceans need to exercise control over their lives. They need to be able to raise their children and navigate a complex social environment. Cetaceans need social opportunities to bond, to relate, to interact, to reproduce, and to learn from each other. They also need a social

infrastructure, that is, an intact social network, family ties, and even social competition. And, far from the sheltered life of captivity, they need to be challenged and expend effort solving problems and escaping dangers.

Why are cetaceans these sorts of being?

A species' evolutionary and adaptive history shapes its modern nature, that is, those characteristics that need to be expressed in order for members of that species to flourish. Evolutionary adaptation to a set of specific selective pressures, modified over tens of millions of years, have made cetaceans who they are today. Most cetacean species, e.g., the bottlenose dolphin, have been successfully adapted to their natural environment for a relatively long period of time, as fossil evidence indicates they have not changed in at least 10-15 million years (Marino et al., 2004; Montgomery et al., 2013). Cetacean evolution from terrestrial animals to transitional forms to modern forms represents some of the most significant adaptive changes observed in mammalian evolution. For instance, about 35 million years ago, cetacean bodies became much smaller than their predecessors and their brains became larger (Marino et al., 2004; Montgomery et al., 2013). These changes are necessarily correlated with major shifts in social ecology and how these early cetaceans used their environment to eat, travel and defend against dangers. Around this same time there were changes in the inner ear bones of odontocetes that eventually led to the sophisticated perceptual trait known as echolocation, which eventually became an integral part of their psychology (Geisler et al., 2011). With these changes, the cetacean brain was modified considerably and represents, arguably, the most dramatic example of neurological evolutionary change. Terrestrial ancestors of cetaceans, known as archaeocetes, possessed brains of average size (Marino et al., 2004; Montgomery et al., 2013). And, over time,

cetaceans became the second most highly encephalized taxon on the planet (Marino, 1998; Marino et al., 2004; Montgomery et al., 2013) with above-average Encephalization Quotients (a measure of relative brain size) ranging up to 5.0, that is, brains five times the expected size (compared with a value of 7.0 for modern humans) and a complex, highly convoluted neocortex with characteristics that underlie complex cognition (Hof et al., 2005; Marino, 2011).

Can cetaceans flourish in captivity?

This question is answerable at one level, in a self-evidentiary way, by simply determining whether captivity offers cetaceans the kind of environment that allows them to express their adaptive nature as long-ranging, fast-moving, socially complex, autonomous and cultural beings. The clear response is no. However, this question is also an empirical question that should also be based upon objective measures of welfare in captivity compared with the natural environment.

Physical and Psychological Damage

Captive dolphins and whales display physical and behavioral abnormalities stemming from chronic stress (Stewart & Marino, 2009). The United States Marine Mammal Inventory Report published by the National Marine Fisheries Service lists numerous stress-related disorders, such as ulcerative gastritis, perforating ulcer, cardiogenic shock and psychogenic shock as ‘cause of death’ along with immunodeficiency-based infections (US MMIR, 2010).

One of the common manifestations of stress, besides physical illness, is behavioral abnormalities. These include behavioral stereotypies, i.e., repetitive purposeless behaviors (Defran and Pryor, 1980; Fowler, 1978; Greenwood, 1977; Sweeney, 1988), self-mutilation and

self-inflicted trauma (Sweeney, 1988), as well as excessive aggressiveness towards other cetaceans and humans (Marino and Frohoff, 2011 for a review of this copious literature). Confinement impacts not only physical freedom but social relationships. As an example, captive orcas have a long history of injuring and killing each other because there is no way for them to disperse during a conflict. Likewise, serious aggression is rare in the natural setting. Furthermore, there is no evidence that an orca has ever killed a human in the natural setting despite multiple instances of orcas killing humans in captivity (Marino & Frohoff, 2011). As further evidence that captive cetaceans are psychologically stressed by captivity, they are often given anti-anxiety psycho-active drugs. For example, two male orcas at SeaWorld Orlando were acting aggressively toward a very young calf (and even trying to mate with her). They, and the calf's mother, were all given diazepam, a drug initially marketed as Valium and used to treat panic attacks, general anxiety, and seizures (Affidavit by Michael Walsh, SeaWorld trial). There is every indication that drugs like this are used regularly to "mellow out" anxious and disturbed captive whales and dolphins.

In addition to behavioral effects, chronic stress leads to immunosuppression and susceptibility to physical disease in marine mammals that impacts mortality rates (St. Aubin & Geraci 1988; Noda et al. 2007; Spoon and Romano 2011). Captivity for orcas is catastrophic. Most captive orcas do not survive past the age of 20 years (Williams 2001). The natural average lifespan for male and female orcas is 29.2 and 50.2 years, respectively, with a maximum longevity of 60 and 90 years, respectively (Ford 2009; Ford, Ellis and Balcomb 1994; Olesiuk, Bigg and Ellis 1990; Wells and Scott 1990; Woodley, Hannah and Levine 1997). DeMaster and Drevenak (1988) estimated the annual mortality rate for captive orcas at 7.0%, and two additional studies by Small and DeMaster (1995) and Woodley, Hannah and Levine (1994) both

estimated captive annual mortality rates at 6.2% (excluding calves), considerably higher than the 2.3% annual mortality rate figure for wild populations (DeMaster and Drevanek 1988).

A recent review of orca health in captivity substantiates the many health risks by reporting two cases of deaths from mosquito-borne illnesses (St. Louis encephalitis and West Nile) in captive orcas. Unlike their wild counterparts, who are rarely stationary and spend a significant amount of time under water, captive orcas are often confined in pools too shallow for their body length and typically spend hours every day floating motionless on the surface, leaving them vulnerable to biting mosquitos and, therefore, a variety of blood-borne illnesses (Jett & Ventre, 2012). Moreover, most captive orcas are not provided shade from ultra-violet radiation and are often subject to its immunosuppressing effects (Jett & Ventre, 2012). And, to add insult to injury, captive orcas typically suffer from dental problems associated with raking their teeth on gates and hard parts of their tank. Thus, their teeth are often drilled and left open to the air, exposing them to all kinds of bacteria (Jett & Ventre, 2011). To combat infections they are given chronic doses of antibiotics which, in turn, reduce their immunity to diseases and ultraviolet effects. Jett and Ventre (2012) suggest that this destructive cycle of poor welfare has long term consequences that account for short lifespans and high mortality for captive orcas.

Beluga whales fare little better than orcas. Woodley, Hannah and Levine (1997) report that beluga whales die prematurely in captivity. Although definitive lifespan data have not yet been established for wild belugas, there is growing evidence that captive beluga lifespans are significantly shorter than those in the wild. Wild beluga whales may live as long as 50-60 years (Lockyer et al., 2007; Stewart et al., 2006) but captive beluga whales routinely die before the age of 30. Likewise, mortality rates for belugas in captivity are higher than in the wild. (DeMaster and Drevanek, 1988; Small and DeMaster, 1995; Woodley et al., 1997).

Bottlenose dolphins do somewhat better in captivity than orcas and beluga whales but still suffer from stress-related diseases brought about by confinement and loss of autonomy. Only recently have survivorship statistics in captivity (6.4%) reached a level not statistically significantly different from that thought to exist in the wild (3.9%) (DeMaster & Drevenak 1988; Duffield & Wells 1991; Olesiuk, Bigg & Ellis 1990; Small & DeMaster 1995). The best estimate of average and maximum lifespan for captive and wild bottlenose dolphins is about 25 and 45 years, respectively (Small and DeMaster, 1995). But there are biases in these data that make it doubtful that bottlenose dolphins live as long in captivity as in the wild. Survivorship statistics from captive facilities often exclude periods of sharply increased mortality – those associated with capture and transfer. Bottlenose dolphins face a six-fold increase in risk of mortality immediately after capture from the wild and immediately after every transfer between facilities (Small & DeMaster 1995). According to Small and DeMaster (1995) the first 60 days of captivity should not be taken into account when calculating survival rates for captured individuals, since the mortality during this time is so high. Further, remote locations and many non-western or developing countries were not included in these studies; hence it is likely that the worst of these facilities were omitted from these data. These biases can easily lead to artificially inflated survivorship data.

Cetacean Research Superstars: Where are they now?

Throughout the history of research with captive cetaceans, some individuals have attained a kind of “superstar” status as they have participated in cutting-edge cognitive research and are responsible for adding substantially to our knowledge by demonstrating some of the most

sophisticated capacities we know of in cetaceans. Much is owed to them in terms of our understanding of who cetaceans are. But what has become of these individuals who shared the scientific spotlight at one time or another? A very cursory review of “where they are now?” reveals the tragic reality of cetacean captivity.

In 2001 two young male bottlenose dolphins, Presley and Tab, residing at the New York Aquarium in Brooklyn, shot to international fame by being the first cetaceans to demonstrate the ability to recognize themselves in a mirror (Reiss & Marino, 2001). This capacity, found in just a handful of other highly intelligent animals, indicates a complex level of self-awareness which overlaps with our own. These findings not only changed how we viewed dolphins but also engendered enthusiastic media excitement. However, after all the attention faded another, more common, story of cetacean captivity unfolded. Presley and Tab were captive-born and 13 and 17 years old, respectively, at the time of the study. Not long after the study each of them were transferred to other captive facilities where they met untimely deaths from diseases related to stress and immune-system dysfunction. Presley succumbed to fungal encephalitis at age 19, Tab to gastroenteritis at 21 years of age (MMIR, 2010).

Presley and Tab were not alone in their fate. All of the bottlenose dolphins who were subjects in the famed experiments by Louis Herman at the Kewalo Basin lab in Hawaii, that is, Phoenix, Akeakamai, Hiapo, and Elele died prematurely, two from cancer, one from enteritis and toxemia, and one from unknown causes. They were all under 27 years of age. Natua, another bottlenose dolphin at the Dolphin Research Center in Florida, who provided definitive evidence that dolphins reflect upon what is on their minds, died at age 18 of hepatitis and cirrhosis (MMIR, 2010).

NOC, the beluga whale who mimicked human speech, was captured from the wild and endured 22 years in captivity at U.S. Navy facilities in California before dying of aspergillus encephalitis at the young age of 24 (Ceta-Base http://www.ceta-base.com/lugalogue/ddl/ddl_nmmp.html). These specific examples are representative of a much larger death toll for captive dolphins and belugas and, especially, orcas, in general; 159 orcas have died in captivity thus far (The Orca Project <http://theorcaproject.wordpress.com/killer-whale-orca-database/killer-whale-orca-dead-date/>).

The abundance of scientific evidence reviewed above shows, unequivocally, that cetaceans cannot thrive in captivity. Some individuals may cope better than others, but there is a fundamental incompatibility between what cetaceans need to flourish and what captivity offers. This is not a matter of opinion or even intention. With all good intentions, it is still impossible to provide what is needed for cetaceans to flourish in captivity.

Under what circumstances would cetaceans do better in an artificial setting than in one to which he or she is exquisitely adapted?

The captivity industry claims that it protects cetaceans from the rigors of the natural environment. If this were the case, why the higher mortality rates, lower survival rates, prevalence of stress-related and infectious disease, and abnormal behavior in captivity? As said above, cetaceans evolved to cope with the rigors of the wild and, therefore, flourish with the challenges of living a natural life. They have no such adaptive history with captivity. The claim that captivity is better for cetaceans than the rigors of the wild has no support.

As Rose, Parsons and Farinoto (2009) point out:

“To use the rigors of the wild as a justification for the conditions of captivity is misleading and disingenuous. This argument implies that the natural state is an evil to be avoided and that the captive environment is the preferred state. The suggestion is that animals must be protected from the very surroundings that sustain them. This misrepresentation of the natural environment as threatening to the health of these animals will certainly not encourage people to protect, respect, or understand the animals’ natural habitat. (p. 19)

An interesting and often neglected issue of captivity has to do with the procedures used to train cetaceans to produce husbandry-related behaviors and performances – essentially all methods used to control their behavior. Here too there is a fundamental misunderstanding of who cetaceans are. As pointed out by developmental psychologist Simon Baron-Cohen, generic behavioristic techniques for training orcas do not take into account the nature of orcas or their evolutionary adaptive history. This kind of “behavior modification” approach used to shape the behavior of orcas and other cetaceans in captivity ignores their “underlying evolved neurocognitive make-up”. He further goes on to argue that the use of what he calls...” radical behaviourism towards such animals in captivity is doubly unethical, because of its lack of respect for the animal's real nature. The focus on shaping surface behavior ignores who or what the animal really is.” (<http://edge.org/response-detail/25473>). There can be no better example of this disconnect between orca nature and the artificial training environment of captivity than Tilikum, the male orca at SeaWorld Orlando. Tilikum has killed three people and, in the last instance, he actually acted out in the midst of a so-called learned routine. This was an ill-fated demonstration that the link between captive orcas and the kinds of techniques used to attempt to control them are tenuous at best. As a wild autonomous free-ranging animal who is predisposed to the natural

environment Tilikum's tragic life results from false assumptions about orcas made by the captivity industry.

What should we do about what we know about the answers to the first two questions?

It is clear that, because of their evolutionary and adaptive history, cetaceans cannot flourish in captivity. The question remains as to how to respond to this information. The scientific method is built upon the premise that one's views and behavior should change with, i.e., accommodate, incoming data. Therefore, the evidence for poor welfare in captive cetaceans requires an appropriate response. I argue that the only ethical and scientifically-valid one is to provide cetaceans with an environment in which they can flourish. This environment can only be the natural environment. No progressive society would do any less. Yet, the captivity industry continues to ignore the science and the ethical obligation it comes with.

Coming full circle, "pro" and "anti" -captivity contingents are firmly fixed in their positions and each expends tremendous energy, resources and talent to oppose the other. The captivity industry faces a choice to either continue down the same combative path with cetacean advocates or to create a new business model that will shift the paradigm from one of exploitation to one of respect and real conservation. I contend that the captivity industry is perfectly poised to become leaders of that progressive societal shift in our relationship with cetaceans. The tide is shifting and the public sentiment against cetacean captivity, and particularly orca captivity, is welling up. The popularity of the film *Blackfish*, recent efforts to reconsider whether cetacean captivity is viable by the National Aquarium, and the rejection of the Georgia Aquarium's proposal to import wild belugas by the National Oceanic and Atmospheric Administration are but a few of signs of things to come. The captivity industry should utilize its considerable

resources and talents to join cetacean advocates to come together over shared interests and objectives and create this change. The opportunity to choose this progressive path exists now but, I also argue, sooner or later that window will close.

References

- Abramson, Jose' Z., Hernandez-Lloreda, Victoria, Call, Josep, & Colmenares, Fernando. 2013. "Experimental Evidence for Action Imitation in Killer Whales (*Orcinus orca*)." *Animal Cognition* 16 (1): 11-22.
- Allman, John M., Watson, Karli. K., Tetrault, Nicole A. & Hakeem, AtiyaY. 2005. "Intuition and Autism: A Possible Role for Von Economo Neurons." *Trends in Cognitive Science* 9: 367-373.
- Bigg, M.A., Olesiuk, Peter E., Ellis, Graeme M., Ford, John K. and Balcomb, Kenneth C. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Reports of the International Whaling Commission. Special issue v. 12: 383-405.
- Ceta-Base http://www.ceta-base.com/lugalogue/ddl/ddl_nmmp.html). Accessed on August 4, 2014.
- Connor, Richard C., Smolker, Rachel A., & A.F. Richards. (1992). Two levels of alliance formation among male bottlenosed dolphins (*Tursiops* sp.). *Proceedings of the National Academy of Sciences* **89**, 987-990.
- Connor, Richard C., Richards, A.F., Smolker, Rachel.A., and Mann, Janet. (1996). Patterns of female attractiveness in Indian Ocean bottlenose dolphins. *Behaviour* **133**, 37-69.
- Connor, Richard C., Heithaus, Michael R., and Barre, Lynn M. 1999. Superalliance of bottlenose dolphins. *Nature* 397: 571-572.

- Deecke, Volker B., Ford, John K., and Spong, Paul. 2000. Dialect change in resident killer whales: Implications for vocal learning and cultural transmission. *Animal Behaviour* 40: 629-638.
- Defran Richard H & Pryor Karen (1980) The behavior and training of cetaceans in captivity. In: Herman L, ed. *Cetacean Behavior: Mechanisms and Functions*. New York: John Wiley and Sons 319 – 364.
- Delfour, Fabienne and Marten, Kenneth. 2001. “Mirror Image Processing in Three Marine Mammal Species: Killer Whales (*Orcinus orca*), False Killer Whales (*Pseudorca crassidens*), and California Sea Lions (*Zalophus californianus*). *Behavioral Processes* 53: 181-190.
- DeMaster Douglas P, & Drevenak Jeannie K (1988) Survivorship patterns in three species of captive cetaceans. *Mar Mamm Sci* 4(4): 297–311.
- Duffield David A & Wells Randy S (1991) The combined application of chromosome, protein, and molecular data for investigation of social unit structure and dynamics in *Tursiops truncatus* In: Hoelzel AR, ed. *Genetic Ecology of whales and dolphins Rep Intl Whaling Comm Special Issue* 13: 155–169.
- Fish, Marie P. and Mowbray, William H. 1962. “Production of Underwater Sound by the White Whale or Beluga, *Delphinapterus leucas* (Pallus).” *Journal of Marine Research* 20: 149-161.
- Foote, Andrew D., Griffin, Rachel M., Howitt, David, Larrison, Lisa, Miller Patrick J.O., and and Hoelzel, A. Russ. 2006. “Killer whales are capable of vocal learning.” *Biology Letters* 2(4): 509-512.

- Ford, John K.B. 2009. "Killer whale (*Orcinus orca*)." In *Encyclopedia of Marine Mammals*, edited by William F. Perrin, Bernd Wursig, and J.G.M. Thewissen, 650-656., San Diego: Academic Press.
- Ford, John K.B. 1989. "Acoustic Behaviour of Resident Killer Whales (*Orcinus orca*) off Vancouver Island, British Columbia." *Canadian Journal of Zoology* 67: 727-745.
- Ford, John K.B. 2009. Killer whale. In Perrin, William F, Wursig, Bernd, & Thewissen JGM, eds. *Encyclopedia of Marine Mammals* (2nd ed). Academic Press: 650-657.
- Ford, John K., Ellis, Graeme M., and Balcomb, Kenneth C. 2000. *Killer Whales*. University of British Columbia Press, Vancouver.
- Fowler Murray E (1978) A stereotyped behavior pattern in dolphins. In: Fowler Murray E, ed. *Zoo and wild animal medicine*. Philadelphia: WB Saunders. pp 33–34.
- Gazda, Stefanie K., Connor, Richard C., Edgar, Robert K and Cox, Frank. (2005). A division of labor with role specialization in group-hunting bottlenosed dolphins (*Tursiops truncatus*) off Cedar Key, Florida. *Proceedings of the Royal Society of London Series B* **272**, 135-140.
- Geisler, Jonathan H., McGowen, Michael R., Yang, Guang, and Gatesy, John. (2011). A supermatrix analysis of genomic, morphological, and paleontological data from crown Cetacea. *BMC Evolutionary Biology*, **11**: 112. doi: [10.1186/1471-2148-11-112](https://doi.org/10.1186/1471-2148-11-112)
- Greenwood Andrew G (1977) A stereotyped behavior pattern in dolphins. *Aquat Mamm* 5: 15–17.
- Hastie, G.D., Wilson, B., Thompson, P.M. (2006). Diving deep in a foraging hotspot: Acoustic insights into bottlenose dolphin dive depths and feeding behaviour. *Marine Biology*, 148, 1181-1188.

- Herman, Louis M. 2002. "Vocal, Social, and Self-imitation by Bottlenosed Dolphins. In *Imitation in Animals and Artifacts*, edited by Kirsten Dautenhahn and Chrystopher L. Nehaniv, 63-108. Cambridge, Mass.: MIT Press.
- Herman, Louis M. 2006. "Intelligence and Rational Behaviour in the Bottlenosed Dolphin." In *Rational Animals?*, edited by Susan Hurley and Matthew Nudds, 439-468. Oxford: Oxford University Press.
- Herman, Louis M., Matus, David S., Herman, Elia Y. K., Ivancic, Marina, and Pack, Adam A. 2001. "The Bottlenosed Dolphin's (*Tursiops truncatus*) Understanding of Gestures as Symbolic Representations of its Body Parts. *Animal Learning & Behavior* 29: 250-264.
- Herman, Louis M. 1986. "Cognition and Language Competencies of Bottlenosed Dolphins." In *Dolphin Cognition and Behavior: A Comparative Approach*, edited by Ronald J. Schusterman, Jeanette Thomas and Forrest G. Wood, 221 – 251. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Hof, Patrick R., Chanis, Rebecca, and Marino, Lori. 2005. "Cortical Complexity in Cetacean Brains." *The Anatomical Record* 287A: 1142-1152.
- Hof, Patrick R. and Van Der Gucht, Estel. 2007. "The Structure of the Cerebral Cortex of the Humpback Whale, *Megaptera novaeangliae* (Cetacea, Mysticeti, Balaenopteridae)." *The Anatomical Record* 290: 1-31.
- Hooper, Stacie L., Reiss, Diana R., Carter, Melissa, and McCowan, Brenda. 2006. "Importance of Contextual Saliency on Vocal Imitation by Bottlenose Dolphins." *International Journal of Comparative Psychology* 19: 116-128.

- Jacobs, M. S., McFarland, W. L. and Morgane, Peter J. 1979. 'The Anatomy of the Brain of the Bottlenose Dolphin (*Tursiops truncatus*). Rhinic Lobe (Rhinencephalon): the Archicortex.'" *Brain Research Bulletin*, 4: pp1-108.
- Jerison, Harry J. 1973. *Evolution of the Brain and Intelligence*. New York: Academic Press.
- Jett, John S. & Ventre, Jeffrey M. 2012. Orca (*Orca orcinus*) captivity and vulnerability to mosquito-transmitted viruses. *Journal of Marine Animals and their Ecology* 5(2): 9-16.
- Jett, John S., and Jeffrey M. Ventre. 2011. "Keto & Tilikum Express the Stress of Orca Captivity." *The Orca Project* .
- Kesarev, V. S. (1971) 'The inferior brain of the dolphin', *Soviet Science Review*, 2, pp52-58.
- Krützen, Michael, Janet Mann, Michael R. Heithaus, Richard C. Connor, Lars Bejder, and William B. Sherwin. 2005. "Cultural Transmission of Tool Use in Bottlenose Dolphins." *Proceedings of the National Academy of Sciences of the United States of America* 102(25): 8939-8943.
- Leung, Elaine S., Vergara, Valeria, and Barrett-Lennard, Lance G. 2010. Allonursing in captive belugas (*Delphinapterus leucas*). *Zoo Biology* 29: 633-637.
- Lockyer Chistine, Hohn Aleta, Doidge DW, Heide-Jørgensen Mads Peter, Suydam, R (2007). Age determination in belugas (*Delphinapterus leucas*): a quest for validation of dentinal layering. *Marine Mammals* 33(3): 293–304.
- Lusseau, David (2007). Evidence for social role in a dolphin social network. *Evolutionary Ecology* 21, 357-366.
- Lusseau, David and Conradt, Larissa. 2009. The emergence of unshared consensus decisions in bottlenose dolphins. *Behavioral Ecology and Sociobiology* 63: 1067-1077.

- Lydersen, Christian, Martin, Anthony R., Kovacs, Kit M., and Gjertz, Ian. 2001. "Summer and Autumn Movements of White Whales (*Delphinapterus leucas*) in Svalbard, Norway." *Marine Ecology Progress Series* 219: 265-274.
- Manger, Paul R. 2006. "An Examination of Cetacean Brain Structure with a Novel Hypothesis Correlating Thermogenesis to the Evolution of a Big Brain." *Biological Reviews of the Cambridge Philosophical Society* 81: 293-338.
- Mann, Janet, Sargeant, Brooke L. and Minor, Matthew 2007. Calf inspection of fish catches: Opportunities for oblique social learning. *Marine Mammal Science* 24: 749-773.
- Marino, Lori (2011). Brain structure and intelligence in cetaceans. In P. Brakes & M.P. Simmonds (Eds.) *Whales and Dolphins: Cognition, Culture, Conservation and Human Perceptions*, 115-128, London: Earthscan.
- Marino, Lori. 2009. "Brain Size Evolution." In *Encyclopedia of Marine Mammals* (2nd ed), edited by William F. Perrin, Bernd Wursig, and J.G.M. Thewissen, 149-152. San Diego, Academic Press.
- Marino, Lori. 1998. "A Comparison of Encephalization Between Odontocete Cetaceans and Anthropoid Primates. *Brain, Behavior, and Evolution* 51: 230-238.
- Marino, Lori, Butti, Camilla, Connor, Richard C., Fordyce, R. Ewan, Herman, Louis M., Hof, Patrick R., Lefebvre, L., Lusseau, D., McCowan, Brenda, Nimchinsky, Esther A., Pack, Adam A., Reidenberg, Joy S., Reiss, Diana, Rendell, Luke, Uhen, Mark D., Van der Gucht, Estelle, and Whitehead, Hal. 2008. "A Claim in Search of Evidence: Reply to Manger's Thermogenesis Hypothesis of Cetacean Brain Structure. *Biological Reviews of the Cambridge Philosophical Society* 83: 417-440.

- Marino Lori and Frohoff Toni (2011) Towards a New Paradigm of Non-Captive Research on Cetacean Cognition. PLoS ONE 6(9): e24121. doi:10.1371/journal.pone.0024121.
- McCowan, Brenda, Marino, Lori, Vance, Eric, Walke, Leah and Reiss, Diana. 2001. “Bubble Ring Play of Bottlenose Dolphins: Implications for Cognition. *Journal of Comparative Psychology* 114: 98-106.
- Montgomery, Stephen H., Geisler, Jonathan, McGowan, Michael R., Fox, Charlotte, Marino, Lori, and Gatesy, John. (2013). The evolutionary history of cetacean brain and body size. *Evolution* 67(11), 3339–3353.
- Murayama, Tsukasa, Fujii, Yuki, Hashimoto, Takayuki, Shimoda, Aya, Iijima, So, Hayasaka, Kohei, Shiroma, Narumi, Koshikawa, Mana, Katsumata, Hiroshi, Soichi, Makoto, and Arai, Kazutoshi. 2012. “Preliminary Study of Object Labeling Using Sound Production in a Beluga. *International Journal of Comparative Psychology* 25: 195-207.
- Murayama, Tsukasa, Iijima, So, Katsumata, Hiroshhi, and Arai, Kazutoshi. in press. “Imitation in a Beluga.” *International Journal of Comparative Psychology*.
- Noda K, Akiyoshi H, Aoki M, Shimada T, Ohashi F (2007) Relationship between transportation stress and polymorphonuclear cell functions of bottlenose dolphins, *Tursiops truncatus*. *J Vet Med Sci* 69(4): 379–383.
- Nussbaum, Martha C. 2011. “The Capabilities Approach and Animal Entitlements” in *The Oxford Handbook of Animal Ethics*, edited by Tom L. Beauchamp and Frey, R. G. (Oxford: Oxford University Press), p. 237.
- O’Corry-Crowe, Gregory M. 2009. Beluga whale. In *Encyclopedia of Marine Mammals*, edited by William F. Perrin, Bernd Wursig, and J.G.M. Thewissen. 108-112. San Diego: Academic Press.

- Oelschlager, Helmut. A., and Oelschlager, Jutta S. 2009. "Brains". In *Encyclopedia of Marine Mammals*, edited by William F. Perrin, Bernd Wursig, and J.G.M. Thewissen. 134-158. San Diego: Academic Press.
- Olesiuk Peter, Bigg Michael, Ellis Graeme M (1990) Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Rep Int Whaling Comm Special issue 12: 209–244.
- Pack, Adam A. and Herman, Louis M. 2007. "The Dolphin's (*Tursiops truncatus*) Understanding of Human Gaze and Pointing: Knowing *What* and *Where*. *Journal of Comparative Psychology* 121: 34-45.
- Reiss, Diana and Marino, Lori. 2001. "Self-Recognition in the Bottlenose Dolphin: A Case of Cognitive Convergence. *Proceedings of the National Academy of Sciences USA* 98: 5937-5942.
- Reiss, Diana and McCowan, Brenda (1993). Spontaneous vocal mimicry and production by bottlenosed dolphins (*Tursiops truncatus*): Evidence for vocal learning. *Journal of Comparative Psychology* **107**, 301-312.
- Rendell, Luke E. & Whitehead, Hal (2001). Culture in whales and dolphins. *Behavioural and Brain Sciences* **24**, 309-324.
- Richard, P.R., Heide-Jorgensen, M.P., Orr, J.R., Dietz, R., and Smith, T.G. (2001). Summer and autumn Movements and habitat use by belugas in the Canadian High Arctic and adjacent areas. *Arctic*, 54, 207- 222.
- Ridgway, Sam H. & Brownson, R.H. (1984). Relative brain sizes and cortical surface areas in odontocetes. *Acta Zoologica Fennica*, 172, 149-152.

- Rose, Naomi, A., Parsons, E.C.M., & Farinato, R. 2009. "The Case Against Marine Mammals in Captivity". Wash. DC: Humane Society of the United States.
- Schevill W.E. and Lawrence, B. 1949. "Underwater Listening to the White Porpoise (*Delphinapterus leucas*).” *Science* 109: 143-144.
- Sergeant, Brooke L. and Mann, Janet. 2009. Developmental evidence for foraging traditions in wild bottlenose dolphins. *Animal Behaviour* 78: 715-721.
- Small Robert J & DeMaster Douglas P (1995) Survival of five species of captive marine mammals. *Mar Mamm Sci* 11(2): 209–226.
- Smith, J. David, Schull, Jonathan, Strote, Jared, McGee, Kelli, Egnor, Rojan and Erb, Linda. 1995. "The Uncertain Response in the Bottlenose Dolphin (*Tursiops truncatus*). *Journal of Experimental Psychology: General* 124 : 391-408.
- Spoon Tracey R & Romano Tracy A (2011). Neuroimmunological response of beluga whales (*Delphinapterus leucas*) to translocation and a novel social environment. *Brain, Behavior and Immunity* 26(1): 122-131.
- St. Aubin, David J & Geraci, Joseph R (1988). Capture and handling stress suppresses circulating levels of thyroxine (T4) and triiodothyronine (T3) in beluga whales *Delphinapterus leucas*. *Physiological Zoology* 61(2): 170-175.
- Stewart, Brent S. 2009. "Killer Whale (*Orcinus orca*). In *Encyclopedia of Marine Mammals* (2nd ed), edited by William F. Perrin, Bernd Wursig, and J.G.M. Thewissen. 321-326. San Diego: Academic Press.
- Stewart, Kristin L. and Marino, Lori (2009) Dolphin-human interaction programs: Policies, problems, and practical alternatives. Policy paper for *Animals and Society Institute*.

Stewart REA, Campana SE, Jones CM, Stewart BE (2006). Bomb radiocarbon dating calibrates beluga (*Delphinapterus leucas*) age estimates *Canadian Journal of Zoology*. 84: 1840–52.

Sweeney Jay C (1988) Specific pathologic behavior in aquatic mammals: Self- inflicted trauma. *Soundings: Newsletter of the Intl Marine Animal Trainers Assoc* 13(1): 7.

The Orca Project

<http://theorcaproject.wordpress.com/killer-whale-orca-database/killer-whale-orca-dead-date/>

Accessed on August 4, 2014.

United States Marine Mammal Inventory Report (2010) National Marine Fisheries Service, Office of Protected Resources.

Van Bresse, Marie Francois et al (2009) Epidemiological pattern of tattoo skin disease: a potential general health indicator for cetaceans. *Diseases of Aquatic Organisms* 85: 225-237.

Wells Randall S & Scott Michael D (1990) Estimating bottlenose dolphin population parameters from individual identification and capture-release techniques. In: Hammond PS, Mizroch SA, Donovan GP, editors. Individual recognition of cetaceans: Use of photo-identification and other techniques to estimate population parameters. *Rep Intl Whaling Comm Special Issue* 12: 407–415.

White, Thomas I. "Whales, Dolphins and Ethics: A Primer," *Dolphin Communication & Cognition: Past, Present, Future*, edited by Denise L. Herzing and Christine M. Johnson. MIT Press, forthcoming.

Whitehead, Hal 2011. The culture of whales and dolphins. In *Whales and Dolphins: Cognition, culture, conservation and human perceptions* (ed by Philippa Brakes and Mark P. Simmonds)., pp149-165. London: Earthscan.

- Williams, Rob and Lusseau, David 2006. A killer whale social network is vulnerable to targeted removals. *Biology Letters* 2(4): 497-500.
- Wise, Steven M. 2005. "Entitling Non-human Animals to Fundamental Legal Rights on the Basis of Practical Autonomy." In *Animals, Ethics and Trade: The Challenge of Animal Sentience*, edited by Jacky Turner and Joyce D'Silva. 87-100. Virginia: Earthscan.
- Woodley Thomas H, Hannah Janice L & Lavigne David M (1997). A comparison of survival rates for captive and free-ranging bottlenose dolphins (*Tursiops truncatus*), killer whales (*Orcinus orca*) and beluga whales (*Delphinapterus leucas*). *International Marine Mammal Association Technical Report* 97-02.
- Xitco, M. J. Jr, Gory, J. D. & Kuczaj II, S. A.(2001). Spontaneous pointing by bottlenosed dolphins (*Tursiops truncatus*). *Animal Cognition* 4, 115-123.
- Xitco, Mark J., Gory, John D., and Kuczaj II, Stan A. 2004. "Dolphin Pointing is Linked to the Attentional Behavior of a Receiver. *Animal Cognition* 7: 231-238.
- Yurk, Harald (2003). Do killer whales have culture? In *Animal social complexity: intelligence, culture, and individualized societies*. (eds. F.B.M. de Waal and P. L. Tyack), pp. 465 – 467. Harvard University Press, Cambridge, MA.