Exhibit 3

**Affidavit of Bob Jacobs**

Bob Jacobs being duly sworn, deposes and says:

**Introduction and Qualifications**

1. My name is Bob Jacobs. I graduated with a Bachelor of Arts, *Magna Cum Laude*, in German from Whitman College in 1980. I received an M.A. in Germanics, with a minor in Teaching English as a Second Language, from the University of Washington in 1982. I received my Ph.D. from the University of California, Los Angeles (UCLA) in Applied Linguistics in 1991, completing a neuroanatomy dissertation under the supervision of Drs. Arnold B. Scheibel and John Schumann. The dissertation was entitled: "A Quantitative Dendritic Analysis of Wernicke's Area". During this time, I also worked with Dr. Marian Diamond of the University of California, Berkeley. Post-doctoral research in neuroimaging was also completed from 1991-1993 under the supervision of Dr. Harry Chugani at UCLA. I began my tenure track professorship in the Department of Psychology at Colorado College in 1993, started the school's Neuroscience major in 1996, and have been at Colorado College since that time, becoming a full professor in 2006. I reside in Colorado Springs, CO.
2. I submit this affidavit in support of Petitioner The Nonhuman Rights Project, Inc. (NhRP) in its habeas corpus case on behalf of the captive elephant named above. I have professional knowledge of the facts to which I attest and am not a party to this proceeding.
3. I have been conducting research on the mammalian brain since 1984 when I began my dissertation research in the Laboratory of Dr. Arnold B. Scheibel at the UCLA Brain Research Institute. I have 44 peer-reviewed publications to my name, all in well-respected scientific journals. I also have two chapters in edited volumes, and 63 professional talks/posters presented at academic conferences, and over 60 invited lectures about the brain. From 1984 to 2010, my main research focus was on the human cerebral cortex, specifically on the quantitative neuromorphology in the cerebral cortex, that is, the shape and size of nerve cells (neurons) in the outmost layers of the brain involved in higher cognitive functions—18 publications have focused on human tissue.

4. From 2010 onward, I focused on comparative neuroanatomy, examining the brains of a variety of species—for many of these species, our studies constitute the first time anyone had explored the neurons in the brains of these animals. Species examined included: African elephant, giraffe, minke whale, humpback whale, bottlenose dolphin, Siberian tiger, clouded leopard, Florida manatee, cheetah, African leopard, chimpanzee, African wild dog, domestic dog, banded mongoose, caracal, zebra, wildebeest, pygmy hippopotamus, greater kudu, ring-tailed lemur, golden lion tamarin, chacma baboon, macaque monkey, Flemish giant rabbit, Bennett's wallaby, and Long-Even's rat. A total of 18 publications have focused on these non-human animals.
5. With regard to the African elephant, we documented the types of neurons in both the cerebral cortex and in the cerebellum, a part of the brain involved in balance, body control, and coordination. This research was conducted on adult and newborn elephants—resulting in a total of 4 publications focused exclusively on the elephant brain, which had not been explored previously. In addition to academic publications, I have presented these results at several scientific conferences (e.g., Society for Neuroscience, Performing Animal Welfare Society), and have written summaries of this research for the online publication known as "The Conversation" (https://theconversation.com/what-elephants-unique-brain-structures-suggest-about-their-mental-abilities-100421; https://theconversation.com/the-neural-cruelty-of-captivity-keeping-large-mammals-in-zoos-and-aquariums-damages-their-brains-142240).
6. My Curriculum Vitae fully sets forth my educational background and experience and is attached as "Exhibit A."

**Basis for opinions**

7. My early interest in brain research involved using the research techniques of Dr. Scheibel to extend both his and Dr. Diamond's interest into the effects of the environment on the brain. Dr. Diamond was a pioneer in documenting the effects of an impoverished and enriched environment on neuroanatomy in non-human animals; my dissertation extended that to the human brain, where we found education-related differences in the neurons of the cerebral

cortex. Specifically, individuals with a university education had more complex neurons than individuals with a high school or less than high school education. I have followed this area of research my entire career, including when we examined the brains of both free and captive animals. As such, several decades of neuroscientific research has led me to several conclusions about the state of the brain in captive non-human animals, particularly with regard to long-lived, large-brained mammals such as cetaceans and elephants. A full reference list of peer-reviewed literature cited is attached as "Exhibit B."

8. One of the main findings of our elephant cortex paper (Jacobs et al., 2011) was that pyramidal neurons in the elephant are just as complex as similar neurons in the human cortex. Like the human, these neurons were also more complex in the frontal lobe, involved with higher cognitive function, than in the occipital lobe, involved in the early processing of incoming visual information. These are remarkable parallels in terms of overall complexity of neurons and the functional involvement of these neurons. One difference was noted between the cortical neurons in the African elephant and in humans—those in the African elephant appear to extend their branches more broadly than neurons in the human, which tended to be more compact. As such, elephant neurons sample a very wide array of information because of the length of their dendrites. In discussion with Dr. Joyce Poole, we concluded that this broad synthesis of information in the African elephant may contribute to their contemplative nature—elephants often appear to be examining their surroundings and thinking very deeply about what is going on around them. They have the leisure of their great size and few natural predators, which allows them to consider their decisions very carefully. Primate cortical neurons, by contrast, seem more designed for quick responses to the environment. This contemplative aspect of the elephant further supports the findings expressed below with regard to how their brains respond to captivity.

9. Although my own research has focused on the African elephant, the conclusions here all apply equally to Asian elephants as well. All evidence suggests the brain of an Asian elephant is

remarkably similar to the brain of an African elephant, both in terms of structure (Maseko et al., 2012) and function (Plotnick et al., 2006; Hart et al., 2008).

**Opinions**

10. In addition to a rather large list of well-documented physical ailments (Riddle & Stremme, 2011) and behavioral abnormalities (Greco et al., 2017) that afflict elephants as well as Orca whales (Marino et al., 2020), the neural consequences of an impoverished environment have been demonstrated in many species to date, including humans (Jacobs et al., 1993). No research of this nature has been completed on elephants and cetaceans as these are post-mortem studies and would therefore require killing of the animal; as such, we are extrapolating from controlled scientific studies with all evidence suggesting that the brains of animals such as cetaceans and elephants would not "behave" any different than the brain of any other mammal, including humans. There is a great deal of evolutionary continuity across the brains of the species that have been examined, which makes this a very logical extension of the existing research. Over 50 years of neuroscience research indicates that an impoverished environment negatively affects the cerebral cortex (Diamond et al., 1964; Diamond, 2001). These effects include a thinner cerebral cortex, decreased blood supply, smaller neuronal cell bodies with few glial ("helper") cells for metabolic support, decreased dendritic branching for synthesizing information, fewer dendritic spines (indicating fewer connections with other neurons), and smaller, less efficient synapses. Additional studies reveal similar epigenetic-related deficiencies at the molecular (van Praag et al., 2000) and neurochemical (Kozorovitskiy et al., 2005) level throughout the brain.
11. A crucial component to an enriched environment is exercise (Basso & Suzuki, 2017), which not only increases the supply of oxygenated blood to a metabolically expensive brain, but also contributes to potential neurogenesis and enhanced cognitive abilities through a series of complex biochemical cascades (Horowitz et al., 2020). Large, captive mammals like elephants and orcas are severely deprived of the exercise component of enrichment, particularly when one realizes that elephants and orcas naturally travel tens of kilometers a day (sometimes more

than 100 kilometers), something they cannot do in a small enclosure (Holdgate et al., 2016)—not to mention that free orcas may also dive hundreds of meters (Reisinger et al., 2015). To put this in perspective, the average tank for an orca is about 10,000 times smaller than its natural home (https://www.cascadiaresearch.org/projects/killer-whales/using-dtags-study-acoustics-and-behavior-southern). Overall, these findings imply that cortical neurons in captive/impoverished elephants and orcas are less complex, receive less metabolic support, and process information less efficiently than cortical neurons from animals in an enriched, more natural environment (Rosenzweig & Bennett, 1969).

12. Two other brain areas are affected negatively by a captive/impoverished environment because such an environment severely constrains or even prevents the natural behavior of elephants and orcas, resulting in chronic frustration, boredom, and stress. Two subcortical (beneath the cortex) brain structures negatively affected by such stress are the hippocampus, involved primarily in declarative (i.e., facts and events) and spatial memory formation, and the amygdala, involved in emotional processing. Decades of neuroscientific research in the laboratory and in the field (Sapolsky, 2005) have demonstrated that prolonged stress results in chronically elevated levels of glucocorticoids (stress hormones) (Sapolsky, 1996). Chronic exposure to these stress hormones contributes to wide-ranging neurodegeneration (Vyas et al., 2016), including neuronal damage/death in the hippocampus (Sapolsky et al., 1990), resulting in memory deficits, and in the amygdala (McEwen et al., 2015), resulting in emotional processing deficits.

13. In natural environments, the body's stress-response system is designed for quick activation to escape from danger; in captivity, there is no escape. In captivity, animals have an almost complete lack of control (Sapolsky, 2012) over their environment. Such situations foster learned helplessness (Maier & Seligman, 2016), which involves the amygdala (Hammack et al., 2012) and broad dysregulation of the neurotransmitter serotonin (Maier & Watkins, 2005). Under similar conditions (Chugani et al., 2001), stress is associated with a variety of neuropsychiatric diseases in humans such as anxiety/mood disorders (Zhang et al., 2018)

including major depression and post-traumatic stress disorder (PTSD) (Koenigs & Grafman, 2009). Given the highly conserved (Nikolova et al., 2018) nature of neural structures (i.e., brains have a lot in common across species), there is no logical reason to believe that the large, complex brains of animals such as elephants (Jacobs et al., 2011) and orcas (Marino et al., 2007) would react any differently to a severely stressful environment than does the human brain.

14. Finally, captivity, and the psychosocial stress it engenders, has negative effects on the complex circuitry between a subcortical collection of nuclei (groups of neurons) known as the basal ganglia and the cerebral cortex. Through a series of reciprocal connections, the basal ganglia select and orchestrate appropriate cortical activity for a given situation, including the two pathways involved in movement: the direct pathway and the indirect pathway. The direct pathway tends to be involved in generating movement/behavior whereas the indirect pathway is more crucial for inhibition of movement/behavior. Normal movement depends on a delicate balance between these two pathways. Stereotypic behavior resulting from stress has been documented in a large number of species (including humans) and is invariably associated with an imbalance in the direct/indirect pathways (McBride & Parker, 2015). More specifically, the indirect pathway is suppressed as a result of dysregulation of two neurotransmitter systems, dopamine and serotonin (Langen et al., 2011). Such behavioral stereotypies may represent a coping strategy as the animal attempts to mitigate the overwhelming effects of psychosocial stress (Poirier & Bateson, 2017). It is worth noting that elephants and cetaceans in their natural habitats have never been noted to exhibit such stereotypies, which reflect underlying (abnormal) disruption of neural mechanisms.

**Summary**

15. Long-lived individuals with large, complex brains integral to their intricate sociobehavioral existence cannot function normally in captivity. I believe Dr. Joyce Poole has accurately outlined in her affidavit not only the sociobehavioral characteristics of elephants, but also the neural characteristics as well—my contributions here serve to extend her conclusions from the

neural point of view. Physical and behavioral abnormalities are easy to observe, but one has to look deeper to see the neural consequences. Evolution has constructed the brain—of all organisms—to be extremely and exquisitely responsive to the environment (for better and worse). This responsivity extends to the level of gene expression, meaning that the environment can turn on or off different genes (Sapolsky, 2017). As such, the captive environment we place animals in significantly and sometimes permanently alters their brains in a negative manner. From a neural perspective, imprisoning elephants and orcas and putting them on display is undeniably cruel. They should either remain free (and protected) or, if already in captivity, they should be released into well-designed sanctuaries. Several elephant sanctuaries already exist, for example in Tennessee (https://www.elephants.com/) and Northern California (http://www.pawsweb.org/about_our_sanctuaries.html).

I, Bob Jacobs, Ph.D., certify under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

11/24/20 [signature]

Date Bob Jacobs, Ph.D.