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The Case Against Octopus Farming

For ethical and environmental reasons,
raising octopuses in captivity
for food is a bad idea.

Octopuses stand out among invertebrates for their complex behavior. They are capable of problem-solving, mimicking their surroundings using color changes that take place on a scale of seconds, outwitting predatory sharks, discriminating individual humans, engaging in playful behavior, and hunting in response to cooperative signals sent by fish. As these patterns of behavior suggest, octopuses (as well as some other cephalopods) have sophisticated nervous systems and large brains.

Given their exceptional abilities, one might ask whether humans should be eating octopus at all, but here we want to raise a different ethical question. As global demand for octopus grows, especially in affluent markets, so have efforts to farm them. We believe that octopuses are particularly ill-suited to a life in captivity and mass-production, for reasons both ethical and ecological.

Sheep were probably the first animals domesticated by humans for food, starting at least 9,000 years ago. Goats, cows, pigs, and chickens followed. In the twentieth century, in tune with economics and the norms of the Industrial Revolution, a factory model was applied to farming these animals, which facilitated an extraordinary increase in the number of animals produced for food. Factory farming also led to concerns about animal welfare and environmental impacts, including habitat loss, excessive use of fresh water, and pollution.

Until fairly recently, aquatic animals were mostly exempt from this factory-farming fate and were almost exclusively

harvested from their natural habitats. Intensive aquaculture became part of the global food system in the latter half of the twentieth century and is now one of the fastest growing food industries. Aquatic animals are under rapid domestication, and approximately 550 different aquatic animal species, from oysters and shrimp to rainbow trout and even bluefin tuna, are raised in captivity in nearly 190 countries. Farmed aquatic animals now constitute half of the seafood market in many industrialized countries.

As with terrestrial animals, the intensive farming of aquatic animals is associated with animal welfare and environmental concerns, but little is known about how to ensure the welfare of farmed aquatic animals. Fish kept in captivity develop traits not seen in the wild and tend to be more aggressive, experience more chronic stress and injury, and contract more diseases. Fish raised in intensive production systems may have lower immune function than do fish that have more control over their lives. Even simple parameters such as tank-wall color can have dramatic effects on fish preferences and aggression.

Feeding fish with fish

The environmental impacts of aquaculture are well known. They include pollution from nitrogen and phosphorus released from feces and food decomposition; contamination from fertilizers, algicides, herbicides, and disinfectants; excessive use of antibiotics; interbreeding and disease

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Judy Fox: Sculptor

The clay sculptures of New York-based artist Judy Fox oscillate between reality and the imagined. She first attracted notice in the 1980s in New York for her intensely realistic, life-size babies and toddlers made of fired clay and painted with casein paint. In the 1990s, she began to include adults and older children in allegorical tableaux. In 2011, Fox applied her technique to the ocean animals depicted here, transforming the clay into organic and realistic textures.

The *Cephalopod* series was part of an installation called *Out of Water* presented at the PPOW Gallery in New York City in 2012. The anatomically correct sea creatures stand as if terrestrial. They are intelligent, predatory mollusks at once alien and akin to the humans who return their gaze. Fox plays with a cartoon tradition of the anthropomorphized animal character, highlighting our conflicted relationship with animals and our discomfort with the primitive, especially within ourselves.

Fox studied at the Skowhegan School of Painting and Sculpture in 1976, earned a BA from Yale University in 1978, studied at the École Nationale Supérieure des Beaux-Arts Paris, France, in 1979, and received an MFA from New York University in 1983.

Fox has received two National Endowment for the Arts grants and the Anonymous Was a Woman Award. She is a fellow of Yaddo and the MacDowell Colony and was a 2006 fellow of the John Simon Guggenheim Memorial Foundation and a 2009 fellow of the New York Foundation for the Arts.

Images courtesy of the artist.

JUDY FOX
Octopus 2, 2011
Aqua-resin and casein
12 X 18 X 16 inches

transmission between escaped fish and wild varieties; and loss of natural habitat (such as mangrove swamps) used for farms. But the biggest ecological concern is less familiar.

Unlike terrestrial farmed animals, the majority of which evolved as herbivores, most farmed aquatic animal species, including salmon, trout, and shrimp, are carnivorous, and depend on fish protein and oil during certain developmental stages. Feeding most farmed aquatic animals puts additional pressure on wild fish and invertebrates for fishmeal. Around one-third of the global fish catch is turned into feed for other animals, roughly half of which goes to aquaculture. Many fishmeal fisheries are subject to overfishing and are declining.

Reducing the ecological impact of catching fish to feed fish means reducing the reliance on wild fish and invertebrates for fishmeal. One option is to focus aquatic farming on invertebrates and other species lower on the food web, yet the percentage of farmed aquatic species that need to be fed is increasing relative to species such as freshwater carps, bivalves, and aquatic plants that require little to no feed.

Indeed, many invertebrates occupy a lower level on the food chain than vertebrates and therefore are less carnivorous. Bivalves, which due to their evolutionary history and body plan belong to mollusk phylum along with octopus, subsist on plankton, so farming them requires no fishmeal. Invertebrates are often assumed to present fewer welfare concerns than vertebrates because many invertebrates are considered to be less cognitively and behaviorally complex. Accordingly, research facilities are investigating the mass-production potential of aquatic invertebrates, including, in some cases, species of octopus. But octopuses are atypical invertebrates as well as atypical mollusks. They are both carnivorous (none can survive on plants or algae alone) and behaviorally sophisticated. Farming octopus is counterproductive from a perspective of environmental sustainability and misguided from a perspective of humane food production.

There are approximately 300 species of octopuses, more than 100 of which are captured in the wild using nets, pots, lines, and traps. Since 2008, the reported annual global catch of octopuses has been about 350,000 metric tons (about 385,000 English tons), which is likely a conservative estimate as catches are often underreported, particularly in nearshore, artisanal fisheries. Regionally, octopus fisheries are in decline as measured by peak catches, and many octopus fisheries are now overfished. However, new fisheries for octopus continue to open, particularly as groundfish, octopuses' main ecological competitors, are themselves depleted. Overfishing of octopus combined with growing demand is driving octopus prices up.

Asia accounts for two-thirds of the reported global octopus catch, and China alone accounts for more than one-third. The principal importers are Japan, the Republic of Korea, and the northern Mediterranean countries (especially Spain, Greece, Portugal, and Italy). Demand is

also growing in China, the United States, and Australia. Octopus that are globally traded are served primarily in upscale markets. A 2015 report of the Australian Fisheries Research and Development Corporation on the prospects for octopus aquaculture notes: "Octopus is now supplied as raw fresh and/or frozen product for use in local restaurants and cafes and value-added marinated varieties suitable for gourmet delicatessen outlets and supermarkets."

Given the growing gourmet markets and rising octopus prices, some people have turned to the idea of aquaculture as a way to make money and to smooth out the inevitable variability in the supply of wild-caught animals. Octopuses grow fast and have short life spans (typically just one to two years), features that make them potentially appealing for farming. According to one aquaculture research study, the common species *Octopus vulgaris*, which lives in many marine environments, "meets many of the requirements to be considered as a candidate for industrial culture: easy adaptation to captivity conditions, high growth rate, acceptance of low-value natural foods, high reproductive rate and high market price."

Domestication of many animals turns out to be a technically complicated process, however, and octopuses are no exception. As early as the 1970s, one researcher described the problems to be overcome in the case of cultivating octopus as "cannibalism, containment, dependence upon live food and the death of gravid females before laying second generation eggs in the laboratory." Despite these challenges, some governments, universities, and private companies have recently invested major resources in farming octopus.

Spain, supported in part by the European Union, has led the way. Spanish production of *O. vulgaris* now occurs, at least experimentally, in tanks on land, in open-ocean net pens, and on "ranches" where wild-caught octopuses are raised in captivity. The Spanish Institute of Oceanography in Vigo has carried out the majority of published research on octopus farming, but research is also occurring in Portugal and Greece, where the Mediterranean-based company Nireus Aquaculture has funded octopus-farming research. Octopus ranching is being tried in Italy and Australia as well. A farm in the Yucatan Peninsula of Mexico has reportedly successfully farmed another species, *Octopus maya*, and attempts to farm octopus are under way in other parts of Latin America, including Chile. In China, up to eight different species of octopus are now being experimentally farmed. In Japan, the seafood company Nissui reported hatching octopus eggs in captivity in 2017 and is predicting a fully farmed market-ready octopus by 2020. Many scientists are contributing to the tools and technology to make genetic modifications that may accelerate industrial aquaculture of octopus and other types of cephalopods.

Such efforts are occurring despite the fact that octopus farming has the same environmental consequences as other types of carnivorous aquaculture. And, like other carnivorous aquaculture, octopus farming would increase, not alleviate,



JUDY FOX
Large Octopus 2, 2011
Aqua-resin and casein
31 X 19 X 21 inches



JUDY FOX
Cuttlefish 1, 2011
Aqua-resin and casein
16 X 9 X 11.5 inches



JUDY FOX
Large Octopus 1, 2011
Aqua-resin and casein
43 X 11 X 10 inches

pressure on wild aquatic animals. Octopuses have a food conversion rate of at least 3:1, meaning that the weight of feed necessary to sustain them is about three times the weight of the animal. Given the depleted state of global fisheries and the challenges of providing adequate nutrition to a growing human population, increased farming of carnivorous species such as octopus will act counter to the goal of improving global food security. But even if aquaculture researchers could discover a less unsustainable diet for octopus, and also are able to reduce other ecological impacts, farming octopus would still be unethical.

Smarter than your average mollusk

Octopuses exhibit cognitive and behavioral complexity, and they appear capable of experiencing pain and suffering. The neuroscientists who wrote the 2012 Cambridge Declaration on Consciousness, considered to be the first formalization of the scientific consensus about the consciousness of several nonmammal species, singled out octopuses as the sole invertebrate capable of conscious experience (although it remains possible that other invertebrates might also be sentient). Widespread observations of octopus as curious and exploratory creatures have been confirmed by experimental work. Once octopuses have solved a novel problem, they retain long-term memory of the solution. One study found that octopuses retained knowledge of how to open a screw-top jar for at least five months. They are also capable of mastering complex aquascapes, conducting extensive foraging trips, and using visual landmarks to navigate.

Although there has been little research on the welfare of octopuses in farmed settings, existing evidence suggests intensive farming systems are likely to be associated with high mortality rates and increased aggression, parasitic infection, and a host of digestive tract issues. Beyond their basic biological health and safety, octopuses are likely to want high levels of cognitive stimulation, as well as opportunities to explore, manipulate, and control their environment. Intensive farm systems are inevitably hostile to these attributes. Aquaculture depends on tightly controlled and monotonous environments, with constant ambient conditions, simplified and sterile enclosures, and rigid feeding schedules, aimed at supporting high stocking densities. Many octopus species appear to be largely asocial and show little tolerance of other individuals of the same species. Farming such species that, in addition, are carnivorous will almost inevitably require that individuals be kept isolated in small containers, with no scope for environmental enrichment and very poor overall well-being. If octopuses of some species can be kept together in moderate numbers and in larger enclosures with significant enrichment, this might mitigate some, though not all, of the welfare problems.

A growing scientific and public awareness of the rich cognitive capacities of many domesticated land animals makes clear that the welfare of farmed animals cannot be achieved

simply by eliminating obvious sources of suffering, such as overcrowding. Many species are susceptible to boredom and frustration, and they require species-appropriate challenges and mental stimulation as a condition of well-being. These considerations apply also to octopus.

Meanwhile, factory farming is a key part of a highly industrialized food system that is both cruel to individual animals and environmentally unsustainable. Despite efforts of animal welfare and environmental groups to redress these problems, they are deeply embedded in the global food systems' production technologies, corporate profits, and patterns of consumer demand. Decoupling the ethical and environmental consequences of food production from this system is a daunting challenge, and it should lead us to ask whether we want to repeat mistakes already made with terrestrial animals with aquatic animals, especially octopus.

Indeed, the case in favor of octopus farming is weak. The main markets for farmed octopus—upscale outlets in Japan, South Korea, northern Mediterranean countries, the United States, China, and Australia—are largely food secure. (Food security is defined as when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life.) As consumers become increasingly concerned about animal welfare and sustainability, the case against octopus farming should only become stronger. If society decides we cannot farm octopus, it will mean relatively few people can continue to eat them. But it does not mean that food security will be undermined; it will mean only that affluent consumers will pay more for increasingly scarce, wild octopus.

Right now, the farming of octopus is constrained by the technology—it has been difficult to reliably keep animals alive through the early stages in their lives. But with further investments, research, and testing, the technology may well become available to farm octopus at an industrial scale. It is our hope that if such an option does become practical, society will recognize the serious welfare and environmental problems associated with such projects and octopus farming will be discouraged or prevented. Better still would be for governments, private companies, and academic institutions to stop investing in octopus farming now and to instead focus their efforts on achieving a truly sustainable and compassionate future for food production.

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