PNAS

Supporting Information for

Evolving around humans: a universal definition for domestication

Kathryn A. Lord[1,2]*, Greger Larson[3], Robin G. Allaby[4], Elinor K. Karlsson[1,2]

Affiliations

[1] Genomics and Computational Biology, University of Massachusetts Chan Medical School, Worcester, MA, USA 01655

[2] Medical and Population Genetics Program, Broad Institute of MIT and Harvard, Cambridge, MA 02142

[3] The Palaeogenomics and Bio-Archaeology Research Network, School of Archaeology, University of Oxford, UK OX1 3TG

[4] School of Life Sciences, University of Warwick, Coventry, UK CV4 7AL

* Corresponding author: Kathryn Lord

Email: kathryn.lord@umassmed.edu

This PDF file includes:

Supporting text

Figure S1

Table S1 and Table S2

SI References

Supporting Information Text

Lab model origins

The individuals used to establish nearly all major laboratory model organisms may have come from populations that were either human exploiters or domestic. Here, we describe several of the species from Table 2 in more detail.

Dogs. Purpose-bred beagles were established as the first standardized laboratory dog model in the 1940s using dogs sourced from hunting or show breeders(1). The choice of beagles was likely due to the breed's prevalence, although their health, small size, and ability to be group- or singly-housed have also been suggested as factors.

Fruit Flies. The fruit flies used to start the first experimental inbred lines were collected by leaving fruit on windowsills(2). The earliest use of fruit flies traces back to 1900 by C.W. Woodworth, a graduate student of W.E. Castle, who acquired his flies by leaving Concord grapes on a windowsill. W.E. Castle later collected more flies using the same technique, substituting bananas for grapes. Thomas Hunt Morgan, who popularized the use of Drosophila in genetics through a series of seminal experiments, sourced his flies either from Castle's inbred strain or by using the windowsill technique.

Maize. Laboratory strains of maize were developed from crop varieties, including unusual strains found at agricultural 'corn shows' (3). The use of maize as a model organism traces back to inheritance studies performed in 1869 by Gregor Mendel. Today, hundreds of maize inbred lines are described, and the most widely used were developed from crop varieties. For example, B73 was developed at Iowa State University from an Iowa Stiff Stalk Synthetic maize population (4), W22 was developed at the University of Wisconsin and is notable for its unusual purple pigmentation(5), and MO17 is an inbred representative of Lancaster, an heirloom field corn variety.

Mice. Many of the inbred strains of mice now used in laboratories were originally purchased from people breeding mice as pets(6, 7), and even the "wild" mice crossed into lab strains may have been commensal. The most prolific early provider of mice was Abbie Lathrop of Granby, Massachusetts(8, 9), who started as a mouse fancier who occasionally sold mice to local children. When her advertisements requesting mice for breeding were misunderstood as advertisements offering mice for sale, her business grew. Her customers included Clarence Cook Little, who created the first inbred strains (including the C57 and C58 strains) during his coat color experiments. Lathrop and others did use some "wild" (possibly commensal) mice in their breeding programs. For example, when L.C. Strong at Cold Spring Harbor Laboratory outcrossed laboratory mice with "wild" mice, the wild mice were in fact captured from a commensal population living in a pigeon coop(6).

Rats. Most laboratory rat strains were likely started using pet rats or rats caught in urban environments(10). The creation of laboratory rat strains was first undertaken by Dr. Helen Dean King at the Wistar Institute in Philadelphia, who bred and distributed rats through the 1940s, and many modern laboratory rat strains are descended from these strains(10–13). While the original four albino rats are known to have been provided by H.H. Donaldson, Donaldson's own papers give inconsistent information on their origins, mentioning European dealers and "wild" rats(14). More is known about other laboratory strains. For example, Dr. King established the rat strain now known as Brown Norway using rats captured in the city of Philadelphia(14). Similarly, the Long-Evans rat strain was created using two female Wistar rats and a male caught on the campus of the University of California, Berkeley, and the Sprague-Dawley rat strain was started using rats captured at the Oscar Mayer company dump(15, 16).

Nematode. The first nematodes (*Caenorhabditis elegans*) used in research, in 1676, were found in a bottle of wine and dubbed "vinegar eels" by Antonie van Leeuwenhoek, the inventor of the microscope(17). The founders of the Bergerac strain were collected from garden soil

(18) and the founders of the Bristol strain were collected from mushroom compost (19).

Sand Fleas. Populations of sand fleas (*Parhyale hawaiensis)* are found in tropical waters worldwide. However, the lab cultures of Parhyale were developed by William Browne using animals that had opportunistically colonized the seawater filtration system of the Shedd Aquarium in Chicago, Illinois in 1997(20).

Yeast (*Saccharomyces cerevisiae*). Carl and Gertrude Lindegren, who started their work in yeast in the 1940s used commercial baking yeast from various locations to produce their laboratory strains. They also used strains previously isolated by Emil Mrak from rotting figs in Merced, California in the late 1930s. Another strain was isolated by C. Kurtzman from rotting bananas in Costa Rica (21).

South African clawed frog (*Xenopus laevis*). Populations of Xenopus thrive in slow-moving, turbid water, including many human-created waterways that have allowed for their expansion outside of their native habitat (22). By the time Xenopus became a popular laboratory model for developmental biology in the 1940s and 1950s, they were easily acquired from commercial labs in Europe and the United States using Xenopus for pregnancy testing. These animals were originally acquired from commercial dealers in South Africa to meet the demand(23).

Zebrafish (*Danio rerio*). Populations of zebrafish thrive in slow-flowing waterways with sandy substrates, including many human-created environments such as canals created for irrigation, paddy fields, and ponds created for aquaculture of other species (24). The original lab strain was purchased from a pet store in Oregon selling ornamental fish (25). Mitochondrial evidence suggests the source population was from near the capital city Kolkata (26).

Arabadopsis. The earliest seed collections were established by Friedrich Laibach, a German botanist. Laibach sent four strains to the Hungarian botanist Barna Györffy in 1955. When Dr. Györffy's student, George Rédei, set up his own lab at the University of Missouri, Columbia, in 1956, he brought seeds from one of these four strains (labeled Landsberg) with him. Subsequent work revealed that the Landsberg seeds were not isogenic, and they are the source for several wild-type lines (including the Columbia wild type) as well as Rédei's early mutants (e.g. Landsberg *erecta*). Although little is known from historical records about where Friedrich Laibach collected his seeds, genetics is helping address this gap. Lines developed from Laibach's seeds (including Columbia and Landsberg *erecta*) were used to develop the earliest Arabidopsis genome data resources(27) and subsequent comparisons between plants from different parts of the world have confirmed that the Columbia strain shares significant ancestry with individuals from North Germany (28).

Classification of captive populations

The definition can be used to assess the domestication status of any self-sustaining population. Captive populations are often sink populations that cannot sustain themselves without direct human intervention, and thus cannot be independently assessed for their position on the domestication spectrum. When individuals in captivity are a subpopulation of a self-sustaining population, their domestication status is that of the parent population. For example, a dog breed like poodles can be inferred to be domestic because the source population (dogs) is domestic, but poodles cannot be independently assessed for their domestication status.

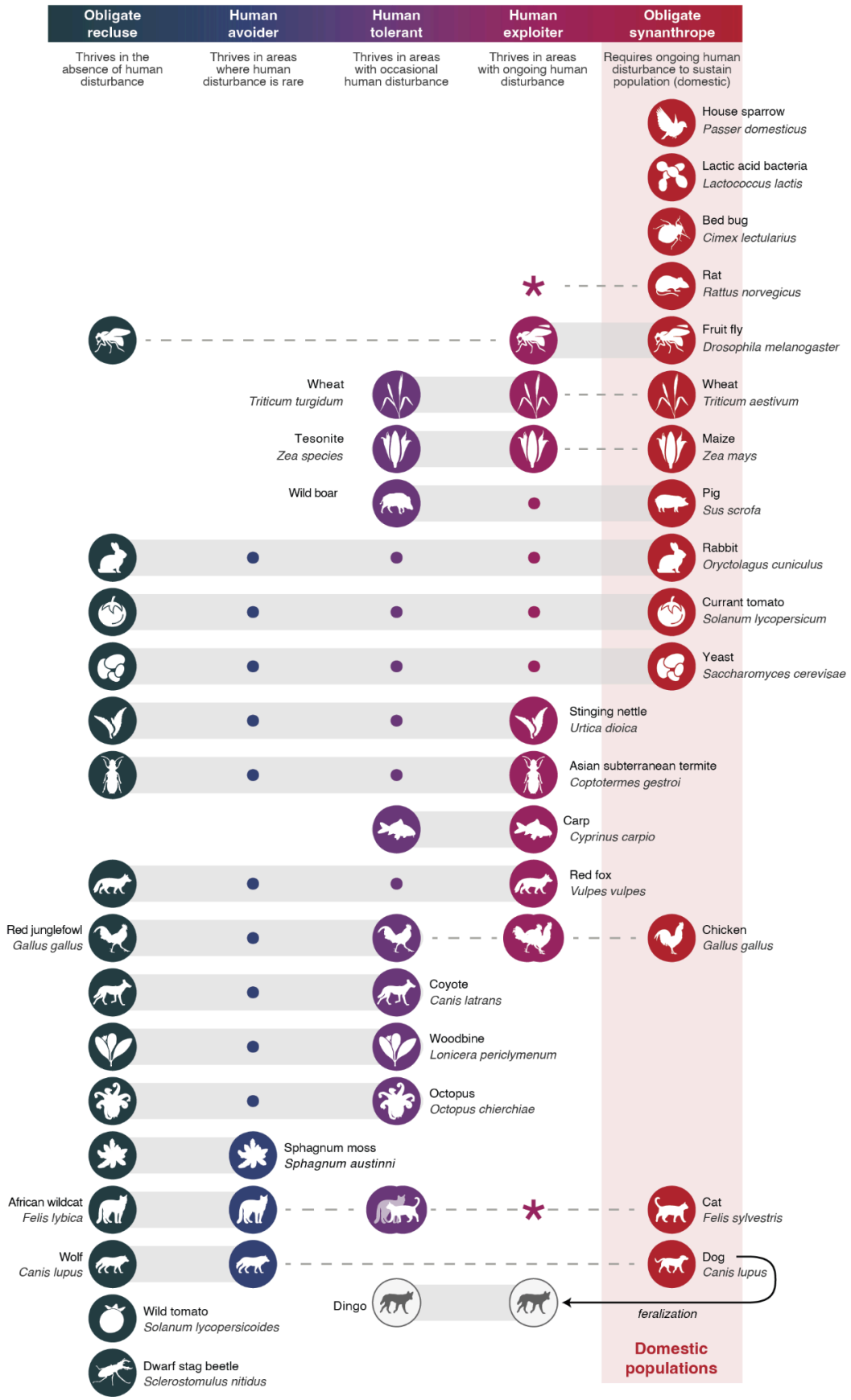
Obligate recluse
Thrives in the absence of human disturbance
Human avoider
Thrives in areas where human disturbance is rare
Human tolerant
Thrives in areas with occasional human disturbance
Human exploiter
Thrives in areas with ongoing human disturbance
Obligate synanthrope
Requires ongoing human disturbance to sustain population (domestic)
House sparrow
Passer domesticus
Lactic acid bacteria
Lactococcus lactis
Bed bug
Cimex lectularius
Rat
Rattus norvegicus
Fruit fly
Drosophila melanogaster
Wheat
Triticum turgidum
Wheat
Triticum aestivum
Tesonite
Zea species
Maize
Zea mays
Wild boar
Pig
Sus scrofa
Rabbit
Oryctolagus cuniculus
Currant tomato
Solanum lycopersicum
Yeast
Saccharomyces cerevisae
Stinging nettle
Urtica dioica
Asian subterranean termite
Coptotermes gestroi
Carp
Cyprinus carpio
Red fox
Vulpes vulpes
Red junglefowl
Gallus gallus
Chicken
Gallus gallus
Coyote
Canis latrans
Woodbine
Lonicera periclymenum
Octopus
Octopus chierchiae
Sphagnum moss
Sphagnum austinni
African wildcat
Felis lybica
Cat
Felis sylvestris
Wolf
Canis lupus
Dog
Canis lupus
Dingo
feralization
Wild tomato
Solanum lycopersicoides
Dwarf stag beetle
Sclerostomulus nitidus
Domestic populations

Figure S1. The domestication spectrum. This is an expanded version of Figure 2, illustrating how the new definition can be operationalized. Populations are categorized along a spectrum of domestication types defined by their relationship with anthropogenic environments. Each row is a species (or broader clade for maize and wheat). Circles (both with silhouettes or without) indicate that populations are described in the corresponding category. Gray areas show the likely range of the domestication spectrum occupied by populations in that species or subspecies. Dashed lines demarcate categories in species with wild and domestic subspecies for which no populations are observed. Overlapping circles with silhouettes represent populations with admixture between wild and domestic subspecies. Asterisks indicate that populations are observed in that category only as a result of human translocations.

Term	Type	Relationship between human and non-human populations
Parasitic	Asymmetric (+/-)	One population benefits and the other is harmed
Mutualistic	Symmetric (+/+)	Both populations benefit
Interspecific competition	Symmetric (-/-)	Both populations are harmed
Commensal	Asymmetric (+/0)	One population benefits and the other neither benefits nor is harmed
Amensalism	Asymmetric (-/0)	One population is harmed and the other neither benefits nor is harmed

Table S1. Mutualism is one of five types of symbiotic relationships that may exist between human and non-human populations. Identifying the type of symbiosis that characterizes a given relationship requires measuring its effect on the evolutionary fitness of both populations.

Neologism	Definition	Ref.	Species & populations described
#1 Auto-domestication	#1 Sudden appearance of tameness in a population of wild animals primarily through habituation	(29)	Bighorn Sheep (*Ovis canadensis canadensis*); Cape buffalo (*Syncerus caffer*)
	#2 When domestication occurs without human involvement	(30)	Cat
	#3 When members of a species manage the environment and reproductive opportunities of other members of the same species. Used to explain human morphological and behavioral phenotypes considered by author to be degenerate and maladaptive	(31)	Human
#2 De-domestication	#4 The establishment of a self-sustaining population of animals in the wild from a domestic source population, or the intentional creation of wild populations from a domestic source population (used interchangeably with re-wilding)	(32)	Heck cattle (*Bos taurus*); Konik horse (*Equus ferus*)
		(33)	European rabbit (*Oryctolagus cuniculus*) bred to be wild-type from domestic populations
	#5 The evolution of wild-like traits and the ability to live outside of human management (equated with feralization)	(34)	Dingo (*Canis lupus dingo*); feral Kauai chicken (*Gallus gallus*); Tibetan sheep (*Ovis aries*); Weedy eggplant (*Solanum melongena*); Tibetan semi-wild wheat (*Triticum aestivum*); Weedy rice (*Oryza sativa*)
	#6 The practice of releasing domestic populations into the wild or into a managed park to alter the ecosystem or for human sport or profit	(35)	Feral chickens in Hawaii; feral rabbits in Australia (*Oryctolagus cuniculus*); feral swine; Weedy rice (Oryza sativa)
	#7 The process of a domestic species evolving to no longer require human control. Used to explain why some domestic species have pest populations.	(36)	Cat; Dog; Fruit tree (Apple tree); Fruit tree (Olive tree); Fruit tree (Orange tree); Horse; Pig
	#8 Undergoing the evolutionary process of domestication in reverse	(37)	
#3 Endosymbiotic domestication	#9 A mutualistic relationship leading to an endosymbiotic relationship	(38)	Organelle (e.g. mitochondria)
#4 Hyper-domestic	#10 An abnormally high expression of traits associated with domestication in species that have undergone self-domestication	(39)	Human
#5 Hypo-fomestic	#11 An abnormally low expression of traits associated with domestication in species that have undergone self-domestication (as a result of reduced neural crest activity)	(40)	Human
#6 Peri-domestic	#12 Domestic populations that have evolved to become "wild", which is defined as no longer being in a mutualistic relationship with humans or under human control	(36)	Cat; Dog; Fruit tree (Apple tree); Fruit tree (Olive tree); Fruit tree (Orange tree); Horse; Pig
	#13 Outdoor environments near houses	(41)	Mosquito (Anopheles species)
	#14 Populations that are adapted to the human environment but are not under human control	(36)	Fruit fly (*Drosophila melanogaster*); House mouse (Mus musculus)
	#15 Undefined, but used broadly to refer to uncontrolled domestic populations and urban wildlife	(42)	Feral cat; Black rat (*Rattus rattus*); Gull (no species name); Squirrel (no species name)
#7 Pre-	#16 Before domestication (as determined by lack of	(43)	Gazelle (*Gazella gazella*) hunting

Neologism	Definition	Ref.	Species & populations described
domestication	physiological changes or not specified)	(44)	Domestic cattle (*Bos taurus*)
		(45)	Wild relative of domestic corn (*Zea mays* spp. *parviglumis*)
	#17 Early harvesting/cultivation/breeding of a species Not yet physically distinguishable as domestic. Used to explain why some genetic changes predate domestication in the archeological record	(46)	Javan porcupine (*Hystrix javanica*)
		(47)	Goat during the mid Pre-Pottery Neolithic B (no species name)
		(48)	Plants
		(49)	Wild plants
#8 Proto-domestication	#18 An evolutionary step that involves a non-human population living closer to humans without being controlled by humans	(50)	Dogs(*Canis lupus familiaris*)
		(51)	Fox (*Vulpes vulpes*)
	#19 An evolutionary step that involves a nonhuman population undergoing unconscious selective pressure from humans prior to intentional human selection	(52)	Landrace fruit
	#20 Populations that due to hybridization have both behaviors and morphological traits that are midway between the wild and domestic populations	(53)	Pig
	#21 Populations that undergo management and culling by humans, but do not experience any other human control	(43)	Gazelle (*Gazella gazella*)
		(47)	Gazelle (no species name); Goat (*Capra aegagrus*) in the Southern Levant; Nubian Ibex (*Capra ibex nubiana*)
		(54)	Truffle (*Tuber melanosporum*)
#9 Re-domestication	#22 Creating domestic populations with increased tameness by selectively breeding of the wild relatives of current domestic populations	(55)	Chicken (*Gallus gallus*)
	#23 Creating useful plant cultivars from the wild ancestors of current domestic populations	(56)	Cereals; Ground cherry (*Physalis pruinosa*); Tomato (no species name)
#10 Self-domestication	#24 Domestication occurring without any human involvement	(57)	
		(35)	
		(58)	Dog
	#25 Domestication through selection for prosociality and against aggression.	(59)	Belyaev's fox (*Vulpes vulpes*); Bonobos (*Pan paniscus*); Dog; Human
	#26 Selection for reduced aggression in wild populations leading to the development of traits associated with domestication	(60)	Bonobo (*Pan paniscus*)
	#27 Selection in human populations due to social pressure favoring less violence	(57)	Human
	#28 The production of domestication-associated traits in a population that is not captive nor under human control, but is experiencing selective pressures similar to those in populations that are captive or under human control	(61)	Human
	#29 When humans domesticate themselves	(35)	Human
	#30 When selection for increased sociality in wild species leads to the development of traits associated with domestication	(62)	African elephant (*Loxodonta africana* and *Loxodonta cyclotis*); Asian elephant (*Elephas maximus*)

Neologism	Definition	Ref.	Species & populations described
	#31 When selection for reduced fear in a wild species leads to the development of traits associated with domestication	(63)	Ansell's mole rat (*Fukomys anselli*)
	#32 When selection for tameness in a wild species results in the development of traits associated with domestication	(64)	Marmoset (*Callithrix jacchus*)
#11 Semi-domestication	#33 Populations of a non-domestic species that are being bred or cultivated in captivity	(65)	White-lipped peccary (*Tayassu pecari*)
		(66)	Fence post tree (*Gliricidia sepium*)
			Mango ginger (*Curcuma amada*)
		(67)	Deer mouse (*Peromyscus maniculatus bairdii*)
	#34 Populations that are no longer under human control, but that are still useful to humans	(68)	Passion fruit (*Passiflora edulis*)
		(66)	Lima bean (*Phaseolus lunatus*)
	#35 Populations that are under partial or indirect human control	(69)	Asian elephant (*Elephas maximus L.*); Camel (*Camelus spp. L.*); Hunted ungulate
		(70)	Mongoose (*Herpestes ichneumon*).
		(71)	Reindeer (*Rangifer tarandus*)
	#36 Populations that spend part of their life cycle indoors and part of it outdoors	(72)	Muga silk worm (*Antheraea assamensis*)
#12 Super-domestication	#37 Selection for increased usefulness using genetic editing technology	(73)	Canola (*Brassica napus L.*)
#13 Trans-domestication	#38 When a wild species is moved by humans out of its native range and is then undergoes domestication	(74)	Cluster or Guar bean (*Cyamopsis tetragonoloba*)

Table S2. Neologisms that modify the word domestication are common. We documented 13 of these terms with at least 38 distinct definitions. Many attempt to address the ambiguity inherent in earlier attempts to define domestication.

SI References

1. B. Bolman, Dogs for Life: Beagles, Drugs, and Capital in the Twentieth Century. *J. Hist. Biol.* **55**, 147–179 (2022).

2. G. E. Allen, The Introduction of Drosophila into the Study of Heredity and Evolution: 1900-1910. *Isis* **66**, 322–333 (1975).

3. E. H. Coe Jr, The origins of maize genetics. *Nat. Rev. Genet.* **2**, 898–905 (2001).

4. Z. Liang, J. C. Schnable, RNA-Seq Based Analysis of Population Structure within the Maize Inbred B73. *PLoS One* **11**, e0157942 (2016).

5. N. M. Springer, *et al.*, The maize W22 genome provides a foundation for functional genomics and transposon biology. *Nat. Genet.* **50**, 1282–1288 (2018).

6. H. Hedrich, *The Laboratory Mouse* (Academic Press, 2004).

7. H. C. Morse III, *Origins of Inbred Mice* (Elsevier, 2012).

8. D. P. Steensma, R. A. Kyle, M. A. Shampo, Abbie Lathrop, the “mouse woman of Granby”: rodent fancier and accidental genetics pioneer. *Mayo Clin. Proc.* **85**, e83 (2010).

9. “The Mouse Fancier of Granby” in Springfield Weekly Republican. *Chronicling America: Historic American Newspapers. Library of Congress* (1913). Available at: https://chroniclingamerica.loc.gov/lccn/sn83020847/1913-10-09/ed-1/seq-7/.

10. B. T. Clause, The Wistar Rat as a right choice: establishing mammalian standards and the ideal of a standardized mammal. *J. Hist. Biol.* **26**, 329–349 (1993).

11. Wistar Institute of Anatomy and Biology, *Memoirs. No. 1-7 ...: The rat; reference tables and data for the albino rat (Mus norvegicus albinus) and the Norway rat (Mus norvegicus) Comp. and ed. by H. H. Donaldson. 1915* (1915).

12. W. E. Castle, The domestication of the rat. *Proc. Natl. Acad. Sci. U. S. A.* **33**, 109–117 (1947).

13. R. Boice, Laboratorizing the wild rat (Rattus norvégiens). *Behavior Research Methods & Instrumentation* **3**, 177–182 (1971).

14. J. R. Lindsey, “Historical Foundations” in *The Laboratory Rat*, H.J. Baker, J.R. Lindsey, S.H. Weisbroth, Ed. (Academic Press, 1979), pp. 1–36.

15. L. Birke, Who—or What—are the Rats (and Mice) in the Laboratory. *Soc. Anim.* **11**, 207–224 (2003).

16. H. L. Foster, The history of commercial production of laboratory rodents. *Lab. Anim. Sci.* **30**, 793–798 (1980).

17. V. M. Nigon, M.-A. Félix, History of research on C. elegans and other free-living nematodes as model organisms. *WormBook* **2017**, 1–84 (2017).

18. A. T. Daigle, T. C. Deiss, R. H. Melde, U. Bergthorsson, V. Katju, Bergerac strains of Caenorhabditis elegans revisited: expansion of Tc1 elements imposes a significant genomic and fitness cost. *G3 (Bethesda)* **12** (2022).

19. D. L. Riddle, T. Blumenthal, B. J. Meyer, J. R. Priess, Eds., *C. elegans II* (Cold Spring Harbor Laboratory Press, 1997).

20. M. Paris, C. Wolff, N. H. Patel, M. Averof, “Chapter Eight - The crustacean model Parhyale hawaiensis” in *Current Topics in Developmental Biology*, B. Goldstein, M. Srivastava, Eds.

(Academic Press, 2022), pp. 199–230.

21. R. K. Mortimer, J. R. Johnston, Genealogy of principal strains of the yeast genetic stock center. *Genetics* **113**, 35–43 (1986).

22. G. Lobos, P. Cattan, C. Estades, F. M. Jaksic, Invasive African clawed frog Xenopus laevis in southern South America: key factors and predictions. *Stud. Neotrop. Fauna Environ.* **48**, 1–12 (2013).

23. J. B. Gurdon, N. Hopwood, The introduction of Xenopus laevis into developmental biology: of empire, pregnancy testing and ribosomal genes. *Int. J. Dev. Biol.* **44**, 43–50 (2000).

24. M. Arunachalam, M. Raja, C. Vijayakumar, P. Malaiammal, R. L. Mayden, Natural history of zebrafish (Danio rerio) in India. *Zebrafish* **10**, 1–14 (2013).

25. M. J. Crim, C. Lawrence, A fish is not a mouse: understanding differences in background genetics is critical for reproducibility. *Lab Anim.* **50**, 19–25 (2021).

26. A. R. Whiteley, *et al.*, Population genomics of wild and laboratory zebrafish (Danio rerio). *Mol. Ecol.* **20**, 4259–4276 (2011).

27. Arabidopsis Genome Initiative, Analysis of the genome sequence of the flowering plant Arabidopsis thaliana. *Nature* **408**, 796–815 (2000).

28. G. Shirsekar, *et al.*, Multiple Sources of Introduction of North American Arabidopsis thaliana from across Eurasia. *Mol. Biol. Evol.* **38**, 5328–5344 (2021).

29. M. Montgomery, *A Cow's Life* (Walker Books, 2009).

30. M. Gross, Shopping with hunter-gatherers. *Curr. Biol.* **32**, R596–R599 (2022).

31. R. G. Bednarik, A. Saniotis, M. Henneberg, Auto-domestication hypothesis and the rise in mental disorders in modern humans. *Med. Hypotheses* **164**, 110874 (2022).

32. C. Gamborg, B. Gremmen, S. B. Christiansen, P. Sandøe, De-Domestication: Ethics at the Intersection of Landscape Restoration and Animal Welfare. *Environmental Values* **19**, 57–78 (2010).

33. C.-G. Thulin, P. C. Alves, M. Djan, L. Fontanesi, D. Peacock, Wild opportunities with dedomestication genetics of rabbits: Rabbit dedomestication genetics. *Restor. Ecol.* **25**, 330–332 (2017).

34. D. Wu, S. Lao, L. Fan, De-domestication: An extension of crop evolution. *Trends Plant Sci.* **26**, 560–574 (2021).

35. E. Gering, D. Incorvaia, R. Henriksen, D. Wright, T. Getty, Maladaptation in feral and domesticated animals. *Evol. Appl.* **12**, 1274–1286 (2019).

36. M. D. Purugganan, What is domestication? *Trends Ecol. Evol.* **37**, 663–671 (2022).

37. E. O. Price, Behavioral development in animals undergoing domestication. *Appl. Anim. Behav. Sci.* **65**, 245–271 (1999).

38. M. Oborník, In the beginning was the word: How terminology drives our understanding of endosymbiotic organelles. *Microb. Cell* **6**, 134–141 (2019).

39. A. Niego, A. Benítez-Burraco, Williams syndrome, human self-domestication, and language evolution. *Front. Psychol.* **10**, 521 (2019).

40. G. Šimić, V. Vukić, J. Kopić, Ž. Krsnik, P. R. Hof, Molecules, mechanisms, and disorders of

self-domestication: Keys for understanding emotional and social communication from an evolutionary perspective. *Biomolecules* **11**, 2 (2020).

41. B. O. Manin, *et al.*, Investigating the contribution of Peri-domestic transmission to risk of zoonotic malaria infection in humans. *PLoS Negl. Trop. Dis.* **10**, e0005064 (2016).

42. A. Gamble, X. A. Olarte-Castillo, G. R. Whittaker, Backyard zoonoses: The roles of companion animals and peri-domestic wildlife. *Sci. Transl. Med.* **15**, eadj0037 (2023).

43. T. Dayan, D. Simberloff, Natufian gazelles: Proto-domestication reconsidered. *J. Archaeol. Sci.* **22**, 671–675 (1995).

44. B. Gutiérrez-Gil, J. J. Arranz, P. Wiener, An interpretive review of selective sweep studies in Bos taurus cattle populations: identification of unique and shared selection signals across breeds. *Front. Genet.* **6**, 167 (2015).

45. G. Michon, H. De Foresta, Agroforests: pre-domestication of forest trees or true domestication of forest ecosystems? *NJAS* **45**, 451–462 (1997).

46. W. R. Farida, R. Ridwan, Giving of formulated pellet on Javan Porcupine (Hystrix javanica F. Cuvier, 1823): Effects on feed intake, feed conversion, and digestibility in pre-domestication condition. *J. Biol. Indonesia* **7**, 157–170 (2011).

47. L. K. Horwitz, *et al.*, Animal domestication in the Southern Levant. *Paléorient* **25**, 63–80 (1999).

48. S. Manrique, *et al.*, Genetic insights into the modification of the pre-fertilization mechanisms during plant domestication. *J. Exp. Bot.* **70**, 3007–3019 (2019).

49. P. Smýkal, M. Nelson, J. Berger, E. Von Wettberg, The impact of genetic changes during crop domestication. *Agronomy (Basel)* **8**, 119 (2018).

50. F. Galibert, P. Quignon, C. Hitte, C. André, Toward understanding dog evolutionary and domestication history. *C. R. Biol.* **334**, 190–196 (2011).

51. L. N. Trut, Early Canid Domestication: The Farm-Fox Experiment: Foxes bred for tamability in a 40-year experiment exhibit remarkable transformations that suggest an interplay between behavioral genetics and development. *American Scientist* **87**, 160–169 (1999).

52. E. Kullaj, Fruit genetic resources of Albania. *Chronica Hortic* **48**, 20–23 (2008).

53. M. R. Jarman, “Prehistoric economic development in sub-alpine Italy” in *Problems in Economic and Social Archaeology*, G. de G Sieveking, I. H. Longworth, K. E. Wilson, Eds. (Duckworth, 1976), pp. 523–548.

54. E. Taschen, *et al.*, How the truffle got its mate: insights from genetic structure in spontaneous and planted Mediterranean populations of Tuber melanosporum. *Mol. Ecol.* **25**, 5611–5627 (2016).

55. B. Agnvall, J. Bélteky, R. Katajamaa, P. Jensen, Is evolution of domestication driven by tameness? A selective review with focus on chickens. *Appl. Anim. Behav. Sci.* **205**, 227–233 (2018).

56. T. Hanak, C. K. Madsen, H. Brinch-Pedersen, Genome Editing-accelerated Re-Domestication (GEaReD) - A new major direction in plant breeding. *Biotechnol. J.* **17**, e2100545 (2022).

57. L. Del Savio, M. Mameli, Human domestication and the roles of human agency in human evolution. *Hist. Philos. Life Sci.* **42**, 21 (2020).

58. M. Germonpré, M. Lázničková-Galetová, M. V. Sablin, H. Bocherens, “Self-domestication or human control? The Upper Palaeolithic domestication of the wolf” in *Hybrid Communities*, (Routledge,

2018), pp. 39–64.

59. B. Hare, Survival of the Friendliest: Homo sapiens Evolved via Selection for Prosociality. *Annu. Rev. Psychol.* **68**, 155–186 (2017).

60. B. Hare, V. Wobber, R. Wrangham, The self-domestication hypothesis: evolution of bonobo psychology is due to selection against aggression. *Anim. Behav.* **83**, 573–585 (2012).

61. J. Thomas, S. Kirby, Self domestication and the evolution of language. *Biol. Philos.* **33**, 9 (2018).

62. L. Raviv, *et al.*, Elephants as an animal model for self-domestication. *Proc. Natl. Acad. Sci. U. S. A.* **120**, e2208607120 (2023).

63. G. Serrano Nájera, K. Kin, Unusual occurrence of domestication syndrome amongst African mole-rats: Is the naked mole-rat a domestic animal? *Front. Ecol. Evol.* **10** (2022).

64. A. A. Ghazanfar, *et al.*, Domestication phenotype linked to vocal behavior in marmoset monkeys. *Curr. Biol.* **30**, 5026–5032.e3 (2020).

65. W. Balée, The culture of Amazonian forests. *Advances in Economic Botany* **7**, 1–21 (1989).

66. W. A. Moyon, E. Chara, N. K. Moyon, R. K. Moyon, Ethnobotanical resources: Edible plants consumed by the Moyon Naga tribe of Manipur (India) and Myanmar. *Int. J. Bot. Stud.* **6**, 1–9 (2021).

67. E. Price, The effect of reproductive performance on the domestication of the prairie deermouse, Peromyscus maniculatus bairdii. *Evolution* **21**, 762–770 (1967).

68. W. A. Moyon, E. Chara, Indigenous fishing methods of the Moyon tribe of Manipur (India) and Myanmar. *Society & Sustainability* **3**, 54–67 (2021).

69. A. Mysterud, Still walking on the wild side? Management actions as steps towards "semi‐domestication" of hunted ungulates: "Semi-domestication" of hunted ungulates. *J. Appl. Ecol.* **47**, 920–925 (2010).

70. B. Rosen, Reidentified animals in the "Orpheus mosaic" from Jerusalem. *Isr. Explor. J.* **34**, 182–183 (1984).

71. M. Weldenegodguad, *et al.*, Adipose gene expression profiles reveal insights into the adaptation of northern Eurasian semi-domestic reindeer (Rangifer tarandus). *Commun. Biol.* **4**, 1170 (2021).

72. D. Goswami, B. Rabha, V. Veer, "Muga silk- the golden thread of Assam" in *Bioprospecting of Indigenous Bioresources of North-East India*, J. Purkayastha, Ed. (Springer Singapore, 2016), pp. 279–294.

73. D. A. Vaughan, E. Balázs, J. S. Heslop-Harrison, From crop domestication to super-domestication. *Ann. Bot.* **100**, 893–901 (2007).

74. T. Hymowitz, The trans-domestication concept as applied to Guar. *Econ. Bot.* **26**, 49–60 (1972).