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An overview on species hybridization in animals

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Abstract
Species hybridization is the breeding between two distinct species that produce progeny, regardless of the fertility of progeny. It occurs worldwide either spontaneously due to habitat fragmentation and the small population size of animals or by captive breeding where progenies of combined ancestry utilize hybrid vigour to improve their performances in comparison to their parents. However, the reproductive and fitness traits in progeny were found to reduce greatly due to their uneven number of chromosomes and the interaction between genes received from parents. The paper in this context gives a brief knowledge of the various aspects of species hybridization and hybrids found all over the world.

Keywords: Species hybridization, reproductive traits, fitness traits, hybrid vigour, hybrids

Introduction
A Cross made between genetically diverse populations represents species hybridization (Harrison, 1993) [1]. Species hybridization, either spontaneous or anthropogenic, tends to produce newer breeds but at the same time, it is deemed to destroy the genetic integrity of parental species (either wild or domestic) (Wakchaure and Ganguly, 2017) [2]. The produced offspring (hybrids) are fit but differ from parental species in terms of breeding ability i.e. they fail to breed with the members of parental species (Wikipedia, 2019a) [3]. Though hybridization is seen in plants and animals, it is regarded as a matter of interest in plants and not so among animals (Mallet, 2005) [4]. It is well supported by the fact that hybrids are rarely fertile (mostly sterile), as are incapable of producing sperm and egg due to the uneven number of chromosomes. Males, in this context, are usually always infertile. Windsor (2019) [5] enlightens this fact and considers the failure of chromosomal pairing at the pachytene stage of meiotic prophase as the possible reason for azoospermia led infertility. Accordingly, females also suffer from the death of oogonia during meiosis. However, possibilities of the mature follicles in adult females have also been reported by some researchers. These hybrids, by nature, are polyphyletic as the distinct parental species are crossed without sharing any common ancestry (Wikipedia, 2019a) [3]. Species hybridization is however very infrequent in the wild due to various reasons such as, different mating seasons and intrauterine environments of species, species wise differences in the acrosomes of spermatozoa as well as enzymes required by spermatozoa to penetrate ova, treating spermatozoa of a species as a foreign body by the female of other species etc. The paper in this context gives a brief knowledge of the various aspects of species hybridization and hybrids found all over the world.

Types of species hybridization: Broadly, two types of species hybridization are studied and discussed under given heads:

1. **Natural hybridization:** Natural hybridization represents natural breeding between two distinct populations or species or higher-ranking taxa that ultimately handovers the interspecific genomes to offspring, thereby causing changes in their genotype and phenotype. In this context, the production of diploid, triploid and tetraploid hybrids are the result of changes in genotype, whereas, utilization of hybrid vigour to exhibit improvement in survival, growth rate, disease resistance, etc. of offspring represents changes in the phenotype (Liu, 2010) [6].
2. **Anthropogenic hybridization:** This is explained by the steps taken by animal breeders such as, habitat fragmentation and species introduction which results in breeding between distinct species, and is generally done in a controlled environment as recommended by the

Animal breeders (Paul and Holdren, 1971) [7]. This has seriously affected the conservation of genetics of populations, no matter if it was done with a good heart for use as biological control or done without a deliberate mind, as with accidental evasion of animals.

Reasons for species hybridization

1. **Small population size:** Poorly developed habitats or ones that are destroyed under natural calamities lead to escape of species to other habitats, thereby reducing their size of populations in the original habitat. This has been revealed as the possible cause for lesser mate availability and narrow sex ratios which ultimately is a cause for breeding between distinct species (Jansson *et al*., 2007) [8].
2. **Habitat fragmentation and species introduction:** There's not just one but several reasons for the habitat fragmentation such as, increasing rate and intensity of deforestation, desertification, eutrophication, urbanization, water and oil extraction, etc. that has led the animal species to migrate or evade or introduce to newer surroundings. This increases the sex ratio of distinct species in the newer surroundings that seriously affect the population and leads to inter-species breeding.
3. **Anthropogenic hybridization:** It is synonymously known as artificial or human-led hybridization that delivers a helping hand to the researchers to study reproductive compatibility between species (Grabenstein and Taylor, 2018) [9].
4. **Visual, chemical and acoustic interferences:** We all are well acquainted with the importance of visual, chemical and acoustic cues in sexual signaling. Any interference in these cues reduces the ability of species existing at the same time to differentiate between the same and opposite species, thus leading to species hybridization. This is however only reported in aquatic taxa (Grabenstein and Taylor, 2018) [9].

Breeding strategy for species hybrids: Forsdyke (2000) [10] mentioned in his literature about the breeding between closely related species and considered human interventions and sharing of overlapping habitat as the possible reasons. Besides, the desirable impact of the pairing of favourable genes received from parental species was also given importance in his literature. However, he also brought restricted fertility in homogametic sex as a serious matter of concern in front of the peoples which was later found to overcome by repeated backcrossing to animals from one of its parent species (called introgression) till a fertile hybrid population is established.

Advantages of species hybridization: The advantages of species hybridization are as below:

1. **Evolution of new interspecific breed:** Mating of two distinguished species produces new interspecific breeds like, mule, hinny, etc.
2. **Hybrid vigour:** The hybrids utilize hybrid vigour to become stronger, hardier and more productive than the parents.
3. **Enhanced longevity and immunity to diseases:** The hybrids have increased longevity and are highly immune to diseases.

Limitations of species hybridization: The limitations of species hybridization are as below (Anonymous, 2019a) [11]:

1. **Genetic extinction:** Genetic extinction or loss of native species is favoured by the production of hybrid swarms. Hybrid swarms are the group of animals that are hybrid to various degrees and the hybrids are considered to extinct their parental populations.
2. **Outbreeding depression:** Hybrids arise from the cross between genetically distant populations show a reduction in fitness and reproductive isolation in comparison to their parents. This is termed as outbreeding depression.

Examples of species hybridization: Several species hybrids have been produced in this context and are tabulated below in table no. 1.

Table 1: Examples of species hybridization

S. No.	Hybrid and its origin	Parents		Hybrids					
		Sire	Dam	C. No.	Fertility	B. wt. (kg)	Particulars	Utility	Adaptability
01.	Hinny (Africa)	Stallion	Jennet	63 [12]	Both infertile [13]	NA	Poor man's mule, more tolerant to water scarcity than mules, smaller than mule, more like donkey [12]	Draught animal, cow working competition [12], pet	Dry, desert climate [12]
02.	Mule (Africa)	Jack	Mare	63 [12]	Both infertile [14] (Rarely fertile female) [15]	370-460 [14]	Best choice for work, more like horse [12]; Inherits sure-footedness and intelligence from donkey and, speed, conformation and agility from horse [14]	Draught animal, pet [12]	Dry, desert climate [16]
03.	Geep	Buck (Goat)	Ewe (Sheep)	57 [17]	May be infertile or fertile [18, 19]	NA	Usually stillborn [20]; Less conception rate [21]; Outer coarse coat and inner woolly coat, very high libido, tail hangs down [18]	NA	NA
04.	Liger (19th century)	Lion	Tigeress	38 [22]	Male-infertile, female-fertile [23]	320-340 [23]	Largest in feline family, strength of lion and speed of tiger [24]; Social like lion and	No conservation value, no breeding value [27]	Do not occur in wild, live in captivity [28]

							swimmer like tiger [23]; Length of male- 3-3.6m [25]; Spotted bellies and striped back [26]		
05.	Tigon (19th century)	Tiger	Lioness	38 [29]	Male-infertile [30], female-fertile [31]	90-230 [32]	Smaller than parents due to growth inhibitory hormones received from both parents [30]; Length, in general- 1.2-2.7m [32]	No conservation value, no breeding value [27]	Do not occur in wild, live in captivity [33]
06.	Yakalo (19th century)	Tibetan yak	American bison/ buffalo	60	Male-infertile, female-fertile [34]	NA	Outcome of hybridisation experiments [35]; Tolerates heavy winters [36]	Meat [36]	Mountainous regions
07.	Beefalo/Cattalo (18th century)	Domestic cattle (*Bos Taurus*)	American bison/ Buffalo	60 [37]	Male-rarely fertile, female-fertile [38]	Birth: 18-27 Adult680-907 [39]	37.5% inheritance from bison and 62.5% from cattle, cattle in appearance [38], docile [40]; Lower infant mortality rate [41]; Heat and cold tolerant, non-selective grazers, excellent rate of gain in calves, no or little grain feeding [42]	Meat (Beef): 4-6% more protein, more tender, flavoured and nutritious [43], less calorie, fat and cholesterol [44] than a standard steer; Skin [45]	Harsh climates with less feed availability [46]
08.	Yakow/ Yattle	Yak	Domestic cattle	60	Male-infertile, Female-fertile [47]	Upto 590 [48]	Male hybrid is termed as Dzo and female hybrid is Dzomo [48]; Larger and stronger than parents [47]	Milk [48] and meat [49] (low fat and cholesterol than beef) purpose; Pack animal, dried dung used as source of fuel, provides hide and fiber [48]	Mountainous regions, survives on the altitude of more than 10000 feet [48]
09.	Zubron (1847)	European bison (Wisent) [50]	Domestic cattle [50]	60	Male-infertile, Female-fertile [51]	810-1200 [51]	Males obtained from backcrossing female zubron are fertile [51]; European bison in appearance, Extremely heavy breed, more hardiness, extremely resistant to diseases and pest [52]	Meat [53]	NA
10.	Leopon (Kolhapur, India; 1910)	Leopard	Lioness	38	Both fertile [54]	NA	Head resembles to that of a lion, spotted body like leopard (smaller, closer and brown coloured spots), tufted tail [55]; Excellent climbers and swimmers [56]	Only for public display [57]; No conservation value [58]	Do not occur in wild, live in captivity [59]
11.	Jaglion/ Jaguon (Bear Creek Wildlife Sanctuary, Barrie Ontario, Canada; 2006)	Jaguar	Lioness	38	NA	86-140 [60]	Jaguar like rosettes, lion's background colour, female hybrid is a melanistic jaglion inheriting dominant melanism gene of jaguar [61]; Height- 1.10-1.22m [60]	Only for public display [62]; No conservation value [58]	Do not occur in wild, live in captivity [60]
12.	Savannah cat (1980)	Domestic cat	African wild cat/ Serval cat	38 [63]	Male-F_1 to F_3-infertile, F_4 to F_7-fertile, Female-fertile [64]	3.6-9 [65]	Dog-like personality, Large to medium sized, spotted body with short and soft coat i.e. cheetah like appearance, very intelligent and expensive cat (F_1 and F_2 – $ 20,000/ cat), banned in Hawaii, Massachusetts,	Exotic pet (World's tallest domestic cat breed) [66]	Captivity, mostly in houses

							Georgia, New York [65, 64]		
13.	Zedonk/ Zonkey (18th century)	Zebra	Donkey	47-54 (depending upon species of zebra) [67]	Male- infertile, female- poorly fertile [67]	226-318 [68]	Looks like donkey, zebra stripes on its legs and face [69]; Behaves like zebra [70]; Difficult to handle [67]	Riding, draft animals and for public display in circuses and zoos [67]	Wild and captivity [68]
14.	Zorse (18th century)	Zebra	Horse	54 [71]	Both infertile [72]	227-450 [72]	Zebra like stripes on body, natural resistance to nagana disease (transmitted by tse-tse fly) inherited from zebra, excellent sense of hearing and smell, skin type- fur, social behaviour [72]	Riding, draft animals and for public display in zoos [72]	Do not occur in wild, live in captivity [72]
15.	Zony/ Zetland (18th century)	Zebra stallion	Shetland pony mare	54 [67]	Both infertile [73]	NA	Riding zonies are produced from medium sized pony mares [73]; Zony resembles pony parent, zebra stripes on body [74]	Riding [73]	Do not occur in wild, live in captivity
16.	Cama (Camel Reproduction Centre, Dubai)	Dromedary camel (one humped)	South American llama	74 [75]	Both fertile [76]	82-454 [75]	Covered with soft fur, humpless, produced from artificial insemination [75]; Camel like temperament [77]	Pack animal, production of soft fleece, may be used for herding cattle [75]	Harsh desert climate [75]
17.	Wholphin (Tokyo Sea World; 1981)	False killer whale (not a whale but a second biggest dolphin species)	Bottlenose dolphin	44 [78]	Male- NA, Female- fertile [79]	272 [79]	Length- 3.65- 6.70m, whale like eyes, 66 teeth, carnivore [79]; No whale DNA [78]	It's a natural mating and not with a purpose	Ocean but found in captivity in Sea Life Park [80]
18.	Mulard/ Moulard/ Mule ducks	Muscovy duck	Mallard duck (generally used American Pekin)	80	Both infertile [81]	4-7 [82]	Produced naturally but artificial insemination is also used [81]; Incubation period of hybrid eggs- 32 days [83]; Hatchability of chicks under hen- 60% and in incubator- 100%, quiet and clean breed [82]	Females- for meat purpose, Males- for luxury food named foie gras (made from the liver of duck) [82]	Do not occur in wild, live in captivity [82]
19.	Jatsa/ Jatsamin	Mithun	Siri cow	NA	Male- infertile, female- fertile [2]	NA	Male hybrid is called Jatsa, female hybrid is called Jatsamin [2]	Jatsa- Draft purpose, Jatsamin- high milk production and fat content [2]	NA
20.	Iron age pig (1980)	European wild boar	Tamworth sow	37 [84]	NA	NA	Aggressive and hard to handle [85]; Slow growing [86]; Piglets are born with stripes that disappear with age [87]	Distinctive gamey pork [86],	NA
21.	Coydog (America)	Coyote	Dog	78	Both fertile [88]	10.7 (female) – 16.2 (male) [89]	Dog do not form pair bonds with coyote, pup survival rate is low [90]; Bushy tail [91]	Good temperamental loyal gaurdians [92]	Wild [93]
22.	Grolar bears	Grizzly bear	Polar bear	74 [94]	Both fertile [95]	181-680 [96]	Better adaptation to warmer climate, weak swimmer, thick, creamy-white fur with brown patches around eyes, humped back [96]	NA	Wild and captivity both [97]

Note: C. No. = Chromosome number; B. wt. = Body weight; NA = Not available

Conclusion

Species hybridization is possibly the widest form of outbreeding and produces interspecific hybrids with lower fitness and restricted fertility as compared to their parents. However, they are also believed to utilize hybrid vigour and show enhanced performances than their parents. Though, species hybridization occurs in both plants and animals either naturally or by human led activities, it is given less

importance in animals as the hybrids produced are rarely fertile (mostly sterile) than plants. In this context, several literatures suggest repeated backcrossing of hybrids to the members of one of the parent species as the possible solution for establishing a fertile hybrid population. Besides, species hybridization is believed to be a cause for the loss of native species.

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References

1. Harrison RG. Hybrids and hybrid zones: Historical perspective. In: Harrison RG ed. Hybrid Zones and the Evolutionary Process. New York: Oxford University Press, 1993.
2. Wakchaure R, Ganguly S. A review on species hybridization. In: Proceedings of state level seminar on Recent Trends in Zoology, Mula Education Society's Shri Dnyaneshwar Mahavidyalaya, Newasa, Ahmednagar, Maharashtra, India, 20th January, 2017.
3. Wikipedia. Hybrid speciation. Wikipedia, 2019a. https://bit.ly/2G0izjy.
4. Mallet J. Hybridization as an invasion of the genome. Trends in Ecology & Evolution. 2005; 20(5):229-237.
5. Windsor P. Abnormalities of development and pregnancy. Veterinary Reproduction and Obstetrics. 10th Edn., Elsevier, Saunders Publishing, United States, 2019.
6. Liu SJ. Distant hybridization leads to different ploidy fishes. Science China Life Sciences. 2010; 53:416-425.
7. Paul E, Holdren J. Impact of population growth. Science. 1971; 171(3977):1212-1216.
8. Jansson G, Thulin CG, Pehrson A. Factors related to the occurrence of hybrids between brown hares *Lepuseuropaeus* and mountain hares *L-timidus* in Sweden. Ecography. 2007; 30:709-715.
9. Grabenstein KC, Taylor SA. Breaking barriers: Causes, consequences, and experimental utility of human-mediated hybridization. Trends in ecology & evolution. 2018; 33(3):198-212.
10. Forsdyke DR. Haldane's rule: Hybrid sterility affects the heterogametic sex first because sexual differentiation is on the path to species differentiation. Journal of Theoritical Biology. 2000; 204:443-452.
11. Anonymous. Hybridization and genetic extinction. 2019a. https://bit.ly/2XBgcyx. Accessed on 09 July, 2019.
12. McLean AK. Comparing the physiological and biochemical parameters of mules and hinnies to horses and donkeys. In: Proceedings in the Donkey and Mule Welfare Symposium, Hydra, Greece, October, 2015.
13. Wikipedia. Hinny. Wikipedia, 2019b, https://bit.ly/2KQi0ud.
14. Wikipedia. Mule. Wikipedia, 2019c, https://bit.ly/2odNlxp.
15. BBC News. Morocco's miracle mule. BBC News, 2002, https://bbc.in/2HeBQyl. Accessed on 18 August, 2019.
16. Hiskey D. Difference between a donkey and a mule. Today I Found Out, 2012. https://bit.ly/2Z7OO6Z.
17. Mine OM, Kedikilwe K, Ndebele RT, Nsoso SJ. Sheep–goat hybrid born under natural conditions. Small Ruminant Research. 2000; 37(1-2):141-145.
18. Amos J. Funny creature toast of Botswana. BBC News. 2000. https://bbc.in/2NfzgvC. Accessed on 18 August, 2019.
19. Tucker EM, Denis B, Kilgour L. Blood genetic marker studies of a sheep-goat hybrid and its back-cross offspring. Animal Genetics. 2009; 20(3):179-186.
20. BBC News. Geep: Rare 'goat-sheep' born on Irish farm. BBC News. 2014. https://bbc.in/2HdhHIN. Accessed on 18 August, 2019.
21. McCarthy EM. Goat-sheep hybrids. Macroevolution.net. 2019a. https://bit.ly/2KEvQRm. Accessed on 18 August, 2019.
22. Anonymous. Ligers genetics. Liger world. 2019b. https://bit.ly/2ZgIdeu. Accessed on 19 August, 2019.
23. Wikipedia. Liger. Wikipedia, 2019d, http://bit.ly/2NDAhOc.
24. Anonymous. Ligers: Info and facts. Ligerfacts.org. 2019c. https://bit.ly/2MozNvP. Accessed on 19 August, 2019.
25. Buhler M. Liger - The biggest cats in the world. Bestiarium, 2007. https://bit.ly/2KS5TNl.
26. Anonymous. Ligers. Messybeast.com, 2019d. https://bit.ly/1ipD9v6. Accessed on 19 August, 2019.
27. Anonymous. What is a tigon? Big Cat Rescue. 2012. https://bit.ly/2KWqss1. Accessed on 19 August, 2019.
28. Anonymous. Tigons and ligers. Evolution Library. 2019e. https://to.pbs.org/2NdYSJq. Accessed on 19 August, 2019.
29. Anonymous. Hybrid animals: Tigon. 2019f. https://bit.ly/2z5fSJH. Accessed on 19 August, 2019.
30. Anonymous. Hybrid species- Ligers and tigons. Turpentine Creek Wildlife Refuge. 2019g. https://bit.ly/2z9jrOQ. Accessed on 19 August, 2019.
31. Ghosh S, Sinha PC, Sinha A. The litigon rediscovered. Nature India, 2017. https://go.nature.com/2P41kou.
32. Grant D. What is a tigon? - Size, history and facts. Study.com. 2019. https://bit.ly/33Ku1dp. Accessed on 19 August, 2019.
33. Guggisberg CAW. Wild cats of the world. Taplinger Publishers, New York, USA, 1975.
34. Deakin A, Muir GW, Smith AG. Hybridization of domestic cattle, bison and yak. Report of Wainwright experiment. Publication 479, Technical Bulletin 2, Dominion of Canada, Department of Agriculture, Ottawa, Canada, 1935.
35. Wikipedia. Yakalo. Wikipedia, 2019e. https://bit.ly/2z6XqjK.
36. Brasch S. 10 farm animal hybrids you didn't know existed. Modern Farmer, 2014. https://bit.ly/2YY1RNc.
37. Anonymous. Hybrid animals: Beefalo. 2019h. https://bit.ly/2P3V1kI. Accessed on 20 August, 2019.
38. Wikipedia. Beefalo. Wikipedia, 2019f. https://bit.ly/2l9ppGM.
39. Anonymous. Beefalo facts. SoftSchools.com. 2019i. https://bit.ly/2HgpllN. Accessed on 20 August, 2019.
40. Brower J. Lost tracks: National buffalo park, 1909-1939. Athabasca University Press, 2008, 132-133.
41. Wikipedia. Bovid hybrid. Wikipedia, 2019g. https://bit.ly/2Z0kZKu.
42. Nichols J. Broadcasting the beefalo blog: Buffalo more than outstanding beef. Beefalo Northwest Association, 2018. https://bit.ly/2Mospk9.
43. O'Connor. Beefalo facts. Mother Earth News, 1981. https://bit.ly/2KYOMJt.

44. Anonymous. Why should you eat beefalo. Beefalo meats. 2019j. https://bit.ly/2P67e8B. Accessed on 20 August, 2019.
45. Irvine K. Beefalo cattle breed: Everything you need to know. Domestic Animal Breeds, 2019. https://bit.ly/30uWq4Q.
46. Jones CJB. Charles Jesse Buffalo Jones. Kansas Historical Society: Kansapedia, 2003. https://bit.ly/2Zf7EgE.
47. Madsen DB, Chen F, Gao X. Late quaternary climate change and human adaptation in arid china. Elsevier, 2007, 207.
48. Anonymous. Dzo facts. SoftSchools.com.2019k. https://bit.ly/2HgJ4Sq. Accessed on 20 August, 2019.
49. Mummolo J. Yattle what? Washington post.com, 2007. https://wapo.st/2Z81JuE.
50. Anonymous. Zubron: Zubron is a cross-breed hybrid of European bison and domestic cattle. Biologia Zubra. 2019l. https://bit.ly/2HgQgOm. Accessed on 21 August, 2019.
51. Wikipedia. Zubron. Wikipedia, 2019h. https://bit.ly/2HblsP5.
52. Forde K. Weird cow breeds: The zubron. That's Farming, 2018. https://bit.ly/2zbLkpv.
53. Łozicki A, Olech W, Dymnicka M, Florowski T, Adamczak L, Arkuszewska E, Niemiec T. Nutritive value and meat quality of domestic cattle (*Bos taurus*), zubron (*Bos taurus* × *Bison bonasus*) and European bison (*Bison bonasus*) meat. Agricultural and Food Science. 2017; 26(3):118-128.
54. Vargas J. Are leopons real? Quora, 2015. https://bit.ly/33NzYpR.
55. Wikipedia. Leopon. Wikipedia, 2019i. https://bit.ly/2Zknre7.
56. McCarthy EM. Leopon. Macroevolution.net, 2019b. http://www.macroevolution.net/leopon.html. Accessed on 21 August, 2019.
57. Broad M. What is a leopon? PoC- Cat Welfare at Heart, 2018. https://bit.ly/2L2eoVQ.
58. Actman J. Cat experts: Ligers and other designer hybrids pointless and unethical. National Geographic. 2017. https://on.natgeo.com/2ZnAbk4.
59. Anonymous. Hybrids between leopards and lions: Leopon. Messybeast.com. 2019m. https://bit.ly/30n4Xa3. Accessed on 21 August, 2019.
60. Darkness E. Hybrid animals: Jaglion (real). quotev.com. 2016. https://bit.ly/2L1svL7.
61. Wikipedia. Panthera hybrid. Wikipedia. 2019j. https://bit.ly/2Zi1ywa.
62. Broad M. Jaglion- A lion, jaguar hybrid. PoC- Cat Welfare at Heart. 2016. https://bit.ly/2ZchcJt.
63. Anonymous. Hybrid animals: Savannah cat. sites.google.com. 2019n. https://bit.ly/2Hj3Dh4. Accessed on 22 August, 2019.
64. Callaghan AO. Are savannah cats good pets?. The Happy Cat Site. 2018. https://bit.ly/2Mw5wey.
65. Anonymous. Savannah facts. SoftSchools.com. 2019o. https://bit.ly/2Zow7Qy. Accessed on 22 August, 2019.
66. Tuck M. Savannah cats: The world's tallest domestic cat breed. F1 Hybrids Savannah Cats. 2018. https://bit.ly/2KOAIDH.
67. Wikipedia. Zebroid. Wikipedia. 2019k. https://bit.ly/2Z4ZdVY.
68. Anonymous. Zonkey facts. SoftSchools.com. 2019p. https://bit.ly/2ZiN7bc. Accessed on 22 August, 2019.
69. Miller M. You say zedonk, I say zonkey: 5 Best hybrid animals. Big Think. 2010. https://bit.ly/2zdeKn9.
70. Shahan Z. Zebra/donkey hybrid: Zedonk. Planetsave. 2010. https://bit.ly/2Hk0bm6.
71. Wambugu DM. Is the zorse a real animal?. Worldatlas. 2018. https://bit.ly/2KNh9eT.
72. Anonymous. Zorse facts. SoftSchools.com. 2019q. https://bit.ly/2KQtYW5. Accessed on 22 August, 2019.
73. Anonymous. Zebroid (hybrids between zebra and other equus). Rare Animals. 2019r. https://bit.ly/2ZoZsKE. Accessed on 22 August, 2019.
74. Anonymous. Zony. Wild Animal Safari. 2019s. https://bit.ly/2Z8cld2. Accessed on 22 August, 2019.
75. Anonymous. Cama facts. SoftSchools.com. 2019t. https://bit.ly/2Zli4eC. Accessed on 22 August, 2019.
76. Bergeron C. Cross species hybridization: Camel-llama hybrid. University of Prince Edward Island, 2019. http://bit.ly/31X4njS.
77. Nelson B. 11 Amazing hybrid animals. Mother Nature Network, 2010. http://bit.ly/2TSJXWr.
78. Anonymous. Hybrid animals: Wolphin. sites.google.com. 2019u. http://bit.ly/2L8coMa. Accessed on 22 August, 2019.
79. Anonymous. Wholphin facts. SoftSchools.com. 2019v. http://bit.ly/2P9OCoe. Accessed on 22 August, 2019.
80. Anonymous. Family attractions in Oahu: Swim with dolphins in Hawaii. Sea Life Park Hawaii. 2019w. http://bit.ly/2L1qZcb. Accessed on 22 August, 2019.
81. Dohner JV. The encyclopaedia of historic and endangered livestock and poultry breeds. Yale University Press, New Haven and London, 2001, 457.
82. Anonymous. Growing mulard at home. About The Farm: Birds, Animals, Plants and Insects. 2019x. http://bit.ly/2ZezF96. Accessed on 22 August, 2019.
83. Wikipedia. Mulard. Wikipedia. 2019l. http://bit.ly/2L0uJL2.
84. Silva PVCD, Lui JF, Band GDO, Regitano LCDA, Grossi SDF, Sollero BP and Nunes CDS. Genetic variability among the wild boars (*Sus scrofa scrofa*), crossbred animals and pigs using microsatellite markers (STRs). Brazilian Archives of Biology and Technology. 2011; 54(2):301-306.
85. McDonald-Brown L. Choosing and keeping pigs. Firefly Books, North America. 2009. ISBN: 978-1-55407-469-3.
86. Hajdukiewicz M. Iron age pigs: This boar is no bore. Pocket Farm Magazine. 2015. http://bit.ly/2ZbkbSU.
87. McCurry-Schmidt M. Fun fact: Iron age pigs show ancient traits. American Society of Animal Science, 2013. http://bit.ly/2KNeMZF.
88. Young SP & Jackson HHT. The clever coyote. University of Nebraska Press, United States, 1978, 121-124.
89. Mahan BR, Gipson PS, Case RM. Characteristics and distribution of coyote x dog hybrids collected in Nebraska. American Midland Naturalist, 1978, 408-415.
90. Cartaino C. Myths & truths about coyotes: What you need to know about America's most misunderstood predator. Menasha Ridge Press, Birmingham, USA, 2010.
91. Fox MW. The dog: Its domestication and behavior. Dogwise Publishing, Wenatchee, Washington, USA,

1978.
92. Valadez R, Rodríguez B, Manzanilla L, Tejeda S. 13. Dog-wolf Hybrid Biotype Reconstruction from the Archaeological City of Teotihuacan in Prehispanic Central Mexico. Dogs and People in Social, Working, Economic or Symbolic Interaction, 2006, 121-131.
93. Zimmerman D. Eastern coyotes are becoming coywolves. Caledonian-Record. 2005. http://bit.ly/2TU5M80.
94. Anonymous. Hybrid animals: Grolar bear. sites.google.com. 2019y. http://bit.ly/2ZudxqA. Accessed on 23 August, 2019.
95. Clisset C. Pizzly bears: When polar bears and grizzlies breed, they can produce fertile offspring. Why can't other species? Slate, 2010. http://bit.ly/2KRO0Q1.
96. Anonymous. Grolar bear facts. SoftSchools.com. 2019z. http://bit.ly/2PpHuUX. Accessed on 23 August, 2019.
97. Wikipedia. Grizzly-polar bear hybrid. Wikipedia, 2019m. http://bit.ly/33MHAch.