

Supplementary information

Supplementary table 1: Diseases infecting equids that are transmitted by biting flies in Africa

Disease Name	Transmitted by:					Known in zebra?	Disease effects in equids:	Disease effects in artiodactyls:
	Horsefly	Tsetse Fly	Stable Fly	Mosquito	Midge			
Trypanosomosis: Nagana	Yes ¹	Yes ²				Yes ³	Fever, weakness, lethargy, weight loss; eventual death in all domestics unless treated ³	Cattle, sheep, goats: similar symptoms ³ Many wild ungulates native to Africa show no evidence of harm ¹
Equine infectious anemia	Yes ⁴		Yes ⁴			Yes ⁵	Anemia, swelling, death, fetal abortion ⁶	Not known outside of equids ¹
African horse Sickness*	Yes ⁷				Yes ⁸	Yes ¹	Fever followed by dyspnea and spasmodic coughing. Death within a week, recovery rare. ¹ Zebra often experience inallarent form of disease with prolonged viremia ⁹	Disease unknown outside of equids ¹⁰ although antibodies detected in other animals ¹
Anaplasmosis	Yes ¹¹					Yes ²	Inappetence, loss of coordination, breathlessness when exerted, and a rapid bounding pulse ⁷	Cattle, sheep, goats, buffalo, and some wild ruminants: similar symptoms ¹
Anthrax	Yes ⁶					Yes ¹	Fever, sudden death ⁹	Cattle and sheep: same effects ¹
Babesiosis	Yes ⁷					Yes ⁷	Persistent fever, inappetence, weight loss ¹	Cattle, sheep, goats (wide range): similar symptoms ¹
Equine Influenza	Yes ²					Yes ¹	Respiratory infection, fatal particularly in zebras ¹	Not known outside of equids ¹
Eastern Equine Encephalitis				Yes ¹		Yes ¹²	paralysis, seizures, and death Mortality 90% ¹	Other arboviruses cause diseases in other animals. Those that cause EEE are transmitted by mosquitoes and birds, and can infect other mammals ¹
Equine Encephalosis*					Yes ⁷	Yes ¹³	One to five days of fever, inappetence, sometimes females abort. Infects all equids. Clinical signs only seen in horses ¹³	Not known outside of equids, although some evidence elephants may become infected ¹³
Trypanosomosis: Dourine*	Yes ⁷					Likely ²	Paralysis, progressive emaciation. Fatality 50-70% ¹	Not known outside of equids ²
Trypanosomosis: Surra	Yes ¹⁴	Yes ¹⁴	Yes ¹⁰			Not known	Fever, weakness, lethargy, weight loss; fatal when not treated ¹⁵	All domestic animals susceptible, similar symptoms ¹

* disease found only in Africa

Supplementary note 1:

Photograph sources

Photographs used for scoring animal pelage were obtained from reputable sources (see the list below) on the internet and print. “Reputable” sources are those such as encyclopedic websites, published mammalogy books, zoo websites, national park websites, and other peer-reviewed sources; no image was taken from an individual’s personal or unidentified website. Only photographs with accurately identified animals where the entire animal could be seen were used. Only one animal per photograph was scored. Superscripts refer to references not found in the main text. Sources used are:

Plains Zebra: Damara (*Equus burchelli antiquorum*)

Macdonald (1984)¹⁶ p. 120

Groves (1974) p. 72

Madamzebra.com

flickr.com

123rf.com

biology4kids.com

oregonzoo.com

zooinstitutes.com (cincinatti)

zooinstitutes.com (Izhevsk)

zooinstitutes.com (Riga)

zooinstitutes.com (Philly)

zooinstitutes.com (Kerkrade)

Plains Zebra: Burchell’s (*Equus burchelli burchellii*)

Macdonald (1984)¹⁶ p. 109

theequinest.com

petermass.nl (photo of specimen from Berlin's Museum fur Naturkunde)

biopix.com

treknature.com

pawsforwildlife.co.uk

biolib.cz

calphotos.berkeley.edu

wikipedia.org

commons.wikimedia.org

Plains Zebra: Chapman’s (*Equus burchelli chapmannii*)

Macdonald (1984)¹⁶ p. 132

shoarns.com
 zoobarcelona.cat
 theequinest.com
 wikipedia
 zoochat.com
 de.wikipedia.org
 zoo-safari.com.pl (upper)
 jameshagerphoto.com
 biolib.cz
 arkive.org

Plains Zebra: Crawshay's (*Equus burchelli crawshayi*)

Madamzebra.com
 theequinest.com
 arkive.org
 wikipedia
 pawsforwildlife.co.uk
 en.wikipedia.org
 africaimagelibrary.com

Plains Zebra: Upper Zambezi (*Equus burchelli zambeziensis*)

<http://www.africabespoke.com/wp-content/uploads/2009/05/Lochinvar-National-Park-150x150.jpg>
<http://www.jenmansafaris.com/african-countries/tanzania/attractions/saadani-national-park.html>
<http://www.zambia-the-african-safari.com/images/zebras2.jpg>
<http://www.noble-minded.org/photography.html>
<http://www.sunsafaris.com/safari/zambia/kafue-national-park/>
<http://www.yukiba.com/7433-zambia-africa-photo.html>
<http://www.rainbowsafaris.biz/Kafue.html>
<http://www.justluxe.com/travel/luxury-vacations/feature-1428217.php>

Plains Zebra: Grant's (*Equus burchelli boehmi*)

Macdonald (1984)¹⁶ p. 132
 Madamzebra.com
 treknature.com
 theequinest.com
 en.wikipedia.org
 brightszoo.com
 wikipedia.com
 naturephoto-cz.com
 pawsforwildlife.co.uk
 johnwasserman.com
 zoochat.com

Plains Zebra: Quagga (*Equus burchelli quagga*) EXTINCT

Macdonald (1984)¹⁶ p. 137

Groves (1974) p. 72

<http://www.quaggaproject.org/>; Amsterdam specimen

<http://www.quaggaproject.org/>; Bamberg specimen

<http://www.quaggaproject.org/>; Basle specimen

<http://www.quaggaproject.org/>; Berlin specimen

<http://www.quaggaproject.org/>; Darmstadt

<http://www.quaggaproject.org/>; Edinburgh

<http://www.quaggaproject.org/>; Frankfurt

<http://www.quaggaproject.org/>; Kazan

<http://www.quaggaproject.org/>; Leiden

<http://www.quaggaproject.org/>; Mainz

Grevy's Zebra (*Equus grevyi*)

Macdonald (1994)¹⁶ p. 110

Macdonald (1994)¹⁶ p. 119

Macdonald (1994)¹⁶ p. 128

Macdonald (1994)¹⁶ p. 134

Hosking & Withers; Larger Mammals of East Africa p.77

wikipedia

art.com

carnivoraforum.com

wikimedia commons.org

madamzebra.com

theequinest.com

Mountain Zebra: Hartman's (*Equus zebra hartmannae*)

Macdonald (1984)¹⁶ p. 111

Groves (1974) p. 71

Nowak (1999)¹⁷ p. 1021

Frandsen (1992)¹⁸ p. 144

biodiversityexplorer.org

Madamzebra.com (upper)

madamzebra.com (lower)

shoarns.com

zoochat.com

arkive.org

Mountain Zebra: Cape (*Equus zebra zebra*)

Macdonald (1984)¹⁶ p. 123

Macdonald (1984)¹⁶ p. 133

Groves (1974) p. 71

Maberly & Goss (1986)¹⁹ (plate)

Frandsen (1992)¹⁸ p. 142

Madamzebra.com

biodiversityexplorer.org

sout-africa-tours-and-travel-com

arkive.org

African Wild Ass: Somali (*Equus africanus somaliensis*)

sandiegozoo.org
 ln.wikipedia.org
 arkive.org
 okapia.wordpress.com
 zoochat.com
 en.wikipedia.org
 treknature.com
 biolib.cz
 factzoo.com
 theequineest.com

African Wild Ass: Nubian (*Equus africanus africanus*)

Kimura et al. (2010) fig. 1
<http://dpc.uba.uva.nl/cgi/t/text/text-idx?c=zoomed;sid=b1971dea61cd3bc2aa0902085c8e9883;rgn=main;idno=m8101a06;view=text>
 Groves (1974)
 egyptheritage.com
 mustangs4us.com
 animalinfo.org
 biogeodb.stri.si.edu
 flickr.com

African Wild Ass: Atlas (*Equus africanus atlanticus*) EXTINCT

Kimura et al. (2010) (drawing, fig 1)

Przewalski's Horse (*Equus ferus przewalskii*)

IUCN p. 82
 en.wikipedia.org
 worldwildlife.org
 quantum-conservation.org
 conservationcenters.org
 arkive.org
 britannica.hk

Kiang: Eastern (*Equus kiang holdereri*)

arkive.org
http://animaldiversity.ummz.umich.edu/site/resources/david_blank/kiang.jpg/view.html
 cs.wikipedia.org
 biolib.cz
 zt.tibet.cn
 etc.usf.edu

Kiang: Western (*Equus kiang kiang*)

<http://wgbis.ces.iisc.ernet.in/energy/water/paper/TR123/section5.htm>
<http://www.asmjournals.org/doi/abs/10.1644/835.1.?journalCode=mmssp>
 wildlife of the tibetan steppe, by Schaller

Kiang: Southern (*Equus kiang polyodon*)
Schaller (1998)²⁰ p.169

Asiatic Wild Ass: Mongolian Khulan (*Equus hemionus hemionus*)
arkive.org

Asiatic Wild Ass: Gobi Khulan (*Equus hemionus leuteus*)
http://reino-animal.webege.com/detalle.php?id_especie=110
<http://www.cryptomundo.com/cryptozoo-news/kulan-zoo/>
<http://dtbook.egloos.com/9326537>
<http://www.equids.org/aswildass.php>
<http://www.zoobojnice.sk/cicavce/zivocich/kulan-turkmensky>
http://www.edgeofexistence.org/mammals/species_info.php?id=14

Asiatic Wild Ass: Kulan (*Equus hemionus kulan*)
arkive.org

Asiatic Wild Ass: Onager (*Equus hemionus onager*)
IUCN book p. 62
arkive.org

Asiatic Wild Ass: Indian (*Equus hemionus khur*)
IUCN book p. 63
arkive.org

Asiatic Wild Ass: Syrian (*Equus hemionus hemippus*) EXTINCT
http://en.wikipedia.org/wiki/Syrian_wild_ass
<http://www.biolib.cz/en/image/id172157/>

Supplementary note 2: Group sizes

Mean and maximum herd sizes respectively: *E. przewalski* 7.0, 20^{ref 21}; *E. zebra* 4.7^{ref 22}, 13^{ref 21}; *E. burchelli* 5.6^{ref 23}, 16^{ref 21}; *E. hemionus* 6.3, 850^{ref 24}; *E. grevyii* 5.1^{ref 25}, 150^{ref 26}; *E. kiang* 8.9, 500^{ref 27}; *E. africanus* 4.0, 49^{ref 28}.

Supplementary note 3: Derivation of phylogenies

We downloaded a consensus phylogenetic tree of all seven species from the 10KTrees website²⁹; a polytomy between *E. kiang*, *E. hemionus*, and *E. africanus* was resolved using the *multi2di* function of the “ape” package³⁰ in R³¹. This tree was used to run all species level statistical tests and served as the base for the subspecies level tree. We resolved the subspecies of *E. burchelli* as follows: *E. b. boehmi* was placed ancestral to *E. b. quagga* and other subspecies following³²; *E. b. quagga* was placed ancestral to the remaining *E. burchelli* subspecies because it is often listed as a separate species³³; *E. b. chapmanii* and *E. b. antiquorum* were set as sister taxa because they are currently recognized as the same subspecies³³, although there is disagreement as to this point. The relationship between the three subspecies of *E. africanus* is unclear because *E. a. atlanticus* is extinct; we set these subspecies as a polytomy. The validity of the three subspecies of *E. kiang* is also unclear and may just represent a cline; therefore, we set these subspecies as a polytomy. The *E. kiang* and *E. asinus* polytomies were both resolved as described above using the *multi2di* function. While some have placed *E. kiang* and *E. hemionus* as sister taxa³⁴⁻³⁶, we followed Harris and Porter³⁷ and Kruger et al.³⁸ by placing the subspecies of *E. kiang* as derived from the subspecies of *E. hemionus*. Following ref 38, we placed *E. kiang* as sister to *E. h. leuteus*, *E. h. kulan* as ancestral to both *E. kiang* and *E. h. leuteus*, and *E. h. khur* sister to *E. h. kulan*. Following refs 37 and 38 we placed *E. h. onager*

ancestral to this entire group (*E. kiang*, *E. h. leuteus*, *E. h. khur*, *E. h. kulan*) and *E. h. hemippus* was placed ancestral to all other *E. heminous* and *E. kiang* subspecies. *E. b. crawshayii*, *E. b. zambeziensis*, and *E. h. heminous* were excluded from the tree and all further analyses due to a lack of published evidence of their relationships to other subspecies. Branch lengths on the subspecies tree initially based on those of the consensus tree and the remaining branch lengths within each species were divided up equally.

Supplementary note 4:

We placed a millimeter metal ruler a nine places on museum pelts of these species³⁹: forehead, neck, side, belly, mid-rump, upper and lower forelegs and hindlegs, and measured the depth of fur perpendicular to the skin⁴⁰; we measured and length of the longest hair shafts at eight sites: neck, side, belly, buttock, upper and lower hindlimbs. In addition we measured widths of both black and white stripes along “transects” on the cheek (muzzle to ear), neck (ear to forelimb), side (middle of body from forelimb to hindlimb), rump (diagonal line beginning at point on spine above the hindlimb stretching to lower edge of rump for Mountain and Burchell’s zebra, but from anus to Y shape and then Y shape to lower edge of rump in Grevy’s zebra), foreleg, and hindleg. Different transects were averaged across individuals of each species and then an average was calculated for the three zebra species. We used average stripe widths at each point across pelts of the same species. We extracted lengths of biting fly mouthparts from the literature⁴¹⁻⁴³.

Supplementary references

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