Birth and death

implications of zoo data for biology and husbandry – what we can and what we can't derive

Marcus Clauss

Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Switzerland

EAZA 2021 Science session

University of Zurich[UZH]

Clinic of Zoo Animals, Exotic Pets and Wildlife

Structure

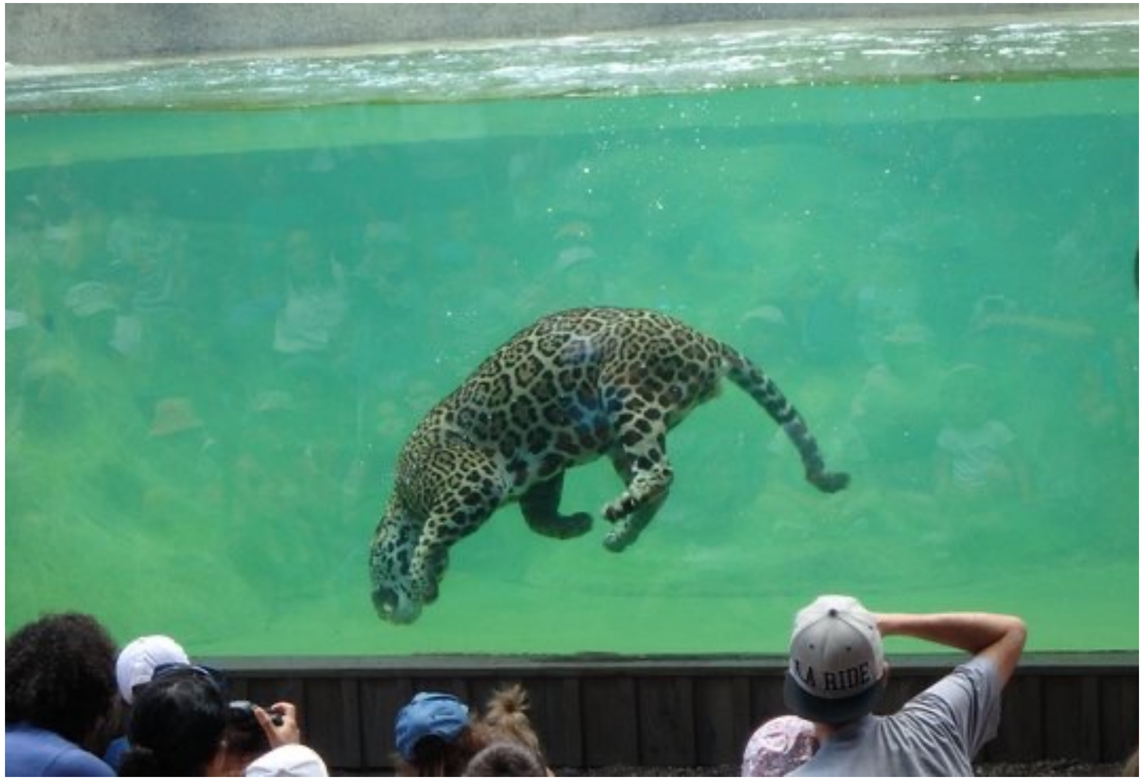
1. Zoos are special
2. Principles of dealing with birth and death data
3. Comparing zoos and natural habitats
4. Comparisons between species
5. Historical developments

Zoos are special …







SPECIES 360

Global information
serving conservation.

ISIS
International Species Information System

SPECIES 360
Global information serving conservation.

EAZA

Standards for the Accommodation and Care of Animals in Zoos and Aquaria

Approved by EAZA Annual
General Meeting
2 October 2020

EAZA

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Approved by EAZA Annual General Meeting
2 October 2020

5.2 Stock records

1. Animal records are to be kept on a computer system using the Zoological Information Management System (ZIMS), and to be included on the global zoo animal database of Species360, by means of which information can be quickly retrieved.
2. Alternatively, records may be kept by means of an established and globally recognised and accepted record system, that is easily able to share data with ZIMS and that is and maintained in relation to all individually recognised animals and groups of animals. If a Member wishes to use an alternative record system, it shall request prior approval of the Council. The Council shall decide in its absolute discretion.
3. Where animals are disposed of or die, the records to be kept in the appropriate recording system as described in Article 95.
4. The records should provide the following information:
   a. the correct identification and scientific name;
   b. the origin (i.e. whether wild or captive born, including identification of parents, where known, and previous location/s, if any);
   c. the dates of entry into, and disposal from, the collection and to whom;
   d. the date, or estimated date, of birth;
   e. the sex of the animals (where known);
   f. any distinctive markings, including tattoo or freeze brands etc.;
   g. clinical data, including details of and dates when drugs, injections, and any other forms of treatment were given, and details of the health of the animal;
   h. the date of death and the result of any post-mortem examination;
   i. the reason, where an escape has taken place, or damage or injury has been caused to, or by, an animal to persons or property, for such escape, damage or injury and a summary of remedial measures taken to prevent recurrence of such incidents.

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EAZA Membership and Accreditation Manual

You learn a lot about the natural world if you keep your animals in an intelligent way.

- David Attenborough, *2016*

European Association of Zoos and Aquaria
Amsterdam
Version 4
Approved by the EAZA Annual General Meeting on 22 April 2021

EAZA Membership and Accreditation Manual

EUROPEAN ASSOCIATION OF ZOOS AND AQUARIA

EAZA

ACCREDITED MEMBER

EAZA Members are required to meet obligations regarding, e.g.:

- Participation in EAZA Ex situ Programmes (EEPs) for population management
- Animal records (Species360 membership)

Birth data

How zoos contribute to fundamental biological knowledge
the example of reproductive seasonality

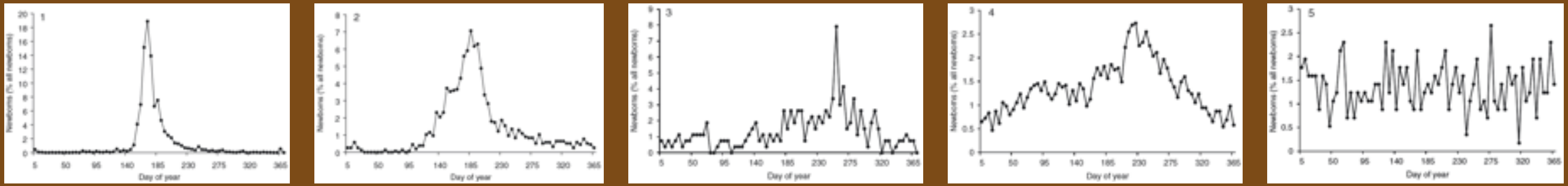
Marcus Clauss

Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Switzerland

EAZA Leipzig 2020

University of Zurich[UZH]

Clinic of Zoo Animals, Exotic Pets and Wildlife

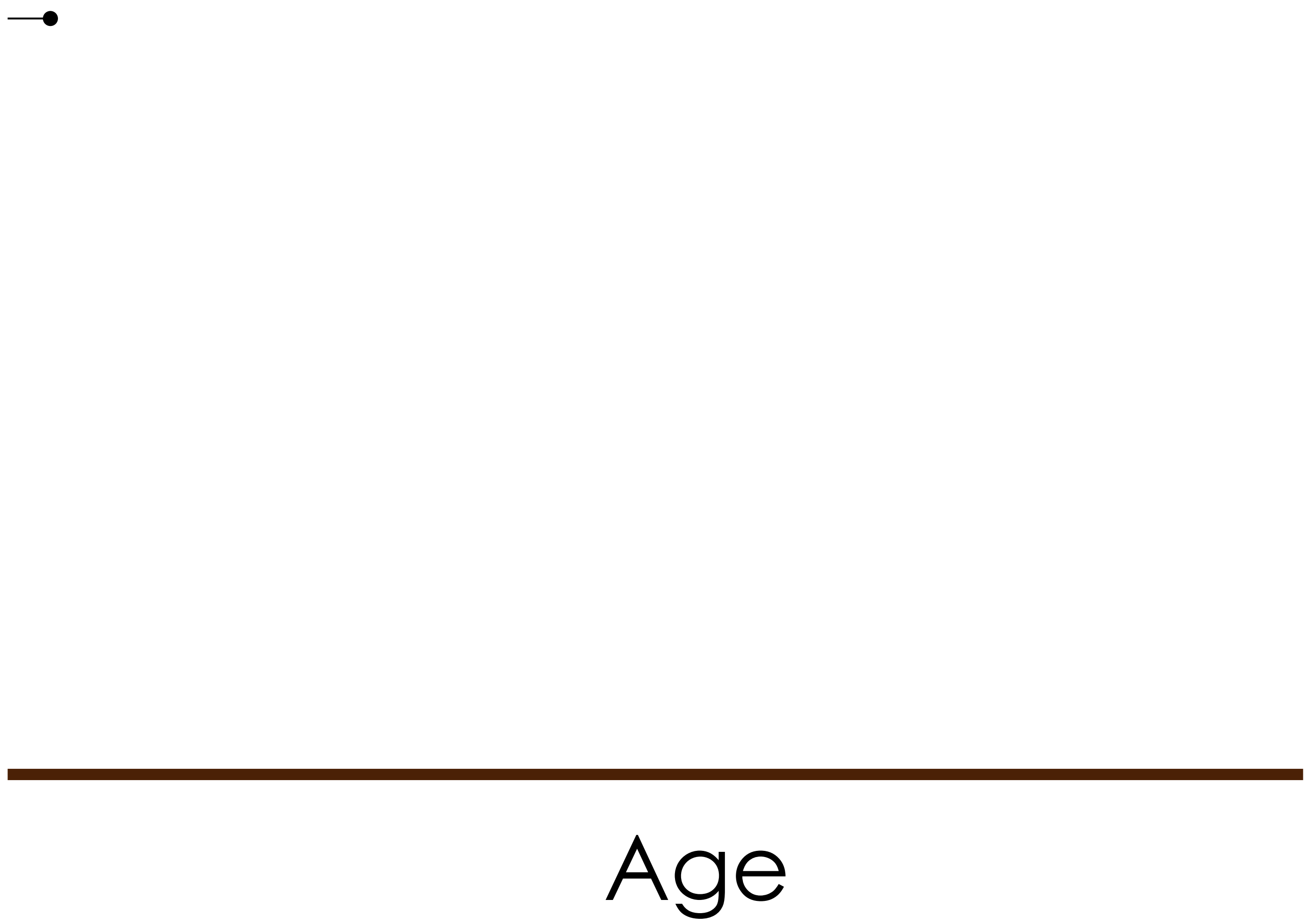


Birth and death data

Data in Species360: Birth and Death

Age

Data in Species360: Birth and Death



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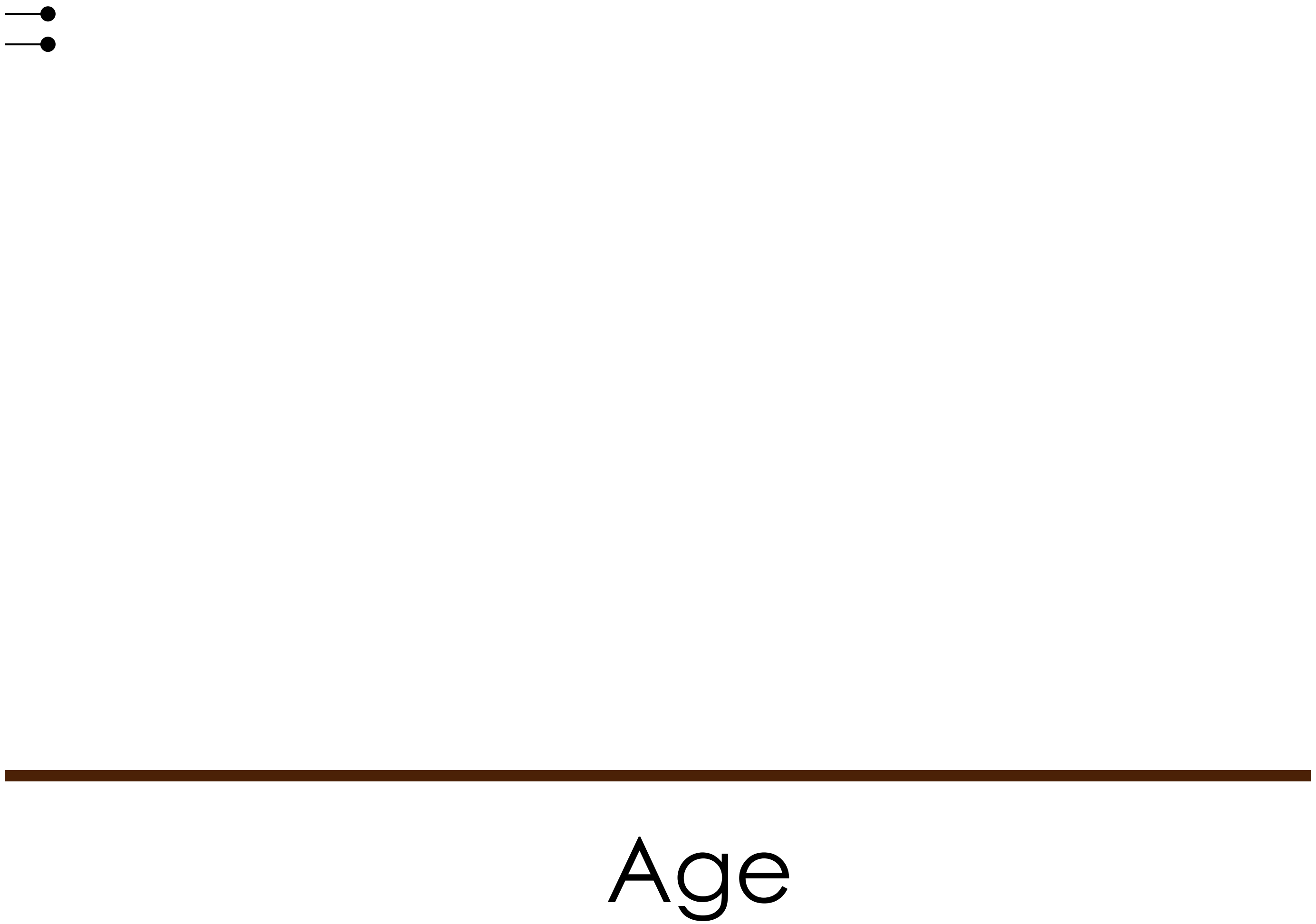

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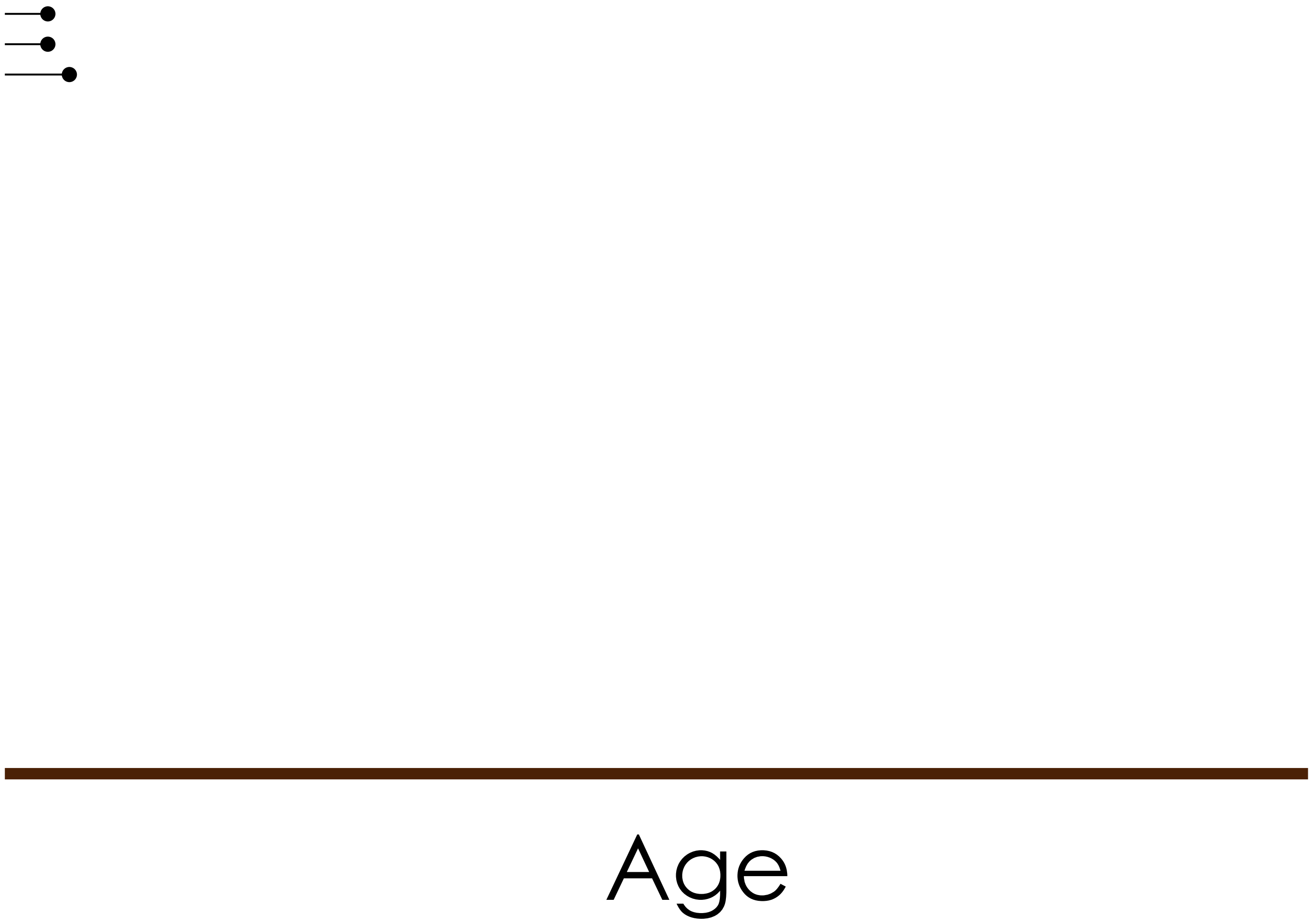

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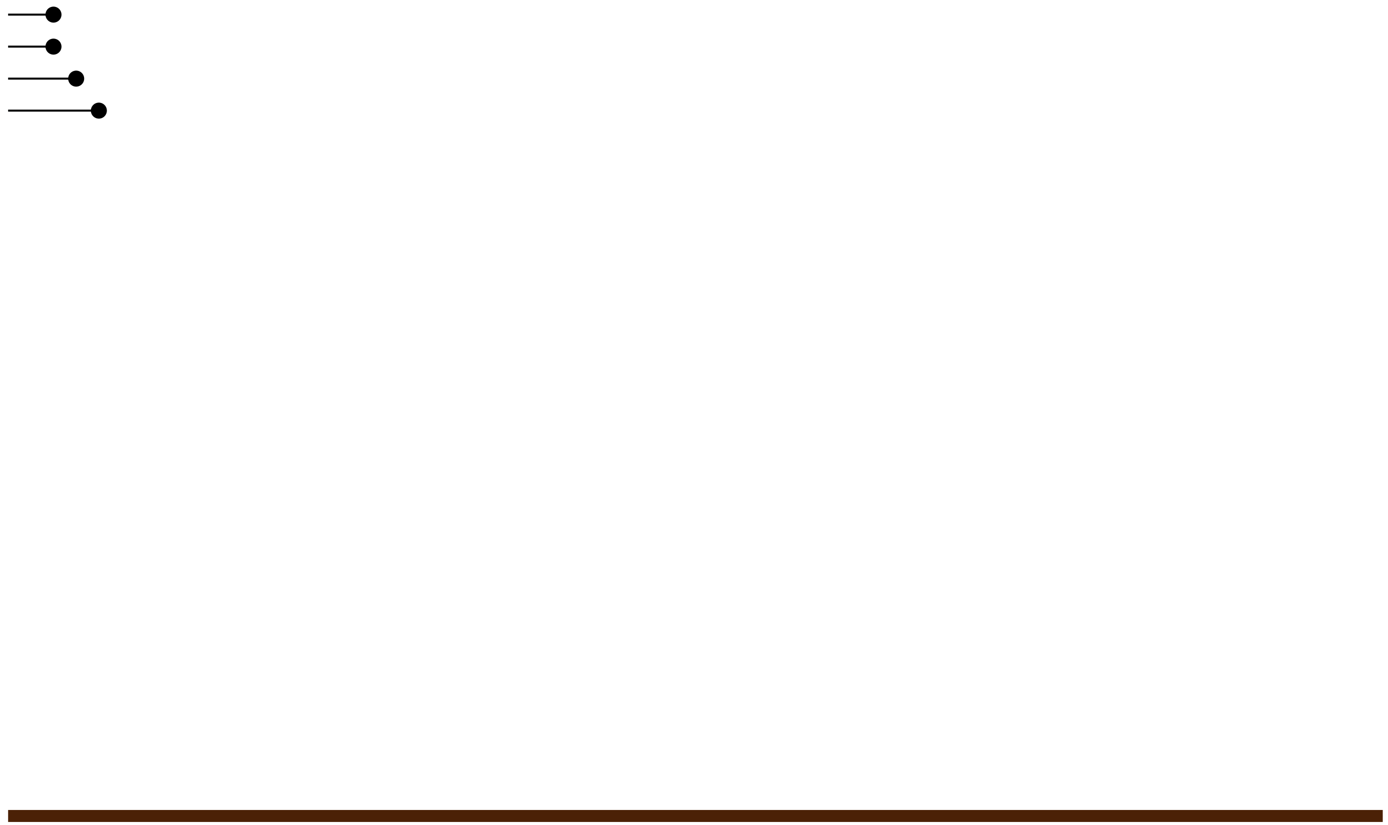

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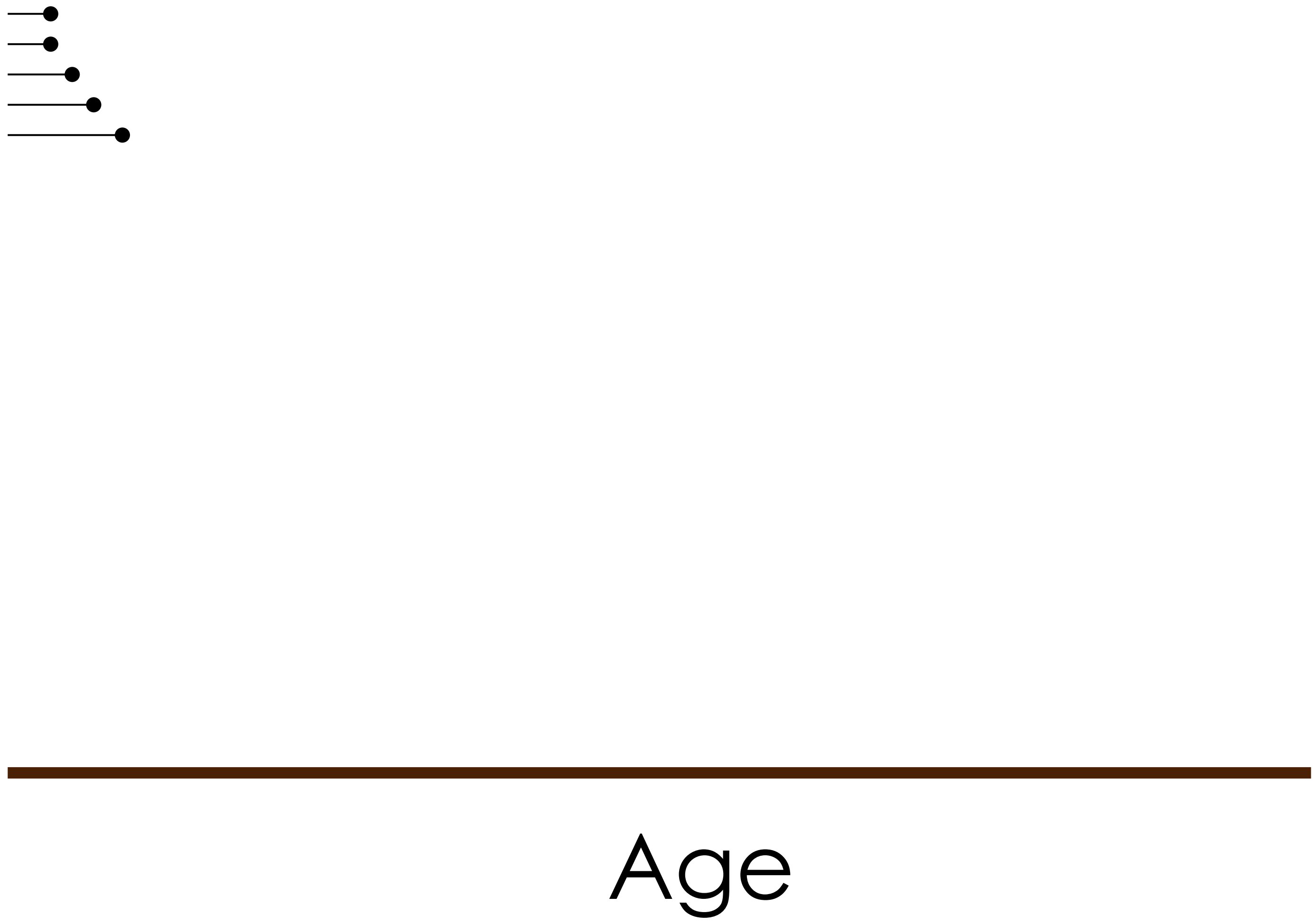

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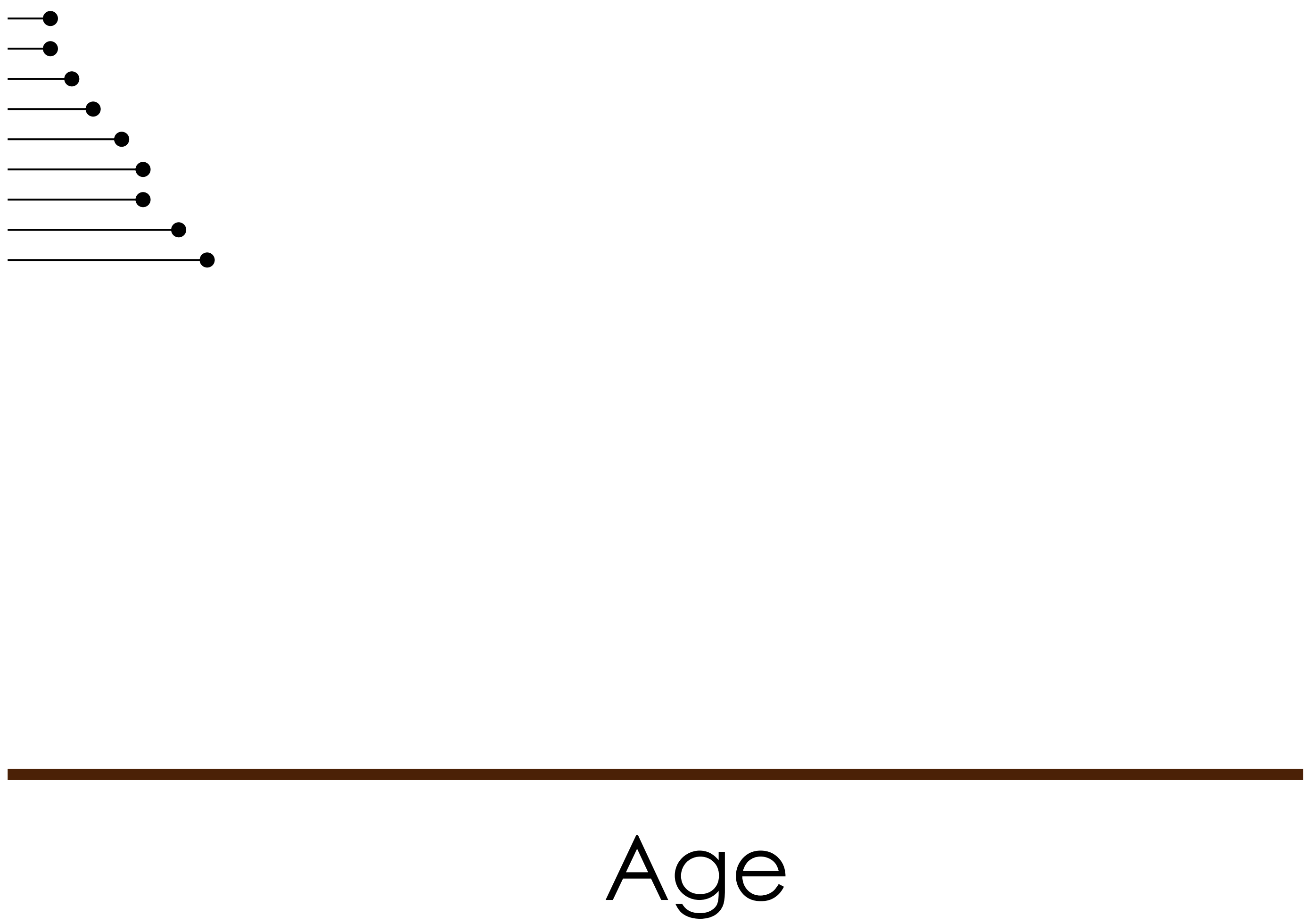

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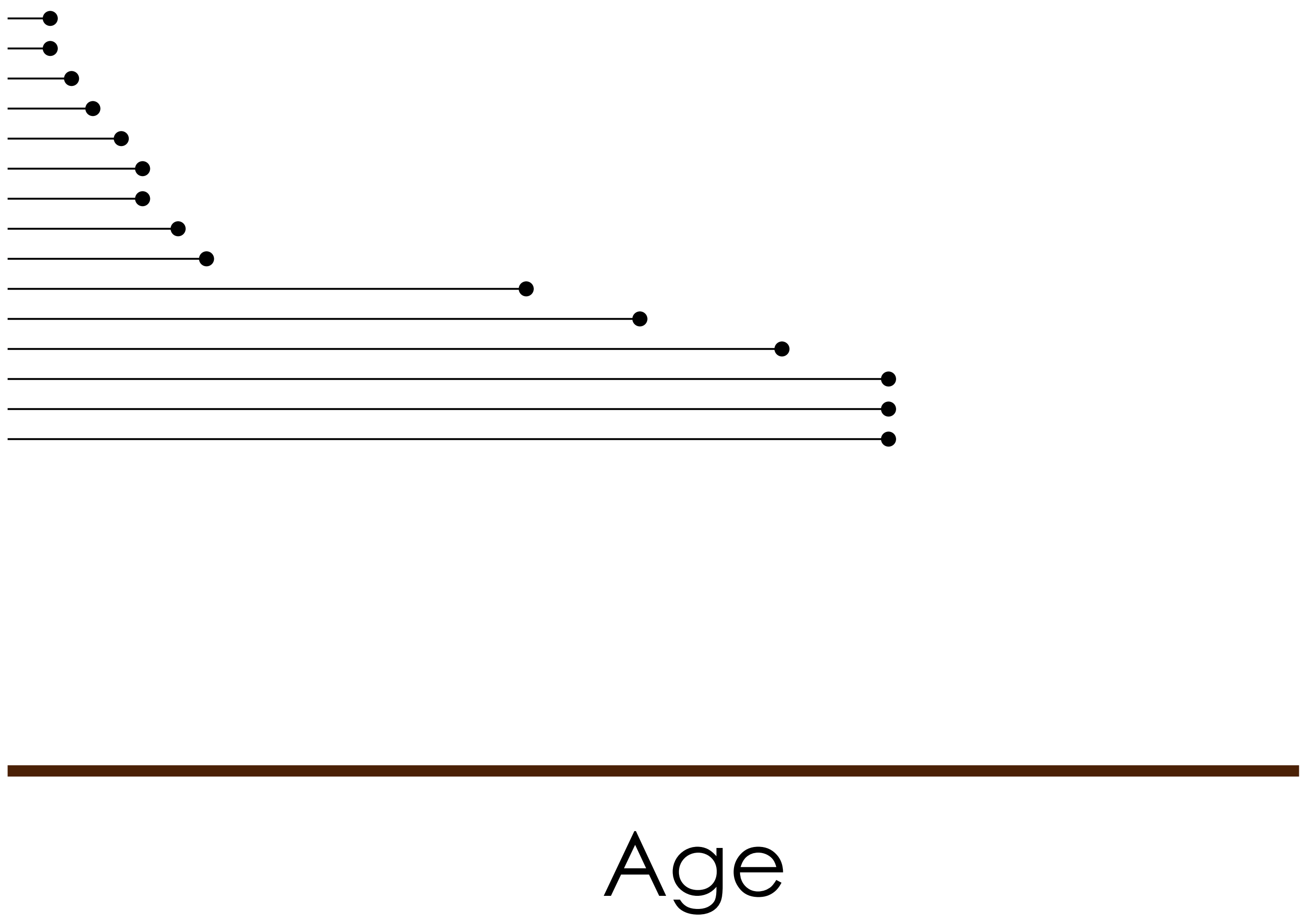

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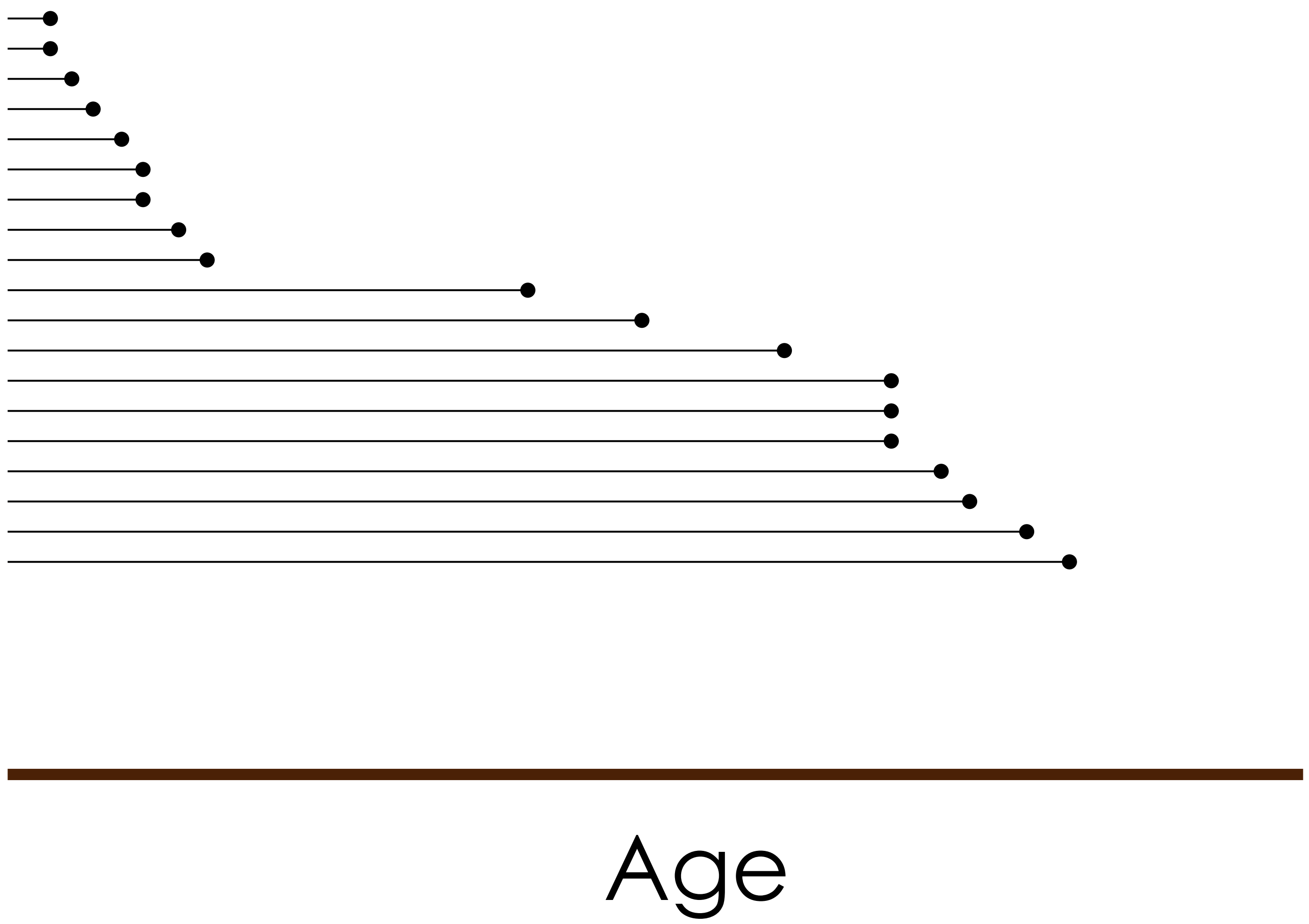

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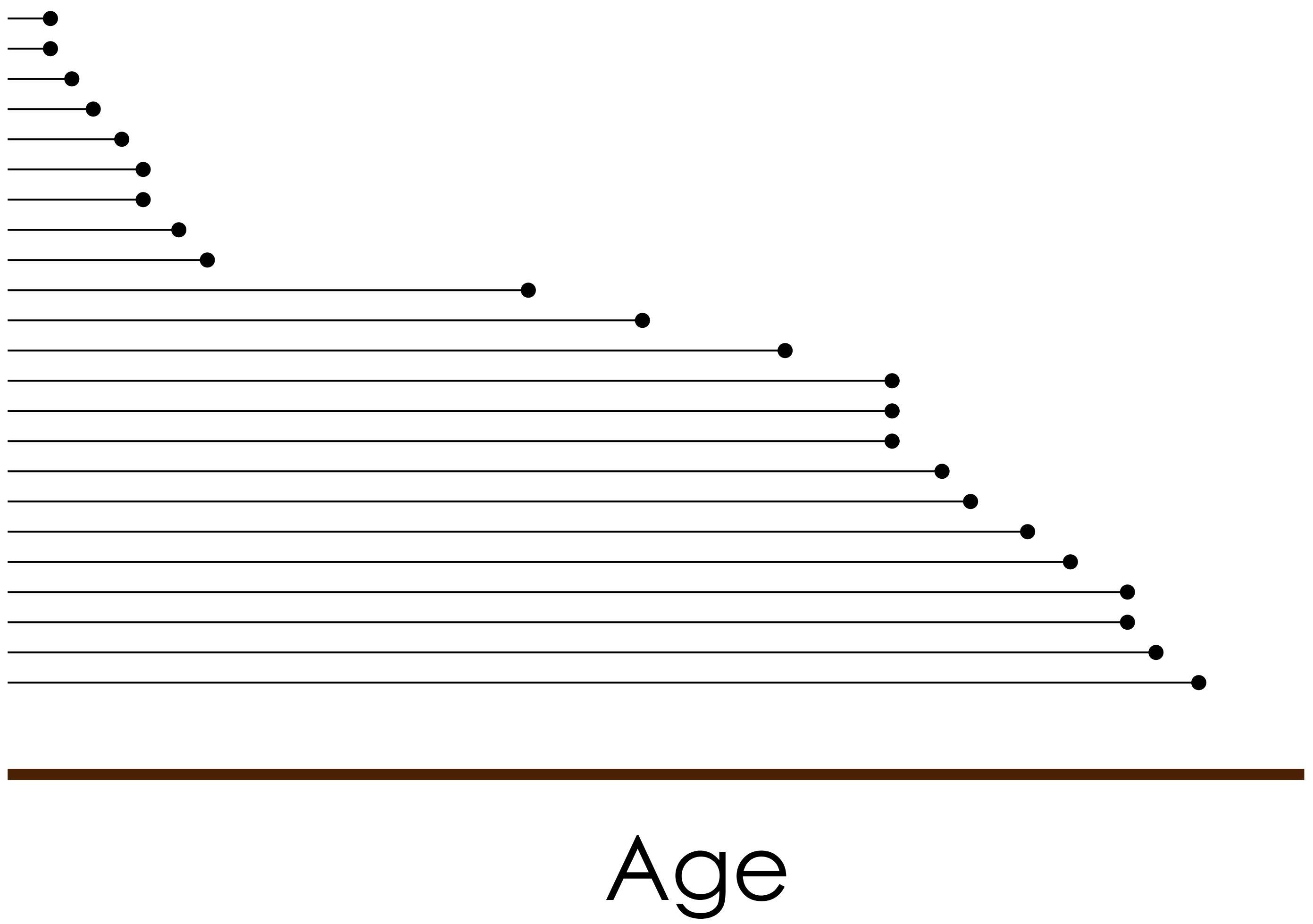

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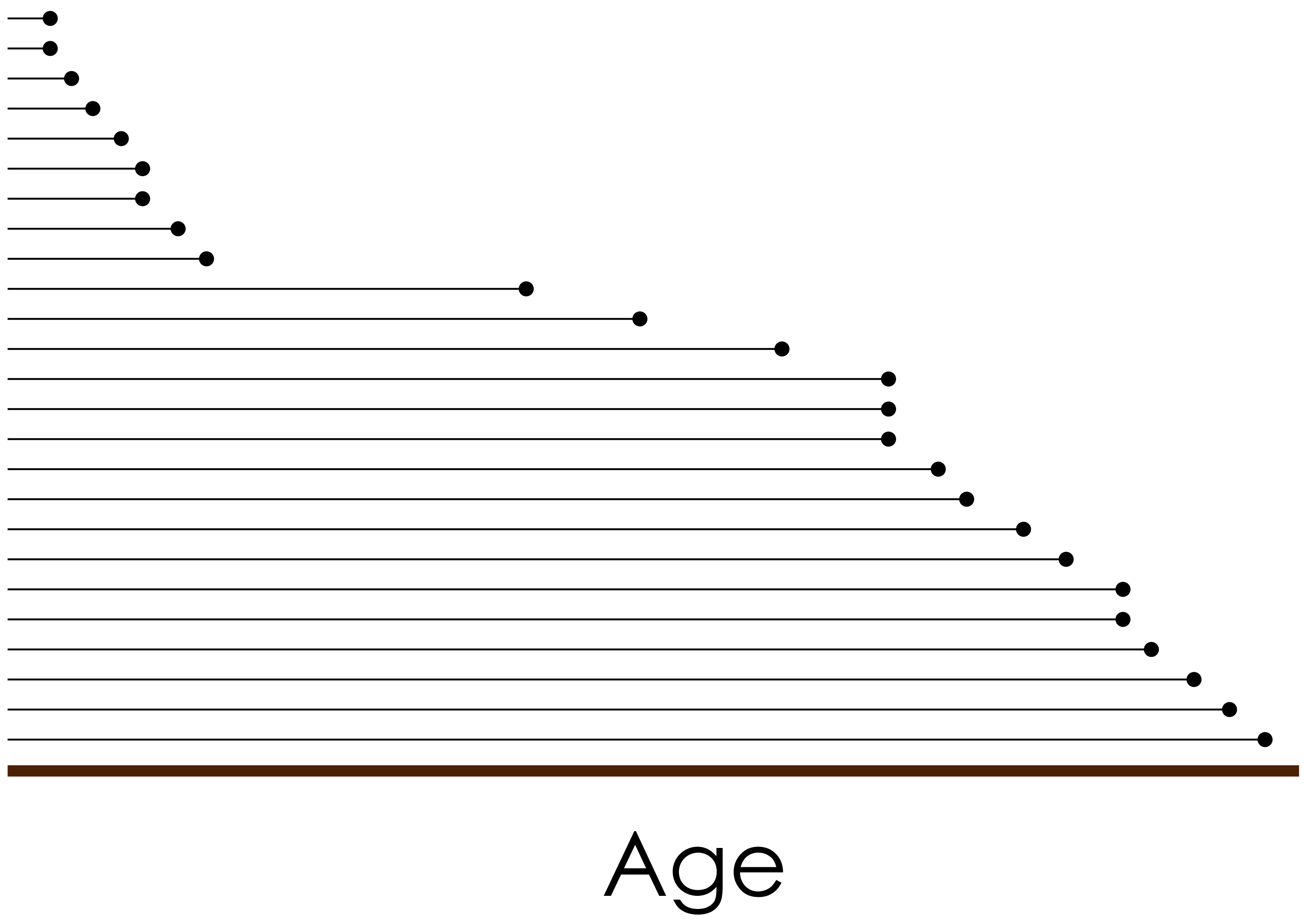

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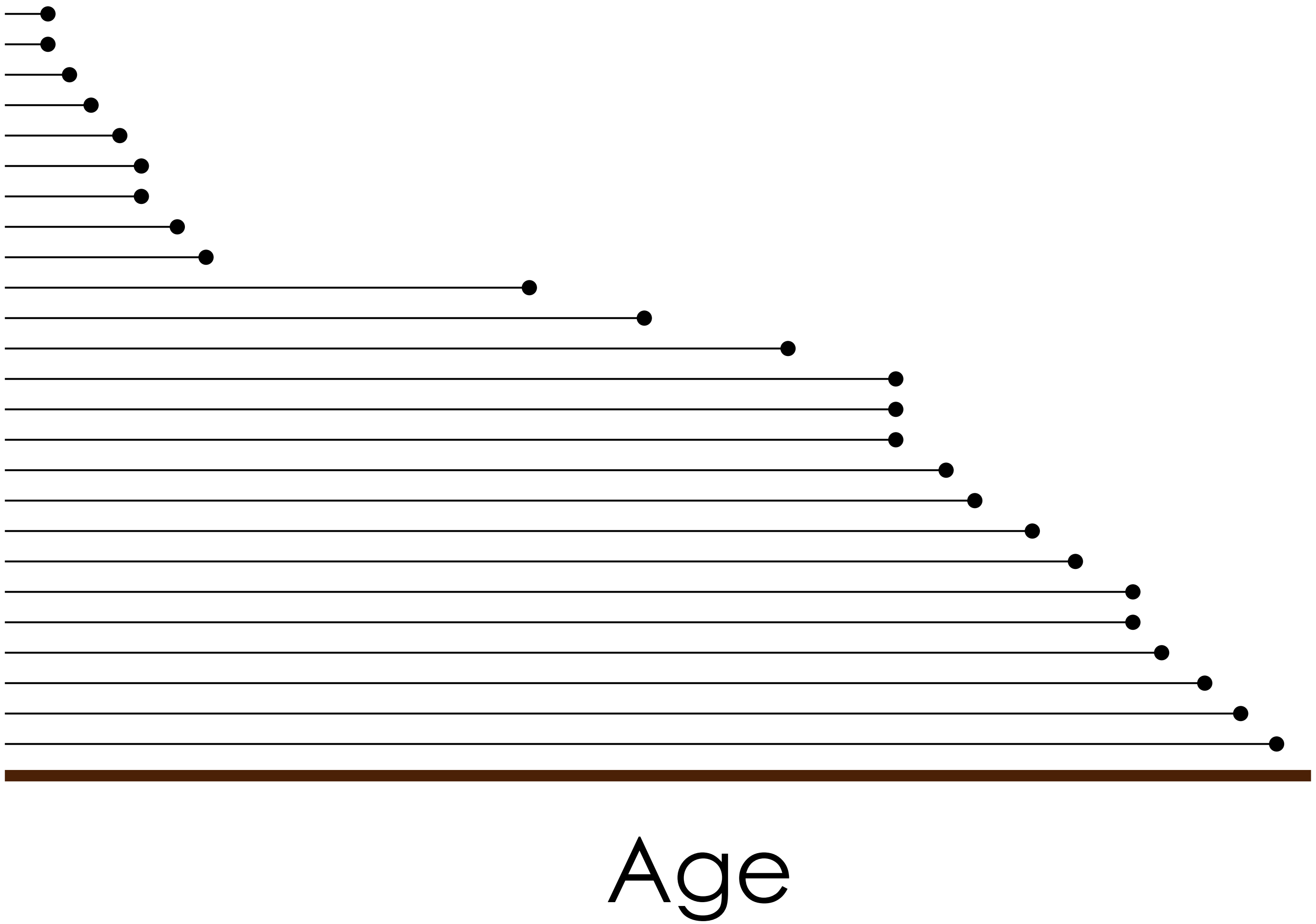
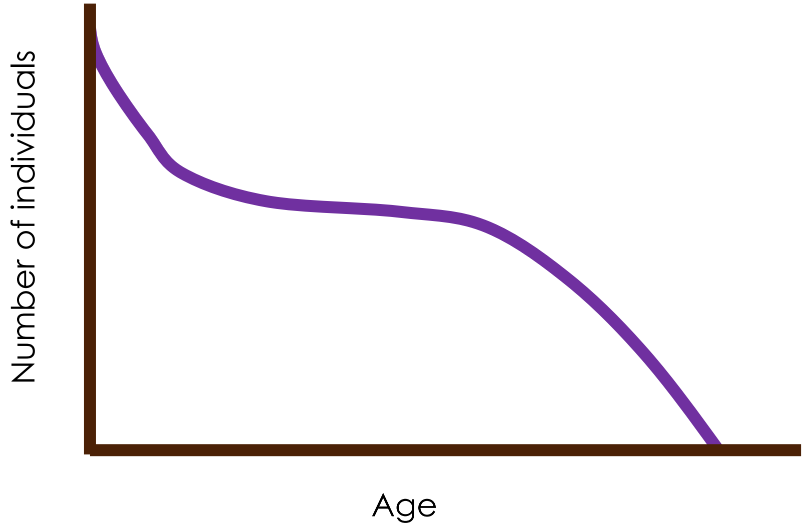
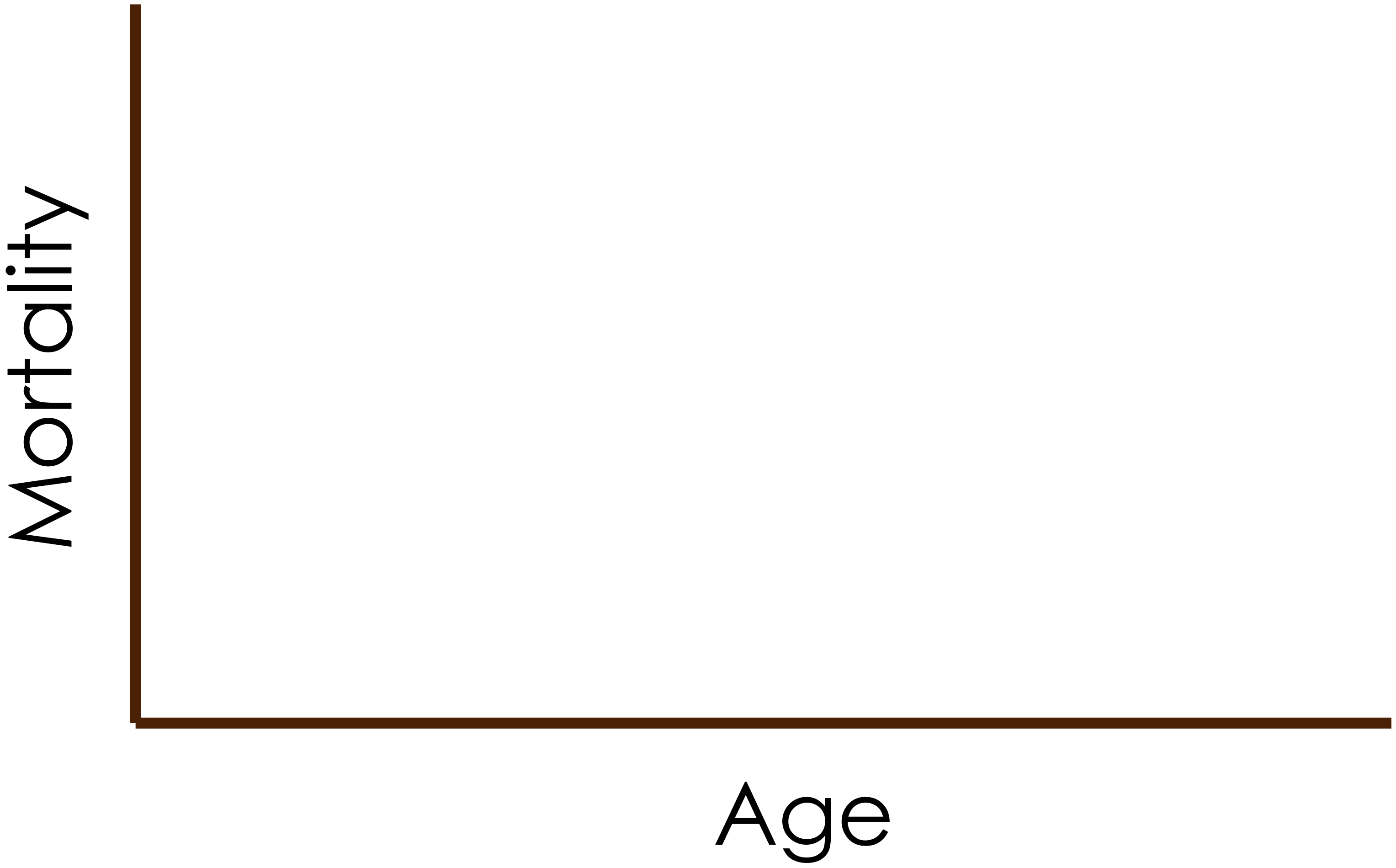




Mortality



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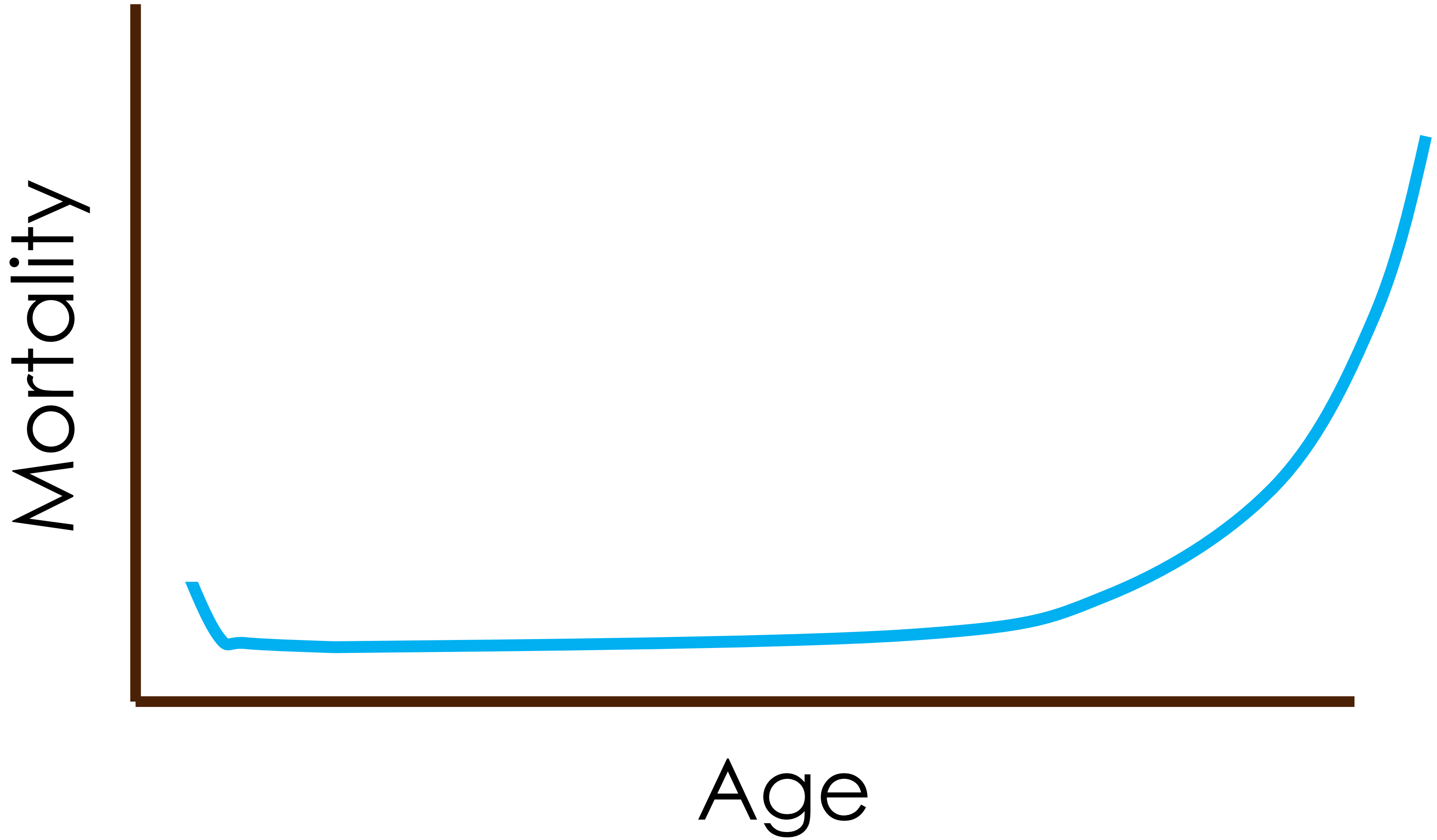

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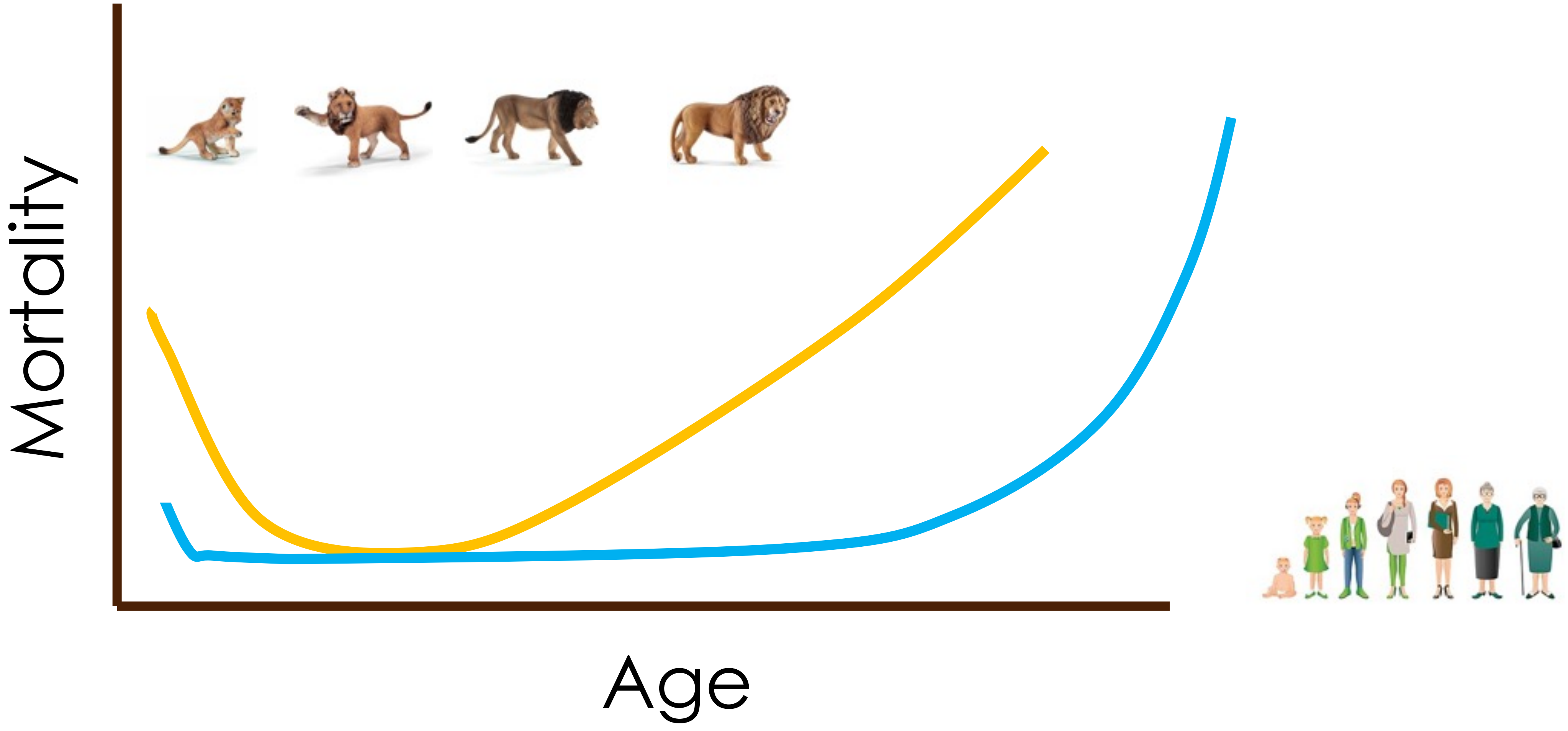

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(iii) a measure for the variance of life expectancy – is it equally distributed or not?

(i) should be low
(ii) should be high
(iii) should be low

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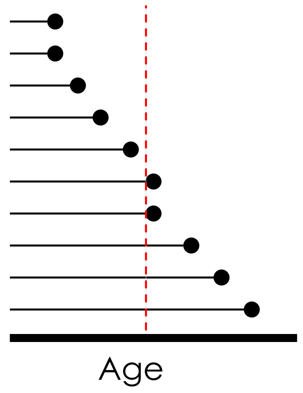

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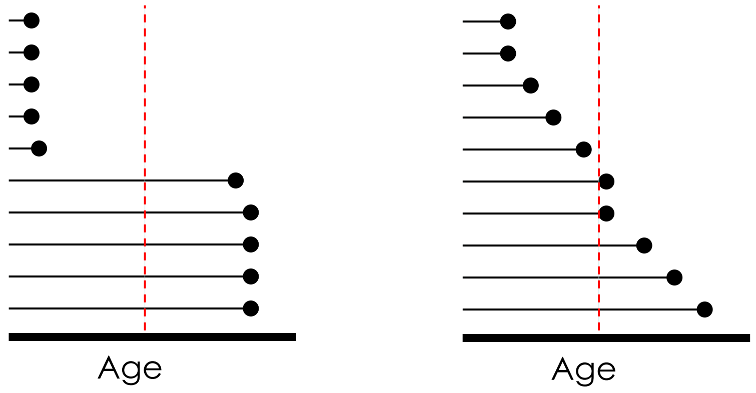

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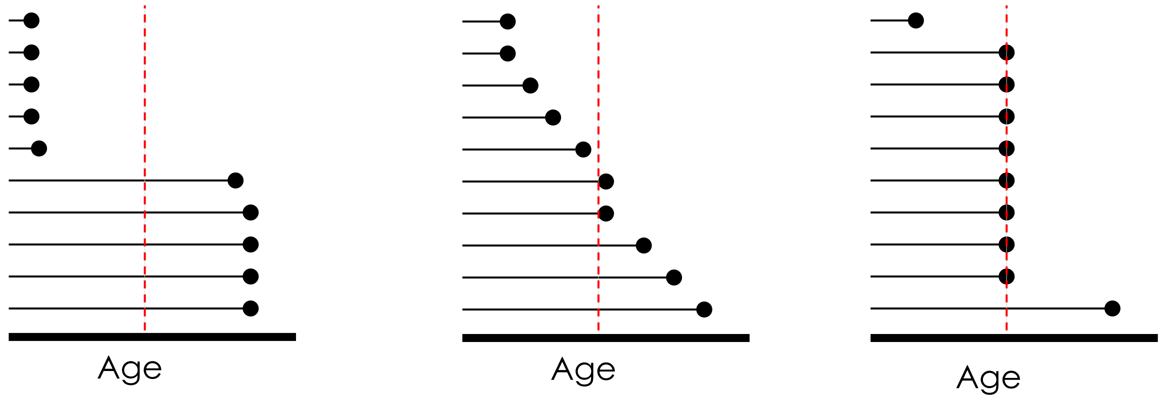

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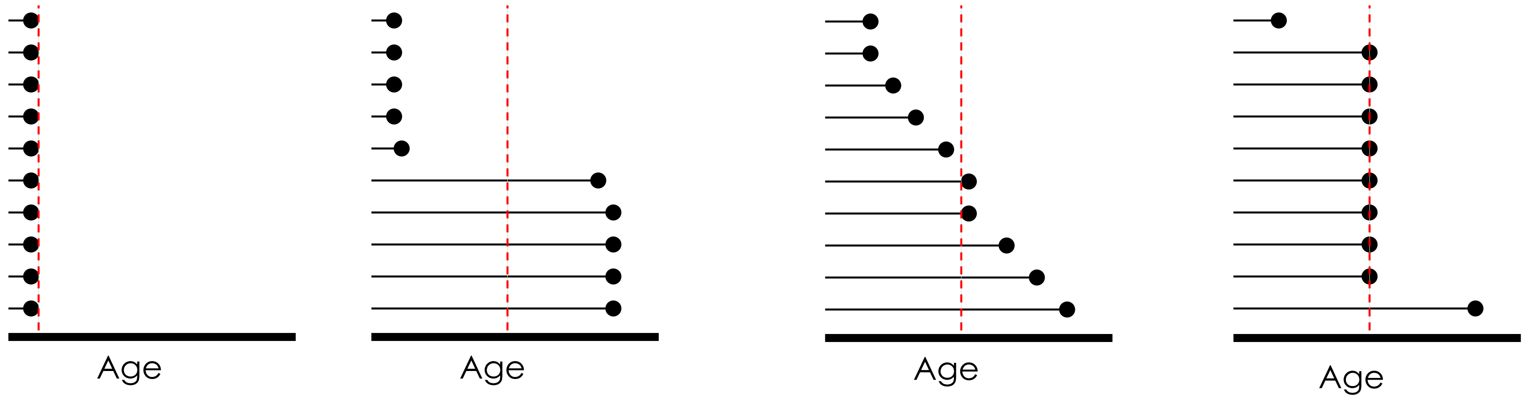
(ii) should be high
(iii) should be low
… *if (ii) is adequate*



Comparisons of individual species in natural habitats

Comparisons of individual species in natural habitats

Morgane Tidière,
Species360

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SCIENTIFIC REPORTS

OPEN

Comparative analyses of longevity and senescence reveal variable survival benefits of living in zoos across mammals

Received: 10 June 2016
Accepted: 30 September 2016
Published: 07 November 2016

Morgane Tidière[1], Jean-Michel Gaillard[1], Vérane Berger[1], Dennis W. H. Müller[2], Laurie Bingaman Lackey[3], Olivier Gimenez[4], Marcus Clauss[5] & Jean-François Lemaître[1]

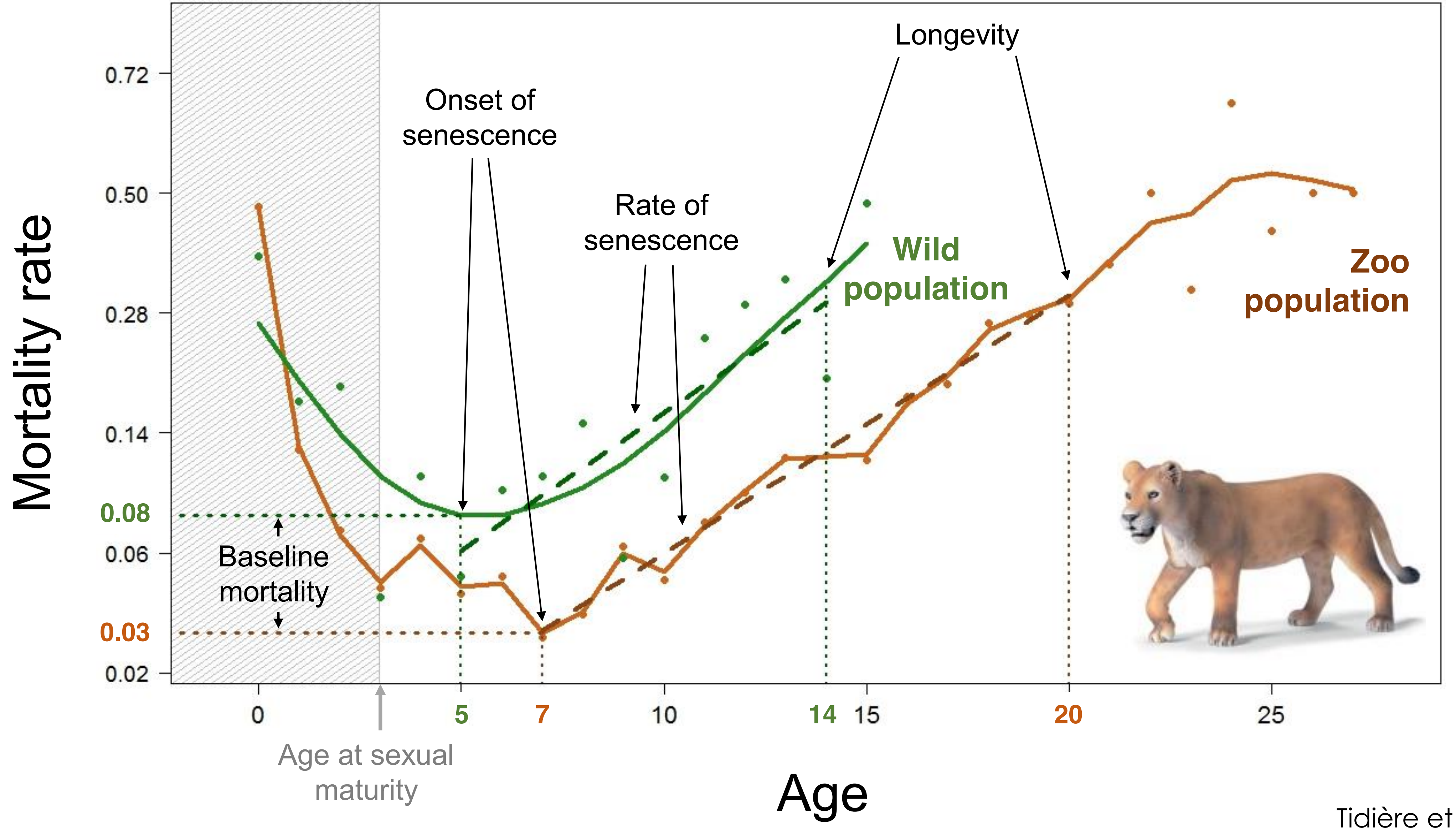
While it is commonly believed that animals live longer in zoos than in the wild, this assumption has rarely been tested. We compared four survival metrics (longevity, baseline mortality, onset of senescence and rate of senescence) between both sexes of free-ranging and zoo populations of more than 50 mammal species. We found that mammals from zoo populations generally lived longer than their wild counterparts (84% of species). The effect was most notable in species with a faster pace of life (i.e. a short life span, high reproductive rate and high mortality in the wild) because zoos evidently offer protection against a number of relevant conditions like predation, intraspecific competition and diseases. Species with a slower pace of life (i.e. a long life span, low reproduction rate and low mortality in the wild) benefit less from captivity in terms of longevity; in such species, there is probably less potential for a reduction in mortality. These findings provide a first general explanation about the different magnitude of zoo environment benefits among mammalian species, and thereby highlight the effort that is needed to improve captive conditions for slow-living species that are particularly susceptible to extinction in the wild.

Zoological gardens represent artificial environments in which animals are maintained, bred and displayed. By doing so, zoos achieve a diversity of goals beyond their visitors' recreation: basic zoological and conservation education reaches 700 million visitors per year all over the world[1]. Continuing research and expertise building by many thousands of zoo staff worldwide continuously improves knowledge of animal, population and ecosystem management. Zoos also aim to maintain viable *ex situ* insurance populations of endangered species that can be used for re-introduction to the wild[2,3]. Zoo staff manages and generates funding for *in situ* conservation projects[1,4]. Finally, zoos facilitate opportunities for researchers to increase expertise in a large variety of areas, from basic zoology to applied husbandry and molecular biology.

When assessing the justification of holding nondomestic species in zoos, the welfare of the individual animals housed in captivity is a critical ethical issue that has to be weighed against these aims[5]. There is no single proxy to measure the welfare of animals. Indicators typically employed include measures of survival (such as longevity, annual survival, or ageing rate), reproduction (such as fertility or litter size), physiology (such as stress hormones or the occurrence of specific diseases) and behavior (such as stereotypies)[5,6]. It is typically believed that zoo animals live longer than their free-ranging conspecifics due to the consistent provision of food, water, and shelter from harsh climates, the absence of predation and management to minimize violent intraspecific encounters and accidents, as well as veterinary prophylactic and therapeutic intervention. However, zoo animals may be subject to behavioral deficits[6]. While an increasing number of comparative studies have demonstrated species-specific differences in the response to zoo-conditions[7–9], and a few species-specific comparisons of survival metrics between free-ranging and captive specimens have been published[10,11], large-scale inter-specific comparisons of captive and

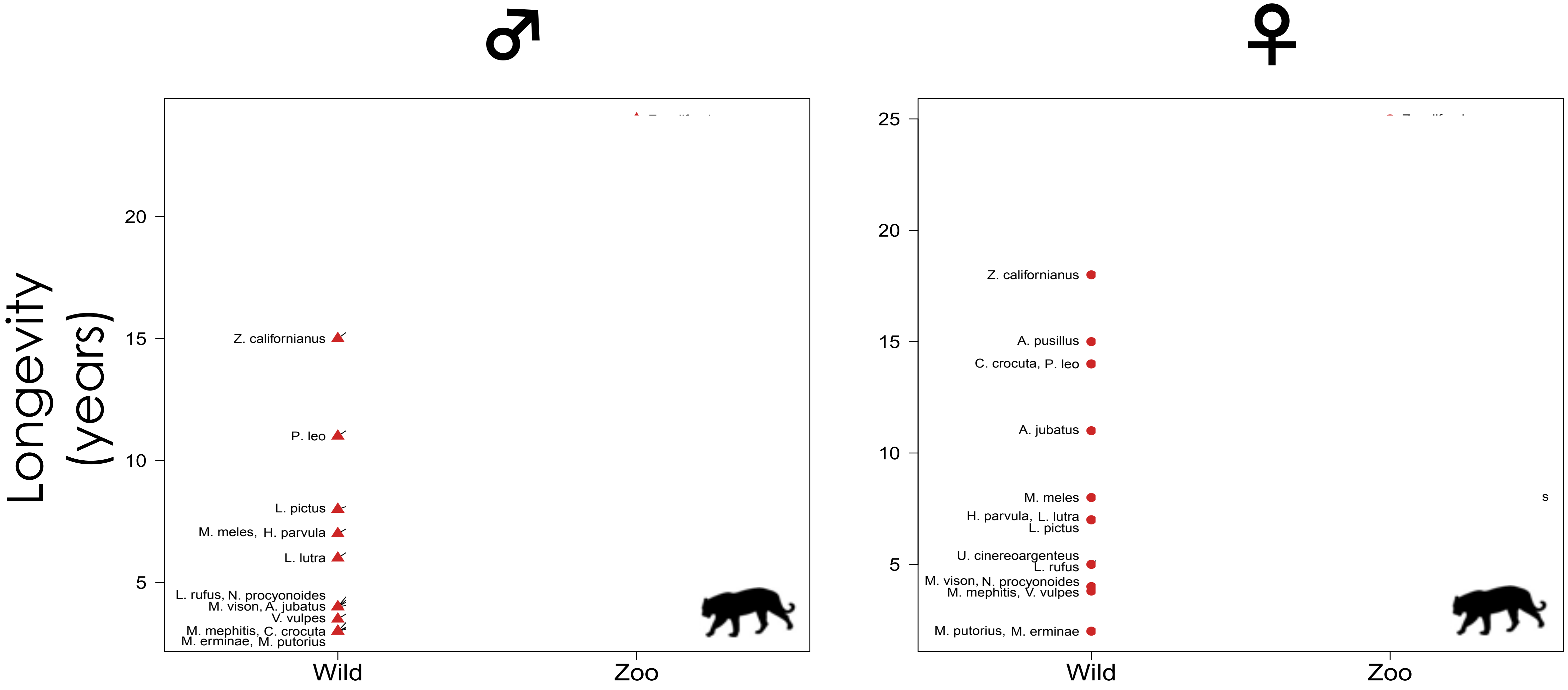
[1]Université de Lyon, F-69000, Lyon; Université Lyon 1; CNRS, UMR5558, Laboratoire de Biométrie et Biologie Evolutive, F-69622, Villeurbanne, France. [2]Zoologischer Garten Halle GmbH, Fasanenstr. 5a, 06114 Halle (Saale), Germany. [3]World Association of Zoos and Aquariums (WAZA), Gland, Switzerland. [4]UMR 5175, Centre d'Ecologie Fonctionnelle et Evolutive, campus CNRS, 1919 route de Mende, 34293, Montpellier Cedex 5, France. [5]Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Winterthurerstr. 260, 8057 Zurich, Switzerland. Correspondence and requests for materials should be addressed to M.T. (email: mtidiere@gmail.com)

Mortality



Tidière et al. (2016)

Zoo carnivores live …



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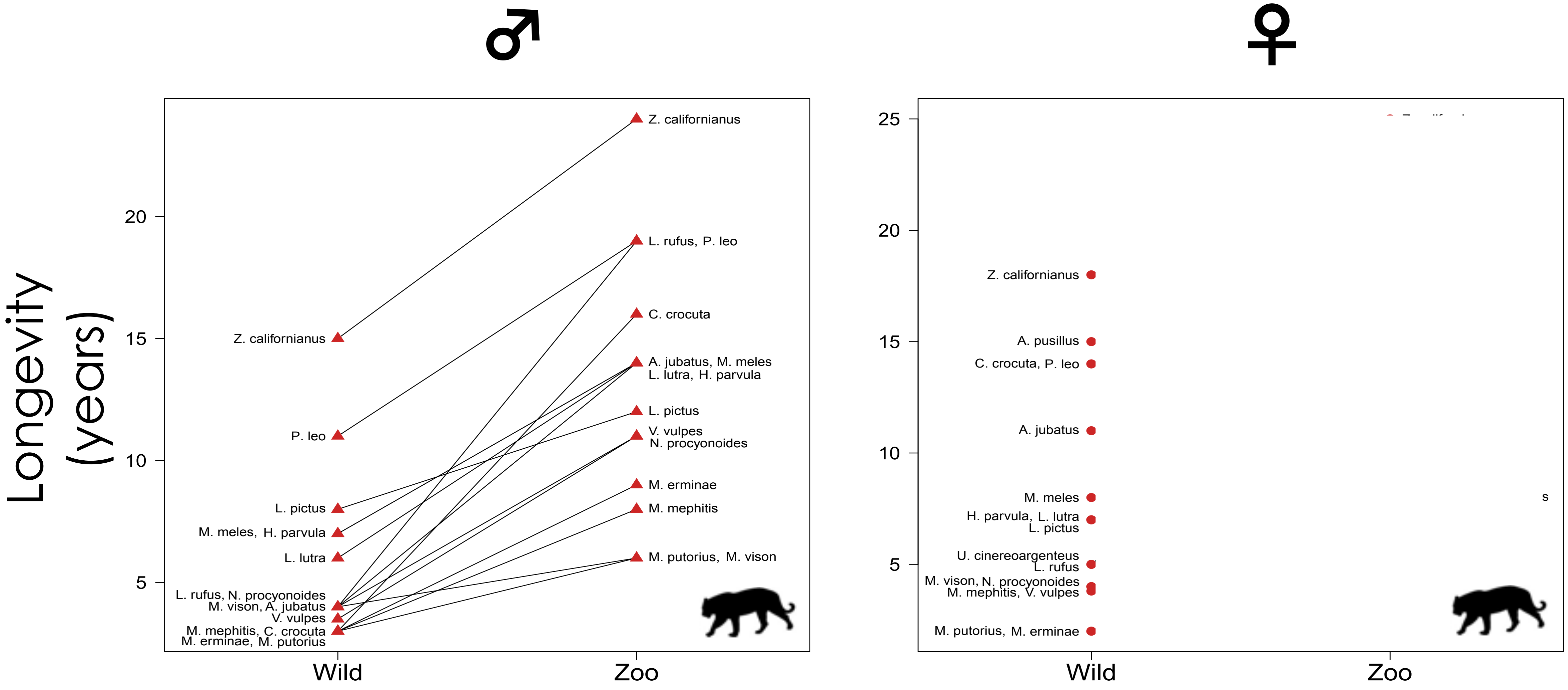
Zoo carnivores live … *longer*



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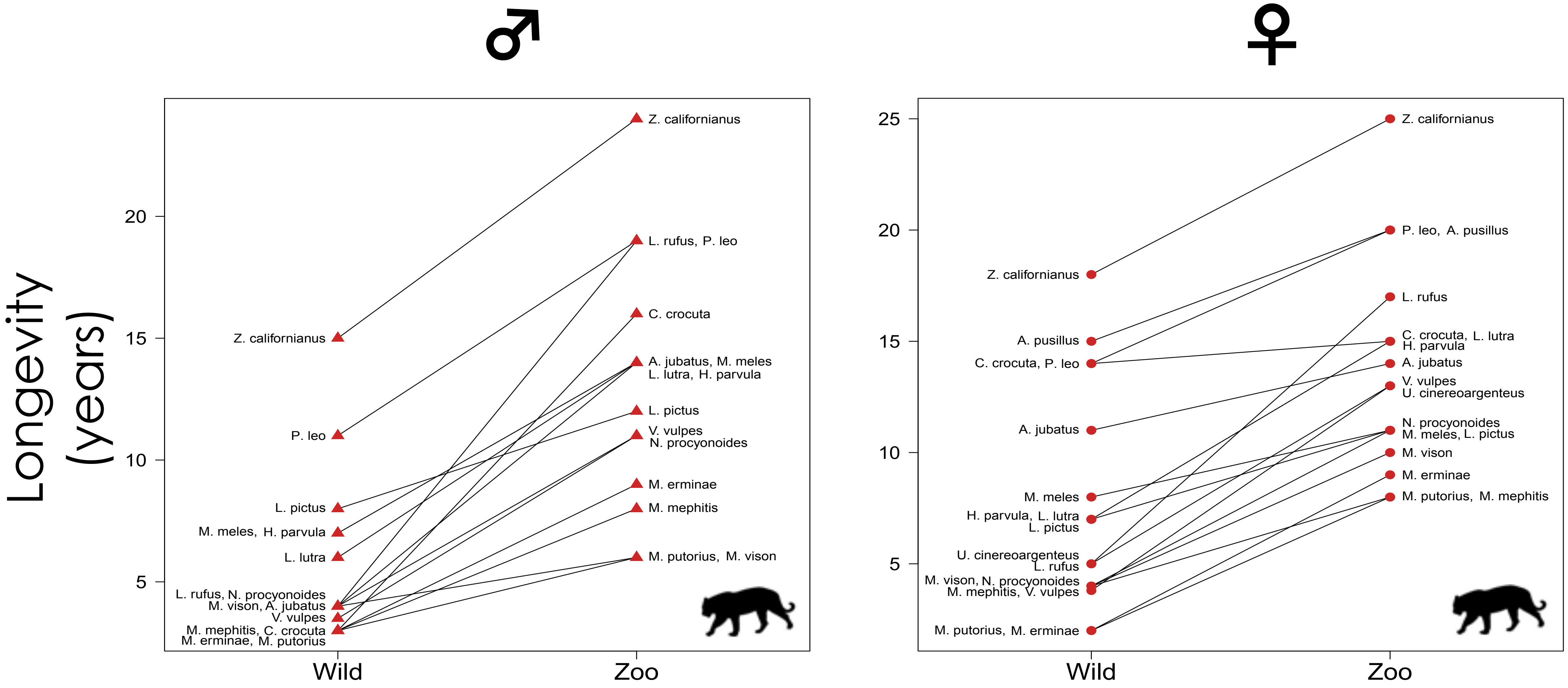

Tidière et al. (2016)

Why do zoo carnivores live longer ?

Why do zoo carnivores live longer?

Why do zoo carnivores live longer?




Why do zoo carnivores live longer?






Why do zoo carnivores live longer?







Why do zoo carnivores live longer?








Comparisons between species

Comparisons between species

Dennis Müller,
Zoological Garden of Halle

Comparative assessments: which parameters?

(i) Mortality of certain life stages (neonate, age at weaning, age at sexual maturity) or at arbitrary setpoints (1 week, 1 month, 1 year)

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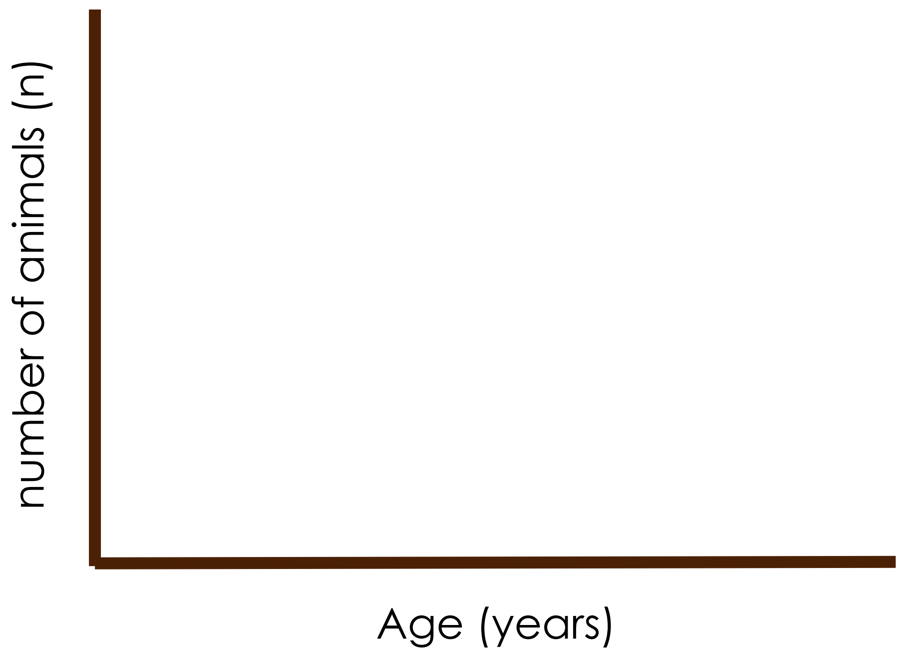

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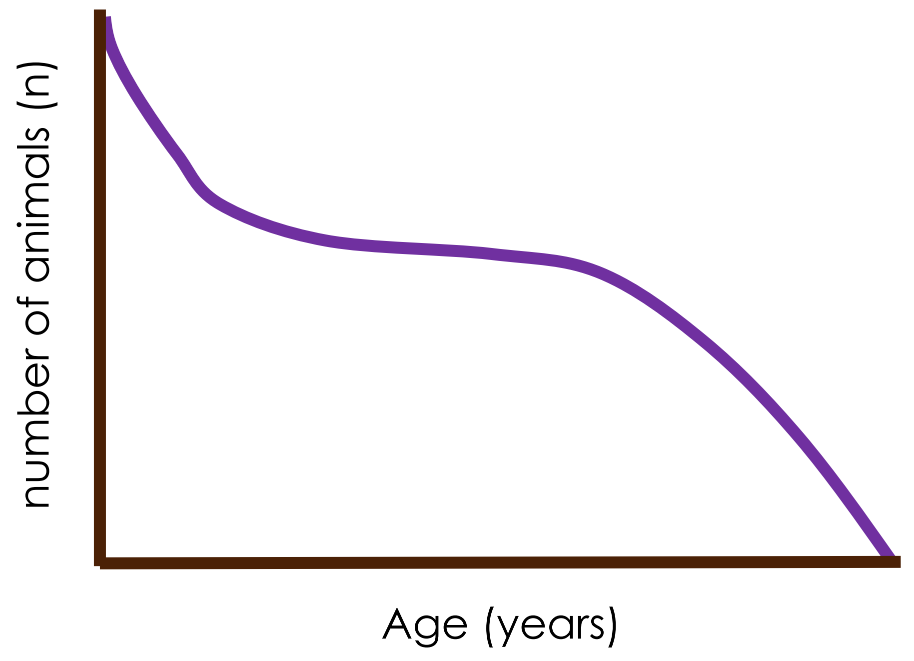

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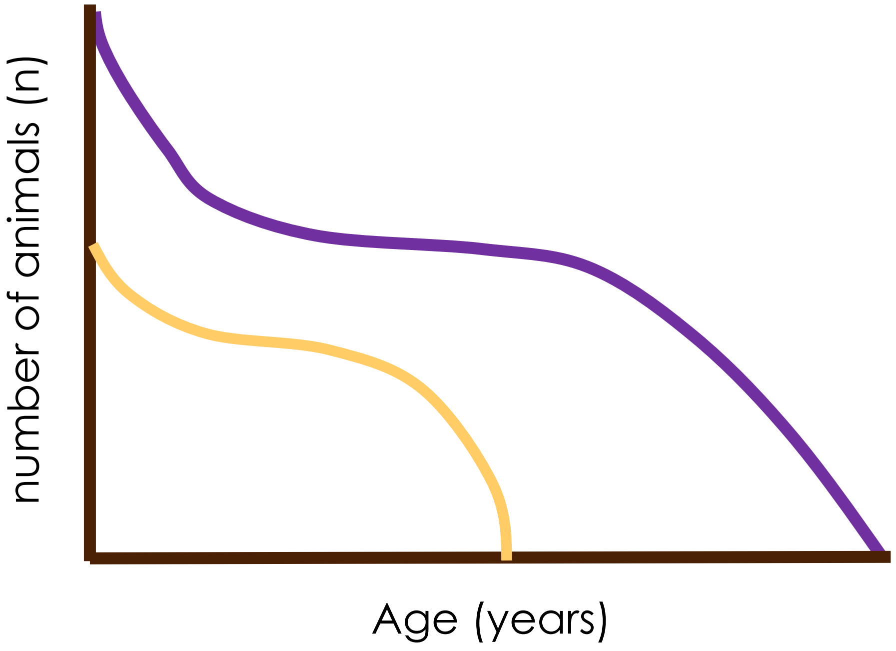

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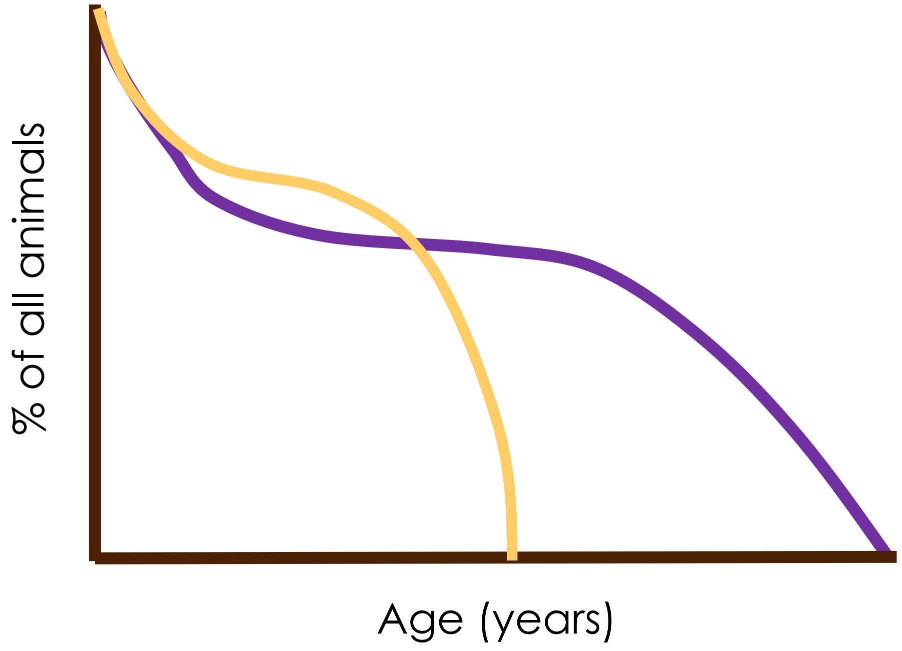

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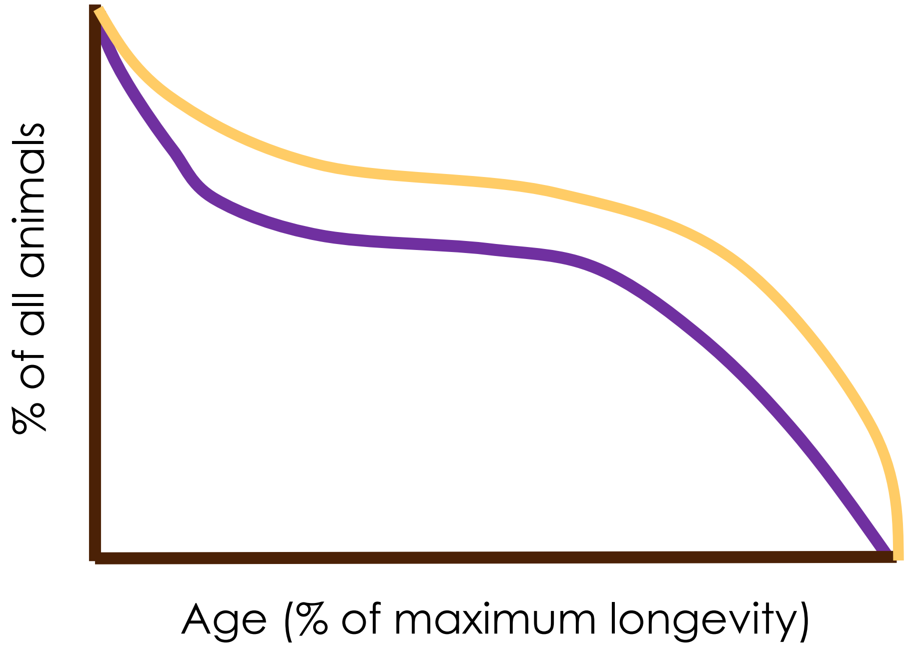

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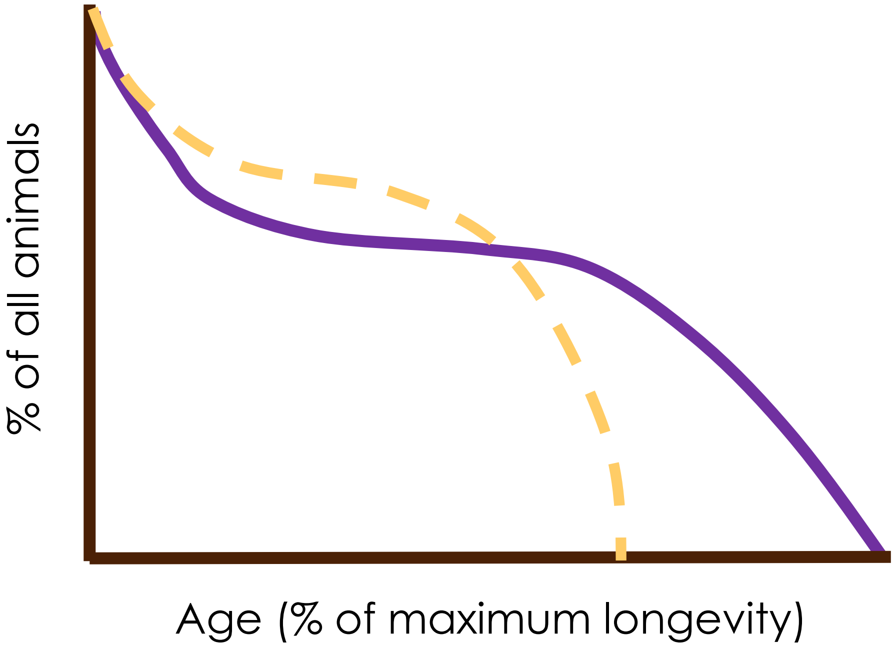

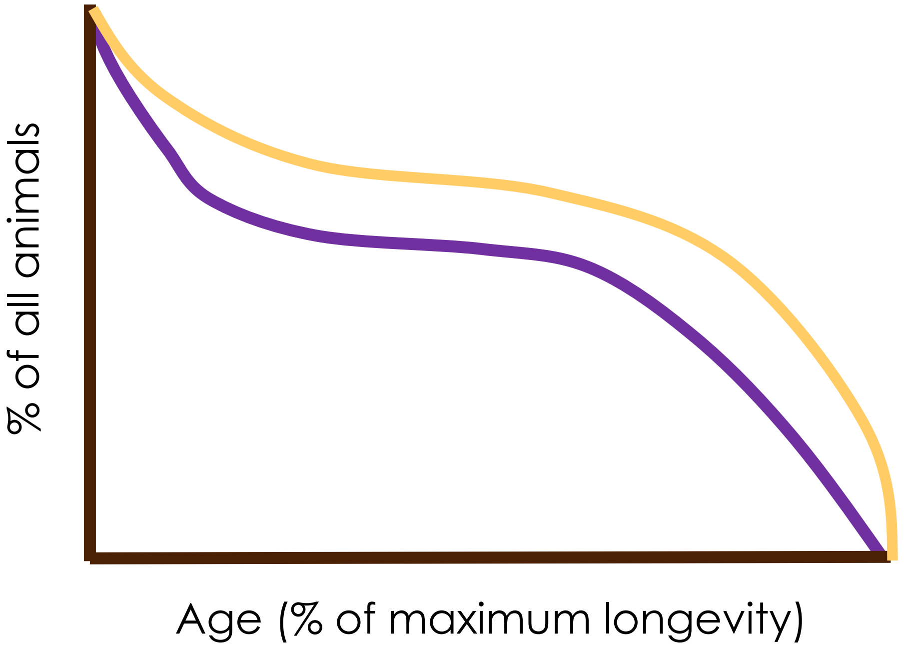

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(ii) Average life expectancy / average longevity ***– in relation to maximum longevity***

Rank	Species	Maximum longevity
1	Red deer	27.0
1	European bison	27.0
1	Moose	27.0
4	Fallow deer	25.4
5	Sika deer	25.0
6	Ibex	20.4
7	Roe deer	17.0

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Rank	Species	Maximum longevity	Average longevity
1 1	Red deer	27.0	13.4
2 1	European bison	27.0	12.7
3 4	Fallow deer	25.4	10.5
4 5	Sika deer	25.0	10.0
5 6	Ibex	20.4	9.2
6 7	Roe deer	17.0	7.9
7 1	Moose	27.0	7.3

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Rank	Species	Maximum longevity	Average longevity	/ max
1 1 1	Red deer	27.0	13.4	0.50
2 2 1	European bison	27.0	12.7	0.47
2 6 7	Roe deer	17.0	7.9	0.47
3 5 6	Ibex	20.4	9.2	0.45
4 3 4	Fallow deer	25.4	10.5	0.42
5 4 5	Sika deer	25.0	10.0	0.39
6 7 1	Moose	27.0	7.3	0.27

Example: Ruminants

Mating system, feeding type and *ex situ* conservation effort determine life expectancy in captive ruminants

Dennis W. H. Müller[1,*], Laurie Bingaman Lackey[2], W. Jürgen Streich[3], Jörns Fickel[3], Jean-Michel Hatt[1] and Marcus Clauss[1]

Proc. R. Soc. B (2011) **278**, 2076–2080

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Proc. R. Soc. B (2011) **278**, 2076–2080

Question:
Does the relative life expectancy change with body mass?

Example: Ruminants

Mating system, feeding type and *ex situ* conservation effort determine life expectancy in captive ruminants

Dennis W. H. Müller[1,*], Laurie Bingaman Lackey[2], W. Jürgen Streich[3], Jörns Fickel[3], Jean-Michel Hatt[1] and Marcus Clauss[1]

Proc. R. Soc. B (2011) **278**, 2076–2080

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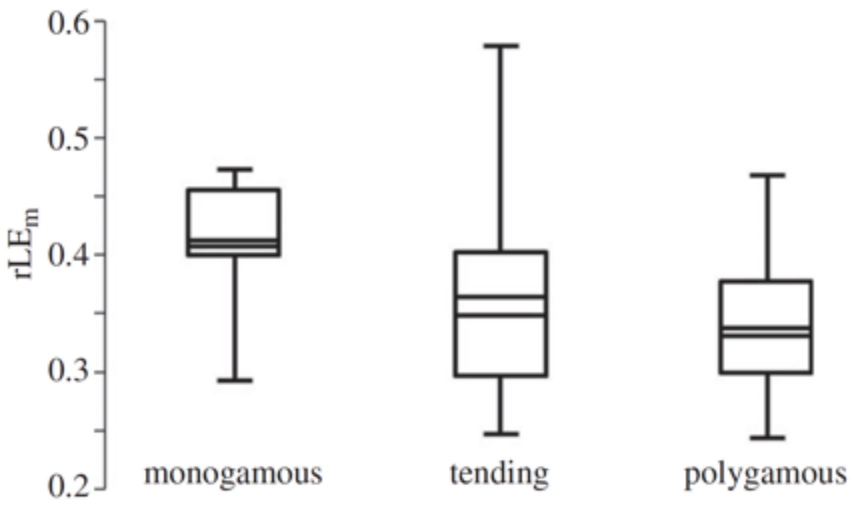

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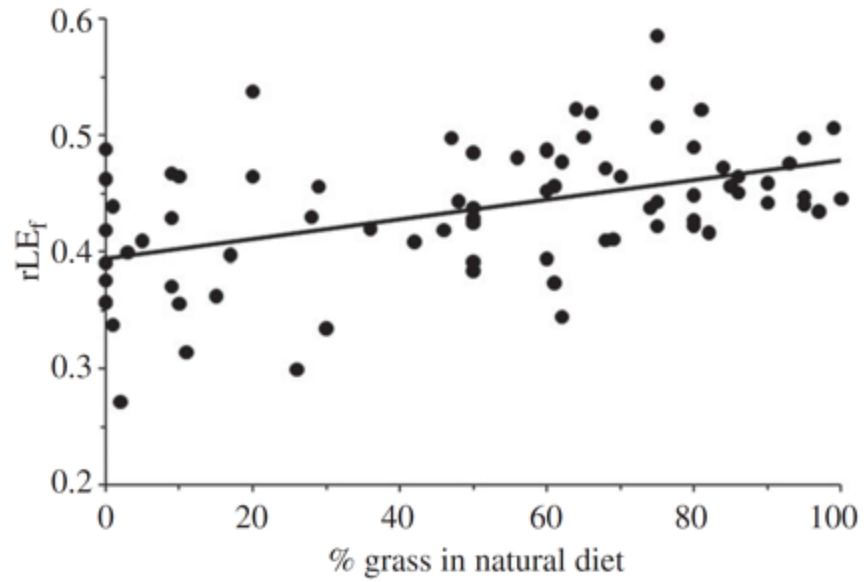

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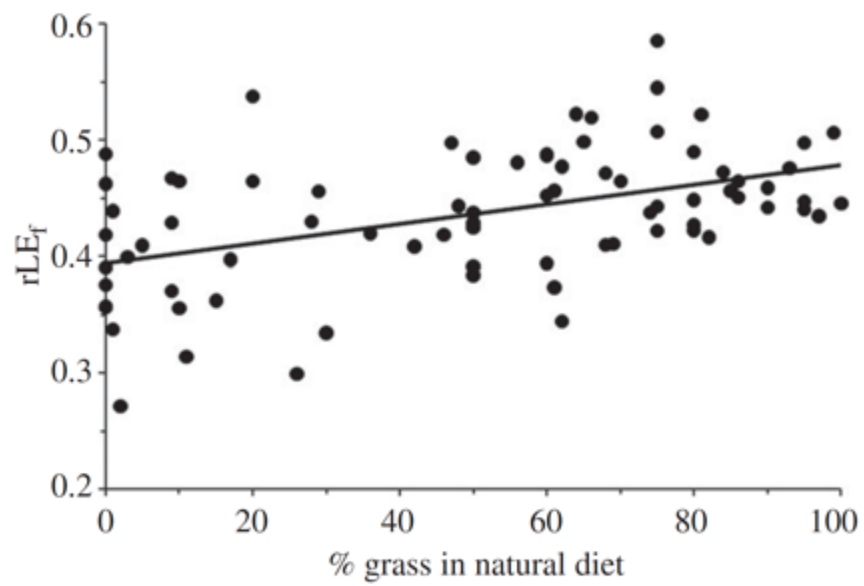

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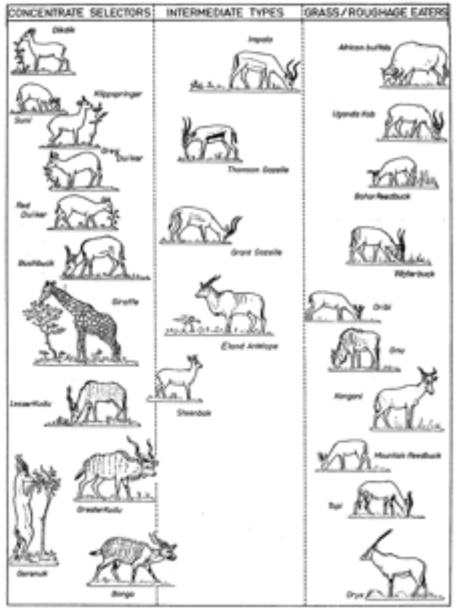

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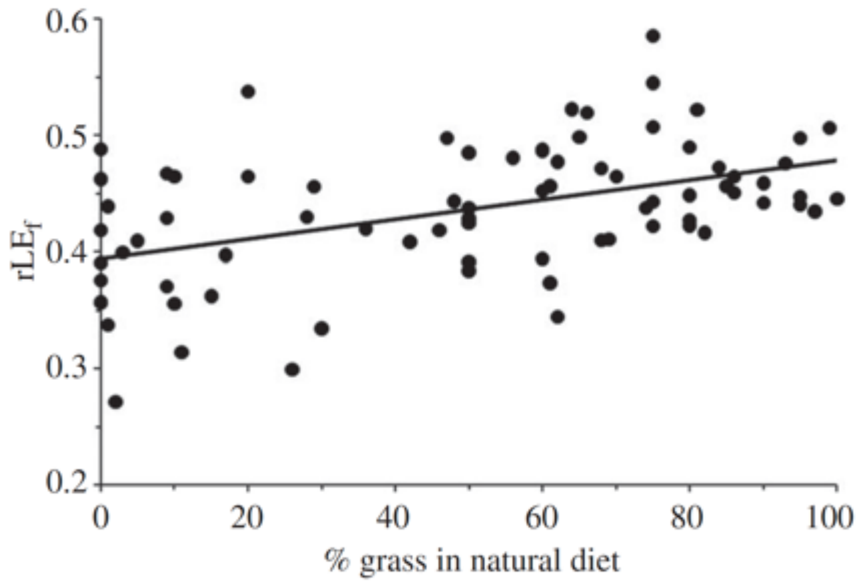

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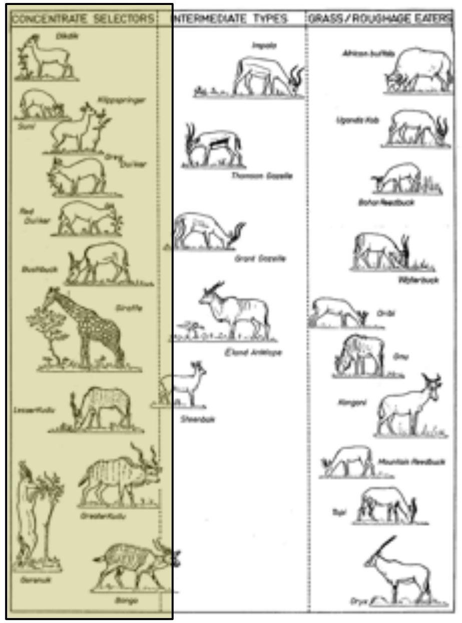

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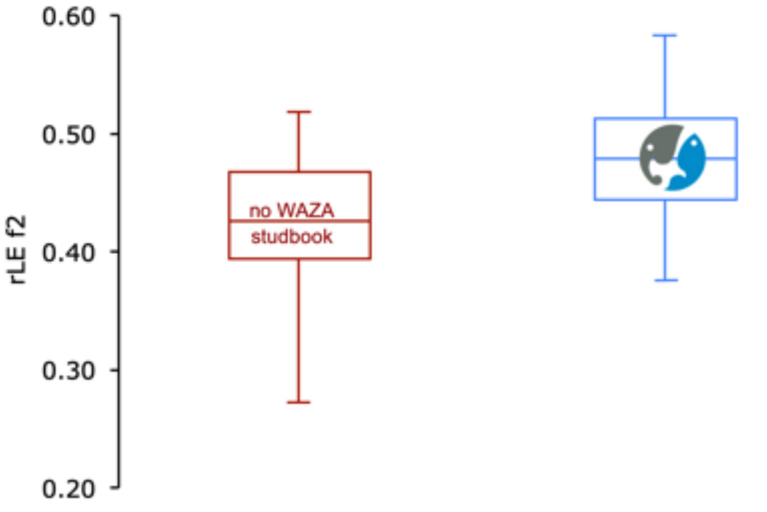

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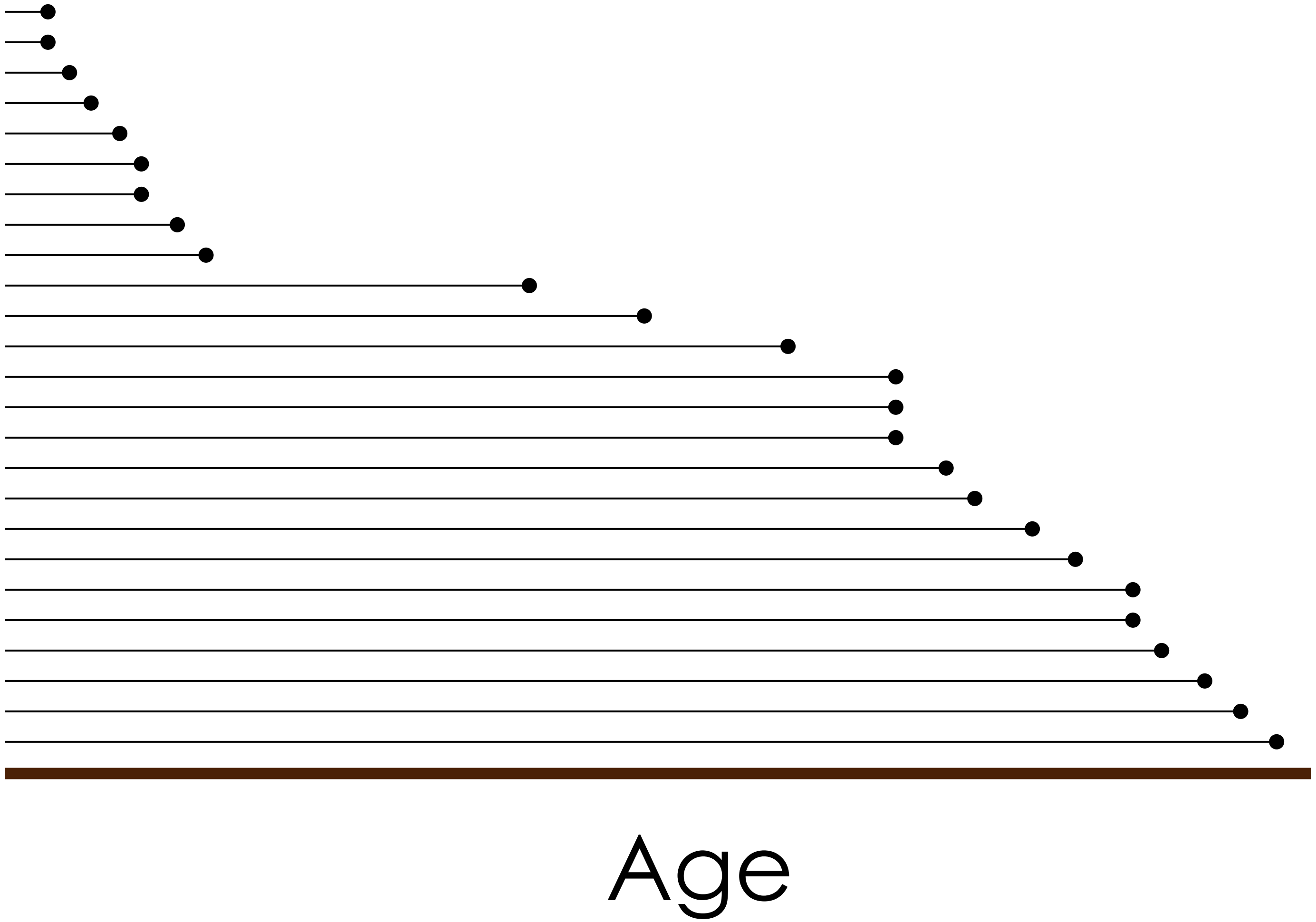
Talking about cohorts

Data in Species360: Birth and Death



It's easy to calculate an average longevity.

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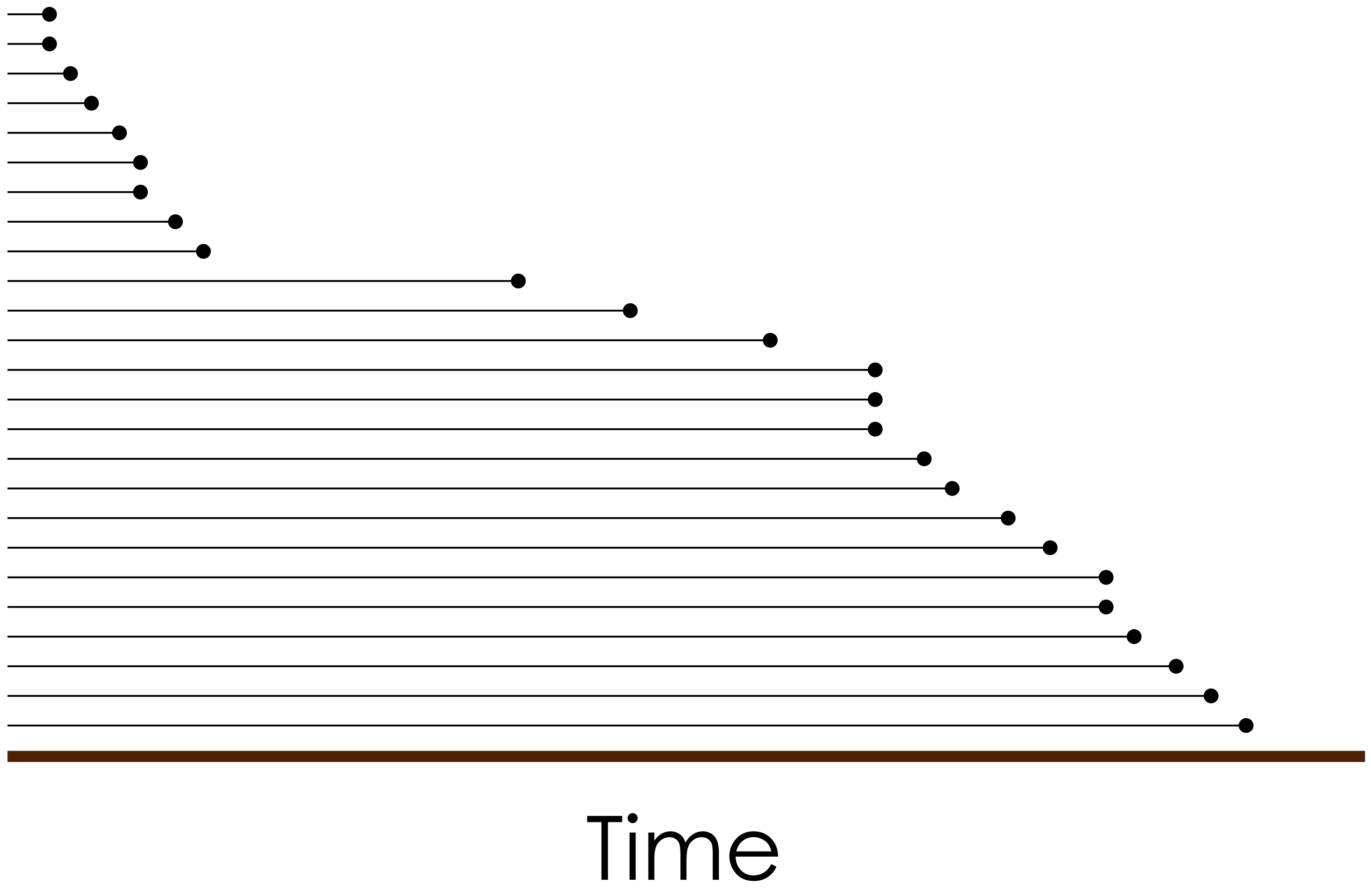

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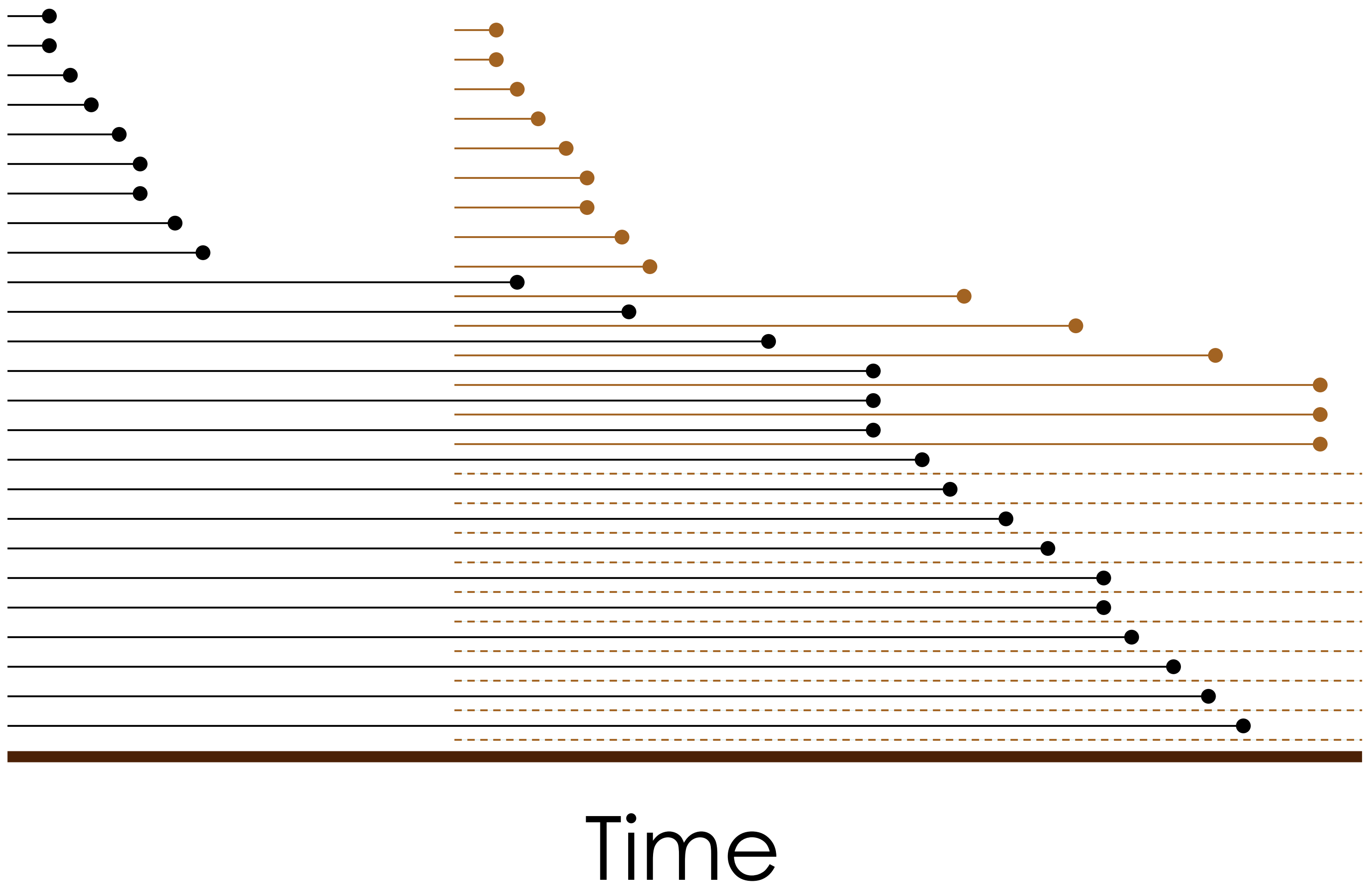

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But not all animals can be used.

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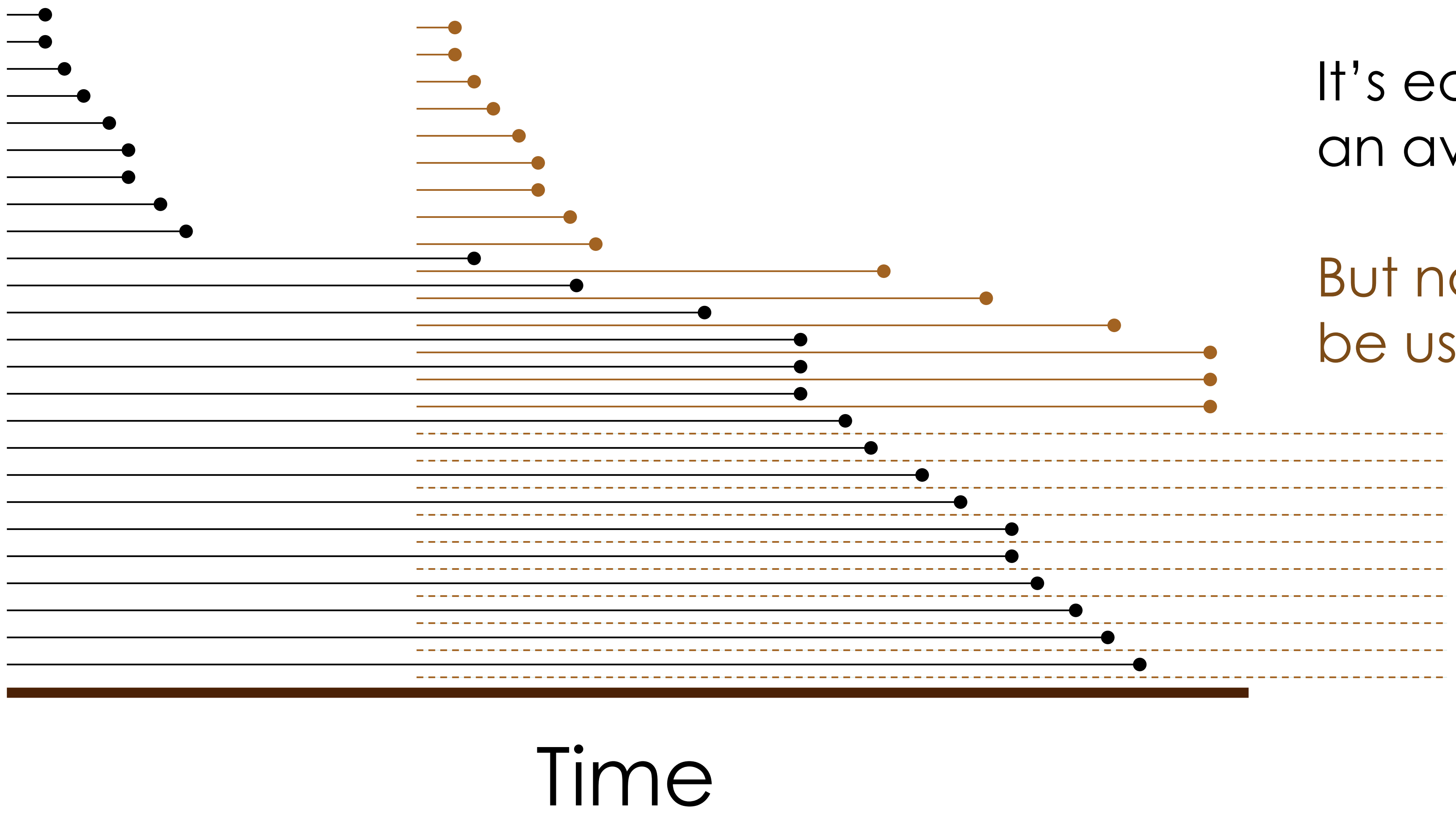

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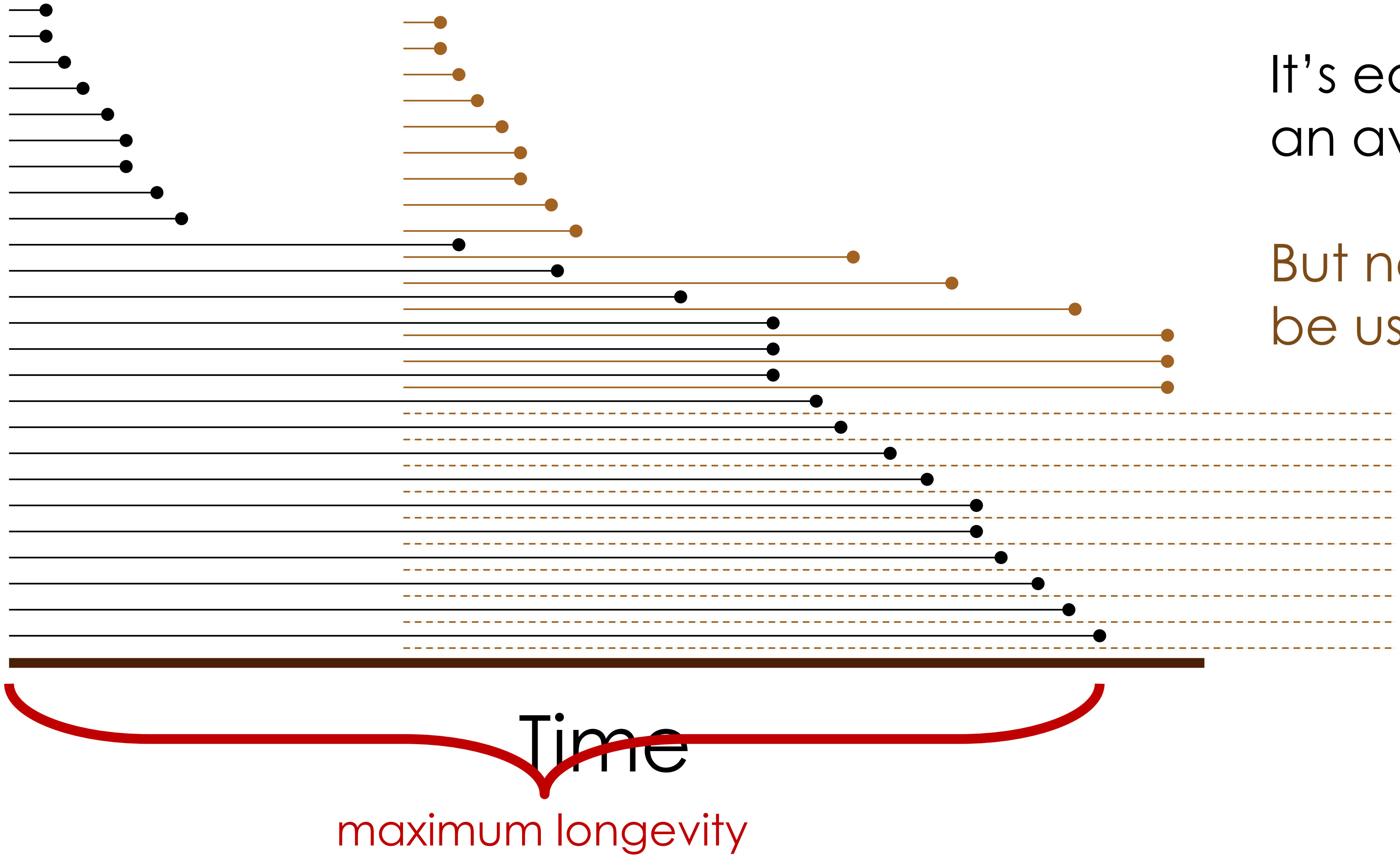

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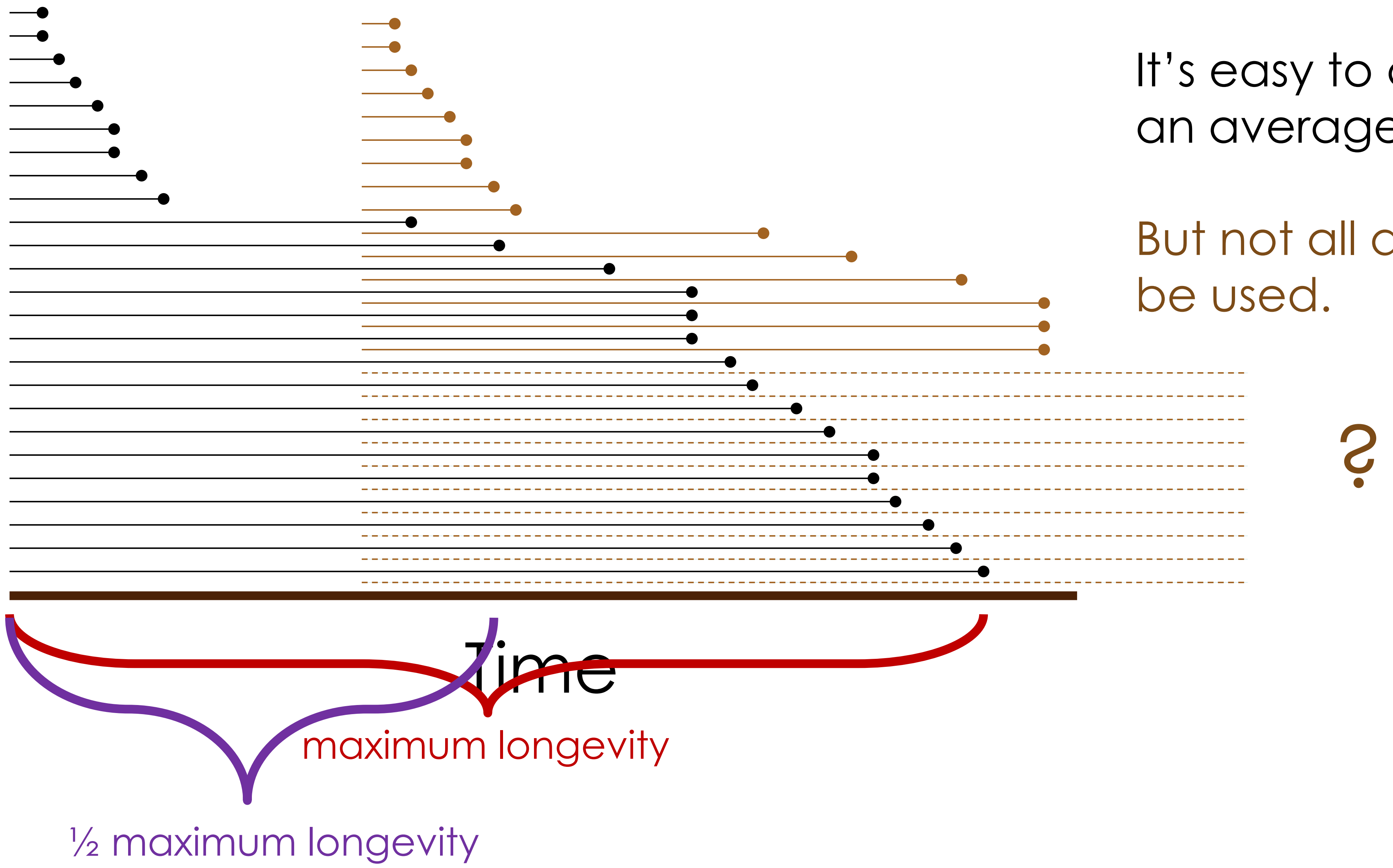

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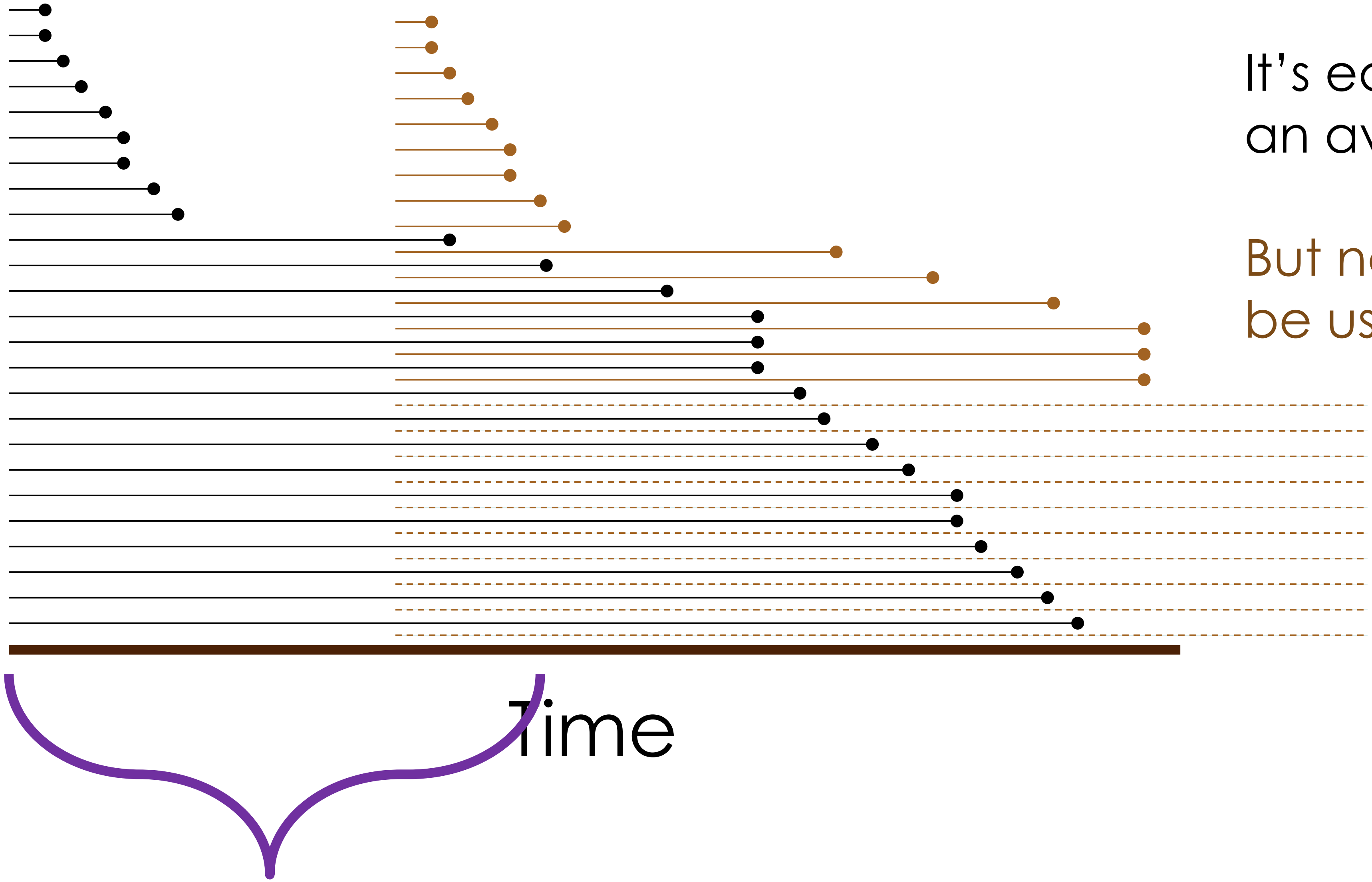

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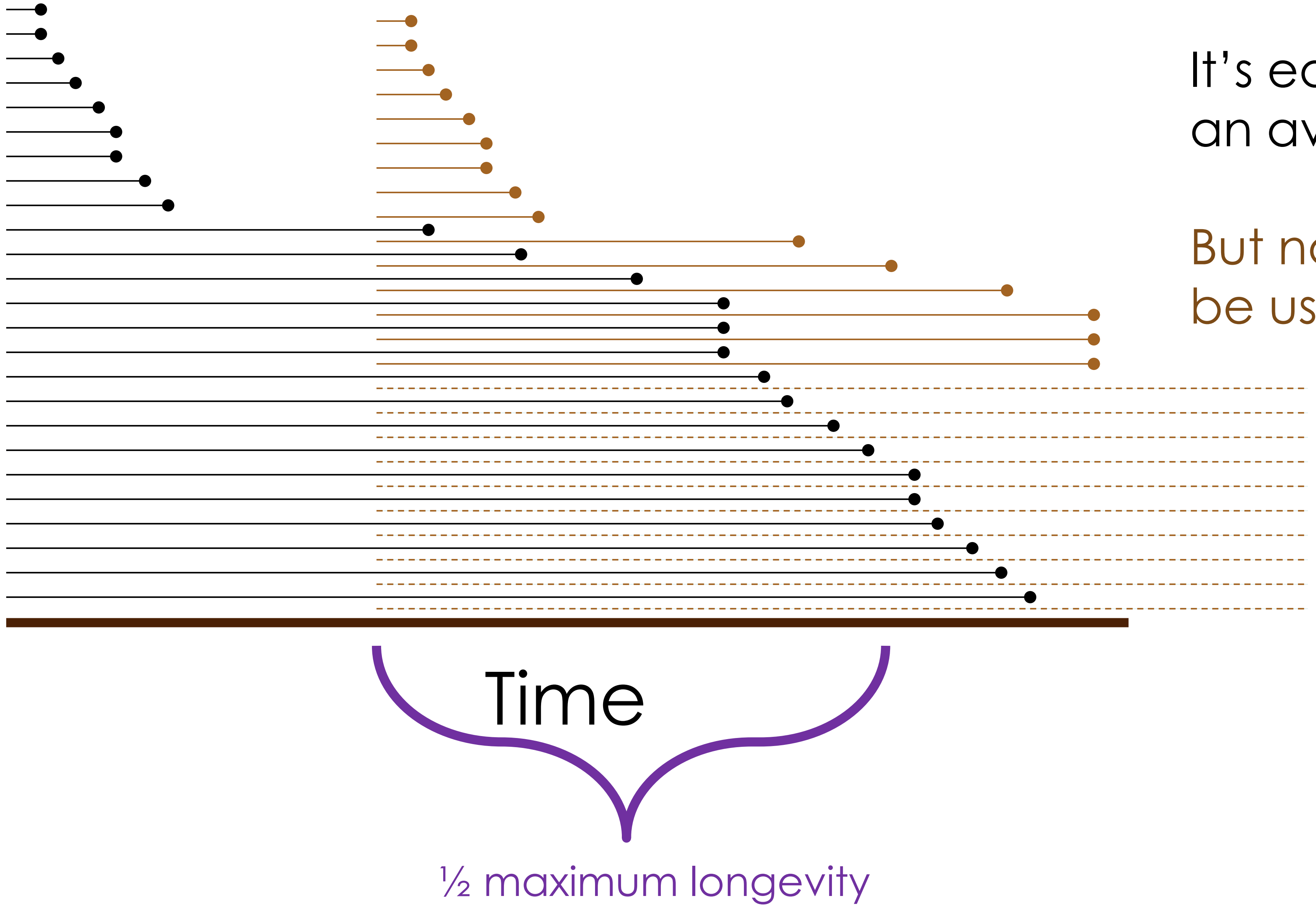

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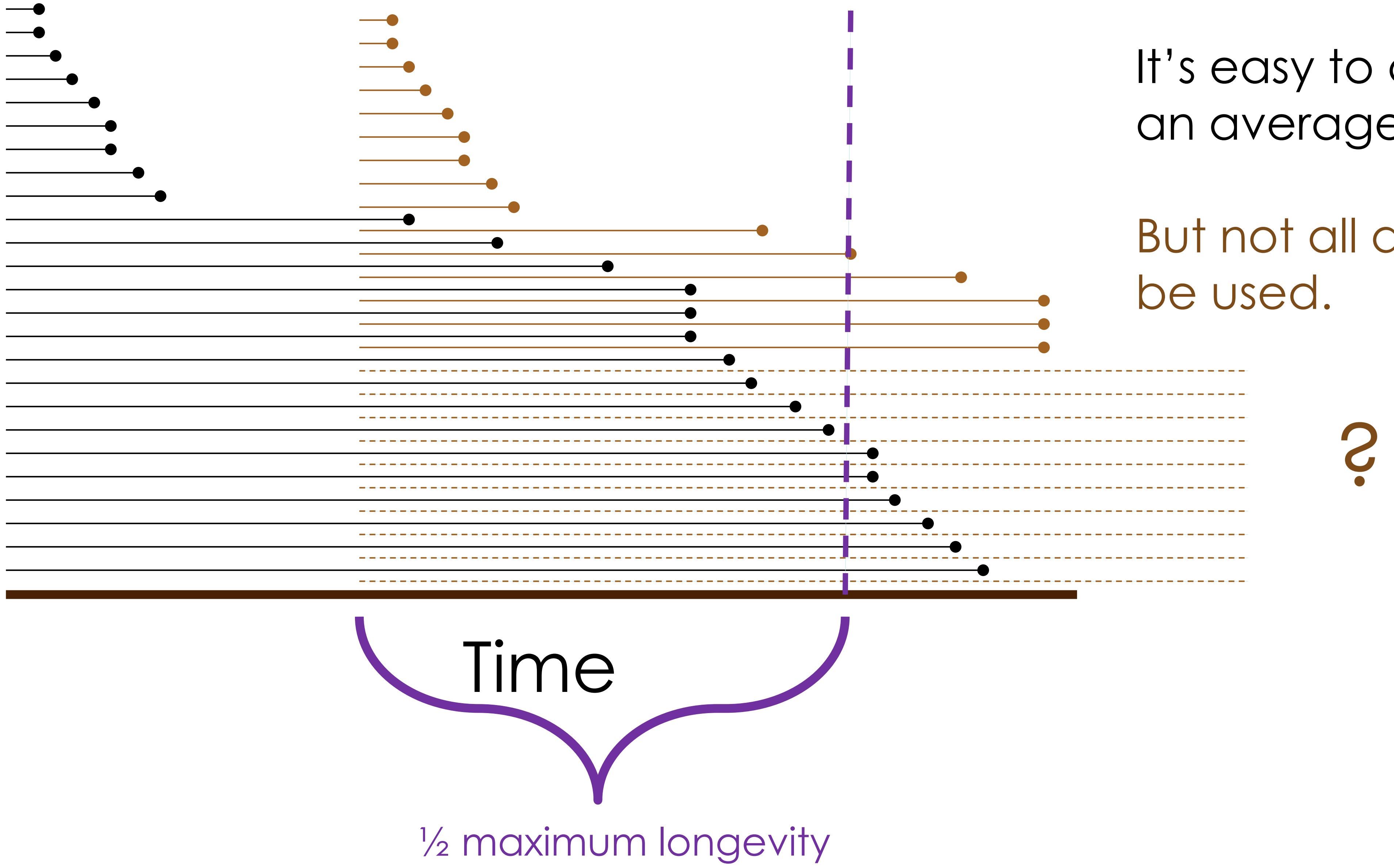

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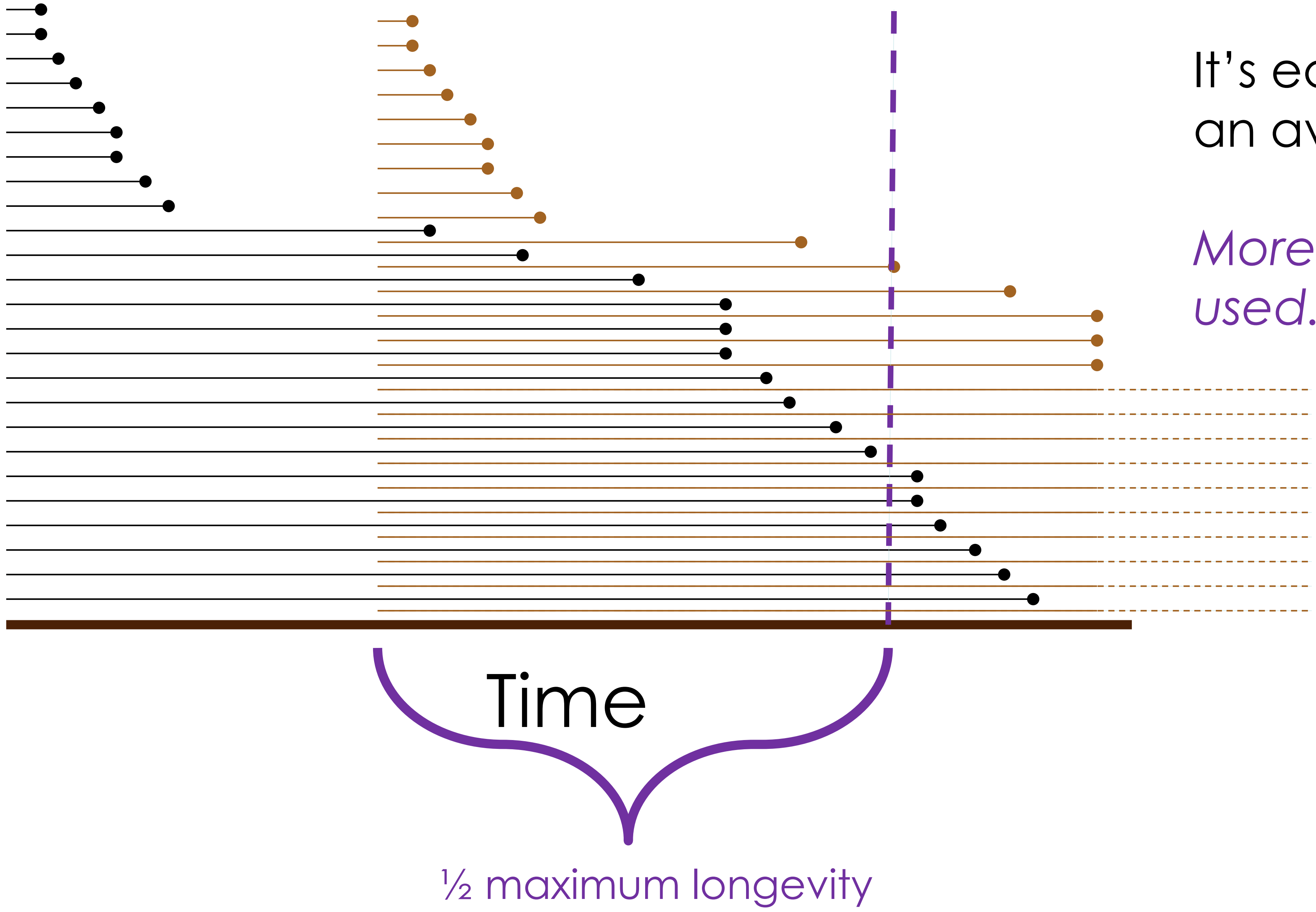

It's easy to calculate an average longevity.

More animals can be used.

Is there development in the zoo world ?

European Association of Zoo- and Wildlife Veterinarians (EAZWV)
7th scientific meeting, April 30—May 3 2008. Leipzig, Gemany

EVALUATION OF OKAPI (*Okapia johnstoni*) NECROPSY REPORTS AND STUDBOOK DATA AS PART OF THE EAZWV SUMMER SCHOOL

STUDENTS 1ST EAZWV SUMMER SCHOOL[1]

1. for a list of contributors, see acknowledgements

	Newborn mortality (died within first year after birth)		
	Global	Epulu	Europe
Total births	505	71	248
Birth date	in % of all births		
before 1960	25.0	13.5	77.8
1960-69	36.8	0.0	40.5
1970-79	39.7	0.0	40.0
1980-89	25.3	0.0	39.6
1990-99	25.8	0.0	38.0
2000-2007	24.0	0.0	25.0
total	28.9	7.0	38.3

Captive and Wild Orangutan (*Pongo* sp.) Survivorship: A Comparison and the Influence of Management

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American Journal of Primatology 71:680–686 (2009)

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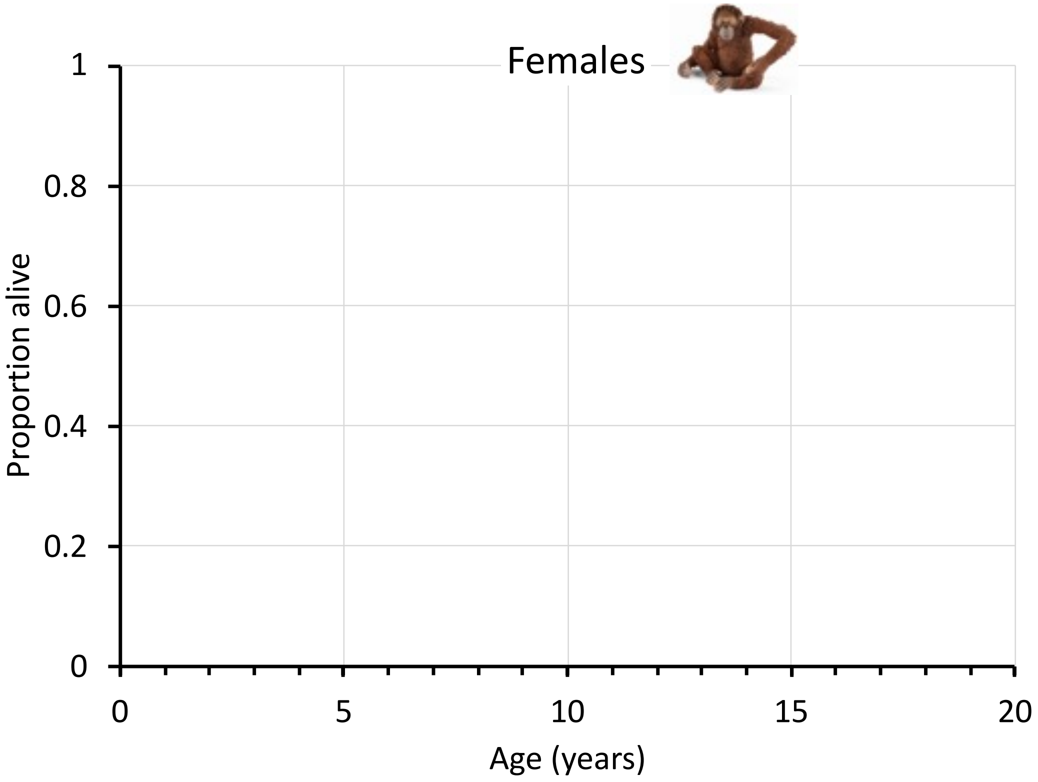

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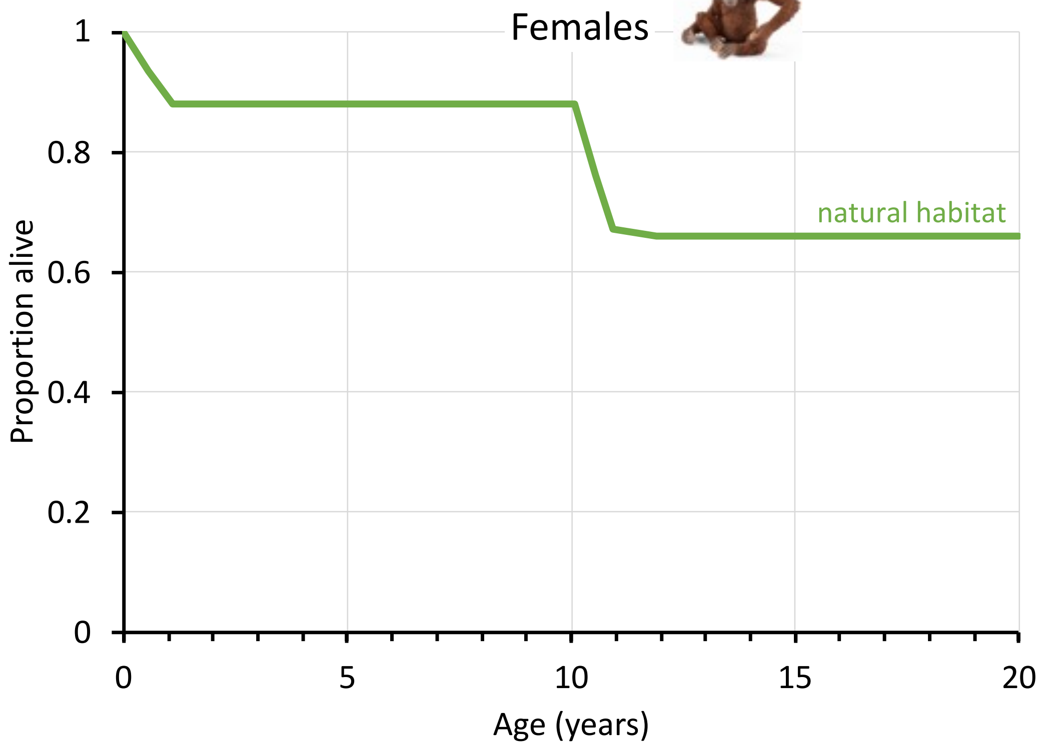

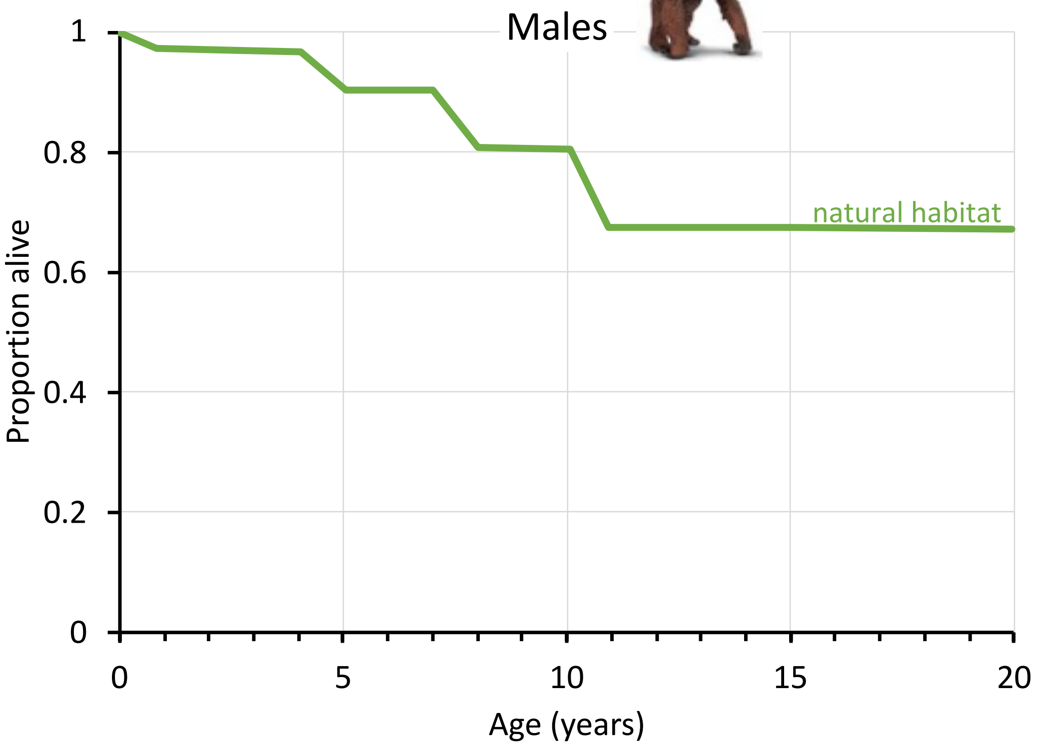

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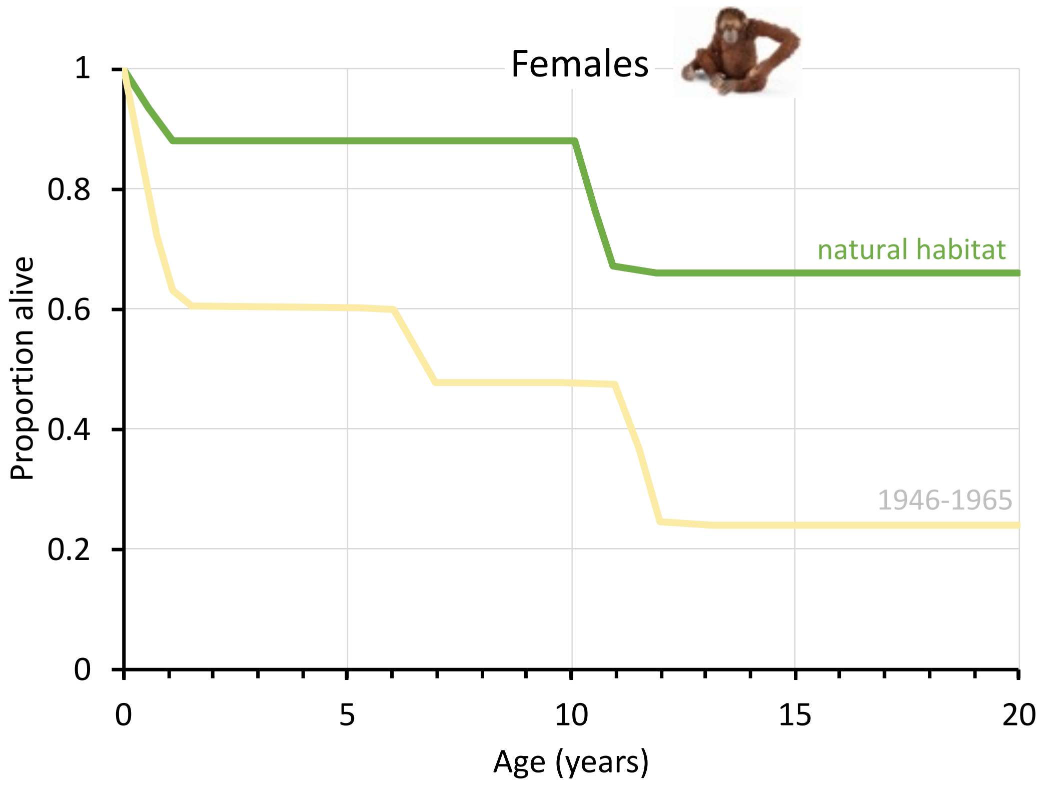

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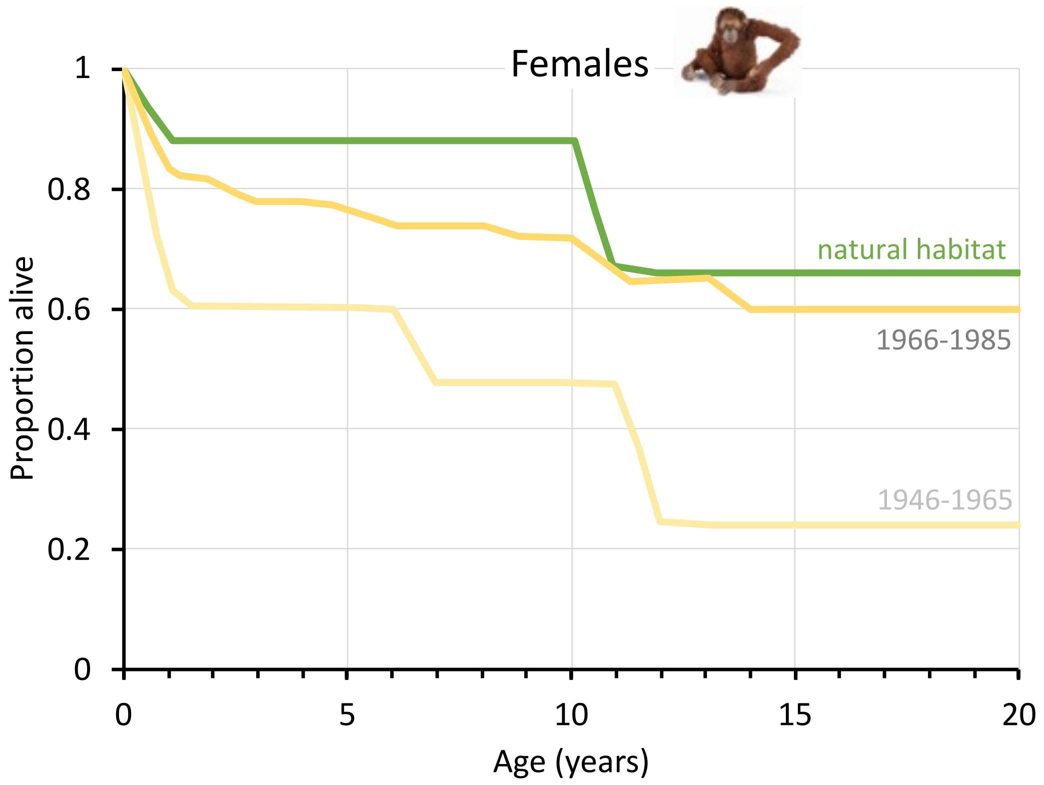

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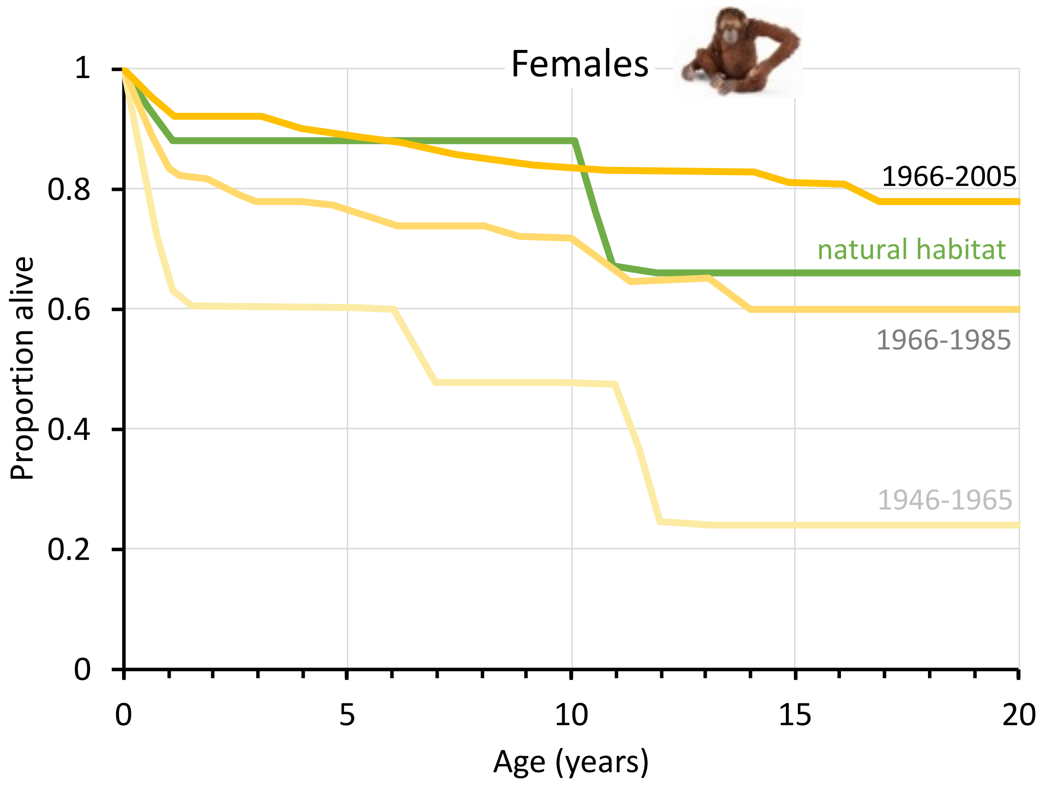

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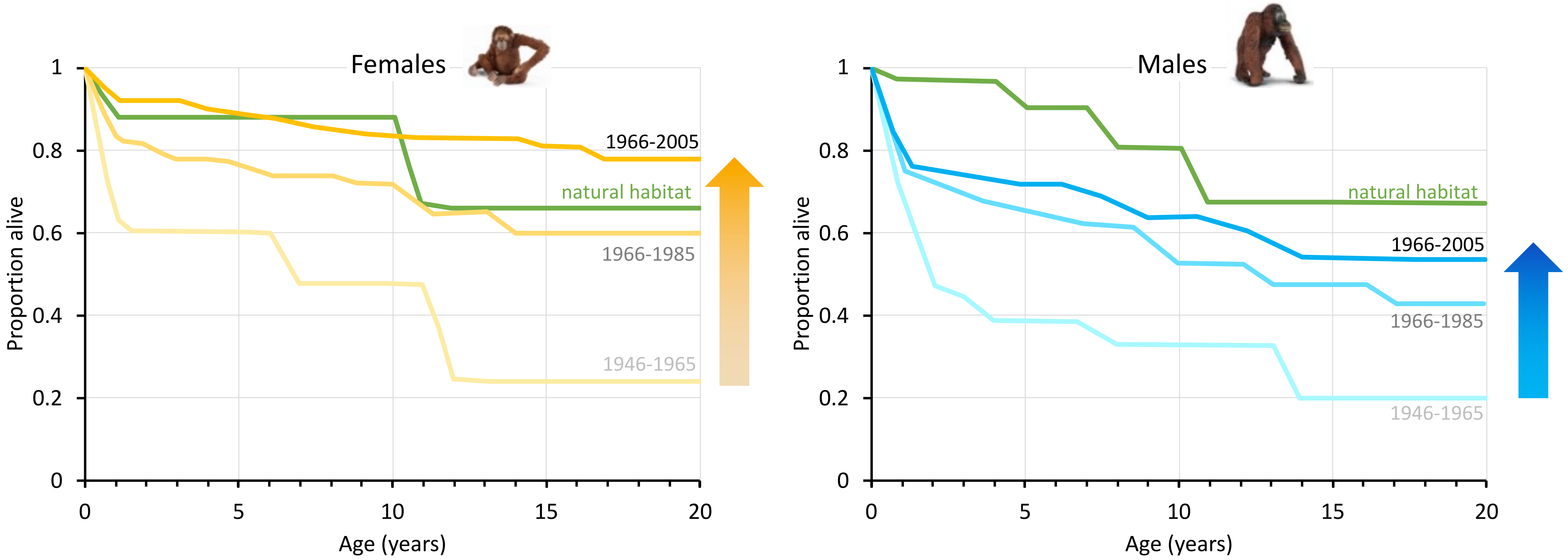

Is there development in the zoo world ?

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Marco Roller,
Zoological Garden of Karlsruhe

Comparisons over time: which parameters ?

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(i) Mortality of certain life stages (neonate, age at weaning, age at sexual maturity) or at arbitrary setpoints (1 week, 1 month, 1 year)

(i) should decrease

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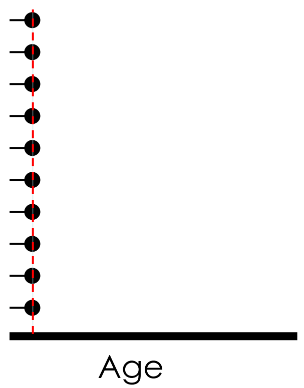

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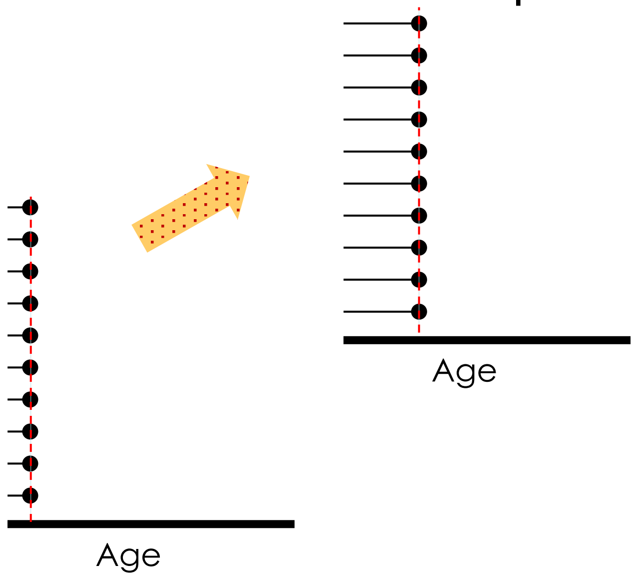

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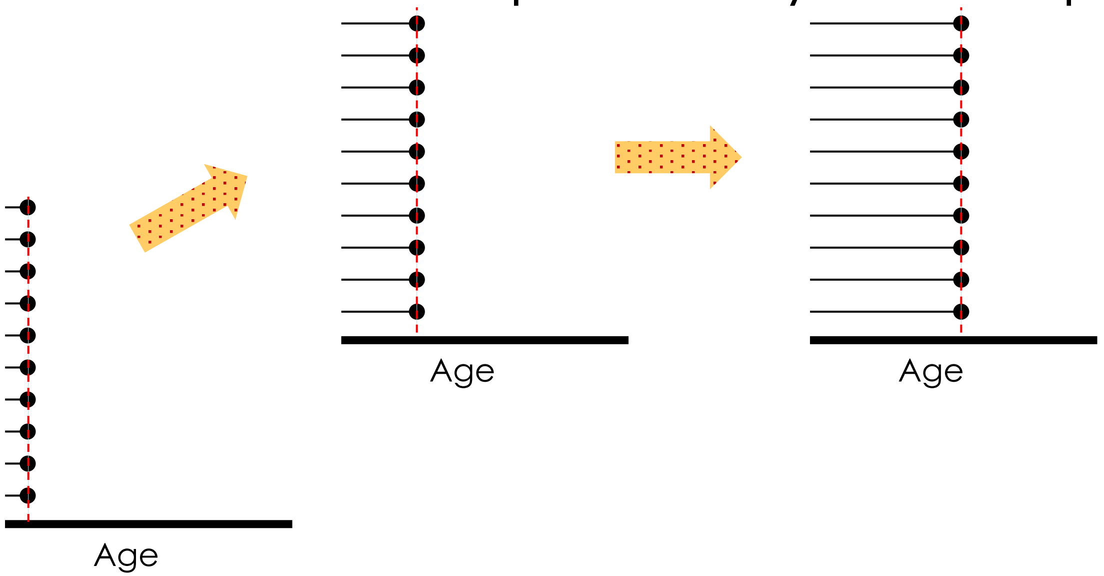

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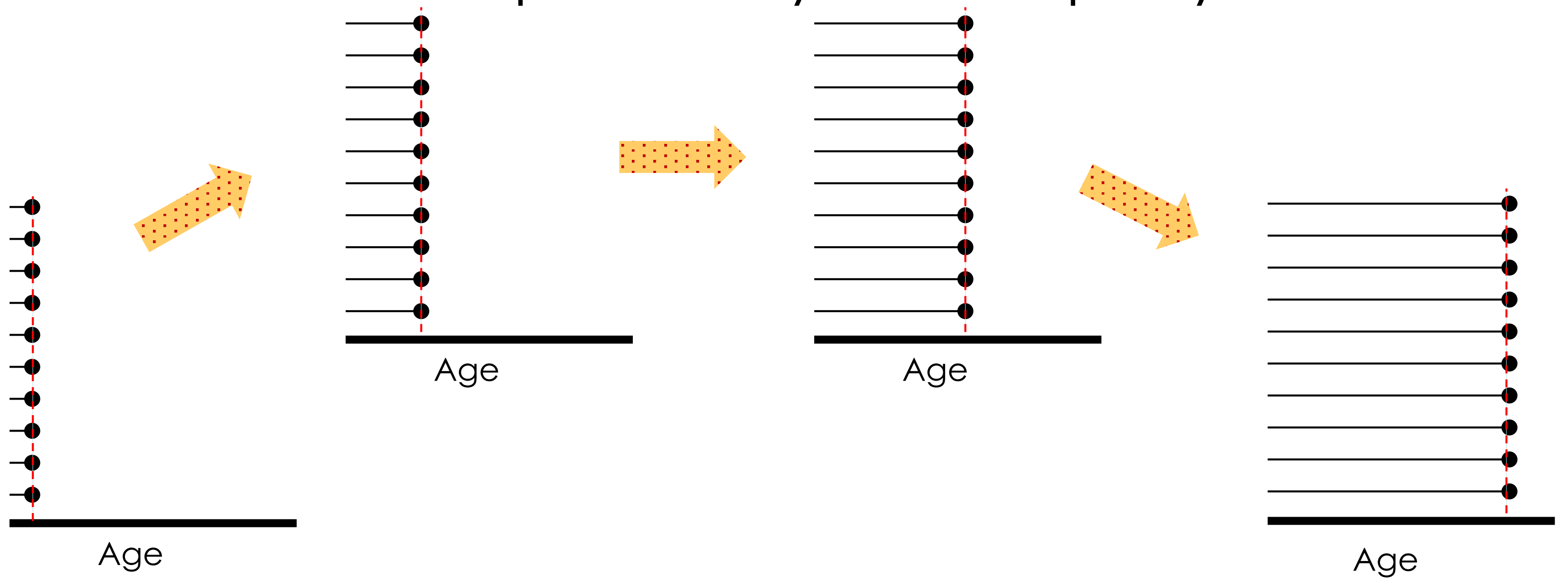

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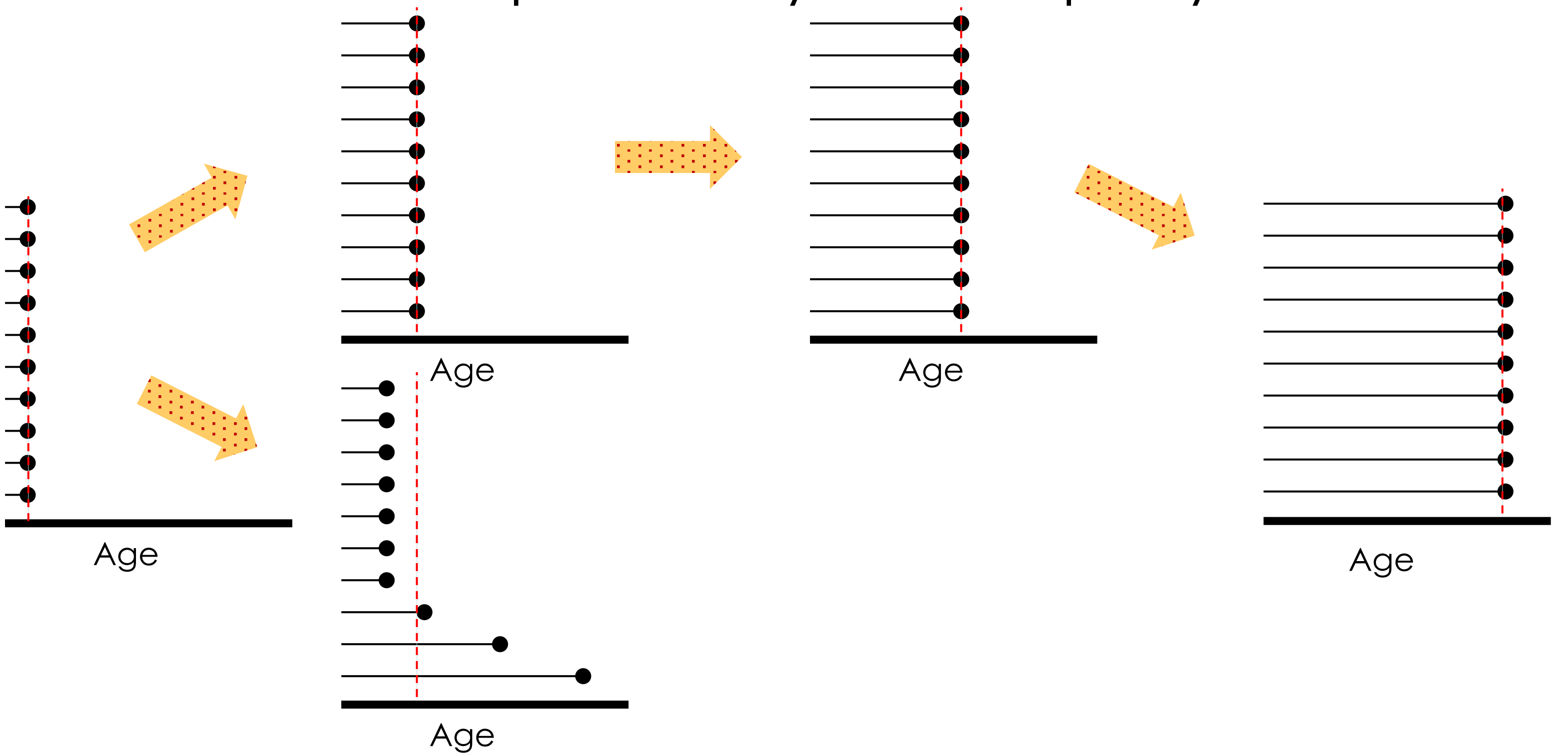

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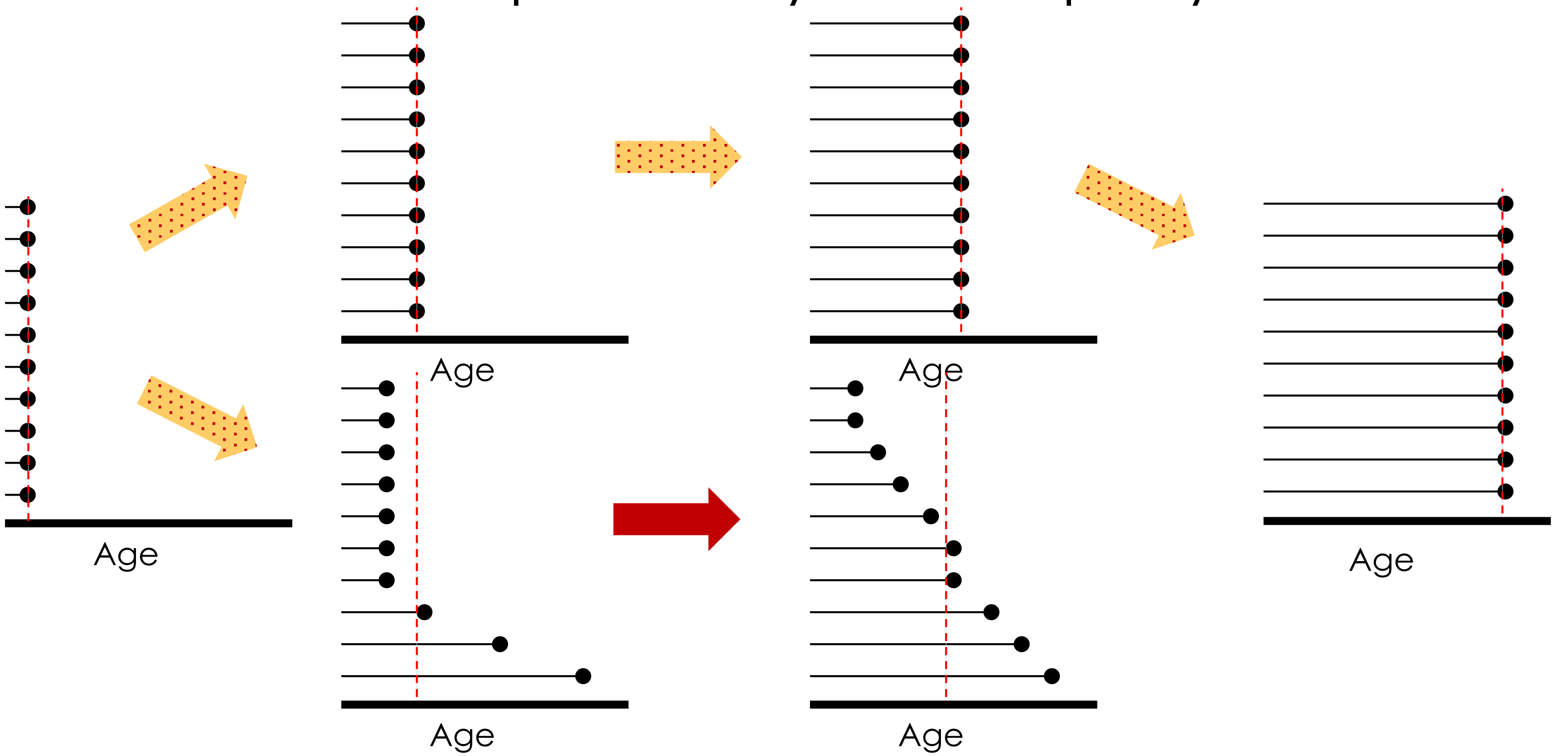

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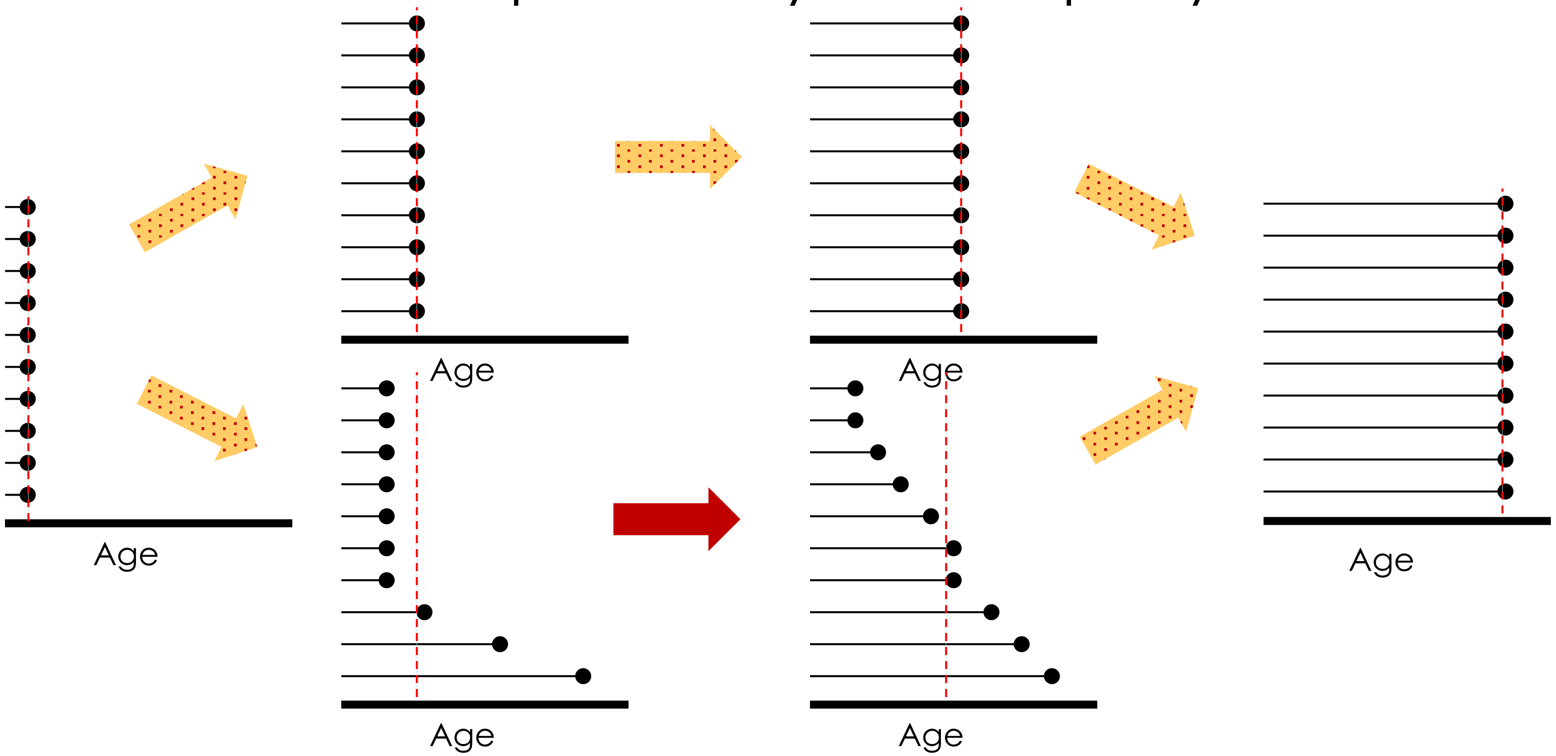

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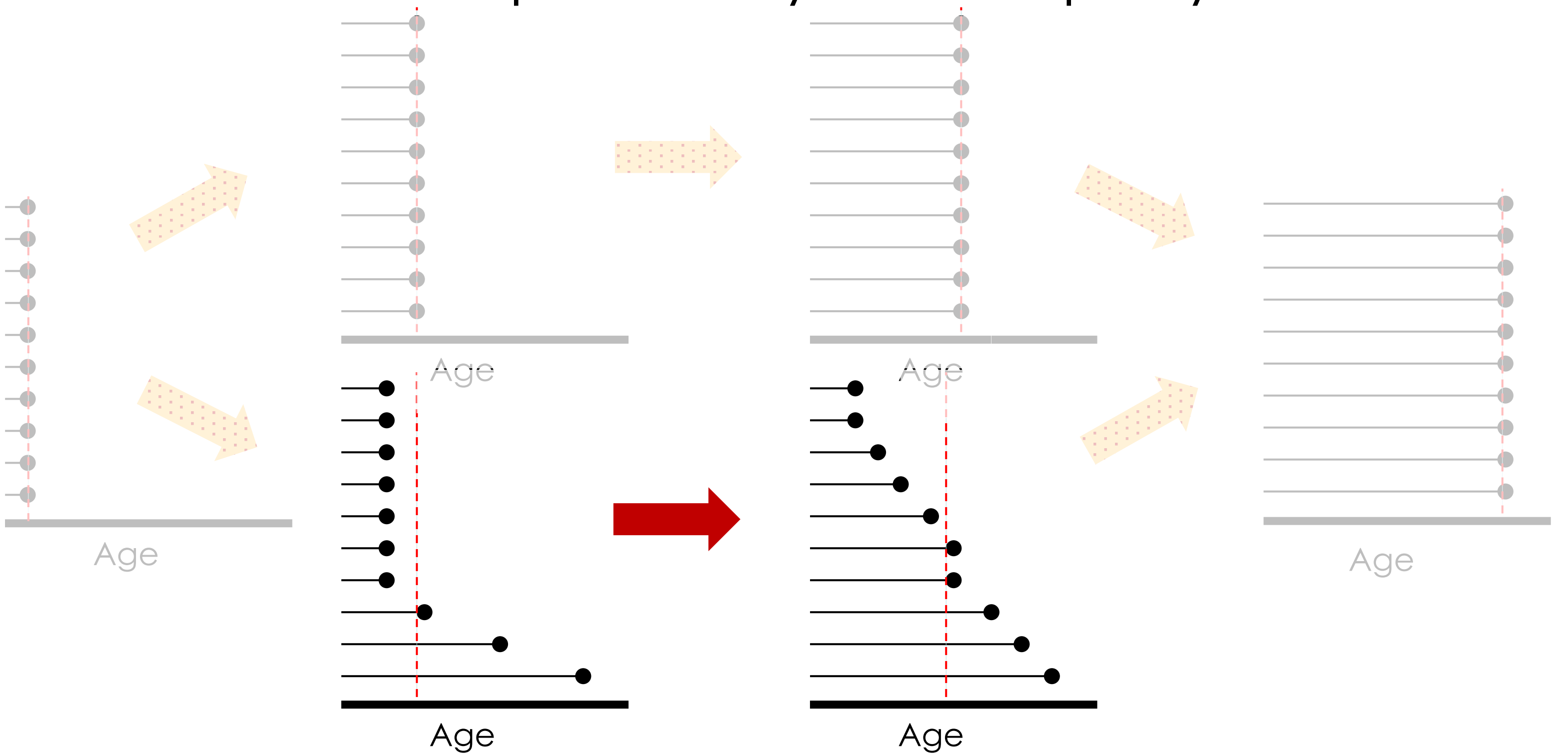

Do zoos improve?

Do zoos improve?

TECHNICAL REPORT

ZOOBIOLOGY WILEY

The historical development of juvenile mortality and adult longevity in zoo-kept carnivores

Marco Roller[1] | Dennis W. H. Müller[2] | Mads F. Bertelsen[3] | Laurie Bingaman Lackey[4] | Jean-Michel Hatt[5] | Marcus Clauss[5]

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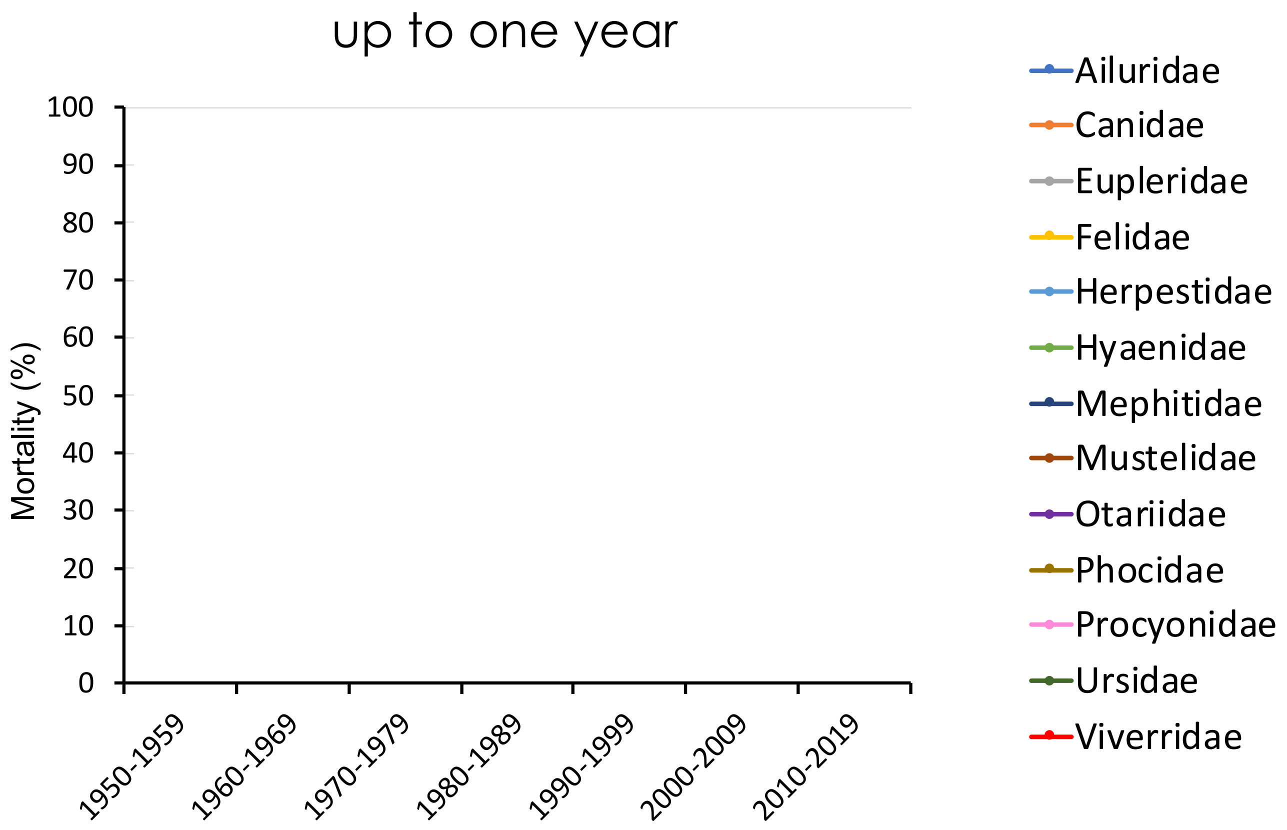

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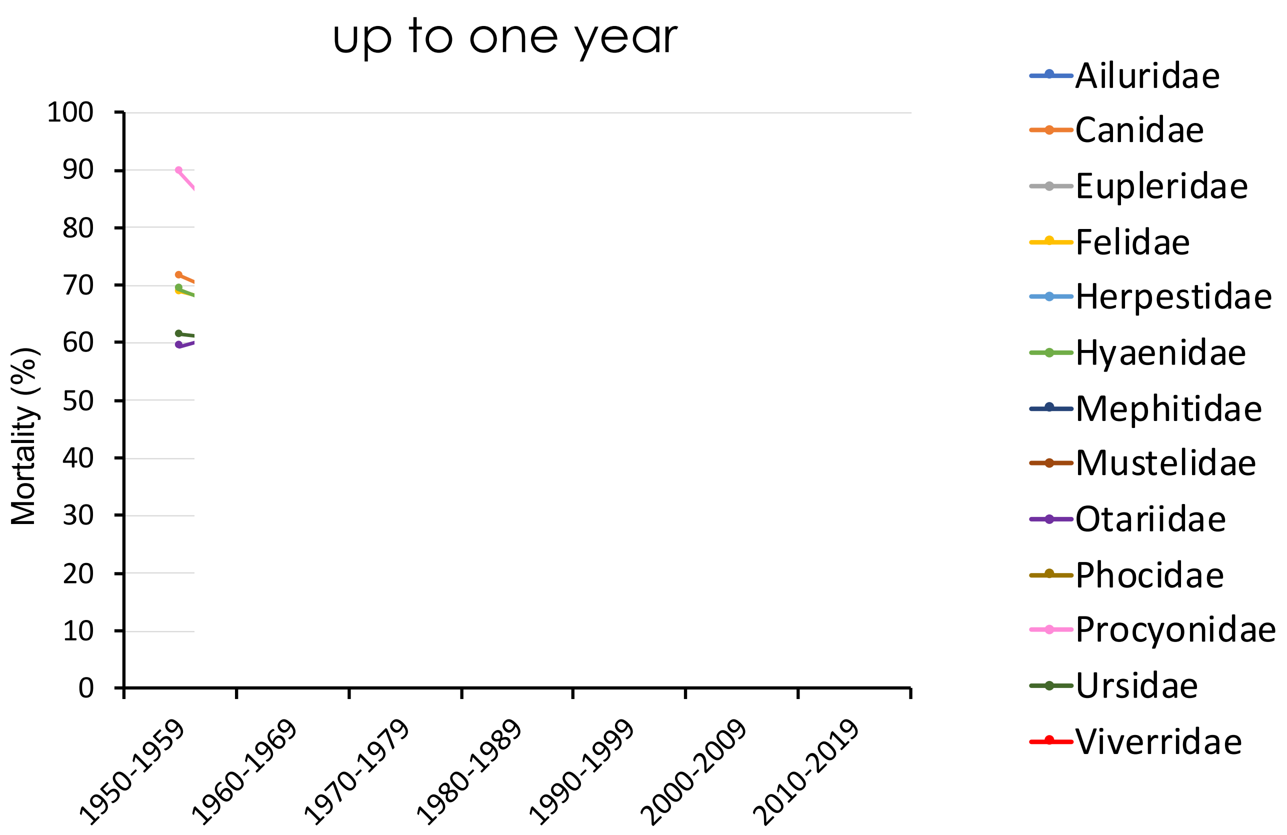

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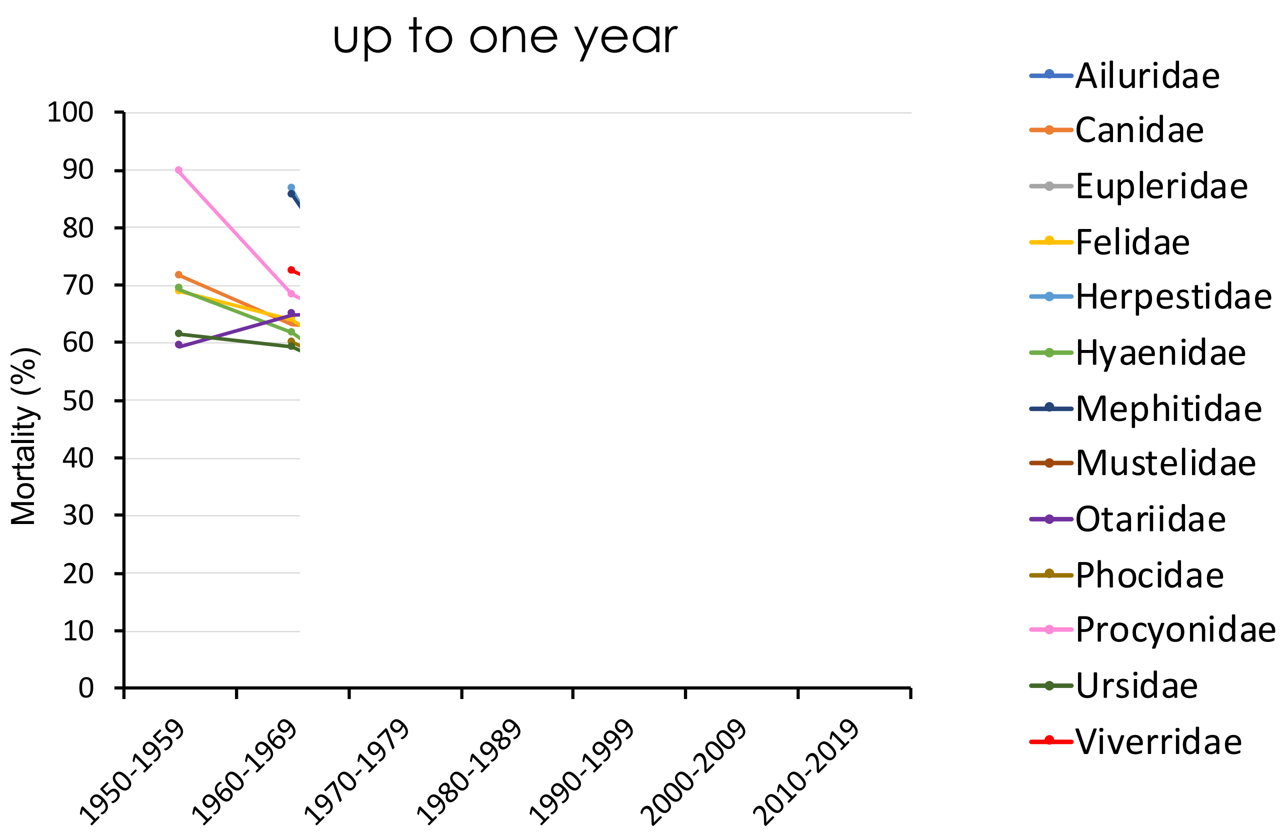

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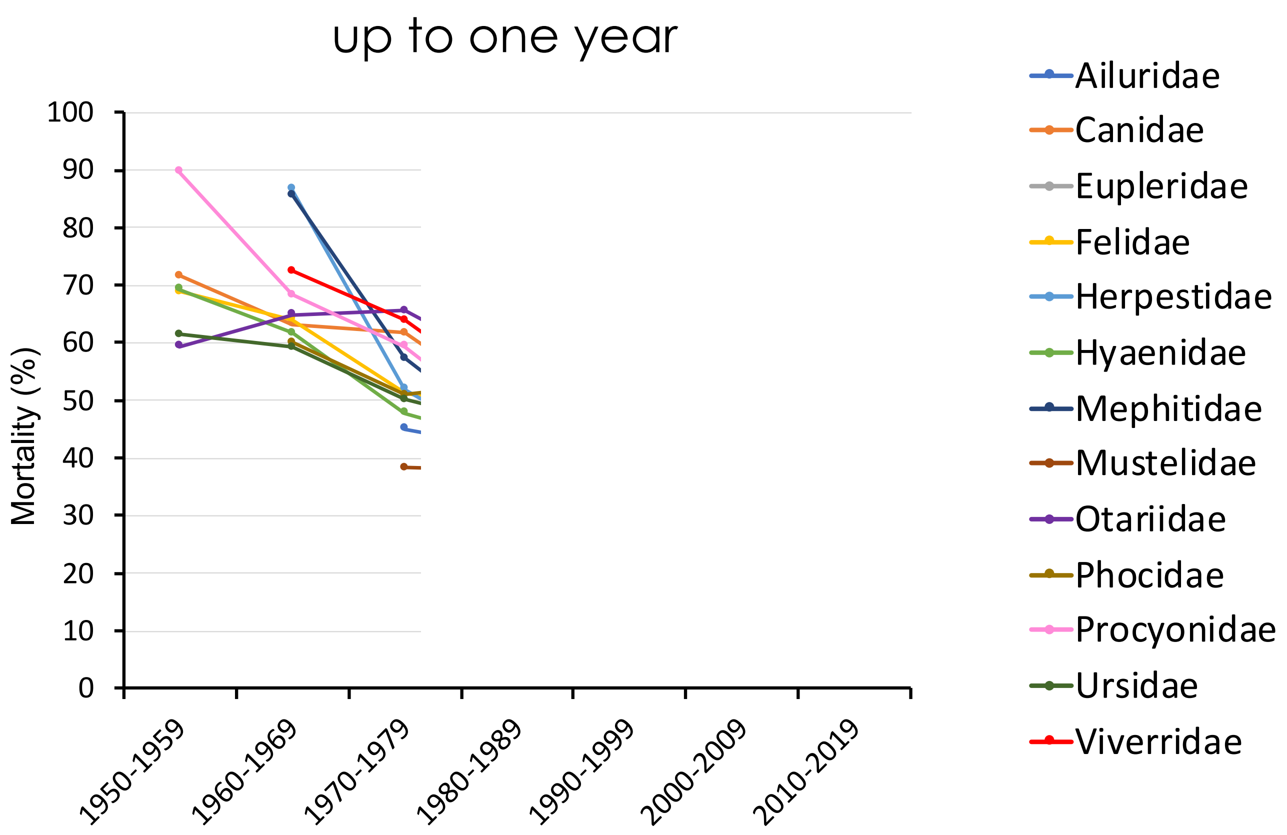

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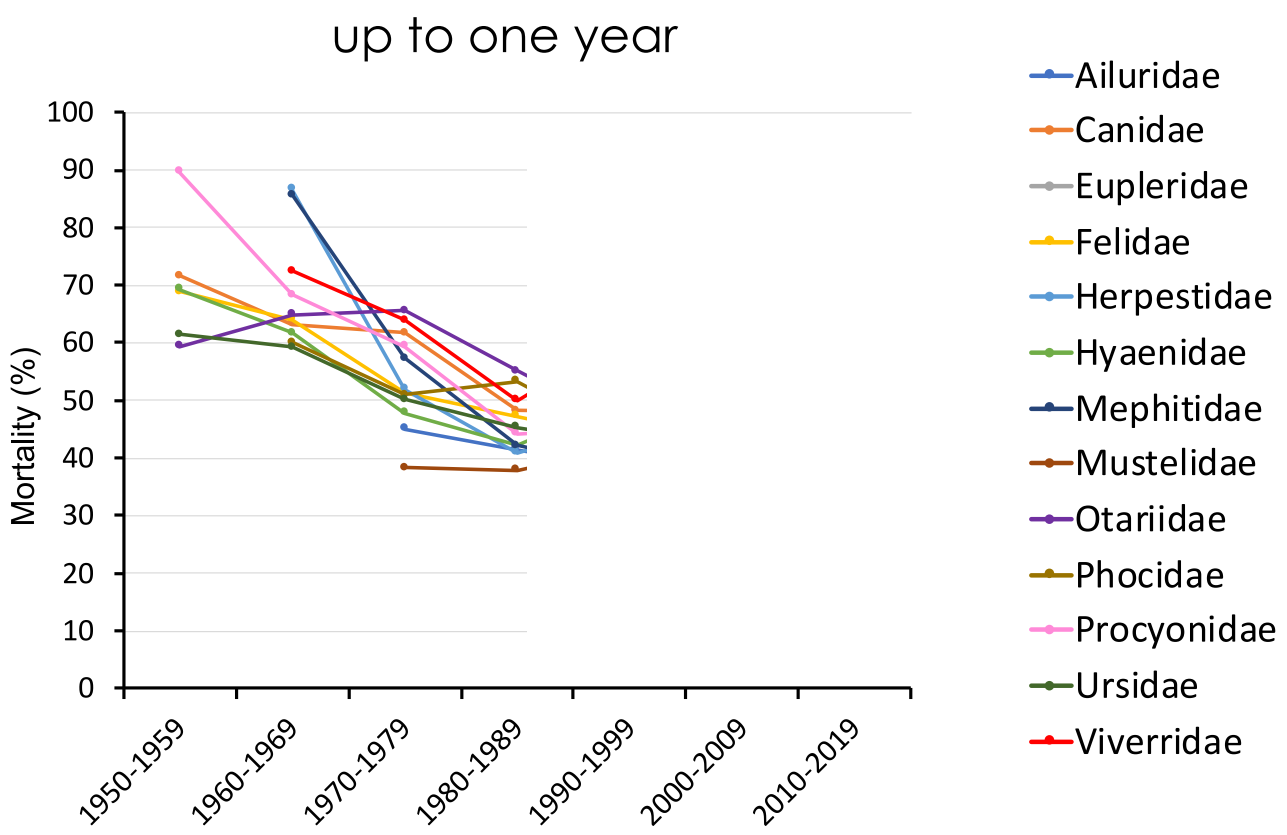

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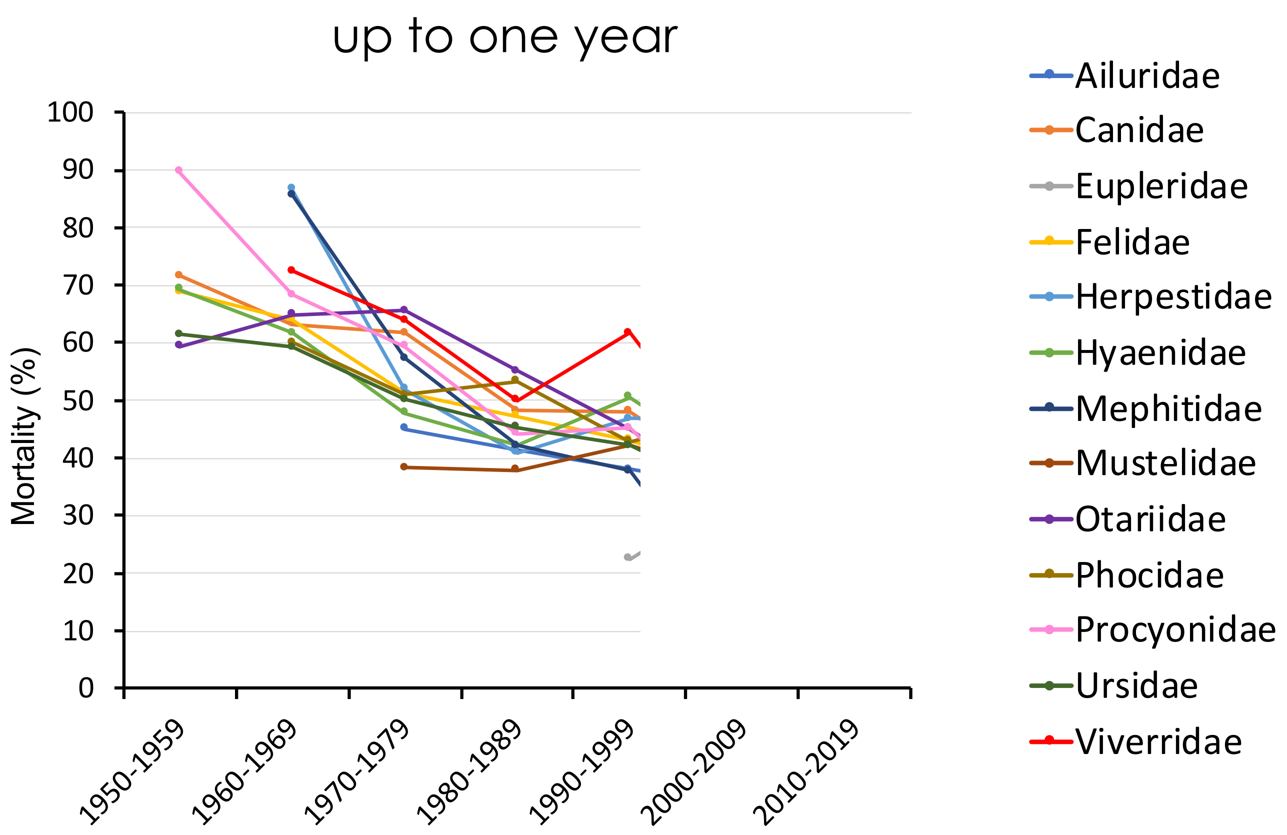

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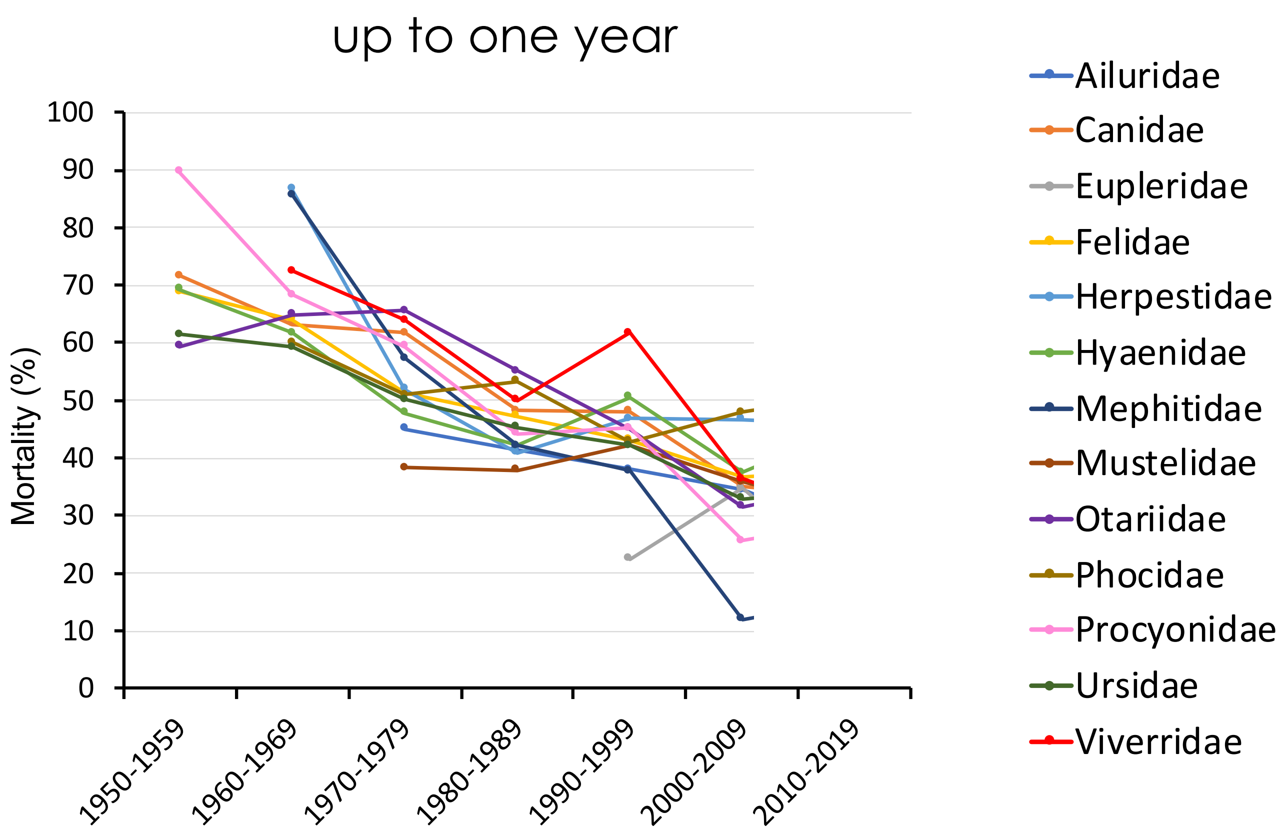

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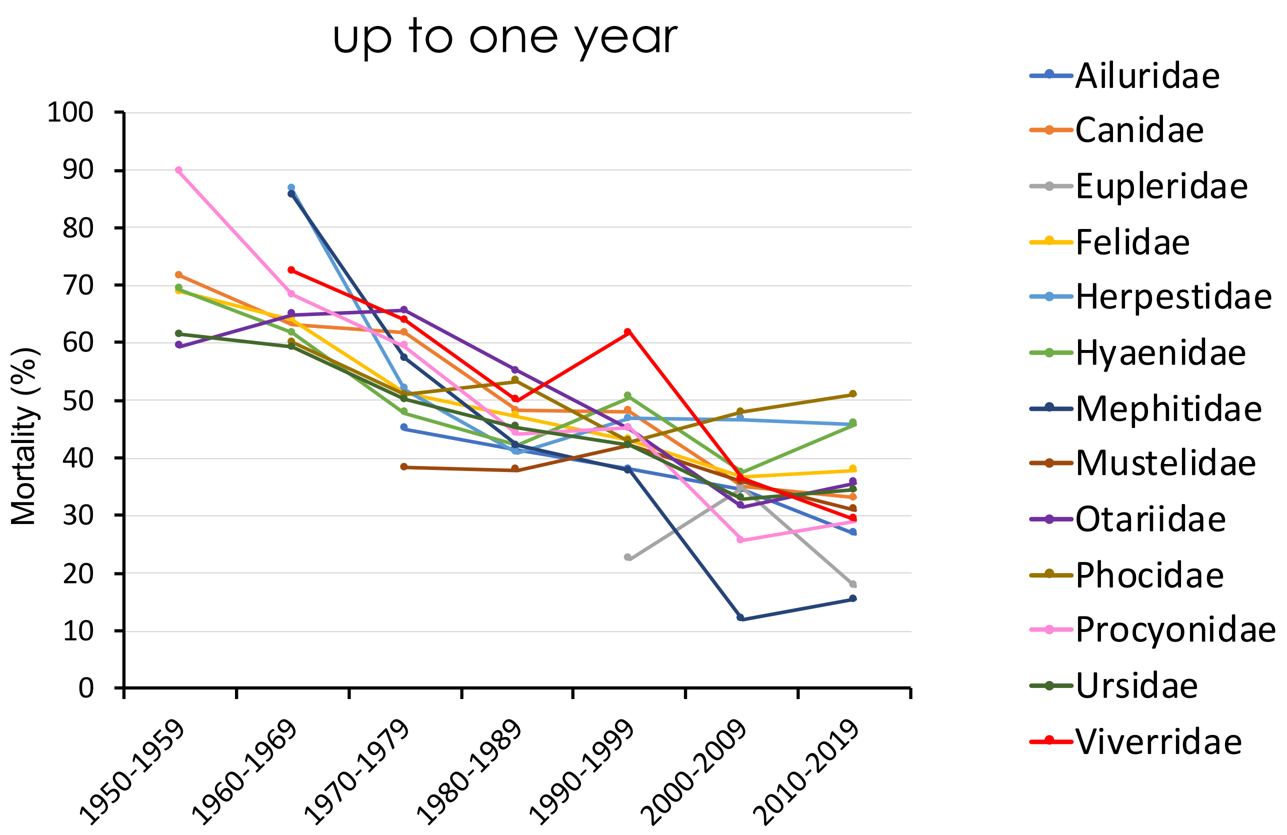

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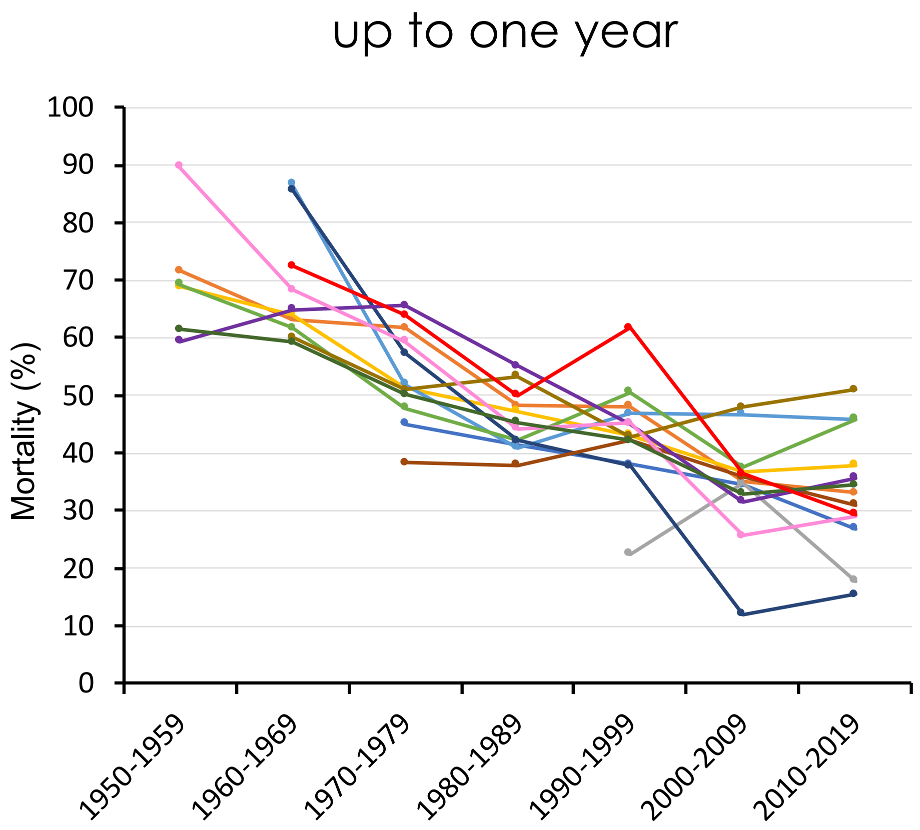

	df	*F*	*p*	*p* normality residuals
Model ($n = 66$)	Day 365 mortality = Decade × Family + VPreviousDecade			.491
Decade	1	216.093	<.001	
Family	12	3.951	<.001	
Decade × Family	12	3.656	.001	
Value previous decade	1	5.880	.020	
Model ($n = 79$)	Day 365 mortality = Decade × Family			.594
Decade	1	257.717	<.001	
Family	12	2.937	.003	
Decade × Family	12	4.131	<.001	

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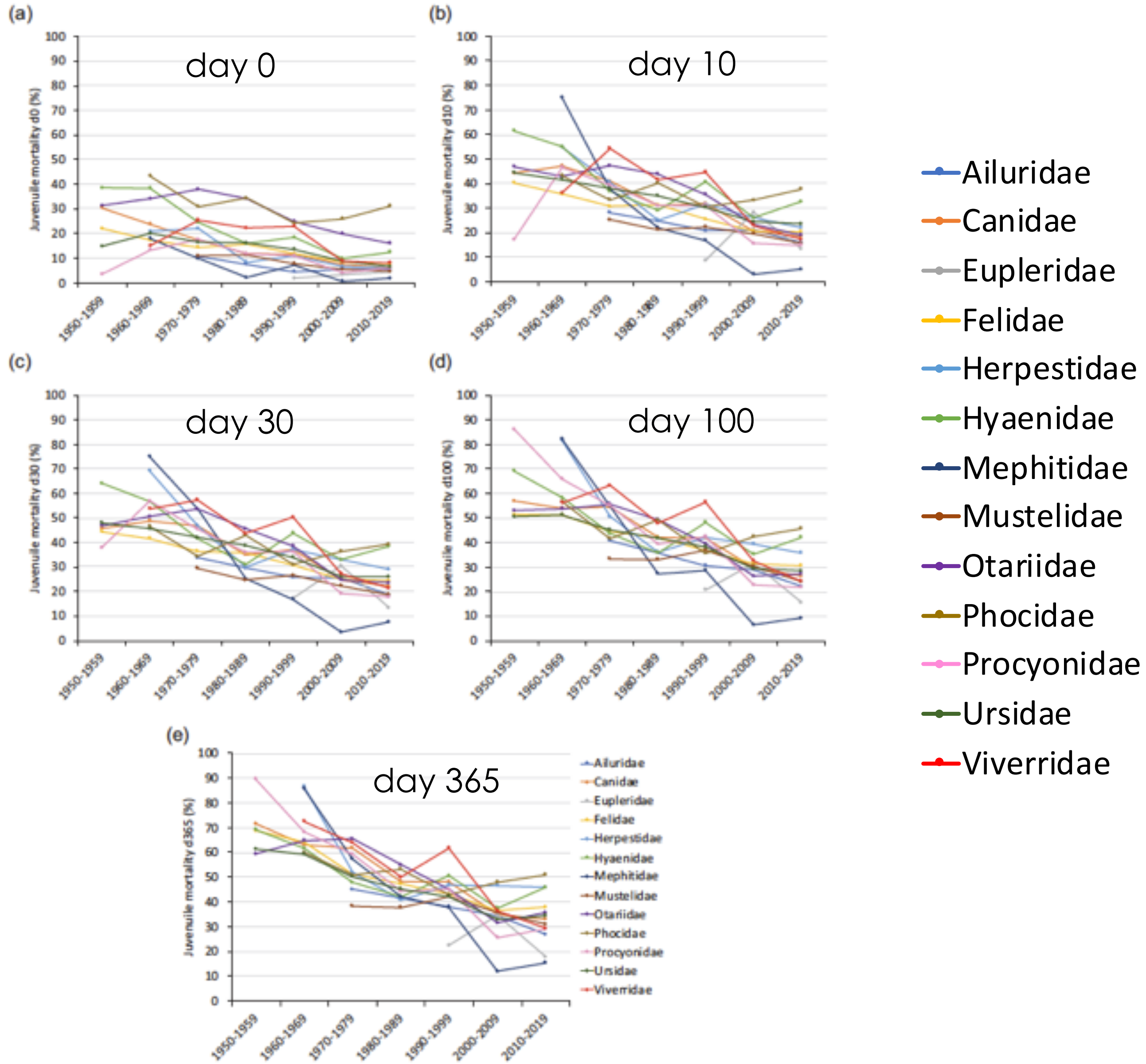

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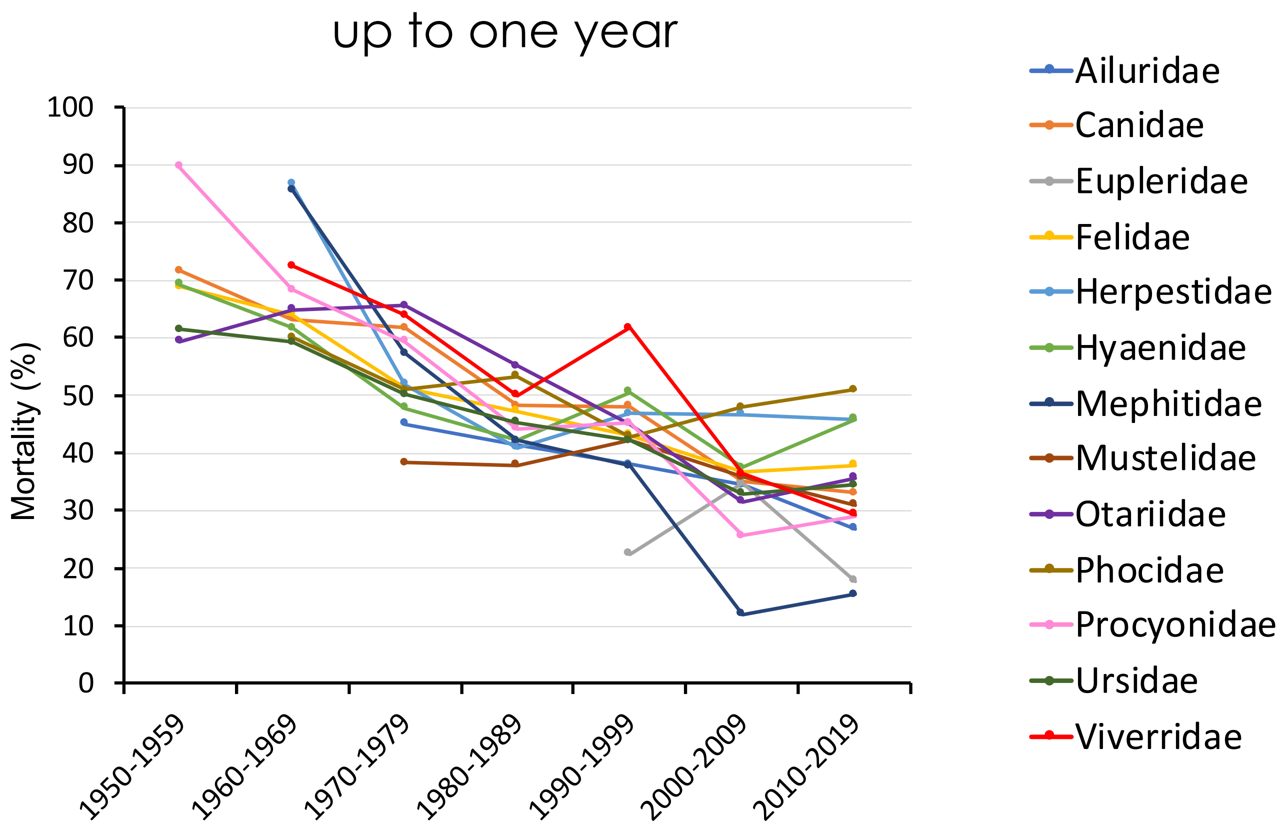

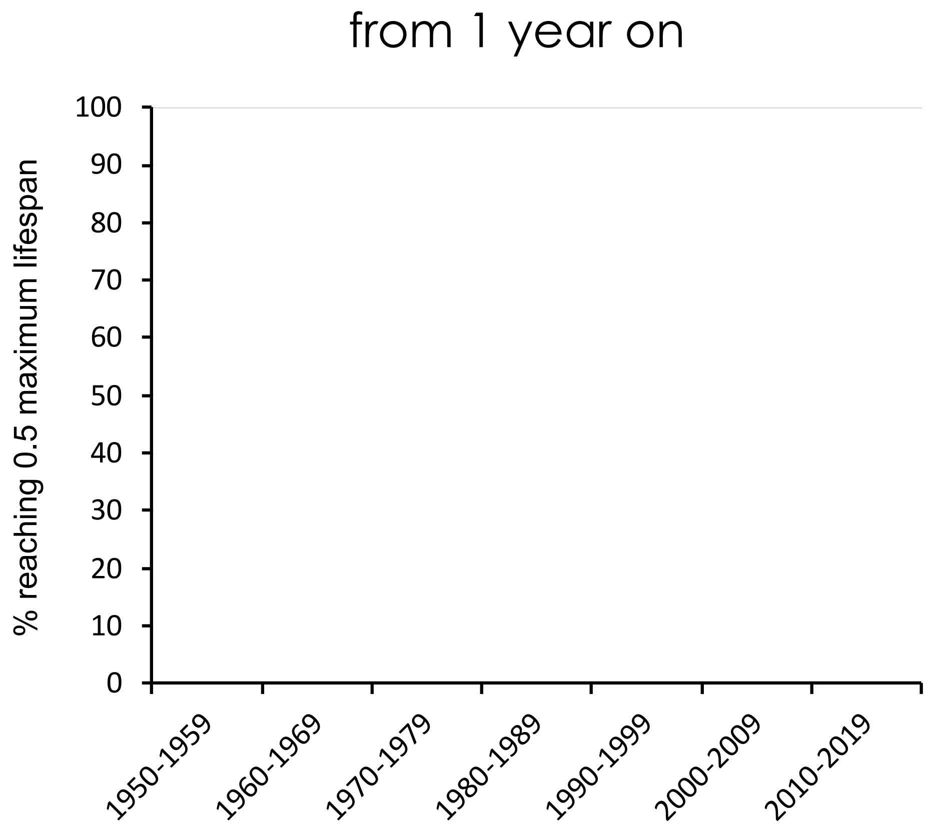

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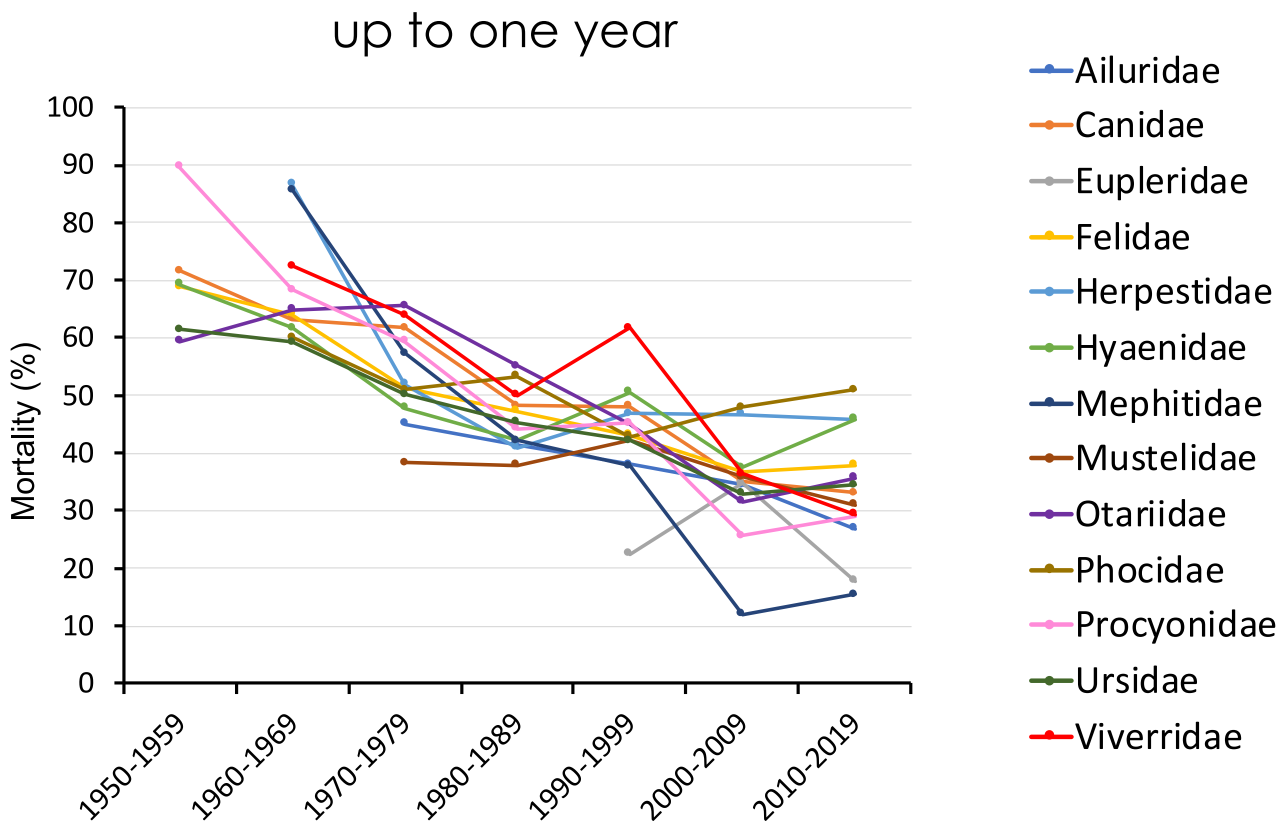

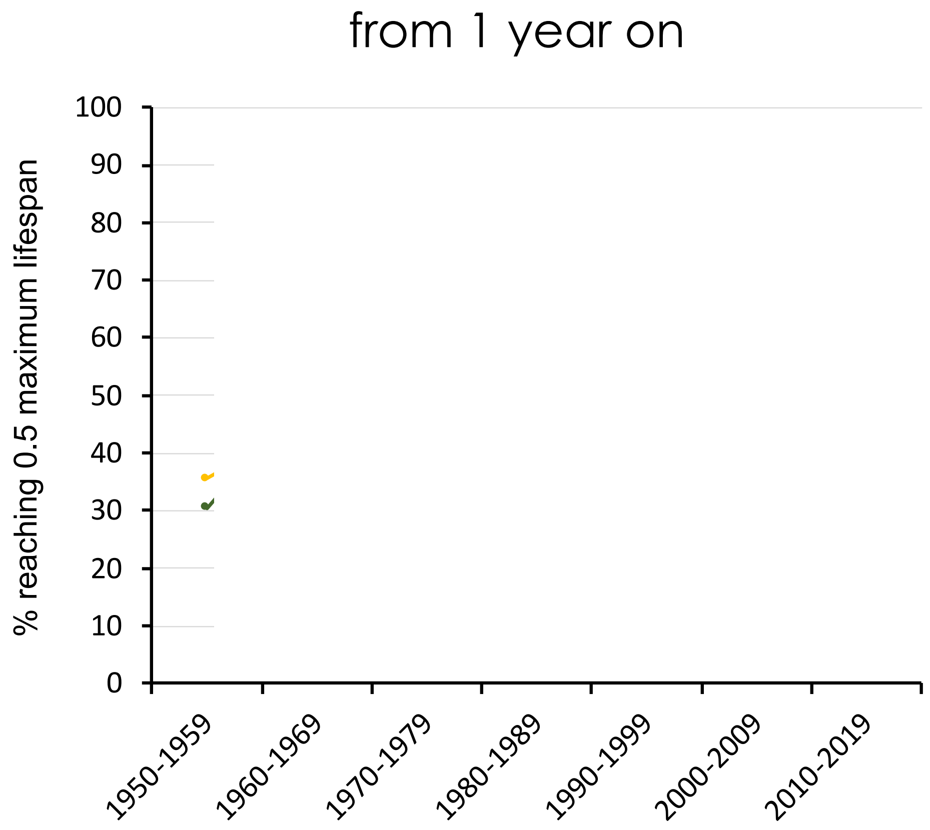

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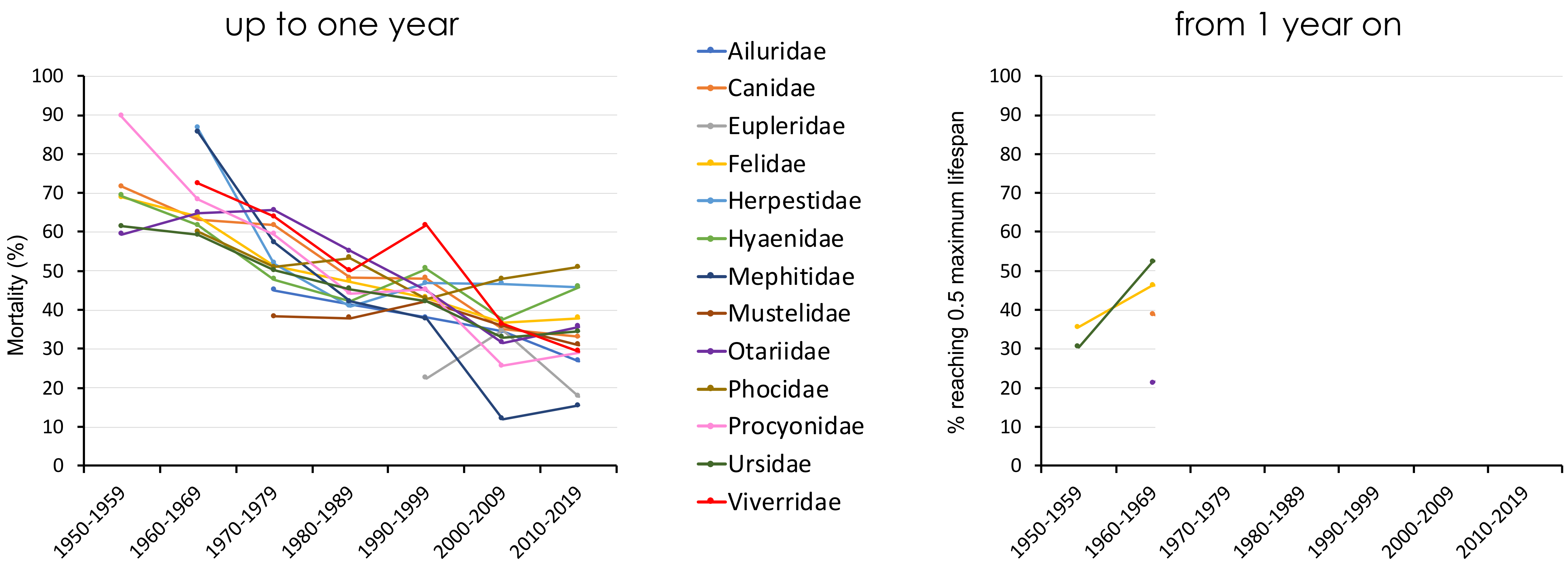

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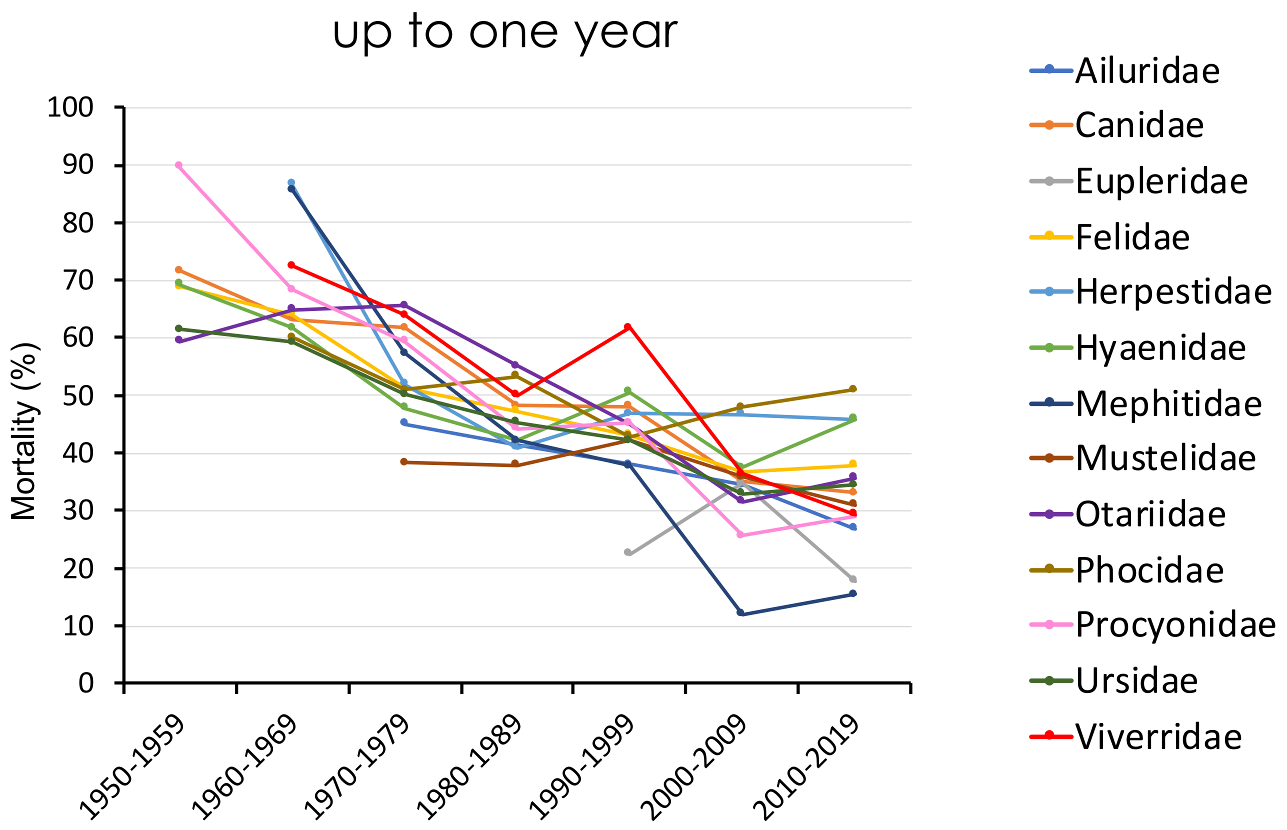

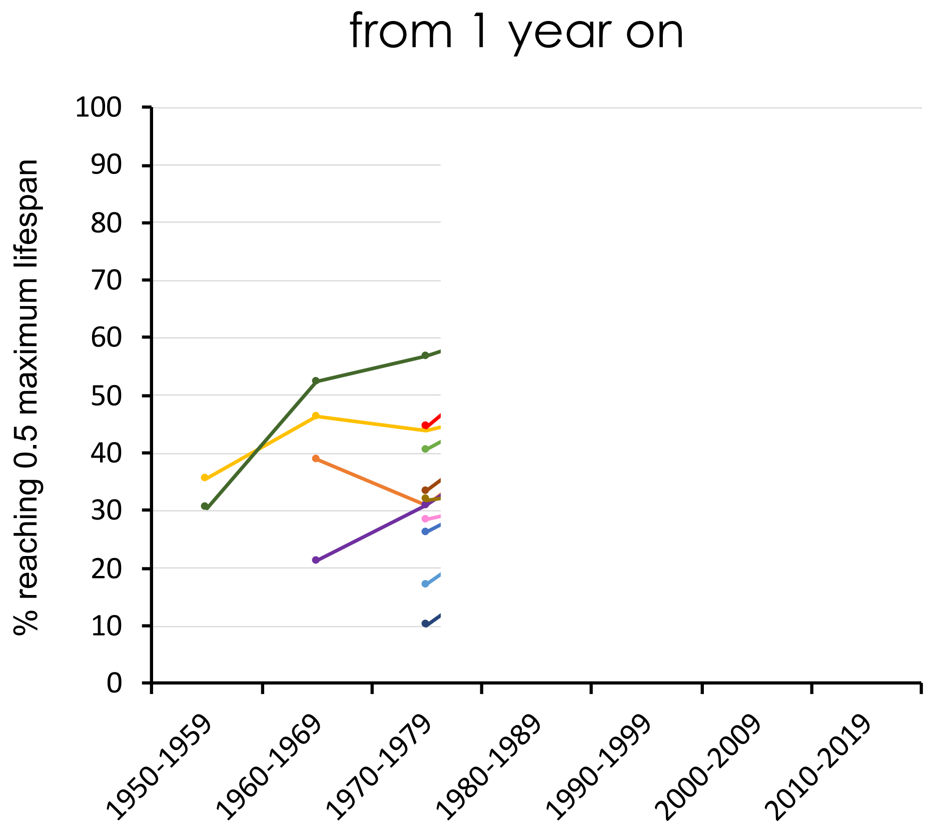

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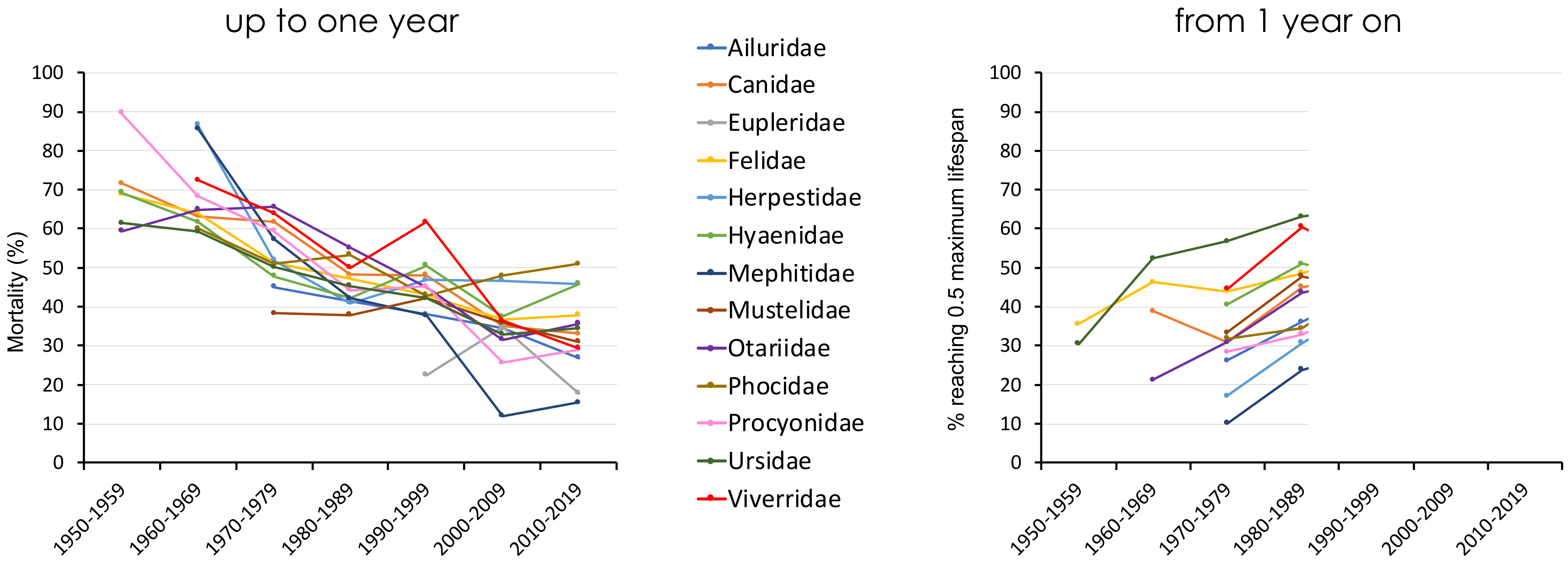

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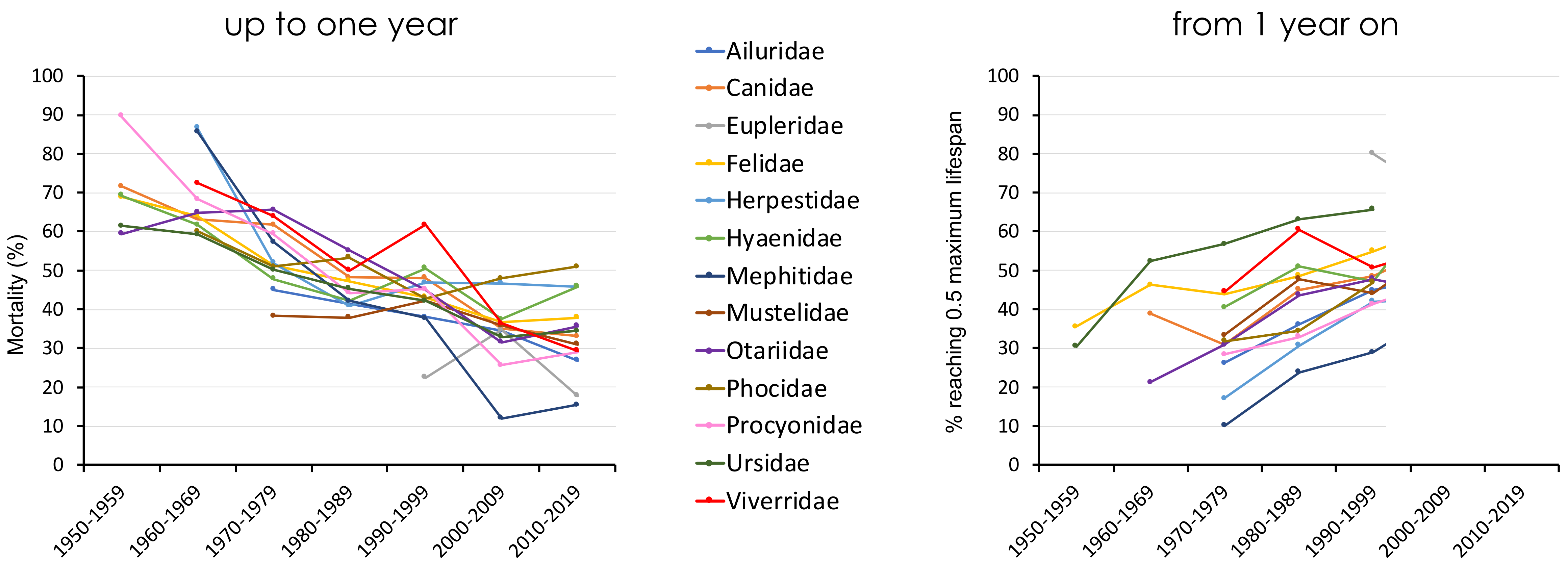

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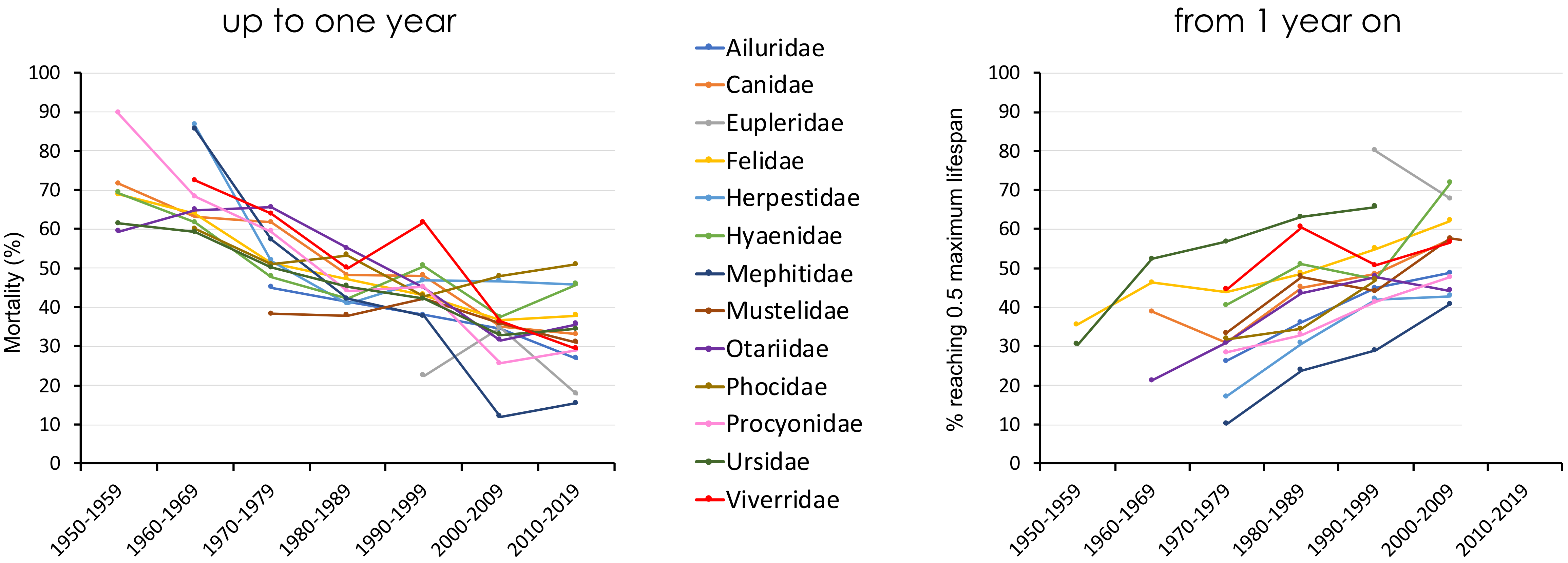
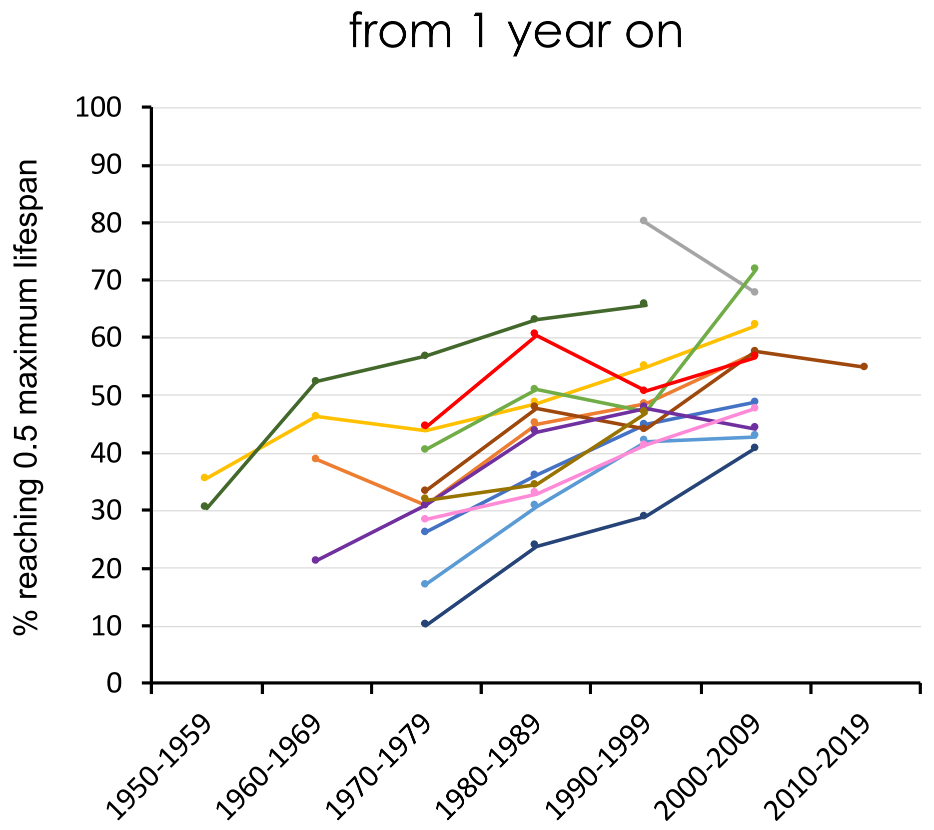


Do zoos improve?

	df	*F*	*p*	*p* normality residuals
Model (*n* = 42)	Adult longevity = Decade × Family + VPreviousDecade			.236
Decade	1	37.015	<.001	
Family	12	18.500	<.001	
Decade × Family	12	1.922	.114	
Value previous decade	1	4.264	.056	
Model (*n* = 55)	Adult longevity = Decade × Family			.982
Decade	1	105.662	<.001	
Family	12	18.532	<.001	
Decade × Family	12	1.452	.199	



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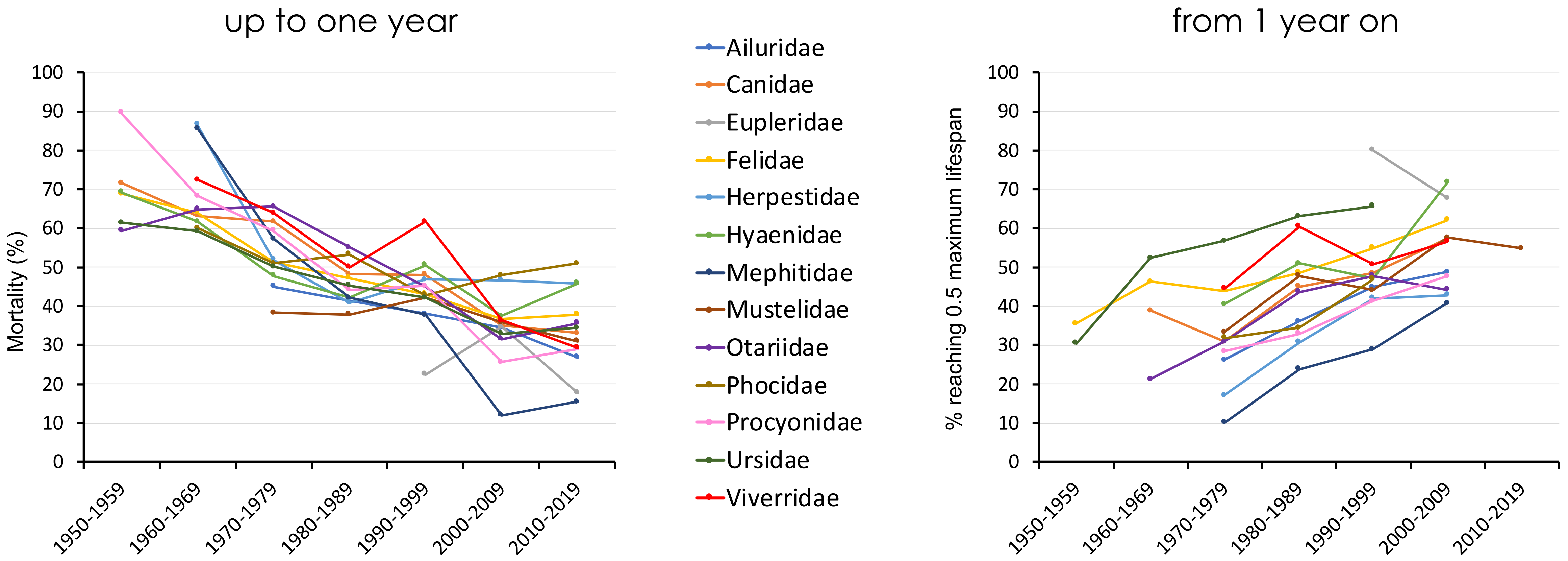

a reason to be proud – but not complacent

Summary

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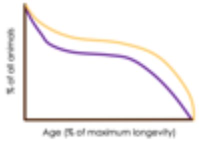

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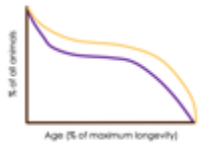

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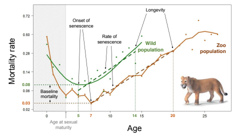

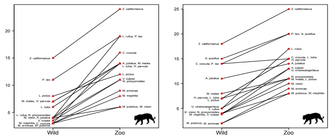

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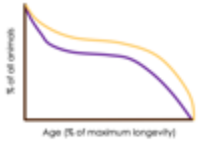

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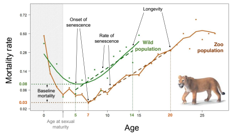

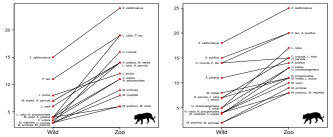

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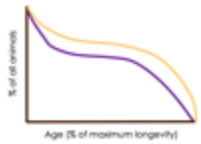

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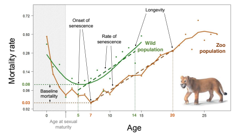

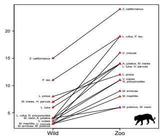

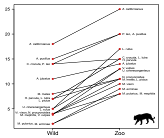

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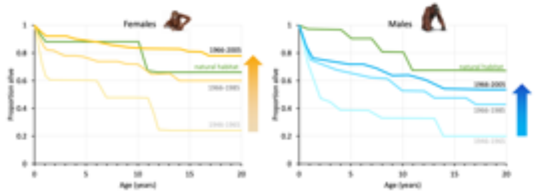
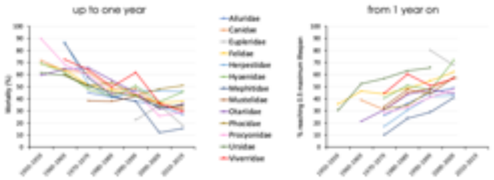
5. Comparing husbandry success over time:

   zoos keep improving !





… but how are longer lives achieved ?

Outlook

We need studies that assess the state-of-the-art of husbandry for specific species repeatedly over time to be able to link husbandry conditions to demographic effects.

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European Association of Zoo- and Wildlife Veterinarians (EAZWV)
6th scientific meeting, May 24 - 28 - 2006. Budapest, Hungary

GIRAFFE HUSBANDRY AND FEEDING PRACTICES IN EUROPE RESULTS OF AN EEP SURVEY

J. HUMMEL[1,2], W. ZIMMERMANN[1], T. LANGENHORST[3], G. SCHLEUSSNER[4], M. DAMEN[5] and M. CLAUSS [6]

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6. Division of Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Winterthurer Str. 260, CH-8057 Zurich, Switzerland

Abstract
Problems of the locomotory system (like overgrown hooves, laminitis or joint problems) have been reported from the EEP giraffe population. To evaluate relevant husbandry practices and frequency of the problem, a survey was done covering EEP institutions (response to the questionnaire from 70 institutions representing 74 individually managed groups). 40 of the 74 groups reported that cases of problems of the locomotory system had occurred in their animals. Animals older than 8 years seemed to have a higher probability to develop such problems. Giraffe were generally kept on concrete (69%) or asphalt (16%) floors. Being known as demanding animals to feed, giraffe were offered considerable amounts of non-forage feeds. An influence on the occurrence of laminitis is therefore possible. Based on studies on dairy cattle, indoor sections with softer floor surfaces should be considered as a viable option for facilities were problems have occurred repeatedly.

Key words: giraffe, *Giraffa camelopardalis*, floor surface, overgrowth, laminitis, feeding

Introduction
Despite the broad distribution of giraffes over numerous European facilities, they are still regarded as demanding animals in captivity. Repeatedly occurring problems in captive giraffe are related to either their locomotory system like overgrown hooves and joint problems (Kovacs et al. 1975) or to nutrition (e. g. Junge and Bradley 1993, Clauss et al. 2002, Hummel et al. 2003). In cattle husbandry, problems of the locomotory system like overgrown hooves, laminitis or joint problems are regularly mentioned to occur in large animals confronted with the husbandry practice and floors of agricultural settings. They are regarded as multifactorially influenced (Cook et al. 2004), e. g. by nutrition, parturition and obviously floor characteristics like hardness, abrasiveness or humidity. They generally develop when animals are not on pasture, but in their stables (Maton 1987).
To get an overview of the situation in European zoos, an inventory of the "state of the art" of several relevant aspects of giraffe husbandry in the EEP was initiated.

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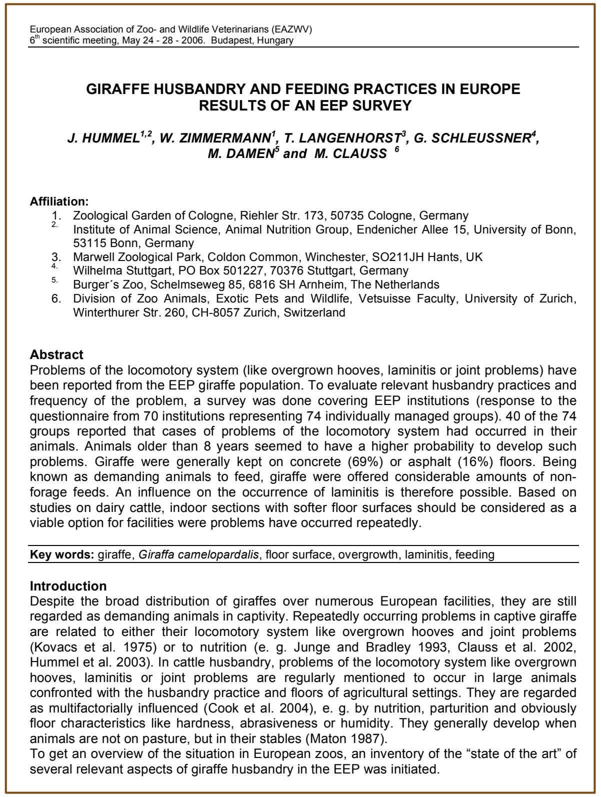

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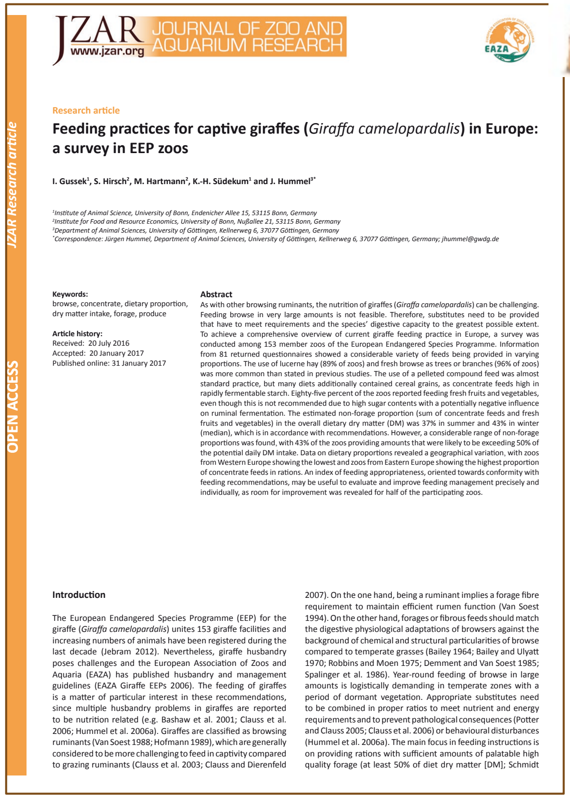

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Feeding practices for captive giraffes (*Giraffa camelopardalis*) in Europe: a survey in EEP zoos

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Keywords:
browse, concentrate, dietary proportion, dry matter intake, forage, produce

Article history:
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Abstract
As with other browsing ruminants, the nutrition of giraffes (*Giraffa camelopardalis*) can be challenging. Feeding browse in very large amounts is not feasible. Therefore, substitutes need to be provided that have to meet requirements and the species' digestive capacity to the greatest possible extent. To achieve a comprehensive overview of current giraffe feeding practice in Europe, a survey was conducted among 153 member zoos of the European Endangered Species Programme. Information from 81 returned questionnaires showed a considerable variety of feeds being provided in varying proportions. The use of lucerne hay (89% of zoos) and fresh browse as trees or branches (96% of zoos) was more common than stated in previous studies. The use of a pelleted compound feed was almost standard practice, but many diets additionally contained cereal grains, as concentrate feeds high in rapidly fermentable starch. Eighty-five percent of the zoos reported feeding fresh fruits and vegetables, even though this is not recommended due to high sugar contents with a potentially negative influence on ruminal fermentation. The estimated non-forage proportion (sum of concentrate feeds and fresh fruits and vegetables) in the overall dietary dry matter (DM) was 37% in summer and 43% in winter (median), which is in accordance with recommendations. However, a considerable range of non-forage proportions was found, with 43% of the zoos providing amounts that were likely to be exceeding 50% of the potential daily DM intake. Data on dietary proportions revealed a geographical variation, with zoos from Western Europe showing the lowest and zoos from Eastern Europe showing the highest proportion of concentrate feeds in rations. An index of feeding appropriateness, oriented towards conformity with feeding recommendations, may be useful to evaluate and improve feeding management precisely and individually, as room for improvement was revealed for half of the participating zoos.

Introduction

The European Endangered Species Programme (EEP) for the giraffe (*Giraffa camelopardalis*) unites 153 giraffe facilities and increasing numbers of animals have been registered during the last decade (Jebram 2012). Nevertheless, giraffe husbandry poses challenges and the European Association of Zoos and Aquaria (EAZA) has published husbandry and management guidelines (EAZA Giraffe EEPs 2006). The feeding of giraffes is a matter of particular interest in these recommendations, since multiple husbandry problems in giraffes are reported to be nutrition related (e.g. Bashaw et al. 2001; Clauss et al. 2006; Hummel et al. 2006a). Giraffes are classified as browsing ruminants (Van Soest 1988; Hofmann 1989), which are generally considered to be more challenging to feed in captivity compared to grazing ruminants (Clauss et al. 2003; Clauss and Dierenfeld 2007). On the one hand, being a ruminant implies a forage fibre requirement to maintain efficient rumen function (Van Soest 1994). On the other hand, forages or fibrous feeds should match the digestive physiological adaptations of browsers against the background of chemical and structural particularities of browse compared to temperate grasses (Bailey 1964; Bailey and Ulyatt 1970; Robbins and Moen 1975; Demment and Van Soest 1985; Spalinger et al. 1986). Year-round feeding of browse in large amounts is logistically demanding in temperate zones with a period of dormant vegetation. Appropriate substitutes need to be combined in proper ratios to meet nutrient and energy requirements and to prevent pathological consequences (Potter and Clauss 2005; Clauss et al. 2006) or behavioural disturbances (Hummel et al. 2006a). The main focus in feeding instructions is on providing rations with sufficient amounts of palatable high quality forage (at least 50% of diet dry matter [DM]; Schmidt

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Abstract
As with other browsing ruminants, the nutrition of giraffes (*Giraffa camelopardalis*) can be challenging. Feeding browse in very large amounts is not feasible. Therefore, substitutes need to be provided that have to meet requirements and the species' digestive capacity to the greatest possible extent. To achieve a comprehensive overview of current giraffe feeding practice in Europe, a survey was conducted among 153 member zoos of the European Endangered Species Programme. Information from 81 returned questionnaires showed a considerable variety of feeds being provided in varying proportions. The use of lucerne hay (89% of zoos) and fresh browse as trees or branches (96% of zoos) was more common than stated in previous studies. The use of a pelleted compound feed was almost standard practice, but many diets additionally contained cereal grains, as concentrate feeds high in rapidly fermentable starch. Eighty-five percent of the zoos reported feeding fresh fruits and vegetables, even though this is not recommended due to high sugar contents with a potentially negative influence on ruminal fermentation. The estimated non-forage proportion (sum of concentrate feeds and fresh fruits and vegetables) in the overall dietary dry matter (DM) was 37% in summer and 43% in winter (median), which is in accordance with recommendations. However, a considerable range of non-forage proportions was found, with 43% of the zoos providing amounts that were likely to be exceeding 50% of the potential daily DM intake. Data on dietary proportions revealed a geographical variation, with zoos from Western Europe showing the lowest and zoos from Eastern Europe showing the highest proportion of concentrate feeds in rations. An index of feeding appropriateness, oriented towards conformity with feeding recommendations, may be useful to evaluate and improve feeding management precisely and individually, as room for improvement was revealed for half of the participating zoos.

Introduction

The European Endangered Species Programme (EEP) for the giraffe (*Giraffa camelopardalis*) unites 153 giraffe facilities and increasing numbers of animals have been registered during the last decade (Jebram 2012). Nevertheless, giraffe husbandry poses challenges and the European Association of Zoos and Aquaria (EAZA) has published husbandry and management guidelines (EAZA Giraffe EEPs 2006). The feeding of giraffes is a matter of particular interest in these recommendations, since multiple husbandry problems in giraffes are reported to be nutrition related (e.g. Bashaw et al. 2001; Clauss et al. 2006; Hummel et al. 2006a). Giraffes are classified as browsing ruminants (Van Soest 1988; Hofmann 1989), which are generally considered to be more challenging to feed in captivity compared to grazing ruminants (Clauss et al. 2003; Clauss and Dierenfeld 2007). On the one hand, being a ruminant implies a forage fibre requirement to maintain efficient rumen function (Van Soest 1994). On the other hand, forages or fibrous feeds should match the digestive physiological adaptations of browsers against the background of chemical and structural particularities of browse compared to temperate grasses (Bailey 1964; Bailey and Ulyatt 1970; Robbins and Moen 1975; Demment and Van Soest 1985; Spalinger et al. 1986). Year-round feeding of browse in large amounts is logistically demanding in temperate zones with a period of dormant vegetation. Appropriate substitutes need to be combined in proper ratios to meet nutrient and energy requirements and to prevent pathological consequences (Potter and Clauss 2005; Clauss et al. 2006) or behavioural disturbances (Hummel et al. 2006a). The main focus in feeding instructions is on providing rations with sufficient amounts of palatable high quality forage (at least 50% of diet dry matter [DM]; Schmidt

	Hummel et al. (2006d)	Present study
Grass/lucerne		
Lucerne hay	81%	89%
Grass hay	40%	27%
Ensiled lucerne/grass	—	4%
Browse		
Fresh browse (trees and branches)	80%	96%
Dried/ensiled/frozen browse	4%	47%
Fresh forage		
Grass	53%	31%
Lucerne	—	19%
Nettles, thistles, blackberry, rose leaves	—	12%

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THE “GOOD” ZOO

David Williams-Mitchell
Speaker

- By rejecting the “unique” label, progressive zoos and aquariums can put clear space between themselves and bad zoos
- We want visitors not to say, “your zoo is different to all the others”, but instead to say **“your zoo is a good zoo”**
- This means that we need to work together to show the public as a whole what being a “good” zoo means – including all of the work you do as **individuals**, as **institutions** and as a **community of zoos**
- If we are successful, the public will understand what to expect of a zoo – we believe that this will drive change at institutions that don’t share the view of the roles of a zoo we present

WE’RE ALL GREAT

- Showing the collaboration between zoos demonstrates to the public the strength of our collective voice and actions, generating more trust and a greater mandate to act and speak (Hello, EAZA 21+)
- We know that competition between zoos is a relative concept so there’s very little stopping EAZA Members from publicizing each others’ successes
- This will establish the sense of an effective community with a larger objective in mind: *Progressive zoos and aquariums saving species together with you*
- Public will support a coherent and effective community more than individual institutions – and push bad zoos to be better

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