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Short communication

Do domesticated mammals selected for intensive production have less variable gestation periods?

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ABSTRACT

The variability of life history traits is affected by domestication. As gestation length is an important life history trait for production management, its variability is hypothesized to be lower in highly controlled production animals. Furthermore, some authors claim that horses have a particularly variable gestation length compared to other domesticated mammalian species. To test this, we compared 192 gestation lengths from the literature for eight different mammalian species. In this sample, gestation length does not contain a phylogenetic signal. Instead, production animals display lower variation than non-production animals. Horses fall well within the range of variation of gestation length in other domesticated companion animals.

The process of domestication can alter life history traits (Geiger et al., 2016; Herre and Röhrs, 1990; Kihlström, 1972) and affects the variability of these traits. This can be particularly evident in cases where there are clear selection goals as in cases of intense and directed domestication. If a trait is of little importance, then its variability is probably high, whereas if the trait is important, then variability should be low (Darwin, 1859).

One of the life history traits affected by domestication is gestation length (Heck et al., 2017). As reproduction is important in production animals such as cattle, sheep, and pigs (where one could easily hypothesize that economic pressures favor the selection of short gestation periods, i.e. fast reproduction), one could expect production animals to have less variability in this life history trait than animals bred for non-production purposes, such as most horse breeds or dogs. The gestation length in horses allegedly shows a larger variation than in other domesticated mammal species (Aoki et al., 2013; Bos and Van der Mey, 1980). Bos and Van der Mey (1980) concluded this after finding that the coefficient of variance (CV) for the gestation lengths in horses [2.8 to 3.7] was higher than that established for cattle [1.5] (Banerjee-Schotsman, 1964), sheep [1.6] (Prud'hon et al., 1970), and pigs [1.4] (Cox, 1964).

We aimed to investigate the differences of variation in gestation length among different domesticated mammal species, as suggested by some studies on cattle or goats (Asdell, 1929; Brakel et al., 1952). We tested the hypothesis that more strictly controlled production animals have less variation in their gestation length than non-production animals. As in any comparison across taxa, in this case encompassing a large portion of the placental mammal tree of life, the effect of phylogeny should be considered. Changes in anatomical and life history traits associated with domestication are known to be affected by the degree of relatedness among the species considered (Francis, 2015; Sánchez-Villagra et al., 2016). Furthermore, the variation in anatomical or life history traits can be phylogeny-dependent (Asher et al., 2011). Previous research has shown that gestation lengths scale differently with size depending on the taxonomic level (Clauss et al., 2014).

We gathered literature data on 192 mean gestation lengths and their standard deviations (SD) from domesticated forms of eight species (Table 1, Supplement Table 1). The average sample size was 24 recorded mean gestation lengths; species with three or more records of mean gestation lengths were included in the analysis. In studies where more than one mean was presented per breed, we used the data with the largest sample size. Furthermore, we included data from veterinary studies where parturition was, for example, induced by different hormonal treatments or embryo transfers were conducted. From these veterinary studies, we only used the datasets marked as control. In some research articles, the mean was presented with the standard error (SE). In these cases we used the sample size (n) and the SE to calculate the SD [$\sqrt{n}$*SE]. To compare the different species, we calculated the coef-

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Table 1
Details of literature sources for specimens in Supplementary Table 1.

Animal	Literature Source
Cat	Platz et al. (1978), Pope et al. (2009), Root et al. (1995), Sparkes et al. (2006)
Cattle	Akkayan and Ada (1975), Brakel et al. (1952), Burris and Blunn (1952), DeFries et al. (1959), Dessouky and Rakha (1961), Fitch et al. (1924), Knott (1932), Piedrafita et al. (2000), Rendel (1959), Sabatini (1908), Stallcup et al. (1956), Tessier (1817), Ward and Castle (1947)
Dog	Chakraborty (1987), Concannon et al. (1983), Eilts et al. (2005), Krzyzanowski et al. (1975), Kutzler et al. (2003), Okkens et al. (1993), Shimatsu et al. (2007), Tsutsui et al. (2006)
Goat	Amoah et al. (1996), Asdell (1929), Greyling (2000), Mellado et al. (2000), Talukder et al. (2016)
Horse	Ali et al. (2014), Aoki et al. (2013), Bene et al. (2014), Cilek (2009), Davies Morel et al. (2002), Dicken et al. (2012), El-Wishy et al. (1990), First and Alm (1977), Heck et al. (2017), Heidler et al. (2004), Hrasnica (1944), Hura et al. (1997), Matassino (1962), Mauch (1937), Meliani et al. (2011), Pérez et al. (2003), Pozo-Lora (1954), Rezac et al. (2013), Rosales et al. (2017), Sabatini (1908), Salerno and Montemurro (1966), Talluri et al. (2016), Taveira and da Mota (2007), Tessier (1817), Valera et al. (2006), Villani and Romano (2008), Winter et al. (2007)
Pig	Baxter et al. (2008), Chidgey et al. (2016), Cox (1964), Diehl et al. (1974), Farkas et al. (2007), Hanenberg et al. (2001), Kennedy and Moxley (1978), Omtvedt et al. (1965), Rydhmer et al. (2008), Sabatini (1908), Sasaki and Koketsu (2007), Van Dijk et al. (2005)
Rabbit	Ewuola et al. (2016), Lukefahr and Hamilton (1997), Rosahn et al. (1935)
Sheep	Alexander (1956), Bradford et al. (1972), Cleal et al. (2007), Fogarty et al. (2005), Forbes (1967), Ford et al. (2007), Osinowo et al. (1993), Öztürk et al. (2016), Roda and Otto (1989), Sabatini (1908), Smith et al. (2008), Tessier (1817), Thompson et al. (1995), West (1996), Zarkawi (1997)

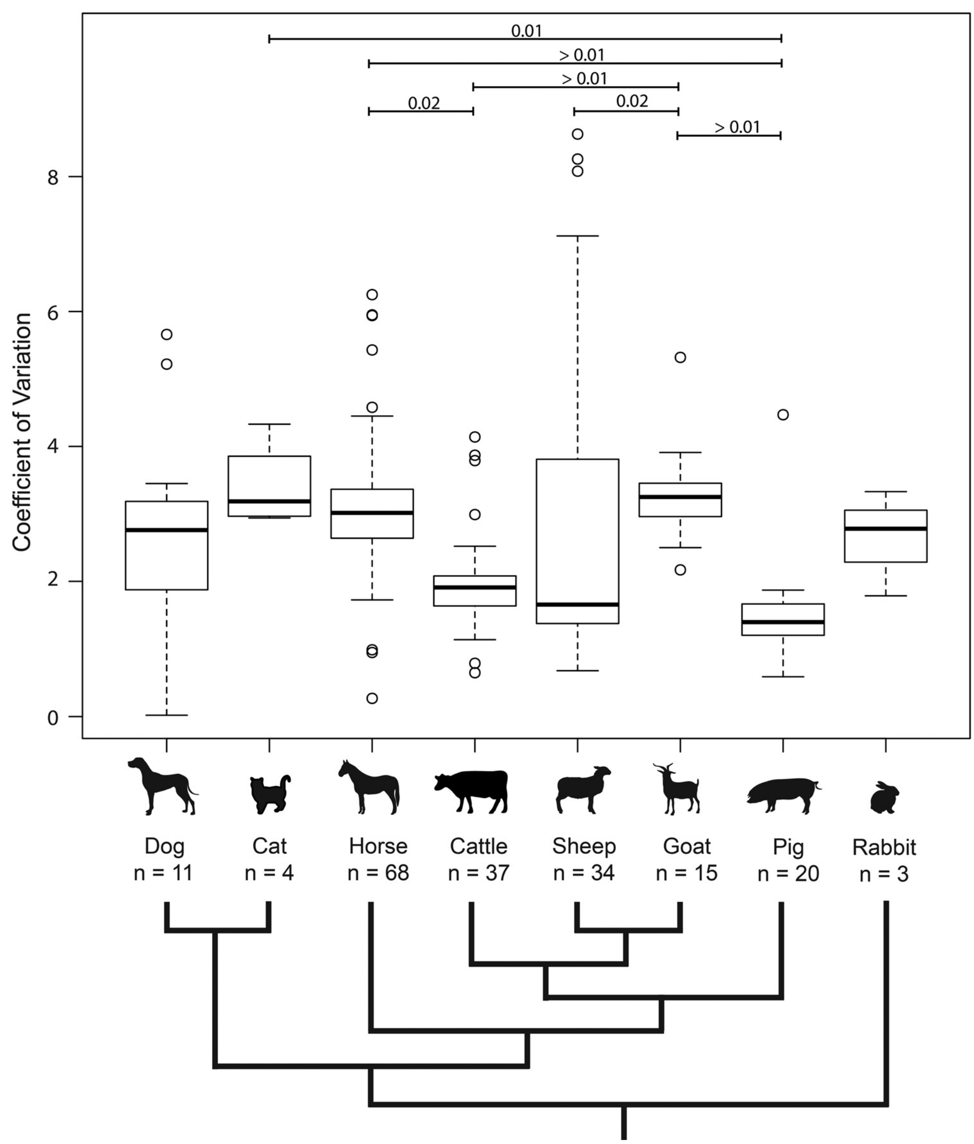

Fig. 1. Comparison of gestation length variation among domesticated forms of eight mammal species; CV = coefficient of variance; n = sample size; the bold black line shows the median and the bars denote the non-outlier range; the tree is based on the tree from Sánchez-Villagra et al. (2016), O'leary et al. (2013), and Bibi (2013) with the length of the branches not being time calibrated; the black lines above show the significant comparisons of the post-hoc Tukey test.

ficient of variance [(SD*100)/Mean], which is an informative value independent of the differences in average gestation length. We evaluated differences in gestation length among species using a non-parametric Kruskal-Wallis test followed by a Tukey post-hoc test. Although we consider that variation in life history traits can be phylogeny-dependent, the limited data on gestation length of

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