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Predictors of animal sponsorship to support zoo-based conservation activities

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Abstract

Public donations are an important form of fundraising for zoos and are used to support conservation activities. Understanding what influences zoo animal sponsorship by the public is crucial if zoos are to optimize strategies for increasing income from sponsors. Using sponsorship data obtained from seven diverse zoos within the UK, we used a phylogenetically informed approach to investigate predictors of the number of sponsors a species receives. We found no support for an effect of body mass, conservation status, solitary versus group housing, phylogenetic distance from humans, daily activity patterns, or the diet of the species on the number of sponsors a species attracts. However, we found strong phylogenetic signal, suggesting that particular groups of animals attract disproportionate sponsorship attention (but the specific species within these groups is of limited importance). Moreover, we found support for species with common names that are found toward the start of the alphabet having more sponsors. This is likely driven by the common practice of listing species that can be sponsored in alphabetical order when presenting them to potential sponsors (with people being more likely to choose species near the start of a list). Interestingly, the lack of effect of body mass, phylogenetic distance, and conservation status contrast with previous work on non-zoo conservation preferences, suggesting possible differences between motivations of zoo and non-zoo conservation donors, or between animal sponsorship and other forms of conservation involvement. We suggest two strategies for maximizing sponsorship for zoo animals. If zoos manage sponsorship income as a collective pool then allowing sponsorship of a range of species within particularly well-sponsored animal groups should improve uptake. Alternatively, if zoos allocate sponsorship income to the specific species sponsored, then funding may be effectively diverted to priority species simply by altering the order of lists of animals which can be sponsored.

KEYWORDS
body size, conservation status, ecological traits, ex situ conservation, fundraising, human preferences, phylogenetic patterns, zoo biology

1 | INTRODUCTION

Despite the widely acknowledged global loss of biodiversity, current efforts to slow this ongoing phenomenon fall short of recent targets (Rounsevell et al., 2020). Zoos are key contributors to conservation efforts, working to help achieve global biodiversity targets in several ways (Moss et al., 2014; Olive & Jansen, 2017). Education practices such as formal education initiatives, visitor talks (Packer & Ballantyne, 2010), and animal ambassador encounters (Spooner et al., 2021) are used by zoos to improve public understanding of biodiversity-related issues (Moss et al., 2017). In addition, zoos aid scientific understanding of many aspects of animal biology by carrying out a broad range of research (Fernandez & Timberlake, 2008). Zoos engage in both ex situ and in situ conservation activities (Gusset & Dick, 2010; Kaplan, 2021; Kasso & Balakrishnan, 2013), but this work relies on funding predominantly derived from visitors.

Funds are raised for conservation in a variety of ways, with donations and sponsorship playing a vital role alongside entry fees, sale of merchandise, etc. (Shreedhar & Mourato, 2019). Although not all funds raised by zoos are used directly for conservation projects, in the United Kingdom most zoos, including all those in our study, are members of the British and Irish Association of Zoos and Aquaria. This organization requires all member organizations to be actively involved in conservation, whether in situ or ex situ, and so funds raised will either directly or indirectly support such activities. Within animal sponsorship schemes, sponsors donate money to assist with the protection of a given species, usually one of a subset of those held by the zoo, which are listed as sponsorable animals. In return, sponsors receive rewards such as admission tickets or certificates, and often zoos will add the name of the sponsor to a plaque associated with the sponsored species. Public opinion can therefore have a large impact on the prioritization of funding (Colléony et al., 2017), and understand why some species attract more sponsorship interest than others may help to maximize the funding available to zoos from this income stream (Colléony et al., 2017; Fančovičová et al., 2021; Lundberg et al., 2019).

There are many factors which appear to affect donation behavior for conservation efforts. Characteristics of individual people, such as age, political orientation, gender, and level of education affect their opinions of conservation issues and their willingness to donate (Harnish et al., 2022; Martín-López et al., 2007; Sharp et al., 2011). In addition, species traits have been found to affect the amount of protection and the number of public donations that they receive (Colléony et al., 2017). For instance, charismatic species, those with a high public appeal (Colléony et al., 2017; Sitas et al., 2009), are more likely to be the focus of general conservation efforts (Forster et al., 2023; Thompson & Rog, 2019). However, charisma is a challenging concept to work with in practice and hence to use to improve fundraising strategies, not least due to various definition in the literature. While some studies use the term charisma synonymously with popularity, others attempt to define charisma through the typical characteristics which affect species popularity (Albert et al., 2018; Lorimer, 2007; Prokop et al., 2024).

Large body size appears to have a significant effect on public awareness, with larger species appearing more regularly on zoo websites, film posters (Albert et al., 2018), social media posts (Roberge, 2014), and Google searches (Huynh, 2023). Larger species are also better represented throughout scientific literature (Prokop et al., 2022). As a result, there is a bias in general conservation efforts toward larger species (Cardoso, 2011; Clucas et al., 2008). Larger-bodied species have reduced breeding success and they are more expensive to keep in captivity (Martin et al., 2013) but despite this, species of a larger body size are more likely to be kept in zoos (Frynta et al., 2013; Marešová & Frynta, 2008). This can be explained as large-bodied species are more popular among zoo visitors (Ward et al., 1998), therefore keeping larger species increases zoo revenue through entrance fees and donations (Frynta et al., 2013).

The IUCN Red List categorizes species by their current extinction risk, and is an important tool for prioritizing species that require protection and for conveying this information to the public via familiar language such as "critically endangered" or "vulnerable." However, as threat assessments are often based upon literature that is biased toward generally larger and charismatic animals, most conservation efforts have prioritized the protection of such species (Rodrigues et al., 2006). Despite the increase in public awareness associated with a high extinction risk (Huynh, 2023), groups of endangered species are not over-represented within zoos (Marešová & Frynta, 2008). In addition, while survey-based studies have suggested that people are more likely to say they would donate to protect a more highly threatened species in a hypothetical scenario (Curtin & Papworth, 2018), the few studies that have focused on donation data within zoos have found there to be little effect of conservation status (Colléony et al., 2017; Fančovičová et al., 2021).

Phylogenetic distance between two species refers to the amount of time since they diverged in their evolutionary history and began evolving independently (Gilbert & Parker, 2022), and therefore is usually related to similarity (with less phylogenetically distant species being more similar). Humans are more likely to show preferences for the survival of phylogenetically closer

species (Tisdell et al., 2006), potentially due to feelings of compassion and empathy that are common for such species (Miralles et al., 2019; Prokop et al., 2021). As a result, species that are phylogenetically closer to humans are over-represented within conservation education campaigns (Clucas et al., 2008), conservation projects (Fischer & Lindenmayer, 2000), and the scientific literature (Albert et al., 2018). Nevertheless, despite the potential to influence decisions to sponsor particular animal species, the effect of phylogenetic distance from humans on zoo animal sponsorship is poorly known.

Perhaps related to the aforementioned preference for species similar to humans, those which are more social or have the opportunity to interact with other individuals in group-housing setups may also be preferred by zoo visitors. Indeed, interactions between conspecifics are among the most common reasons given by zoo visitors for why a particular species is their favorite (Carr, 2016). Moreover, watching animals interact with other individuals is a key predictor of positive emotional states in zoo visitors (Luebke et al., 2016). Hence, it is possible that species that are typically kept in group-housed (multi-individual) enclosures are likely to be preferred by zoo visitors over those housed in solitary conditions, and consequently receive a higher number of sponsors.

What an animal eats influences the prevalence of certain species within conservation education, with carnivores or herbivores often overrepresented compared with omnivores (Clucas et al., 2008), and a significant proportion of the species rated as the most charismatic are carnivorous (Albert et al., 2018). This disproportionate popularity also applies to larger species (Clucas et al., 2008; Marneweck et al., 2021; Prokop et al., 2024). Hence, larger carnivores or herbivores might be expected to attract more sponsors than omnivores or smaller species.

As diurnal species, humans may also prefer those species with a similar activity cycle, perhaps because of the implicit similarity with humans but also because zoo visitors are more likely to see diurnal species involved in interesting behaviors (rather than sleeping). Consistent with this, species that are active during zoo opening hours often receive more attention (Carr, 2016) and are preferred by zoo visitors (Fernandez et al., 2009). Furthermore, visitors are more likely to stay for longer at the exhibits of active species (Margulis et al., 2003), and these are likely to be disproportionately diurnal species during zoo opening hours.

Despite the range of biological attributes that might influence the ability of a species to attract sponsorship in a zoo setting, little research has focused on understanding the variation in number of sponsors. Colléony et al. (2017) investigated the effect of species traits on the amount of money donated to animals within a single zoo in France, which had 29 species that could be adopted. They found that more charismatic species (measured using the number of Google searches for the species), those phylogenetically closer to humans (based on a rough ordinal scale), and those with names closer to the beginning of the alphabet, attracted greater amounts of funding; only charisma and alphabetical order of common name influenced the number of sponsors. As the species were listed on the adoption section of the zoo website in alphabetical order, as is typical, this suggests that sponsors were more likely to choose animals which appeared first. Extinction risk (IUCN Red List category) neither influenced the number of sponsors nor the amount of funding obtained for the different species. Fančovičová et al. (2021) analyzed donation data for 287 species across four zoos in Slovakia, including body mass, extinction risk (binary categorization based on the IUCN Red List), phylogenetic distance, and a measure of "appeal." None of these factors was found to influence zoo donations, but this particular analysis was restricted to mammals only and did not account for phylogenetic relationships (despite finding indications for phylogenetic effects in that donations varied by taxonomic class). Hence, previous studies of predictors of zoo sponsorship have either focused on limited datasets or analyses that are limited in terms of generality (restricted to mammals) or appropriateness for interspecific data (see Arbuckle, 2018 for a discussion of the importance of accounting for phylogeny for such data).

Here, we aim to investigate what factors influence the number of sponsors a species attracts in a zoo, using a phylogenetic comparative approach and data on a diverse set of species and zoos. Based on previous work or the rationale discussed above, we predict that species that attract more sponsors will be larger, phylogenetically closer to humans, diurnal, housed in groups, and more specialist in diet (compared with omnivores). Following Colléony et al. (2017), we also predict that species with common names earlier in the alphabet will gain more sponsors, but based on previous studies (and in contrast to perhaps intuitive expectations), we expect to find no effect of conservation status. Finally, we investigate whether variation in the number of sponsors shows structure across different zoos, phylogenetic relatedness, and individual species (while accounting for phylogeny), and we expect substantial variation to be explained by each of these components.

2 | METHODS

2.1 | Data collection

We collected data from seven UK zoos of widely varying size and characteristics on the number of sponsors for

187 species covering a broad taxonomic scope (all vertebrate classes plus invertebrates). Because many species are kept at multiple zoos, we have 271 records for the number of sponsors. We collected this data by either visiting the zoos and recording the number of sponsor names listed on the adoption plaques of the associated species (Chester Zoo, Folly Farm, and Plantasia Tropical Zoo), or by contacting zoo adoption teams and directly requesting the data we required (Colchester Zoo, Cotswold Wildlife Park and Gardens, Edinburgh Zoo, and The Highland Wildlife Park). Data from Edinburgh Zoo and the Highland Wildlife Park were provided as combined data as both zoos are managed together as part of the Royal Zoological Society of Scotland.

We note that previous work in this area, including Colléony et al. (2017) and Fančovičová et al. (2021), has also analyzed the amount of money received for sponsorship, whereas we only investigate number of sponsors. The financial intake from sponsorship programs was not available to us for this study, but when both aspects are considered, the relationships appear to be broadly similar between them (Colléony et al., 2017; Fančovičová et al., 2021). Moreover, all zoos in this study either have single-price sponsorships or a small number of set-price packages such that, although some scope for independent information from the two measures remains, we would expect a strong relationship between how many sponsors a species receives and how much sponsorship income is generated. This is especially the case as variation in the price of sponsorship packages within a zoo is rarely two-fold or higher, such that one additional sponsor will have greater effect than a single sponsor choosing to opt for a more expensive package.

We then collected data on our proposed predictors for each sponsored species: body mass (kg), phylogenetic distance from humans (million years; my), conservation status, diet type (omnivore, herbivore, or carnivore), activity period type (nocturnal, cathemeral, crepuscular, or diurnal), housing conditions (group or solitary), and alphabetical order of common name.

Body mass data were collected either from the AnAge database (Tacutu et al., 2012) when available, or otherwise from primary literature searches or field guides (references for each individual datapoint for all variables are provided in the link below in the Data Availability Statement section). When alternative sources of literature were used and a range of values were present, the mean body mass was calculated (Magalhaes et al., 2007).

We extracted phylogenetic distance from humans from the TimeTree database (Kumar et al., 2022).

Conservation status was extracted from the IUCN Red List (IUCN, 2023) as "data deficient," "critically endangered," "endangered," "vulnerable," "near threatened," or "least concern." For species within the IUCN database for which the global and national level rating varied, the global level rating was used as this better reflects the standard information UK zoos provide to visitors on signage etc.

The primary diet type of species was categorized into carnivorous, herbivorous, and omnivorous, using Gainsbury et al. (2019) and supplemented by primary literature sources for species not included in that database. Similarly, activity period for each species was categorized into diurnal, crepuscular, nocturnal, or cathemeral using Bennie et al. (2014) were possible and supplemented with literature searches.

Typical husbandry conditions for each species were evaluated using primary literature to categorize species as usually housed in groups or individually. For each zoo, species were ranked in alphabetical order using the first letter of the common names listed on the zoo adoption webpages. These were assigned a rank order with 1 as the name closest to the start of the alphabet.

2.2 | Data analysis

We obtained a phylogeny for the 187 species in our dataset from the TimeTree database (Kumar et al., 2022). We had 27 species in our dataset that were not present in the TimeTree database, so these were included in the final phylogeny by substituting them with other subspecies or phylogenetically equivalent species during the tree download (Pennell et al., 2016), after which they were renamed to match our dataset. All statistical analysis in this study were performed using R 4.1.1 (R Core Team, 2021).

We evaluated the suitability of the categorical traits in our dataset (diet, IUCN Red List status, activity period, and group vs. solitary housing) using the phylogenetic imbalance ratio (PIR) as described by Gardner and Organ (2021). This metric provides an indication of whether the distribution of categorical traits is likely to provide sufficient information for good parameter estimation, incorporating both evolutionary sample size and balance of states of the trait in question. Although PIR should not be interpreted with a strict threshold, Gardner and Organ (2021) recommended a rule of thumb of PIR <0.1 as indicative that the categorical trait data are suitable for model-based analysis. PIR was estimated for each of our categorical traits in windex 2.0.7 (Arbuckle & Minter, 2015).

We fitted a phylogenetic generalized linear mixed-effects model (pGLMM) with Poisson-distributed residual error in MCMCglmm 2.34 (Hadfield, 2010) to estimate the effects of our other variables on the number of sponsors. We included the individual zoo, phylogeny, and the

TABLE 1 Summary output for the pGLMM predicting number of sponsors, showing the posterior mean of the estimated coefficient, 95% confidence intervals (lower 95% CI and upper 95% CI), ESS, and p-value (p).

Explanatory variable[a]	Coefficient (posterior mean)	Lower 95% CI	Upper 95% CI	ESS	p
Intercept	3.787	−5.848	12.880	1000	.402
Body mass	5.173×10^{-4}	-9.075×10^{-5}	0.001	1000	.110
Diet type					
Herbivore	0.099	−0.779	0.943	1000	.806
Omnivore	−0.072	−0.875	0.633	1000	.862
IUCN Red List status					
Data deficient	**−2.405**	**−4.438**	**−0.268**	**895.6**	**.018**
Endangered	−0.245	−0.837	0.385	1000	.460
Least concern	−0.434	−0.983	0.172	1098	.142
Near threatened	−0.810	−1.679	0.051	1000	.064
Vulnerable	−0.523	−1.120	0.082	1000	.088
Alphabetical order	**−0.009**	**−0.016**	**−0.001**	**879.2**	**.010**
Phylogenetic distance	−0.003	−0.019	0.013	1000	.746
Activity period type					
Cathemeral	0.391	−0.267	1.010	1000	.268
Crepuscular	0.374	−0.486	1.148	1000	.374
Diurnal	0.492	−0.019	1.028	1000	.058
Housing type					
Solitary	−0.252	−0.704	0.318	1000	.326

Abbreviations: ESS, effective sample size; pGLMM, phylogenetic generalized linear mixed-effects model.

[a]Reference levels for categorical variables were carnivore (diet type), critically endangered (IUCN Red List status), nocturnal (activity period type), and group-housing (housing type). Statistically significant effects ($p \leq .05$) are highlighted in bold.

species as random effects, and all other variables described above as explanatory variables. The MCMC was run for 1,100,000 generations, the first 100,000 of which were removed as burn-in, and the remainder were sampled every 1000 generations to give a posterior distribution of 1000 samples. The effective sample sizes for every parameter were checked (the lowest effective sample size = 879.2) and trace plots of likelihood and parameters were examined to ensure there were no patterns in the chains that would suggest poor exploration of the parameter space.

To visualize any phylogenetic structure in the number of sponsors, we estimated and plotted ancestral states across the phylogeny for the log-transformed mean number of sponsors per species. We used the contMap function in phytools 2.0.3 (Revell, 2012) for ancestral state estimation using maximum likelihood.

3 | RESULTS

All categorical variables were considered suitable for modeling in a comparative framework as evaluated with the PIR (Appendix S2). All values were well below the suggested PIR <0.1 criterion for modeling (PIR_{Diet} = 0.011; $PIR_{RedListStatus}$ = 0.028; $PIR_{ActivityPeriod}$ = 0.034; $PIR_{HousingType}$ = 0.011).

Our pGLMM revealed that species with common names that appear earlier in the alphabet were found to be more likely to receive donations ($\beta = -0.009$, 95% CI = [−0.016, −0.001], $p = .010$) (Table 1; Figure 1). In addition, data deficient species attracted significantly fewer sponsors than critically endangered species ($\beta = -2.405$, 95% CI = [−4.438, −0.268], $p = .018$), but there is no clear association between greater or lower extinction risk and number of sponsors (Table 1). The model suggests there may be a weak tendency for diurnal species to have more sponsors than nocturnal species ($\beta = 0.492$, 95% CI = [−0.019, 1.028], $p = .058$). However, the limited importance of any effect here is clear from Figure 1, as the detected association is not evident in the raw data and only weakly supported after all other variables were simultaneously controlled for. There was no evidence for body mass, diet, phylogenetic distance from humans, or group housing having any influence on number of sponsors (Table 1; Figure 1).
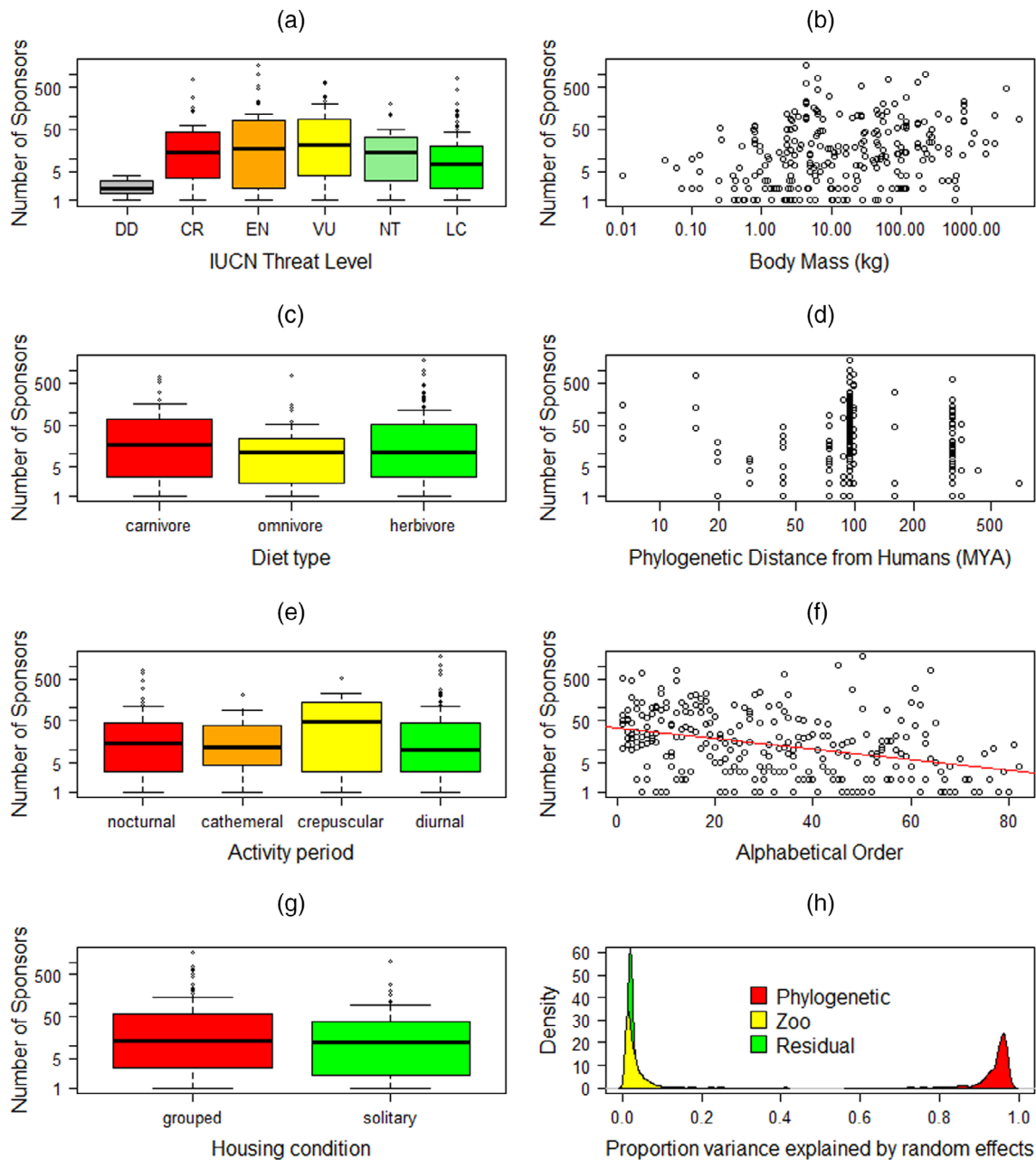
FIGURE 1 (a–g) Relationships between number of sponsors and its potential predictors. Note that number of sponsors, body mass, and phylogenetic distance from humans is plotted on log scales. Line of best fit is only shown for scatterplots representing significant effects according to our results. (h) Posterior distributions of the proportion of total variance explained by the random effects in our model. Species-specific variance is not included in the plot because it appears to explain no detectable proportion of the variance beyond the phylogenetic effect.

There is a substantial phylogenetic signal in the number of sponsors a species attracts, with ∼95% of the variance explained by phylogeny (Figure 1). Although there is variation within all major groups, certain clades (notably carnivorans, perissodactyls, and crocodilians) are relatively attractive to sponsors (Figure 2). Interestingly, despite substantial diversity in the zoos from which data were collected, only ∼3% of the variance is explained by differences between zoos (Figure 1); certainly a detectable effect but one that is dwarfed by the phylogenetic signal.

When accounting for fixed, zoo, and phylogenetic effects, there is no detectable variance attributable to individual species (posterior distribution of the species random effect peaks at 0, with a posterior mean of ∼0.1%).

4 | DISCUSSION

In our phylogenetic comparative analyses of a wide taxonomic sample across a diversity of zoos, we find
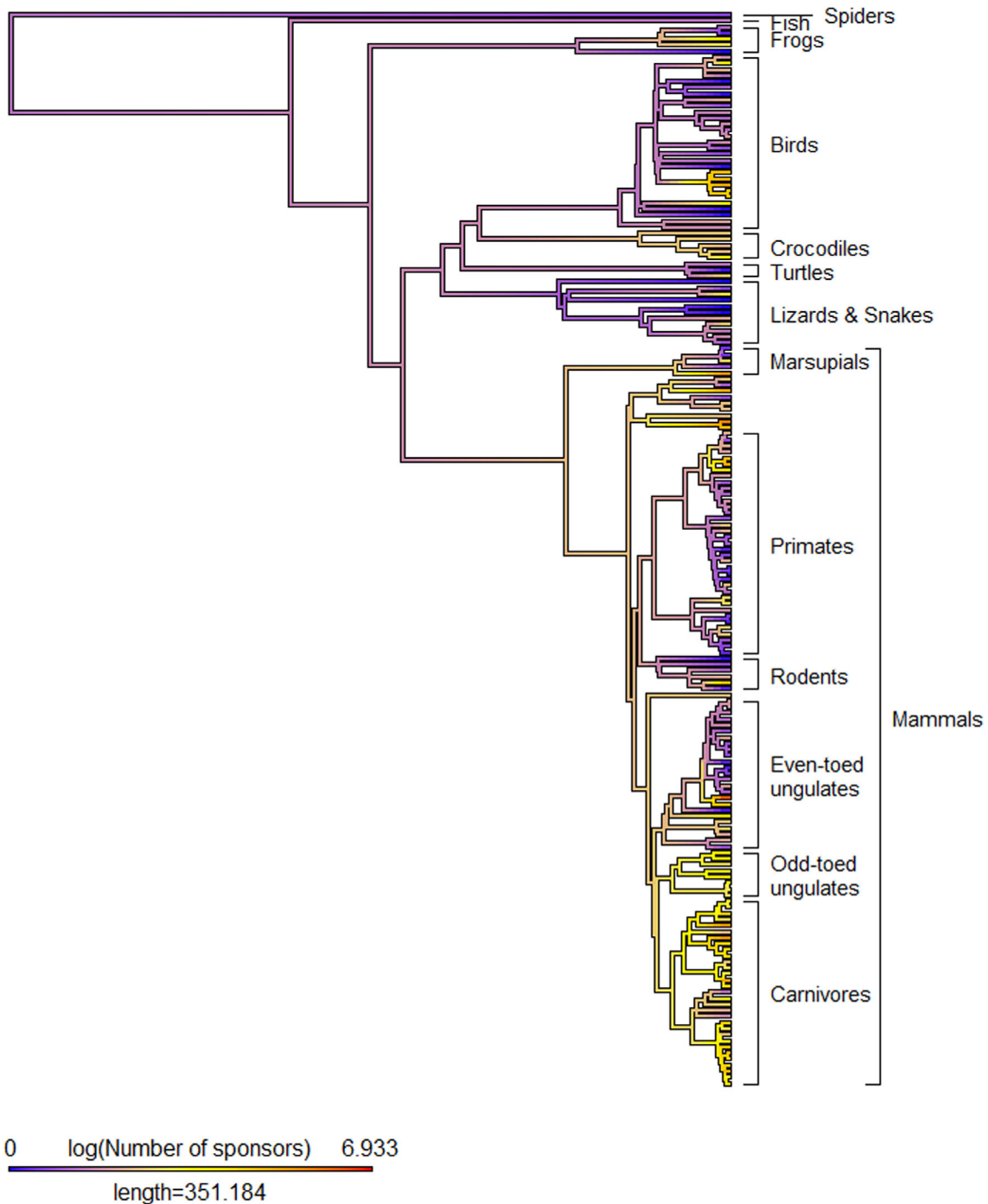
FIGURE 2 Ancestral state estimation showing substantial phylogenetic signal in number of sponsors. Although the scale of the phylogeny prevents us from clearly displaying the tip labels, we have indicated major clades represented on the tree. To facilitate readers who might wish to view finer-scale patterns, we have also included a separate pdf version of this figure as Appendix S1, which contains visible species names when enlarged.

surprisingly little evidence that hypothesized biological attributes of species influence the decision of members of the public to sponsor an animal. In contrast, we find support for the ordering of species on sponsorship lists being a key factor whereby potential sponsors choose an animal to sponsor nearer the top of lists. We also find substantial phylogenetic signal such that particular groups of animals are more likely to attract sponsors, and this had a much greater influence than the particular zoo. Our study adds substantially to the currently sparse literature on factors influence animal sponsorship behavior in zoos.

The alphabetical order of a species' common name was the strongest influence on the number of sponsors in our analyses. At first, this seems an arbitrary attribute of a species, but zoos typically list species on their adoption websites in alphabetical order by common name. Therefore, our results suggest that a notable part of the decision made over which animal to sponsor is how near it is to the start of lists of options; people presumably read down the list and stop at the first species which they would like to sponsor. Colléony et al. (2017) found the same relationship between the alphabetical order of animal names and the amount of money donated to each species, which prompted our inclusion of this variable in our study. Our study further supports these results, but strengthen them by considering multiple zoos, a wider range of potential biological predictors, and analyses that account for phylogeny.

Although the strongest influence on number of sponsors per animal in Colléony et al. (2017) study was species charisma, we did not analyze this trait directly (but we did include traits thought to be linked to charisma, such as body size). Charisma is a rather ambiguous attribute and adds little to our understanding of why species are favored; if charisma is defined by popularity then it does not explain why those species are popular choices for sponsorship. However, we found that none of the biological attributes that were hypothesized to be linked to charisma had an influence on number of sponsors. Moreover, notions of charisma that are concerned with the appeal of particular species is inconsistent with our results, since we found species-specific variation was undetectable once other attributes, including phylogenetic history, was included. Instead, we find that certain groups of animals are more likely to be sponsored, and hence possibly are more charismatic, regardless of the particular species involved or a diverse set of biological attributes.

Although the primary focus of modern zoos is to be centers of education and conservation (Smith & Broad, 2008), and hence try to generate interest in the conservation plights of the species they house, we find little or no evidence that extinction risk influences decisions to sponsor animals. This is consistent with previous studies concerning donation behavior in zoos (Colléony et al., 2017; Fančovičová et al., 2021), but is nevertheless unexpected as zoo donors report greater emotional responses toward threatened species (Colléony et al., 2017) and the explicit aim of sponsorship schemes is to contribute to the conservation of the species. One potential explanation of this finding is that sponsors are uninformed about the conservation status of the species, either directly on lists or via ineffective educational messaging within zoos (Carr & Cohen, 2011; Falk et al., 2007; Roe

et al., 2014). Alternatively, sponsors may simply select species based on what appeals to them personally (their favorite animal) and be relatively unconcerned with the conservation aims in many cases. The latter is consistent with entertainment being the primary motivator behind zoo visits and zoo visitor animal preferences (Carr, 2016) such that, despite the efforts of zoos, many visitors remain disconnected from the conservation messaging, including those that become sponsors (who have chosen to donate their money for reasons beyond mere entertainment).

Phylogenetic distance from humans is expected to influence donations because is has been reported that species more closely related to humans are preferred and prioritized in conservation (Colléony et al., 2017; Martín-Forés et al., 2013; Miralles et al., 2019; Prokop et al., 2021; Tisdell et al., 2006). The underlying mechanism of this is likely to be that phylogenetically closer species are likely to be more similar, and hence generate more empathy in potential zoo animal sponsors (Miralles et al., 2019). However, as with our results, some previous studies on zoo visitors or sponsors have not supported this effect (Fančovičová et al., 2021; Landová et al., 2018). The conflicting evidence across studies may be explained by differences in the specific context of the work (e.g. zoo vs. non-zoo, preference vs. willingness to take action in a hypothetical situation vs. actual donations, etc.), consideration of number of sponsors versus amount of sponsorship money, or differences in methods for measuring phylogenetic distance from humans or data analysis. In particular, one key limitation of previous studies is the lack of accounting for phylogenetic signal in the data, which can result in both Type 1 and Type 2 errors when dealing with interspecific data (Arbuckle, 2018). Indeed, we found very strong phylogenetic signal in our dataset, consistent with clade-level differences in species' appeal to humans (Frynta et al., 2013; Janovcová et al., 2019; Lišková & Frynta, 2013), and failing to account for this may well have led to spurious interpretations.

Large carnivores are often used as flagship species by conservation programs as they are commonly seen as charismatic species (Albert et al., 2018; Landová et al., 2018). Furthermore, people report being more likely to be willing to protect large carnivores as they are more dangerous to humans (Albert et al., 2018), partly because species perceived as dangerous are more likely to capture and maintain the attention of humans (Prokop et al., 2024; Yorzinski et al., 2014). However, while we do find that carnivorans are especially well sponsored, this is not particularly related to diet since carnivorous animals in our dataset did not attract more sponsors than herbivores or omnivores.

Consistent with Fančovičová et al. (2021), but in contrast with much of the literature on animal preferences

among humans, we found no evidence for an effect of body size on zoo sponsorship. Zoo visitors are more likely to feel connected with larger species (Howell et al., 2019) and larger bodied species are often preferred by visitors (Carr, 2016; Ward et al., 1998). In addition, people are more likely to donate more money toward larger species in non-zoo conservation campaigns (Veríssimo et al., 2018). However, the latter study did not account for phylogenetic effects, and this may explain part of the difference; although we found that most large animals were relatively well sponsored, there seems to be a substantial phylogenetic component to this. For instance, larger carnivorans or (with the exception of great apes) primates did not consistently attract more sponsors than smaller species in these groups. Few studies have found the opposite result of a higher willingness of people to protect animals with smaller body size (Prokop et al., 2021), suggesting that different clades might be subject to different patterns. For instance, in the case of carnivores, some of the smaller species frequently kept in zoos (meerkats and other mongooses) also have bipedal vigilance postures, which Prokop et al. (2021) found created a greater impression of cuteness and willingness to protect.

Species that are active, visible, and performing behaviors such as interacting with other animals or humans have been found to be commonly preferred by zoo visitors (Carr, 2016; Fernandez et al., 2009; Luebke et al., 2016) and visitors are more likely to stay at the exhibits of active species for longer periods of time (Margulis et al., 2003). As diurnal species are more active during the day, they are therefore more likely to be active and visible during zoo opening hours, and are also more likely to be social species that will perform behaviors zoo visitors find particularly appealing (Carr, 2016; Shultz et al., 2011). Despite this, neither diurnal nor group-housed species attracted more sponsors. This might be related to our finding that alphabetical order of common names is an important determinant of sponsorship, because it suggests that sponsors are not necessarily making decisions based on experiences during zoo visits, but based on what species appeal to them first as they peruse down a list of options. In such a situation, the animal's behavior or visibility may not play a large role because that is functionally disconnected from the decision of what species to sponsor. Alternatively, in some cases (for instance in bat houses) zoos will have nocturnal animals on reversed light cycles so that their natural activity period is aligned with zoo opening times. Similarly, some naturally social species may not always be maintained in group-housing within a given collection. These complications were the case for only very few nocturnal or social species in our dataset, but could nevertheless introduce noise that negatively impacts our ability to detect effects.

We note that several of our results conflict with the few studies considering predictors of animal sponsorship in zoos. However, we suggest that by taking a more comprehensive approach in terms of traits considered, variation across zoos, and (probably most importantly) appropriately accounting for phylogenetic patterns, we have been able to test hypotheses more robustly. In particular, because our results reveal strong phylogenetic patterns that are even substantially stronger than variation between zoos, we underscore the need to analyze such interspecific data using a phylogenetic comparative approach that can handle the nonindependence such patterns impose. This will hopefully reduce the inconsistencies between future studies by reducing both type 1 and type 2 statistical errors which can result from failure to incorporate phylogeny in such analyses. We highlight that one potentially important factor we were unable to account for in our study was the time since the species was available for sponsorship in a given zoo (although systematic differences between zoos are accounted for in our mixed model random effect structure). This information has also been lacking in most previous studies, so we encourage future workers to try to incorporate such data where possible.

Our surprising lack of evidence for species-specific traits that influence sponsorship of zoo animals suggests that our understanding of what species are most appealing to humans, and how that translates to financial or active contributions to conservation, is not yet well understood. Nevertheless, our findings provide clear guidelines for zoos looking to manage sponsorship programs for maximum or targeted income from these routes. The optimal strategy will depend on how zoos manage sponsorship income.

If sponsorship income is pooled and allocated internally to conservation programs that may or may not be related to the sponsored species (including general collection maintenance and development), focusing on clades that attract many sponsors should be the best strategy. Importantly, the particular species within these groups is far less important, and there are highly sponsored clades within most major groups of animals, which can enable zoos to main a diverse and potentially numerous, but strategically biased, list of options. Other than the major clades highlighted in Figure 1, we have provided a pdf version of this figure with species names visible upon enlargement, as Appendix S1, to facilitate use of our results in this way.

Alternatively, if sponsorship income is ring-fenced to be allocated to the particular species receiving the sponsorship, then zoos should be able to bias donations toward particular species that they deem high priority without reducing the diversity of species able to be

sponsored. This should be possible simply by moving desired species toward the top of lists of animals to be sponsored sent to potential sponsors or advertised on websites etc. Indeed, if zoos adopt this "ring-fenced for the sponsored species" approach but want to avoid overly biased sponsorships, our results suggest that this is achievable by regularly changing the order of species on the list. One possible risk of such a strategy would be that if a potential sponsor struggles to find the animal they are looking for they might give up and not provide sponsorship at all. Nevertheless, this is unlikely to be common and a well curated or easily browsable/searchable list should be able to limit such inconvenience. In any case, our results enable us to present practical opportunities to make the most of sponsorship list management to optimize income from sponsorship programs in zoos.

DATA AVAILABILITY STATEMENT

The dataset, accompanying phylogenetic tree, and R script from this study are available at https://doi.org/10.6084/m9.figshare.25187969.v2.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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