

Impact on species' online attention when named after celebrities

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Article Impact Statement: Impacts of naming species after celebrities are strongest for less desirable taxa such as invertebrates.

Abstract

Celebrities can generate substantial attention and influence public interest in species. Using a large-scale examination of publicly available data, we assessed whether species across 6 taxonomic groups received more page views on Wikipedia when the species was named after a celebrity than when it was not. We conducted our analysis for 4 increasingly strict thresholds of how many average daily Wikipedia page views a celebrity had (1, 10, 100, or 1000 views). Overall, we found a high probability (0.96–0.98) that species named after celebrities had more page views than their closest relatives that were not named after celebrities, irrespective of the celebrity threshold. The multiplicative effect on species' page views was larger but more uncertain as celebrity page-view thresholds increased. The range for thresholds of 1 to 1000 was 1.08 (95% credible interval [CI] 1.00–1.18) to 1.76 (95% CI 0.96–2.80), respectively. The hierarchical estimates for the taxa tended to be positive. The strongest effects were for invertebrates, followed by amphibians, reptiles, fish, and mammals, whereas the weakest effect was for birds at lower page-view thresholds. Our results suggest that naming species after celebrities could be particularly significant for those belonging to taxonomic groups that are generally less popular than others (e.g., invertebrates). Celebrities may further influence the effectiveness of this marketing strategy, depending on their likability and connection to the species named after them. Eponyms may serve as a reminder of the disproportionate power dynamics between populations and some namesakes' untenable actions. However, they also provide an opportunity to recognize remarkable individuals and promote equity, inclusivity, and diversity in taxonomic practice. We encourage taxonomists to examine whether naming threatened species after celebrities could affect conservation support, especially for species that are otherwise typically overlooked by the public.

KEYWORDS

culturomics, conservation marketing, biodiversity, taxonomy, animals

Impacto sobre la atención virtual de una especie si lleva el nombre de una celebridad

Resumen: Las celebridades pueden generar atención considerable e influir sobre el interés público por las especies. Usamos un análisis a gran escala de datos con disponibilidad pública para evaluar si las especies de seis grupos taxonómicos recibían más visitas en Wikipedia cuando el nombre de la especie provenía del de una celebridad que cuando no. Realizamos nuestro análisis en cuatro umbrales cada vez más estrictos de cuántas visitas diarias en promedio tenía la página de Wikipedia de una celebridad (1, 10, 100 or 1000 visitas). En general, descubrimos una probabilidad alta (0.96–0.98) de que las especies con nombres de celebridades tuvieran más visitas que sus parientes más cercanos que no tenían un nombre así, sin importar el umbral de la celebridad. El efecto multiplicativo sobre las visitas a la página de la especie fue mayor pero más incierto si incrementaba el umbral de

visitas de la celebridad. El rango para los umbrales de 1 a 1000 fue de 1.08 (95% intervalo creíble [IC] 1.00–1.18) a 1.76 (95% IC 0.96–2.80) respectivamente. Los estimados jerárquicos para los taxones tuvieron una tendencia positiva. Los efectos más fuertes se presentaron en los invertebrados, seguidos de los anfibios, reptiles, peces y mamíferos, mientras que el efecto más débil fue para las aves en los umbrales de menor número de visitas. Nuestros resultados sugieren que nombrar a una especie con el nombre de una celebridad podría ser particularmente importante para aquellas que pertenecen a grupos taxonómicos que generalmente suelen ser menos populares que otros (invertebrados). Las celebridades podrían influir todavía más en la efectividad de esta estrategia de marketing, dependiendo de su popularidad y la conexión con la especie que lleva su nombre. Los epónimos pueden funcionar como recordatorios de las dinámicas disparejas de poder entre las poblaciones y las acciones indefendibles de algunos homónimos. Sin embargo, los epónimos también proporcionan la oportunidad para reconocer individuos destacados y promover la equidad, inclusividad y diversidad en la práctica taxonómica. Alentamos a que los taxónomos analicen si nombrar a una especie amenazada con el nombre de una celebridad podría afectar el apoyo a su conservación, especialmente para las especies que de otra manera suelen ser ignoradas por el público.

PALABRAS CLAVE

animales, biodiversidad, culturomía, marketing de la conservación, taxonomía

用名人命名对于物种网络关注度的影响

【摘要】名人能引起大量关注,并影响公众对物种的兴趣。本研究通过分析大量公开数据,评估了6个类群中用名人命名的物种的维基百科页面浏览量是否高于未用名人命名的物种。我们将名人的维基百科日均页面浏览量按照4个越来越高的阈值(1、10、100、1000次)划分并进行分析。总体而言,我们发现,无论名人的页面浏览量处于何种阈值范围,用名人命名的物种比未用名人命名的近缘物种拥有更多页面浏览量的概率都很高(0.96–0.98)。随着名人页面浏览量阈值范围增高,对物种页面浏览量的倍增效应更大,但不确定性也更高。阈值从1到1000的效应量分别为1.08(95%置信区间为1.00–1.18)到1.76(95%置信区间为0.96–2.80)。各类群的层级估计值趋于正值。无脊椎动物的效应最强,其次是两栖动物、爬行动物、鱼类和哺乳动物,而效应最弱的是页面浏览阈值较低情况下的鸟类物种。我们的研究表明,用名人命名物种对于通常不太受欢迎的类群(如无脊椎动物)来说意义尤其重大。名人可能会进一步影响这种营销策略的成效,取决于他们的受喜爱程度以及与其命名的物种之间的联系。用名人命名可能会提醒人们注意人群之间不成比例的权力分配,以及某些同名者不可靠的行为。不过,它们为表彰杰出个人提供了机会,促进了分类学实践中的公平性、包容性和多样性。我们鼓励分类学家研究以名人命名濒危物种是否会影响公众对其保护的支持程度,尤其是那些通常被忽视的物种。**【翻译:胡怡思;审校:聂永刚】**

关键词:文化组学, 保护营销, 生物多样性, 分类学, 动物

INTRODUCTION

There is often the expectation that conservation action should be driven by differences in the population size, ecological role, geographic distribution, and evolutionary distinctness of species (Faith, 1992; Mills et al., 1993; Vane-Wright et al., 1991). Yet, species also differ in how they are perceived by people (and therefore how much attention they receive [Roll et al., 2016]). For example, preservation of species less likely to exhibit aesthetically preferred traits (such as being large, colorful, with forward-facing eyes [Macdonald et al., 2015; Smith et al., 2012]) has generally been less valued and received less

interest, funding, support, and coverage by the public and conservation organizations (Clucas et al., 2008; Czech et al., 2001; Martín-López et al., 2009; Skibins et al., 2017). Because species do not always possess such traits (Colléony et al., 2017), it is vital to consider strategies that enhance species' visibility, regardless of their appearance. This would be particularly beneficial for less familiar endangered species. For example, a lack of public awareness and thus engagement has arguably contributed to recent extinctions in Australia (Woinarski et al., 2017), whereas recognition of species can significantly increase willingness to support conservation efforts (Pearson et al., 2022).

Increasing public interest and engagement with species can be achieved through effective “conservation marketing” (Veríssimo et al., 2017): the application of marketing techniques to influence the attitudes, perceptions, and behaviors of individuals and societies for the benefit of conservation (Wright et al., 2015). Specifically, it has been suggested that techniques such as branding—the process of creating names or symbols to make a product distinguishable from its competitors, regardless of its aesthetics (Kotler et al., 2005)—could enhance the visibility of species. This strategy could especially affect species that would otherwise be less popular (Díaz-Restrepo et al., 2022), and warrants further study (Wright et al., 2015). Particularly, more behavioral data is needed to understand the successful use of conservation marketing (Veríssimo et al., 2017). For example, Gregg et al. (2020) assessed how species names drive positive or negative sentiment scores based on how strongly they evoke human emotions. However, they did not explore how such associations may influence public engagement with species. Additionally, even though Díaz-Restrepo et al. (2022) and Blades (2020) found that species names do not significantly influence conservation support for them, they focused on mammals (whose favorable aesthetics may have overshadowed any influence of naming). Thus, it should be explored whether the potential impacts of naming remain insignificant across other taxonomic groups.

Because visibility and recognition are key factors in brand awareness (Veríssimo et al., 2014), we explored the suggestion that naming taxa after celebrities raises public awareness of them (Mammola et al., 2023). Contemporary and historical figures often have species or genera named after them (Chen-Kraus et al., 2021; Pillon, 2021). Such eponyms can reflect trends in popular culture and honor individuals who have made notable contributions to knowledge about biodiversity (Pillon, 2021). Indeed, celebrities can generate substantial public attention (Anderson, 2013; Goodman & Littler, 2013), as well as influence awareness, opinion, and action (Craig, 2019; Udo & Stella, 2015). Therefore, it is worthwhile to explore the potential impact of celebrity-related eponyms. Adding to this, familiarity appears to be a factor that drives success of endorsements (Amos et al., 2008; Hanna et al., 2018; Udo & Stella, 2015), and celebrity involvement could be particularly significant for less recognized brands (Udo & Stella, 2015). Thus, there is reason to question whether being named after increasingly famous (i.e., familiar) celebrities can further drive the attention species receive and whether the effect of this affiliation differs across taxonomic groups. There has been limited empirical exploration into the effects of using celebrities for conservation marketing (Olmedo et al., 2020), specifically regarding celebrity-related eponyms. This is surprising given that such a marketing strategy, if successful, could be more achievable than others. For example, although celebrities have been publicly affiliated with environmental nongovernmental organizations and conservation work (see Olmedo et al., [2020] for review), initiating and maintaining endorsements can be impeded by a lack of time, financial support, and personal connections (Duthie et al., 2017).

We explored the potential impact of naming species after celebrities and aimed to advance the literature on how species names can influence public engagement with them. Based on the literature cited above, we made the following *a priori* hypotheses: species whose scientific names are etymologically related to celebrities receive more attention on Wikipedia than their closest relatives that are not named after celebrities; mean daily Wikipedia page views of celebrities affect the disparity in attention received by species named after celebrities and their closest relatives that are not; and the effectiveness of naming a species after a celebrity differs across taxonomic groups.

METHODS

Celebrity species

Our study design was preregistered (<https://aspredicted.org/68b7i.pdf>). Data collection took place from October 2020 to September 2021. We used Google to search for phrases, such as “*species named after celebrities*” and “*species named after famous people*,” and found the following comprehensive web pages: List of Organisms Named after Famous People (Born before 1800) (Wikipedia, 2022a), List of Organisms Named after Famous People (Born 1800–1899) (Wikipedia, 2022b), List of Organisms Named after Famous People (Born 1900–1949) (Wikipedia, 2022c), List of Organisms Named after Famous People (Born 1950–present) (Wikipedia, 2022d), and Etymology: Named after People (Curiosities of Biological Nomenclature, 2020). All web pages provided citations for the original sources where each species was described. We traced these sources with Google and Google Scholar to verify that each species’ etymology was related to a celebrity (here, a person who has a Wikipedia page). Institutional access from the University of Exeter and University of Oxford was used to retrieve available resources, and this added 5 mammals, 4 reptiles, 13 amphibians, 3 birds, 259 invertebrates, and 19 fish to our final data set. Additional searches, for phrases such as “*eponyms of species famous people*,” led to a series of relevant key texts (Beolens, 2018; Beolens et al., 2009, 2011, 2013; Beolens et al., 2014; Watkins & Beolens, 2015), which each offered 653 mammals, 1,007 reptiles, 607 amphibians, 1,021 birds, 452 invertebrates, and 159 fish, respectively, for our final data set.

Quantifying the extent that someone is considered a celebrity can be challenging. Any ordinary person can become a celebrity. It is differences in, for example, national and cultural boundaries, a person’s achievements, and whether a person was recognized during modern versus historical periods that affect how celebrity status is interpreted (Driessens, 2013). Therefore, we defined a *celebrity* as, broadly, a person who has their own Wikipedia page that receives at least 1 daily page view on average (see subsection “Wikipedia page views” below). We defined *celebrity species* as those that were clearly named after a person meeting our definition of *celebrity* (e.g., *Aphonopelma johnnycashi*, named after Johnny Cash, and *Pristimantis attenboroughi*, named after David Attenborough) and that have a Wikipedia page dedicated to them.

Because species' scientific and vernacular names can be used interchangeably online (Jarić et al., 2016), we only included species with scientific names etymologically related to celebrities. This was done to avoid collecting irrelevant data on Wikipedia page views where vernacular names can have loose and multiple meanings (e.g., *teal* or *jaguar* [Correia et al., 2017]). Where these conditions were met, we recorded the following information on a Google Sheet: vernacular name, scientific name, and taxonomic group (amphibian, bird, fish, invertebrate, mammal, or reptile) of selected species; name and primary occupation types of the celebrity; URLs for the species' and celebrity's Wikipedia page (available in any language). We did not include cases in which subspecies, genera, or only vernacular names were related to celebrities, or species with scientific names related to multiple celebrities. We standardized the data set to avoid overrepresentation of etymological associations with celebrities. We did not include taxonomically invalid species or species with a name not clearly associated with a celebrity (e.g., *Presenocoila imallsbookupis*, named in honor of Elvis Presley).

Control species

We paired each celebrity species with a *control species*, defined as the phylogenetically closest relative that also had a Wikipedia page dedicated to them but was not named after a celebrity. To identify control species, we wrote a Python script with *DendroPy* package (Sukumaran & Holder, 2010) to access and interact with the phylogenetic data provided by the OpenTree Synthetic Tree, a comprehensive and open-source tree of life with associated taxonomic data. Although the *DendroPy* package provides an application programming interface (API) for calculating phylogenetic distance matrices (and thus a simple way to determine the closest related species), the OpenTree data does not contain any distance data or branch lengths for use within these functions. Therefore, it was necessary to use a simple algorithm to traverse the tree manually. First, the script iterates through the parent hierarchy of the original (celebrity species) node until a parent is found that has more than 1 child node. Then, with a uniform distribution to generate a random index, a child is chosen at random. If any selected child species was already on the celebrity species list, they were discarded, and we chose another with the same process. We discarded pairs for which celebrity species (and therefore closest relatives) could not be found in the OpenTree data. This occurred when the tree instead contained a taxonomic synonym or when the taxon contained flags that indicated the species was considered invalid (either hidden by a curatorial decision, extinct, or "incertae sedis/incertae sedis_inherited" [describing an unplaced taxon]).

Wikipedia page views

To find Wikipedia pages for the control species and calculate statistics for each item (celebrities, celebrity species, and control species), we wrote a second Python script with *pageviewapi*

TABLE 1 Number of species pairs per taxonomic group for each of the Wikipedia page-view thresholds, where celebrities had at least 1, 10, 100, or 1000 daily Wikipedia page views on average.

Taxonomic group	1	Views10	100	1000
Mammal	658	303	61	17
Bird	1,024	464	94	30
Reptile	1,011	364	63	19
Amphibian	620	194	50	21
Fish	178	79	26	16
Invertebrate	711	390	281	209

(<https://github.com/Commonists/pageview-api>) and *wikipediaapi* (<https://github.com/martin-majlis/Wikipedia-API>) packages. We chose page views as a metric for public attention due to the frequent use of this approach in the field of culturomics and the advantages it provides for research (e.g., it is multilingual, open access, and attracts a vast audience [Millard et al., 2021; Mittermeier et al., 2021; Nolan et al., 2022; Roll et al., 2016]). Because all pages use a common naming scheme, these can be consistently formed by trimming extraneous whitespace around each item, replacing spaces with underscores, and capitalizing the first letter of the resultant string. If this page existed, a list of language-linked pages (describing the same article subject in different languages) was also generated. If a Wikipedia page for an identified control species could not be found, we randomly selected a new control species with the first Python script. For each of these pages, we used the *pageviewapi* package to retrieve the number of page views from 1 July 2015 to 1 July 2021, and a mean daily view count was then calculated using the result. It was at this point that we removed celebrities (and the affiliated species) from the data set if they did not, on average, receive at least 1 daily page view.

Data analyses

We fit Bayesian hierarchical generalized linear mixed effects models (GLMMs) to assess the effect of species being named after celebrities on Wikipedia page view counts. These GLMMs were constructed with random intercepts to account for the paired nature of celebrity and noncelebrity species. When inspecting model fit, we noted better model fit (fewer outliers that our models could not account for as assessed with posterior predictive simulation draws) with the higher thresholds of celebrity. We also questioned whether 1 was a sufficient average daily Wikipedia view to define a celebrity. Therefore, we considered 4 thresholds for defining a celebrity species: 1, 10, 100, and 1000 average daily views. The number of species pairs that qualified under these definitions were 4,202, 1,794, 575, and 312 for the 4 thresholds, respectively. The number of species pairs can also be broken down by taxa (Table 1).

We considered 2 forms of observation error: Student *t* observation error on the (natural) log of average species daily

views on Wikipedia and negative binomial (NB2) (Hilbe, 2011) observation error on the total number of species views.

The Student t model represents a continuous value (log of average species daily views) with a heavy-tailed observation error distribution. We were unable to use a simple Gaussian error distribution because of the heavy-tailed nature of the observations (confidence intervals would have been overly precise and the parameters biased by rare outlying values). The log transformation necessitated excluding 64, 50, 47, or 41 species pairs from the data sets defining a celebrity as >1 , 10, 100, or 1000 average daily page views, where the noncelebrity species had an average (rounded) value of 0 page views. This corresponded to 1.5, 2.8, 8.2, or 13.1% of the species pairs for the 4 thresholds.

The NB2 is a count distribution in which the observation variance grows quadratically with the expected value. This maintains the integer nature of the data-generating process and allows for 0s but may not sufficiently account for outliers. Furthermore, it is based on the assumption that the total Wikipedia views for each species were measured over the same time, which was usually but not always the case (e.g., where species' Wikipedia pages were created after 1 July 2015, so their average daily page view was calculated based on a shorter period).

Starting with the Student t model, our model took the following form:

$$\begin{aligned} \log(y_i) &\sim \text{Student-}t(\nu, \mu_i, \sigma), \\ \mu_i &= \alpha + \alpha_j + \delta_s + \beta C_i + \beta_j C_i, \end{aligned} \quad (1)$$

where y_i is the response variable (average species daily views) for observation i , μ is the expected value (mean), and σ is a scale parameter. We assumed that the observation error was drawn from a heavy-tailed Student t distribution with $\nu = 4$ to account for occasional outliers. We chose $\nu = 4$ based on posterior predictive checks. The parameter α is a global intercept, α_j is a taxa-specific (indexed by j) intercept, and δ_s is a matched species identifier (indexed by s) intercept. The coefficient β is a global effect of celebrity status (C), $C = 0$ if a noncelebrity, $C = 1$ if a celebrity), and β_j is a taxa-specific effect of celebrity status.

We constrained the taxa-specific intercepts α_j , taxa-specific slopes β_j , and the celebrity and species-specific intercepts δ_s according to normal distributions:

$$\begin{aligned} \alpha_j &\sim \text{normal}(0, \tau_\alpha^2), \beta_j \sim \text{normal}(0, \tau_\beta^2), \\ \delta_s &\sim \text{normal}(0, \tau_\delta^2). \end{aligned} \quad (2)$$

We placed the following weakly informative priors on the parameters:

$$\begin{aligned} \beta &\sim \text{normal}(0, 1), \alpha \sim \text{normal}(0, 5^2), \sigma \sim \text{Student-}t(3, 0, 2.5), \\ \tau_\alpha &\sim \text{Student-}t(3, 0, 2.5), \tau_\beta \sim \text{Student-}t(3, 0, 2.5), \\ \tau_\delta &\sim \text{Student-}t(3, 0, 2.5). \end{aligned} \quad (3)$$

We placed an LKJ(1) prior on the correlation between β_j and α_j , which is the default in the package brms (Bürkner, 2017).

The negative binomial model was the same except for the main equations:

$$\begin{aligned} z_i &\sim \text{NB2}(\mu_i, \phi), \\ \log(\mu_i) &\sim \alpha + \alpha_j + \delta_s + \beta C_i + \beta_j C_i, \end{aligned} \quad (4)$$

where z_i is counts of page views. We placed a Student $t(3, 0, 5)$ prior on the shape parameter ϕ .

We constructed Stan (Carpenter et al., 2017) models with the R package brms (Bürkner, 2017). For each fitted model, we used brms and cmdstanr (Gabry & Češnovar, 2022) to sample 2000 iterations across 4 chains with 1000 iterations of warm up per chain with the Stan No U-Turn Sampler. We assessed convergence visually with traceplots and made sure that ESS (effect of sample size) was >100 and Rhat (the scale reduction factor) was <1.01 for all parameters. We assessed the ability for our probabilistic models to generate our observed data via density plots of posterior predictive checks (Gelman et al., 2014).

To assess the degree to which the taxonomic groups with the most data were affecting inference for the taxonomic groups with fewer data (due to the hierarchical structure), and as a check that our Bayesian model with priors did not unduly influence our inference, we fit alternative versions of the Student t model in which each taxon was fit independently with (restricted) maximum likelihood and without priors. In this case, each model took the form:

$$\begin{aligned} \log(y_i) &\sim \text{Student-}t(\nu, \mu_i, \sigma), \\ \mu_i &= \alpha + \delta_s + \beta C_i, \\ \delta_s &\sim \text{normal}(0, \tau_\delta^2) \end{aligned} \quad (5)$$

where α and β are unique to each taxon. This version retained the random intercept for δ_s to account for the paired nature of the data. We fit these models with the R package sdmTMB (Anderson et al., 2022 [preprint]), which uses template model builder (TMB) to construct the log likelihood function and to integrate over the random effects with the Laplace approximation (Kristensen et al., 2016).

Other information (such as data, code, and visualizations related to the data analysis) can be found at <http://doi.org/10.17605/osf.io/v3uke>.

RESULTS

Mammals showed the highest average daily page views (24.59), followed by fish (19.71), birds (16.28), reptiles (13.55), amphibians (5.71), then invertebrates (2.83). The celebrity species with the 5 highest average daily page views were Baran's viper (*Vipera barani*) (4,141.51), Tasmanian devil, *Sarcophilus harrisii* (3,340.25), emperor penguin, *Aptenodytes forsteri* (2,501.66), tiger shark, *Galeocerdo cuvier* (1,652.39), and Hermann's tortoise, *Testudo hermanni* (1,371.66).

The Student t (Figure 1) and NB2 models provided similar inferences (Supporting Information Appendix S1). However,

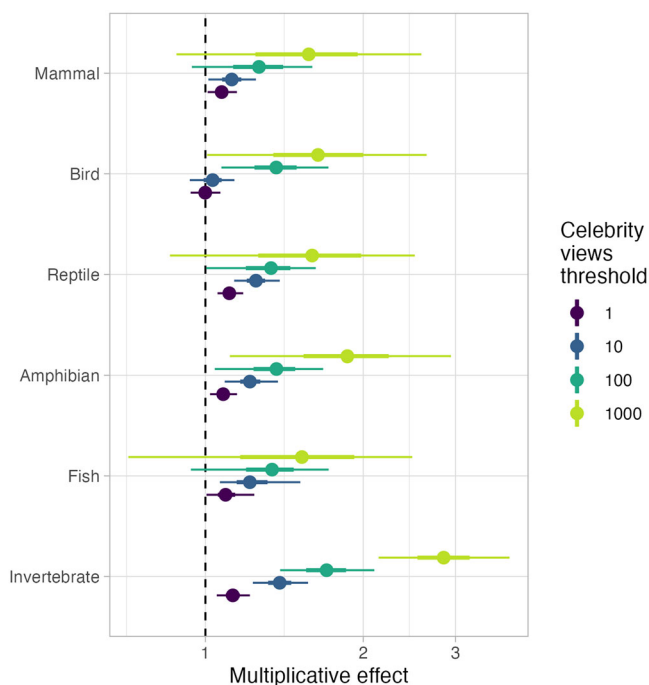


FIGURE 1 Multiplicative effect on average daily Wikipedia views of naming a species after a celebrity compared with control species (those not named after a celebrity [dashed line]) based on the Student *t* observation error model (dots, medians; thick lines, 50% credible intervals of the posterior; thin lines, 95% credible intervals of the posterior).

based on slightly better posterior predictive checks, generally smaller (more conservative) effect sizes, and consistency with the preregistered study design (<https://aspredicted.org/68b7i.pdf>), we moved forward with the Student *t* model.

Overall, we found a high probability (0.96–0.98) that celebrity species had more page views than their respective control species, irrespective of the celebrity threshold. The multiplicative effect was larger but more uncertain as the celebrity page-view threshold increased. Celebrity species had a 1.08 (1.00–1.18 [95% credible interval [CI]], 1.20 [1.02–1.40], 1.38 [1.03–1.77], and 1.76 [0.89–2.80]) times higher expected number of page views than an associated control species at the 1, 10, 100, and 1000 celebrity page-view thresholds, respectively.

The hierarchical estimates for the various taxa tended to be positive but were somewhat variable (Supporting Information Appendix S2). This effect was strongest for invertebrates across all thresholds of defining a celebrity. For example, for a threshold of 100 average views per day defining a celebrity, the associated invertebrate species had a 1.72 (1.37–2.23 95% CI) times higher expected number of page views than the associated control species. The posterior probability that the effect was >1 was lowest for birds at celebrity thresholds of 1 or 10, but the posterior probability of positive effects for birds was high (0.99 and 0.95) at thresholds of 100 and 1000. For reptiles, mammals, and fish, the 95% CIs crossed 1 at celebrity thresholds of 100 and 1000, presumably partially due to the lower sample sizes at stricter celebrity thresholds.

Visualizing the distribution of the raw data medians verified the main outcomes of the models. The largest difference

in central tendency was for invertebrates; precision of the estimates was driven by having the largest sample size. The raw distribution differences tended to be positive (more views for species named after celebrities) and to be slightly stronger at higher thresholds for defining a celebrity. We did not see a consistent pattern (more views for species named after celebrities) across reptiles or fish at higher thresholds for defining a celebrity.

Fitting separate models for each taxonomic group and fitting the models with maximum likelihood and no priors resulted in broadly the same results, with the following exceptions. The magnitude of the largest effects (invertebrates) was slightly more constrained (smaller) in the hierarchical model, as one would expect in a hierarchical model and in a model with priors. The effects for 100 and 1000 celebrity thresholds for reptiles and amphibians were closer to 0 in the independent model, likely due to low sample sizes and the hierarchical model pulling these effects toward the overall mean effect.

DISCUSSION

Most results moved in the expected direction: species named after celebrities across taxonomic groups generally had higher Wikipedia page views than control species. This effect was stronger as the celebrity views threshold increased. However, there remained a low probability that page views for species named after celebrities were overall not larger when compared with control species, and it was not always the case that the effect became more evident when species were named after increasingly famous celebrities.

According to our results, only invertebrates, amphibians, and reptiles named after celebrities tended to show higher page views than control species (with a probability >0.95 up to thresholds of 100 page views defining a celebrity). Considering a recent study revealed that awareness of insects and amphibians has decreased (or only marginally increased [Millard et al., 2021]) on Wikipedia over time, these results suggest that naming species after celebrities is particularly significant for those belonging to taxonomic groups that generally receive limited attention relative to others. It is arguable that this effect was strongest for invertebrates because this group had a substantially larger sample size for each threshold of celebrity page views, thus, increasing confidence in the findings. Adding to these results, even though reptiles have been considered a less favored type of species (Ogle & Devlin, 2022), the attention paid to this group on Wikipedia has greatly increased over time (Millard et al., 2021). Therefore, perhaps the magnitude of the differences in page views across celebrity thresholds was lower for reptiles because better-known types may already receive comparable levels of attention, regardless of whether they are named after celebrities.

Regarding mammals and birds, the null results (especially for mammals with the NB2 observation error) were consistent with previous literature, whereupon changing species' names did not significantly influence public engagement with them (see Blades, 2020; Díaz-Restrepo et al., 2022). Because species belonging to

these taxonomic groups generally receive more interest and coverage than those with less aesthetically desirable traits (Clucas et al., 2008; Martín-López et al., 2009; Skibins et al., 2017), this result is unsurprising. It is conceivable that this effect occurred because birds and mammals already attract public attention due to their appearances, so naming has limited influence on increasing public engagement. Finally, although no notable differences were found for fish, it was difficult to deduce whether naming such species after celebrities had less impact for this taxa than others. On the one hand, the group had a substantially smaller sample size than others, so further research would need to ensure that group sizes are more comparable. On the other hand, it has been suggested that online attention could be linked to consumer behavior (Millard et al., 2021). For example, market demand and recreational fishing activities have been globally affected by the COVID-19 pandemic (Cooke et al., 2021). Therefore, perhaps public consumption and recreational behavior has more impact than naming on fish species' Wikipedia attention. Overall, our results support suggestions that conservation marketing techniques (here, naming) can particularly affect species that are typically less popular than others (Díaz-Restrepo et al., 2022; Veríssimo et al., 2017). Moreover, they add to the notion that celebrities can help generate public attention (Anderson, 2013; Goodman & Littler, 2013), especially for less recognized brands (i.e., species [Udo & Stella, 2015]).

A strength of our study is that we measured actual behavioral data—this has previously been advised to better understand differences in popularity between species (Veríssimo et al., 2017). Although a possible drawback of focusing only on Wikipedia data is that the most recently described species may have been missing from our data set, due to a delay between when they are announced and when an encyclopedic entry is created for them, it is arguable that our large sample was generally representative of the potential impact of naming species after celebrities. We also recognize that the quantity of page views may not necessarily be a direct result of eponyms. For example, species may gain visibility from being featured in popular media: those named after Beyoncé, Sting, Freddie Mercury, and James Brown, among others, have been featured in *Rolling Stone* (2012). However, comparing Wikipedia page views between celebrity and control species as an approach to gauge public attention has specific benefits. First, quantifying interest in conservation by analyzing trends in Wikipedia is a growing practice in the field of culturomics (see Millard et al., 2021; Mittermeier et al., 2021; Nolan et al., 2022; Roll et al., 2016), notably due to its abundance of articles on species that are freely accessible and standardized in structure (Mittermeier et al., 2021; Roll et al., 2016). A second advantage pertains to our decision to only examine species whose scientific names are etymologically related to celebrities. Although species' scientific names are less familiar to people outside the scientific community (Díaz-Restrepo et al., 2022), vernacular names can have loose and multiple meanings (e.g., teal and jaguar [Correia et al., 2017]). Therefore, even though search results have shown that these names can successfully be used interchangeably online (Jarić et al., 2016) and searching for either scientific or vernacular names can direct users to the same Wikipedia page, our decision to search for species' scientific

names with the Wikipedia API ensured that data automatically collected across languages was for the correct pages, rather than the reverse where multiple irrelevant pages could be available for the same term.

Because increasing public awareness and support for threatened species is vital for successful biodiversity conservation (Davies et al., 2018; Toomey & Domroese, 2013), it must be considered whether naming species after celebrities aids their protection (Mammola et al., 2023). Drawing attention online is beneficial because platforms like Wikipedia may offer information, including the conservation status, ecological roles, and cultural value of species, that could generate enhanced interest in their protection (Millard et al., 2021; Roll et al., 2016), and participants have been more likely to allocate donations to lesser-known species when learning they are threatened (Tisdell et al., 2007; Wilson & Tisdell, 2005). Furthermore, marketing techniques can be particularly successful at bringing more donations to species often considered less physically appealing (Veríssimo et al., 2017). However, heightened interest in taxa may arguably not result in sustained increases in awareness or knowledge about biodiversity (Millard et al., 2020 [preprint]), and attention and information-seeking about species does not necessarily lead to behaviors representative of continued interest or support for them (Acerbi et al., 2020; Schwartz et al., 2012; Veríssimo et al., 2020). Therefore, further study should explore whether increasing attention paid to species, as a result of being named after celebrities, influences levels of conservation support. This is worthwhile given our strong results for amphibians and especially invertebrates—an underappreciated group that is essential for sustaining all life, yet faces critically high levels of extinction (Cardoso et al., 2020). Inspired by Díaz-Restrepo et al.'s (2022) choice experiment design, future researchers could examine how participants choose to allocate real donations between species named after celebrities and those that are not. Moreover, such research would benefit from including taxonomic groups besides mammals to more thoroughly explore how the name, appeal, or familiarity of a species may predict the donations they receive. Additionally, as species are increasingly named after people (as seen with spiders [Mammola et al., 2023]), it would be worthwhile to assess why, and at what point, naming may begin to have weaker implications for attracting attention and conservation support to different taxa.

It should be appreciated that having celebrities closely affiliated with species is a potential double-edged sword. They are often involved in conservation marketing because they are idolized by members of the public, who mimic celebrities' behavior (Bergman et al., 2022), but this can have negative outcomes for conservation. On the one hand, increased online attention can result from successful conservation campaigns (Mittermeier et al., 2021), and such outcomes can be amplified when endorsed by celebrities. For example, Leonardo DiCaprio used his Oscar acceptance speech in 2016 to promote climate action. On the day he spoke, Google searches for the terms “climate change” and “global warming” increased by 261% and 210%, respectively, and the number of tweets including these terms was 636% higher than expected (Leas et al., 2016). Notably, these trends were compared with online attention during Earth Day

and the United Nations Conference of the Parties (COP), both held in 2015. The number of Google searches was 3.8 and 4.3 times higher than those observed during COP and Earth Day, respectively, and the response to DiCaprio's speech on Twitter was 3.2 and 5.3 times larger than responses to COP or Earth Day activity (Leas et al., 2016). On the other hand, increased online attention could result from people wanting to hunt or catch species (Mittermeier et al., 2021), and naming species after celebrities could play a role in such issues. For example, our data set showed *Anophthalmus hitleri* to have a high number of daily page views, but being named after Adolf Hitler is driving this blind cave beetle to extinction as it is collected as a piece of Nazi memorabilia (Jóźwiak et al., 2015). Thus, there can be risks in associating species with celebrities, and these must be considered when seeking to enhance the visibility of taxa for the benefit of conservation.

If celebrities are used to enhance awareness and perceptions of matters related to biodiversity, then it is helpful to understand what makes this marketing technique effective (Duthie et al., 2017). One approach to naming species after celebrities could be based on the "product match-up hypothesis" (Parmar et al., 2020): the effectiveness of an endorsement increases when there is a clear and strong association between the celebrity and a product, service, or brand. A good fit between celebrities and brands could be of relevance if seeking to directly elicit support for species. For example, Duthie et al. (2017) found that celebrities who are considered knowledgeable about an issue being endorsed lead to significantly higher levels of willingness to engage with a campaign. However, the extent to which this effect can help audiences recall products and issues has shown varying outcomes (Duthie et al., 2017; Udo & Stella, 2015). An alternative approach may be to prioritize the importance of familiarity for celebrity endorsements (Amos et al., 2008; Hanna et al., 2018; Udo & Stella, 2015), and therefore species' names because many celebrities used to promote products or services are popular people (e.g., actors, athletes, musicians, artists, authors, or even well-known politicians and other public figures) (Belch & Belch, 2013; Friedman & Friedman, 1979). Additionally, it may be worthwhile to assess the effects of naming species after contemporary versus historical familiar figures. For example, particularly popular celebrities in our data set included Donald Trump, Lady Gaga, and Leonardo DiCaprio, as well as Queen Victoria, Vincent van Gogh, and William Shakespeare. Further testing regarding the effects of celebrity attributes, such as their familiarity, connection to species, and period in which they lived, could help to inform the decisions of taxonomists and conservationists who use celebrity-inspired eponyms to draw more public attention to species.

If these eponyms are created, then another factor to consider is whether public perceptions of a person may affect the species named after them. Through "affect transfer", celebrities can influence perceptions toward brands (Ilicic & Baxter, 2014) and should therefore ideally be likable because those associated with a negative image risk implicating the brands they are affiliated with (Udo & Stella, 2015). Although our results showed whether species named after celebrities attracted significantly more attention on Wikipedia than control species,

we did not explore the nature of this attention. This is important to recognize, because high awareness of a species could potentially be accompanied by negative attitudes toward them (Mittermeier et al., 2021; Verissimo et al., 2014). For example, online interest in bat species boomed in 2020 according to Google searches and Wikipedia page views (Cerri et al., 2022). However, this occurred during a period of increased media coverage in which bats became closely associated with the COVID-19 pandemic (Cerri et al., 2022), and public understanding about this association has had severe implications regarding attitudes toward these vulnerable mammals and how their populations are managed (Lu et al., 2021; Sasse & Gramza, 2021). Therefore, analyzing the sentiment of species' names (i.e., whether they have positive or negative connotations; Díaz-Restrepo et al., 2022) would be a useful step in this line of research. Future studies could assess whether there is a correlation between the sentiment attributed to celebrities and species named after them. Adding to this, sentiment of names can interact with taxonomic biases to further affect public perceptions of species (Gregg et al., 2020). Thus, how possible associations between the sentiment attached to celebrities and species named after them may differ across taxonomic groups should also be explored. Finally, there is practical value in examining this matter, given previous suggestions that improving the sentiment of species' names could offer a simple and cost-effective approach to increasing conservation support for them (Gregg et al., 2020; Karaffa et al., 2012; Wright et al., 2015). This is especially vital given the possible implications for a threatened species if they are named after a controversial or unfavorable figure.

In addition to the potential impacts of creating eponyms for conservation, it is imperative to address social implications. The use of eponyms has been increasingly questioned because many namesakes are associated with actions and beliefs now widely regarded as unacceptable (e.g., racism, slavery, and imperialism) (Chen-Kraus et al., 2021; Guedes et al., 2023; Tracy, 2022). Species' names can serve as a reminder of such social ills and disproportionate power dynamics between the Global North and South (Chen-Kraus et al., 2021), men and women (Chen-Kraus et al., 2021; Pillion, 2021), and colonialist versus indigenous populations (Chen-Kraus et al., 2021; Guedes et al., 2023). For example, birds and plants have a history of being named for people who are not native to these species' localities—a practice strongly tied to colonialism (Smith & Figueiredo, 2022; Trisos et al., 2021).

On this basis, there have been calls to abandon the use of eponyms (Guedes et al., 2023), including those dedicated to celebrities (Poulin et al., 2022). However, this would mean losing opportunities to recognize an abundance of remarkable individuals (Garbino, 2023; Shiffman, 2019). Naming species is a chance to acknowledge the diversity of people who have helped advance the understanding of nature (Chen-Kraus et al., 2021; Pillion, 2021), as well as celebrate those who advocate for human rights (Mammola et al., 2023; Orr et al., 2023). For example, Agnarsson et al. (2018) recently named spiders of the genus *Spintharus* after Michelle Obama, Barack Obama, David Attenborough, and Leonardo DiCaprio. Other admirable and popular examples from our data set include species named

after Nelson Mandela, Mahatma Gandhi, and Wangari Maathai. Furthermore, it is an opportunity to advance inclusivity in taxonomy. For example, DuBay et al. (2022 [preprint]) found that when an author's country of origin is consistent with newly described birds' locality, birds are 62% more likely to be named in honor of someone from that country. They are still 42% more likely to be named in this way as long as 1 person's country of origin matches the species' locality. Moreover, it allows describers to honor historic Indigenous figures, to recognize that species newly discovered by Western scientists were not necessarily unknown to native populations (Shiffman, 2019). Importantly, dedicating eponyms to members of local communities could even strengthen attention, attachment, and conservation support given to species (Chen-Kraus et al., 2021; Pillon, 2021).

Ultimately, the creation and use of eponyms can signal which values society should aspire to have and play an important role in addressing issues of equity, diversity, and inclusivity (Shiffman, 2019). To understand the extent that such values are represented when species are named after celebrities, it would be worthwhile to extend DuBay et al.'s (2022 [preprint]) research and assess which species in our data set share their locality with the people they are named by and in honor of. It was beyond the scope of our work to perform such an analysis, but we encourage others to build on our freely accessible data set to help identify the presence of sociocultural biases in eponyms and whether they vary across different taxonomic groups. Such observations could enable taxonomists to begin to address imbalances and even offensive practices. Unfortunately, strict and highly formalized rules produced by the International Commission on Zoological Nomenclature (ICZN) govern scientific names and make it difficult to revise those currently deemed problematic (Chen-Kraus et al., 2021; Guedes et al., 2023). Although the ICZN advises that authors should not knowingly propose offensive names (Ride et al., 1999), judgments on their inappropriateness are arguably subjective and culturally shift over time (Ceriaco et al., 2023; Chen-Kraus et al., 2021; Poulin et al., 2022). Thus, nomenclatural stability is prioritized over ethical reasoning in taxonomy (Ceriaco et al., 2023). While we appreciate that widespread changes in nomenclature could be highly disruptive and laborious (Ceriaco et al., 2023), like Driver and Bond (2021), we contend that taxonomists should have appropriate flexibility and guidance to revise eponyms if namesakes demonstrate untenable actions or beliefs. This could engender a more responsible use of eponyms, better attract support for species protection, and promote inclusivity and equity.

Celebrities can successfully generate attention for brands and influence public interest in species. Our large-scale investigation regarding approaches to naming species provides a novel contribution to the conservation marketing literature. Overall, our results suggest that naming species after celebrities has stronger effects for those belonging to taxonomic groups that are generally less popular than others (i.e., invertebrates, amphibians, and reptiles). Altogether, we argue that if eponyms are created and used, then they must be done so respectfully and

responsibly—appreciating both conservation and sociocultural needs.

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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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