

Exploring the impact of politics on biodiversity knowledge

Alexander Zizka^{1,2,3}, Oskar Rydén^{3,4,5}, Daniel Edler⁴, Johannes Klein⁴,
Helén Aronsson⁴, Allison Perrigo⁴, Daniele Silvestro^{4,5}, Sverker Jaegers⁶,
Staffan Lindberg³ & Alexandre Antonelli^{5,7}*

1. German Center for Integrative Biodiversity Research, University of Leipzig, Leipzig, Germany
2. Naturalis Biodiversity Center, Leiden University, 2300RA Leiden, The Netherlands
3. Varieties of Democracy Institute, Department of Political Sciences, University of Gothenburg, Gothenburg, Sweden
4. Gothenburg Global Biodiversity Centre, University of Gothenburg, Gothenburg, Sweden
5. Department of Biological and Environmental Sciences, University of Gothenburg, Gothenburg, Sweden
6. Centre for Collective Action Research, Department of Political Sciences, University of Gothenburg, Gothenburg, Sweden
7. Royal Botanical Gardens Kew, Richmond, Surrey, United Kingdom

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Countries are the main actors responsible for mapping and protecting their biodiversity. However, political regimes may differ in their capacity, willingness and efficiency to collect primary biodiversity data necessary for research and conservation. Here we present an online tool for the easy exploration of the links between democracy, armed conflicts, and other socio-economic variables and the availability of natural history specimens and species observations. Around the world, strong and previously unknown patterns emerge. We urge for increased collaboration between natural and social scientists to further unveil these patterns and underlying processes.

Politics can contribute to international differences in the availability of biodiversity data¹⁻³, and political systems vary, for instance from democratic to autocratic^{5,6}. The level of democracy in a country has multiple dimensions, including among others, suffrage (the fraction of citizens entitled to vote), freedom of expression, quality of elections, civil society characteristics, or constraints on executive power^{7,8}. Although several aspects of democracy are tend to co-vary, countries can, and do, position themselves differently concerning these aspects. Since individual dimensions of democracy might matter differently for biodiversity conservation and the availability of biodiversity data, it can be misleading to use one-dimensional indicators (such as democratic vs. autocratic) to explore the role of politics on biodiversity knowledge⁹. Hence, a more detailed understanding of countries' political institutions is the key to better understand the politics of global biodiversity knowledge.

Political regimes may influence the availability of biodiversity data via several mechanisms¹⁰. For instance, the generally more open and reliable legal situation in liberal democracies makes them more accessible for researchers and international collaborations for biodiversity data collection and sharing, relative to more autocratic regimes¹¹. Free, fair and repeated elections can provide citizens with a means to express their demand for good environmental conditions and thus also incentivise political leaders to invest in biodiversity management¹². Countries where the threat of conflict or physical violence is lower data collection may be safer, especially for international researchers¹³. Countries with higher levels of education might have a higher overall level of environmental awareness and together with a higher freedom of association might also make the development of ecological and naturalist societies

47 (“citizen science”) which contribute considerably to the availability of biodiversity data (e.g.,
48 www.ebird.org, www.inaturalist.org).

49 Here we present a free software (www.bio-dem.surge.sh) to explore the relationship between
50 the availability of primary biodiversity data (geo-referenced natural history specimens and
51 species observations; obtained from www.gbif.org) with various democratic institutions,
52 indexes and categories⁸. Furthermore, we quantify the proportion of global biodiversity that
53 is managed by different regime types¹⁴. For these analyses, we calculate the range-weighted
54 species richness of three vertebrate groups and seed plants per country globally. Specifically,
55 we ask three questions: 1) Which fraction of the studied biodiversity is managed by democratic
56 or autocratic regimes?; 2) How does the availability of primary biodiversity data relate to the
57 political situation in countries?; and 3) What is the relation between democratization and
58 the availability of primary diversity data through time?

59 The analyses of distribution data from 22,805 species of vertebrates and >300,000 seed plants
60 show that the majority of globally threatened and non-threatened species (according to the
61 International Union for the Conservation of Nature) are managed under democratic regimes,
62 mostly electoral democracies (Fig. 1a). However, several countries with particularly high
63 biodiversity—and hence critical importance for conservation—include autocracies such as
64 China, Venezuela, Madagascar and Papua New Guinea, besides democratic countries such
65 as Brazil, Indonesia, Colombia and Peru (Fig. 1b). Especially the electoral democracies of
66 South America contribute to a disproportionately large share of global vertebrate diversity
67 under democratic rule (Fig. 1c), increasing the concern regarding the recent democratic
68 backsliding and populism in this region and the potential severe consequences of conservation
69 and the environment in general¹⁵.

70 Exploring the availability of biodiversity data in the context of the political regimes around
71 the world reveals several interesting and poorly documented patterns. FOr instance, the
72 amount of available biodiversity data correlates with polyarchy which is a measure of electoral
73 democracy (Fig. 2a). Similarly, the density of available biodiversity data correlates with the
74 level of education (Fig. 2b). Costa Rica emerges as an outlier, with an outstandingly high

density of occurrence records despite the country’s relatively low average education length. Conversely, numerous countries formerly part of the Soviet Union stand out by their low number of records but high average education length.

Many countries have changed political regimes in the course of their history. Bio-dem enables the exploration of how those changes, as well as armed conflicts, affected the availability of primary biodiversity data. Taking Cambodia as an example, we unveil a decrease of such data by orders of magnitude in the 1970s, with the beginning of a period of conflicts and autocratization (Fig. 2c). The end of this period and the corresponding increase in the level of democracy led to an abrupt increase in data availability. Similarly, in India political turmoil and a related decrease in the level of democracy in 1975 and 1976 led to an abrupt decrease in the availability of biodiversity data from national institutions (Fig. 2d). Despite those historical turmoils and a minor recent decline in the level of democracy, Cambodia and India mirror most other countries in exhibiting a general increase in biodiversity data, probably attributable to the widespread use of citizen science applications for mobile phones such as iNaturalist.

The relationship between political differences, socio-economic variables and biodiversity knowledge emerges as multi-faceted. These links are also likely to be multi-directional, with raising societal concerns for environmental protection being able to affect political processes and biodiversity data gathering. Other relations are less clear, for instance between democracy and data availability (Fig. 2). In general, a rigid interpretation of the observed patterns is difficult, due to indirect or unclear mechanisms, and the large number of potentially confounding factors¹⁰. The Bio-dem app and its underlying data sources will provide a useful platform for further research at a global scale and through time and facilitate a collaboration between biologists, conservationists and political scientists¹⁶.

Methods

Commented scripts for all analyses are available in the electronic supplement of this article and the source code of the Bio-Dem app is available at <https://github.com/AntonelliLab/Bio-Dem>

under a **XX** license.

Biodiversity and political regimes We used two datasets of species geographic distributions to estimate the fraction of species covered by regime type. For amphibians, non-marine birds and mammals, we used species geographic ranges as publicly available from the International Union for the Conservation of Nature (www.iucn.org) together with country borders as provided by *naturalearth* (www.naturalearth.org) to estimate the range-weighted species endemism per country¹⁷. To do so, we first downloaded the ranges for all species, excluded marine birds based on expert knowledge (because most of their range is in international waters), and overlayed the range of each species with country borders. We then divided the size of a species' range within each country by the total range size of this species and summed the values for all species per country. For instance, if a species is endemic to a country (i.e., the entire range is within country borders), it adds 1 unit to the countries species richness, and if 10% of a species range is within a country this species increases the country's score by 0.1. We then combined this per country species richness with data on species threat level (www.iucn.org) and with information on the state of democracy in each country for the year 2017 from the Varieties of Democracy project⁸, for the visualizations in Figure 2. For plants we approximated the species range by data from the world checklist of selected plant families (<https://wcsp.science.kew.org>). WCSP provides distribution information on level-3 of the World Geographical Scheme for Recording Plant Distributions (www.tdwg.org). We used this information as species range and continued the analyses as for animals.

Software availability. The results presented here were generated by a novel software developed for this study, the Bio-dem web application (www.bio-dem.surge.sh). Bio-Dem is implemented in Javascript. This is a free app, which allows users to explore the relationship between biodiversity data availability and the state of political regimes across countries globally and through time (since 1900). It also allows the generation of publication level graphs in an easily accessible way. The app includes a large number of political as well as key socio-economic indicators of expected relevance to biodiversity data collection and mobilization. It further allows faceting the data by time period and biological group. Bio-Dem obtains information on species occurrence records from the GBIF API and data on political

131 indicators from the Varieties of Democracies database version 8 (www.v-dem.net). All data
132 shown in Figure 2 are directly exported from Bio-Dem.

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Author contributions

AZ, AA, OR, SJ, DS, AP, and SL conceived of this study. AZ analyzed the data. AZ, OR, DE and JK developed the Bio-Dem application. AZ and AA wrote the manuscript with contributions from all authors.

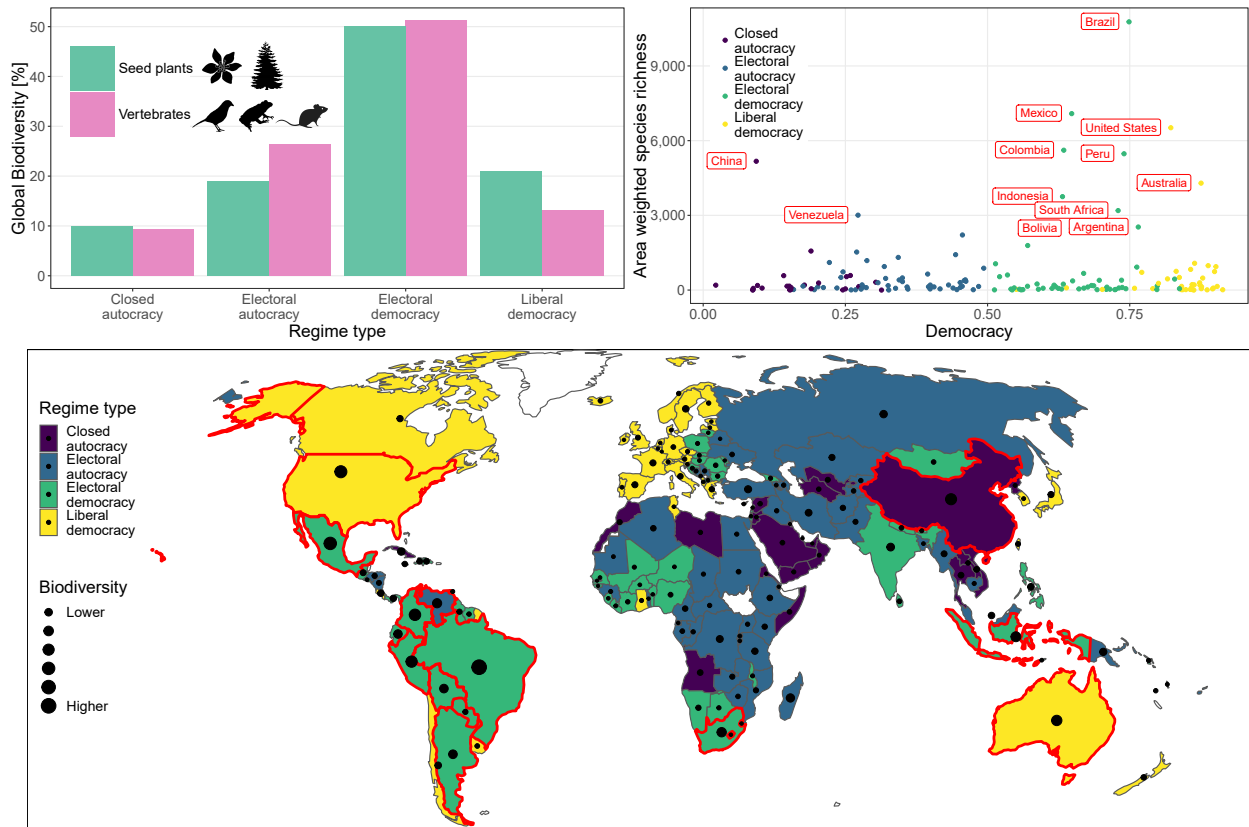
186 **Figures**

Figure 1: The majority of the world's vertebrate and seed plant diversity is managed by democratic regimes. Biodiversity is approximated as range weighted species richness of amphibians, mammals, and non-marine birds, democracy is measured by importance of elections in a country (polyarchy) and regime type. **a)** The majority of global biodiversity is managed by democratic countries, predominantly electoral democracies. **b)** The relation between vertebrate diversity and level of democracy. **c)** The high fraction of biodiversity managed by democracies is mostly due to high biodiversity and levels of democracy in South America. Red labels and outlines in **b)** and **c)** point to the twelve most biodiverse countries globally.

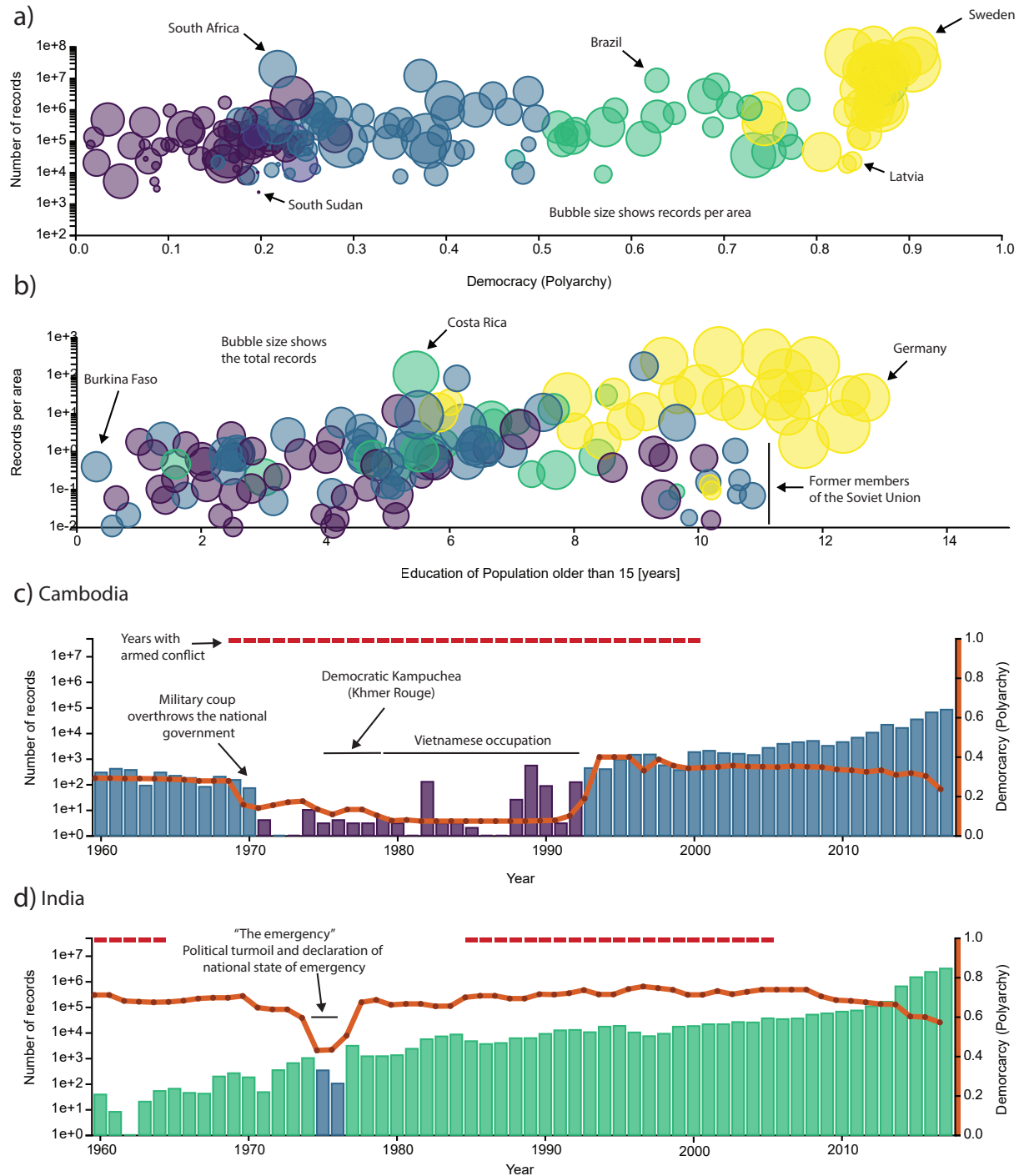


Figure 2: Biodiversity data availability correlates with the state of political systems through space and time. Colors indicates the regime type. **a)** There is no clear correlation between democracy and amount of area protected, but liberal democracies have on average more records available per area. **b)** Countries with long education times have on average more biodiversity data available. **c)** A period of autocratization and armed conflict in Cambodia is related to a decrease in biodiversity data available from this country between the years 1970 and 1992. **d)** A period of political emergency and the resulting drop in democratic rights correlate with a drop in record availability from Indian institutions by one order of magnitude in the years 1975 and 1976.