The relevance of political regime types for biodiversity conservation and knowledge

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Currently, potentially up to 1 million species are threatened with extinction, primarily by increasing human resource use and human-caused climate and land-use change. Considerable societal and political efforts will be necessary to prevent, or at least mitigate, a global extinction crisis. National countries are the primary actors orchestrating such efforts. Different political systems and regime types—from autocratic to democratic—may differ in their capacity, willingness and efficiency to employ conservation measures, and to collect primary biodiversity data necessary as basis for conservation decision, but it is unclear which to which extent this is relevant for global conservation and which dimension of political systems is most relevant.

Beyond the efficiency to decide on and implement conservation measures, political systems might differ in their capability to collect, mobilize and distribute primary biodiversity data, i.e. geographic records of species occurrences, for instance from museum or herbaria collection or citizen science data, which are essential to plan conservation measures. Ecology and biodiversity science are currently transitioning into a period of big data (*REFERENCE*). While time series of population's density and abundance monitory necessary to evaluate the efficiency of conservation measures are still scarce (*REFERENCE*), the availability of primary biodiversity data has increased rapidly in the last decade, mostly due to data mobilization via the Global Biodiversity Information Facility (www.gbif.org). While there is evidence that the political system and stability of countries affect the collection and mobilization of biodiversity data (*REFERENCE*), the role of democratization and different aspects of political systems for biodiversity data collection is unclear, and it is unclear if they effect different taxa and groups similarly.

The political situation in a country, its institutions, and political regime might influence the availability of primary biodiversity data via many mechanisms. For instance liberal democracies will likely be more accessible for researchers, allocate more resources to research, and provide a more reliable legal framework for data collections, to engage in international collaborations for data collection and sharing than autocratic and repressive regimes. However, political system and the degree of democratization of a country have multiple dimensions, including among others suffrage (the proportion of the population having access to the election), the freedom of movement, the freedom of expression, the freedom of association,

among others. A given country might reach different levels of democratization in these dimensions, so that, for instance, a country might have low suffrage, but relatively high freedom of expression, or no real elections, but relatively high freedom of movement. Since individual dimensions of democracy might be of different relevance for the availability of biodiversity data (e.g. freedom of movement, might be more important than freedom of expression), using one-dimensional indicators (e.g. democratic/autocratic) to understand the role of the political situation for biodiversity data availability might be misleading. Furthermore, to understand specific mechanisms mediating the availability of biodiversity data a detailed understanding of individual dimensions of political systems is desirable.

Countries with a high level of electoral accountability, might have a higher commitment to secure good environmental conditions for voting citizens and hence a higher incentive to allocate resources to biodiversity monitoring and data collection. Countries with lower levels of conflict or physical violence might safer for biodiversity data collection, especially for international researchers from other countries. Countries with higher levels of education might have a higher overall level of environmental awareness and interest in research and hence biodiversity data collection. Countries with higher levels of freedom of association are more likely to develop ecological and naturalist societies ("citizen science") which contribute considerably to the available biodiversity data.

Here, we use the area weighted species richness of three vertebrate groups with good data availability to quantify the proportion of global biodiversity that is managed by democratic and autocratic societies. Furthermore, we developed a novel software to explore the relation between the availability of primary biodiversity data (as available from www.gbif.org) with political regimes and democracy indicators. Specifically we ask three questions: 1) Which fraction of the studied biodiversity is managed by democratic or autocratic regimes?; 2) How relates the availability of primary biodiversity data to the political situation in countries?; and 3) What is the relation between democratization and armed conflicts with the availability of primary diversity data through time.

The majority of the studied vertebrate diversity is part of democratic countries, namely

electoral democracies (Fig 1a. This is the equally the case for those species considered threatened with extinction by the International Union for the Conservation of Nature and those that are of less concern. The list of countries with particular high biodiversity, and hence high importance for successful conservation, includes autocratic countries such as China, Venezuela, Madagascar and Papua New Guinea as well as democratic countries such as Brazil, Indonesia, Columbia and Peru (Fig. 1b). Especially the relative democratic societies of South America contribute to the large share of global vertebrate diversity under democratic rule (Fig. 1c)).

Exploring the availability of biodiversity data in the context of the political regime of countries worldwide reveals several interesting patterns. While the amount of protected areas seems largely unrelated to the polyarchy, the amount of biodiversity data available increased with polyarchy (Fig. 2a). Similarly, the density of available biodiversity data increases with the level of education in a countries population 2b. In the latter case Costa Rica emerges as outlier, with an outstandingly high density of available occurrence records, given the countries average education length, and numerous countries formerly part of the Soviet Union stand out with a low number of records available give the average education length of the country. Within biodiversity data. For instance the availability of primary biodiversity data decreased by orders of magnitude in the 1970s with the beginning of a period of conflicts and autocratization. The end of this period and the corresponding increase in the level of democracy lead to an abrupt increase in data availability. However, a recent decrease in the level of democracy did no effect data availability from the country. Furthermore, in India, political turmoil and related decrease in the level of democracy in 1975 and 1976 led to an abrupt decrease in the availability of biodiversity data from Indian institutions (Fig. 2d)

The analyses of distributino data from 22,805 species of vertebrates showed that the majority of threatend and non-threatend species is managed under democratic regimes. The exploration of the availability of species geographic occurrence records suggests that more data is available for more democratic countries and that periods of autocratization as well as armed conflicts reduce the amount of data available for countries. The high proportion of global vertebrate biodiversity managed by democratic countries is encouraging that the raising societal concern

with environmental issues can affect political processes and national biodiversity management on a globally relevant scale. While the relation between some political factors such as conflict, political instability and education emerge clearly from our data other relations are less clear, for instance between polyarchy and data availability are more complex (Fig. 2). In general, an interpretation of observed patterns is difficult, due to the indirect or unclear mechanistic link of many political variables with biodiversity data collection and the correlation among different political variables. Especially for this reason the bio-dem app can be a valuable tool for research and teaching to explore possible connection on the global scale as well as through time.

Methods

Biodiversity and political regimes We used species geographic ranges as provided by 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 richness for mammals, amphibians and non-marine birds per country. To do so, we first downloaded the ranges for all species (*DOWNLOAD DATE*), excluded marine birds based on expert knowledge, and overplayed 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 democratic state of each country in the year 2017 from the Varieties of Democracy project (www.v-dem.net), for the visualizations in Figure 2.

Biodiversity record collection and political regimes the results on the relation between biodiversity data and the state of political systems presented here are generated novel software developed for this study, namely the Bio-dem web application (www.bio-dem.surge.sh). Bio-Dem is implemented in Java script. The app allows users to explore the relation between

131 biodiversity data availability and the state of political systems across countries globally and
132 through time (since 1900) and to generate publication level graphs in an easily accessible way.
133 The app includes a large number of political indicators conception ally related to biodiversity
134 data collection and mobilization, and allows faceting by time and biological taxon. Bio-Dem
135 obtains information on species occurrence records from the GBIF API and data on political
136 indicators from the Varieties of Democracies database version 8. All data shown in Figure 2
137 are directly exported from Bio-Dem.

References

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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 invented and developed the Bio-Dem app. AZ and AA wrote the manuscript with contributions from all authors.

Figures

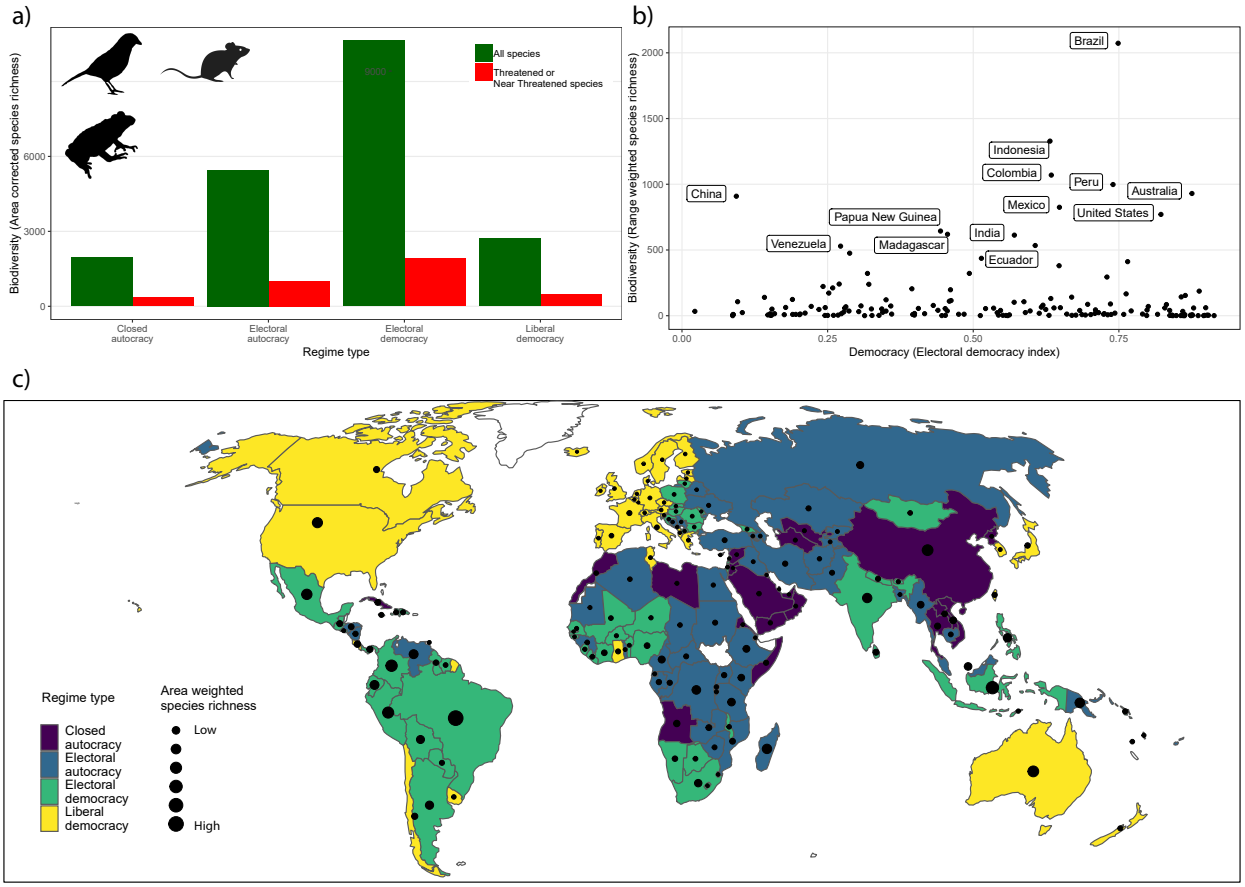

Figure 1: The majority of the world's vertebrate diversity is managed by democratic regimes. **a)** The global distribution of range weighted vertebrate diversity and political regime types. **b)** The relation between vertebrate diversity and level of democracy. **c)** The fraction of global range weighted bird, mammal and amphibian diversity in different regime types.

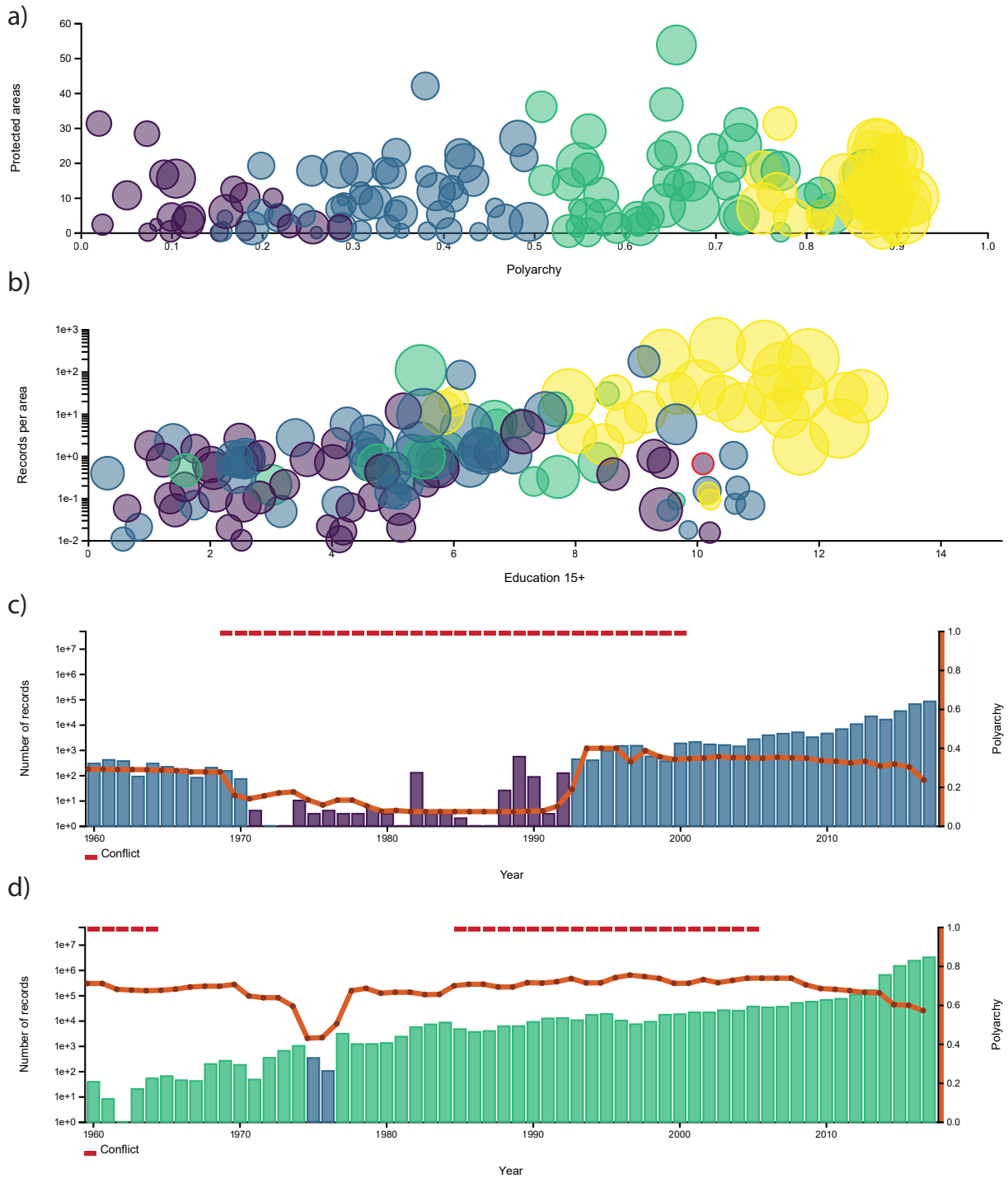

Figure 2: Biodiversity data availability correlates with the state of political systems through space and time. **a)**.There is no clear correlation between democracy and amount of area protected, but liberal democracies have on average more records available per area. Bubble size shows the number of records per area, bubble color indicates the regime type. **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 availability 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.