Exploring the impact of politics on biodiversity knowledge

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Countries are the primary 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 links between multiple levels of democracy, armed conflicts, and other socio-economic variables and the generation and 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 could contribute to international differences in the availability of biodiversity data, but political systems are complex and diverse. The degree of democratization of a country has multiple dimensions, including suffrage (the proportion of the population having access to elections), freedom of movement, freedom of expression, freedom of association, among others (REF: V-dem, etc). A country may reach different levels of democratization in each of these dimensions, so that, for instance, a country might have low suffrage, but relatively high freedom of expression; or it may have 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, it could be misleading to use one-dimensional indicators (such as democratic vs. autocratic) to fully explore the role of politics on biodiversity knowledge. A detailed understanding of individual dimensions of political systems is therefore crucial for exploring specific mechanisms mediating the availability of biodiversity data.

The influence of political regimes on biodiversity data may happen via several mechanisms. For instance, liberal democracies are likely to be more accessible for researchers, allocate more resources to science, provide a more reliable legal framework for data collections, engage in international collaborations for data collection and sharing than autocratic and repressive regimes. 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 be safer for biodiversity data collection, especially for international researchers. 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 availability of biodiversity data.

Here we present a free software to explore the relationship between the availability of primary biodiversity data (geo-referenced natural history specimens and species observations; obtained from www.gbif.org) with political regimes and democracy indicators (liberal democracies, electoral democracies, electoral autocracy, and closed autocracy; from www.v-dem.net). We demonstrate this tool by quantifying the proportion of global biodiversity that is managed by each regime type. For these analyses, we calculate the area-weighted species richness of three vertebrate groups with good data availability. Specifically, we ask three questions: 1) Which fraction of the studied biodiversity is managed by democratic or autocratic regimes?; 2) How does the availability of primary biodiversity data relate 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 analyses of distribution data from 22,805 species of vertebrates show that the majority of globally threatened and non-threatened species (according to the International Union for the Conservation of Nature) are managed under democratic regimes, mostly electoral democracies (Fig 1a. However, several countries with particularly high biodiversity —-and hence critical importance for conservation—-include autocracies such as China, Venezuela, Madagascar and Papua New Guinea, besides democratic countries such as Brazil, Indonesia, Colombia and Peru (Fig. 1b). Especially the electoral democracies of South America contribute to a disproportionately large share of global vertebrate diversity under democratic rule (Fig. 1c)).

Exploring the availability of biodiversity data in the context of the political regimes around the world reveals several interesting and poorly documented patterns. While the number of protected areas today is largely unrelated to regime, the amount of available biodiversity data increases with polyarchy (Fig. 2a). Similarly, the density of available biodiversity data increases with the level of education 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. Our tool enables the assessment 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. 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.

Perhaps not surprisingly, 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, an interpretation of observed patterns is difficult, due to indirect or unclear mechanisms. The bio-dem app and its underlying data sources will hopefully provide a useful platform for further research at a global scale and through time. Paramount to this goal will be a tighter collaboration between biologists, conservationists and political scientists.

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.

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 (XX) 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 indicators from the Varieties of Democracies database version 8. All data shown in Figure 2 are directly exported from Bio-Dem.

References

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Author contributions

AZ, AA, OR, SJ, DS, AP, and SL conceived 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

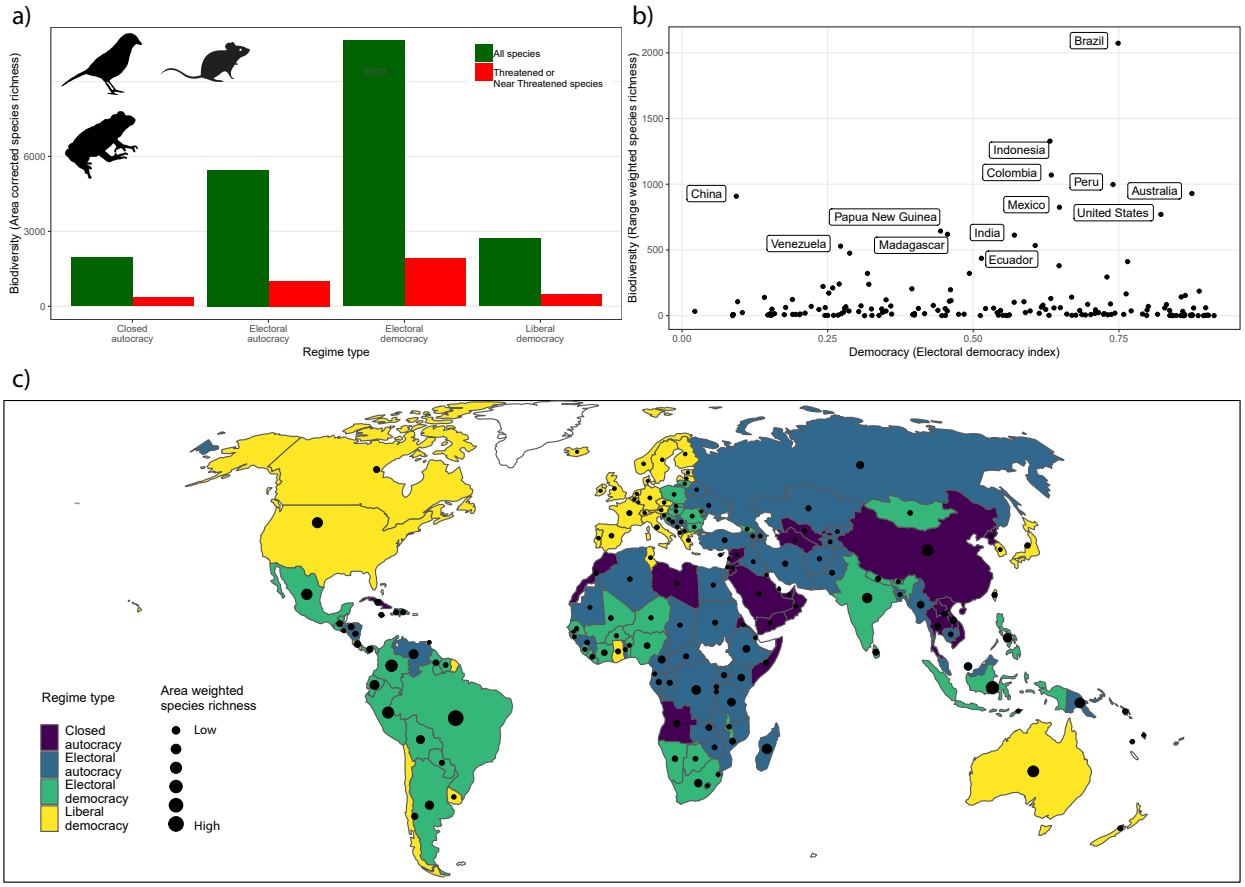

Figure 1: The majority of the world's vertebrate diversity is managed by democratic regimes. **a)** The global distribution of range weighted vertebrate diversity and political regime types. **b)** The relation between vertebrate diversity and level of democracy. **c)** The fraction of global range weighted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

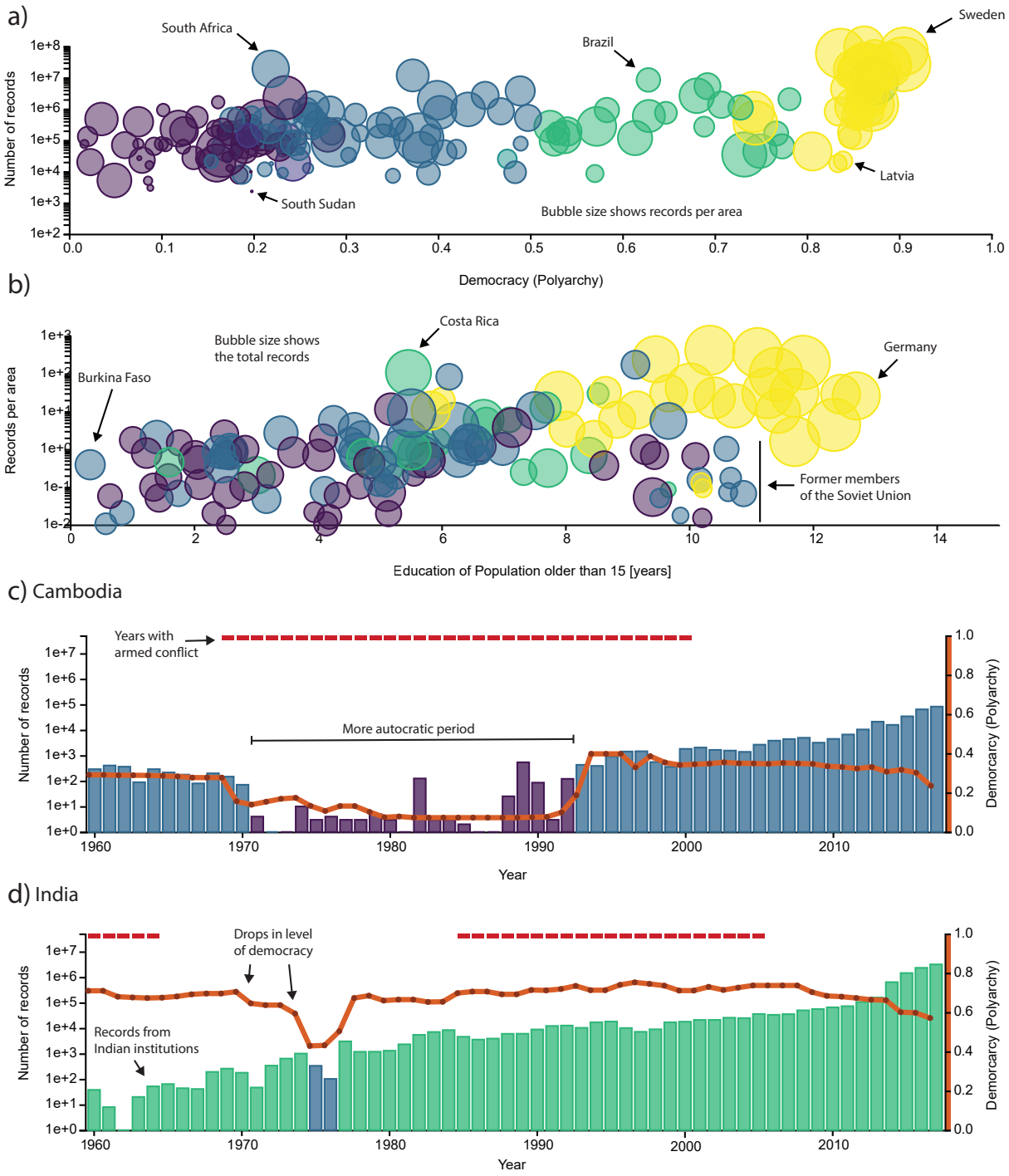

Figure 2: Biodiversity data availability correlates with the state of political systems through space and time. **a)**.There is no clear correlation between democracy and amount of area protected, but liberal democracies have on average more records available per area. Bubble size shows the number of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