Exploring the impact of politics on biodiversity knowledge

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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 multiple aspects 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 can contribute to international differences in the availability of biodiversity data [@Neumayer2002; @McClanahan2016], but political systems do vary [@Geddes2014; @Lindberg2014]. The level of democracy in a country at any given point in time exhibits multiple dimensions, including, for example, suffrage (fraction of citizens entitled to vote), freedom of expression, quality of elections, civil society characteristics, or constraints on executive power [@Coppedge2011; @Coppedge2019]. Although several aspects of democracy are bundled and move together, 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 knowledge [@Escher2018]. Hence, a more detailed understanding of countries' political institutions is the key to better understand the politics of global biodiversity knowledge.

The influence of political regimes on biodiversity data may happen via several mechanisms [@Ryden2019]. For instance, the generally more open and reliable legal framework with higher academic freedoms in liberal democracies can make them more accessible for researchers and international collaborations for biodiversity data collection, relative to less liberal regimes [@Li2006]. 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 management [@Bernauer2009]. In places where the threat of conflict or physical violence is lower one can expect the data collection process to be safer, certainly for international researchers [@Amano2013]. Countries with higher levels of education might have

46 a higher overall level of environmental awareness. This is relevant to the point about elections

47 made above, but might also lead to the development of "citizen science" if the regime is

48 allowing of citizens organizing freely and sharing information, nationally and internationally,

49 which contribute considerably to the availability of biodiversity data (e.g., www.ebird.org,

50 www.inaturalist.org).

51 Here we present a free software (www.bio-dem.surge.sh) to explore the relationship between

52 the availability of primary biodiversity data (geo-referenced natural history specimens and

53 species observations; obtained from www.gbif.org) with various democratic institutions,

54 indexes and categories [e.g. regime type, "polyarchy", the freedom of expression etc. from

55 @Coppedge2019]. Furthermore, we quantify the proportion of global biodiversity that is

56 managed by different regime types [@Luhrmann2018]. For these analyses, we calculate the

57 area-weighted species richness of three vertebrate groups and seed plants per country globally.

58 Specifically, we ask three questions: 1) Which fraction of the studied biodiversity is managed

59 by democratic or autocratic regimes?; 2) How does the availability of primary biodiversity

60 data relate to the political situation in countries?; and 3) What is the relation between

61 democratization and the availability of primary diversity data through time?

62 The analyses of distribution data from 22,805 species of vertebrates and >300,000 seed plants

63 show that the majority of globally threatened and non-threatened species (according to the

64 International Union for the Conservation of Nature) are managed under democratic regimes,

65 mostly electoral democracies (Fig 1a). However, several countries with particularly high

66 biodiversity——and hence critical importance for conservation——include autocracies such as

67 China, Venezuela, Madagascar and Papua New Guinea, besides democratic countries such

68 as Brazil, Indonesia, Colombia and Peru (Fig. 1b). Especially the electoral democracies of

69 South America contribute to a disproportionately large share of global vertebrate diversity

70 under democratic rule (Fig. 1c). However, one must not forget the very recent political

71 development in terms of democratic backsliding or populism and what the associated political

72 leaders might do to the natural environment in a broad sense [@Dasgupta2018].

73 Exploring the availability of biodiversity data in the context of the political regimes around

74 the world reveals several interesting and poorly documented patterns. While the number of
75 **protected areas** today is largely unrelated to the political regime, the amount of available
76 biodiversity data correlates with polyarchy which is a measure of electoral democracy (Fig.
77 2a). Similarly, the density of available biodiversity data correlates with the level of education
78 (Fig. 2b). Costa Rica emerges as an outlier, with an outstandingly high density of occurrence
79 records despite the country's relatively low average education length. Conversely, numerous
80 countries formerly part of the Soviet Union stand out by their low number of records but
81 high average education length.

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

94 Perhaps not surprisingly, the relationship between political differences, socio-economic vari-
95 ables and biodiversity knowledge emerges as multi-faceted. These links are also likely to be
96 multi-directional, with raising societal concerns for environmental protection being able to
97 affect political processes and biodiversity data gathering. Other relations are less clear, for
98 instance between democracy and data availability (Fig. 2). In general, an interpretation of
99 observed patterns is difficult, due to indirect or unclear mechanisms. The Bio-dem app and
100 its underlying data sources will hopefully provide a useful platform for further research at a
101 global scale and through time. Paramount to this goal will be a tighter collaboration between
102 biologists, conservationists and political scientists [@Agrawal2006].

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 state of democracy in each country for the year 2017 from the Varieties of Democracy project [@Coppedge2019], 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.

129 References

Acknowledgments

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 application. AZ and AA wrote the manuscript with contributions from all authors.
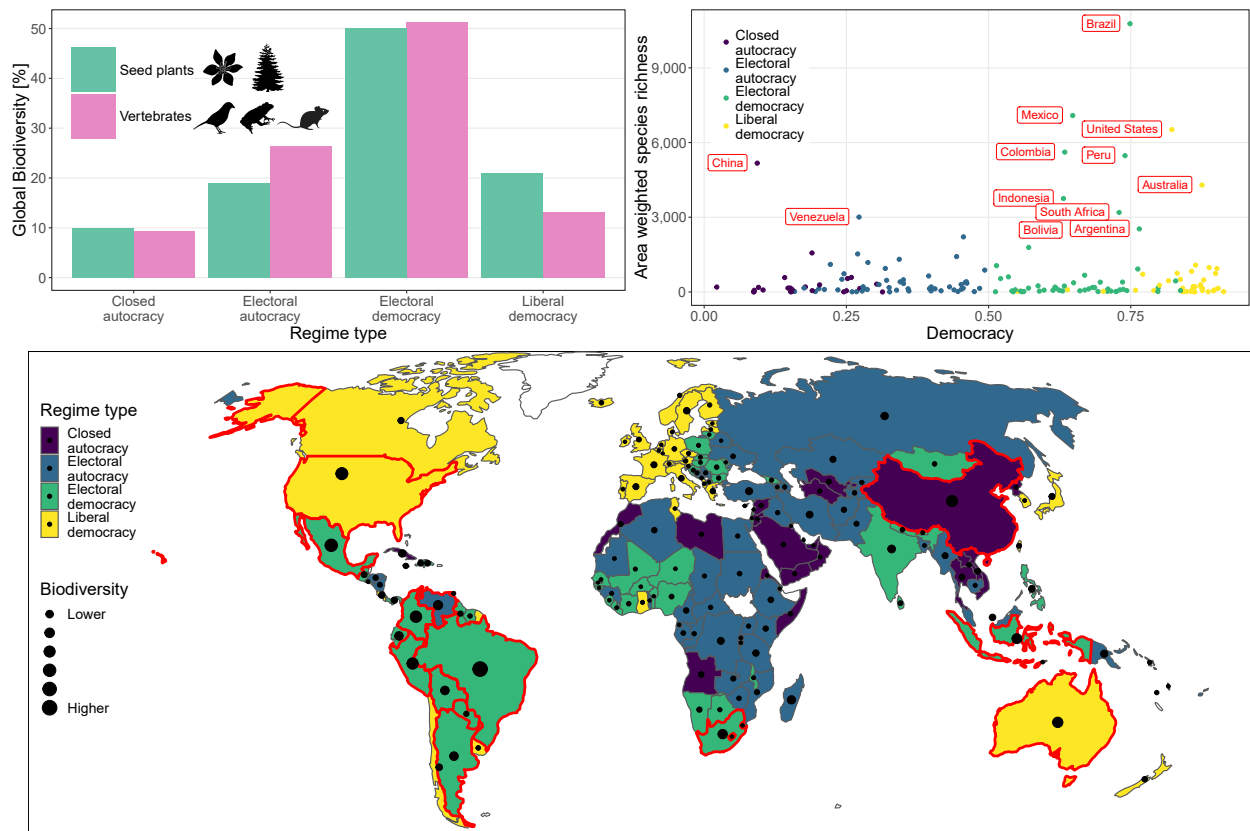
144 # Figures

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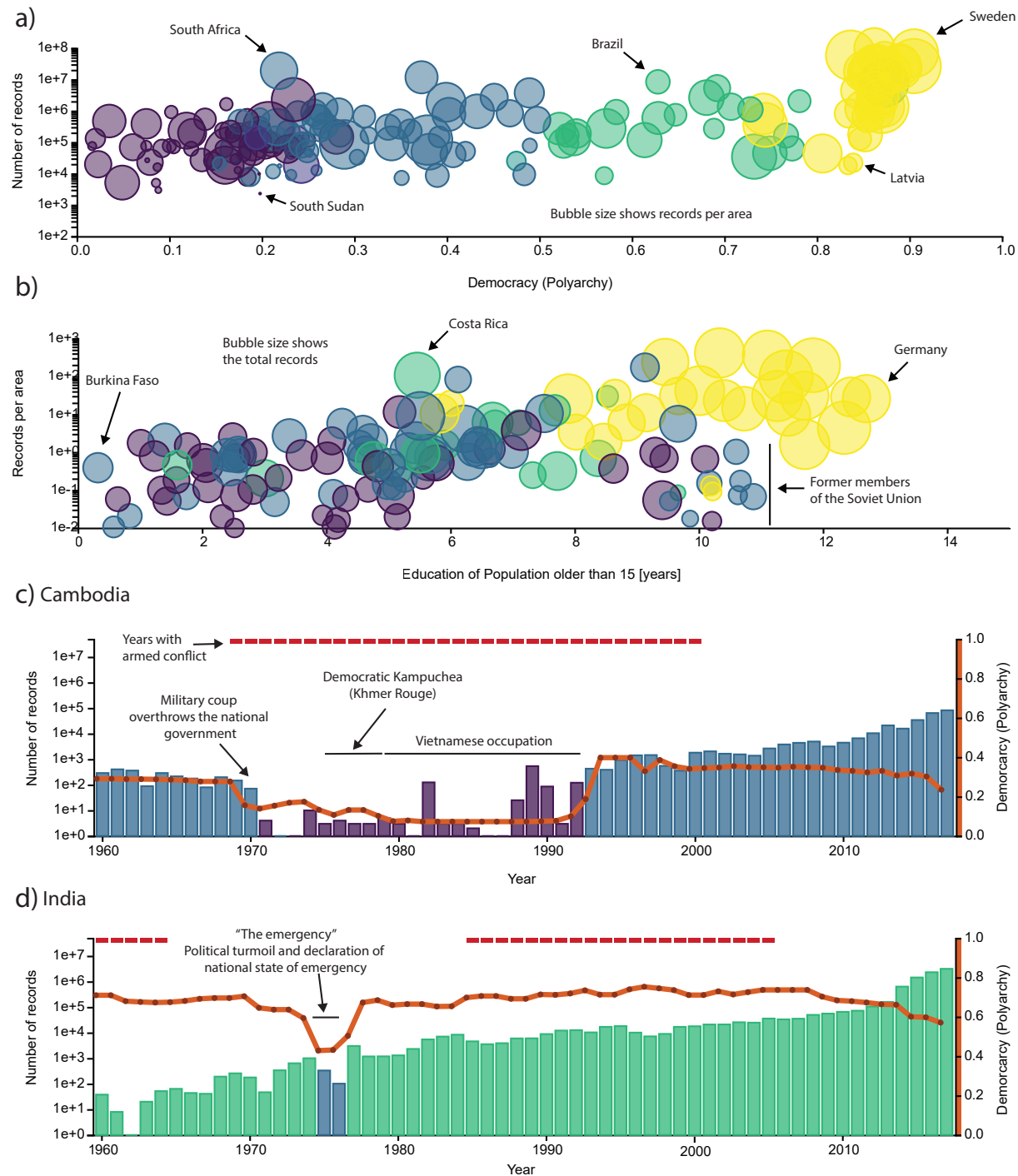
Figure 2: Biodiversity data availability correlates with the state of political systems through space and time. Colors indicates the regime type. **a)**. There is no clear correlation between democracy and amount of area protected, but liberal democracies have on average more records available per area.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

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