The New *Handbook of the Mammals of Europe*: Background and Introduction

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These are good times for mammalogy. New mammal species are constantly being described, and a renewed interest in taxonomy and biodiversity in general has resulted in a number of authoritative new book series on mammals, most notably the *Handbook of the Mammals of the World* (since 2009, e.g., Wilson and Mittermeier 2009) but also a new (first?) volume of the famous *Walker's Mammals of the World* (Nowak 2018). There are also continent-specific multivolume publications like the *Mammals of Africa* (Kingdon et al. 2013) and the *Mammals of South America* (so far two volumes: Gardner 2007; Patton et al. 2015), and it therefore seems timely to also tackle the task of an updated *Handbook of the Mammals of Europe*. The most comprehensive such series to date is the multivolume *Handbuch der Säugetiere Europas*. Its first volume was published in 1978 (Niethammer and Krapp 1978; Fig. 1) and the last, an overall index and bibliography, in 2005. None of the earlier volumes has ever been updated, and the fact that the whole series is in German makes it largely inaccessible to the vast majority within the European mammalogical community and beyond. This is exactly where the present book series comes in. We aim to present an updated account in English of every living mammal species in Europe. As some original research is still published in non-English journals, we provide an extensive and (near-)complete compilation of current knowledge about each mammal species in Europe.

The present introductory volume aims at setting the stage for the core volumes dealing with

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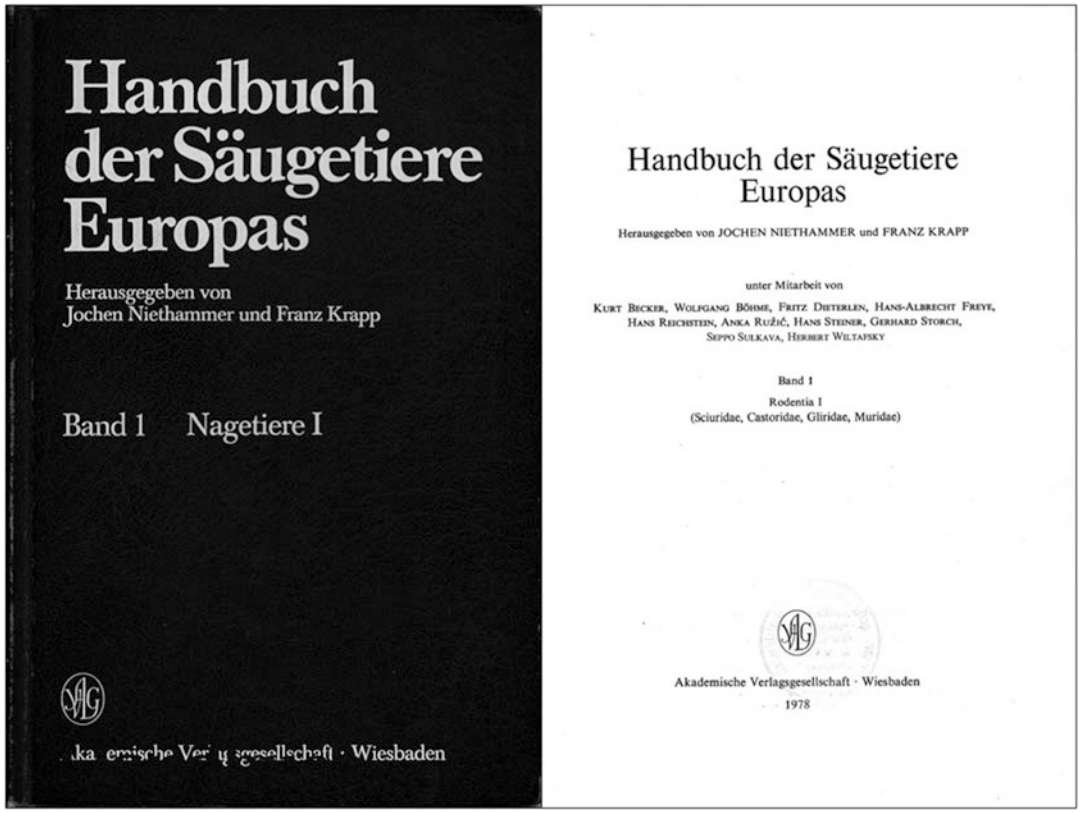

Fig. 1 Cover and title page of the first volume of the *Handbuch der Säugetiere Europas*, published in 1978. (Courtesy of Quelle & Meyer Verlag, 7 Oct 2019)

mammalian diversity in Europe at the species level. The selection of chapters in introductory volumes is often, perhaps by necessity, somewhat arbitrary, and we could have included other topics in addition to the ones dealt with here, for instance, reviews on diseases and zoonoses or cultural aspects of mammals throughout European history, i.e., their spiritual role in mythology and different societies, and their depiction in the arts from the awe-inspiring cave paintings by our ancestors to Rilke's poem *The Panther* and beyond. What we have decided on, apart from this extended preface, is five chapters that hopefully provide a framework and perspective for the species accounts in the remaining volumes.

Because geology, climate, and vegetation differ hugely across Europe, the contribution by Karl-Georg Bernhardt deals with the continent's different biogeographical regions, with a particular focus on vegetation ▶ Chap. 4, "Mammal Habitats in Europe: Geology, Vegetation, and Climate". This chapter serves as a reference and background for the information in the species accounts on habitat and distribution, especially for readers outside Europe.

Frank Zachos gives a brief summary and overview of the substantial progress made over the last 20 or so years with respect to mammalian phylogenetics ▶ Chap. 3, "Mammalian Phylogenetics: A Short Overview of Recent Advances". Although the whole taxon Mammalia is covered, including monotremes and marsupials, the focus is on placental mammals, in accordance with the extant European mammal fauna. Today, mammals in Europe belong to a limited number of higher taxa ("orders") – rodents, lagomorphs, a single

(nonhuman) primate species, eulipotyphlans (i.e., what is left of the former "Insectivora"), bats, carnivorans, and cetartiodactyls including whales and dolphins. In the past, however, a number of groups today perceived as exotic also occurred in Europe, among them proboscideans (most famously, the woolly mammoth), great apes, pangolins, and even marsupials. A wider phylogenetic perspective therefore seemed appropriate.

The less distant past of mammalian faunas is covered by Robert Sommer's chapter on the Late Quaternary history of mammals in Europe (▶ Chap. 5, "Late Pleistocene and Holocene History of Mammals in Europe"). The cyclic climate changes brought about by glacial and interglacial periods have had a deep impact on the biogeography of mammals and other taxa, and any present distribution and composition will always be the result of past processes.

In addition to the history of mammals themselves, there is another chapter, by Rainer Hutterer and Boris Kryštufek, on the history of research on mammals in Europe. Mammals, even European ones, include many iconic and emblematic species such as European bison (*Bison bonasus*), red deer (*Cervus elaphus*), wolves (*Canis lupus*), or whales, and apart from birds, there are few other animal groups that have fascinated humans as much as mammals have. Accordingly, there is a long tradition of mammal research in Europe and a large number of mammalogical societies and publications (including journals), a brief overview of which is presented in ▶ Chap. 2, "A History of Mammal Research in Europe" by Hutterer and Kryštufek.

Finally, since globally about one in four (perhaps even one in three) mammal species is threatened with extinction and more than half of the world's mammals are declining (Schipper et al. 2008; see also Turvey 2018), conservation and sustainable use of mammals is key to their survival. On the other hand, conflict species including aliens are controlled to reduce ecological or economic damage. Klaus Hackländer and Arie Trouwborst provide an introduction to policies, laws, and strategies pertaining to the management of mammals in Europe, focusing in particular on the pan-European Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention of 1979) and the wildlife legislation of the European Union ▶ Chap. 6, "Management of European Mammals".

The *Handbook* at large mainly consists of species entries, combined into volumes covering larger taxonomic groups such that, including the present introduction volume, the content looks like this:

1. Mammals of Europe – Past, Present, and Future
2. Primates and Lagomorpha
3. Rodentia
4. Eulipotyphla
5. Chiroptera
6. Carnivora
7. Terrestrial Cetartiodactyla
8. Cetacea

Some of these will perhaps comprise more than one tome. The list of volumes follows phylogenetic relationships within mammals but also makes compromises: (1) the single European primate species, the Barbary macaque (*Macaca sylvanus*), is combined with the lagomorphs on account of their both being part of the larger taxon Euarchontoglires. (2) Although it is now well-established that Cetacea (whales and dolphins) are nested within artiodactyl ungulates – hence the name Cetartiodactyla for the taxon combining both – and even that they are phylogenetically closer to the ruminant clade than are the pigs, we still divide the Cetartiodactyla into a terrestrial and an aquatic group. We are aware that the terrestrial cetartiodactyls are paraphyletic, but there has been a long research tradition to study cetaceans separately from their terrestrial relatives, and many issues pertaining to the European ruminant species (Cervidae and Bovidae) will also be relevant to the wild boar but not whales and dolphins.

In line with other handbooks and reference works, we have decided on a standardized chapter structure with (largely) fixed subheadings to

enable direct comparisons between different species. Of course, some species have been studied in much more detail than others, but differences in content and depth among species when it comes to, say, the Life history or the Genetics sections ideally reflect the real differences in our knowledge. Still, in some cases, there are deviations from the strict standardized framework. In the cetacean volume, for example, a slightly modified chapter structure has been adopted in line with the very different research circumstances pertaining to whales and dolphins. For instance, the Genetics section has been combined with information on abundance into a section called Populations. Also, there is a single chapter on rare, vagrant, and extinct cetaceans rather than a chapter for each such species.

In the case of introduced mammal species that have very limited distribution ranges in Europe (e.g., axis deer (*Axis axis*) or Reeves's muntjac (*Muntiacus reevesi*)), the chapters are not only short but may also deviate slightly from the structure found for other species entries. The case of feral domestic taxa is also quite complex at times. In general, we have decided against including chapters on feral cats or horses. In some cases, however, it is not so easy to decide whether we are dealing with ancient feral domestic or truly wild taxa. We followed most authors in treating wild sheep and goats as at least potentially wild European mammal species.

Geographic Delimitation

Europe as a continent is obviously a political construct. From a geographic point of view, it is a rather arbitrary entity and quite simply the westernmost part of Eurasia. Therefore, the spatial delimitation of the region covered by a handbook such as ours is not straightforward, and there are different ways in which Europe can be defined spatially. Following the approach adopted by the National Geographic Society, we consider as Europe's western and southern boundaries the Ural Mountains, the Caucasus Mountains, and the Bosphorus, respectively. We also include Cyprus, the Canary Islands, Madeira, and the Azores as well as other islands that belong to a European country's European territory (e.g., Svalbard in the case of Norway). In contrast to the distribution maps of *The Atlas of European Mammals* (Mitchell-Jones et al. 1999), we therefore include countries like Belarus, Ukraine, parts of Russia (including Novaya Zemlya and Franz Joseph Land), and Moldova (the revised Atlas, to be published in 2024, will also include the eastern European countries). However, we do not take overseas departments and regions of France (French Guiana, Guadeloupe, Martinique, Mayotte, and Réunion) or British Overseas Territories (Bermuda, Cayman Islands, Falkland Islands, etc.) into consideration, with the exception of Gibraltar due to its location on the Iberian Peninsula. Different maps of Europe in mammal publications and identification guides might be confusing, but as mentioned above, Europe is a political construct and not a biogeographic continent. The boundaries of Europe as defined for the purpose of the present *Handbook* can be seen in the map in Fig. 2.

A related issue is which species should be included in a handbook of *European* mammals. When it comes to whales, which are able to cross whole ocean basins, there is inevitably some level of arbitrariness (and there will be a chapter on rare and vagrant species, see above), but the ranges of a number of Asian species also extend into the margins of what we have defined as Europe. We have decided not to include primarily Asian mammals (e.g., the saiga antelope, *Saiga tatarica*). Nor did we include chapters on extinct species such as lions (*Panthera leo*) (but extinct cetaceans will be briefly covered together with the rare and vagrant species). In the case of roe deer, we only cover the European species (*Capreolus capreolus*), while the Siberian roe deer (*C. pygargus*) is only briefly mentioned in the *C. capreolus* chapter where relevant.

Taxonomic Approach

A handbook of all species of a region de facto includes a taxonomic list of that region. As every biologist knows, there are different such lists

Fig. 2 Europe (in white) as defined in the present *Handbook of the Mammals of Europe*

available for a given region that are accepted by different taxonomists from different taxonomic schools of classification. Therefore, any decision on species delimitation will necessarily be appreciated by some and criticized by others. Mammals have occupied center stage in recent debates on species concepts and species delimitation, and there have been many recent publications that deal with the underlying theory and its application in taxonomic practice (e.g., Frankham et al. 2012; Groves 2013; Heller et al. 2013; Zachos et al. 2013; Zachos 2018; Gippoliti 2019, and references therein). We will not discuss these issues at length or repeat the major arguments in favor of more or less inclusive species concepts. Rather, we would like to emphasize that species delimitation necessarily contains an element of arbitrariness – where

exactly one draws the line between two population-level lineages needs an executive decision as well as it does good scientific data and hypotheses (Zachos 2016). Biodiversity and its variability are real and can be measured, but they come in degrees, and the translation of real data into names is necessarily arbitrary to some extent. Taxonomy is a discrete binary classification system (one or two species) imposed on a continuous process (evolution), and there can never be a perfect match and certainly not a perfectly objective one either. There are many mammal species in Europe that have been lumped or split, re-lumped, or re-split. We and the volume editors had to make a decision as to which taxa are granted species rank in our *Handbook* and which are not. Are the *musculus* and *domesticus* taxa of the house mouse (*Mus musculus*) subspecies or species? If we followed a strict phylogenetic species concept based on diagnosability (which we don't), even red deer in Europe would comprise several different species, not subspecies (in addition to *Cervus elaphus* there would, at least, also be *C. pannonensis*, *C. corsicanus*, and *C. italicus*). Other formerly more inclusive species are now usually classified as different species, among them different *Myotis* and *Pipistrellus* species. Other cases in which hitherto unknown ("cryptic") diversity has recently been uncovered have not been settled by the taxonomic community (e.g., the hazel dormouse *Muscardinus avellanarius*; see Mouton et al. 2017). In any case, a handbook is not the place for detailed taxonomic discussions or even revisions, and volume editors and authors have some level of liberty in their taxonomic treatments. This is why complete consistency among volumes will probably not be reached, which should be considered a reminder of inherent problems in taxonomy due to fuzzy boundaries in nature. However, taxonomic traditions also have practical ramifications in that for some taxa that are now considered different species a large part of the literature does not necessarily distinguish between them, making it difficult to treat them in separate chapters. This is, for example, the reason why the two chamois species (*Rupicapra rupicapra* and *R. pyrenaica*) are combined into a single entry with subsections. Alpine and Iberian ibex (*Capra ibex* and *C. pyrenaica*), on the other hand, have a more separate research history and are therefore given completely separate chapters.

Springer Reference Benefits

A major drawback of the *Handbuch der Säugetiere Europas* has already been mentioned above: language barriers. In present times an important factor in science is accessibility. In line with this, open-access journals emerge everywhere allowing academics and students to gather knowledge as easily as never before (even if keeping a clear view gets more difficult). Through Springer Reference, our *Handbook* provides online access as well. Mammal researchers, libraries or universities might purchase the printed series or single volumes. In addition, all volumes are available in digital form, and single volumes or species chapters are accessible via university libraries or other institutions. Moreover, the online system allows for a permanent process of updating and revising chapters as necessary, without publishing a revised edition of a whole volume. Our *Handbook* therefore provides a living source of knowledge on European mammals without major language barriers but with easy accessibility. We are grateful to the vast number of colleagues sharing their expertise in this project and thank Springer Nature Publishers for their trust, patience, and professional editorial work.

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