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Aims and Scope

The Monographiae Biologicae provide a forum for top-level, rounded-off monographs dealing with the biogeography of continents or major parts of continents, and the ecology of well individualized ecosystems such as islands, island groups, mountains or mountain chains. Aquatic ecosystems may include marine environments such as coastal ecosystems (mangroves, coral reefs) but also pelagic, abyssal and benthic ecosystems, and freshwater environments such as major river basins, lakes, and groups of lakes. In-depth, state-of-the-art taxonomic treatments of major groups of animals (including protists), plants and fungi are also elegible for publication, as well as studies on the comparative ecology of major biomes. Volumes in the series may include single-author monographs, but also multi-author, edited volumes.

The titles published in this series are listed at the end of this volume.

Biogeography and Ecology of Bulgaria

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Captions to Cover Photos

Front Cover: Central Balkan National Park. Northern Djendem Reserve near Botev Peak. Photo: Georgi Stoyanov.

Rear Cover 1: *Onconotus servillei* (Orthoptera: Tettigoniidae). One of the most typical steppe animals from Northeastern Bulgaria. Included in the IUCN Red List of Threatened Species as "Vulnerable". Photo: Nikolay Simov and Dragan Chobanov.

Rear Cover 2: *Paralola buresi* (Opiliones: Phalangodidae). This 1.4 mm-long harvestman is one of the most remarkable animals in Bulgaria. The sole species of the local endemic monotypic genus, this troglobite Tertiary relict is found only in four caves near Lakatnik (Iskar Gorge, Western Stara Planina). Photo: Plamen Mitov and Ivan Yanchev.

Rear Cover 3: *Zamenis situla*, or Leopard Snake (Ophidia: Colubridae). Eastern Mediterranean species found in southern Bulgaria (Struma Valley, Black Sea Coast). Extinct in the Rhodopes. Photo: Boyan Petrov.

This book is dedicated to the memory of Dr. Ivan Buresch (1885–1980), Member of the Bulgarian Academy of Sciences, the founder of Bulgarian biodiversity studies.

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Notes from the Editors

Transliteration

When books or articles about Bulgaria are published in foreign languages, there is always a problem with spelling of geographical and proper names. This problem comes from the difference in alphabets. The Cyrillic alphabet was created in Bulgaria by St. Cyril and St. Methodius in 9th century A.D., and was adopted by a number of other Slavic languages. After Bulgaria's acceptance into European Union, the Cyrillic alphabet becomes the third (after Latin and Greek) official alphabet of EU. On this occasion, the Bulgarian Government plans to introduce official transliteration rules from Bulgarian to English, which will become mandatory.

Such attempts have been made in the past. During the Communist regime, the mandatory transliteration system of Bulgarian texts existed regardless of the target language. In this system, each Cyrillic character corresponded to a character of the Latin alphabet. Such principle, however, proved to be impractical since a number of diacritic characters had to be used. Thus, even when made mandatory within Bulgaria, this transliteration system was ignored by many Bulgarian zoologists when they published abroad. In the early 1990s, after the demise of the repressive regime and with broadened use of English, this transliteration system becomes defunct. At the same time, for uniformity of transliteration, certain rules have to be adopted.

In this book, the editors adopted the following rules of transliteration from Bulgarian to English.

Cyrillic	Latin	Cyrillic	Latin
а	a	п	p
б	b	р	r
в	v	с	s
г	g	т	t
д	d	у	u
е	e	ф	f
ж, дж	zh, dj	х	h
з	z	ц	ts
и	i	ч	ch
й	i	ш	sh
к	k	щ	sht
л	l	ъ	a
м	m	ь	y
н	n	ю	yu
о	o	я	ya

Of 30 characters of the Bulgarian Cyrillic aphabet, exactly one half (15) are transliterated identically in all existing systems, while others may have alternative possible transliterations. Among these alternatively transliterated characters, only in four cases we deviate from the system that is most commonly (but not always) used in Bulgaria:

дж = dj instead of **dzh**, e.g. Strandja Mts., not Strandzha Mts.;
й = i instead of **y**, e.g. Aitos, not Aytos;
y = u instead of **ou**, e.g. Uzundjovo, not Ouzoundzhovo;
ъ = a instead of **u**, e.g. Petar, not Petur.

The transliteration system adopted here has two benefits and two drawbacks. It benefits from simplified spelling and from being closer to actual pronunciation. Its first drawback is impossibility of reverse transliteration (from Latin to Cyrillic alphabet) in two cases: the Latin **i** is used for both Bulgarian **и** and **й** (these two sounds are almost identical); and the Latin **a** is used for both Bulgarian **а** and **ъ** (these sounds are close). A commonly used transliteration system also has one such drawback, when the Latin **y** is used for both Bulgarian **й** and **ь**. The second drawback is that the modern reference literature such as maps, atlases, and encyclopedias often transliterate Bulgarian **y** as **ou**, and Bulgarian **ъ** as **u**. At the same time, in many cases the reference literature uses the transliteration system adopted here.

This transliteration system was used for geographic names as well as for the titles of books and journals. In case of Russian names we used Russian transliteration rules, e.g. Russian **x = kh**; but we do not use **e = ye**.

Geographic Names

Some explanations are due on the spelling and translation of geographic names. The major latitudinal mountain range, which divides Bulgaria into its northern and southern parts, is called alternatively either Stara Planina (a Bulgarian name, meaning "the Old Mountain"), or Balkan (a Turkish name, meaning "a mountain area" in general). In this book, only Stara Planina name is used to avoid a confusion between the Balkan Mountains and English terms related to the Balkan Peninsula (such as "the Balkans", "West Balkans" etc.) and corresponding geographic ranges of taxa. For another major mountain range we used "the Rhodopes" instead of spellings Rodope, Rhodope, Rodopi, or Rhodopi, all of which can be found in literature. The adjective names of mountain ranges are translated as nouns with addition of "Mts.", e.g. Bulgarian name Maleshevska Planina is translated Maleshevska Mts. In cases when one mountain range in Bulgarian has alternative names (e.g. Osogovska Planina and Osogovo), we use the noun (Osogovo Mts.) although the adjective variant is more commonly used in Bulgaria. The traditional English spelling with "ia" is adopted for the names Bulgaria and Sofia, but in all other cases "ia" is transliterated as "iya", e.g. Kamchiya (not Kamchia) River.

Authors' Names

Regarding proper names of the authors we adopted the following principles of transliteration:

1. For those Bulgarian authors who have published their works in foreign languages using Latin alphabet (usually German, French, or English), we used transliteration traditionally adopted by these authors, e.g. I. Buresch; V. Guéorguiev, Christo Deltshev. This is why similar and even identical Bulgarian names sometimes have different transliteration, e.g. V. Beschovski and V. Golemansky; Vasil Popov and Vassil Golemansky.
2. For those Bulgarian authors whose names were transliterated *differently* in different publications, we used the most common transliteration; in the case of variable original transliteration, the most common variant was given in square brackets, e.g. [Peshev, G.] Peschev, G. This was necessary in order to bring together all works of the same author in the alphabetized reference list (e.g. spelled Cvetkov and Zvetkov) as well as in chronological order. In some curious cases, there are many alternative transliterations of the same author's name, e.g. Georgi Peshev was also transliterated as Pechev, Péchev, Pešev, and Peschev.
3. For those Bulgarian authors (usually the old ones) who published only in Bulgarian, we used the transliteration of their name given in the foreign-language summary; in case this was lacking, we used the closest possible transliteration. We did not use the spelling given in the foreign-language translation of journal's table of contents since it was usually arbitrary and often incorrect. Thus, it is possible that in different chapters of our book the same author's name is spelled differently (e.g. Jurinich, Jurinitch, or Iurinitsh) but the spelling is uniform within each chapter.

References

The information on books, book chapters, and journal articles written in Cyrillic alphabet is given in References according to the following rules. The obvious goal of this rather elaborate transliteration scheme is to facilitate bibliographic search for the titles of Bulgarian or Russian books and journals. The principles of authors' names spelling are described above.

Journal articles. The translated article title is taken from the foreign-language summary, if available, regardless of its language (usually German, French, or English). If such a summary is lacking, the title is translated to English without capitalized words. In both cases, translated title is given in square brackets to emphasize that it is not an original title. Journal titles are transliterated in Latin characters according to the transliteration rules described above. If translation of the journal title is present on the cover or title page, it is placed in parentheses after the transliterated title. If such a translation is lacking, the journal title is

translated to English (with capitalized words) and placed in square brackets after the transliterated title. In rare cases when a translation of a journal title is given in two or three foreign languages using Latin characters, all translations are listed in parentheses consequently. The place of publication is placed in parentheses only when the translated title coincides with another existing journal, e.g. *Priroda* [*Nature*] (Sofia); *Ekologiya* (*Ecology*) (Sofia). All journal titles are given in full, non-abbreviated form.

Books (including dissertations). Book titles are transliterated in Latin characters, and followed by its translation. If translation of the book title is present on the cover or title page, it is placed in parentheses after the transliterated title. If such a translation is lacking, the book title is translated to English (with capitalized words) and placed in square brackets after the transliterated title. The title is followed by the publishers name and the place of publication. The publishers name is transliterated in Latin characters, and is followed by its translation in parentheses (if translated by the publishers) or square brackets (if translated by the editors of this book).

Book chapters. The title of the chapter is translated as for journal articles. The title and publishers of the book are translated as for books. Editor(s) are given except those cases when the book was edited by an editorial board rather than specific editor(s).

Zoogeographical Terminology

In addition to commonly accepted and frequently used zoogeographical categories, this book introduces a number of new terms, in some cases quite complex ones. This compelled us to formulate the following rules for construction and spelling of these terms in English.

1. A single word (no hyphenation) is used for those zoogeographical categories, which:
   (a) contain one geographic name, e.g. European, Pontian;
   (b) are derived from (a) via prefixes, e.g. Holomediterranean, Subboreal, Transpalearctic;
   (c) contain two unequal components, e.g. Pontomediterranean (which refers to the taxa from the Pontian part of the Mediterranean Subregion but not to the taxa from both Pontian and Mediterranean areas; those would be called Pontian–Mediterranean; see below);
   (d) are commonly used in the literature as a single word, but are derived from two geographic terms, e.g. Eurosiberian, Oreotundral, arctoalpine distribution.
2. Two separate words (no hyphenation) are used for those zoogeographical categories, which contain a single geographic term with a place adjective, e.g. Central European, Western Palearctic.
3. Two or more words or their combinations hyphenated (connected) by *en dash* (*not* hyphen) are used for those zoogeographical categories, which contain two or more geographic terms but are not commonly used in the literature. In this

case, the connected components can either be single words, e.g. Turanian–Mediterranean, Afrotropical–Palearctic, Macedonian–Rila–Rhodopean; or can also contain two separate words, e.g. European–Western Asian, Southeast European–Anatolian, North Mediterranean–Central Asian, Pontian–Caspian–Southeast European. *En dash* is also used in this book to designate value ranges (e.g. 100–200 m), year ranges, and page ranges.

4. Note that we do *not* use *hyphen* anywhere in geographic terminology, as opposed to the common practice of using hyphen to connect parts of adjectives, e.g. we use Southeastern but not South-Eastern.

The following example clarifies the necessity and significance of such elaborate conventions. In the present book, the term "Atlantic–Mediterranean" is used for marine species distributed in the Atlantic Ocean and Mediterranean Sea, while the term "Atlantomediterranean" is applied to terrestrial species distributed in Atlantic (Iberian) part of the Mediterranean Subregion.

The above mentioned rules were applied to any zoogeographical terminology independent of author's specific scheme of classification; it was not our goal to create standard or uniform zoogeographical classifications, but only to provide uniform spelling. In six chapters of this book, the authors use, or comment upon, the popular classification of zoogeographical chorotypes in the Western Palearctic introduced (in English) by Vigna Taglianti et al. (1999, *Biogeographia*, 20:31–59). Without discussing this scheme, we need to comment here that some of the proposed chorotype names were not formed correctly as English words, e.g. Sibero–European, Centralasiatic–Europeo–Mediterranean, Turano–Europeo–Mediterranean. Such names were changed in this book to make them appear more natural in English.

1 Introduction

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Europe grades to Asia through the Balkans. They act as a connecting corridor, a liberal barrier, and a mediating buffer. On top of this, humans with their several millennia of Balkan tenure have changed the biota here. Many creatures perished; others still fight back, meeting the anthropogenic challenge and coexistence with humans. A combination of geological factors, high mountains and river valleys, glacial processes, extensive karst regions with caves, forests and sea coast, as well as incessant human activity, made the Balkan Peninsula one of the two—along with the Iberian Peninsula—most interesting biogeographic regions in Europe. Biogeography, and specifically zoogeography, of the Balkans presents a fascinating reading for any specialist.

The interest in the Balkan biodiversity grew steadily during the last hundred years; its patterns and processes have been recently reviewed in an important volume (Griffiths et al., 2004). The authors of this volume addressed the Balkan Peninsula as "the great European hotspot" of biodiversity. As they commented, "The extremely high level of endemism in the Balkans compared to other parts of Europe is perhaps the most striking element of comparative pattern of biodiversity. …The Balkans offer great potential at European scale for conserving the "last untouched" wilderness on the continent". These authors concluded, however, that "in many respects, we are far from achieving the goal of understanding pattern and process in Balkan biodiversity" (Griffiths et al., 2004).

Through a variety of geographical, historical, and cultural circumstances, Bulgaria is currently the best-studied of all countries in the Balkan Peninsula in regard of its biodiversity. Intensive research in this area started in Bulgaria immediately after this country's independence was restored in 1878. To study and preserve the rich nature and natural resources was an organic part of the young nation's patriotism, much as the study of its ethnographic, historical, and archeological heritage.

By the end of the 19th–beginning of the 20th century, already the best European expertise has been summoned to survey the still largely undisturbed Balkan landscapes of Bulgaria. The Royal (now National) Museum of Natural History, founded as early as in 1889, the oldest and the richest museum of this kind in the Balkans, served as a major focus of biodiversity research (Buresch, 1928; Atanasov, 1955; Popov, 1989), especially in the field of entomology

V. Fet and A. Popov (Eds.), Biogeography and Ecology of Bulgaria, 1–8.

(Buresch, 1924; Drenski, 1931). Another important center of such studies was the Physical-mathematical Faculty of the St. Kliment Ohridski University of Sofia. Studies of species diversity of the Black Sea commenced at the Marine Biological Station in Varna (Paspalew, 1933).

Numerous contributions and reviews on various taxonomic groups have been published in several professional Bulgarian journals: *Travaux de la Société bulgare des sciences naturelles* [*Trudove na Balgarskoto prirodoizpitatelno druzhestvo*], 18 volumes, 1900–1939; *Annuaire de l'Université de Sofia "St. Kliment Ohridski"* [*Godishnik na Sofiiskiya universitet "Sv. Kliment Ohridski"*], 95 volumes, since 1905; *Mitteilungen der Bulgarischen Entomologischen Gesellschaft in Sofia* [*Izvestiya na Balgarskoto entomologichno druzhestvo*], 12 volumes, 1924–1942; *Mitteilungen aus den Königlichen naturwissenschaftlichen Instituten in Sofia – Bulgarien* [*Izvestiya na Tsarskite prirodonauchni instituti v Sofia*], 16 volumes, 1928–1943 (Buresch, 1942).

It will be prudent to state that even under the repressive Communist regime of 1944–1989, which did not allow unrestricted exchange of ideas and specialists between Bulgaria and free Europe, a considerable effort and progress has been invested in biodiversity studies. Several generations of Bulgarian scientists with a great amount of expertise in taxonomy, systematics, biogeography, and ecology of various groups of organisms labored to amass the extensive knowledge (Popov, 1991; Golemansky, 1997). These studies have been conducted by the Institute of Zoology, Institute of Botany and National Museum of Natural History, all created in the Bulgarian Academy of Sciences on the basis of the former Royal Museum, as well as by biological faculties of the University of Sofia and Paisii Hilendarski University of Plovdiv, and by the Institute of Oceanology in Varna. The first Bulgarian natural history journals were followed by new periodicals: *Bulletin de l'Institut botanique* [*Izvestiya na Botanicheskiya institut*], 25 volumes, 1950–1974; *Bulletin de l'Institut de zoologie et musée* [*Izvestiya na Zoologicheskiya institut s muzei*], 41 volumes, 1951–1974; *Acta zoologica bulgarica*, 58 volumes, since 1975; *Ecology* [*Ecologiya*], 26 volumes, 1975–1994; *Hydrobiology* [*Hidrobiologiya*], 40 volumes, 1975–1996; *Fitologija*, 48 volumes, 1975–1996; *Phytologia Balcanica*, 12 volumes, since 1995; and *Historia naturalis bulgarica*, 17 volumes, since 1989 (Popov, 2000).

The Bulgarian science was also lucky to rely on the expertise of Soviet specialists, some of whom still preserved the brilliant academic traditions of the pre-1917 Russian school of zoology and botany. Similar expertise was drawn in 1950s–1980s from Eastern Europe; the specialists from Czechoslovakia, Poland, or East Germany took part in the surveys of this rich southeastern end of Europe. In addition, many Western European experts have always been keenly interested to bring together the pieces of the biogeographic and ecological puzzle which is the Balkan Peninsula.

Since 1989, many changes have occurred in the structure and practice of the Bulgarian academic research. With the collapse of the old socialist system, the state budgets designated for basic research, field expeditions, and purchase of modern research equipment decreased heavily. The number of personnel employed by basic

research institutions was not steadily increasing anymore, which was the case during previous decades. The researcher's job ceased to be prestigious due to low salaries.

On the other hand, new opportunities have been emerging. Free research exchange became quite common, and possibilities to visit similar research institutions in Western Europe and North America increased significantly due to unrestricted access to foreign and international grant competition. The financial support by foreign governments and NGO allows maintaining activities in biodiversity conservation throughout Bulgaria, including those in protected territories.

As a result of these studies, several research initiatives have been recently designed and implemented: National Biological Diversity Conservation Strategy (Meine, 1998), with a special attention to endemic, relict, and rare species; CORINE Biotopes in Bulgaria; Biodiversity of Central Balkan and Rila National Parks (Sakalian, 2000a, 2000b; Popov & Meshinev, 2000); studies of biodiversity of some water bodies (Michev et al., 1998; Golemansky & Naidenov, 1998, 2000) and almost all nature parks. Currently, the research efforts are focused on creation of NATURA 2000 network in Bulgaria.

Still keep their importance, as milestones for the studies of Bulgarian biodiversity, the volumes of several ongoing periodical series: *Fauna bulgarica* [*Fauna na Balgariya*] (27 volumes, since 1950); *Flora Reipublicae Bulgaricae* [*Flora na Republika Balgariya*] (10 volumes, since 1963); and *Catalogus faunae bulgaricae* (five volumes, since 1992).

Another relevant development that has to be mentioned is the emergence of Pensoft, the new publishing house headed by Dr. Lyubomir Penev. In a very short time since the 1990s, Pensoft became the leading publisher of natural science books in Eastern Europe. While its production of research literature is very diverse, the favorite subject of Pensoft is biodiversity. It produced many splendidly published monographs on various systematic groups from all over the world, as well as periodical series, monographs, and reviews focused on Bulgarian biota. In addition to the abovementioned series, of which most are published by Pensoft, we need to mention two new series of this publishing house: *Zoocartographia Balcanica* (two volumes, since 2001) and *Biodiversity of Bulgaria* (together with National Museum of Natural History, two volumes, since 2001). The first volume of the latter (Beron, 2001) inaugurated an ambitious idea of regional surveys of the major natural and significant for conservation regions of Bulgaria, and is the first such project in the Balkan Peninsula. The second volume (Beron & Popov, 2004), is devoted to Eastern Rhodopes, and contains information on 4329 species of animals and 1962 species of vascular plants.

The most recent review of Bulgarian biodiversity (Petrova, 2005) addresses the current state of knowledge on animals, plants, fungi, and protists. Also, the second edition of the "Red Book of Bulgaria" is being prepared, which for the first time, along with vascular plants and vertebrates, will include bryophytes, fungi, and invertebrates, as well as habitats.

As Bulgaria is now heading for the admission to the European Union, new challenges present themselves. Not only academic biodiversity knowledge has to be conveniently assessed in modern databases, available at a click for anybody anywhere in the world, rendered in an inevitable *lingua franca* of English language. Further, the biodiversity data are of course inseparable from conservation policies, legislation, and its implementation in upcoming environmental surveys and assessments. Among others, the United Nations Development Program (UNDP), United States Agency of International Development (USAID), Bulgarian–Swiss Biodiversity Conservation Program (BSBCP), Regional Ecological Center for Southeastern Europe in Budapest (REC), and Bulgarian–French Foundation Le Balkan have been working in Bulgaria for years now, heavily relying on available local expertise, in order to help to determine and address priorities addressing biodiversity. An important role of mediators between these organizations and Bulgarian research community has been played by such NGOs as Bulgarian Society for Protection of Birds (BSPB), Wilderness Fund, and Green Balkans.

The total number of animal species currently recorded in Bulgaria is approximately 29,850. This figure results from combining the data of Hubenov (1996) on all animal groups, with the most recent data summarized in Petrova (2005); the latter, however, did not include several groups. Insects, at 20,574 species (Hubenov, 2005), comprise 69% of the fauna. Vertebrates include 792 species (2.7% of all animal species); however, this number includes all bird species recorded in Bulgaria even if they are occasional visitors. These data can be compared to the information from the *Fauna Europaea* project on animal species diversity in Europe (excluding all marine taxa and Protista). The number of species of terrestrial and freshwater animals (without protozoans) in Bulgaria is 26,655, which is 21% of ca. 130,000 animal species recorded in Europe. Since many animal groups are still to be investigated, the projected number of animal species for Bulgaria is ca. 56,000, with ca. 40,000 of insects (Hubenov, 1996).

The biodiversity census for Bulgaria can be further complemented by the data on non-animal taxa summarized in Petrova (2005). There are ca. 3840 species of seed plants, 60 species of pteridophytes, 719 species of bryophytes, 3063 species of algae (including Cyanoprokaryota), and ca. 4900 species of fungi. In total, Bulgarian biota includes ca. 42,400 identified species.

Due to the geographic location of Bulgaria and historical events that led to the formation of its fauna, one can observe two major, separate zoogeographical complexes: the northern complex of cold-tolerant species, and the southern complex of thermophilic species. Josifov (1988) named these two complexes, correspondingly, Eurosiberian and Mediterranean. These have been subdivided by Gruev & Kuzmanov (1994) into six complexes with 15 types of faunal elements. A varied combination of Siberian and Central European faunal elements on the one hand, and Mediterranean faunal elements on the other, expected for this transitional corner of Europe, correspond to two major zoogeographic complexes, and embrace majority of species in Bulgarian fauna and flora. They are often supplemented by a limited number of steppe elements in Northeastern Bulgaria; Anatolian and

Iranian (Iranian–Turanian) migrants in the southeastern part of this country; Pontian (Euxinian) species in Eastern Bulgaria, etc. A small but distinct group of species has a disjunctive Arctoalpine distribution (56 species according to Beron, 1969). Among the Mediterranean faunal elements, nearly all species are Holomediterranean and Pontomediterranean. In addition, Bulgarian fauna includes a large number of endemics. These are mainly arthropod species and subspecies, but a few endemic genera are also known. Two major groups of relicts are distinguished: preglacial (Tertiary) and glacial (Quaternary) relicts.

The ideas on zoogeographical subdivision of Bulgaria have been developed by several authors. Drenski (1946) correlated his division with that of the neighboring territories of the Balkan Peninsula. Buresch & Popov (1973) based their division on ecological-zoogeographical concepts. Guéorguiev (1982) reduced the number of regions and did not correlate with territories outside Bulgaria. Finally, Gruev (1988) based his subdivision scheme on general biogeographical principles. Current phytogeographical subdivision of Bulgaria includes 29 floristic regions and subregions (Assyov et al., 2002).

The current volume does not by any means embrace or even review all existing knowledge on Bulgarian biodiversity. However, animal groups selected for this volume's surveys are those presenting some of the best case studies in biogeography. Our goal was to address in detail the issues and interpretations concerning Bulgarian fauna and zoogeography. Some groups such as vertebrates are necessarily much better studied literally by the generations of academic researchers. This allows for in-depth analysis of distribution along ecological gradients of mammals (V. Popov) and birds (Boev, Milchev & V. Popov) as well as for the reviews of the Bulgarian herpetofauna (Petrov) and ichthyofauna (Stefanov).

Invertebrates, as always, present a mosaic of well-known and less-known groups, and a challenge of choice. Traditional, large insect groups of ground beetles (Guéorguiev) and Orthoptera (A. Popov) provide a broad-stroke approach to endemism and biogeographic trends, as well as selected, well-known groups of spiders (Deltshev; Blagoev; Lazarov). Additional information comes from more specialized insect groups such as Odonata (Beschovski & Marinov) and jewel beetles (Sakalian & Langourov). A review of all Bulgarian Myriapoda is presented by Stoev, and a chapter on harvestmen ecology, by Mitov. An account of scorpions, a small but interesting arachnid group, is given by Fet & Soleglad. An exhaustive analysis of mollusks by Hubenov provides both zoogeographical and ecological generalizations of this most important invertebrate group on land, in fresh waters, and in the Black Sea. A separate, detailed review of remarkable freshwater stygofauna is provided by Pandourski; intriguing, unique Protozoa of the Black Sea littoral are discussed by Golemansky. The book is supplemented by general reviews of the cave fauna (Beron) and the Bulgarian Black Sea fauna (Golemansky) as well as brief overviews of flora and vegetation (Peev & Delcheva; Meshinev) and landscapes of Bulgaria (Velikov & Stoyanova).

As its background, any study of biodiversity is impossible without regional surveys. Bulgaria has a great tradition of floristic and faunistic research.

Generalizations and theoretical treatments arrive as a product of those but only after the decades of groundwork. The case studies given in this volume provide a broad diversity of approaches to those generalizations. It was not our goal to unify all zoogegraphical schemes and patterns of evolution provided by the authors; on the contrary, one should appreciate the difference in those patterns among very different animal groups. At the same time, a few unifying themes sound clear through the mosaic of presented surveys. For instance, the difference and prevalence of mountain faunal elements is emphasized; among those, the endemism is prominent in the major ranges of Stara Planina and, especially, Rila–Rhodopes, but also expressed at much more local scale. Glacial processes of Pleistocene impacted heavily on many faunal elements, trapping boreal elements on the mountaintops and endemics in the caves. Similar zoogeographical trends are seen in Bulgaria in many other well-studied animal groups not included in our volume, e.g. Isopoda, Pseudoscorpiones, Ephemeroptera, Plecoptera, Heteroptera, Neuroptera, Trichoptera, Lepidoptera, and some families of Coleoptera (Elateridae, Cerambycidae, Chrysomelidae, Curculionidae).

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2 Terrestrial Mammals of Bulgaria: Zoogeographical and Ecological Patterns of Distribution

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Abstract: Our present knowledge of the terrestrial mammals of Bulgaria is reviewed on the basis of published records and original data collected in 1990–2002. The study is based on 93 species of terrestrial mammals. They are classified into four faunal complexes reflecting the influence of historical and environmental factors. The spatial differentiation of the mammalian fauna is considered within a network of landscape territorial units, or natural regions (NRs). Physiographic and climatic indices of each NR are used in the quantitative analyses in order to explore the environmental causes of the observed patterns. The variability of species richness across the NRs does not correlate with environmental variables and seems to depend on the completeness of regional inventory. However, the species richness of carnivores and artiodactyls shows patterns which could be due to the human impact in the lowlands and the greater habitat diversity in the mountains. Faunal differentiation of the Bulgarian mammals is primarily related to the altitudinal gradient and secondarily, to the humidity and continentality of the climate in the lowlands. Detailed analyses are performed on a set of 83 local assemblages of small epigean mammals (pitfall data) from 16 sampling areas. Each assemblage represents a specific habitat type within the sampling area hypothesized as perceived by the small mammals. Conditions within the habitats are described through the environmental variables. The ordination analyses reveal that, again, the composition and structure of the local assemblages are primarily affected by the altitudinal gradient, the secondary group of factors being local vegetation type and humidity. The classification analysis distinguishes five assemblage types. The structure of the local assemblages is affected primarily by the external environmental factors; the role of internal factors, such as competition, could be suggested only in one case. The environmental relationships of species change along the overall gradient. On the basis of the observed patterns we propose a zoogeographical subdivision of Bulgaria into two districts, with two subdistricts each. The changes of the zoogeographical structure of the mammalian fauna in Bulgaria are due to environmental differentiation, modified by human impact since the middle of Holocene

1 Introduction

To date, 95 species of wild terrestrial mammals have been recorded in Bulgaria. One species (*Mus musculus*) consists of two well defined forms, sometimes considered as semispecies: *Mus musculus musculus* and *M. musculus domesticus*. Three species of bats (*Pipistrellus pygmaeus* Leach, 1825, *Myotis aurascens* Kusjakin, 1935, and *M. alcathoe* Helversen et Heller, 2001) have been recently accepted as valid species in the European fauna. There are records of these species from Bulgaria as well

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(Benda et al., 2003; Peshev et al., 2004; Schunger et al., 2004). The first species is a sibling species of *Pipistrellus pipistrellus*, while the last two species belong to the group of *Myotis mystacinus*. Their distribution and systematic status need further clarification, so, they are not treated separately. Thus, the present study is based on 93 species of terrestrial mammals (the forms of *Mus musculus* are considered separately).

Main features of distribution of mammals in Bulgaria have been known for a long time (Boetticher, 1933), but because of the scarcity of detailed records, especially on the small mammals (insectivores, bats, and rodents), the knowledge remained sketchy. Later, using a greater amount of information, Zimina (1962) described general distributional patterns within Bulgaria, but defined it in rather general terms: "The characteristic features of the northern and mountainous areas of the country include typical European forest mammal species and the Eurasian (steppe and boreal) species, whereas the southern areas are characterized by West Asian and Mediterranean species".

The distributional maps in the recent *Atlas of European Mammals* (Mitchell-Jones et al., 1999) as well as those in *The National Biological Diversity Conservation Strategy* (Meine, 1994) show that even today there is no detailed information on the species occurrence and distribution for many areas of Bulgaria. Since effective implementation of conservation measures needs such detailed information, active regional surveys have been conducted in the various areas of Bulgaria. Total information has been recently summarized by Peshev et al. (2004).

Explaining the factors and mechanisms affecting patterns of distribution and diversity is one of the most important goals in the ecological and biogeographical studies. The climate-species relationship has been well documented at the macrogeographical scale. However, its role at the regional and local scales is still poorly known despite of its theoretical importance for the detailed zoogeographical subdivision, which in turn has practical applications for species management and conservation.

The goals of the present study are: (1) to analyze the entire available faunistic data in order to reveal the distributional patterns of (non-marine) mammals in Bulgaria, and to suggest the possible causes for these patterns; (2) to present a more detailed analysis based on the landscape (ecological) determinants for the quantitative structure of the small mammal assemblages representative for various terrestrial habitats across Bulgaria; (3) to propose a zoogeographical subdivision of Bulgaria; and (4) to characterize the mammalian associations in each zoogeographical unit, providing a base for further studies, as well as for conservation and land development.

2 Material and Methods

Faunistic data. It may be expected that, besides geographical regularities, the major spatial determinants of distribution on a limited territory such as Bulgaria are ecological. In this respect, in order to bring together the distribution of mammals

and environmental spatial heterogeneity, the system of 24 landscape subprovinces (Fig. 1), proposed by Petrov (1997), was used as a reference system to record the presence or absence of species. These subprovinces are relatively homogeneous territories with a particular combination of relief, climate, and vegetation; they are referred to in further analysis as natural regions (NRs). This approach offers a possibility to accumulate the often disparate faunistic records in an environmentally meaningful context and to reveal environmental aspects of mammalian distribution. Additionally, this approach allows recognizing ecologically significant spatial boundaries.

The environmental data used at this scale of analysis are based on indices, which characterize each of the 24 NRs (Petrov, 1997). They comprised the range and mean values of 24 quantitative environmental variables. The following climatic variables are used in the analyses: v1. Annual temperature amplitude, expressed as a difference between the mean annual temperatures of July and January (°C); v2. Sum of average monthly temperatures above 0 °C; v3. Sum of precipitation (mm) for months with average temperature above 0 °C; v4. Coefficient of air humidity; v5. Annual precipitation (mm); v6. Annual evaporation (mm).

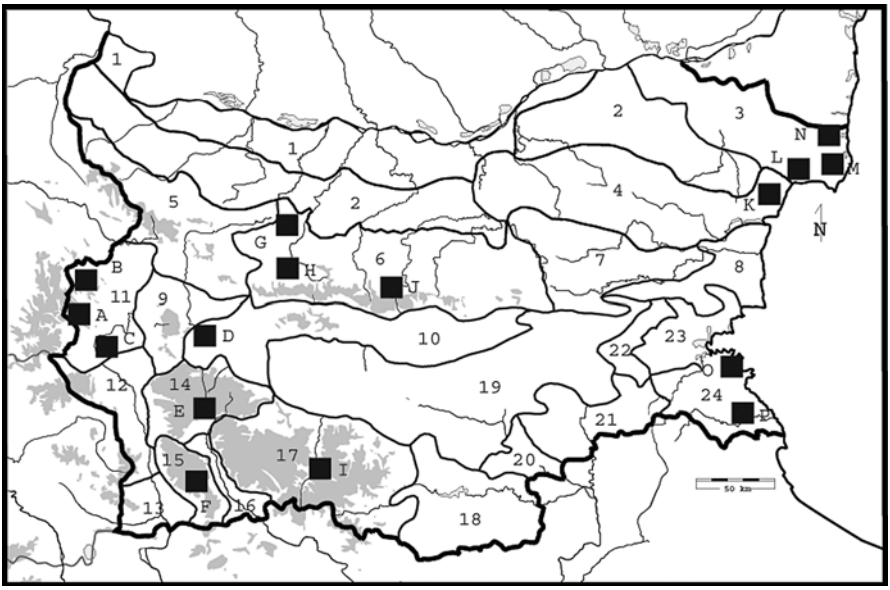

Fig. 1 Map of Bulgaria showing the natural regions (1–24, from Petrov, 1997, modified) and sampling areas (A–P). Natural regions: 1, Northern Danubian Plain; 2, Southern Danubian Plain; 3, Southern Dobrudja; 4, Popovo–Shumen–Franga; 5, Western Stara Planina; 6, Central Stara Planina; 7, Eastern Stara Planina; 8, Maritime Stara Planina; 9, Vitosha–Ihtiman; 10, Sredna Gora–Podbalkan; 11, Kraishte; 12, Osogovo–Middle Struma; 13, Southern Struma; 14, Rila; 15, Pirin; 16, Middle Mesta; 17, Western Rhodopes; 18, Eastern Rhodopes; 19, Upper Thrace; 20, Lower Thrace; 21, Sakar–Dervent; 22, Bakadjik–Hisar; 23, Burgas–Aitos; 24, Strandja.