RESEARCH ARTICLE

Teodora Teofilova [1]
Emilia Markova [1]
Nikolai Kodzhabashev [2]

Habitats diversity as factor for the conservation significance of the area of Cape Emine in relation of the ground beetles (*Coleoptera, Carabidae*)

ABSTRACT

The region of Cape Emine (the middle of the Bulgarian Black sea coast) is one of the most interesting, but not sufficiently investigated areas in relation to the carabid fauna. In 2010 and 2011 biological monitoring studies in the area were conducted including an assessment of the presented natural habitats. Species composition of the ground beetles communities was analyzed through terrestrial pit-fall traps. Connections of the carabids with specific habitats, affiliation to a certain zoogeographical complex, and the attachment to particular environmental conditions were established. The relationships of the ground beetles with the status of their environment were traced. Anthropogenic impact in the area was also assessed. The main threats and problems related to the degradation and destruction of natural habitats, and hence, decreasing the conservation significance of the area, were established.

Key words: habitats, Carabidae, ground beetles, Cape Emine, conservation significance

Authors' addresses:
[1] Sofia University, Faculty of Biology, Sofia, Bulgaria.
[2] University of Forestry, Sofia, Bulgaria.

Correspondence:
Teodora Teofilova
Faculty of Biology, Sofia University,
8, Dragan Tsankov Blvd., 1164 Sofia,
Bulgaria.
Tel.: +359 89 8236139
e-mail: oberon_zoo@abv.bg

Introduction

Ground beetles (Coleoptera, Carabidae) represent one of the largest beetle families with cosmopolitan distribution and with decisive importance for the functioning of ecosystems. The high taxonomic richness, the large numbers and the diverse life specializations are the reasons they cover the entire environmental spectrum of fundamental natural gradients. These substantive arguments lie at the base of the possibility ground beetles and their communities to be widely used as bioindicators of terrestrial environment in the system of biological monitoring (Desender & Baert, 1995; Luff, 1996; Cranston & Trueman, 1997; Pearsall, 2007).

One of the interesting, but not enough explored areas in terms of the carabid fauna and carabid coenoses is the zoogeographical region of the Bulgarian Black Sea coast (Gruev & Kuzmanov, 1994). The climate specificity, coupled with a variety of plant formations have predetermined the forming of a wide range of carabid species and their communities. Of particular scientific interest is the structure of the coastal communities, as well as the measures to be taken with a view to conservation and restoration of the aborigine fauna.

The object of this study is the area of Cape Emine, where clashes between developers and environmentalists are still continuing.

Cape Emine marks the end of the Stara planina mountain chain (Balkan Mountains) and it is the easternmost geographical point of Bulgaria, which divides the Black Sea coast to northern and eastern part (Galabov, 1956). It is controversial whether that is also phytogeographical border between the northern and southern parts of the coast, as claimed by Bondev, 1997 and others. Another opinion is that the flora and vegetation of the large dune complex near Kamchia River mouth, located north from Cape Emine, and should be assigned to the southern group of phytocoenoces (Tzonev et al., 2005). Due to the geo-strategic location of this part of the coast, there are fused different zoogeographical, chorological and ecological complexes here, which leads to the creation of original and unique biocoenoses. This makes the studied area very

RESEARCH ARTICLE

attractive and interesting not only from a practical, but also from a scientific point of view. It could be claimed with confidence that this is one of the few remaining intact natural areas of the coast. The rare combination of physical and environmental factors determines the uniqueness of living conditions. The presence of a large number of intra- and extrazonal landscapes increases the mutual infiltrating and mixing of the faunal elements. This, in turn, was a prerequisite for the holding of more ecological niches and bigger species variety.

Biological and ecological value of the area still manages to be preserved with the help of the Bulgarian and international legal regulatory mechanisms. The importance of the territory with regards to conservation of valuable plant species and significant habitats was properly assessed.

Conservation status of the area:

1976 – Natural Landmark "Cape Emine"
1994 – Protected Site "Irakli"
1996 – CORINE Biotopes place (code F0008100)
1997 – BirdLife International Important Bird Area "Cape Emine"
2004 – Natura 2000 sites with the codes BG0000114 and BG0000111
2008 – Protection Zone "Emine – Irakli" with the code BG0001004
2009 – Protection Zone "Emine" with the code BG 0002043
2010 – Application for a declaration of Managed Nature Reserve in the Irakli site

Within the boundaries of the protected by "Natura 2000" zones were included three Protected Sites with code BG 06 – "Smrikite", "Ortoto" and "Irakli" and the Protected maritime aquatory "Koketrays", announced in 2001 for protection of the sand bank in the Bourgas Bay (Kostadinova & Gramatikov, 2007; Commission Decision 2009/92/EC; Directive 79/409/EEC; Directive 92/43 EEC; Law for the biological diversity).

Materials and Methods

In connection with the participation in a project for biological monitoring studies in the area, a series of observations and samplings were carried out. In November 2009 the working trial sites were determined and set. Subsequently, six fieldworks in March, August and November 2010 and in April, June and December 2011 were carried out. Designated field trial sites sought to cover the full diversity of natural conditions and included representative excerpts of the characteristic for the area types of ecosystems – anthropogenically loaded and relatively unaffected. Evaluation of the presented habitats was made.

Sampling areas covered territories near the sea coast (the beach near the military recreation base and the shore ecotone between the mixed forest and the rock edge in the Irakli site); Pine culture; Oak forests (near Irakli site and on top of the ridge above the sea shore, in the extensive spaces near the signal repeater station); steppe habitat in the ridge grassland and, in consequence, in the ploughed up ground in place of the steppe habitat and in the ecotone between it and a saved island with natural vegetation; an abandoned vineyard in Irakli; the banks of the Vaya River and the neighbouring wheat field.

Ground beetles were collected by the approved method with terrestrial pit-fall traps. The traps were made of plastic bottles, buried at the level of the substrate. As fixation fluid a 4% solution of formalin was used. In all trial sites each trap line included 10 – 14 traps.

According to their zoogeographical belonging, species were separated in zoogeographical categories and faunal types (Casale & Vigna Taglianti, 1999; Vigna Taglianti et al., 1999). In order to obtain more informative and adequate results, some changes in the classification were made (Kodzhabashev & Penev, 2006).

Results

The investigated territory was extremely heterogeneous and mosaic of habitat types. In the area of Cape Emine 23 natural habitats, included in the Red Data Book of Bulgaria (Volume III. Natural Habitats) were to be found, of which 5 with the category Near Threatened, 6 – Vulnerable, 11 – Endangered, and 1 (the estuary of the Vaya River) – Critically Endangered. During the study some of them were established. In a survey of the species composition of the carabid beetles from the zoogeographical region of the Bulgarian Black Sea coast (Teofilova *et al*., 2011a; 2012), 465 species of ground beetles were pointed to be present in the region. Cape Emine conventionally separates the Black Sea coast to Northern and Southern part, which suggests conditions for discovering there of a major part of the species. In addition, here ends the Stara Planina mountain chain, which provided additional variety of habitats favouring the presence of mountain species.

RESEARCH ARTICLE

The territory could be defined as mainly occupied by forest communities. The vegetation was xerophytic and mesoxerophytic, of natural origin and formed during the Quaternary period with the warming of climate. The preserved forest vegetation had a high conservation value. It is part of the natural habitat of European significance 91MO "Balkan- Pannonian Turkey oak – sessile oak forests" with dominant species Turkey oak (*Quercus cerris*), mixed with sessile oak (*Quercus polycarpa*). Red ash (*Fraxinus pubescens*), linden (*Tilia* sps.), hornbeam (*Carpinus orientalis*) and traveler's joy (*Clematis vitalba*) were to be found. One of the studied land properties had relatively flat terrain. There the dominant plant species was Hungarian oak (*Quercus frainetto*). Species as: *Quercus polycarpa*, *Quercus cerris*, *Acer campestre*, *Acer platanoides* were also encountered. Ranges near the sharp sea shore were overgrown with Christ's thorn (*Paliurus spina-christi*), dog rose (*Rosa canina*), wild pear (*Pyrus pyraster*), blackberry (*Rubus caesius*). In the better illuminated parts of the forest *Carpinus orientalis*, *Cornus mas*, *Cornus sanguinea*, *Cotinus coggigria*, *Rhamnos cataractus* were observed. Regardless of their status these xerothermic forests have a natural origin, i.e., their type and composition are close to the ones present before the appearance of man. They are relatively young and of sprouts, but dense, tall and broad enough for the creation of the characteristic forest microclimate. The major faunal complexes here included primarily widespread in similar habitats species, but also such, specific only to these latitudes. A large proportion of the territory was occupied by private abandoned agricultural properties – old vineyards, almond gardens, orchards and fields. The vegetation in these properties was secondary and derivative. To such degraded terrains a slow and unpredictable succession is peculiar. It differs depending on the land exploitation methods and the period during which the land had not been used. Despite the low quality of these habitats, their geographical location and climatic characteristics predetermined that a number of rare species such as *Carabus ullrichi* could be found there.

Proof of the increased anthropogenic impact were the plantations of Scots pine (*Pinus sylvestris*) and the section with dominant species of black pine (*Pinus nigra*) near the sea shore, built by thin and sparse specimens in not very good condition. The age of some of these secondary communities was 50 – 60 years and more. Successions in these habitats were mainly turned towards degradation, associated with abrupt changes of the edaphic conditions and with difficulties to predict forecasts for the development of the faunal complexes. Established carabid coenoses had a relatively poor species composition.

Global xerophytization as a result of both natural climatic changes and anthropogenic influences led to serious degradational alterations of the faunal complexes and unforeseeable changes and trends in future. It also caused expansion of the northern borders of distribution of some thermophilic southern species.

A large part of the territory was occupied by secondary plant communities with prevailing ruderal, weedy and secondary successional steppe vegetation replacing ligneous vegetation and primal steppe. The fauna of these communities consisted of a relatively large number of Pontic, Mediterranean and steppe species, which very often appear to be extrazonal and most important – they never penetrate in depth into the Eastern zoogeographical subregions and in the interior of the country. The separation of this native fauna from the invasive one is a very difficult, controversial and speculative problem that requires in-depth analysis and specific chorological and taxonomic knowledge. This fauna is indicative of the status and conservation importance of natural habitats in the area, but it is difficult to determine and differentiate with a practical application point of view.

From the perspective of ecological coherence, here was situated one of the three coastal zones in Bulgarian where the thermophilic oak forests (91MO) still form a long fragmented ecotone with the coastal habitats. Along the seashore of the researched area five habitats listed in annex I to Directive 92/43 were established: 2130 "Fixed coastal dunes with herbaceous vegetation ("grey dunes")", 1240 "Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.", 2190 "Humid dune slacks" (especially vulnerable), 2110 "Embryonic shifting dunes" and 2120 "Shifting dunes along the shoreline with *Amophylla arenaria* ("white dunes")". The main biotic complexes among the animals from the coastal shores were built from halophilic, psamophilic and chasmophilic species. These habitats had a characteristic and specific fauna, most often, with Mediterranean or Neareastern distribution. The forms which inhabit these complexes were almost always intraor extrazonal stenobionts.

Important aquatic habitats were River Vaya and its mouth as a brackish estuary (code 1130). The river was relatively clean, due to the lack of industrial and household pollutants. In its undamaged part natural groupings of hygrophitic,

RESEARCH ARTICLE

mesohygrophytic and mesophytic species were formed, accompanied by the relevant specific faunal complex. The fauna of these habitats might be considered as unaffected or slightly affected by the anthropogenic activities. It was of a riparian type and included hygrophilic and mesohygrophilic species, some of which with a limited range of habitation (*Carabus cancellatus*, *Carabus ullrichi*, *Tachys fulvicollis*).

In recent years, the river was affected by the incompetent and barbaric correction of the riverbed, which was carried out after the floods in 2006 – 2007. The "Cleansing" included cutting down the natural riparian vegetation and "straightening" of areas with "large elbows". Reduced water flow rate of the river, resulting from the water catches and the concrete barrier hindrance of the half-destructed bridge crossing the road from Irakli to the village of Emona, were the main reasons in recent time the river to be turned into a little stream with intermittent sections during the hot summer months, and her mouth – into a small lake completely separated from sea water.

It is known that the distribution of ground beetles is in direct proportion to the humidity, soil conditions and vegetation. The combination of more temperate coastal climate and higher humidity of the area contributed to the unusual occurrence of some species of mountainous and semi-mountainous parts of the country, as well as some typical forest species (eg. *Leistus rufomarginatus* in the riverine habitat in the Irakli site; *Amara communis* in the steppe habitat and in the gully near the military recreation base, where was also discovered the typical forest species *Carabus intricatus*; *Harpalus honestus* and *Harpalus quadripunctatus* in the steppe biotope). These habitats should be considered as important refugia for these forms.

Species diversity along the river banks was found to be high. This fact harmonized with the assumption about the primal hygromesophilic preferences of the carabid beetles (Kryzhanovskij**,** 1965, 1983; Sharova, 1981). Even the typical forest dweller *Myas chalibaeus* was found here. This was probably due to the fact that this species was established in the not corrected part of the river, where the original ligneous vegetation was preserved. Proof of the conservation significance of this riparian habitat was the presence of *Carabus granulatus* – indicator species with high requirements in respect to the moisture and soil composition (Turin et al., 2003). Surprisingly, some xerophilic Mediterranean elements (*Harpalus cupreus*) were established, which was probably due to the close proximity of the open steppelike biotope, turned later into a wheat field. Similar participation of open habitat dwellers was discovered also in the oak forest near the signal repeaters, where the influence was perhaps from the near steppe habitat.

A variety of forms was found in the sampling area, located along the coast and in the small gully near the military recreation base. This was probably due to the heterogeneity of the environmental conditions (rough terrain, tree and shrub vegetation, sandy strip along the edge of the gully, presence of salt and fresh water).

Of particular interest was the presence in the forests of species, otherwise typical for the open habitats (*Amara anthobia*, *Calathus fuscipes*, *Carabus scabriusculus*, *Pterostichus melas*).

Steppe-like biotopes were very essential, since maintaining populations of rare and stenotopic species (*Amara sabulosa*, *Brachinus berytwnsis*, *Ophonus oblongus*, *Harpalus metallinus*, *Notiophilus interstitialis*) or species with restricted distribution (southern and Mediterranean species like *Brachinus brevicollis*, *Brachinus plagiatus*, *Ditomus calydonius*, *Scybalicus obl*., *Cymindis ornata*).

Namely the steppe habitat near the signal repeaters was the most opulent trial area in respect to the species richness. There some forest elements (*Brachinus brevicollis*, *Calosoma inquisitor*, *Harpalus quadripunctatus*, *Myas chalibaeus*) were also found. This type of habitats represented a peculiar relationship with the Asian steppes and they were corridors for distribution and refugia for steppe and rare elements. Unfortunately, the analyzed steppe habitat was destroyed at the end of the study period.

Characteristic was the presence of a smaller number of species in the anthropogenically loaded trial sites, especially in the area Irakli– the abandoned vineyard, the oak forest, the coastal ecotone and the wheat field – affected by increased human presence, especially during the summer.

Taxonomic structure showed the highest participation of the representatives of tribe Harpalini. Similar results were obtained by Popov & Krusteva (1999) and Kodzhabashev & Penev (2006). According to them, the higher richness of Harpalini was due to the prevalence of open habitats.

Regarding the zoogeographical elements it could be claimed, that the European faunal complex predominated. In only two of the trial sites its representatives were equal to those of the Northern Holarctic and the Mediterranean faunal complexes (respectively it were the agrocoenose and the shore ecotone in Irakli), and in one trial site most highly was

RESEARCH ARTICLE

the presence of the Northern Holarctic complex (the oak forest near the signal repeater station). Peculiarity was that in the shore ecotone in Irakli species distribution between the individual faunal complexes was almost even, but in the steppe habitat Euroasiatic faunal type predominated. Generally most strongly was the presence of the European-Neareastern elements. Relatively large was also the number of Palearctic species. In the steppe habitat enhanced presence of the Balkan-Neareastern chorotype was observed.

The presence of many species with typically southern distribution should be noted, as well as species which in Bulgaria could be found only in the zoogeographic sub-region of the Southern Black Sea coast, such as *Brachinus berytwnsis* and *Ophonus oblongus* (Guéorguiev & Guéorguiev, 1995; Teofilova et al., 2011a, 2012).

Discussion

The modern fauna in the investigated region is very diverse in origin, which very often makes it difficult to determine the main approaches in definition of its conservation significance in the different types of habitats. In the context of this fact, the species could be categorized into three main directions. The first category represented the ***species, inhabitants of the unchanged or relatively little changed habitats (autochthonic species)***. Residues of this faunal complex were established in riparian habitats, in mixed deciduous forests near the sea, in coastal habitats. The second category included ***species that settled down in the distant past thanks to human activity or other natural causes and changed the original countenance of the area***. Very often they are seen as natural and as an undivided part of the autochthonic fauna. Assessment of such taxa is very difficult and requires a thorough analysis. The approach in such assessments is always relative and needs the coenoses of the natural and those of the secondary habitats to be compared. Albeit conditional, because of the relatively long period of existence and establishment of relatively dynamic ecological balance, part of this fauna we could consider as secondary autochthonic. A typical example for such fauna was found in pastures and meadows – a big part of the habitats in the study area. The third category included ***expansive species inhabiting anthropogenic coenoses***. This fauna included predominantly ecologically plastic species, which used agrocoenoses and synanthropic areas as ecological corridors (*Amara aenea*, *Calathus fuscipes*, *Carabus coriaceus*, *Harpalus rubripes*, *Pseudoophonus rufipes*, *Trechus quadristriatus*). Very often apart from mass species it also included a small number of stenobionts – those who were in the early stages of colonization and expansion. Such species were wrongly defined as rare and a conservation status they did not deserve was attached to them.

Species peculiar to the Black Sea zoogeographical region were characteristic with their presence mainly in the seaside 10 to 30 km of coastline and they rarely entered only at the periphery of the Eastern sub-regions, i.e. in most cases they were highly specialized stenobionts (intra- or extrazonal).

Usually species are described as inhabitants of open biotopes, forest species, extraand intrazonal (psammobionts, halobionts, bothrobionts, and riparian), and eurytopic (Thiele, 1977). There were plenty of varieties between those groups, due to the possibilities of some species to inhabit more than one habitat. Therefore ground beetles were separated to 3 major groups: stenotopic (living in very restricted environmental conditions), oligo- and polytopic (inhabitants of several habitats), and eurytopic species. Predominance of stenotopic species showed once again the urgent need to extend the protection of several natural and seminatural habitats as reference biotopes and "islands" of preservation of the biodiversity. Such habitats included coastal and riverside biotopes, swamps, floodlands, mesophilous and xerophilous forests, steppe or steppe-like grasslands. An important group of habitats was formed by the great variety of seashore, river, swamp and lake banks. Of special conservation value were the salinized habitats along the coasts, where a remarkable number of halobionts exists, mostly of the tribes Pogonini, Dyschiriini and Bembidiini.

The analysis of the fauna indicated various composition of geographical elements such as the prevalent European-Neareastern forms. Environmental conditions have been kept favorable for these species, but the European-Siberian, Central European and most of the representatives of the Mediterranean complex, or those distributed in the so-called region of the "Ancient Mediterraneum" (Popov, 1927; Kryzhanovskij, 1965), suffered from destruction of the habitats.

From the point of view of protecting endemic forms, it should be noted that most of them were found in (sub)Mediterranean regions (Koomen & van Helsdingen, 1996), manifestation of which there were in the investigated area. Therefore, the priorities in the conservation of nature should be directed to this type of habitats.

RESEARCH ARTICLE

Proper study and retrace of the moisture gradient could give us correct information for the distribution of vegetation, which would be useful in imposing measures for protection of conservationally significant species. Particular attention must be payed to the "mixed" habitats, where a combination of different environmental conditions was observed.

Conclusion

In the last decades intensified processes of secondary xerophytization were observed as a result of global climate changes and deforestation of the natural ligneous vegetation. This successional degradation gives a strong reflection on the contemporary state of the fauna, which found expression in species impoverishment, severe dystrophy of the zoocoenoses and replacement of natural communities with eco-plastic, invasive elements. Most intense are the processes of droughting and even desertification in regions where the press of anthropogenic impacts was added to the natural arid conditions (Bragina, 2004). Such impacts are the massive plough up of virgin lands (especially around the middle of the 20th century), the regulation of watercourses and the distortion of water balance of the territory, the sharp increase of anthropogenic pressure with the influx of population and unregulated tourism. All this leads to changes in natural conditions, which in turn cause conversions in the species composition of communities too.

Considering that most of the rare species are stenobionts, it could be assumed that in parallel with the destruction of the natural vegetation much of the characteristic faunal elements were also destroyed. Remnants of the ancient native fauna of the region are preserved in the spots of natural ligneous vegetation, in riparian and coastal habitats, as well as in the primarily steppe elements, saved in highly restricted in area perimeter. A part of the natural flora is probably preserved, adapting to the conditions in cultural agrocoenoses. This component of the fauna is revealing in terms of the primacy of the communities, respectively the habitats, and therefore should be used when analyzing the specific situation and the resolution of disputes related to the naturalness and the qualities of habitats.

Despite of all negative anthropogenic activities (Teofilova et al., 2011b), presence of rich, original and diverse ground beetle fauna was established, which reinforces the need to extend the network of protected areas so that they will cover all main natural habitats of the region of Cape Emine. Actions for restoration and protection of the biodiversity are needed, such as recovery of the destroyed part of the bed of the River Vaya and recuperation of the affected riverine forests, as well as regulation of the negative impact on the dunes. Recovery and maintenance of extensive agricultural practices in abandoned agricultural lands (grazing, extensive vineyards and gardens) is of paramount importance for the preservation of essential habitats.

Acknowledgement

The study was carried out thanks to the financial assistance of "LITEX COMMERCE" LTD. (through the Project "Monitoring scientific researches in the areas of land properties № 53045.232.11 in "Balabana" locality and № 53046.639.3 in "Ivanov dol" locality in the land of the town of Obzor, Nesebar Municipality, Bourgas Province") and the Fund for Scientific Researches of the Sofia University (through the Project № 61/05.04.2012 "Ecological and zoogeographic studies on the carabid communities (Coleoptera, Carabidae) from the region of the Bulgarian Black Sea coast"). The authors express their gratitude to Lyubomira Lyubomirova, Radostina Pravcheva, Yanica Ivanova, Anton Stamenov and Pencho Pandakov for their invaluable assistance during the collection and initial processing of the samples and to Dr. Svetlana Boycheva for her help with the translation of some parts of the text.

References

Bondev I. 1997. Geobotanical zoning. – In: Yordanova, M. and Donchev, D. (eds.) Geography of Bulgaria. "M. Drinov", Acad. Press, Sofia: p. 283–305. (in Bulgarian).

Bragina TM. 2004. Patterns in soil animal population changes in desertification: with example of the dry-steppe zone of Central Asia. Dissertation, Moscow, p. 290.

Casale A, Vigna Taglianti A. 1999. Caraboid beetles of Anatolia, and their biogeographical significance (Coleoptera: Caraboidea). Biogeographia, 20: 1–405 .

Commission Decision 2009/92/EC, 2008. Commission Decision adopting, pursuant to Council Directive 92/43/EEC, an initial list of sites of Community importance for the Black Sea biogeographical region (notified under document number C(2008) 7974).

Directive 79/409/EEC, 1979. Council Directive of 2 April 1979 on the Conservation of Wild Birds. – OJ L 103, 25.4.1979, p. 1–18.

Directive 92/43/EEC, 1992. Council Directive of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora. – OJ L 206, 22.07.1992. p. 7–50.

Cranston PS, Trueman JWH. 1997. "Indicator" taxa in invertebrate biodiversity assessment. Memoirs of the Museum

RESEARCH ARTICLE

of Victoria, 56(2): 267–274.
Desender K, Baert L. 1995. Carabid beetles as bio-indicators in Belgian coastal dunes: a long term monitoring project. Bulletin de L'Institut Royal de Belgique Entomologie, 65: 35–54.
Galabov J. 1956. The Black Sea Coast. – In: Galabov, J. (eds): Physical Geography of Bulgaria. BAS, Sofia, p. 317–333. (in Bulgarian).
Gruev B, Kuzmanov B. 1994. General biogeography. Nauka i Izkustvo, Sofia, p. 498 (in Bulgarian).
Guéorguiev VB, Guéorguiev BV. 1995. Catalogue of the ground-beetles of Bulgaria (Coleoptera: Carabidae). PENSOFT Publishers, Sofia-Moscow, p. 279.
Kodzhabashev ND, Penev LD. 2006. The ground beetles (Coleoptera: Carabidae) of South Dobrudzha, Bulgaria. *Acta Zoologica Bulgarica*, 58(2): 147–180.
Kostadinova I, Gramatikov M (resp. ed.). 2007. Ornitologically important places in Bulgaria and Natura 2000. BSPB, Sofia, p. 639.
Koomen P, van Helsdingen PJ. 1996. Listing of biotopes in Europe according to their significance for invertebrates. - Nature and environment, 77: 75.
Kryzhanovskij OL. 1965. Composition and origin of the terrestrial fauna of Middle Asia. Nauka, Moscow-Leningrad, p. 420. (in Russian).
Kryzhanovskij OL. 1983. Fauna of USSR. Coleoptera, 1, 2. Adephaga. Families Rhisodidae, Trachypachidae; family Carabidae. Nauka, Leningrad, p. 320. (in Russian).
Law for the biological diversity (prom. SG. 77/2002, amend. SG. 88, 105/2005, amend. SG. 29, 30, 34/2006, amend. SG. 52, 64, 94/2007, amend. SG. 43/2008, amend. SG. 19, 80, 103/2009, amend. SG. 62, 89/2010, amend. SG. 19, 33/2011, amend. and suppl. SG. 32/2012, amend. and suppl. SG. 59/2012).
Luff ML. 1996. Use of Carabids as environmental indicators in grasslands and cereals. Ann. Zool. Fennici, 33: 185–195.
Pearsall IA. 2007. Carabid beetles as ecological indicators. - In: "Monitoring the Effectiveness of Biological Conservation" (Proceeding of conference, 2-4 November 2004, Richmond), BC, p. 389–399.
Popov MG. 1927. The main features of the historical development of the flora of Middle Asia. *Bull. Middle Asian State Univ.*, 15: 239–292. (In Russian).
Popov VV, Krusteva IA. 1999. Epigeobiont animal assemblages from two landscapes of the Bulgarian Black Sea Coast: relationship to environmental gradients, assemblage structure and biodiversity. Part I: Ground beetles. Acta Zoologica Bulgarica, 51(1): 81–114.
Red Data Book of the republic of Bulgaria, volume III. Natural Habitats, digital edition: www.e-ecodb.bas.bg/rdb/en/.
Report on Project "Monitoring scientific researches in the areas of land properties № 53045.232.11 in "Balabana" locality and № 53046.639.3 in "Ivanov dol" locality in the land of the town of Obzor, Nesebar Municipality, Bourgas Province" – private contract with head Prof. Dr. Svetoslav Gerasimov, 2009–2011.
Sharova I. 1981. Life forms of Carabids. Nauka, Moskow, p. 360. (in Russian).
Teofilova TM, Markova EP, Kodzhabashev ND. 2011a. A Brief Overview of the Ground Beetles (Coleoptera: Carabidae) of the Bulgarian Black Sea Coast. Science & Technologies, Section "Nautical & Environmental studies", I(2): 40–44.
Teofilova TM, Markova EP, Kodzhabashev ND. 2011b. Negative anthropogenic activities and threats to the biodiversity in the area of Cape Emine. Science & Technologies, Section "Nautical & Environmental studies", II(2): 13–18.
Teofilova TM, Markova EP, Kodzhabashev ND. 2012. The Ground Beetles (Coleoptera: Carabidae) of the Bulgarian Black Sea Coast. Journal of Bulgarian Agricultural Science, 18(3): p. 370–386.
Thiele HU. 1977. Carabid beetles and their environments: a study on habitat selection by adaptations in physiology and behaviour. Springer-Verlag, Berlin, p. 369.
Turin H, Penev LD, Casale A. 2003. The genus Carabus in Europe. A synthesis (eds). PENSOFT Publishers & Europaean Invertebrate Survey, p. 536.
Tzonev R, Dimitrov M, Roussakova V. 2005. Dune vegetation of the Bulgarian Black Sea coast. Hacquetia, 4(1): 7–32.
Vigna Taglianti A, Audisio AP, Biondi M, Bologna MA, Carpaneto GM, De Biase A, Fattorini S, Piattella E, Sindaco R, Venchi A, Zapparoli M. 1999. A proposal for chorotype classification of the Near East fauna, in the framework of the Western Palearctic region. Biogeographia, 20: 31–59

.