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Lamellicorn Beetles (Coleoptera, Scarabaeoidea) of the Islands of the Peter the Great Gulf, Sea of Japan (Primorsky Krai of Russia)

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Abstract: The species diversity of lamellicorn beetles (Coleoptera, Scarabaeoidea) on the 20 islands of Peter the Great Gulf was considered and analyzed for the first time, where 83 species from 38 genera were identified. There are 60 species (72.3%) and 20 genera (52.6%) are new for the fauna of the islands, with reference to the literature data. The total fauna with Russky Island (21 islands) includes 87 species from 38 genera of 13 subfamilies and four families of the superfamily Scarabaeoidea. The diversity and degree of study of the group on individual islands is very uneven. Russky Island with 80 species (92% of the total fauna of 21 islands), Popov Island with 42 species (48.3%) and Putyatins Island with 39 species (44.8%) have the most species-rich fauna. On the islands of Kozlov, Rikord, Zheltukhin, and Durnovo, one species was recorded (1.1%). The Scarabaeidae Latreille, 1802 dominates the fauna of 21 islands—77 species (88.5%), other families are represented by a single species: Trogidae Macleay, 1819—5 species (5.7%), Lucanidae Latreille, 1804—3 species (3.5%), Geotrupidae Latreille, 1802—2 species (2.3%). Scarabaeinae with 15 species (19.5%), Aphodiinae Leach, 1815 with 14 species (18.2%), and Rhizotroginae with 13 species (16.9%) are dominant in the Scarabaeidae fauna. The article deals with the annotated list of species and the studied material, discusses the ecological and zoogeographical features of the local faunas of Scarabaeoidea and features of the faunagenesis of the study area. The local Scarabaeoidea faunas of the islands are characterized by a significant depletion and mosaic composition of the species composition in comparison with the continental fauna. Despite the peculiarity of the climatic conditions of the islands and their significant isolation from the continental coast, the insular faunas of Scarabaeoidea demonstrate a high degree of similarity to the area, and have a logical structure with the continental fauna of lamellicorn beetles due to the geological youth of the island. The islands appeared during the post-Pleistocene transgression of the sea 11 to 8.5 thousand years ago.



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1. Introduction

Lamellicorn beetles occupy a separate position in the system of the order Coleoptera and form a separate series, Scarabaeiformia Crowson, 1960, with a single superfamily Scarabaeoidea Latreille, 1802. Today, there is no established opinion on the number of families and subfamilies within the superfamily. Different researchers distinguish 3 to 20 families [1]. The intensity of description of taxa of species rank on a planetary scale is consistently high—up to 200 species per year. Currently, the total number of described recent species reaches 35,000 [2,3]. Representatives of the group are characterized by a wide variety of morphological features, as well as a wide range of ecological adaptations. At this stage of evolution, Scarabaeoidea have inhabited most of the natural areas on the planet and plays a significant role in the functioning of ecosystems. Many species are of



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great economic importance, since they can be harmful to agriculture and forestry, or they can be an intermediate hosts of parasites [4]. The group reaches the greatest diversity in equatorial and tropical regions. About 500 species of Scarabaeoidea have been identified within Russia [5], which indicates the poverty of the fauna of the group over such a vast territory. This is due to the harsh climatic conditions of the country, a significant part of which is located in the permafrost zone. For comparison, 544 species have been identified in the USA state of Texas [6]. According to the latest data, 225 species of Scarabaeoidea from 61 genera, 19 subfamilies, and six families have been identified in the fauna of the Russian Far East [7]. Moreover, in the fauna of Primorsky Krai, in the waters of which the islands we study are located, 175 species from 54 genera of 18 subfamilies of six families have been noted [8].

The studies of most insect groups in the southern Russian Far East have traditionally focused on the continental area. The islands, particularly small ones in the coastal shelf zone, have been almost unstudied. To date, only scarce faunistic and taxonomic reports on some insect groups have been published on the entomofauna of the Peter the Great Gulf islands. A few reviews have been published, mainly on Lepidoptera and Orthoptera [9,10]. Only one publication is available on Scarabaeoidea, referring to only two islands of the Rimsky-Korsakov archipelago [11], where 22 species from 18 genera have been reported. These are Furugelm Island (19 species from 16 genera) and Bolshoy Pelis Island (19 species from 16 genera). Fragmentary data on one species *Holotrichia oblita* (Falderman, 1835) from Putyatin Island can be found in the review on the crustaceans of the USSR fauna [12]. The fact that the entomofauna of the islands have been insufficiently studied is also due to the poor accessibility and, until recently, the restricted access to certain areas for researchers. Given the changes in the access regime for several islands, the areas have currently become more open to research and monitoring. Taken together, the previously obtained fragmentary material and new contributions provide an opportunity to summarize and analyze the diversity and specific features of the distribution of Scarabaeoidea beetles on the Peter the Great Gulf islands (Sea of Japan).

2. Materials and Methods

2.1. Characteristics of the Research Area

Peter the Great Gulf borders the southern coast of Primorsky Krai of Russia, between the estuary of the Tumannaya River in the west and Cape Povorotny in the east (Figure 1).

Until 1859, it was called Victoria Gulf. The length of the gulf from north to south is about 80 km, with the greatest width from west to east up to 200 km. The area is about 9000 km², and the coastline is 1500 km long. The gulf shores are highly indented and form inner bays: Possiet, Slavyansky, Amursky, Ussuriysky, Strelok, Vostok, and Nakhodka Bay. Located on the shores of Peter the Great Gulf are the cities of Vladivostok, Nakhodka, Bolshoi Kamen, Fokino, and the largest port on the Pacific Ocean in Russia, Vostochny. The following archipelagos are located within the gulf: the Empress Eugénie (Russky, Popov, Rikord, Reyneke and Shkot, Moiseev, Zheltukhin, and other islands), Pakhtusov (three unnamed islands and four groups of rocks), and Rimsky-Korsakov (Bolshoy Pelis, Stenin, De Livrone, Matveeva, Durnovo, Gildebrandt, and several kekurs), and individual islands: Furugelm, Dva Brata, Askold, Putyatin, Lisy, and others (Figure 1).

The climate is temperate monsoon, with an average rainfall of 830 mm/year (85% is in summer). The average temperature is +19 °C in August and −12 °C in January. In winter, the water surface of the gulf is not entirely frozen, and only near-shore landfast ice is formed in secondary bays [13]. The relief of the islands varies: it is usually hilly with widely represented rocky outcrops.



Figure 1. Collection and observation points of Scarabaeoidea on the islands of the Peter the Great Gulf.

The islands flora is related to the nearby mainland, the East Asian Manchurian-type. The vegetation has a distinctly mosaic character and strongly correlates with the relief, associated with the windward or leeward orientation of slope exposures. Depending on the size and position of the island, meadow or shrub communities may dominate. Broadleaved, coniferous-broadleaved, and sparse forests dominate on large and medium-sized islands. There are practically no representatives of some cenotic complexes common to the southern part of Primorsky Krai: boreal forest, taiga, and urema. The wide distribution of erosive stony and sandy substrates contributes to the preservation of small sections of communities formed by typical steppe elements on the islands [14].

2.2. Insect Collection Methods and Data Analysis

Collections of researchers who visited the Peter the Great Gulf islands in different years and provided insects to the authors (Acknowledgements) have served as data for the analysis. We have also studied the collections of scientific institutions: Federal Scientific Center of the East Asia Terrestrial Biodiversity Far Eastern Branch of the Russian Academy of Sciences, Vladivostok (FSCB) and Institute of Systematics and Ecology of Animals Siberian Branch of the Russian Academy of Sciences, Novosibirsk (ISEA). It is worth noting the exceptional scarcity of collections from most islands, which did not allow any analysis to be carried out earlier.

The main methods for trapping insects were used by the authors in studies on the island. On other islands, other collectors collected material, mainly using the manual collection of insects from plants, examining the droppings and carcasses of animals, as well as with a net in mowing and on the fly. The collection of Scarabaeoidea by the authors was carried out according to standard methods, taking into account phenology, trophic confinement, and attraction by certain factors (phototropism) of different groups. Representatives of the family Lucanidae were caught by light in the evening and at night, less often on the flowing sap of deciduous trees. The lighting system was connected to a generator (900 W); DRL-250 W lamps were used. Rutelinae, Sericinae, Rhizotroginae, Hopliinae, Trichiinae and Cetoniinae were collected on plants, when viewing flowers and green parts. Most of the collections from Rutelinae, Rhizotroginae, Sericinae were

carried out in the light, as well as in the course of soil excavations (*Lasiopsis* Erichson, 1847, *Brahmina* Faldermann, 1835, *Holotrichia* Hope, 1837). Part of the Cetoniinae species were gathered in the daytime on deciduous trees, in places where sap flowed out. A universal entomological net was used to catch the beetles. Rutelinae and Sericinae and some Cetoniinae were harvested from plants by cutting. Coprophages and saprophages from Geotrupidae, Scarabaeidae (Scarabaeinae, Aphodiinae) were collected from dung and animal corpses, and were also caught using light. The collection of Trogidae keratophages was gathered from dried animal corpses, or from litter. The soil under the specified substrate was viewed. After pickling, all collected material (ethyl acetate was used) was laid out on insect storage mattresses, and partially placed in test tubes with ethyl alcohol (96%).

For the statistical analysis, the basic data matrix was supplemented with materials of the species composition of Scarabaeoidea fauna from the Russian mainland Primorsky Krai (175 species) [8,15], which was the basis for the formation of the island fauna. The statistics for each of the 21 islands has been compiled based on the list of species given in this study and, partially, on literature data [11,12], as well as materials from Russky Island that are in press (80 species) [16]. The multivariate analysis of the final data matrix, including lists of species from the listed localities, was performed using cluster analysis based on the calculation of Jaccard's faunal similarity coefficient [17]. The similarity dendrogram was built using the PAST software package [18] using neighbor-joining types.

The taxon nomenclature is presented according to the main summaries and catalogs of Scarabaeoidea from Russia and Palearctic [19–21]. The system of the superfamily Scarabaeoidea is given as interpreted by the authors [22]. The material in the species list without references is held in the collection of the first author. New taxa from the islands are marked (*). The sex in the annotated list is indicated for species with pronounced sexual dimorphism. Roman numerals indicate the months of activity of imago. The general distribution is given for the subspecies if it is present. When considering the ranges of the general distribution of species, we summarized the chorological groups of Scarabaeoidea by following the method of K. B. Gorodkov [23].

3. Results

3.1. Species Composition and Taxonomic Structure

The analysis of the materials and literature data from 20 small and medium-sized islands of Peter the Great Gulf revealed 83 species from 38 genera of 13 subfamilies and four families of the superfamily Scarabaeoidea. A total of 80 species from 36 genera of 12 subfamilies of four families were identified from the Russky Island [15]. For the 21 islands of the gulf, 87 species from 38 genera of 13 subfamilies and four families of the superfamily Scarabaeoidea were found. As a result, 60 species (72.3%) and 20 genera (52.6%) are new to the fauna of 20 islands (not including Russky Island) compared to the literature data [11,12].

The distribution of Scarabaeoidea over individual islands is extremely uneven due to their different remoteness from the mainland, area, nature of relief, as well as peculiarities of biocenosis and, of course, the level of study (Figure 2).

The total fauna of 21 islands is represented by Scarabaeidae Latreille, 1802–77 species (88.5%), other families are represented with a single species: Trogidae Macleay, 1819 with five species (5.7%), Lucanidae Latreille, 1804 with three species (3.5%), Geotrupidae Latreille, 1802 with two species (2.3%). In Scarabaeidae, the Scarabaeinae dominate with 15 species (19.5%), Aphodiinae Leach, 1815 with 14 species (18.2%), and Rhizotroginae with 13 species (16.9%). It should be noted that data on Scarabaeinae from 20 islands of Peter the Great Gulf are reported for the first time.

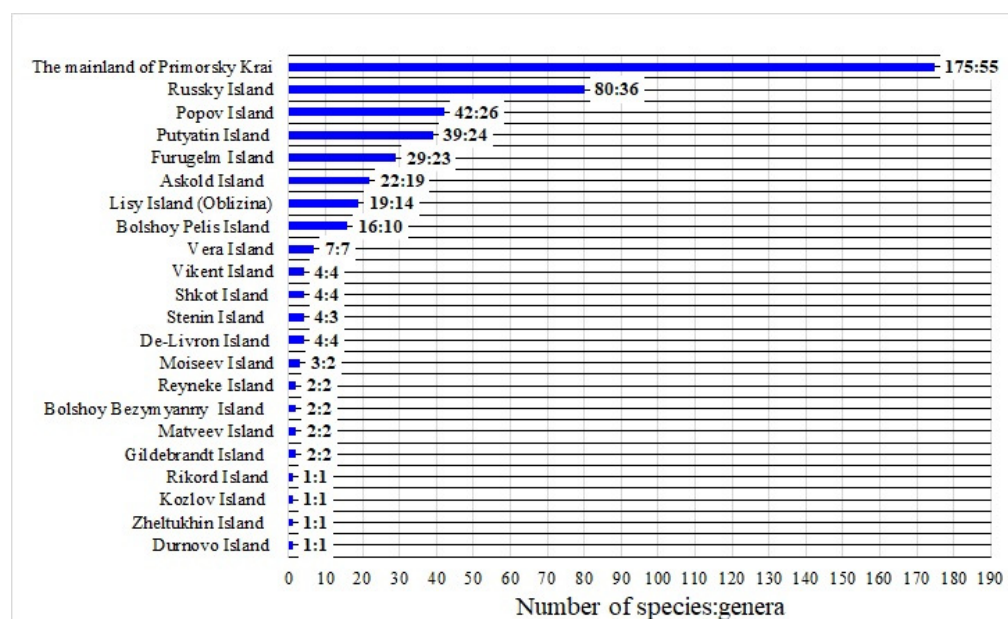


Figure 2. Distribution of Scarabaeoidea on the islands of the Peter the Great Gulf.

The most diverse fauna has been found on Russky Island: 80 species (92% of the total fauna of the 21 islands and 45.7% of the entire fauna of Primorsky Krai of Russia), Popov Island—42 species (48.3%), and Putyatin Island—39 species (44.8%). Kozlov, Ricord, Zheltukhin, and Durnovo islands have been found to host only one species each (1.1%).

3.2. Annotated List of Species of Lamellicorn Beetles from Twenty Islands of the Peter the Great Gulf without about Russky Island

SCARABAEOIDEA

Lucanidae

Lucaninae

1. **Dorcus rubrofemoratus rubrofemoratus* (Snellen van Vollenhoven, 1865)

Material. 1 ♂—Askold Island, 19 July 1995, Morozov; 2 ♀♀—Popov Island, near the Popov vill., 8–11 July 2011, Chuvilin.

Ecology. East Asian nemoral species. Lymphophagous. Imago are active from VI to IX. Note. It is reported for the first time from the islands of Peter the Great Gulf.

2. **Lucanus dybowsky dybowsky* Parry, 1873

Material. 1 ♂—Putyatin Island, Lake Gusinoe, 11–15 July 1998, F. Solodovnikov; 1 ♀—Popov Island, near the Popov vill., 8–11 July 2011, Chuvilin.

Ecology. East Asian nemoral species. Lymphophagous. Imago are active from VI to IX. Note. It is reported for the first time from the islands of Peter the Great Gulf.

3. *Prismognathus dauricus* Motschulsky, 1860

Material. 1 ♂, 2 ♀♀—Askold Island, sea coast, 10–13 July 1989, M. Lipatov; 1 ♂—Reyneke Island, Gryazny Stream, 28 July 2001, S. Akimova, 1 ♂—Popov Island, 27 July 2005, A. Sergeev.

Ecology. East Asian nemoral species. Lymphophagous. Imago are active from VII to IX.

Note. Recorded from Furugelm Island by S.A. Shabalin [11].

Trogidae

Troginae

4. **Trox (Trox) cadaverinus komareki* Balthasar, 1931

- Material. 1 spm.—Putyatin Island, oak forest, 30 July 1978, G.Sh. Lafer (FSCB); 1 spm.—Popov Island, near the Popov vill., 8–11 July 2011, Chuvilin.
 Ecology. East Palaearctic subspecies of the Transpalaearctic boreal species. Kerato-necrophagous. Imago are active from V to X.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
5. **Trox (Trox) sabulosus ussuriensis* Balthasar, 1931
 Material. 1 spm.—Askold Island, 21 September 1995, Morozov.
 Ecology. East Palaearctic subspecies of the Transpalaearctic boreal species. Kerato-necrophagous. Imago are active from V to X.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
6. *Trox (Niditrox) koreanus* Kim, 1991
 Ecology. East Asian nemoral species. Keratophagous. Imago are active from V to X.
 Note. Given from Furugelm Island only by S.A. Shabalin [11].
7. *Glyptotrox mandli* (Balthasar, 1931)
 Material. 2 spms.—Popov Island, near the Popov vill., 4–18 October 2011, Chuvilin.
 Ecology. East Palaearctic boreal species. Kerato-necrophagous. Imago are active from IV to X.
 Note. Recorded from Furugelm Island by S.A. Shabalin [11].
 Geotrupidae
 Geotrupinae
8. **Phelotrupes (Chromogeotrupes) auratus auratus* (Motschulsky, 1858)
 Material. 1 spm.—Furugelm Island, 19–22 July 2001, A. Kucherenko; 1 spm.—Putyatin Island, Putyatin vill., 29 July–5 August 2004, Mirokhin, 1 spm.—Askold Island, 21 August 2007, M. Lipatov; 1 spm.—Popov Island, coast of Stark Strait, 25–27 June 2009, S.V. Veriga.
 Ecology. East Asian nemoral species. Copro-necrophagous. Imago are active from V to X.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
9. **Geotrupes (Geotrupes) koltzei* Reitter, 1892
 Material. 1 spm.—Putyatin Island, cow dung, 20 August 1967, G.Sh. Lafer (FSCB), 1 spm.—same locality, Lake Gusinoe, 11–15 July 1998, F. Solodovnikov, 1 spm.—Askold Island, sea coast, 13–15 September 1989, M. Lipatov; 1 spm.—Lisy Island, Erzhikovich Cape, 17 July 1991, V. Molchanov.
 Ecology. East Palaearctic boreal species. Copro-necrophagous. Imago are active from V to X.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
 Scarabaeidae
 Aegialiinae
10. **Aegialia (Psammoporus) friebi* Balthasar, 1935
 Material. 1 spm.—Putyatin Island, 18 August 2000, Mirokhin.
 Ecology. East Palaearctic boreal species. Sapro-coprophagous. Imago are active from V to X.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
 Aphodiinae
11. **Aphodius (Acanthobodilus) languidulus* A. Schmidt, 1916
 Material. 2 spms.—Furugelm Island, 19–22 July 2001, A. Kucherenko; 1 spm.—Reyneke Island, near the Reineke vill., 21–23 September 2010, Chuvilin.
 Ecology. East Asian nemoral species. Coprophagous. Imago are active from VI to IX.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
12. **Aphodius (Acrossus) binaevulus* Heyden, 1887

- Material. 1 spm.—Putyatin Island, Lake Gusinoe, 11–15 July 1998, F. Solodovnikov; 1 spm.—Popov Island, near the Popov vill., 8–11 July 2011, Chuvilin.
Ecology. East Asian nemoral species. Coprophagous. Imago are active from VI to IX.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
13. **Aphodius (Acrossus) rufipes* (Linnaeus, 1758)
Material. 1 spm.—Bolshoy Pelis Island, 5–10 June 1992, I. Makhortov; 1 spm.—Putyatin Island, 22 July 2001, Zemlyansky; 1 spm.—Popov Island, 28 July 2008, O. Ozerov.
Ecology. Holarctic intrazonal species. Coprophagous. Imago are active from V to IX.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
14. **Aphodius (Acrossus) superatratus* Nomura and Nakane, 1951
Material. 1 spm.—Kozlov Island, 2–3 July 1999, Petrenko; 1 spm.—Lisy Island, 17 July 2008, Yu. Mikhailov.
Ecology. East Asian nemoral species. Coprophagous. Imago are active from VI to IX.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
15. **Aphodius (Agrilinus) convexus* Erichson, 1848
Material. 1 spm.—Stenin Island, 6–8 August 1986, P. Astakhov.
Ecology. Transpalearctic intrazonal species. Coprophagous. Imago are active from VI to VIII.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
16. **Aphodius (Aphodaulacus) koltzei* Reitter, 1892
Material. 3 spms.—Putyatin Island, 22 July 2001, Zemlyansky; 1 spm.—Lisy Island, 25 August 2005, Yu. Mikhailov.
Ecology. East Palaearctic boreal species. Coprophagous. Imago are active from VI to VIII.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
17. **Aphodius (Aphodaulacus) variabilis* C.O. Waterhouse, 1875
Material. 4 spms.—Shkot Island, Battery 904, 14–15 July 1998, 1 spm.—Vikent Island, 4–5 July 1999, Petrenko; 2 spms.—Putyatin Island, Putyatin vill., 27 October 2004, Mirokhin.
Ecology. East Asian nemoral species. Coprophagous. Imago are active from V to XI.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
18. **Aphodius (Aphodiellus) impunctatus* C.O. Waterhouse, 1875
Material. 1 spm.—Gildebrandt Island, 8 September 1999, M. Sergeev; 1 spm.—Lisy Island, 25 July 2005, Yu. Mikhailov.
Ecology. East Asian nemoral species. Coprophagous. Imago are active from VI to VIII.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
19. **Aphodius (Colobopterus) notabilipennis* Petrovitz, 1972
Material. 1 spm.—Putyatin Island, seashore, on faeces, 28 July 1978, A.V. Plutenko (FSCB); 1 spm.—Popov Island, near the Popov vill., 8–11 July 2011, Chuvilin.
Ecology. East Palaearctic boreal species. Coprophagous. Imago are active from VI to VIII.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
20. **Aphodius (Colobopterus) propraetor* Balthasar, 1932
Material. 1 spm.—Askold Island, 10–13 July 1989, M. Lipatov, 1 spm.—Putyatin Island, Lake Gusinoe, 11–15 July 1998, F. Solodovnikov; 1 spm.—Lisy Island, Erzhikovich Cape, 17 July 1991, V. Molchanov.
Ecology. East Palaearctic boreal species. Copro-necrophagous. Imago are active from IV to IX.
Note. It is reported for the first time from the islands of Peter the Great Gulf.

21. **Aphodius (Eupleurus) subterraneus subterraneus* (Linnaeus, 1758)
 Material. 1 spm.—Moiseev Island, 23–29 June 2005, V. Volchik, 2 spms.—Popov Island, near the Popov vill., 8–11 July 2011, Chuvilin.
 Ecology. Holarctic intrazonal species. Coprophagous. Imago are active from VI to VIII.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
22. **Aphodius (Labarrus) sublimbatus* Motschulsky, 1860
 Material. 1 spm.—Lisy Island, 8 June 2008, A. Zhirnov; 1 spm.—Putyatin Island, Putyatin vill., 29 July–5 August 2004, Mirokhin.
 Ecology. Central-East Palaearctic boreal species. Coprophagous. Imago are active from VI to VIII.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
23. **Aphodius (Phaeaphodius) rectus* (Motschulsky, 1866)
 Material. 1 spm.—Askold Island, 10–13 August 1989, M. Lipatov, 3 spms.—Putyatin Island, 11–15 July 1998, F. Solodovnikov; 1 spm.—Lisy Island, Erzhikovich Cape, 28 October 1991, V. Molchanov; 2 spms.—Zheltukhin Island, 28–30 July 2004, Petrenko; 5 spms.—Popov Island, near the Popov vill., 8–11 July 2011, Chuvilin.
 Ecology. Subtranspalaearctic intrazonal species. Copro-necro-saprophagous. Imago are active from IV to X.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
24. **Aphodius (Teuchestes) brachysomus* Solsky, 1874
 Material. 1 spm.—Bolshoy Pelis Island, from the stomach of a black-tailed gull, 10 May 1966, G.Sh. Lafer (FSCB); 1 spm.—Moiseev Island, 23–29 June 2005, V. Volchik.
 Ecology. East Palaearctic intrazonal species. Coprophagous. Imago are active from V to IX.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
 Scarabaeinae
25. **Coprins ochus* (Motschulsky, 1861)
 Material. 1 ♂, 1 ♀—Putyatin Island, sea coast, 28–29 July 1978, G.Sh. Lafer (FSCB); 1 ♀—Popov Island, coast of Stark Strait, 25–27 June 2009, S.V. Veriga.
 Ecology. East Asian nemoral species. Coprophagous. Imago are active from VI to IX.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
26. **Caccobius (Caccobius) brevis* C.O. Waterhouse, 1875
 Material. 14 ♂♂, 10 ♀♀—Putyatin Island, 28 June 1978, A.V. Plutenko (FSCB); 2 ♀♀—Stenin Island, 3–6 July 1986, P. Astakhov, 1♀—Bolshoy Pelis Island, 23 September 1991, I. Makhortov.
 Ecology. East Palaearctic boreal species. Copro-necrophagous. Imago are active from V to X.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
27. **Caccobius (Caccophilus) christophi* Harold, 1879
 Material. 1 ♂—Stenin Island, 3–6 July 1986, P. Astakhov, 1 ♀—Bolshoy Pelis Island, 28 August 1991, I. Makhortov.
 Ecology. East Asian nemoral species. Coprophagous. Imago are active from V to X.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.
28. **Caccobius (Caccophilus) kelleri* (Olsoufieff, 1907)
 Material. 1 ♂—De-Livron Island, 9 July 1995, Voronenko; 1 ♀—Popov Island, 19–21 July 2013, S. Mikhailov.
 Ecology. East Asian nemoral species. Copro-necrophagous. Imago are active from V to X.
 Note. It is reported for the first time from the islands of Peter the Great Gulf.

29. **Caccobius (Caccophilus) sordidus* Harold, 1886

Material. 3 ♀♀—Furugelm Island, 19–22 July 2001, A. Kucherenko; 1 ♂—Putyatin Island, 29 July–5 August 2004, Mirokhin; 1 ♀—Askold Island, 21 July 2007, M. Lipatov; 2 ♂♂—Popov Island, coast of the Stark Strait, 21 October 2010, D. Demidov.

Ecology. East Asian nemoral species. Copro-necrophagous. Imago are active from V to X.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

30. **Onthophagus (Altonthophagus) uniformis* Heyden, 1886

Material. 1 ♂—Putyatin Island, 28 August 2005, Mirokhin; 1 ♀—Lisy Island, 14 July 2008, V. Skabeev;

Ecology. East Asian nemoral species. Copro-sapro-necro-mycetophagous. Imago are active from V to X.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

31. **Onthophagus (Gibbonthophagus) atripennis* C.O. Waterhouse, 1875

Material. 1 ♂, 3 ♀♀—Popov Island, 28 June 2008, S.V. Veriga.

Ecology. East Asian nemoral species. Copro-necro-mycetophagous. Imago are active from V to X.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

32. **Onthophagus (Onthophagus) bivertex* Heyden, 1887

Material. 2 ♂♂, 16 ♀♀—Putyatin Island, 31 June 1978, G.Sh. Lafer (FSCB); 1 ♂—Shkot Island, town of artillerymen, 25–26 July 2003, Titorenko.

Ecology. East Asian nemoral species. Copro-necro-mycetophagous. Imago are active from IV to X.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

33. **Onthophagus (Palaeonthophagus) gibbulus* (Pallas, 1781)

Material. 1 ♀—Furugelm Island, 19–22 July 2001, A. Kucherenko; 1 ♂, 2 ♀♀—Putyatin Island, 29 July–5 August 2004, Mirokhin; 1 ♂—Askold Island, 18 July 2005, Markova; 2 ♂♂—Popov Island, 10–13 August 2011, Zhirnov.

Ecology. Transpalaeartic intrazonal species. Copro-necrophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

34. **Onthophagus (Palaeonthophagus) marginalis* (Gebler, 1817)

Material. 1 ♂—Putyatin Island, 15 July 2007, Mirokhin.

Ecology. Subtranspalaeartic intrazonal species. Coprophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

35. **Onthophagus (Palaeonthophagus) olsoufieffi* Boucomont, 1924

Material. 1 ♂—Vikent Island, 3 September 1999, Petrenko.

Ecology. East Palaeartic boreal species. Copro-necrophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

36. **Onthophagus (Palaeonthophagus) scabriusculus* Harold, 1873

Material. 2 ♀♀—Bolshoy Pelis Island, 27 September 1990, P. Astakhov, 1 ♂—De-Livron Island, 7 September 1995, Voronenko; 1 ♂—Pakhtusov Islands, Bolshoy Bezymyanny Island, 1–3 August 2007, N. Yakimenko, 1 ♂—Popov Island, 11–15 June 2008, Chuvilin.

Ecology. Central-East Palaeartic intrazonal species. Copro-necrophage. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

37. **Onthophagus (Parentius) punctator* Reitter, 1892

Material. 1 ♂—Bolshoy Pelis Island, 23 August 2000, Solovyov; 2 ♂♂—Putyatin Island, 5 September 2002, S. Romanenko.

Ecology. East Palaearctic intrazonal species. Copro-necrophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

38. **Onthophagus (Phanaeomorphus) fodiens* C.O. Waterhouse, 1875

Material. 1 ♂—Putyatin Island, 13 August 1999, Alekhin.

Ecology. East Asian nemoral species. Copro-necrophagous. Imago are active from V to X.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

39. **Onthophagus (Strandius) japonicus* Harold, 1874

Material. 1 ♂,—Popov Island, 23–24 July 2001, P. Timokhin.

Ecology. East Asian nemoral species. Copro-necrophagous. Imago are active from V to X.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

Rutelinae

40. **Popillia flavosellata* Fairmaire, 1886

Material. 1 spm.—Askold Island, 26–28 July 2000, Charunov, 2 spms.—Putyatin Island, Lake Gusinoe, 19 July 2009, B. Bibikov; 1 spm.—Lisy Island, 12 August 2011, V. Molchanov.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VI to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

41. **Popillia mutans* Newman, 1838

Material. 1 spm.—Vikent Island, 4–5 July 1999, Petrenko, 1 spm.—Popov Island, 20 July 2003, N. Tikhonov.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VI to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

42. **Popillia quadriguttata* (Fabricius, 1787)

Material. 2 spms.—Vera Island, 16 August 2003, B. Pisarenko; 1 spm.—Askold Island, 11–12 July 2004, M. Orlova; 1 spm.—Popov Island, coast of the Stark Strait, 25–27 June 2009, S.V. Veriga.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VI to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

43. **Mimela holosericea* (Fabricius, 1787)

Material. 1 spm.—Popov Island, 25–27 June 2009, S.V. Veriga.

Ecology. Subtranspalaearctic intrazonal species. Phyllo-antophagous. Imago are active from VI to VIII.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

44. *Mimela testaceipes ussuriensis* (S.I. Medvedev, 1949)

Material. 3 spms.—Putyatin Island, 29 July 1997, Arkadiev, 1 spm.—Askold Island, 13 August 2001, M. Lipatov; 2 spms.—Furugelm Island, 16. vii. 2003, Borisov; 1 spm.—Lisy Island, 22 July 2005, Yuryev.

Ecology. Mainland subspecies of the East Asian nemoral species. Phyllo-antophagous. Imago are active from VI to IX.

Note. Recorded from Furugelm Island by S.A. Shabalin [11].

45. *Phyllopertha horticola* (Linnaeus, 1758)
Material. 2 spms.—Vera Island, 16 July 2003, B. Pisarenko; 1 spm.—Popov Island, 25–27 June 2009, S.V. Veriga.
Ecology. Transpalearctic species. Phyllo-antophagous. Imago are active from V to IX.
Note. Recorded from Bolshoy Pelis Island by S.A. Shabalin [11].
46. *Anomala luculenta* Erichson, 1847
Material. 1 spm.—Vera Island, 16 August 2003, B. Pisarenko; 1 spm.—Popov Island, 25–27 June 2009, S.V. Veriga.
Ecology. East Palaearctic boreal species. Phyllo-antophagous. Imago are active from VI to IX.
Note. Recorded from Furugelm Island by S.A. Shabalin [11].
47. **Anomala mongolica* Faldermann, 1835
Material. 1 spm.—Popov Island, 1969, T. Tinlyakova (FSCB); 1 spm.—Furugelm Island, 16 July 2003, Borisov.
Ecology. East Palaearctic boreal species. Phyllo-antophagous. Imago are active from VI to IX.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
48. **Anomala ogloblini* S.I. Medvedev, 1949
Material. 1 spm.—Lisy Island, Erzhikovich Cape, 7–12 July 1988, V. Molchanov, 1 spm.—there, 8 June 2008, A. Zhirnov.
Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VI to VIII.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
49. **Exomala conspurcata* (Harold, 1878)
Material. 1 spm.—Matveev Island, 27 July 1993, Filatov, 1 spm.—Furugelm Island, 16 July 2003, Borisov.
Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VI to VIII.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
50. *Exomala pallidipennis* (Reitter, 1903)
Material. 1 spm.—Putyatin Island, 29 July 1997, Arkadiev, 1 spm.—there, 28 June 1998, F. Solodovnikov, 1 spm.—Askold Island, 13 August 2001, M. Lipatov; 4 spms.—Lisy Island, 22 July 2005, Yurieva.
Ecology. East Palaearctic boreal species. Phyllo-antophagous. Imago are active from VI to VIII.
Note. Recorded from Furugelm Island by S.A. Shabalin [11].
- Sericinae
51. **Maladera castanea* (Arrow, 1913)
Material. 1 spm.—Popov Island, 16 August 1989, Korshikov; 3 spms.—Putyatin Island, 19 June 2001, Salyukov.
Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from V to X.
Note. It is reported for the first time from the islands of Peter the Great Gulf.
52. **Maladera orientalis* (Motschulsky, 1858)
Material. 5 spms.—Askold Island, 21 October 2003, D. Denisov; 1 spm.—Lisy Island, 27 June 2007, V. Skabeev.
Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from IV to X.
Note. It is reported for the first time from the islands of Peter the Great Gulf.

53. *Maladera renardi* (Ballion, 1871)

Material. 1 spm.—Bolshoy Pelis Island, 19–21 July 1990, P. Astakhov; 1 spm.—Pakhtusov Islands, Bolshoy Bezymyanny Island, 1–3 August 2007, N. Yakimenko, 4 spms.—Popov Island, 11–15 June 2008, Chuvilin.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from IV to IX.

Note. Recorded from Furugelm Island by S.A. Shabalin [11].

54. *Maladera spissigrada* (Brenske, 1897)

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from IV to IX.

Note. Given from Bolshoy Pelis Island only by S.A. Shabalin [11].

55. *Nipponoserica koltzei* (Reitter, 1897)

Material. 5 spms.—Furugelm Island, 27 July 1975, A. Velizhanin (ISEA), 1 spm.—Bolshoy Pelis Island, 23 July 2001, P. Astakhov, 1 spm.—De-Livron Island, 18 July 2003, Voronenko.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from V to IX.

Note. Recorded from Furugelm Island by S.A. Shabalin [11].

56. *Sericania fuscolineata* Motschulsky, 1860

Material. 1 spm.—Vera Island, 16 August 2003, B. Pisarenko; 2 spms.—Askold Island, 29 August 2005, D. Denisov; 3 spms.—Popov Island, coast of the Stark Strait, 25–27 June 2009, S.V. Veriga.

Ecology. East Palaearctic boreal species. Phyllo-antophagous. Imago are active from V to X.

Note. Recorded from Furugelm and Bolshoy Pelis Islands by S.A. Shabalin [11].

57. *Serica polita* (Gebler, 1832)

Material. 1 spm.—Furugelm Island, meadow, 27 July 1975, A. Velizhanin (ISEA), 1 spm.—Gildebrandt Island, 8 September 1999, M. Sergeeva.

Ecology. East Palaearctic boreal species. Phyllo-antophagous. Imago are active from V to X.

Note. Recorded from Furugelm Island by S.A. Shabalin [11].

58. **Serica rosinae rosinae* Pic, 1904

Material. 1 spm.—Durnov Island, 13 August 1994, Filatov, 2 spms.—Furugelm Island, 19–22 July 2001, A. Kucherenko; 1 spm.—Putyatin Island, Putyatin vill., 29 July–5 August 2004, Mirokhin, 1 spm.—Askold Island, 21–24 August 2007, M. Lipatov; 3 spms.—Popov Island, coast of the Stark Strait, 25–27 June 2009, S.V. Veriga.

Ecology. Mainland subspecies of the East Asian nemoral species. Phyllo-antophagous. Imago are active from VI to X.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

Melolonthinae

59. *Hoplosternus incanus* Motschulsky, 1854

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VII to IX.

Note. Given from Furugelm Island only by S.A. Shabalin [11].

Rhizotroginae

60. **Apogonia cupreoviridis* H.J. Kolbe, 1886

Material. 1 spm.—Vera Island, 16 August 2003, B. Pisarenko; 1 spm.—Askold Island, 29 August 2005, D. Denisov.

Ecology. East Asian nemoral species. Phyllo-antophage. Imago are active from VI to VIII.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

61. **Hilyotrogus bicoloreus* (Heyden, 1887)

Material. 1 spm.—Furugelm Island, 19–22 July 2001, A. Kucherenko; 7 spms.—Putyatin Island, Putyatin vill., 29 July–5 August 2004, Mirokhin, 2 spms.—Askold Island, 21–24 August 2007, M. Lipatov; 2 spms.—Popov Island, coast of the Stark Strait, 23 October 2009, S.V. Veriga.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from V to X.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

62. **Brahmina faldermanni* Kraatz, 1829

Material. 1 spm.—Popov Island, 28 June 2008, S.V. Veriga.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VI to VIII.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

63. **Lasiopsis golovjankoi* S.I. Medvedev, 1951

Material. 1 spm.—Putyatin Island, 29 June–5 August 2004, Mirokhin.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VII to VIII.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

64. **Sophrops heydeni* (Brenske, 1892)

Material. 1 spm.—Popov Island, 29 July 2010, Zhirnov.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VII to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

65. *Eotrichia niponensis* (Lewis, 1895)

=*titanis* (Reitter, 1902)

Ecology. East Asian nemoral species. Phyllophagous. Imago are active from V to VI.

Note. Reported from Furugelm Island by only S.A. Shabalin as *Eotrichia titanis* (Reitter, 1902) [11].

66. *Holotrichia diomphalia* (Bates, 1888)

Material. 1 spm.—Furugelm Island, 10–20 June 1969, Yu.M. Nazarov (FSCB); 1 spm.—Putyatin Island, 19 June 2001, Salyukov; 4 spms.—Popov Island, 9 September 2011, Zhirnov.

Ecology. East Palaearctic boreal species. Phyllophagous. Imago are active from V to IX.

Note. Recorded from Furugelm Island by S.A. Shabalin [11].

67. *Holotrichia kiotonensis* Brenske, 1894

Material. 1 spm.—Popov Island, 10–13 August 2011, Zhirnov.

Ecology. East Asian nemoral species. Phyllophagous. Imago are active from VI to VIII.

Note. Recorded from Furugelm Island by S.A. Shabalin [11].

68. *Holotrichia oblita* (Falderman, 1835)

Ecology. East Asian nemoral species. Phyllophagous. Imago are active from VI to VIII.

Note. Reported as *Holotrichia amplipennis* (Fairmaire, 1887) from Putyatin Island only S.I. Medvedev [12].

69. *Holotrichia picea* C.O. Waterhouse, 1875

Ecology. East Asian nemoral species. Phyllophagous. Imago are active from VI to VIII.

Note. Given from Furugelm Island only by S.A. Shabalin [11].

70. *Holotrichia sichotana* Brenske, 1897

Material. 1 spm.—Popov Island, 14 July 1968. (FSCB); 1 spm.—Putyatin Island, 7 September 2001, Salyukov.

Ecology. East Asian nemoral species. Phyllophagous. Imago are active from VI to IX.

Note. Recorded from Furugelm and Bolshoy Pelis Islands by S.A. Shabalin [11].

Hopliinae

71. *Ectinohoplia rufipes* (Motschulsky, 1860)

Material. 1 spm.—Askold Island, 10 June 2003, D. Denisov; 1 spm.—Lisy Island, 27 June 2007, V. Skabeev.

Ecology. East Asian nemoral species. Phyllo-antophagous. Imago are active from VI to IX.

Note. Reported from Furugelm Island by S.A. Shabalin [11].

72. **Hoplia aureola* (Pallas, 1781)

Material. 1 spm.—Furugelm Island, 4–5 June 2000, A. Kucherenko; 1 spm.—Putyatin Island, 16 June 2002, Khomenko; 1 spm.—Lisy Island, 14 July 2008, V. Skabeev.

Ecology. Central-East Palaearctic boreal species. Anto-phylophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

Trichiinae

73. *Lasiotrichius succinctus* (Pallas, 1781)

Material. 5 spms.—Putyatin Island, 29 July–5 August 2004, Mirokhin, 3 spms.—Askold Island, 25 August 2007, M. Lipatov; 2 spms.—Lisy Island, 22 September 2005, O. Demitrienko; 1 spm.—Popov Island, 21 July 2009, Chuvilin.

Ecology. East Palaearctic boreal species. Antophagous. Imago are active from VI to IX.

Note. Recorded from Furugelm Island by S.A. Shabalin [11].

74. **Trichius fasciatus* (Linnaeus, 1758)

Material. 1 spm.—Shkot Island, town of artillerymen, 25–26 July 2003, Titorenko, 1 spm.—Popov Island, 30 June 2009, Chuvilin; 1 spm.—Putyatin Island, Putyatin vill., 29 July–5 August 2004, Mirokhin, 1 spm.—Askold Island, 13 August 2005, Volkov; 1 spm.—Lisy Island, 19–21 July 2007, O. Demitrienko.

Ecology. Transpalaearctic intrazonal species. Antophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

75. **Gnorimus subopacus* Motschulsky, 1860

Material. 1 spm.—Vera Island, 28 July 2004, B. Pisarenko; 1 spm.—Putyatin Island, 15 June 2005, Mirokhin.

Ecology. East Asian nemoral species. Anto-lymphophagous. Imago are active from VI to VII.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

Cetoniinae

76. *Cetonia magnifica* Ballion, 1871

Material. 2 spms.—Bolshoy Pelis Island, 11 September 1966, G.Sh. Lafer (FSCB), there, 1 spm.—6 September 1966, M. Kazykhanova (FSCB); 3 spms.—Popov Island, coast of the Stark Strait, 25–27 June 2009, S.V. Veriga.

Ecology. East Asian nemoral species. Anto-lymphophagous. Imago are active from V to IX.

Note. Recorded from Furugelm and Bolshoy Pelis Islands by S.A. Shabalin [11].

77. **Cetonia viridiopaca* (Motschulsky, 1858)

Material. 1 spm.—Lisy Island, Erzhikovich Cape, 7–12 July 1988, V. Molchanov.

Ecology. East Asian nemoral species. Anto-lymphophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

78. * *Protaetia brevitarsis* (Lewis, 1879)

Material. 2 spms.—Vera Island, 28 July 2004, B. Pisarenko; 1 spm.—Askold Island, 21 June 2005, M. Orlova; 3 spms.—Popov Island, 28 June 2009, S.V. Veriga.

Ecology. Central-East Palaearctic boreal species. Anto-lymphophagous. Imago are active from IV to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

79. *Protaetia famelica* (Janson, 1878)

Material. 4 spms.—Bolshoy Pelis Island, 8–12 September 1964, G.Sh. Lafer (FSCB), 1 spm.—Matveev Island, 27 July 1993, Filatov, 2 spms.—Furugelm Island, 16 July 2003, Borisov; 1 spm.—Popov Island, 11–15 June 2008, Chuvilin.

Ecology. East Asian nemoral species. Anto-phylo-lymphophagous. Imago are active from V to IX.

Note. Recorded from Bolshoy Pelis Island by S.A. Shabalin [11].

80. **Protaetia marmorata kalinka* Kemal and Kocak, 2009

=*orientalis* (S.I. Medvedev, 1964)

Material. 1 spm.—Putyatin Island, Putyatin vill., 29 July–5 August 2004, Mirokhin, 1 spm.—Askold Island, 25 August 2007, M. Lipatov; 1 spm.—Lisy Island, 29 July 2005, O. Demitrienko; 1 spm.—Popov Island, 30 June 2009, Chuvilin.

Ecology. East Palaearctic subspecies of the Transpalaearctic boreal species. Anto-lymphophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

81. **Protaetia cuprea daurica* (Motschulsky, 1860)

Material. 1 spm.—Bolshoy Pelis Island 9–11 August 2003, M. Fedorov, 1 spm.—De-Livron Island, 15 July 2007, Artyukhov; 3 spms.—Popov Island, 11–15 June 2008, Chuvilin.

Ecology. East Palaearctic subspecies of the Transpalaearctic boreal species. Anto-lymphophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

82. **Glycyphana fulvistemma* Motschulsky, 1858

Material. 2 spms.—Stenin Island, 3–6 June 1986, P. Astakhov, 1 spm.—Bolshoy Pelis Island, 12 June 1995, I. Makhortov; 3 spms.—Putyatin Island, Putyatin vill., 13 June 2005, Mirokhin; 4 spms.—Popov Island, 24–28 June 2010, Chuvilin.

Ecology. East Asian nemoral species. Antophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

83. **Gametis jucunda* (Faldermann, 1835)

Material. 1 spm.—Shkot Island, Battery 904, 14–15 June 1998, A. Parilova, 1 spm.—Vikent Island, 4–5 July 1999, Petrenko, 1 spm.—Rikord Island, 19–21 June 2002, Petrenko, 1 spm.—Moiseev Island, 23–29 June 2005, V. Volchik; 1 spm.—Putyatin Island, 13 June 2005, Mirokhin.

Ecology. East Asian nemoral species. Antophagous. Imago are active from V to IX.

Note. It is reported for the first time from the islands of Peter the Great Gulf.

3.3. Chorology

The areal analysis of the species detected on 21 islands allowed us to distinguish seven chorological groups: East Asian—51 species (58.6%), East Palearctic—21 species (24.1%), Central East Palearctic—5 species (5.7%), Transpalearctic—4 species (4.7%),

Subtranspalearctic—3 species (3.5%), Holarctic—2 species (2.3%), and Cosmopolitan—1 species (1.1%). The island fauna is dominated by the non-moral East Asian zoogeographic complex—51 species (58.6%), with the boreal one slightly inferior—36 species (41.4%).

3.4. Faunogenesis and Zoogeographical Features of Local Faunas

The Peter the Great Gulf islands have a small area, are located on the continental shelf near the coast (Figure 1), and are spurs of the coastal mountain rises that were part of the continental landmass in the Pleistocene. The islands were formed between 11 and 8.5 thousand years ago due to post-Pleistocene sea transgression [24]. All these factors impact the low identity of the biota of these islands at this stage of natural history. At the same time, the local terrestrial ecosystems of the islands feature a complicated external exchange and are of interest for studying the structures and adaptation processes of terrestrial communities under almost pure natural experimental conditions [9]. The analysis of the species composition and distribution over individual islands has revealed a classical pattern of dependence of biodiversity on the island area and its remoteness from the continent as a source of biota replenishment (Figure 3).

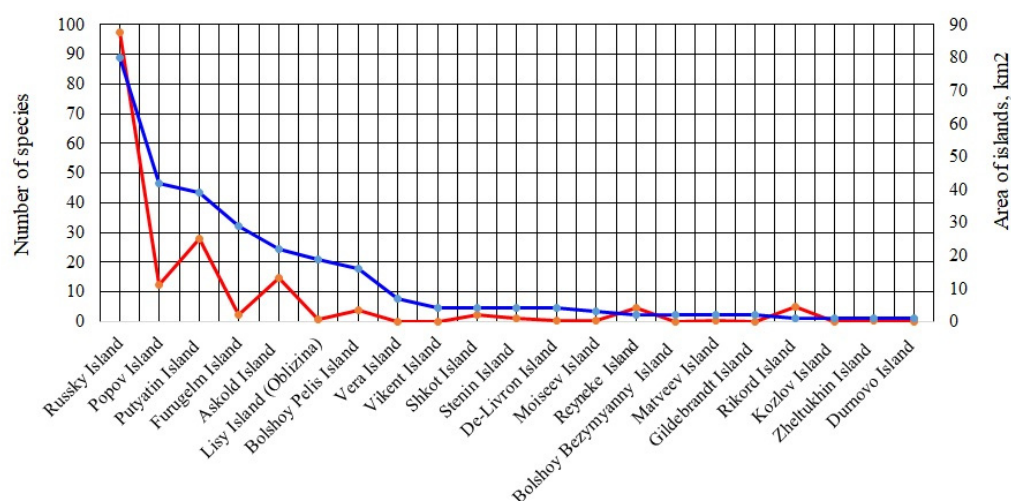


Figure 3. Dependence of taxonomic diversity of Scarabaeoidea on the area of islands in Peter the Great Gulf. Note: The area of the islands is indicated in red, and the number of species is indicated in blue.

4. Discussion

The results of the cluster analysis of species composition by islands show that four clusters are distinguished with a low level of similarity but a high bootstrap value of up to 100% (Figure 4).

The first single branch cluster represents the continental fauna of the Scarabaeoidea of Primorsky Krai of Russia (100%). The second one combines the faunas of the largest and closest to the continent islands, with Russky and Popov islands forming a separate subcluster with a bootstrap value of 46% and a similarity index of 0.20, indicating the similarity in the formation of faunas by the species inhabiting the Muravyov-Amursky Peninsula on the continent. On the Putyatyn, Askold, and Lisy islands, which are part of the second subcluster (36–44%), with a similarity of 0.30, the formation of the Scarabaeoidea faunas was influenced by the southern part of the Sikhote-Alin continental mountain system (the Livadian Ridge). An intermediate position between large and small islands is occupied by the single branch cluster of Furugelma Island of 16% and similarity of 0.25, which has a close position to the continent and a significant Scarabaeoidea species diversity. The species entered this island and the eastern islands of the Rimsky-Korsakov Archipelago from the continental part of the Khasansky District of Primorsky Krai. Then, a cluster of 15 small islands (from 4 to 57%) is formed, with similarities from 0.32 to 0.50; these islands

are more distant from the continent. The considerable variation in similarity and bootstrap values indicates a mosaic distribution of species and a poverty of species composition. Most of these islands were populated through the territories of intermediate islands closer to the continent. Finally, we have deduced three ways for the formation of the Peter the Great Gulf island faunas; primarily by overland communication in the Pleistocene (Figure 1). These findings are supported by studies on other insect groups (Lepidoptera, Orthoptera) studied on these islands [9,10]. It is also possible for some species to be transported by air in these directions from nearby areas by tailwinds and by water using large objects with high buoyancy. At present, the developing transport infrastructure may also play a specific role in species dispersal.

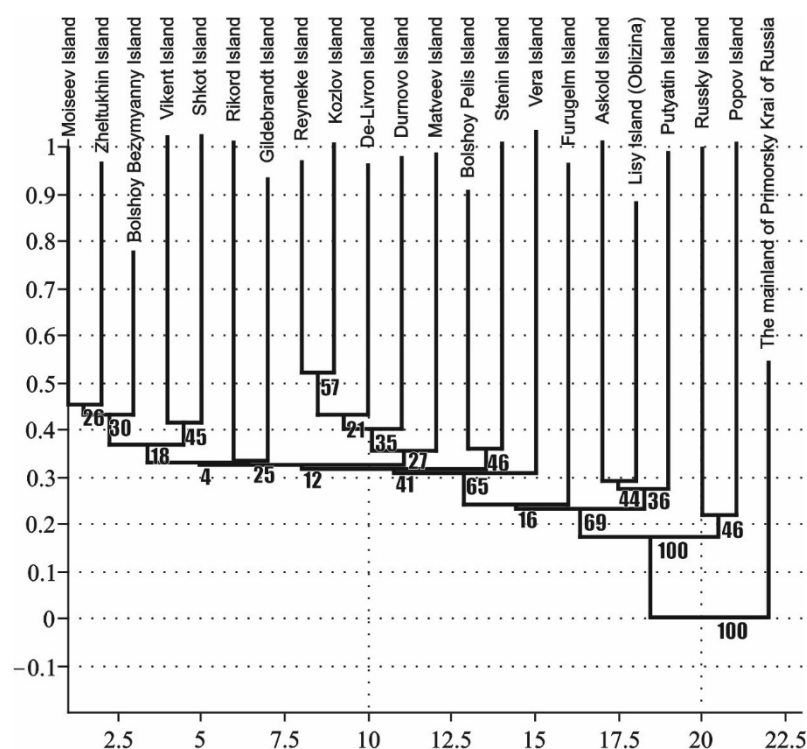


Figure 4. Dendrogram of the similarity of the local faunas of Scarabaeoidea of the islands of the Peter the Great Gulf with the mainland of the Primorsky Krai of Russia.

A significant discrepancy in the diversity of Scarabaeoidea of Russky Island from other islands under consideration is accounted for by the largest size of the island and the narrowness of the Eastern Bosphorus Strait separating it from the mainland (800 m). Due to the large area and rugged topography, a high floral and biotopic diversity is formed on the island, resulting in numerous ecological niches for Scarabaeoidea. A similar pattern, only on a smaller scale, has been revealed on Popov Island. Only these two islands host three species of Lucanidae from three genera. Putyatn and Askold islands also have 1–2 species of Lucanidae in their fauna. All four islands have 1–2 species of Geotrupidae. So far, *Trox koreanus*, *Hoplosternus incanus*, and *Eotrichia niponensis* have been found only on Furugelma Island [11]. One species of Lucanidae and Geotrupidae were also found on this island. The poor and mosaic taxonomic composition of the faunas of small islands is accounted for by the small area, poor biotopic spectrum, and insufficient study of these territories.

Environmental Characteristics

The analysis of the results obtained on some aspects of the ecology of Scarabaeoidea of the Peter the Great Gulf islands highlights the limitations of observations in the natural environment and the fragmentariness of the materials obtained from small islands. However, it is possible to make some generalizations about the total fauna from the studied

islands in the gulf. The climate of the islands is characterized by a longer frost-free period in comparison with the coastal areas of the continent, on average up to 200 days. In addition, these islands have a high humidity and intense fogs [13]. Taken together, all these factors provide conditions favorable for insects with a long period of development during the warm season and species sensitive to low winter temperatures, but not demanding high summer temperatures, adaptive to high humidity and strong winds [1], directly affecting the development of preimaginal stages and specificity of imago activity.

The phenology of imago flight in the study area allows us to distinguish four groups, as in the entire south of the continental part of Primorsky Krai of Russia [8]. However, the activity terms are markedly shifted to the right.

The spring-early summer group with a peak of imago activity in V–VI, this group includes the species from the genera: *Hoplia* Illiger, 1803, *Eotrichia* Medvedev, 1951, *Glycyphana* Burmeister, 1842, and *Gnorimus* Serville, 1825. Adult beetles can be found until the beginning of IX. There are only four species from four genera (4.6% of all fauna).

The summer group is characterized by the activity of imago in VI–VIII, and numerous species can be found till the end of IX. This group includes the representatives of the genera: *Dorcus* Macleay, 1862, *Lucanus* Scopoli, 1763, *Aphodius* Illiger, 1798, *Copris* Geoffroy, 1762, *Onthophagus* Latreille, 1802, *Ectinohoplia* Redtenbacher, 1868, *Brahmina* Blanchard, 1851, *Holotrichia* Hope, 1837, *Apogonia* Kirby, 1819, *Serica* Macleay, 1819, *Anomala* Samouelle, 1819, *Exomala* Reitter, 1903, *Mimela* Kirby, 1825, *Phyllopertha* Stephens, 1830, *Popillia* Dejean, 1821, *Lasiotrichius* Reitter, 1899, *Trichius* Fabricius, 1775, *Protaetia* Burmeister, 1842. There are 33 species from 18 genera in total (37.9%).

The late summer-fall group with imago activity in VII–X includes the species from the genera: *Prismognathus* Motschulsky, 1860, *Hoplosternus* Guérin-Meneville, 1838, *Lasiopsis* Erichson, 1847, *Sophrops* Fairmair, 1887. There are only four species from four genera (4.6%).

The spring-summer-fall group includes representatives with activity in V–IX and separate species in VI–X and up to the beginning of XI. These are the species of the genera: *Phelotrupes* Jekel, 1866, *Geotrupes* Latreille, 1796, *Trox* Fabricius, 1775, *Glyptotrox* Nikolajev, 2016, *Aegialia* Latreille, 1806, *Aphodius*, *Caccobius* Thomson, 1859, *Onthophagus*, *Hilyotrogus* Fairmaire, 1886, *Maladera* Mulsant and Rey, 1871, *Nipponoserica* Nomura, 1973, *Serica*, *Sericania* Motschulsky, 1860, *Cetonia* Fabricius, 1775, *Protaetia*. There are 46 species in total from 15 genera (52.9%).

The similarity of trophic structure with the fauna of the mainland part of Primorsky Krai is worth noting when considering the trophic preferences of Scarabaeoidea beetles on the islands. In the total fauna of the Scarabaeoidea from 21 islands (including the Russky Island), four trophic groups are distinguished: phytophages, 47 species (54%), coprophages, 34 species (39.1%), keratophages, 5 species (5.8%), and saprophages, 1 species (1.1%).

5. Conclusions

The formation of local island faunas followed three continental directions—the territory of Khasansky District, the Muravyov-Amursky Peninsula (Bogataya Griva Ridge), and the southern spurs of the Sikhote-Alin Ridge. Due to the area and topography, the distribution of Scarabaeoidea over the islands is very different. The total fauna of the 21 islands is mainly composed of typical species from the continental fauna of nemoral forests of East Asia. Some species can be found in meadows and other open biotopes. In island conditions, they are often found in the coastal zone and the windward exposures of slopes. Specific features of the local island climate with a longer period of positive temperatures allow several Scarabaeoidea species to exhibit the later phenological activity of imago compared to continental territories. In particular, this activity is characteristic of some Aphodiinae, Scarabaeinae, and even Sericinae and Rhizotroginae; observed in some years up to the middle of November. Given the active anthropogenic pressure on the coastal territories of mainland Primorsky Krai of Russia, a significant part of the islands has a limited regime of exploitation of natural resources or are part of specially protected areas.

Taken together, these findings allow consideration of the islands as reference territories for studying natural processes in ecosystems.

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