

# Biogeography of the Dytiscidae (Coleoptera) of Kamchatka: Preliminary Note

Sergey K. Kholin<sup>1)</sup> and Anders N. Nilsson<sup>2)</sup>

<sup>1)</sup> Laboratory of Entomology, Institute of Biology and Soil Science  
Vladivostok 22, 690022 Russia

<sup>2)</sup> Department of Biology and Environmental Sciences  
SE-901 87 Umeå University, Sweden

**Abstract** Thirty-eight species of predaceous diving beetles (Dytiscidae) are known from the Kamchatka peninsula. Cluster analysis showed that the Kamchatkan fauna is more similar to that of the northeasternmost part of Asia and the North Kurils. The faunas of these three regions are characterized by the predominance of Holarctic elements. No species endemic to Kamchatka is known. Future studies to clarify the biogeography of dytiscids in North East Asia are considered necessary.

**Key words:** Dytiscidae, biogeography, Kamchatka Peninsula.

The fauna of the Kamchatka Peninsula is generally characterized by a very low species diversity (Kurentzov, 1963; 1966; Levandova, 1982). However, relatively poor knowledge of the fauna of many taxa in combination with some taxonomic problems have made it difficult to make more firmly based estimates of species richness and faunal composition. Since 1993, we have carried out taxonomic studies of Far Eastern dytiscids. At present, the diving beetle fauna of Primorye, Sakhalin, the Kuriles and Kamchatka (Nilsson, unpublished data; Nilsson and Kholin, 1994; Nilsson et al., 1997; Nilsson et al., 1999) are well known. The present report gives a brief review of the biogeography of the Dytiscidae of the Kamchatka Peninsula and its relationships to adjacent regions.

## Materials and Methods

The faunal composition of Kamchatka (KAM: Nilsson et al., 1999) was compared with those of six neighboring regions, based on the following literature: northeasternmost part of Asia (NEA: Zasyapkina et al., 1996); the North and South Kurils (NKR and SKR: Nilsson et al., 1997; Nilsson et al., 1999); Sakhalin Island (SAK: Nilsson and Kholin, 1994), Primorye (PRM: Nilsson, unpubl. data), and Hokkaido, Japan (HOK: Mori and Kitayama, 1993). Table 1 shows the distribution rec-

ords of species in these regions.

Comparison of the fauna of the northeasternmost part of Asia (about 60 species) with other regions may be speculative because of taxonomic problems, and also the need for its species composition to be revised. Existing knowledge of the Hokkaido dytiscid fauna is more firmly based (about 50 species).

*Statistical analyses.* Faunal similarity between the geographical regions was estimated by Sorensen's coefficient of similarity (Legendre and Legendre, 1983). The similarity matrix resulting from pairwise calculations was subjected to UPGMA cluster analysis (by NTSYS program, version 1.70). The significance of grouping of the regions was tested statistically by the bootstrap technique (Felsenstein, 1985) as follows: 1) The same number of species as the total were resampled randomly from the original data matrix without changing the distribution of each species among the regions. Consequently, each bootstrap sample gave a new data matrix with the same set of regions but with some of the original species duplicated and others dropped by the process of resampling. 2) A new dendrogram was deduced from each bootstrap sample. 3) This process was repeated 1000 times. 4) For each regional cluster deduced from the original data matrix, the relative frequency of its occur-

**Table 1.** List of species of Dytiscidae found in northeasternmost part of Asia (NEA), Kamchatka (KAM), North Kurils (NKR), South Kurils (SKR), Sakhalin (SAK), Primorye (PRM) and Hokkaido (HOK).

Species	Region							Distribution
	NEA	KAM	NKR	SKR	SAK	PRM	HOK	
COLYMBETINAE								
<i>Agabus aequalis</i> Sharp, 1882						+	+	East Palearctic
<i>Agabus affinis</i> Paykull, 1798	+	+					+	Palearctic
<i>Agabus alinae</i> Lafer, 1988							+	East Palearctic
<i>Agabus arcticus</i> Paykull, 1798	+	+	+					Holarctic
<i>Agabus balkei</i> Fery et Nilsson, 1993	+	+						East Palearctic
<i>Agabus biguttulus</i> Thomson, 1867		+						Palearctic
<i>Agabus brandti</i> Harold, 1880							+	East Palearctic
<i>Agabus clavicornis</i> Sharp, 1882	+							Holarctic
<i>Agabus clypealis</i> Thomson, 1867	+	+	+					Holarctic
<i>Agabus confinis</i> Gyllenhal, 1808	+		+					Holarctic
<i>Agabus congener</i> Thuberg, 1794	+			+	+	+	+	Palearctic
<i>Agabus conspicuus</i> Sharp, 1873				+	+		+	Japano-Kurilian
<i>Agabus costulatus</i> Motschulsky, 1859	+	+	+			+		East Palearctic
<i>Agabus coxalis</i> Sharp, 1882	+	+			+			Holarctic
<i>Agabus daisetsuzanus</i> Kamiya, 1938 <sup>1</sup>							+	?
<i>Agabus discolor</i> Harris, 1828		+	+					Holarctic
<i>Agabus erichsoni</i> Gemminger et Harold, 1868					+	+	+	Holarctic
<i>Agabus infuscatus</i> Aubé, 1838	+							Holarctic
<i>Agabus japonicus</i> Sharp, 1873			+	+	+	+	+	East Palearctic
<i>Agabus kholini</i> Nilsson, 1994					+	+		East Palearctic
<i>Agabus labiatus</i> Brahm, 1790					+			Palearctic
<i>Agabus laferi</i> Nilsson, 1994						+		East Palearctic
<i>Agabus lapponicus</i> Thomson, 1867	+							Palearctic
<i>Agabus lineatus</i> Gebler, 1848	+							Palearctic
<i>Agabus luteaster</i> Zaitzev, 1906	+							East Palearctic
<i>Agabus mandsuricus</i> Guignot, 1956						+		East Palearctic
<i>Agabus matsumotoi</i> Satô et Nilsson, 1990					+		+	Japano-Kurilian
<i>Agabus moestus</i> Curtis, 1835	+							Holarctic
<i>Agabus neglectus</i> Erichson, 1837	+							Palearctic
<i>Agabus nigroaenus</i> Erichson, 1837 <sup>2</sup>	+							Holarctic
<i>Agabus opacus</i> Aubé, 1837	+	+			+	+		Holarctic
<i>Agabus serricornis</i> Paykull, 1799	+							Palearctic
<i>Agabus sikhotealinensis</i> Lafer, 1988						+		East Palearctic
<i>Agabus thomsoni</i> J. Sahlberg, 1871	+		+					Holarctic
<i>Agabus tristis</i> Aubé, 1838	+	+	+					Holarctic
<i>Agabus udege</i> Nilsson, 1994						+		East Palearctic
<i>Agabus vittiger</i> Gyllenhal, 1827	+							Palearctic
<i>Agabus zetterstedti</i> Thomson, 1856	+							Palearctic
<i>Colymbetes dahuricus</i> Aubé, 1836	+	+	+		+	+		Holarctic
<i>Colymbetes dolabratus</i> Paykull, 1798	+	+	+					Holarctic
<i>Colymbetes tolli</i> Zaitzev, 1906					+		+	East Palearctic
<i>Ilybiosoma striolatus</i> Gyllenhal, 1808	+							Palearctic
<i>Ilybius angustior</i> Gyllenhal, 1808	+	+	+		+			Holarctic
<i>Ilybius anjae</i> Nilsson, 1999					+	+	+	East Palearctic
<i>Ilybius apicalis</i> Sharp, 1873				+	+	+	+	East Palearctic
<i>Ilybius chishimanus</i> Kôno, 1944		+	+			+		East Palearctic
<i>Ilybius cinctus</i> Sharp, 1882						+		East Palearctic
<i>Ilybius crassus</i> Thomson, 1856	+							Palearctic
<i>Ilybius discedens</i> Sharp, 1882		+	+					Holarctic
<i>Ilybius guttiger</i> Gyllenhal, 1808	+							Palearctic

Table 1. Continued

Species	Region							Distribution
	NEA	KAM	NKR	SKR	SAK	PRM	HOK	
<i>Ilybius lateralis</i> Gebler, 1832						+		East Palearctic
<i>Ilybius nakanei</i> Nilsson, 1994				+	+		+	Japano-Kurilian
<i>Ilybius poppiusi</i> Zaitzev, 1907	+							East Palearctic
<i>Ilybius subaeneus</i> Erichson, 1837	+							Holarctic
<i>Ilybius weymarni</i> J. Balfour-Browne, 1947 <sup>3</sup>							+	Japanese
<i>Platambus fimbriatus</i> Sharp, 1884						+	+	East Palearctic
<i>Platambus koreanus</i> , 1997						+		East Palearctic
<i>Platambus optatus</i> Sharp, 1884							+	Japanese
<i>Platambus pictipennis</i> Sharp, 1873				+	+		+	Japano-Kurilian
<i>Platambus sawadai</i> Kamiya, 1932							+	Japanese
<i>Platambus ussuriensis</i> Nilsson, 1997						+		East Palearctic
<i>Rhantus erraticus</i> Sharp, 1884							+	Japanese
<i>Rhantus notaticollis</i> Aubé, 1837	+	+	+	+	+	+	+	Palearctic
<i>Rhantus suturalis</i> MacLeay, 1825				+	+	+	+	Palearctic
<i>Rhantus suturellus</i> Harris, 1828	+	+	+					Holarctic
<i>Rhantus yessoensis</i> Sharp, 1891							+	East Palearctic
COPELATINAE								
<i>Copelatus weymarni</i> J. Balfour-Browne, 1946						+	+	East Palearctic
DYTISCINAE								
<i>Acilius canaliculatus</i> Nicolai, 1822	+	+			+	+		Palearctic
<i>Acilius japonicus</i> Brinck, 1939							+	Japanese
<i>Acilius sulcatus</i> Linnaeus, 1758					+	+		Palearctic
<i>Cybister japonicus</i> Sharp, 1873						+	+	East Palearctic
<i>Dytiscus circumcinctus</i> Ahrens, 1811	+	+						Holarctic
<i>Dytiscus dauricus</i> Gebler, 1832	+	+	+	+	+	+	+	Holarctic
<i>Dytiscus delictus</i> Zaitzev, 1906			+			+		East Palearctic
<i>Dytiscus latro</i> Sharp, 1882						+		East Palearctic
<i>Dytiscus marginalis czerskii</i> Zaitzev, 1953						+	+	East Palearctic
<i>Eretes sticticus</i> Linnaeus, 1767						+	+	Palearctic
<i>Graphoderus adamsii</i> Clark, 1864						+	+	East Palearctic
<i>Graphoderus austriacus</i> Sturm, 1834						+		Palearctic
<i>Graphoderus bieneri</i> Zimmermann, 1921						+		East Palearctic
<i>Graphoderus perplexus</i> Sharp, 1882		+						Holarctic
<i>Graphoderus zonatus</i> Hoppe, 1795	+			+	+	+	+	Palearctic
<i>Hydaticus aruspex</i> Clark, 1864					+	+	+	Holarctic
<i>Hydaticus bowringii</i> Clark, 1864							+	East Palearctic
<i>Hydaticus grammicus</i> Germar, 1827						+	+	Palearctic
HYDROPORINAE								
<i>Allopachria flavomaculata</i> Kamiya, 1938							+	East Palearctic
<i>Hydroglyphus japonicus</i> Sharp, 1873						+	+	East Palearctic
<i>Hydroporus acutangulus</i> Thomson, 1856	+				+	+		Palearctic
<i>Hydroporus aenescens</i> J. Sahlberg, 1880 <sup>4</sup>	+							East Palearctic
<i>Hydroporus angusi</i> Nilsson, 1990						+		East Palearctic
<i>Hydroporus bergmani</i> Nilsson, 1995	+	+						East Palearctic
<i>Hydroporus breviusculus</i> Poppius, 1905					+	+		East Palearctic
<i>Hydroporus elongatulus</i> Sturm, 1835	+							Palearctic
<i>Hydroporus erythrocephalus</i> Linnaeus, 1758	+							Palearctic
<i>Hydroporus fuscipennis</i> Schaum, 1868	+	+			+	+	+	Holarctic

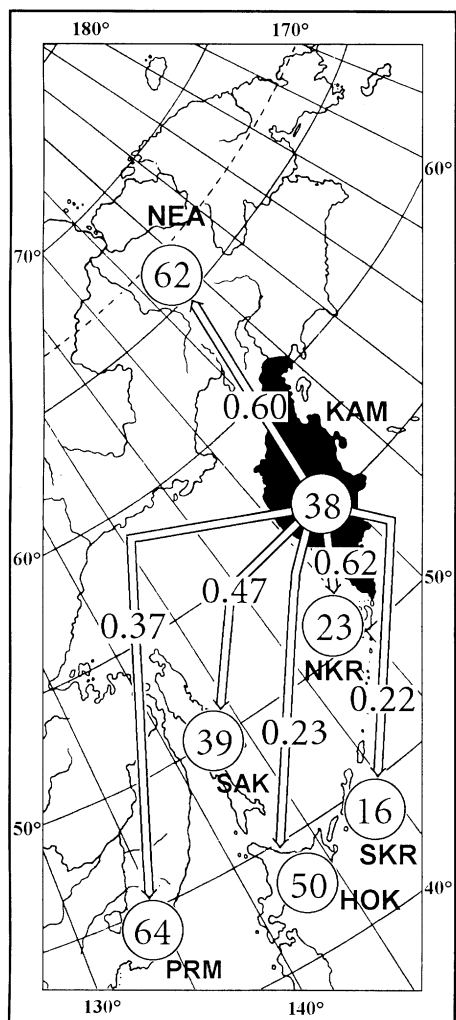
Table 1. Continued

Species	Region							Distribution
	NEA	KAM	NKR	SKR	SAK	PRM	HOK	
<i>Hydroporus glabriusculus</i> Aubé, 1838	+							Holarctic
<i>Hydroporus lapponum</i> Gyllenhal, 1808	+							Holarctic
<i>Hydroporus laticollis</i> Zimmermann, 1922		+				+	+	East Palearctic
<i>Hydroporus morio</i> Aubé, 1838	+	+	+	+	+	+	+	Holarctic
<i>Hydroporus nigellus</i> Mannerheim, 1853	+	+	+		+			Holarctic
<i>Hydroporus notabilis</i> LeConte, 1850	+	+	+					Holarctic
<i>Hydroporus picicornis</i> J. Sahlberg, 1875	+							Palearctic
<i>Hydroporus saghalienis</i> Takizawa, 1933				+	+		+	Japano-Kurilian
<i>Hydroporus sibiricus</i> J. Sahlberg, 1880	+							East Palearctic
<i>Hydroporus submuticus</i> Thomson, 1874	+	+	+		+	+	+	Palearctic
<i>Hydroporus tristis</i> Paykull, 1798	+	+		+	+		+	Holarctic
<i>Hydroporus uenoi</i> Nakane, 1963	+	+		+	+	+	+	East Palearctic
<i>Hydroporus umbrosus</i> Gyllenhal, 1808		+	+			+		Palearctic
<i>Hygrotus chinensis</i> Sharp, 1882						+	+	East Palearctic
<i>Hygrotus enneagrammus</i> Ahrens, 1833	+							Palearctic
<i>Hygrotus impressopunctatus</i> Schaller, 1783	+	+		+	+	+	+	Holarctic
<i>Hygrotus inaequalis</i> Fabricius, 1777	+	+			+	+	+	Palearctic
<i>Hygrotus marklini</i> Gyllenhal, 1813	+	+						Holarctic
<i>Hygrotus mongolicus</i> Jakovlev, 1899 <sup>5</sup>	+							East Palearctic
<i>Hygrotus novemlineatus</i> Stephens, 1829	+							Palearctic
<i>Hygrotus quinquelineatus</i> Zetterstedt, 1828	+							Palearctic
<i>Hygrotus semenowi</i> Jakovlev, 1899						+		East Palearctic
<i>Hyphydrus falckenstromi</i> Gschwendtner, 1939						+		East Palearctic
<i>Hyphydrus japonicus</i> Sharp, 1873							+	East Palearctic
<i>Nebrioporus anchoralis</i> Sharp, 1884							+	Japanese
<i>Nebrioporus hostilis</i> Sharp, 1884						+		East Palearctic
<i>Nebrioporus simplicipes</i> Sharp, 1884				+	+		+	Japano-Kurilian
<i>Oreodytes alpinus</i> Paykull, 1798	+	+			+	+		Palearctic
<i>Oreodytes kanoi</i> Kamiya, 1938							+	Japanese
<i>Oreodytes natrix</i> Sharp, 1884						+	+	East Palearctic
<i>Oreodytes okulovi</i> Lafer, 1988		+				+		East Palearctic
<i>Oreodytes sanmarkii</i> C. R. Sahlberg, 1826	+	+		+	+	+	+	Holarctic
<i>Stictotarsus multilineatus</i> Falckenström, 1922	+	+	+					Palearctic
LACCOPHILINAE								
<i>Japanolaccophilus nipponensis</i> Kamiya, 1939							+	Japanese
<i>Laccophilus difficilis</i> Sharp, 1873						+	+	East Palearctic
<i>Laccophilus lewisoides</i> Brancucci, 1983						+		East Palearctic
<i>Laccophilus minutus</i> Linnaeus, 1758						+		Palearctic
<i>Laccophilus sharpi</i> Regimbart, 1889							+	Oriental
<i>Laccophilus vagelineatus</i> Zinnermann, 1922						+		East Palearctic
Number of species	62	38	23	17	39	64	50	

<sup>1</sup>probably synonym of *Agabus congener* Thunberg, 1794.<sup>2</sup>probably synonym of *Agabus erichsoni* Gemminger and Harold, 1868.<sup>3</sup>probably synonym of *Ilybius chishimanus* Kôno, 1944.<sup>4</sup>probably synonym of *Hydroporus acutangulus* Thomson, 1856.<sup>5</sup>probably synonym of *Hygrotus unguicularis* Crotch, 1874.

rence in 1000 dendrograms resulting from bootstrap samples was calculated. The obtained value gave the statistical confidence

level for each cluster of the regions.



**Fig. 1.** Schematic presentation of dytiscid faunal similarities between Kamchatka and adjacent regions. Faunal similarity calculated using Sorensen's coefficient are given by the arrows. The number of the species recorded from each region is given within circles. KAM, Kamchatka; NEA, northeasternmost part of Asia; NKR, North Kurils; SKR, South Kurils; SAK, Sakhalin; PRM, Primorye; HOK, Hokkaido.

## Results and Discussion

Altogether 38 species of Dytiscidae have been recorded from Kamchatka (Nilsson et al., 1999; Table 1). Sakhalin and the Kuril Archipelago have comparable numbers of species, 39 and 36, respectively (Fig. 1). About twice as many species, 64, are known from Primorye. A total of 94 species of Dytis-

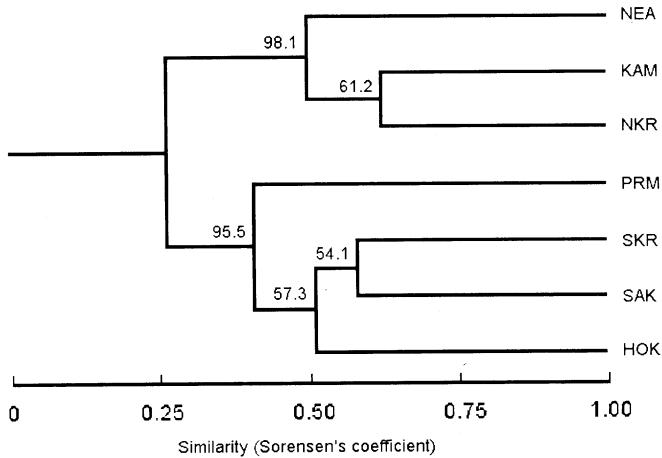
cidae are known from these four regions.

Figure 1 shows the results obtained from this analysis of Kamchatka and six surrounding regions. Two regions (NEA and NKR) are most closely allied with Kamchatka. The very low values of similarity between Kamchatka and the South Kurils and Hokkaido are notable.

Figure 2 shows the results of cluster analysis for the faunal similarities among Kamchatka and six adjacent regions. The frequency of appearance of different branches in the bootstrap-estimated dendrograms supports the stability of the original chaining of the regions. The regions are divided into two major clusters according to geographic position (south and north regions). The three northern regions (NEA, KAM and NKR) formed a stable cluster (bootstrap value = 98.1%). The southern regions (PRM, SAK, SKR and HOK) were clustered into another branch (also with a stable bootstrap value, 95.5%). The mainland fauna of Primorye showed low similarity with the insular faunas of Sakhalin, the South Kuriles and Hokkaido.

Based on their distribution pattern (Table 1), the species found in the Far East were classified into three chorological groups: Holarctic, Palearctic and Japano-Kurilian. The Holarctic and Palearctic elements are well represented in Kamchatka (three of five and one of four species found in the peninsula, respectively). The fauna of northeasternmost Asia and the North Kurils are also characterized by the predominance of Palearctic and Holarctic elements. For example, in Primorye only one of six species has a Holarctic distribution, whereas East Palearctic elements are more important (three of five species). The Japano-Kurilian fauna includes a high proportion of the lotic species that are absent from Kamchatka. No species endemic to Kamchatka is known. Levanidova (1982) and Tshistjakov (2000) noted the same situation for amphibiotic insects and Heterocera (except Geometridae and Noctuidae).

The dytiscid fauna of Kamchatka is characterized by dominance of boreal species, with relatively low species diversity. We suggest that the relatively low diversity of species in Kamchatka is a result of its origin, and the high geographic isolation of the peninsula.



**Fig. 2.** Dendrogram of the dytiscid faunal similarity among seven regions of Far East Asia resulting from UPGMA cluster analysis (evaluated by Sorensen's coefficient). The bootstrap confidence level (from 1,000 replicates) is indicated at the node of each cluster. KAM, Kamchatka; NEA, northeasternmost part of Asia; NKR, North Kurils; SKR, South Kurils; SAK, Sakhalin; PRM, Primorye; HOK, Hokkaido.

The absence of species endemic to Kamchatka suggests a rather young age of its dytiscid fauna, which was possibly formed after the last glacial epoch. The occurrence in Kamchatka of Nearctic species such as *Ilybius discedens* Sharp and *Graphoderus perplexus* Sharp indicates a possible relationship of the area with North America, especially Beringia. However, the taxonomy and fauna of the Dytiscidae in these regions still require considerable study, 92 species being known so far from Alaska and the Aleutian Islands (Bosquet, 1991). Future studies will eventually clarify the biogeography of dytiscids in Eurasia and North America and their origin and formation.

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pal investigator.

#### References

- Bosquet, Y. 1991. Checklist of beetles of Canada and Alaska. 430 pp. Agric. Can. Publ. 1861/E.
- Felsenstein, J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39: 783-791.
- Kurentzov, A. I. 1963. Zoogeography of Kamchatka. *In* Fauna Kamchatskoi oblasti, Trudy Kamchatskoi kompleksnoi ekspeditsii, pp. 4-60. Akademiya Nauk USSR Publishers, Moscow and Leningrad. (In Russian)
- Kurentzov, A. I. 1966. On zoogeographic features of the Kamchatian fauna. *In* Entomofauna lesov Kuril'skikh ostrovov, poluostrova Kamchatki i Magadanskoi oblasti, pp. 63-76. Nauka, Moscow and Leningrad. (In Russian)
- Legendre, L. and P. Legendre. 1983. Numerical ecology. *Developments in Environmental Modelling* 3. 419 pp. Elsevier Scientific Publishing Company, Amsterdam, Oxford, New York.
- Levanidova, I. M. 1982. Amphibiotic insects of the mountains of the Far East provinces of the USSR. 215 pp. Nauka Publishers, Leningrad. (In Russian)
- Mori, M. and A. Kitayama. 1993. Dytiscoidea of Japan. 217 pp. Kankyo-Kagaku Ltd., Osaka.
- Nilsson, A. N. and S. Kholin. 1994. The diving beetles (Coleoptera, Dytiscidae) of Sakhalin—an annotated checklist. *Ent. Tidskr.* 115: 143-156.
- Nilsson, A. N., S. K. Kholin, and N. Minakawa. 1999. The diving beetles of Kamchatka, with additional records from Sakhalin and the Kuril Islands

(Coleoptera: Dytiscidae). Beitr. Ent. 49: 107-131.  
Nilsson, A. N., N. Minakawa and P. B. H. Oberg.  
1997. The diving beetles of the Kuril Archipelago in the Far East of Russia (Coleoptera: Dytiscidae). Beitr. Ent. 47: 365-376.

Tshistjakov, Yu. A. 2000. An annotated checklist of larger moths (Lepidoptera: Heterocera, except Geometridae and Noctuidae) of the Kamchatka Peninsula, with notes on their zoogeography *In* Komai, T. (ed.), Results of recent research on Northeast Asian Biota. Nat. Hist. Res., Spec. Issue 7: 253-266.

Zasypkina, I. A., A. S. Ryabukhin, E. A. Makarchenko and M. A. Makarchenko. 1996. Review of amphibiotic insects of Northeast Asia. 116 pp. Magadan. (In Russian)

### カムチャッカ半島のゲンゴロウ科の生物 地理学: 予備的考察

Sergey K. Kholin<sup>1)</sup> and Anders N. Nilsson<sup>2)</sup>

<sup>1)</sup> Laboratory of Entomology, Institute of Biology and Soil Science

Vladivostok 22, 690022 Russia

<sup>2)</sup> Department of Biology and Environmental Sciences SE-901 87 Umeå University, Sweden

カムチャッカ半島からは、38種のゲンゴロウ科が知られている。極東各地域間（シベリア、サハリン、沿海州、北千島、南千島、および北海道）のゲンゴロウ相の類似性についてクラスター分析を行った結果、カムチャッカ半島のゲンゴロウ相は、北千島およびシベリアのゲンゴロウ相と類似度が高いことが示された。これらの地域のゲンゴロウ相は、全北区要素が卓越することが特徴的である。カムチャッカ固有種は現在のところ知られていない。アジア北東部のゲンゴロウ科の生物地理学を解明するには、さらなる研究が必要である。