

The status of taxa of subgenus *Aedes* (Diptera, Culicidae, *Aedes*) *esoensis* Yamada, *rossicus* Dotheskin, Gorickaja & Mitrofanova, *cinereus* Melgen, *geminus* Peus. 1. Overview

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Abstract

The taxonomic position of the taxa *cinereus*, *esoensis*, *rossicus* and *geminus* of subgenus *Aedes* are discussed with particular regard to their morphology and distribution in Russia.

Introduction

The first species of subgenus *Aedes* to be described in Russia was *Aedes rufus* Gimmerthal, 1845, later synonymised with *Ae. cinereus* Meigen, 1818 by Edwards (1921). Stackelberg (1927) recognised two species of this subgenus in Russia, namely *Ae. cinereus* and *Ae. esoensis* Yamada, 1921. *Aedes rossicus* Dolbeskin, Gorickaja & Mitrofanova, 1930¹ and its synonym *Ae. tarnogradskii* Martini, 1930 were described a few years later. *Aedes yamadai* Sasa, Kano & Takahasi, 1950 and *Ae. sasai* Tonaka, Mizusawa & Saugstad, 1975 were subsequently recorded from Russia by Danilov (1979) and by Gutsevich & Dubitskiy (1981), and *Ae. dahuricus* Danilev, 1987 was described from Russia. In this article some unpublished data on the distribution of *Ae. geminus* in Russia are presented for the first time. All of the Palaearctic species of subgenus *Aedes* listed by Knight & Stone, (1977) and Ward (1992) occur in Russia. Three, *Ae. cinereus*, *Ae. geminus* and *Ae. rossicus*, are found in European Russia.

Gutsevich (1947) was the first to question the species status of *Ae. esoensis*, but it was Monchadskii (1951) who synonymised it with *Ae. cinereus* based on Gutsevich's unpublished data on intermediate forms. He also suggested that *Ae. rossicus* was not a separate species. Data regarding intermediate forms were published by Lvov (1956) and are illustrated in the review by Gutsevich *et al.* (1970). Both Gutsevich *et al.* (1970) and Gutsevich & Dubitskiy (1981) concluded that both *esoensis* and *rossicus* are conspecific with *cinereus*.

Peus (1972), later supported by Labuda (1977) and Britz (1983), regarded *Ae. esoensis* and *Ae. cinereus* as separate species, and furthermore placed *rossicus* as a subspecies of *Ae. esoensis*. In addition, Minar & Kramar (1980) suggested that *Ae. geminus* was not a separate species. However, Knight & Stone (1977) listed *Ae. cinereus*, *Ae. esoensis*, *Ae. rossicus* and *Ae. geminus* as separate species. Subsequently Ward (1984) recognized the work of Peus (1972) and others and *rossicus* is currently listed as a subspecies of *Ae. esoensis*.

Many entomologists (Gutsevich *et al.*, 1970; Tonaka *et al.*, 1975; Bohart & Washino, 1978; Wood *et al.*, 1979) have advocated a revision of Palaearctic members of subgenus *Aedes*. In Tonaka's opinion: "It is desirable that European and Siberian material be studied further for classification of the status of *cinereus*, *geminus*, *rossicus* and continental *esoensis*" (Tonaka *et al.*, 1975). Russia is an especially convenient country in which to conduct such a revision, as all Palaearctic species of the subgenus are present.

It has been repeatedly stated that diagnostic features of the male genitalia are the most reliable for distinguishing between species of the subgenus *Aedes* (Peus, 1972; Tonaka *et al.*, 1975; Labuda, 1977). However published illustrations of male genitalia of *Ae. cinereus*, *Ae. esoensis*, *Ae. rossicus* and *Ae. geminus* lack detail and descriptions are brief. This may be one of the reasons for the different opinions regarding the status of *esoensis*, *rossicus* and *geminus*. In this and the second part of this article more detailed illustrations of male genitalia are given and the geographic distributions of species of the subgenus *Aedes* are discussed in order to aid determination of their taxonomic status.

¹The description of the male of *Ae. rossicus* was made by Y. Mitrofanova, who is acknowledged by Dolbeskin *et al.* (1930). Data regarding the type and type-locality are absent in this article. However it has been discovered that Mitrofanova used larvae and males from the Perm Region, collected near the Karna biological station in June 1928. In the mosquito collections in the Marsinovskiy Institute, we discovered a slide with the male genitalia of *Ae. rossicus* bearing the legend "Perm Region, valley of river Kama, the Lower Kurja, near biological station, 7.06.28, collector U.G. Mitrofanova". This may be the slide used for the description of *Ae. rossicus* or a slide from the type-series. Three of Mitrofanova's slides of male genitalia of *Ae. rossicus* are in the Zoological Institute in St. Petersburg. Therefore, the type material of *Ae. rossicus* is not lost. Dolbeskin & Gorickaja described the female of *Ae. rossicus* in the above-mentioned paper.

Methods

Mosquitoes were collected by Y.N. Danilov and the author from Krasnoyarsk Territory, Khakassia, Tuva, Irkutsk Region, Buriatia, Chita Region and Amur Region in the south of Sibeda. In addition, specimens of *Ae. cinereus*, *Ae. rossicus* and *Ae. geminus* were collected from the Moscow Region, Tatar Republic and Perm Regions of European Russia and from Obol in Byelarus. These, together with specimens of *Ae. esoensis* from Sakhalin Island, were studied from the collection in the Marsinovskiy Institute. In total 148 slides of male genitalia of the subgenus *Aedes* were examined.

Diagnostic features for distinguishing between *Ae. rossicus*, *Ae. esoensis*, *Ae. cinereus* and *Ae. geminus* (figures illustrating these features are in the second part of this article). See also Tables 1 and 2.

Key to male genitalia

1. Longer(lateral)arm of gonostylus apically bifurcate.....2
- Longer (lateral) arm of gonostylus not apically bifurcate.....3
2. Lateral branch of apical bifurcation of gonostylus narrower and shorter than medial branch; basal mesal lobe of the gonocoxite cone-shaped dorsomedially and bearing dense, evenly spaced setae.....*Ae. cinereus*
- Lateral branch of bifurcation of gonostylus longer than medial branch; basal mesal lobe of gonocoxite not cone-shaped and bearing fewer set.....*Ae. geminus*
3. Claspers² with two branches; medial arm of gonostylus more than half length of lateral arm; apex of medial arm with even outline*Ae. rossicus*
- Claspettes with one branch (rudiment of the second branch seldom present); medial arm of gonostylus less than half length of lateral arm; apex of medial arm with wavy outline*Ae. esoensis*

Key to females

1. Abdominal terga unicolorous, without bands.....2
- Abdominal tergites with light-coloured bands at base.....*Ae. esoensis*
2. Eye margin with white scales; proboscis and palpus with numerous white scales*Ae. rossicus*
- Eye margin with grey scales, proboscis and palpus without white scales.....3
3. Pronotal integument rust or rusty-brown*Ae. cinereus*
- Pronotal integument brown, sometimes with black patches.....*Ae. geminus*

² The claspettes in the subgenus *Aedes* are so highly modified that Dyar (1918) and Gutsevich *et al.*, (1970) stated that claspettes are absent; they regarding the structures present as integral with the basal mesal lobe of the gonocoxite. Freeborn (1924) also discussed the relationship between claspettes and the basal mesal lobe. Natvig (1948) coined the term "claspettoid" for the processes presented by the subgenera *Aedes* and *Aedimorphus*, but Harbach and Knight (1980) synonymised this term with claspette. In this paper we follow Harbach & Knight in regarding these modified structures as claspettes.

Table 1. Mean lengths (mm) of the gonocoxite, medial (M) and lateral (L) arms of the gonostylus of *Ae. rossicus*, *Ae. esoensis*, *Ae. cinereus* and *Ae. geminus*.

	Gonocoxite	M	L	M/L
<i>rossicus</i>	0.55(0.54-0.58) n=16	0.13(0.12-0.14) n=20	0.21(0.20-0.22) n=20	0.64(0.60-0.68) n=20
<i>esoensis</i>	0.45(0.41-0.49) n=9	0.09(0.08-0.10) n=18	0.19(0.18-0.20) n=18	0.46 (0.42-0.47) n=18
<i>cinereus</i>	0.46(0.43-0.49) n=14	0.11(0.10-0.11) n=10	0.19(0.18-0.20) n=10	0.58 (0.56-0.61) n=10
<i>geminus</i>	0.49(0.45-0.50) n=13	0.11(0.10-0.12) n=17	0.20(0.19-0.21) n=17	0.56 (0.50-0.60) n=17

Table 2. Mean number of setae on medial and lateral branches of the claspette of *Ae. rossicus*, *Ae. esoensis*, *Ae. cinereus* and *Ae. geminus*.

	Medial branch	Lateral branch
<i>rossicus</i>	4.2 (3-5) n=36	2.5 (1-5) n=36
<i>esoensis</i>	3.2 (2-4) n=14	absent
<i>cinereus</i>	3.1 (3-4) n=14	3.3 (2-5) n=14
<i>geminus</i>	2.9 (2-4) n=61	3.2 (1-7) n=62

Individual variability

All of the described features of *Ae. rossicus*, *Ae. cinereus* and *Ae. geminus* are stable for each species throughout their distribution in Russia. The greatest variation is in the claspettes of species of subgenus *Aedes*, especially *Ae. rossicus*. Nevertheless the structure of the claspette is a reliable feature for diagnosing the species. The descriptions and the illustrations of *Ae. rossicus*, *Ae. cinereus*, *Ae. geminus* from Europe (Natvig, 1948; Peus, 1970, 1972; Labuda, 1977) testify to the stability of the diagnostic features.

Our data on individual variation of *Ae. esoensis* are available only from Sakhalin Island. However the descriptions of *Ae. esoensis* from Maritime Territory (Stackelberg, 1927; Gutsevich *et al.*, 1970) and from Japan (Tonaka *et al.*, 1975, 1979) show stability of described morphological features of this species.

Distributions of *Ae. cinereus*, *Ae. geminus*, *Ae. rossicus* and *Ae. esoensis* in Russia and the Palaearctic

Aedes cinereus

More detailed information is required regarding the distribution of *Ae. cinereus* because *Ae. yamadai*, *Ae. sasai*, *Ae. dahuricus* and *Ae. geminus* were earlier synonymised with *Ae. cinereus*. Furthermore the illustrations of the dististyle (= gonostylus) and claspette variation in forms regarded by Lvov (1956) as intermediate between *Ae. cinereus* and *Ae. esoensis* agree closely with features of *Ae. sasai* (Tonaka *et al.*, 1979). However there is no doubt that in Russia *Ae. cinereus* is distributed from the European borders to the far east (Gutsevich *et al.*, 1970).

Aedes rossicus

The distribution of *Ae. rossicus* ranges from western Europe (Snow & Ramsdale, 1999) through European Russia to Yakut in Asiatic Russia. *Aedes rossicus* was recorded in European Russia in the Yoronzh Region, Nizhni Novgorod Region, Ulyanovsk Region, Chuvashia, Tatarstan, Udmurt Republic, Mariy-El, Rostov-on-Don Region, North-Ossetia (as *Ae. tarnogradskii*), Orenburg and Perm Regions. In Asiatic Russia *Ae. rossicus* was recorded in the Omsk Region, Tyumen Region (near Nefteyugansk, Novosibirsk, Tuva, Buriatia, southern Yakutia. In our collections we additionally have *Ae. rossicus* from the neighbourhoods of Krasnoyarsk (Krasnoyarsk Territory), from Abakan and Maina (Khakassia), from Taximo (Buriatia), from the south of Chita Region. It is known that *Ae. rossicus* also has a wide distribution in the Ukraine. It must be noted that the *Aedes rossicus* of Hara (1958) from Japan is *Ae. dahuricus* (Danilov, 1987).

Aedes geminus

Aedes geminus is a widely distributed species in Europe (Snow & Ramsdale, 1999). *Aedes geminus* is present in the collections of V.N. Danilov and myself from Abakan and Maina (Khakassia), Tuva, Ust Kut (Irkutsk Region), Nothbaikalsk and Taximo (Budatia), Chara (Chita Region), Zeyia (Amur Region) and Komsomolsk Region (Khabarovsk Territory). Males of *Ae. geminus* from Byelorussia and from the Moscow Region were found in the collections of the Marsinovskiy Institute. Therefore, the distribution of *Ae. geminus* covers most of the Palaearctic.

Aedes geminus, *Ae. cinereus* and *Ae. rossicus* are therefore distributed widely in Europe and Asia.

Aedes esoensis

In Russia, *Ae. esoensis* is found in Amur Region, Khabarovsk Territory, Primorski Region (=Maritime Territory), Chita Region and on Kunashir and Shikotan Islands. In the Chita Region both *Ae. rossicus* and *Ae. esoensis* have been recorded in the valley of the river Onon. However *Ae. rossicus* is not found in close association with *Ae. esoensis*. Also it is possible that there may be some confusion between *Ae. dahuricus* and *Ae. esoensis*. At present there is no conclusive information regarding the sympatry or allopatry of *Ae. rossicus* and *Ae. esoensis* in Russia.

Discussion

The differences between the male genitalia of those species of subgenus *Aedes* that have been studied are significant and represent isolating mechanisms. All of the considered morphological features are constant and stable for each species throughout their geographical ranges. The sympatric distributions of *Ae. cinereus*, *Ae. geminus* and *Ae. rossicus* in Europe and Asia, sympatric distributions of *Ae. cinereus* and *Ae. esoensis* in Asia, constancy of described morphological adult features of each species throughout their distribution and absence of intermediate forms may be regarded as indisputable evidence for the non-conspecificity of *Ae. rossicus*, *Ae. esoensis*, *Ae. geminus* and *Ae. cinereus*.

Although the evidence is not conclusive, it would appear that *Ae. rossicus* and *Ae. esoensis* are allopatric in Russia and intermediate forms between these taxa have not been observed³. According to Mayr (1971) in such a case the allopatric taxa should be regarded as separate species. We regard the opinion of Peus (1972) that *Ae. rossicus* and *Ae. esoensis* are conspecific as erroneous.

The taxa *esoensis*, *rossicus*, *cinereus* and *geminus* should therefore be regarded as separate species of subgenus *Aedes*: *Ae. esoensis* Yamada, 1921, *Ae. rossicus* Dolbeskin, Gorickaja & Mitrofanova, 1930, *Ae. cinereus* Meigen, 1818, *Ae. geminus* Peus, 1970. Additionally, all species of subgenus *Aedes* in Russia should be regarded as separate species (Danilov, 1987; Mamedniyazov, 1992; Gornostaeva, 2000).

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³. Illustrations of Lvov (1956) do not show intermediate forms but the species *Ae. sasai* and *Ae. yamadai*

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