International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-2, December, 2019

Information on Tachinid Fauna (Diptera, Tachinidae) Of the Phasiinae Subfamily in the Far East of Russia

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Abstract: ***For the first time, a comparative analysis of the tachinid fauna of the Phasiinae subfamily of the Russian Far East with the fauna of neighboring regions has been presented. The Phasiinae fauna of the Primorsky Krai (Far East of Russia) is characterized as peculiar but closest to the fauna of the southern part of Khabarovsk Krai, Amur Oblast and Eastern Siberia. The following groups of regions have been identified: Southern, Western and Eastern Siberia; Amur Oblast and Primorsky Krai, which share many common Holarctic and Transpalaearctic species.Special mention should be made of the fauna of the Khabarovsk Krai, Sakhalin Oblast, which are characterized by poor species composition and Japan (having a subtropical appearance).***

Key words: Diptera, Tachinidae, Phasiinae, tachinid, Russian Far East, fauna.

I. INTRODUCTION

Tachinid (Diptera, Tachinidae) is a group of parasitic two-winged flies, the hosts of which are insects from the orders of Lepidoptera, Coleoptera, Hemiptera, Orthoptera and others. According to the modern classification of Tachinidae, it includes 4 subfamilies: Phasiinae, Exoristinae, Tachininae, Dexiinae (Herting, Dely-Draskovits, 1993; Tschorsnig, Richter, 1998; Richter, 2004). The former are specialized hemipterans parasites (Hemiptera), while in other subfamilies of Tachinidae parasitization in bedbugs is not known.Works on the study of tachinid of the Phasiinae subfamily in the Far East of Russia and Siberia began in the 60s of the last century (Zimin, 1966; Kolomiets, 1976, 1977; Richter, 1975, 1976, 1977, 1986; Ziegler, Shima, 1996). For the Russian Far East, 65 Phasiinae species have been identified, including 30 species for the Amur Oblast, 15 species for Khabarovsk Krai, 45 species for Primorsky Krai and 10 species for Sakhalin Oblast. There were 48 known species in Siberia, including 20 from Western Siberia, 44 from Southern Siberia and 44 from Eastern Siberia.As a result of our research (Markova, 1999), the species composition of local fauna and habitats of some Phasiinae species in the Russian Far East and Siberia was clarified.

Revised Manuscript Received on December 30, 2019.

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For example, for the *Hemyda hertingi* Ziegler et Shima species described in the Primorsky Krai in 1996 for the first time the data on findings in Western, Southern Siberia and Khabarovsk Krai were given. For the first time, *Redtenbacheria insignis* Egg. for Eastern Siberia and the Kuril Islands, *Phasia barbifrons* (Girschn.) for Western Siberia, and *Elomya lateralis* (Mg.) and *Phasia hemiptera* (F.) were indicated.At the same time, the following species have been found in the Primorsky Krai, previously known in Russia only in the south of Khabarovsk Krai and in the Amur Oblast (Markova, 1999): *Phasia aurigera* (Egg.), *Phasia zimini* (D.-M.), *Leucostoma meridianum* (Rond.), *Leucostoma simplex* (Fll.). A new species for Russian fauna - Cylindromyia umbripennis (Van der Wulp), found in the Primorsky Krai (Richter and Markova, 1999), was previously known in Korea, Japan and the Oriental Region.Thus, there are currently 71 species of tachinid of the Phasiinae subfamily in the Russian Far East, including 50 species in Primorsky Krai, 16 species in Khabarovsk Krai and 10 species in Sakhalin Oblast. For Siberia, there are 51 species of Phasiinae, including 24 species for Western Siberia, 45 species for Southern Siberia and 47 species for Eastern Siberia (Herting, Dely-Draskovits, 1993; Markova, 1999; Richter and Markova, 1999; Markova, 2000a, 2000b, 2003; Richter, 1976, 2004; Markova and Maslov, 2011). Information about the tachinid of the Phasiinae subfamily of China and Korea is fragmentary, which did not allow to include them in the analysis. The most studied is the fauna of Japan, for which 37 species of Phasiinae are indicated (Matsumura, 1916; Mesnil, Pschorn-Walcher, 1968; Mesnil, Shima, 1979; Shima, 1999; Richter, 2004).The purpose of this study is to compare the fauna of the Phasiinae subfamily of tachinid in the Russian Far East (Khabarovsk Krai, Amur Oblast, Primorsky Krai, Sakhalin Oblast) and to compare it with the fauna of Siberia and Japan.

II. OBJECTS AND METHODS OF RESEARCH

The work has been based on more than 2500 specimens of Phasiinae collected by the authors from 1995 to 2015 at field stations and during itinerary trips in the Russian Far East (Primorsky Krai). In addition, the tachinid of the Phasiinae subfamily of the Far East of Russia and Siberia were studied from the collections of the Museums of the Biology and Soil Institute of the Far-Eastern Division of the Russian Academy of Science, Vladivostok (74 specimens), the Institute of Animal Systematics and Ecology of the Siberian Division of the Russian Academy of Science, and Novosibirsk

(Zoomuseum of the the Institute of Animal Systematics and Ecology) (397 specimens) stored at the Department of Natural Science Education of the Far East Federal University, Ussuriysk (Far East Federal University) (100 specimens), as well as at the Zoological Institute of the Russian Academy of Sciences, St. Petersburg. A total of 4,500 specimens of hemipterans were captured, of which 340 specimens of tachinid from the Phasiinae subfamily were extracted. The total volume of the studied material was 3411 specimens.

Processing of materials was carried out in the laboratory of insect systematics of the Zoological Institute of the Russian Academy of Sciences; the following literature was used for the determination: Draber-Mońko, 1965; Herting, 1983; Tschorsnig, Herting, 1994; Richter, 2004. The identification of individual types of Phasiinae has been done by comparison with the types and reference copies in the collection of the Zoological Institute of the Russian Academy of Sciences. The definition of tachinid has been verified by the doctor of biological sciences V.A. Richter.

The Far East is considered in this paper as a region which includes North-East and East Asia. The analysis includes the tachinid fauna of the most studied and geographically comparable regions: The Russian Far East - Amur Oblast, Khabarovsk Krai, Primorsky Krai, Sakhalin Oblast (Sakhalin and the Kuril Islands); Western Siberia (Novosibirsk, Tomsk and Kemerovo Oblasts); Southern Siberia (Altai Krai, Tyva); Eastern Siberia (Irkutsk Oblast, Trans-Baikal Krai, Sakha Republic) and Japan (Hokkaido Islands, Honshu).

The classification of habitats is based on the scheme of zoogeographical division of the globe by A.P. Semenov-Tyan-Shansky (1935) with additions by O.L. Kryzhanovsky (2002).

The names of genera area types are given according to V.A. Richter (Richter, 1995). The names of species area types are given according to V.A. Richter (Richter, 1995) and T.O. Markova et al. (2015).

Taxonomic lists of the Phasiinae subfamily of tachinid from different regions of the Far East and Siberia, based on literary data and collection materials, were mathematically processed. The total list of Phasiinae of the regions under study was 88 species. According to the methods proposed by Y.A. Pesenko (1982), the following types of analysis were carried out on a personal computer of IBM-PC type using Excel 97 spreadsheet and NTSYS, Version 1.40 (Rholf, 1992) software:

1. The polythetic unifying cluster analysis of the similarity of lists with the addition of clusters by the arithmetic mean unweighted similarity assessment (UPGMA), for this purpose the matrix of intersection and similarity measures was calculated on the basis of S×M type matrix. The Dice Index was used as a measure of similarity (Legendre P., Legendre L., 1998).

2. Comparative assessment of the interconnectedness of Phasiinae regional faunas, for which purpose an inclusion column was constructed to represent the participation of species from one region in another based on the inclusion matrix. It was calculated from the Brown-Blancke and Shimkevich-Simpson commonality indices, which are the ratio of the number of common species to the number of species on a larger and smaller list, respectively (Pesenko, 1982).

Brown-Blancke index:

$$I_B = \frac{a}{a+b}, b \geq c, 0 \leq I_B \leq 1;$$

Shimkevich-Simpson index:

$$I_{SzS} = \frac{a}{a+c}, b \geq c, 0 \leq I_{SzS} \leq 1.$$

3. Evaluation of the specificity (originality) of local faunas using the Smirnov coefficient (according to Y.A. Pesenko, 1982).

$$t_{jj} = \frac{M}{S}\left(\sum_{i \in a} \frac{1}{M_i} + \sum_{i \in d} \frac{1}{M - M_i}\right) - 1, -1 \leq t_{jk} \leq \frac{M}{2} - 1$$

with a+d=S, b+c=0 (absolute similarity in assessing the originality of one sample);

$$T_{jj} = \frac{t_{jj}}{M - 1}, 0 \leq T_{jj} \leq 1$$

(relative similarity in estimating the originality of a single sample), where M is the number of samples, S is the number of species in the sample.

III. FINDINGS AND DISCUSSION

Data on the species and genus richness of Phasiinae fauna in the compared regions: Western Siberia, Southern Siberia, Eastern Siberia, Khabarovsk Krai, Primorsky Krai, Sakhalin Oblast and Japan are presented in Table 1.

Table 1
Number of species and genera of Phasiinae fauna of selected regions of Asian part of Russia and Japan

No.	Regions compared	Species number	Genera number
1	Eastern Siberia	24	12
2	Southern Siberia	45	18
3	Western Siberia	47	20
4	Amur Oblast	30	14
5	Khabarovsk Krai	16	9
6	Primorsky Krai	50	22
7	Sakhalin Oblast	10	9
8	Japan	37	21

As can be seen from the dendrogram (Fig. 1), when

approaching the threshold distance of 0.6, groups of regions are clearly distinguished: Southern, Western and Eastern Siberia, Amur Oblast and Primorsky Krai. Fauna of Khabarovsk Krai, Sakhalin Oblast (Sakhalin and the Kuril Islands) and Japan stand out.

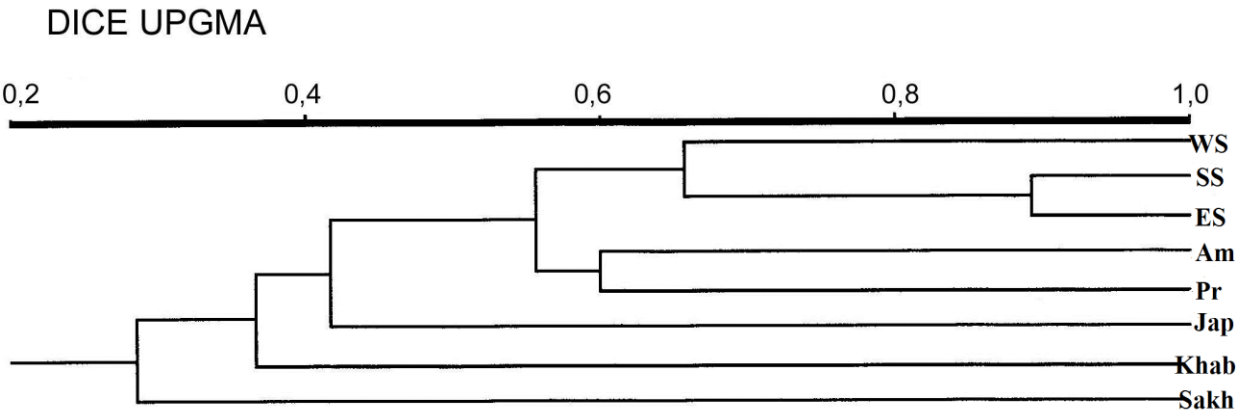

Fig. 1

Note. Regions: WS - Western Siberia, SS - Southern Siberia, ES - Eastern Siberia, Am - Amur Oblast, Khab - Khabarovsk Krai, Pr - Primorsky Krai, Sakh - Sakhalin Oblast, Jap - Japan.A comparative analysis of the Phasiinae fauna of the Russian and Siberian Far East reveals 35 common species of 18 genera (47.3% of the total number of species in these regions), of which *Ectophasia* Town., *Gymnosoma* Mg., *Phasia* Latr., *Cylindromyia* Mg., *Hemyda* R.-D., *Strongygaster* Macq. are found in all comparable areas (Table 2).

Representatives of the Euripalearctic and Boreal European groups were identified in Siberia (Takhtajan, 1986; Richter, 1995): Eulabidogaster Belan. and Catharosia Rond., which are absent in the Russian Far East (see Table 2). In Siberia alone, 15 species of 7 genera were found: *Cistogaster globosa* (F.), *Phasia karczewskii* (D.-M.), *Catharosia pygmaea* Fll., *C. flavicornis* Zett., *Eulabidogaster setifacies* Rond, *Leucostoma anthracinum* (Mg.), *L. tetraptera* (Mg.), *Cylindromyia brevicornis* (Loew), *C. pilipes* (Loew), *C. pusilla* Mg. Only in the Far East there are 8 genera absent in Siberia (see Table 2).

Table 2

Distribution of Phasiinae genera in the regions of Asian part of Russia and Japan

No	Genera	Western Siberia	Southern Siberia	Eastern Siberia	Amur Oblast	Khabarovsk Krai	Primorsky Krai	Sakhalin Oblast	Japan
1	*Ectophasia* Townsend, 1912	+	+	+	+	+	+	+	+
2	*Gymnosoma* Meigen, 1803	+	+	+	+	+	+	+	+
3	*Phasia* Latreille, 1804	+	+	+	+	+	+	+	+

4	*Cylindromyia* Meigen, 1803	+	+	+	+	+	+	+	+
5	*Hemyda* Robineau-Desvoidy, 1830	+	+	+	+	+	+	+	+
6	*Strongygaster* Macquart, 1834	+	+	+	+	+	+	+	–
7	*Subclytia* Pandellé, 1894	+	+	+	+	–	–	+	+
8	*Eliozeta* Rondani, 1856	–	+	+	+	+	+	–	–
9	*Clytiomya* Rondani, 1861	+	+	+	+	–	+	–	–
10	*Dionaea* Robineau-Desvoidy, 1830	+	+	+	–	–	+	–	+
11	*Elomya* Robineau-Desvoidy, 1830	+	+	+	–	–	+	–	–
12	*Besseria* Robineau-Desvoidy, 1830	–	+	+	–	–	–	+	–
13	*Opesia* Robineau-Desvoidy, 1863	+	–	+	–	+	+	–	+
14	*Zambesomima* Mesnil, 1967	–	+	+	+	–	+	–	+
15	*Leucostoma* Meigen, 1803	–	–	+	+	–	+	–	–
16	*Redtenbacheria* Schiner, 1861	–	–	+	–	–	+	+	+
17	*Cistogaster* Latreille, 1829	–	–	+	–	–	+	–	–
18	*Clairvillia* Robineau-Desvoidy, 1830	–	+	+	–	–	+	–	–
19	*Eulabidogaster* Belanovsky, 1951	–	+	+	–	–	–	–	–
20	*Catharosia* Rondani, 1868	–	–	+	–	–	–	–	–
21	*Calyptromyia* Villeneuve, 1915	–	–	–	–	+	+	–	+
22	*Parerigone* Brauer, 1898	–	–	–	–	+	+	–	+
23	*Clelimyia* Herting, 1981	–	–	–	+	–	+	–	+
24	*Perigymnosoma* Villeneuve, 1929	–	–	–	+	–	+	–	–
25	*Arcona* Richter, 1988	–	–	–	–	+	–	–	+
26	*Lophosia* Meigen, 1824	–	–	–	+	–	–	+	+
27	*Riedelia* Mesnil, 1942	–	–	–	–	–	+	–	–
28	*Sepseocara* Richter, 1986	–	–	–	–	–	+	–	–
29	*Euthera* Loew, 1866	–	–	–	–	–	–	–	+
30	*Hermya* Robineau-Desvoidy, 1830	–	–	–	–	–	–	–	+
31	*Pentatomophaga* de Meijere, 1917	–	–	–	–	–	–	–	+
32	*Alophorophasia* Townsend, 1927	–	–	–	–	–	–	–	+
33	*Takanoella* Baranov, 1935	–	–	–	–	–	–	–	+
34	*Clairvilliops* Mesnil, 1959	–	–	–	–	–	–	–	+

Note. «+» - presence of representatives of the genera, «–» - absence of representatives of the genera. When considering at the faunistic composition level the interchange of Phasiinae species of the Russian Far East and Siberia (Fig. 2), the highest half-steps

of inlet-outlet (0.6-0.7) are observed between such regions as the Primorsky Krai and Eastern Siberia, where 30 species (61.9%) are common. Interchange of species between the Amur Oblast and Western Siberia is noted at the level of 0.5-0.7; the level of inclusion of Amur Region species in the fauna of Eastern Siberia was 0.7-0.8, and in the fauna of Southern Siberia - 0.6-0.7. There is a one-sided inclusion of Khabarovsk Krai species in the fauna of Phasiinae Southern and Eastern Siberia at a low level (see Fig. 2). The fauna of the Phasiinae subfamily of Sakhalin Oblast is characterized by poor species composition, and a high level of inclusion in the fauna of Eastern Siberia (see Figure 2) is not indicative, as most common species are found in all comparable areas.

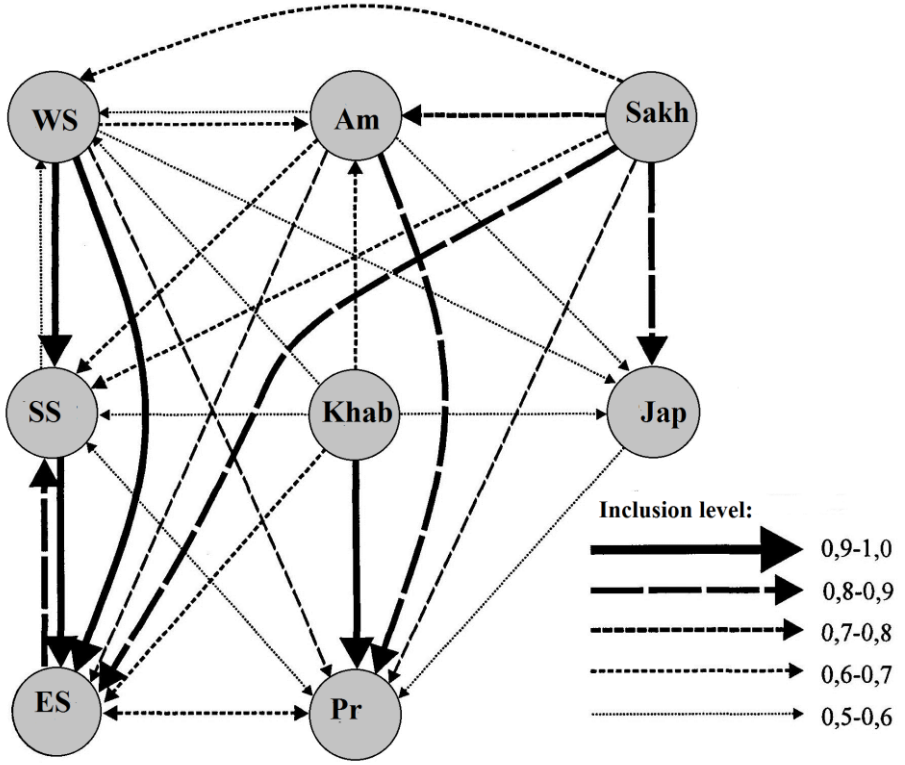

Fig. 2

Note. For the markings of the regions, see Fig. 1.

In the Russian Far East, the Primorsky Krai is the most original of the compared regions (Figures 2-3). The fauna of the Primorsky Krai is characterized by the greatest species and genus richness of two-winged, including tachinid (Kolomiets, 1976; Artamonov, 1978; Richter, 1986; Ziegler, Shima, 1996; Mikhailovskaya, 1998). As the Amur Oblast and the south of Khabarovsk Krai move towards more severe climatic regions, a natural decrease in the species composition of Phasiinae fauna is observed, which leads to the isolation of Khabarovsk Krai on the dendrogram (see Fig. 1).

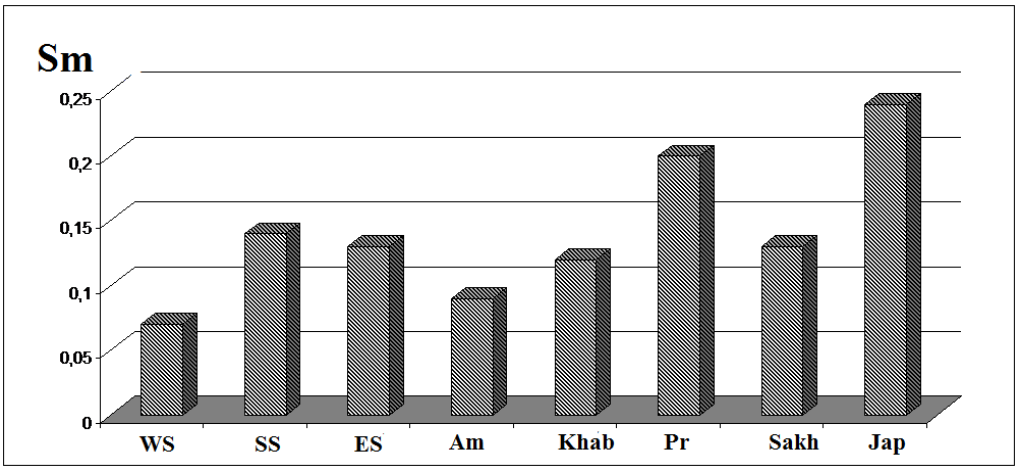

Fig. 3

Note. Sm – Smirnov coefficient of originality. For the markings of the regions, see Fig. 1.

The peculiarity of the Primorsky Krai fauna is conditioned, on the one hand, by the presence of East-Palearctic-Oriental species - *Perigymnosoma globula* Villn, *Cylindromyia umbripennis* (Van der Wulp); palaearctic - *Riedelia bicolor* Mesn., *Phasia takanoi* (D.-M.) and probable endemics of the south of Primorsky Krai - *Cistogaster agata* (Zim.), *Sepseocara itians Richter* (Markova, 2000a; Markova et al., 2015). A comparison of the faunistic composition of the Phasiinae of individual regions of the Far East has shown that 7 genera are present in Primorsky Krai which are absent in the southern part of Khabarovsk Krai and Amur Oblast: *Redtenbacheria* Schn., *Cistogaster* Latr., *Elomya* R.-D., *Dionaea* R.-D., *Clairvillia* R.-D., *Riedelia* Mesn. and *Sepseocara* Richter.

Several genera common to the Khabarovsk and Primorsky regions are absent in the Amur Oblast: *Calyptromyia* Villn., *Parerigone* Brauer and *Opesia* R.-D. In turn, 5 genera common for Amur Region and Primorsky Krai are not observed in Khabarovsk Krai: *Clytiomya* Rond., *Zambesomima* Mesn., *Leucostoma* Mg., *Clelimyia* R.-D., *Perigymnosoma* Villn. The Primorsky Krai does not have 1 genus registered in Khabarovsk Krai: *Arcona* Richter and 2 genera in the Amur and Sakhalin Oblasts: *Lophosia* Mg. and *Subclytia* Pand. A comparison of the species composition of Phasiinae in the Amur Oblast and Primorsky Krai revealed 24 common species (60% similarity) for these regions. The level of inclusion of Amur Oblast species in the Primorsky Krai fauna was 0.8-0.9 (see Fig. 2). In the Primorsky Krai, 28 species were found to be absent in the Amur Oblast; in turn, 5 species were not recorded in the Primorsky Krai: *Subclytia rotundiventris* (Fll.), *Gymnosoma nitens* Mg., *Lophosia fasciata* Mg., *Cylindromyia interrupta* (Mg.) and *C. pusilla* Mg. In the fauna of Khabarovsk and Primorsky Krais 15 common species (45.5%) were identified. The level of inclusion of Khabarovsk Krai species in the Primorsky Krai fauna was 0.9-1.0 (see Fig. 2). In Primorsky Krai, 35 species were recorded that were absent in Khabarovsk Krai and only 2 species - *Gymnosoma nitens* Mg. and *Arcona amuricola* Richter - were not indicated for this area.

Trans-Arctic and East-Palearctic species are common for the fauna of the Russian Far East and Sakhalin Oblast: *Gymnosoma nudifrons* Hert., *G. sylvatica* Zim., *Strongygaster globula* (Mg.), *Redtenbacheria insignis* Egg, *Phasia hemiptera* (F.) and *Cylindromyia brassicaria* (F.) (the last 6 species are also found in Japan).

The fauna of Japan's Phasiinae is subtropical and is the most original of all the regions compared (see Figures 2-3). A comparative analysis of the composition of Phasiinae in the Far East of Russia and Japan revealed 22 common species. Except for two palaearctic species - *Clelimyia paradoxa* Hert. and *Phasia takanoi* (D.-M.) - they all have wide ranges. The highest level of species inclusion (0.8-0.9) is observed for faunas in Sakhalin Oblast and Japan (see Figure 2). There are no East Asian-Oriental species in the Far East: *Euthera tuckeri* Bezzi, *Hermya beelzebul* Wd., *Pentatomophaga latifacia* Villn., *Alophorophasia alata* Town., *Alophorophasia rubida* (Mesn.), *Takanoella parvicornis* Baran, *Clairvilliops breviforceps* van Emden. and probable endemics of Japan: *Phasia grazinae* (D.-M.), *Strongygaster nishijimai* Mesn., *Arcona nishijimai* Mesn., *Parerigone takanoi* Mesn., *P. macrophtalma* Hert. and *Cylindromyia pandulata* Mats. In the Primorsky Krai 15 species and 8 genera typical for Japan are absent. At the same time, representatives of 8 tachinid genera of the Phasiinae subfamily - *Eliozeta* Rond., *Clytiomya* Rond., *Perigymnosoma* Villn., *Cistogaster* Latr., *Elomya* (Mg.), *Leucostoma* Mg., *Clairviilia* R.-D., *Sepseocara* Richter and 29 species specified for the territory of the Russian Far East - have not been found in Japan. In addition, *Cylindromyia* Mg genera (5 species) and *Gymnosoma* Mg. (2 species) are very poorly represented in the fauna of Japan.

IV. CONCLUSION

The fauna of the Phasiinae subfamily in the Russian Far East needs further study: on the one hand, new species to be found are expected, and on the other hand, more accurate data on the distribution of species in this area. Further research in the south of Khabarovsk Krai and Amur Oblast may reveal transpalaearctic species: *Redtenbacheria insignis* Egg., *Eliozeta pelluscens* (Fll.), *Elomya lateralis* (Mg.), *Dionaea aurifrons* Mg.) and *Clairviilia biguttata* (Mg.).

The list of Phasiinae of the Amur Oblast can be expected to be supplemented by species such as *Phasia aurigera* (Egg.), *Parerigone aurea* Brauer, *Hemyda hertingi* Ziegler et Shima, and of the Khabarovsk Krai by *Phasia aurulans* Mg., *Ph. barbifrons* (Girschn.), and *Ph. subcoleoptrata* (L.), which are found in adjacent regions.

According to our assumptions, we can also expect the Phasiinae list of the Primorsky Krai to be replanished: transpalaearctic species with areas widely spread to the east, such as *Subclytia rotundiventris* (Fll.), *Gymnosoma nitens* Mg., *Lophosia fasciata* Mg., *Cylindromyia interrupta* (Mg.), *C. pusilla* (Mg.), can be found in this area.

Undoubtedly, further study of the South Sakhalin and Kuril Islands Phasiinae may reveal greater diversity of fauna in the region and species of the Sakhalin-Hokkaido group (Sakhalin-Hokkaido province according to A.L. Takhtajan (1986) may be found, which will smooth out some isolation of Japanese fauna from the Sakhalin and Kuril Islands fauna.

ACKNOWLEDGEMENT

The authors express their sincere gratitude to doctor of biological sciences A.S. Lelei, doctor of biological sciences S.Y. Storozhenko (Biology and Soil Institute, Far East Branch of the Russian Academy of Sciences, Vladivostok) for their help and support, doctor of biological sciences A.V. Barkalova (Institute of Animal Systematics and Ecology, Siberian Branch of the Russian Academy of Sciences, Novosibirsk), doctor of biological sciences V.A. Richter (Zoological Institute of the Russian Academy of Sciences, Saint-Petersburg) for attention, consultations and provision of an opportunity to work with the palearctic Tachinid collection.

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