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*Dubravka M. Milić**
Snežana R. Radenković
Jelena N. Stepanov
Marija S. Miličić
Ante A. Vujić

[1]University of Novi Sad, Faculty of Sciences
Department of Biology and Ecology, 2 Dositej Obbradović Square
21000 Novi Sad, Republic of Serbia

PREDICTION OF CURRENT SPECIES DISTRIBUTION OF *CHEILOSIA PROXIMA* GROUP (DIPTERA: SYRPHIDAE) ON THE BALKAN PENINSULA

ABSTRACT: Predicting species distribution in different climates is most often made by climate models ("climate envelope models" – CEM) which are using the current geographical distribution of species and climate characteristics of the area. Hoverflies (Insecta: Diptera: Syrphidae) can act as bioindicators and monitors of climate change and habitat quality. *Cheilosia* Meigen, 1822 is one of the largest hoverflies genera, with about 450 described species. The aim of this study was to model the current potential distribution of six species from *Cheilosia proxima* group on the Balkan Peninsula (*Cheilosia aerea* Dufour, 1848*, C. balkana* Vujić, 1994, *C. gigantea* Zetterstedt, 1838, *C. pascuorum* Becker, 1894, *C. proxima* Zetterstedt, 1843 and *C. rufimana* Becker, 1894) using maximum entropy modeling (Maxent). It is observed that parameters with highest influence on the analyzed species are Altitude and BIO 15 (Precipitation Seasonality) for all species, except *C. rufimana*. Parameter that also substantially influenced for all species, except *C. pascuorum*, is BIO 18 (Precipitation of Warmest Quarter). The models of current distribution have shown that the most important area of the Balkan Peninsula, for species from *Cheilosia proxima* group, is Dinaric mountains. Information obtained in this paper can help in future monitoring of species, as well as for the conservation measures, especially for endemics and rare species.
KEYWORDS: Syrphidae, climate envelope modeling, MAXENT, distribution

INTRODUCTION

Great loss of global species biodiversity is one of the biggest threats in the modern era. A large number of species is affected by a recent climate change,

* Corresponding author E-mail: dubravka.milic@dbe.uns.ac.rs
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which is reflected in narrowing and moving its range to higher latitudes and altitudes (Parmesan and Yohe, 2003; Root et al., 2003). Without the diversity of species, ecosystems are more fragile and Liable to natural disasters and climate change. Idea of protecting species entails the question how to determine protection priorities and which conservation strategies should be applied. The fact is that species cannot be protected if their habitats are not protected. Monitoring of biodiversity, especially diversity of bioindicator species, has great importance for the implementation of active strategies in the management of protected areas.

Lack of detailed knowledge of a species distribution has been serious concern in wildlife management and conservation. Understanding species biology and thus their living requirements has to be the first priority before any decision making and action planning (Nazeri et al., 2012). One of the available tools for mapping the geographical distribution and potential suitable habitats are species distribution models. These models are generally based on various hypotheses how environmental factors control the distribution of species and communities (Guisan and Zimmermann, 2000). Predicting species distribution in different climates is most often made by climate models ("climate envelope models" – CEM) which are using the current geographical distribution of species and climate characteristics of the area (Hijmans and Graham, 2006).

Hoverflies (Insecta: Diptera: Syrphidae) can be used for the recognition and assessment of different types of habitats and they can be effective indicators of level of pollution as well. Basic aspects of hoverfly ecology, such as breeding sites, larval feeding habits, outline life cycles and habitat preferences are well enough understood for hoverflies to be incorporated into qualitative and quantitative methods of assessment. There are hoverflies that have conservation significance because, unfortunately, they are endangered by human activities and require action to ensure their survival. As such, they can act as flag species for whole communities and by conserving them, many other species will also be conserved. Also they can be used for monitoring the effects of climate change. Ball and Henshall (2007) used presumed climate preferences obtained from current distribution and other data (topography and land cover) to predict ranges of two species from genus *Chrysotoxum* Meigen, 1803 in United Kingdom under climate changes. Their results showed that *C. arcuatum* (Linnaeus, 1758) would contract in range and move to higher elevation, whereas *C. cautum* (Harris, 1776) would expand its range to northern England. Stuart Ball also undertook a similar kind of analysis for *Cheilosia sahlbergi* (Becker, 1894) which, according to his results, would become almost extinct in 2080 and *Platycheirus melanopsis* Loew, 1856 with little change in distribution (Rotheray and Gilbert, 2011).

Genus *Cheilosia* Meigen, 1822 is one of the largest genera in the family Syrphidae, with about 450 species, mostly Holarctic, from which 300 are present in the Palearctic (Peck, 1988), more than 80 in Nearctic, about 50 in the Oriental region, and several in the northern part of Neotropic (Ståhls et al., 2004). So far, there is about 175 European species, of which more than 50% is present on the Balkan Peninsula (Vujić, 1996).

There is no key that deals with all European species of genus *Cheilosia*, but Vujić et al. (2013) gave an identification key for the European species of the *proxima* species group, including newly described species *C. barbafacies* Vujić et Radenković, 2013. *Proxima* species group comprises following species: *Cheilosia aerea* Dufour, 1848, *C. balkana* Vujić, 1994, *C. gigantea* Zetterstedt, 1838, *C. ingerae* Nielsen & Claussen, 2001, *C. pascuorum* Becker, 1894, *C. proxima* Zetterstedt, 1843, *C. rufimana* Becker, 1894, *C. velutina* Loew, 1840 and *C. vulpina* (Meigen, 1822). All these species were recorded on the Balkan Peninsula, except for North European species *C. ingerae.*

Species from *Cheilosia proxima* group prefer open habitats in oak and beech forests and mountain and alpine pastures up to 2000 meters on the Balkan Peninsula. Flight period of these species is from April to October for *C. aerea* and *C. proxima*, from April to June for *C. pascuorum* and *C. rufimana*, from May to June for *C. gigantea*, from June to July for *C. balkana* and from July to August for *C. velutina* (Vujić, 1996).

The aim of this study was to model the current potential distribution of species from *Cheilosia proxima* group on Balkan Peninsula.

MATERIALS AND METHODS

All distribution data of *Cheilosia proxima* group of species from the Balkan Peninsula were obtained from following publications (Strobl, 1898, 1902; Drensky, 1934; Glumac, 1955, 1959, 1968; Coe, 1960; Bankowska, 1967; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1995, 1996; Vujić et al., 2000) and hoverflies collections deposited at: National Museum of Bosnia and Herzegovina, Sarajevo, Bosnia and Herzegovina; Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad; Natural History Museum, Belgrade, Serbia; Croatian Natural History Museum, Zagreb, Croatia; Zoological Institute and Museum, Sofia, Bulgaria and private collection of J. Lucas (database:

http://www.dbe.uns.ac.rs/o_departmanu/laboratorije/laboratorija_za_istrazivanje_i_zastitu_biodiverziteta/prilog).

Environmental data was obtained from WORLDCLIM (version 1.3, http://www.worldclim.org) which is explained in detail in Hijmans et al. (2005). WORLDCLIM contains climate data (monthly precipitation and monthly mean, minimum and maximum temperature) and elevation at a spatial resolution of 2.5 arc-minutes (~5x5 km resolution) obtained by interpolation of climate station records from 1950–2000.

Environmental suitability was modeled using maximum entropy modeling (Maxent) (Phillips et al., 2006). Maxent calculates the potential geographic distribution of species by finding the probability distribution of maximum entropy and is an effective method for modeling species distributions from presence-only data. This program can work with a small number of samples and with records that have not been collected as a part of systematic biological surveys, which is useful for processing the data that are based on museum collections (Elith et al., 2011).

Choosen Maxent default settings for all models were: regularization multiplier = 1, maximum iterations = 500, convergence threshold = 10^{-5}, maximum number of background points = 10.000. Seventy-five percent of occurrence records were randomly selected by Maxent as training data and 25% reserved for model testing. We ran cross-validation replicates for each model scenario. Covariates were tested for muticolinearity with VIF (various inflation factors) analysis in R package. Selected covariates for SDM analysis are shown in Table 1. The area under the curve (AUC) of the receiver operator characteristic was used to test the agreement between observed species presence and projected distribution (Manel et al., 2001). A jack-knife test was used to evaluate the importance of each environmental variable and to explain the native distribution of the species from *C. proxima* group.

Table 1: Bioclimatic variables* used for modeling the potential distribution of species from *C. proxima* group on Balkan Peninsula

C. aerea	*C. balkana*	*C. gigantea*	*C. pascuorum*	*C. proxima*	*C. rufimana*
BIO 4	BIO 2	BIO 8	BIO 8	BIO 2	BIO 2
BIO 9	BIO 15	BIO 9	BIO 15	BIO 9	BIO 18
BIO 15	BIO 18	BIO 15	BIO 18	BIO 15	
BIO 18	BIO19	BIO 18		BIO 18	
BIO 19				BIO19	

*BIO 2 – Mean Diurnal Range (Mean of monthly (max temp – min temp)); BIO 4 – Temperature Seasonality (standard deviation *100); BIO 8 – Mean Temperature of Wettest Quarter; BIO 9 – Mean Temperature of Driest Quarter; BIO 15 – Precipitation Seasonality (Coefficient of Variation); BIO 18 – Precipitation of Warmest Quarter; BIO 19 – Precipitation of Coldest Quarter

RESULTS AND DISCUSION

Prediction of current distribution was analyzed for six species from *Cheilosia proxima* group registered on the Balkan Peninsula (*Cheilosia aerea, C. balkana*, *C. gigantea*, *C. pascuorum*, *C. proxima* and *C. rufimana*). For two species, *C. velutina* and *C. barbafacies* there were not enough data for modeling.

To estimate success rate of climate models for each species, we calculated training and test AUC values. According to training AUC (0,870-0,993) and test AUC (0,500-0,939), this model can be evaluated as good and excellent (Tab. 2). It is observed that parameters with highest influence on the analyzed species are Altitude and BIO 15 (Precipitation Seasonality) for all species, except for *C. rufimana.* Parameter that also showed substantial influence for all species, except for *C. pascuorum*, is BIO 18 (Precipitation of Warmest Quarter).

Table 2: AUC training/test values and variable contributions for analysed species

	AUC training	AUC test	Variable contributions (%)
Cheilosia aerea	0.870	0.761	BIO 15 (40%) BIO 4 (21.1%) BIO 18 (16.9%) BIO 19 (8.5%) BIO 9 (4.12%) Altitude (0.7%)
Cheilosia balkana	0.993	0.939	BIO 15 (51.6%) Altitude (33.1%) BIO 19 (10%) BIO 18 (5.2%) BIO 2 (1.8%)
Cheilosia gigantea	0.981	0.925	BIO 15 (49.2%) Altitude (20.9%) BIO 8 (15.9%) BIO 9 (10.1%) BIO 18 (2.1%)
Cheilosia pascuorum	0.976	0.624	BIO 15 (65.8%) Altitude (34.2%)
Cheilosia proxima	0.923	0.819	Altitude (39.3%) BIO 15 (36.4%) BIO 19 (10.2%) BIO 18 (9.6%) BIO 2 (4.1%) BIO9 (0.4%)
Cheilosia rufimana	0.984	0.500	Altitude (78.9%) BIO 18 (13.8%) BIO 2 (7.3%)

Habitat and elevation can restrict species ranges, and they are important in explaining the distribution of species (Harris and Pimm, 2008; Sekercioglu and Schneider, 2008; Newbold et al., 2009; Virkkala et al., 2010). Species do not respond directly to elevation, but they change in abiotic variables which are regulated by elevation. However, it may be argued that elevation is a surrogate for other non-climate related factors that may restrict species geographically, e.g. food availability (Remonti et al., 2009), or for climatic parameters when spatially explicit estimates of climate are unavailable. Precipitation (BIO 15, 18) indirectly influences larval development of *Cheilosia proxima* group, because immature stages of these phytophagous species live in stems, roots or rhizomes of different plants.

C. aerea and *C. proxima* are widely distributed species. According to current prediction they can be found on the whole territory of the Balkan Peninsula, not only on known localities (Fig. 1). *C. aerea* does not have special habitat preferences and could be expected, not only on mountains, but also on hills at lower altitudes. *C. proxima* has similar distribution pattern, but lower percentage of occurrence on the coast of the Mediterranean Sea and hills (Fig. 2). This could be explained by different ecological demands of these two species: *C. aerea* prefers lower altitudes and more dry habitats while *C. proxima* usually inhabits humid forests (Vujić, 1996; Speight, 2012).

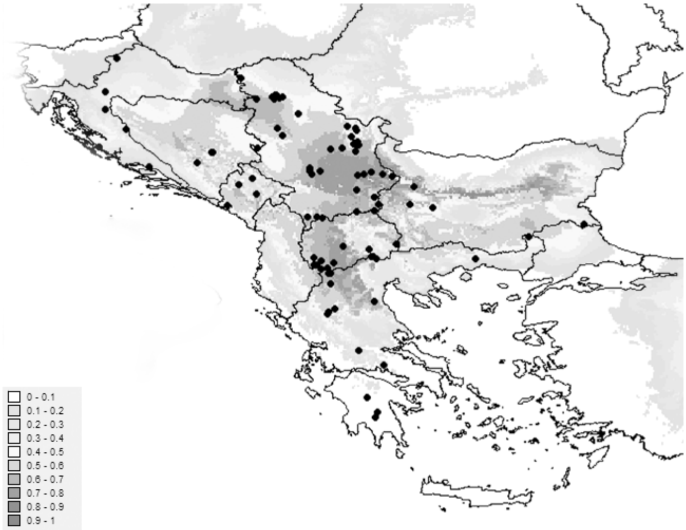


Figure 1: Potential distribution of *C. aerea* Figure 2: Potential distribution of *C. proxima* Legends represent percentage of potential species distribution and spots represent current data of species

C. *gigantea* has wide Palaearctic range, but on the Balkans does not reach extreme south of the Peninsula (Greece). The current prediction corresponds to the actual distribution on high mountains and also confirms the south edge of its range on the Balkan Peninsula (Fig. 3).

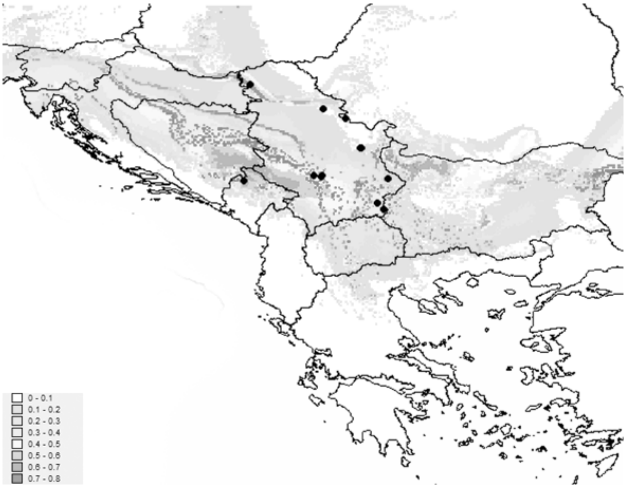
Palaearctic species *C. rufimana* is very rare on the Balkan Peninsula. It was found at few localities of the south Dinaric mountains and the Rilo-Rhodopes (Vujić, 1996). According to the current prediction this species could also find appropriate habitats in the entire ranges of the Dinaric mountains and the Carpathians, but also in the Alps, where has already been registered (Speight, 2010) (Fig. 4).

Figure 3: Potential distribution of *C. gigantea* Figure 4: Potential distribution of *C. rufimana*
Legends represent percentage of potential species distribution and spots represent current data of species

Range of *C. pascourum* extends from Alps, across the Balkan Peninsula to the European part of Russia (Speight, 2012). Except on the high mountains, this species was also recorded from lowland oak forests in the Pannonian

Plain (Vujić, 1996). The similar pattern of distribution is visible in the model where the area with highest percentage of appearance is, besides the high Dinaric Mountains, also Sub-Pannonian hills, low mountains and coast of the Black Sea in the eastern part of the Peninsula (Fig. 5).

C. balkana is endemic species for Alps and south Dinaric mountains (Vujić, 1996). Data of the current prediction almost completely coincide with the records of its relatively narrow distribution. Model predicts that this species could also be present on north and central Dinaric mountains between Alps and south Dinaric mountains, where already has been registered (Fig. 6).



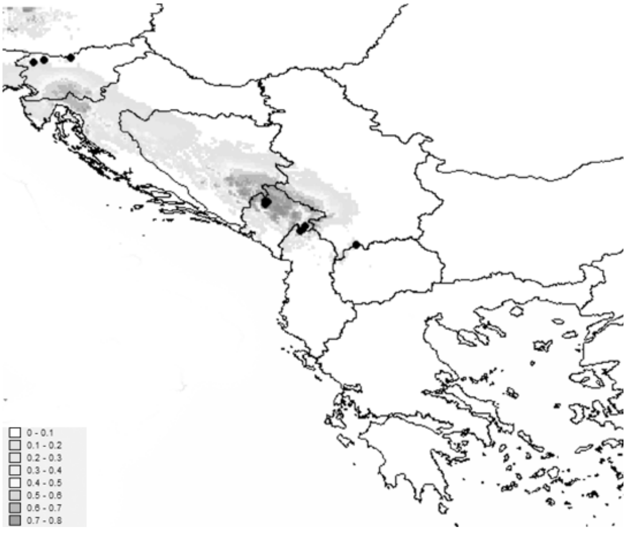


Figure 5: Potential distribution of *C. pascuorum* Figure 6: Potential distribution of *C. balkana*
Legends represent percentage of potential species distribution and spots represent current data of species

CONCLUSION

The models of current distribution of species from *Cheilosia proxima* group have shown that the most important area on the Balkan Peninsula is the Dinaric mountains. Current predictions, based on climate and altitude, highly correspond to actual distribution data, but also reveal new localities with suitable habitats and ecological conditions for particular species (for *C. gigantea*, these are mountains in the south-western part of Serbia and mountain Prokletije and for *C. pascuorum* Strandža mountain in Bulgaria). These information can help in future monitoring of species, as well as for the conservation measures, especially for endemic and rare species.

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REFERENCES

B a l l, S. G.; H e n s h a l l, M. (2007): Using data to interpret changes in UK's biodiversity. *Newsletter of the National Biodiversity Network* 32: 6–8.

B a n k o w s k a, R. (1967): Matériaux pour l'étude des Syrphides (Diptera) de Bulgarie. *Fragmenta Faunistica* 21: 345–389.

C o e, R. L. (1960): A further collection of Diptera from Jugoslavija, with localities and notes. *Glasnik Prirodnjačkog muzeja Beograd* 16: 43–67.

D r e n s k y, P. (1934): Die Fliegen der Familie Syrphidae (Dipt.) in Bulgarien. Izv. Bulg. Entom. Druž. 8: 109–131.

E l i t h, J.; P h i l l i p s, S. J.; H a s t i e, T.; D u d í k, M.; C h e e, Y. E.; Y a t e s, C. J. (2011): A statistical explanation of MaxEnt for ecologists. Diversity and Distributions 17: 43–57.

G l u m a c, S. (1955): Osolike muve Srbije (Syrphidae, Diptera) iz zbirke Prirodnjačkog muzeja Srpske zemlje u Beogradu. *Zaštita bilja* 27: 3–43. [Glumac S (1955): Vasplike flies of Serbia (Syrphidae, Diptera) from the collection of the museum of Natural History of Serbian Lands. *Zaštita bilja* 27: 3–43].

G l u m a c, S. (1959): Syrphidae (Diptera) Fruške gore. Matica srpska, Zbornik za prirodne nauke 17: 37–78. [Glumac S (1959): Hover-flies (Syrphidae, Diptera) in Fruška gora (Vojvodina, Jugoslavija). Matica srpska, *Zbornik za prirodne nauke* 17: 37–78].

G l u m a c, S. (1968): Syrphidae (Syrphoidea, Diptera) u Makedoniji. *Godišnjak Filozofskog fakulteta*, Универзитет у Новом Саду 11 (2): 845–880. [Glumac S (1968): Hover-flies (Syrphoidea, Diptera) in Macedonia. *Godišnjak Filozofskog fakulteta*, 11 (2): 845–880]

G u i s a n, A.; Z i m m e r m a n n, N. E. (2000): Predictive habitat distribution model in ecology. Ecol Model 135: 147–186.

H a r r i s, G.; P i m m, S. L. (2008): Range size and extinction risk in forest birds. *Conserv. Biol.* 22: 163–171.

H i j m a n s, R. J.; C a m e r o n, S. E.; P a r r a, J. L.; J o n e s, P. G.; J a r v i s, A. (2005): Very high resolution interpolated climate surfaces for global land areas. *Int. J. Climatol.* 25: 1965–1978.

H i j m a n s, R. J.; G r a h a m, C. H. (2006): The ability of climate envelope models to predict the effect of climate change on species distributions. *Global Change Biol.* 12: 2235–2486.

M a n e l, S.; W i l l i a m s, H. C.; O r m e r o d, S. J. (2001): Evaluating presence–absence models in ecology: the need to account for prevalence. *J. Appl. Ecol.* 38: 921–931.

N a z e r i, M.; J u s o f f, K.; M a d a n i, N.; M a h m u d, A. R.; B a h m a n, A. R.; K u m a r, L. (2012): Predictive Modeling and Mapping of Malayan Sun Bear (Helarctos malayanus) Distribution Using Maximum Entropy. PLoS One 7 (10): e48104. doi:10.1371/journal.pone.0048104

N e w b o l d, T.; G i l b e r t, F.; Z a l a t, S.; E l G a b b a s, A.; R e a d e r, T. (2009): Climate based models of spatial patterns of species richness in Egypt's butterfly and mammal fauna. *J. Biogeogr.* 36: 2085–2095.

P a r m e s a n, C.; Y o h e, G. (2003): A globally coherent fingerprint of climate change impacts across natural systems. *Nature* 421: 37–42.

P e c k, L. V. (1988): Syrphidae. In: Soos A, Papp L (eds.), *Catalogue of Palaearctic Diptera*, Vol. 8, Elsevier, 11–230.

P h i l l i p s, S. J.; A n d e r s o n, R. P.; S c h a p i r e, R. E. (2006): Maximum Entropy Modeling of Species Geographic Distributions. *Ecol. Model.* 190: 231–259.

R e m o n t i, L. R.; B a l e s t r i e r i, A. B.; P r i g i o n i, C. P. (2009): Altitudinal gradient of Eurasian otter (*Lutra lutra*) food niche in Mediterranean habitats. *Can. J. Zoolog.* 87: 285–291.

R o o t, T. L.; P r i c e, J. T.; H a l l, K. R. (2003): 'Fingerprints' of global warming on animals and plants. *Nature* 421: 57–60.

R o t h e r a y, G. E.; G i l b e r t, F. S. (2011): *The Natural History of Hoverflies*. Forrest Text, Cardigan, 333 pp.

S e k e r c i o g l u, C. H.; S c h n e i d e r, S. H. (2008): Climate change, elevational range shifts, and bird extinctions. *Conserv. Biol.* 22: 140–150.

S p e i g h t, M. C. D. (2010): Species accounts of European Syrphidae (Diptera). In: Speight M. C. D., Castella E., Sarthou J. P., Monteil C. (eds.) *Syrph the Net, the database of European Syrphidae*, Vol. 55, Syrph the Net publications, Dublin.

S p e i g h t, M. C. D. (2012): *Species accounts of European Syrphidae (Diptera). Syrph the Net, the database of European Syrphidae*, Vol. 69, p. 296, Syrph the Net publications, Dublin.

S t å h l s, G.; S t u k e, J. H.; V u j i ć, A.; D o c z k a l, D.; M u o n a, J. (2004): Phylogenetic relationships of the genus *Cheilosia* and the tribe Rhingiini (Diptera, Syrphidae) based on morphological and molecular characters. *Cladistics* 20: 105–122.

S t r o b l, G. (1898): Fauna Diptera Bosne i Hercegovine i Dalmacije. *Glasn. zemalj. Mus. Bosne i Hercegovine* 10 (2): 387–393.

S t r o b l, G. (1902): Novi prilozi fauni diptera Balkanskog poluostrva. *Glasn. zemalj. Mus. Bosne i Hercegovine* 14 (1): 461–517.

V i r k k a l a, R.; M a r m i o n, M.; H e i k k i n e n, R. K.; T h u i l l e r, W.; L u o t o, M. (2010): Predicting range shifts of northern bird species: Influence of modeling technique and topography. *Acta Oecologica* 36: 269–281.

V u j i ć, A. (1995): New data of hoverflies (Diptera: Syrphidae) in Macedonia. *Zbornik Matice srpske za prirodne nauke* 88: 45–50.

V u j i ć, A. (1996): *Genus Cheilosia Meigen and related genera (Diptera: Syrphidae) on the Balkan peninsula*. Mon. Dep. Nat. Sci., Matica srpska: 194. Novi Sad.

V u j i ć, A.; G l u m a c, S. (1994): *Fauna osolikih muva (Diptera: Syrphidae) Fruške gore*. Matica srpska, Odeljenje za prirodne nauke, Novi Sad, 83 pp. [Vujić A, Glumac, S (1994): *Fauna of hover flies (Diptera: Syrphidae) of Fruška gora*. Matica srpska, Odeljenje za prirodne nauke, Novi Sad, 83pp.]

V u j i ć, A.; Š i m i ć , S. (1994): *Syrphidae (Insecta: Diptera) Vršačkih planina*. Matica srpska, Odeljenje za prirodne nauke, Novi Sad, 163 pp. [Vujić A, Šimić S (1994): *Syrphidae (Insecta, Diptera) on the Vršac hills*. Matica srpska, Odeljenje za prirodne nauke, Novi Sad, 163pp.]

V u j i ć, A.; Š i m i ć , S.; R a d e n k o v i ć, S. (2000): New data of hoverflies (Diptera, Syrphidae) in Greece, *Dipteron* 3 (1): 17–26.

V u j i ć, A.; R a d e n k o v i ć, S.; T r i f u n o v, S.; N i k o l i ć, T. (2013): Key for European species of the Cheilosia proxima group (Diptera, Syrphidae) with a description of a new species, *Zookeys* 269: 33–50.

ПРЕДВИЂАЊЕ САДАШЊЕ ПОТЕНЦИЈАЛНЕ ДИСТРИБУЦИЈЕ ВРСТА ИЗ *CHEILOSIA PROXIMA* ГРУПЕ (DIPTERA: SYRPHIDAE) НА БАЛКАНСКОМ ПОЛУОСТРВУ

Дубравка М. Милић, Снежана Р. Раденковић, Јелена Н. Степанов,
Марија С. Миличић, Анте А. Вујић
Универзитет у Новом Саду, Природно-математички факултет
Департман за биологију и екологију
Трг Доситеја Обрадовића 2
21000 Нови Сад, Србија

РЕЗИМЕ: Предвиђање дистрибуције врста у различитим климатским условима најчешће се врши помоћу климатских модела (Climate envelope models – CEM) који користе тренутну географску дистрибуцију врста и климатске карактеристике подручја. Осолике муве (Insecta: Diptera: Sirphidae) могу послужити као биоиндикатори климатских промена и квалитета станишта. *Cheilosia* Meigen, 1822 је један од највећих родова осоликих мува, са око 450 врста. Циљ овог истраживања је моделовање тренутне потенцијалне дистрибуције шест врста из *Cheilosia proxima* групе (*Cheilosia aerea* Dufour, 1848, *Cheilosia balkana* Vujić, 1994, *Cheilosia gigantea* Zetterstedt, 1838, *Cheilosia pascuorum* Becker, 1894, *Cheilosia proxima* Zetterstedt, 1843 и *Cheilosia rufimana* Beker, 1894) на Балканском полуострву помоћу модела максималне ентропије (Maxent). Примећено је да су параметри са највећим утицајем надморска висина и сезонске падавине (BIO 15) за све врсте, осим *C. rufimana*. Параметар који је такође показао значајан утицај на све врсте, осим *C. pascuorum* је BIO 18 (падавине током најтоплијег тромесечја). Модели потенцијалне дистрибуције врста из *Cheilosia proxima* групе показали су да је најважније подручје на Балканском полуострву регија Динарских планина. Информације добијене у овом раду могу да помогну у будућим мониторингу врста, као и успостављању конзервационих мера, посебно за ендеме и ретке врсте.

КЉУЧНЕ РЕЧИ: Сифриде, климатски модели, MAXENT, дистрибуција