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**SEX RATIO OF *LEPTIDEA SINAPIS* LINNAEUS, 1758
(LEPIDOPTERA: PIERIDAE) AND SOME OTHER SPECIES
WITHIN POPULATIONS IN THE BROAD AREA OF SARAJEVO**

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Abstract – Analysis of occurrence of female and male specimens of *Leptidea sinapis* Linnaeus, *Aricia agestis* Hbn., *A. allous* Schiff. (also known as *A. artaxerxes allous* Schiff.) and *Coenonympha tullia lorkovici* Sijarič & Carnelutti was made in the vicinity of Sarajevo. Significant difference in favor of male specimens was established in all species.

KEY WORDS: *Lepidoptera*, *Papilionoidea*, sex ratio, evolution, genetics

Izvleček – SPOLNI DELEŽI PRI VRSTI *LEPTIDEA SINAPIS* LINNAEUS, 1758 (LEPIDOPTERA: PIERIDAE) IN NEKAJ DRUGIH VRSTAH METULJEV V POPULACIJAH ŠIRŠE OKOLICE SARAJEVA

V raziskavi je opravljena analiza zastopanosti samcev in samic v populacijah vrst *Leptidea sinapis* Linnaeus, *Aricia agestis* Hbn., *A. allous* Schiff. (znana tudi kot *A. artaxerxes allous* Schiff.) in *Coenonympha tullia lorkovici* Sijarič & Carnelutti v okolici Sarajeva. Pri vseh proučevanih vrstah je ugotovljen večji delež samcev.

KLJUČNE BESEDE: *Lepidoptera*, *Papilionoidea*, spolni deleži, evolucija, genetika

Introduction

In principle, the mechanism of genetic sex determination depends on the presence of specific chromosomes which, individually or in pairs, appear in most of biparental organisms. Thus, in *Drosophila*-type sex inheritance, males possess a het-

erogamous pair of sex chromosomes (XY), while females are homogamous (XX). In such cases males produce gametes that determine the sex of the offspring. However, there is a whole range of other combinations ($\sigma\sigma$ -X0, $\varphi\varphi$ -XX: numerous Hemiptera, Orthoptera, Coleoptera; $\sigma\sigma$ -n, $\varphi\varphi$ -2n: Hymenoptera; $\sigma\sigma$ -XX, $\varphi\varphi$ -XY or X0: Lepidoptera, etc.). We will elaborate the *Abraxas*-type of sex inheritance in butterflies in more detail. We need to emphasize clear evidence that both the female and male genome contains genes which determine both sexes, and that sex differentiation of an individual, apart from genetic interaction (balanced theory of sex differentiation – Bridges by Baden & Slang, 1969), depends on certain ecological conditions, hence on the expressed physiological features of an individual (physiological theory of sex determination – Marinković et al. 1981).

In butterflies, however, sex determination depends on the presence or absence of a sex chromosome in the egg cell. If both egg cell and spermatozoa contain the Z (equivalent to Y) gonosome the result is a male offspring (ZZ). If the egg cell contains the W (equivalent to X) gonosome or if it is absent the offspring is female (ZW or Z0). Considering these assumptions, the analysis of the formation and distribution of gonosomes in parental gametes clearly shows an equal number of female and male individuals in the F1 generation.

Therefore, we may freely state that even the slightest difference in the sex ratio may indicate significant events in a given population.

In general terms, there are multiple advantages in an even distribution of both sexes. We can identify three mechanisms that may explain the significance of this phenomenon:

The number of females limits the reproductive potential of a majority of sexually reproducible populations. Thus, for the total size of a given population, the actual population growth rate may be expected with a decrease of the sex ratio.

If the encounter between sexes is normal, the maximal probability that two individuals of the opposite sex should meet occurs when the sex ratio is 1:1. Therefore, the development of a recognition system between the sexes during mating serves the purpose of successful fertilization. There is also an issue of extreme differences between male and female cells, which may influence the sex ratio. Such an aspect of sexual differentiation arises from the development of a need for fertilization and zygote formation with maximal probability of sexual unification.

A balanced sex ratio (1:1) completely satisfies the size of the population that is efficient for achievement of the total population size with minimal genetic drift and inbreeding effects (Cavalli-Sforza, Bodmer 1971).

Two basic mechanisms that lead to changes in the sex ratio are known:

- **gamete selection** – unequal genesis of spermatozoa which carry an X or Y chromosome or unequal ability of the X or Y chromosome to fertilize the egg,
- **differential mortality** – the phenomenon that zygotes of specific sex preferentially survive.

It is extremely important to emphasize that natural selection against the sex ratio does not act in the same direction as other genetically determined traits until the occurrence of selective consequences on production of individual progeny calculated as the sex ratio of the population. However, selection among populations respects the sex ratio. It probably depends on mechanisms that are completely different from those imposed by rules of natural selection, which may be applied on changes within population only.

Selective values, in conjunction with the production of offspring in a given sex ratio, must serve the purpose of offspring reproduction. At least, certain genetic variation in sex ratio beyond the influence of natural selection must exist. In general, the advantage of sexual reproduction lies in the transfer of genetic material in the whole population, not only individuals. Genetic changes within populations are strongly engaged in development of independent selection among populations. However, the greatest importance is in providing answers to the questions:

What causes increases or decreases in the sex ratio?

Which mechanism might be in force in a population where the given sex ratio is more favorable for one of the sexes?

One of the most acknowledged theories was set by Fisher. He considered that certain »parental expenditures« exist in the genesis of the subsequent generation and that at least a portion of the total offspring mortality depends on it (Cavalli-Sforza, Bodmer 1971).

Material and methods

1. COLLECTION AND PREPARATION OF SPECIMENS

Material, *Leptidea* (Billberg, 1820) specimens, were collected during 1998 – 1999 in the broad area of Sarajevo (Table 1).

Fig. 1: Map of broad area of Sarajevo with the position of collection sites (sub-population A – dark spots, sub-population B – white spots)



Table 1: List of collection sites

Location No.	Location	Altitude*
1.	Bembaša	580–600
2.	Gazijin Han – tower	940–965
3.	Pašino brdo	920–965
4.	Grdonj – Špicasta stijena	880–900
5.	Grdonj	880–904
6.	Mrkovići	850–900
7.	Gornji Mrkovići	980–1.020
8.	Orlovača	1.200–1.212
9.	Debelj	700–750
10.	Orlovac	750–792
11.	Blekin potok	580–600
12.	Kromolj	600–700
13.	Gornji Kromolj	700–750
14.	Poljine	750–800
15.	Gornje Poljine	900–965
16.	Slatina	560–600
17.	Bare	550
18.	Sokolović–Kolonija	505–510
19.	Sokolovići – Hrasnica	510
20.	Hrasnica	510–520
21.	Stojčevac	490–500
22.	Ilidža – alley	480–490
23.	Vrelo Bosne	500
24.	Župča – Breza	520–540

(*- altitudes are given in ranges because specimens were collected in the area of the stated toponym)

Material was collected according to classical methods. Butterflies were collected with butterfly nets, then transferred into »mortuaries«, i.e. jars containing cotton soaked with a mixture of concentrated acetic acid and ether in a ratio of 1:3. Wet cotton was covered with piece of cardboard to preserve the specimen from damage. Specimens remained there for 30 minutes to ensure the efficiency of the poison. Subsequently, specimens were either transferred in entomological – lepidopterolog-

ical envelopes or immediately prepared. The specimens were transported to their final destination in hand-made lepidopterological field containers (Forster, Wohlfahrt 1955, Williams 1969).

Preparation of specimens was done on hand-made spreading surfaces – a piece of Styrofoam with a groove made by a hot glass rod. Spread specimens were dried for 7–14 days. Dried specimens were transferred to hand-made entomological containers and preserved by a piece of TUS insecticide strip.

2. PREPARATION OF GENITAL APPARATUS

The genital apparatus of specimens was treated in several manners. A piece of the abdomen of completely dried specimens was removed and transferred to 5% KOH. The container was heated for 10 minutes at 80 – 90°C. Following the relaxation process the genital apparatus was dissected. In most cases, muscles were completely removed in order to achieve a better view of chitin elements. A magnifier “MBS 6” of 28x strength was used for the dissection. Fresh specimens were immediately dissected and periodically sprayed with fresh fixative (Lorković, 1927; 1930).

A dissected and cleaned genital apparatus was placed on a microscope slide, immersed in euparal and covered with a cover glass. Such a preparation was labeled and placed in a thermostat at 80°C. After 24 hours, the preparation was stored in an adequate box.

Results and discussion

Analysis of the sex ratio showed intriguing results. The number of male specimens in the field was much higher. It is important to emphasize that all detected specimens of *L. sinapis* L. were captured; the results are based on reliable field data. Results of analysis are presented in Table 2.

For a more delicate analysis the Sarajevo population of *L. sinapis* L. was divided into two sub-populations. The sex ratio was analyzed by generations of sub-populations and also *in toto*.

In Table 2 absolute values and the probability of accidental occurrence of observed differences may be accentuated. However, relative values clearly express their ratios (Table 3). Within the first generation in sub-population A we found 19.42% female and 80.58% male specimens. The figures are somewhat different in the second generation – 15.94% female and 84.06% male specimens. In total we found 16.87% female and 83.13% male specimens (Graph 1).

Within the first generation in sub-population B we found 31.58% female and 68.42% male specimens. In the second generation the number of female specimens dropped significantly: we found 7.58% female and 92.42% male specimens. However, the total values (♀♀ – 16.35%, ♂♂ – 83.65%) are almost identical to the ratio found in sub-population A.

Table 2: Sex ratio in *L. sinapis* L., χ^2 value, and probability that observed difference occurred by chance.

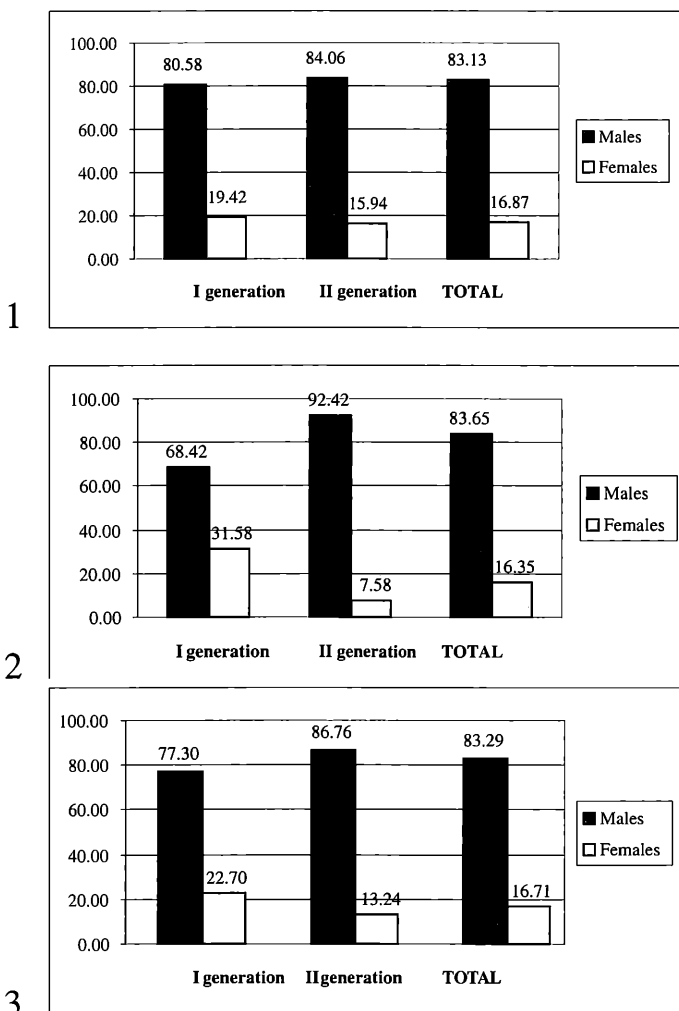
Sub-population	Generation	N	♂♂	♀♀	χ^2	<i>p</i>
A	Total	249	207	42	109.34	P < 0.001
	generation I	103	83	20	38.53	P < 0.001
	generation II	138	116	22	64.03	P < 0.001
	generation III	8	8	0	8.00	0,01 < p < 0.001
B	Total	104	87	17	47.12	P < 0.001
	generation I	38	26	12	5.16	0,05 < p < 0.01
	generation II	66	61	5	47.52	P < 0.001
Total	Total	353	294	59	156.44	P < 0.001
	generation I	141	109	32	42.05	P < 0.001
	generation II	204	177	27	110.29	P < 0.001
	generation III	8	8	0	8.00	0,01 < p < 0.001

Table 3: Sex ratio in *L. sinapis* L. – relative values.

Sub-population	Generation	N	♂♂	♀♀	Σ
A	Total	249	83.13	16.87	100.00
	generation I	103	80.58	19.42	100.00
	generation II	138	84.06	15.94	100.00
	generation III	8	100.00	0.00	100.00
B	Total	104	83.65	16.35	100.00
	generation I	38	68.42	31.58	100.00
	generation II	66	92.42	7.58	100.00
Total	Total	353	83.29	16.71	100.00
	generation I	141	77.31	22.69	100.00
	generation II	204	86.77	13.23	100.00
	generation III	8	100.00	0.00	100.00

At the level of the population we found 16.71% female and 83.29% male specimens. The sex ratio found in the first generation (♀♀ – 22.70%, ♂♂ – 77.30%) changed by 9.46% in favor of males in the second generation (♀♀ – 13.24%, ♂♂ – 86.76%) (Graph 3). A decrease in the number of females was also apparent in both sub-populations.

Graph 1-3: Sex ratio in sub-population A (Graph 1), sub-population B (Graph 2) and in the total population (Graph 3) – relative values.



Analysis of the sex ratio in the population or sub-populations of *L. sinapis* L. in the area of Sarajevo by generations (excluding the third generation) and in total values shows a dramatic increase of males (Table 4). Thus, the sex ratio in this population varies from 2.17:1 to an incredible 12.2:1. In the spring generation, although high, these values were more balanced (A I – 4.15:1; B I – 2.17:1; Total – 3.41:1). However, in the summer generation the values are from slightly to extremely increased (A I – 5.27:1; B I – 12.2:1; Total – 6.56:1). Table 4 shows that the smallest difference was found in the first generation in sub-population B (2.17:1). The

greatest difference was also found in this sub-population, in its second generation (12.2:1). Such rapid variation was not found in sub-population A (I – 4.15:1, II – 5.27:1), still, the values were quite high. In the Sarajevo population we established that the sex ratio almost doubled in the second generation (I – 3.41, II – 6.56). However, the total values of sub-populations and the total population were balanced: A – 4.93:1, B – 5.12:1; Total – 4.98:1.

Table 4: Sex ratio in *L. sinapis* L.

Sub-population	Generation	N	♂♂	♀♀	Sex ratio
A	Total	249	207	42	4.93:1
	generation I	103	83	20	4.15:1
	generation II	138	116	22	5.27:1
	generation III	8	8	0	8.00:0
B	Total	104	87	17	5.12:1
	generation I	38	26	12	2.17:1
	generation II	66	61	5	12.2:1
Total	Total	353	294	59	4.98:1
	generation I	141	109	32	3.41:1
	generation II	204	177	27	6.56:1
	generation III	8	8	0	8.00:0

It is well established that butterflies are heterosexual and that the female gamete determines the offspring sex. These facts led us to expect an even number of female and male specimens in the progeny as well as the population. However, the results showed that the sex ratio in this species did not conform to the laws of biological or mathematical distribution. In all comparisons, the p value (probability of accidental occurrence of observed differences) showed a statistical significance from the observed differences ($p < 0.001$). Even the lowest p values were still high: $0.05 < p < 0.01$ (Table 2).

This finding in *L. sinapis* L. may be correlated with the fact that the female is capable of reproduction the day after hatching. It lays eggs only 48^h following fertilization. That may mean that the extremely high number of male specimens ensures »reliable« fertilization of females following hatching, thus providing a higher probability of maintaining a stable population for generations (Wiklund, 1977; Lorković, 1993).

However, it would be interesting to know whether other butterflies groups demonstrate such a high ratio or it remains at the level of the mathematical model of 1:1.

For objectivity of the total analysis we used the opportunity to analyze some papers containing original data on the collection of other butterfly species and to seek

verification of our assumptions. We used these data in an attempt to establish the actual sex ratio in butterflies.

A paper on morphological differentiation of *A. allous* Schiff. and *A. agestis* Hbn. (Lorković, Sijarić, 1967) contains a list of field trips as well as numbers of captured specimens that may be established from the list. (Table 5, 6).

Table 5: Absolute and relative sex ratio in *A. allous* Schiff. and *A. agestis* Hbn., χ^2 value and probability that observed difference occurred by chance.

Species	Ratio	N	♂♂	♀♀	χ^2	p
<i>A. agestis</i>	Absolute	35	28	7	12.6000	P < 0.001
	Relative	100.00	80.00	20.00		
<i>A. allous</i>	Absolute	201	149	52	46.8109	P < 0.001
	Relative	100.00	74.13	25.87		

Table 6: Sex ratio in *A. allous* Schiff. and *A. agestis* Hbn.

Species	N	♂♂	♀♀	Sex ratio
<i>A. agestis</i>	35	28	7	4:1
<i>A. allous</i>	201	149	52	2.87:1

As Tables 5 and 6 clearly show, there were also significant ratios between number of females and males. The difference was less prominent in *A. allous* Schiff. than in *A. agestis* Hbn. as the figures show: 4:1–2.87:1.

The paper on a new subspecies of *Coenonympha tullia* Mull. (Sijarić, Cernelutti, 1976) also comprises information on the collection of specimens (Tables 7, 8).

Table 7: Sex ratio in *C. t. lorkovici* Sijarić & Cernelutti, χ^2 value and probability that observed difference occurred by chance.

Species	Date	Ratio	N	♂♂	♀♀	χ^2	p
<i>C. t. lorkovici</i>	11.07.69	Absolute	4	3	1	1	0,5>p>0.3
		Relative	100.00	75.00	25.00		
	13.-14. 08.69	Absolute	99	49	50	1,0101	P > 0.90
		Relative	100.00	49,50	50.50		
	14.,15.,14. 07.75	Absolute	78	66	12	37,385	P < 0.001
		Relative	100.00	84.62	15.38		
	Total	Absolute	181	118	63	16,713	P < 0.001
		Relative	100.00	65.19	34.81		

Evidently, significant difference in the absolute number of captured males and females was present in this case also. However, the first two field trips did not find significant differences in the sex presence, while the difference encountered in the last field trip proved to be drastic:

Table 8: Sex ratio in *C. tullia lorkovici* Sijarić & Cernelutti.

Species	N	♂♂	♀♀	Sex ratio
<i>C. t. lorkovici</i>	4	3	1	3:1
	99	49	50	0,98:1
	78	66	12	5,50:1

The sex ratio in these three field trips clearly varied from an almost ideal 0.98:1 to a quite significant 5.50:1.

The presented examples clearly demonstrate an imbalance in the sex ratio in butterflies, i.e. that male specimens were more abundant in given generations. It may be stated that such a situation indicates subtle adaptation. The selective appearance of male and female specimens affects their number in nature, which is different at various periods. Hence, it is to be expected that a greater number of female specimens may be found in certain periods. There are data (Sladen, Bang, 1969) that the mortality rate in butterfly populations as well as in bird populations, is greater in females. This feature is particularly prominent during adult formation. These data, consequently, shed a different light on the given problem but do not explain the phenomenon itself.

It is realistic to assume that fertilization yields even numbers of male and female zygotes and that the same ratio is probably maintained until the chrysalis phase. However, it seems that final metamorphosis into an imago occurs selectively, depending on environmental conditions. We assume that males with wider ecovalence appear first. Once the conditions for fertilization and development of caterpillars are optimal, females appear as well.

Previously described situations were found in the field at the appearance and disappearance of generations. Even then, the number of females was much lower than expected. The fact that a similar situation was found in representatives of three separate Families (*Leptidea sinapis* L. – Pieridae; *Aricia allous* Schiff. and *Aricia agestis* Hbn. – Lycenidae; *Coenonimpha tullia lorkovici* Sijarić & Cernelutti – Nymphalidae) gives additional weight to these results.

It is curious that similar records cannot be found in the available literature. Therefore, it is difficult to verify these findings and establish the actual mechanism behind this phenomenon. The issue of sex ratio in butterfly populations certainly deserves greater attention than it appears at first sight.

Conclusions

The sex ratio in the Sarajevo population of *L. sinapis* L., its sub-populations, and different generations, shows statistically significant differences.

The sex ratio in *L. sinapis* L. ranges from 2.17:1 to 12.2:1 in favor of males.

Based on published data, a significant imbalance in the sex ratio was established in *A. allous* Schiff. and *A. agestis* Hbn.

The sex ratio in *A. allous* Schiff. was established at 4:1, and 2.87:1 in *A. agestis* in favor of male specimens.

Also on the basis of published data, a balanced sex ratio was established in *C. tullia lorkovici* Sijarić & Cernelutti in certain samples. However, field trips with highly significant difference in sex ratio were also established.

The sex ratio in this subspecies ranges from 0.98:1 to 5.50:1 (♂♂ – ♀♀).

Analysis of all the available data indicate an unbalanced sex ratio in three Families in the supra-family Papilionidea. Therefore, it is uncertain that distribution of sexes in nature is even in this group of insects.

Summary

It is a well-established fact that bi-parental organisms maintain even ratios of female and male specimens in nature. Such a ratio is clearly genetically determined. However, this paper clearly indicates that the sex ratio in butterflies favors males in most of the flight period. Thus, the sex ratio in *L. sinapis* L. ranges from 2.17:1 to 12.2:1 in favor of males. Presented examples clearly show that in butterflies a significantly higher number of males than females is found in a given generation. Such a situation indicates subtle adaptation of the species. Selective appearance of male and female specimens affects their numbers in nature, different at various periods. Hence, it is to be expected that a greater number of female specimens may be found at certain periods. There are data (Sladen, Bang 1969) that mortality rate in butterfly populations as well as in bird populations is greater in females. This feature is particularly prominent in the phase of adult formation. These data, consequently, shed different light on the given problem but do not explain the phenomenon itself.

It is realistic to assume that fertilization yields an even number of male and female zygotes and that the same ratio is probably maintained until the chrysalis phase. However, it seems that final metamorphosis into an imago occurs selectively, depending on environmental conditions. On the basis of field observations, we assume that males with wider eco-valence appear first. Once the conditions for fertilization and development of caterpillars are optimal, females appear as well.

However, significantly higher number of males were established also in control populations, i.e. in published papers on other butterflies species. Thus, the sex ratio in *A. allous* Schiff. is 4:1, and 2.87:1 in *A. agestis* Hbn. is in favor of males. Also, based on published data on the new subspecies *C. tullia lorkovici* Sijarić & Cernelutti we established a sex ratio ranging from 0.98:1 to 5.50:1 (♂♂ – ♀♀). These results

indicate that, within butterfly populations a regularity in the change of the sex ratio exists. For a short period it is balanced but most frequently it greatly favors male individuals.

Sažetak

U ovom radu je izvršena analiza zastupljenosti muških i ženskih jedinki vrsta *Leptidea sinapis* Linnaeus, *Aricia agestis* Hbn., *A. allous* Schiff. (danas *A. artaxerxes allous* Schiff.) i *Coenonimpha tullia lorkovici* Sijarić & Cernelutti te je konstatovana signifikantna razlika kod svih spomenutih vrsta u korist mužjaka.

Poznato je da biparentalni organizmi imaju podjednak odnos mužjaka i ženki u prirodi, koji je, između ostalog, i jasno genetički determiniran. Međutim, ovaj rad jasno pokazuje da je kod dnevnih leptira brojni odnos spolova, odnosno, sex ratio znatno veći kod mužjaka nego kod ženki u najvećem dijelu vremenskog raspona u kojem se oni pojavljuju. Tako, sex ratio vrste *L. sinapis* L. kreće se u rasponu od 2,17:1 do 12,2:1 u korist mužjaka. Iz gore navedenih primjera jasno se vidi da kod dnevnih leptira postoji neujednačeni odnos spolova, odnosno, da u datoj generaciji egzistira znatno više mužjaka nego ženki. Preciznije, sve ovo ukazuje na vrlo suptilno prilagodavanje spomenute vrste, tako da selektivno pojavljivanje mužjaka i ženki utiče na njihov brojni odnos (sex ratio) u prirodi, te da je on različit u različitim periodima, tj. za očekivati je da u pojedinim periodima egzistira znatno veći broj ženki nego mužjaka. Napominjemo da postoje podaci (Sladen, Bang 1969) da u populacijama leptira, kao i ptica, ženke imaju veću stopu smrtnosti nego mužjaci, naročito u periodu pojavljivanja generacije (formiranja adultnih organizama). Ovaj podatak, naravno, daje novu sliku datom problemu, ali, nažalost, ne objašnjava sam fenomen.

Realno je pretpostaviti da u periodu polaganja jaja postoji jednak broj zigota muškog i ženskog spola te da se ovaj brojni odnos, vrlo vjerovatno, održava do formiranja lutke. Međutim, preobražaj u samog leptira (imaga), izgleda, odvija se po selektivnom tipu i to ovisno od uslova sredine. Pretpostavljamo, prema terenskim zapažanjima, da se prvo pojavljuju mužjaci koji su nešto šire eko-valence, a po dostizanju optimalnih uslova za oplodnju te razvoj gusjenica dolazi do razvoja i ženskih individua.

Međutim, signifikantno visok broj mužjaka ustanovljen je i u »kontroli«, tj. u radovima o drugim vrstama dnevnih leptira. Tako, sex ratio kod vrsta *A. allous* Schiff. iznosi 4:1, odnosno, *A. agestis* Hbn. – 2,87:1 u korist mužjaka. Također, na osnovu podataka u radu o novoj podvrsti *C. tullia lorkovici* Sijarić & Cernelutti, konstatovan je brojni odnos u rasponu od 0,98:1 do 5,50:1 (♂♂ – ♀♀). Ovi rezultati ukazuju da, unutar populacija dnevnih leptira, postoji pravilnost u promjeni brojnog odnosa mužjaka i ženki koji je samo u vrlo kratkom periodu podjednak, a najčešće je višestruko »na strani« mužjaka.

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Favnistični zapiski / Faunistical notes

MESOVELIA VITTIGERA HORVÁTH AND MICROVELIA PYGMAEA (DUFOUR) (HETEROPTERA: GERROMORPHA) IN CROATIA

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Abstract – The species *Mesovelias vittigera* Horváth, 1894 is recorded for the first time from the territory of Croatia. The occurrence of *Microvelia pygmaea* (Dufour, 1833) is confirmed after a wait of a whole century.

Izveček – *MESOVELIA VITTIGERA* HORVÁTH IN *MICROVELIA PYGMAEA* (DUFOUR) (HETEROPTERA: GERROMORPHA) NA HRVAŠKEM

Vrsta *Mesovelias vittigera* Horváth, 1894 je prvič najdena na ozemlju Hrvaške. Prisotnost vrste *Microvelia pygmaea* (Dufour, 1833) je potrjena po celem stoletju.

The following two species of water bugs are reported from the territory of Croatia. All the material was identified by P. Kment and is preserved in the author's collection and the collection of M. Mantič (Ostrava, Czech Republic).

***Mesovelias vittigera* Horváth, 1895**

Croatia centr. occ., Petrčane (6 km northwest of Zadar), freshwater reservoir among fields, 16.-21.VII.2000, M. Mantič lgt.: 1 male, 3 females (all apterous) (together with *Microvelia pygmaea*, *Gerris costae fieberi* Stichel, 1938 and *Notonecta viridis* Delcourt, 1909); Islam Latinski (19 km northeast of Zadar), freshwater reservoir, 22.VII.2000, M. Mantič lgt.: 6 females (1 macropterous, 5 apterous), together with apterous specimens of *Gerris argentatus*.

Mesovelias vittigera Horváth, 1895 is a widespread species, distributed in southern part of the Palearctic Region as well as in the Ethiopian, Oriental and Australian Regions. In Europe it is known from Albania, Bulgaria, France, Greece, Italy, Malta, Portugal and Spain (Andersen 1996). This author overlooked the paper by Štusák (1980), where this species is mentioned from the locality Bar in Montenegro. Strpič (1997) recorded only *Mesovelias furcata* Mulsant & Rey 1852 from Croatia. It was the first finding of family Mesoveliidae in this country at all. Even Furlan & Gogala (1995) did not find it in the area under their study – Lošinj Island in Dalmatia. *M. vittigera* is a new species for the fauna of Croatia, reaching its northernmost limit of distribution in the Balkan Peninsula.

Microvelia pygmaea (Dufour, 1833)

Croatia centr. occ., Petrčane (6 km northwest of Zadar), freshwater reservoir among fields, 16.-21.VII.2000, M. Mantič lgt.: 6 males, 8 females (all apterous).

The species *Microvelia pygmaea* (Dufour, 1833) occur widely in southern part of the Palaearctic Region. Andersen (1996) recorded it from northern Africa (Morocco, Algeria, Tunisia and Egypt), western and central Asia (Asian Turkey, Cyprus, Azerbaijan, ?Israel, Syria, Kirgizia, Uzbekistan, Tadzhikistan, ?China) and southern, western and part of Central Europe (Albania, Austria, Belgium, Bosnia Hercegovina, Bulgaria, France, Great Britain, Germany, Greece, Hungary, Italy, Lichtenstein, Malta, Macedonia, the Netherlands, Portugal, Spain, Switzerland and Yugoslavia). Data from Ireland (Walton 1981, 1985), Slovenia (Gogala & Gogala 1986, 1989) and Croatia are neglected in this list. Protič (1998) excerpted data from two old papers, where *M. pygmaea* is mentioned from Rijeka (Korlevič 1887) and Orehovica (Horváth 1900). On the other hand, according to the personal communication of A. Gogala, it is a widespread species in Slovenia, especially in the submediterranean region. This fact indicates that this species is probably not rare but only neglected in Croatia.

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