

Studies on the Gall Community of *Diplolepis rosae* (Hymenoptera: Cynipidae) in Vitosha Mountain, Bulgaria

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Abstract: Rose Bedeguar galls support insect community, which consists of hymenopteran parasitoids and inquilines. Although, the structure and phenology of this community, as well as the life history and sex ratio of the gall inducer are subject of detailed investigations in some European countries, such studies have never been conducted in Bulgaria. In this paper we provide information on sex ratio and structure of the insect community bred from galls collected from 3 localities in Vitosha Mt., Bulgaria. Our results confirm the existence of geographical and ecological dependent differences of the parasitoid community's structure and the sex ratio of the gall wasp. We obtained 43.10% of *Diplolepis rosae* males for Vitosha population, the highest figure for whole datasets found until now for this species in Europe. Including the gall-maker, the reared insect community consists of 11 species, namely ichneumonid wasp *Orthopelma mediator*, pteromalids *Pteromalus bedeguaris* and *Caenacis inflexa*, torymids *Glyphomerus stigma* and *Torymus bedeguaris*, eurytomid *Eurytoma rosae*, eulophid *Stepanovia sp.* near *eurytomae*, eupelmids *Eupelmus urozonus* and *Eupelmus vesicularis* and cynipoid inquiline *Periclistus brandtii*. A tenthredinid *Cladius pectinicornis* (with 1 individual only) and three eulophid individuals of *Colpoclypeus florus* are supposed to be accidental inhabitants in the galls volume. The most abundant parasitoid species is *G. stigma* with 19.12% of all reared insects, followed by *P. bedeguaris* (17.74%) and *O. mediator* (13.59%). The correlations between insects in the community and the influence of some environmental factors on the community structure were analyzed and discussed. Some comparisons have been done with the previous records from Europe.

Key words: *Diplolepis rosae*, parasitoids, gall community, sex ratio, Bulgaria

Introduction

Cynipid gall wasps (Hymenoptera: Cynipidae: Cynipinae) include about 1400 species inducing some of the most structurally complex plant galls (MELIKA 2006). Most of the cynipids are associated with oaks (*Quercus*) (86%, SHORTHOUSE 1973) while the remaining species induce galls on different shrub and herbaceous plants. The cynipids have three different forms of reproduction: sexual, parthenogenetic and heterogenous (MELIKA 2006).

The genus *Diplolepis* GEOFFROY, 1762 is strictly associated with roses (*Rosa*) and has Holarctic dis-

tribution. *Diplolepis rosae* (LINNAEUS, 1758) is univoltine species and its life cycle consists of a single, sexually reproducing generation each year. Sexual reproduction occurs by facultative (or generative) arrhenotoky and males are rare or absent from populations (MELIKA 2006). An obligate parthenogenesis is typical to the rose bedeguar gall wasp. *D. rosae* is common and widespread Palearctic species, also introduced to North America (RANDOLPH 2005). It has been reported to utilize over than 20 *Rosa* species (SCHRÖDER 1967, RITCHIE, PETERS 1981, NIEVES-ALDREY 2001).

According to SCHRÖDER (1967) *D. rosae* can cause considerable damage on the host plant when it is abundant; however there are no detailed reports of such events. STILLE (1984) stated that the many-chambered gall of *D. rosae* influences the host plant insignificantly, although sometimes hips are involved in galls.

The rose bedeguar gall wasps support a number of parasitoid species and all together with inquilines form a structured community where some parasite species are normally rare, others are common, and these rates of abundance depend on geographical and temporal reasons (ASKEW 1980). LÁSZLÓ, TÓTHMÉRÉSZ (2011) confirmed the potential usefulness of the insect community of *D. rosae* galls in testing ecological hypotheses because of its wide distribution in large geographical scale and different habitats.

Although, the structure and phenology of this community, as well as the life history and sex ratio of the gall inducer are subject of detailed investigations in many European countries (ASKEW 1960, SCHRÖDER 1967, STILLE 1984, NORDLANDER 1973, RANDOLPH 2005, RIZZO, MASSA 2006, LÁSZLÓ, TÓTHMÉRÉSZ 2011), such studies have never been conducted in Bulgaria.

Material and Methods

Study area, field and laboratory methods

To the aim of the present study, the total of 251 newly produced galls of *D. rosae* were sampled from eastern and southern parts of Vitosha Mts. in 16 different sites (Fig. 1) (all included into Vitosha Nature Park), situated in 3 types of habitats – open lands (OL; 9 sites), ecotone areas (ECT; 5 sites) and shadowed forest ridges (SFR; 2 sites). The ecotone habitats and forest ridges are limited by young forests of *Fagus sylvatica* with isolated groups of *Pinus sylvestris* and, in some areas, with narrow natural slopes, grown by *Juniperus communis*. The galls were collected in the last days of October and the first half of November, 2011, at altitude between 1006 m and 1536 m a. s. l. Galls were sampled on individual shrub or groups of shrubs belonging to 5 *Rosa* species (*Rosa micrantha* SMITH, 1812; *Rosa agrestis* (SAVI 1798); *Rosa canina* L., 1753; *Rosa corimbifera* BORCKHAUSEN, 1790 and *Rosa dumalis* BECHSTEIN 1810) and were placed (immediately after collection) in laboratory conditions

(20 °C) in plastic boxes for 10 months. All galls from every particular site were maintained together in a single box. Complete data about the names of localities, coordinates, type of habitats and plant host species is shown in Table 1. Emerged insects were fixed in 95% ethyl alcohol and identified as follows: species of Cynipidae, Ichneumonidae and Pteromalidae by I. Todorov; Eupelmidae, Eurytomidae and Torymidae by A. Stojanova; Eulophidae by P. Boyadzhiev. Statistical analysis was made by D. Parvanov. All interspecific relationships and relations among community indexes, species and environmental features were tested statistically on the base of the mean number of insects per gall for every particular species.

Statistical analysis

Results are expressed as the mean \pm SD for numeric variables and proportions (%) for categorical variables. The Spearman Correlation Coefficient at 5% significance level was used to quantify the relationships among the investigated variables – number of individuals per gall. The normality of the distributions of different variables was tested with Kolmogorov-Smirnov one sample test. The significance of differences among habitats was assessed using a one-way ANOVA. When the data sets failed the normality test, the Kruskal-Willis one-way ANOVA on ranks was used. Post hoc pairwise comparison between groups was tested for significance using Dunn's and Holm-Sidak method. Results were considered to be significant at the 5% critical level ($P < 0.05$). The statistical analysis was carried out using SigmaStat (v. 3.5).

Results

Emergence of the insects started at least 10 days after placement in laboratory and finished in August, 2012, about 9 months later. The first reared species was *Pteromalus bedeguaris* (THOMSON 1878) (started 10-30 days after placement) and the last was *Glyphomerus stigma* (FABRICIUS 1793) (started 60-122 days after placement). A total of 3833 individuals belonging to 13 species emerged, most of them well known as inhabitants in the bedeguar galls from many previous works. The average density of the community was 17 insects per gall - minimum 9.93 at site 'Shevovitsa area' and maximum 31.63 at site 'near Selskata reka 1'. The total percent of parasitization (calculated for the gall-maker and the

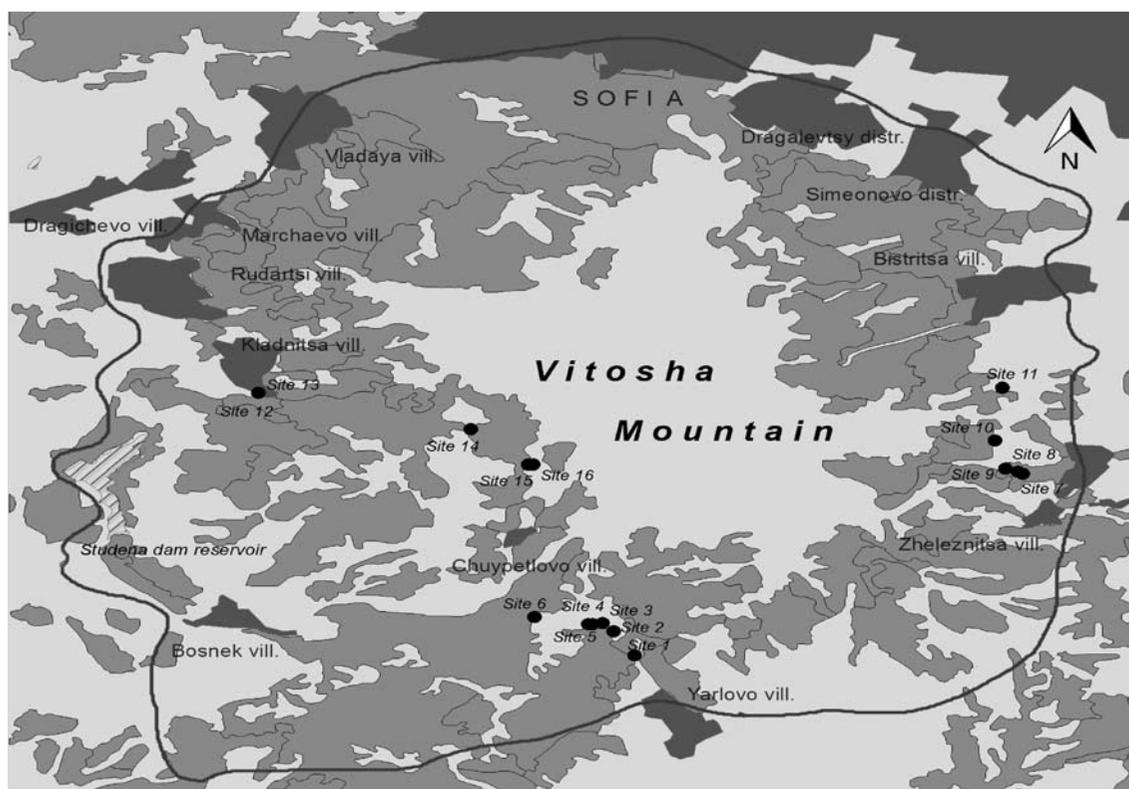


Fig. 1. Sampling sites on Vitosha Mt. The permanent black line shows borders of the mountain. The irregular grey areas are forests, while more lightly coloured areas are open lands. Dark grey areas are settlements (villages or districts). Lakes are depicted with oblique lines.

Table 1. Sites, types of habitats and rose species for sampling of *D. rosae* galls in Vitosha Mt.

Site number and name	Coordinates	Altitude, m	Type of habitat	Galls number	<i>Rosa</i> sp.	
1	Elovitsa 1	42° 29' 08" N/23° 16' 07" E	1133	OL	19	<i>R. micrantha</i>
2	Elovitsa 2	42° 29' 31" N/23° 15' 50" E	1251	OL	20	<i>R. agrestis</i>
3	Smilyo 1A	42° 29' 39" N/23° 15' 41" E	1277	OL	14	<i>R. canina</i>
4	Smilyo 1B	42° 29' 38" N/23° 15' 33" E	1286	OL	18	<i>R. canina</i>
5	Smilyo 1C	42° 29' 38" N/23° 15' 30" E	1300	OL	17	<i>R. canina</i>
6	Smilyo 2	42° 29' 45" N/23° 14' 47" E	1335	OL	25	<i>R. canina</i>
7	near Selskata reka	42° 32' 03" N/23° 21' 16" E	1138	SFR	8	<i>R. corimbifera</i>
8	near Selskata reka	42° 32' 05" N/23° 21' 12" E	1137	SFR	9	<i>R. agrestis</i>
9	Shevovitsa area	42° 32' 08" N/23° 21' 02" E	1162	OL	41	<i>R. agrestis</i>
10	near Shevovitsa area	42° 32' 35" N/23° 20' 54" E	1249	ECT	16	<i>R. dumalis</i>
11	near Terziyski dol area	42° 33' 26" N/23° 21' 00" E	1121	ECT	8	<i>R. dumalis</i>
12	Kladnitsa vill.-1	42° 33' 21" N/23° 11' 07" E	1006	ECT	7	<i>R. corimbifera</i>
13	Kladnitsa vill.-2	42° 33' 21" N/23° 11' 07" E	1006	ECT	8	<i>R. canina</i>
14	Dain Kladenets spring	42° 32' 46" N/23° 13' 56" E	1374	ECT	8	<i>R. canina</i>
15	Near Mecha cheshma - 1	42° 32' 12" N/23° 14' 42" E	1536	OL	9	<i>R. canina</i>
16	Near Mecha cheshma - 2	42° 32' 12" N/23° 14' 46" E	1534	OL	24	<i>R. canina</i>

inquiline) vary from 45.45% to 97.22% in particular samples, corresponding to average 76.95% for all gathered galls.

***Diplolepis rosae* – abundance and sex ratio**

The gall-maker in our samples is the third abundant species and composes 14.69% or 563 individuals of all emerged insects, with an average density of 2.71 individuals per gall (Fig. 2a). We obtained a striking sex ratio (0.95 ± 0.67 ind./gall) (Fig. 2b), which is abnormally high (43.10% males for all samples). The lowest percent of males (5.56%) was yielded in site ‘Near Mecha cheshma – 2’ and the highest (72.41%) – in site ‘Smilyo 1C’. It was not found significant dependence of the sex ratio to the parasitization, nor to altitude.

Density of *D. rosae* correlates positively with overall density of the community ($r = 0.691$; $P = 0.003$) and negatively with the level of parasitization ($r = -0.9$; $P < 0.001$). Moreover, decreasing number of *D. rosae* leads to increase of *Eurytoma rosae* ($r = -0.701$; $P = 0.002$) and the pair *E. rosae* + *Caenacis inflexa* ($r = -0.526$; $P = 0.035$).

Parasitoid-inquiline complex – composition and interspecific relationships

The most abundant member of the community was *Glyphomerus stigma* with 19.12%, followed by *Pteromalus bedeguaris* (17.74%). The ichneumonid wasp *Orthopelma mediator* (THUNBERG, 1824) (13.59%) occupy the fourth position (below *D. rosae*), whereas the other species flew in significantly lower numbers – the inquiline *Periclistus brandtii* (RATZBURG, 1831) was 8.14%, *Caenacis inflexa*

(RATZBURG, 1848) – 7.80%, *Torymus bedeguaris* (L., 1758) – 7.59%, *Eurytoma rosae* NEES, 1834 – 7.04%, *Stepanovia sp. near eurytomae* – 3.89% and *E. urosonus* DALMAN, 1820 – 0.23%. The scarcest were *Calpoclypeus florus* (WALKER, 1839) – 0.08% (3 individuals), *Eupelmus vesicularis* (RETZIUS, 1783) and *Cladius pectinicornis* (GEOFFROY, 1785) – 0.03% (each with 1 individual only) (Fig. 3).

Some of these species showed quantitative relations either with each other or with the parasitism and community density. *P. brandtii* correlates negatively with *E. rosae* ($r = -0.546$; $P = 0.028$) but not significantly with his other primary parasitoid *C. inflexa* ($r = -0.027$; $P = 0.917$). The inquiline is connected also with parasitization rate ($r = -0.617$; $P = 0.01$) and density of the community ($r = 0.661$; $P = 0.005$). Between the other inhabitants, we found correlations as follows: *P. bedeguaris* – *G. stigma* ($r = 0.582$; $P = 0.018$), *O. mediator* – *G. stigma* ($r = -0.553$; $P = 0.026$) and *C. inflexa* – *E. rosae* ($r = 0.642$; $P = 0.007$).

The quantity of two parasitoid species showed relation with the rate of parasitization – *E. rosae* ($r = 0.793$; $P < 0.001$) and *P. bedeguaris* ($r = 0.506$; $P = 0.044$).

Environmental influence on the community

We found that the density of the community in Vitosha Mts. varies significantly (ANOVA, $F_{1,15} = 29.43$, $P < 0.001$) among OL (13.52 ± 3.059 ind./gall), ECT (17.77 ± 2.827 ind./gall) and SFR (30.76 ± 1.23 ind./gall) habitats (Fig. 4a), but it is not influenced by altitude.

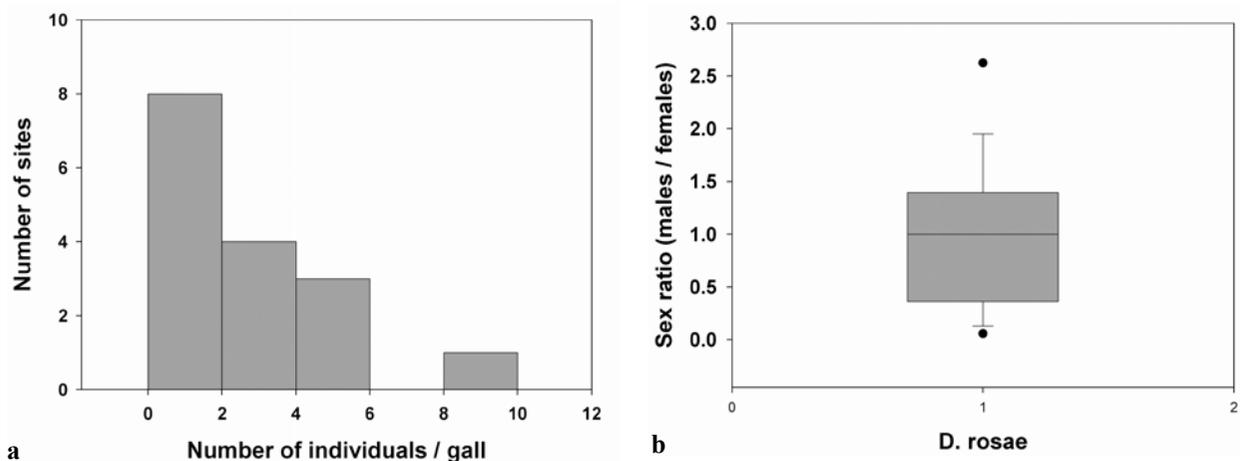


Fig. 2. (a) Histogram showing the abundance of *D. rosae* in different sites; (b) Box plot of the *D. rosae* sex ratio. The box plots depict the five-number summaries, namely the minimum and maximum values, the upper (Q3) and lower (Q1) quartiles and the median.

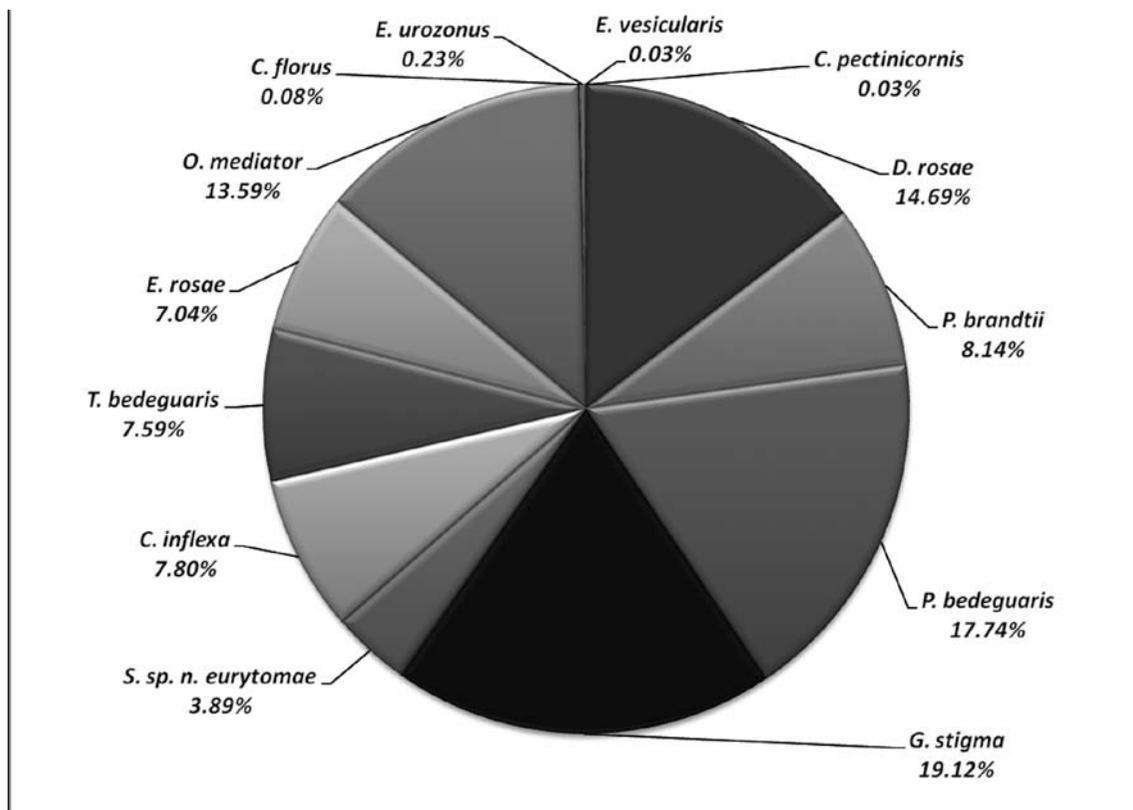


Fig. 3. Composition of the gall community in Vitosha Mt. (addition of *C. florus* and *C. pectinicornis* aims only informativeness).

There was a statistically significant difference between the parasitization in OL and SFR (ANOVA on ranks, $p = 0.011$) - 87.46% and 54.35% respectively (Fig.4b). Furthermore, there was a positive correlation of the level of parasitization with the altitude ($r = 0.572$; $P = 0.021$) and a negative correlation with the community density ($r = -0.591$; $P = 0.016$). Among the emerged inhabitants 4 species showed preferences or avoidance to some of the researched habitats. *P. brandtii* and *O. mediator* are more numerous in the samples from SFR habitats, *D. rosae* is less numerous in OL and *P. bedeguaris* and *G. stigma* are more numerous in OL. Concerning altitude, *P. brandtii* correlates negatively ($r = -0.576$; $P = 0.019$) whereas *O. mediator* correlates positively ($r = 0.532$; $P = 0.033$).

Discussion

Since the relatively short period of hibernation of the insects (30 – 40 days) before collecting the material, it would be incorrect to compare phenology of the species in our results to the previous ones. For example, NORLANDER (1973) has storage his samples outside until the last decade of March and LÁSZLO,

TOTHMÉRÉSZ (2011) have collected the galls in February and March. On the other hand the average density of the gall community in the present results (mean 15.27 insects per gall) makes no doubt that the rate of survival is normal when it is compared to this one known from the previous works (Table 2).

Diplolepis rosae – abundance and sex ratio

The abundance of gall-inducer in this study resembles the records from France and Austria (SHRÖDER 1967), Sweden (NORLANDER 1973) and is very close to these from part of Switzerland - Jura-south (Switzerland 2) (SHRÖDER 1967). According to these and some other works, the bedeguar wasp abundance in the galls from Vitosha Mts. could be considered as common (Table 2).

As a parthenogenetic species, *D. rosae* produce scarce male progeny and this has been demonstrated in many studies (SHRÖDER 1967; RANDOLPH 2005). However, in our study, the male individuals amount to 43.10% of all obtained gall-inducers and this result is surprisingly high compared to the published data till now. The highest percentages of males for Europe are given by HOFFMEYER (1925): 4% for Denmark, ASKEW (1960): 4.2 % for Northern England, RIZZO, MASSA (2006): 4.3% for Sicily (Italy)

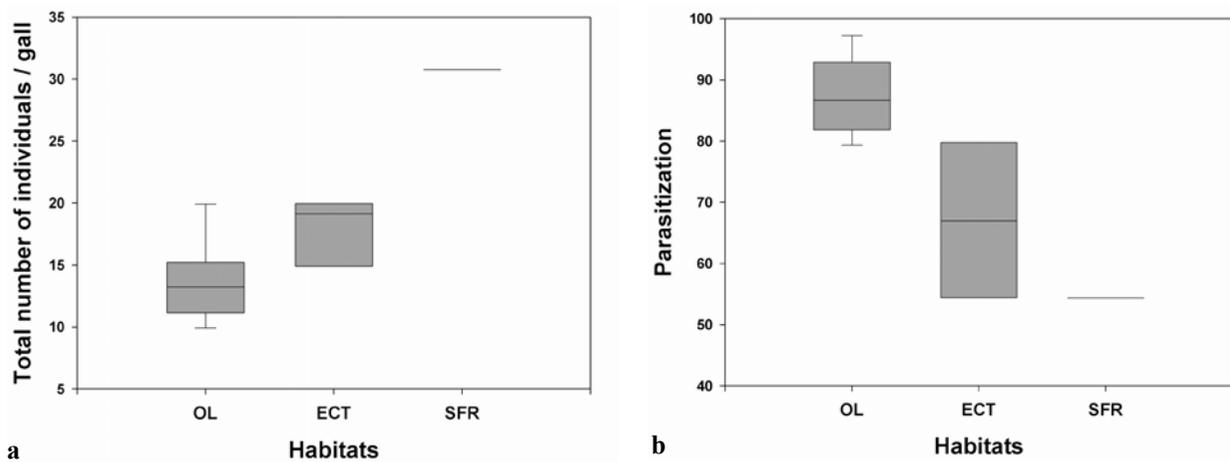


Fig. 4. Box plots of the (a) total number of individuals per gall and (b) parasitization (%) in the investigated habitats. The box plots depict the five-number summaries, namely the minimum and maximum values, the upper (Q3) and lower (Q1) quartiles and the median.

and LÁSZLÓ, TÓTHMÉRÉSZ (2011): 5.2% for Eastern Carpathian basin (Romania and Hungary). Although there are some records for high abundance of males of the rose bedeguar gall-wasp (RIZZO, MASSA 2006; LÁSZLÓ, TÓTHMÉRÉSZ 2011), they are relevant only to single samples, rather than whole datasets.

We found average 0.95 sex ratio of *D. rosae* in Vitosha population, the highest figure obtained till now for this gall-inducer. RIZZO, MASSA (2006) and LÁSZLÓ, TÓTHMÉRÉSZ (2011) FOUND IN THEIR STUDIES THE HIGHEST sex ratio, 0.05 and 0.06 respectively. However, most of the recorded information shows very scarce presence of males *D. rosae* in different European populations, even full absence (RANDOLPH 2005, RIZZO, MASSA 2006).

Published data about sex ratio of other *Diplolepis* species could be found in the literature; ZEROVA, DJAKONTSHUK (1976) studied the gall wasp *Diplolepis mayri* and its parasite complex in USSR and established that males are extremely rare, but in *Diplolepis fructuum* collected in Caucasus, males reached about 43% and only this result is relevant to our findings.

ASKEW (1960) supported HOFFMEYER'S (1925) idea for higher abundance of males in the North, however, RIZZO, MASSA (2006) and LÁSZLÓ, TÓTHMÉRÉSZ (2011), based on their own results suggested the lack of the latitudinal gradient. Our findings for Vitosha population that are in line with the last suggestion lead to the hypothesis that the presence of *D. rosae* males depends on more complicated factors.

Recent investigations of *Wolbachia* infection demonstrate that this endosymbiotic bacterium as-

sociated with arthropod and nematode hosts is the most probable cause of parthenogenesis in rose gall wasps (PLANTARD *et al.* 1998, 1999). *Wolbachia* is maternally inherited and induces gamete duplication following meiosis, thus all offspring are homozygous and diploid and can only be female because of the haplo-diploid sex determination in the most Hymenoptera. PLANTARD *et al.* (1998, 1999) pointed out that *Wolbachia* is wide spread in herb and rose gall wasps, with 12 of 19 rose gall-inducers found to be infected, and in addition, population-level analyses have revealed geographical variation in the prevalence of *Wolbachia* infection within species. The ability of *Wolbachia* to induce thelytoky in cynipid gall-wasps associated with oaks was studied by ROKAS *et al.* (2002). The hypothesis for 'horizontal transmission' of *Wolbachia* infection via parasitization tested by SCHILTHUIZEN, STOUTHAMER (1998) was not confirmed.

In our study, the very high percent of reared males supports the idea of low *Wolbachia* infection or even that the rose bedeguar gall wasps of the Vitosha population are *Wolbachia*-free. *Wolbachia* infection could be the main reason for different frequency of males reared in various geographical regions in combination with some ecological conditions.

Parasitoid-inquiline complex – composition and interspecific relationships

Insect community in the gathered galls from Vitosha Mts. has a specific quantitative composition but it is not unusual feature for this type of microhabitat. It was predicted (LÁSZLÓ, TÓTHMÉRÉSZ 2011)

Table 2. The first three most abundant species and known mean community density in previous works for Europe compared with data for Vitosha Mts.

Author	Country	First abundant species (%)	Second abundant species (%)	Third abundant species (%)	Mean density (ind./gall)
SHRÖDER 1967	Austria	<i>O. mediator</i> (38)	<i>P. brandtii</i> (23.2)	<i>D. rosae</i> (12.4)	-
	Germany	<i>O. mediator</i> (33.1)	<i>G. stigma</i> (28.4)	<i>P. brandtii</i> (10)	-
	France	<i>O. mediator</i> (34.4)	<i>T. bedeguaris</i> (22)	<i>D. rosae</i> (13.3)	-
	Slovakia	<i>O. mediator</i> (30.5)	<i>D. rosae</i> (25.9)	<i>P. brandtii</i> (17.9)	-
	Spain	<i>D. rosae</i> (35)	<i>G. stigma</i> (28.2)	<i>P. bedeguaris</i> (17.2)	-
	Switzerland 1	<i>D. rosae</i> (30.9)	<i>G. stigma</i> (23)	<i>T. bedeguaris</i> (18.4)	-
	Switzerland 2	<i>O. mediator</i> (34.8)	<i>D. rosae</i> (16.2)	<i>P. bedeguaris</i> (14.6)	-
	Switzerland 3	<i>T. bedeguaris</i> (41.2)	<i>D. rosae</i> (27)	<i>G. stigma</i> (17.5)	-
	Total (all countries)	<i>O. mediator</i> (23)	<i>D. rosae</i> (21.2)	<i>G. stigma</i> (16.7)	11.83
NORLANDER 1973	Sweden	<i>P. brandtii</i> (37.1)	<i>O. mediator</i> (17.9)	<i>D. rosae</i> (16.8)	-
STILLE 1984	Sweden	<i>P. brandtii</i> (36.7)	<i>O. mediator</i> (29.7)	<i>D. rosae</i> (14.6)	30.25
LÁSZLO 2001	Romania	<i>P. brandtii</i> (30.9)	<i>D. rosae</i> (21.3)	<i>O. mediator</i> (13.9)	23.26
RIZZO, MASSA 2006	Italy (Sicily)	<i>D. rosae</i> (44.8)	<i>O. mediator</i> (36.5)	<i>T. bedeguaris</i> (9.5)	12.44
LÁSZLÓ, TÓTHMÉRÉSZ 2006	Hungary, Romania	<i>D. rosae</i> (29.3)	<i>O. mediator</i> (18.98)	<i>C. inflexa</i> (18.91)	25.5
LÁSZLÓ, TÓTHMÉRÉSZ 2011	Hungary, Romania	<i>D. rosae</i> (22.1)	<i>G. stigma</i> (18.6)	<i>P. brandtii</i> (16.7)	14.3
Our results	Bulgaria, Vitosha Mts.	<i>G. stigma</i> (19.12)	<i>P. bedeguaris</i> (17.7)	<i>D. rosae</i> (14.69)	15.27

that this composition has longitudinal or latitudinal gradient through Europe. In the mentioned work a detailed review of the abundance of the species has been done as a comparison between some previously recorded data. We agree with this supposition but consider that more statistical analysis should be done for an affirmation. In our study the most abundant species in the community are *G. stigma*, *P. bedeguaris* and *D. rosae*, respectively. For *G. stigma* this presence could be considered as usual, but for *P. bedeguaris* it is obviously occasional (Table 2). Before our study there was no other data for a domination of *G. stigma* and *P. bedeguaris* in the rose bedeguar gall community, although some works has shown similarity in their percent – LÁSZLÓ, TÓTHMÉRÉSZ (2011) and SHRÖDER (1967; from Spain). As is shown in Table 2, among the most abundant species (besides *D. rosae*) commonly are *P. brandtii*, *O. mediator* and *G. stigma*, rarely *T. bedeguaris* and *P. bedeguaris* and only in one study – *C. inflexa*. In the most cases, the first three abundant species occupy more than 60

percent of all emerged insects and only in LÁSZLÓ, TÓTHMÉRÉSZ (2011) they are less numerous – 57.4%. Compared to the previous results, the gall community in Vitosha Mts. has more clear equality in respect of its species composition, with the most abundant species occupy just 51.6% of all community (Fig. 5). A possible reason for this could be the less human influence on the environment in Vitosha Mts., but more detailed research is necessary for testing of such an assumption. Other factors as the type of habitats and interspecific relationships have also not been ignored.

Some of the less numerous inhabitants obtained in our study, namely the inquiline *P. brandtii* and the parasitoids *O. mediator*, *C. inflexa*, *T. bedeguaris* and *E. rosae* emerged in abundance, clearly different from the European mean, calculated for all datasets (cited in Table 2). The inquiline resembles results in Spain (SHRÖDER 1967), but is almost a half less abundant compared to the European mean percentage. *C. inflexa* resembles results by NORLANDER

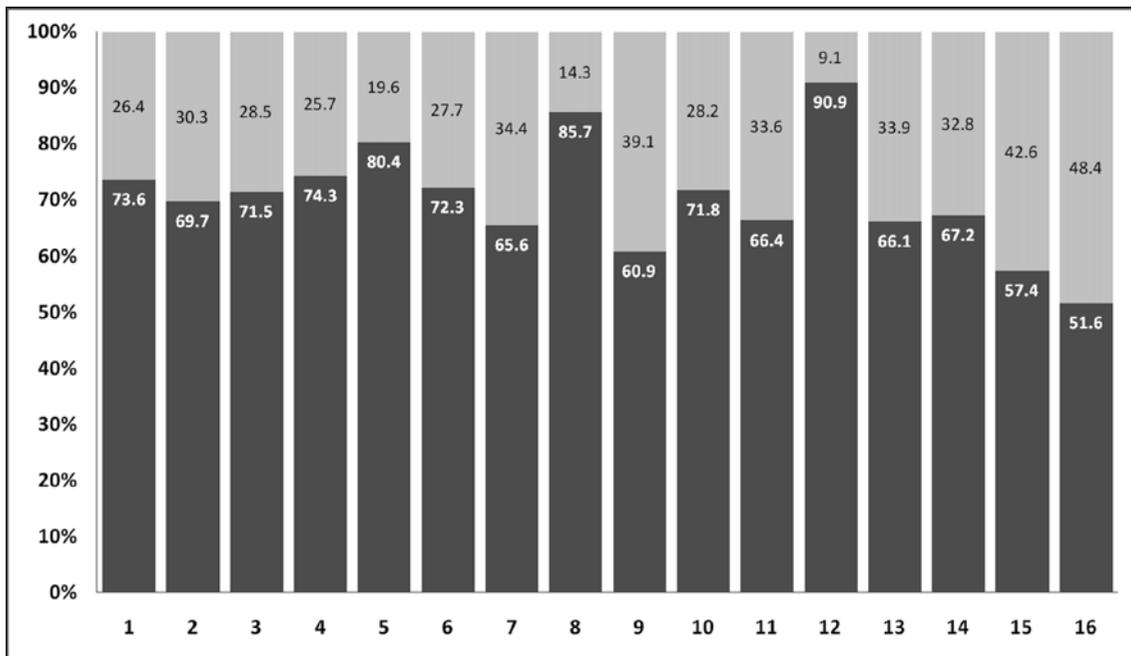


Fig. 5. Relative part of the first three abundant species (from Table 2) (dark grey), compared to the rest inhabitants (light grey) in the *D. rosae* gall community: 1-9. SHRÖDER (1967) - Austria, Germany, France, Slovakia, Spain, Switzerland 1 (Jura-north), Switzerland 2 (Jura-south), Switzerland 3 (Central Alps) and all countries, respectively; 10. NORLANDER (1973); 11. STILLE (1984); 12. RIZZO, MASSA (2006); 13. LASZLO (2001); 14. LÁSZLÓ, TÓTHMÉRÉSZ (2006); 15. LÁSZLÓ, TÓTHMÉRÉSZ (2011); 16. Our study.

(1973), but is about two times more abundant than European mean. *O. mediator*, *T. bedeguaris* and *E. rosae* are presented also in different abundance compared to the previous works (Fig. 6). Obviously, the gall community in Vitosha Mts. is unique, having different dominating species and relative abundance of its members.

Other differences between the community composition in Vitosha Mts. and the previous recorded are presence of two eulophids - *C. florus* and *S. sp.* near *eurytomae*. The first has never been reared from galls of *D. rosae* but it is a common parasitoid of leafrollers (Lepidoptera: Tortricidae), feeding on different plants, among which at least 2 rose species are known – *Rosa damascena* and *R. woodsii* (NOYES 2012). In our study *C. florus* flew from a gall of *R. micrantha*, which probably has enveloped a single leaf (or more) with hibernating parasitized tortricid pupae inside it. This could be confirmed by the late emergence of the eulophid individuals – between 1 and 2 months after placement in laboratory, which excludes a possible hibernation of adult insects among the gall hairs.

The other eulophid - *S. sp.* near *eurytomae* was determined as a distinct species which is close to

S. eurytomae (NEES, 1834) but differs as follows: darker body, head with specific U-shaped yellow spot on lower face, longer ovipositor and gaster in females, male antenna with ventral plaque situated very slightly above the middle of the scape and with very long apical seta, male genitalia with three digital spines. Its taxonomical description will be done in another publication later.

E. vesicularis is a well known polyphagous parasitoid, which attacks a wide range of hosts (NOYES 2012). It has been rarely obtained from rose-bedeguar galls (HERTING 1977, STOJANOVA 2006, LÁSZLÓ, TÓTHMÉRÉSZ 2011). Its presence in the community is clearly random.

The emergence of tenthredinid *C. pectinicornis*, just like *C. florus*, is considered as accidental. Larvae of this sawfly are known to feed on *Rosa* sp., *Fragaria* sp. and *Spiraea* sp. (all members of Rosaceae) (VASSILEV 1978) and its presence could be a result of a similar situation as was discussed about *C. florus*.

The relationships within the community supported by *D. rosae* were studied in detail by NORDLANDER (1973) through dissection of bedeguar galls and later these results serve as a starting point for the interpre-

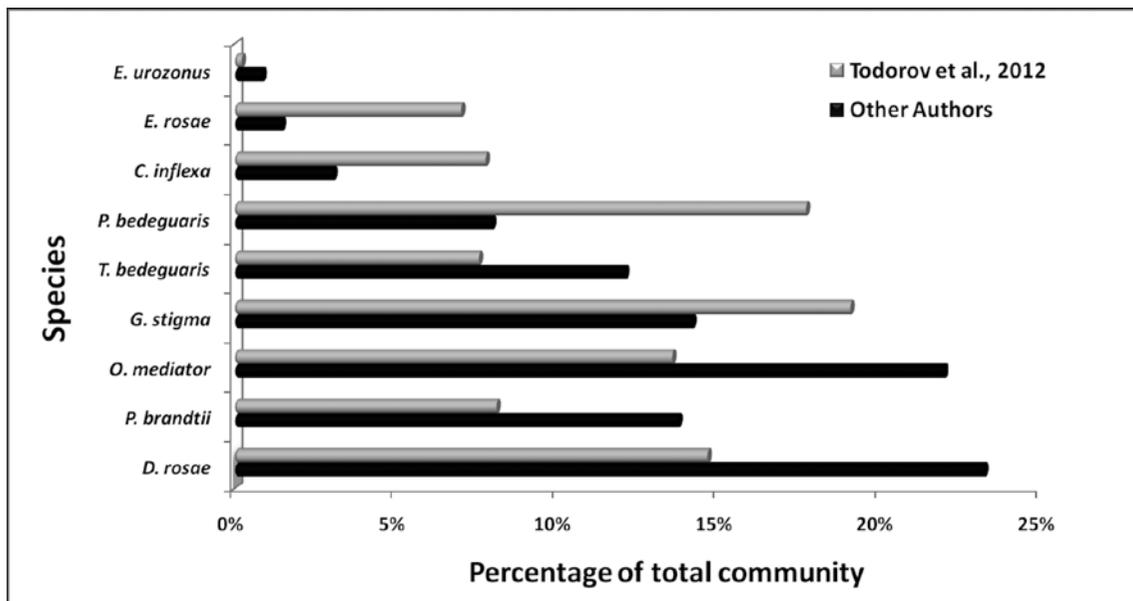


Fig. 6. Comparison between European mean percentage and our results for most of the species, obtained from Vitosha Mt. galls. *C. florus* and *S. sp.* near *eurytomae* are not included because of their lack in the previous records. *E. vesicularis* is also not included because of the insufficient data for this species. STILLE (1984) was useful only for *D. rosae*, *P. brandtii* and *O. mediator* and was taken into account for them here

tations of many authors (STILLE 1984, LÁSZLÓ 2001, RIZZO, MASSA 2006, LÁSZLÓ, TÓTHMÉRÉSZ 2011). By testing the correlations within the insect community reared in our study, we found interesting results that do not match what is already known; only statistically significant correlations have been discussed herein.

One of the results from our research on Vitosha population that contradicts with the findings of NORDLANDER (1973) is that there is a clear host-parasitoid relationship between *E. rosae* and the rose bedeguar gall wasp. When the number of the parasitoid species is greater there is a fall in number of the host species ($r = -0.701$; $P = 0.002$). Having that statistically significant negative correlation in mind it is most likely that *E. rosae* is a primary parasitoid of *D. rosae*. Even though states that *E. rosae* is a parasitoid of the inquiline *P. brandtii* there are some other studies (RIZZO, MASSA 2006, NIEVES-ALDREY 1981) showing more complicated relations between *E. rosae* and *D. rosae*.

C. inflexa is generally considered as a parasitoid only of *P. brandtii* (NORDLANDER 1973). The results from our study show that there is a correlation between the pair *E. rosae* + *C. inflexa* and *D. rosae* ($r = -0.526$; $P = 0.035$) which has a lower value compared to those between *D. rosae* and *E. rosae* ($r = -0.701$; $P = 0.002$). This can be interpreted as a

sign that there is a connection between *E. rosae* and *C. inflexa* in a way which decreases the impact of *E. rosae* on the gall inducer. This could be understood as *C. inflexa* being a parasitoid of *E. rosae*. In contradiction to that the relation only between *C. inflexa* and *E. rosae* is positive ($r = 0.642$; $P = 0.007$). Having that in mind and the relatively low difference in correlation data already discussed (*D. rosae* – *E. rosae*: $r = -0.701$ and *D. rosae* – *E. rosae* + *C. inflexa*: $r = -0.526$) it can be assumed that most likely the hyperparasitoid relations between *C. inflexa* and *E. rosae* are random.

The pteromalid wasp, *P. bedeguaris* is typically associated with *D. rosae* as its common parasitoid but also known to attack *O. mediator*, *G. stigma* and cynipoid inquiline *P. brandtii*. Our results show positive correlation between *G. stigma* and *P. bedeguaris* ($r = 0.582$; $P = 0.018$) and lead to the idea that there is a very slight or lack of hyperparasitoid relation and no competition between them in the Vitosha population. The correlation only between *O. mediator* and *G. stigma* (-0.553) shows considerable high hyperparasitoid relation.

Positive correlations of *D. rosae* and *P. brandtii* with overall density of the community ($r = 0.691$; $P = 0.003$ and $r = 0.661$; $P = 0.005$, respectively) and their negative correlations with the level of parasitization ($r = -0.9$; $P < 0.001$ and $r = -0.617$; $P =$

0.01, respectively) are considered herein as logical. The former relations are a sign of competition between the rest members of the community, decreasing their success in attack on the primary host species. As a result, community density increases on the account of the increasing survival of *D. rosae* and *P. brandtii*. This is partly supported by the lack of correlations between the other members and density. Concerning to the negative correlations above, they probably show a preference of the most parasitoids in attacking the gall-inducer and the inquiline. They also could be considered as an indication of a less frequent (or random) hyperparasitic relationships between the most of the parasitoids. To a certain extent, the negative correlation of the density with the rate of parasitization ($r = -0.591$; $P = 0.016$) is also a result of these interspecific relations at all.

We found only two gall members which were numerically dependent on the rate of parasitization - *E. rosae* ($r = 0.793$; $P < 0.001$) and *P. bedeguaris* ($r = 0.506$; $P = 0.044$). The positive values suggest that these chalcids are more opportunistic in biological aspect than the rest parasitoids. This could mean higher rate of hyperparasitism on the other members and/or not being hosts for the latter. It is known from previous works that *P. bedeguaris* attack some members of the community as *G. stigma*, *O. mediator* and *T. bedeguaris* (BLAIR 1943, REDFERN, ASKEW 1992), but there is no such a data for *E. rosae*. Probably, the eurytomid species develops as more successive competitor compared to the other parasitoids.

Environmental influence on the community

Obtained significant differences between mean community density in OL (13.52 ± 3.059 ind./gall) and SFR (30.76 ± 1.23 ind./gall) habitats could be explained mainly with the rate of parasitization (ANOVA on ranks, $p = 0.011$) - 87.46% and 54.35%, respectively, following the dependences of these indexes at all. As was discussed above a negative correlation was

calculated between the density and parasitization, which results in the habitat analysis. More interesting is how can be interpreted the higher parasitization in OL compared to the SFR. We suppose that possible reasons could be the sunlight and temperature, i.e. in open lands there are temperature and diurnal conditions more close to the optimal for the most parasitoids in the community and they prefer these habitats. Although we do not discuss the phenology in our research, some previous works support this assumption. On the base of the results in RIZZO, MASSA (2006) and their own, LÁSZLÓ, TÓTHMÉRÉS (2011) predicted latitudinal and longitudinal gradient in the number of emergence peaks for certain species. They found the earliest peaks (in April) for the most of the parasitoids - *O. mediator*, *P. bedeguaris*, *C. inflexa*, *E. rosae*, *E. vesicularis*, *E. urozonus*, *T. rubi* and *S. eurytomae*. This means that listed species endeavour to finish their development in a shorter period after ending of hibernation than the rest like *G. stigma*, *T. bedeguaris* and *P. brandtii* and, logically, prefer the habitats with longer days, where the temperatures are higher. Statistically significant difference between mean density of ECT (17.77 ± 2.827 ind./gall) with the other two habitats was not supported by the rate of parasitization. Furthermore, the preference/avoidance of some species to OL and SFR and the correlations of *P. brandtii* and *O. mediator* to altitude (listed in section Results) are probably related to a combined influence of the particular environmental and biological factors - temperature, density of the community and the interspecific relationships. Finally, we consider that more investigations should be done for an affirmation of these dependences.

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