The parasitic complex of *Diplolepis rosae* (Linnaeus, 1758) (Hymenoptera, Cynipidae): influencing factors and interspecific relationships

Zoltán Laszló

Summary

The cynipid gall wasp, *Diplolepis rosae* (Linnaeus, 1758) is one of the most frequent gall wasps on rose shrubs (Rosa spp) in Europe. The rose bedeguar gall is parasitized like other galls. The parasitoid community consists of ecto- and endoparasitoids of *D. rosae*, and those of the inquiline species. The structure of this parasitoid community is constant from Spain to Central-Eastern Europe. A large number of wasp species are associated with the rose bedeguar gall, and the factors influencing the galls parameters, as well as the parasitoid community structure are poorly known. The aim of this paper is to investigate factors which can influence the structure of the community, and the parameters of the galls. Galls were collected from three different sites. Differences between the structure of communities from the three sites were weak. There was found positive significant correlation between the survival rate of gall wasps, and the size of the gall, whereas negative significant correlation between the distance of galls from soil, and total number of hatched specimens, and positive and negative correlations between several parasitoid species .

Rezumat

Complexul parazitic al cinipidului *Diplolepis rosae* (Linnaeus, 1758) (Hymenoptera, Cynipidae): factori şi relaţii interspecifice

Cinipidul galicol *Diplolepis rosae* (Linnaeus, 1758) este unul dintre cele mai frecvente cinipide galicole din Europa pe specii de *Rosa*. Structura complexului parazitic al galei este constantă de la peninsula Iberică până în Europa Centrală şi Estică. Gala are un număr mare de specii parazitoide. Factorii care influenţează parametrii galei şi complexul parazitic al galei nu sunt însă bine cunoscute. Scopul acestui studiu este investigarea potenţialilor factori care ar putea influenţa structura communităţilor şi parametrii galei. Galele au fost colectate din trei zone diferite. Diferenţele dintre structura communităţilor au fost mici. A fost identificată o corelaţie semnificativă pozitivă între rata de supravieţuire a cinipidei şi volumul galelor şi o corelaţie semnificativă negativă între distanţa galei de la sol şi numărul exemplarelor obţinute, precum şi corelaţii pozitive şi negative între numeroase specii parazitoide.

Keywords: *Diplolepis rosae*, parasitoids, community structure, influencing factors.

Introduction

Galls induced by cynipids from superfamily Cynipoidea are among the most complex, and specialized known (Shothouse 1980, Stille 1984). A high number of these are associated with oaks (*Quercus sp*.), and the remaining are mainly parasites on rose species (*Rosa spp*.). *Diplolepis rosae* (L.) causes galls on several species of *Rosa*, mostly *R. canina, R. rubiginosa, R. dumalis, R. rubrifolia* (Stille 1984). It induces complex multichambered galls with various sizes.

D. rosae has been studied by several authors concerning its morphology and taxonomy, the process of gall-formation, its parasitoids and inquilines (Ritchie & Peters 1981, Schaeffer & Meyer 1963, Askew & Shaw 1986). The majority of cynipid galls are host to numerous parasites and inquilines. The galls of *D. rosae* have a specific parasitoid community, and the species forming this community are well known (Nieves-Aldrey 1980, Askew & Shaw 1986, Constantineanu & al. 1956). An illustration of this is provided by rearings in different European countries (Schröder 1967). The community may include at least fourteen species, and there are some differences in relative abundance of species between certain areas. But the main conclusion is that species composition of the communities is constant in Europe (Schröder 1967). So we hypothetized that on a smaller scale there aren't any differences between species composition, not even quantitative differences (e.g. communities from different regions cannot be well separated).

There are few studies on the interactions among parasitoid species, and on the relationships between gall parameters (e.g. location on shrub etc), gall wasps and parasitoids. We investigated factors that could have effect on parasitization on *D. rosae*, like the volume of the galls, the distance of the gall from the soil, and margins of the shrub. We hypothetized that gall volume is positively correlated with the gall wasp/parasitoid ratio, on the basis of Stille's (1984) results. Wiebes Rijks and Shorthouse (1992) shows that there should be a negative relationship between the gall's distance from the surface of the soil, and the number of hatched parasitoids, as well as gall wasps, because of the negative effect of low temperature on higher placed galls. These hypothesis and previous findings were also tested during this study.

Materials and methods

Galls were collected from three sites in December 2000 and January-February 2001. Two sites are near the city of Cluj-Napoca (Cluj county): (1) a clearing in the Făget beech forest, (2) and a dry pasture on the Fânațe. The third sample site is near the city of Târgu-Mureş (Mureş county): a pasture, and margins of the nearest forest. Altogether 46 galls were collected from 26 shrubs, but wasps emerged only from 33 galls.

The collected galls were reared individually in plastic cups at room temperature and emerging insects were preserved in 70% ethilic-alcohol.

The similarity of the gall-complexes of different sample sites was examined with Principal Component Analysis (PCA). We also analysed the behavioral uniformity of the species by separate PCA-ordinations of the gall complexes from the different sites.

Differences on smaller scale were examined by measuring gall parameters like: volume of galls, distance of the galls from the soil and from the margins of the shrub. The volume of a gall was estimated by measuring three perpendicular axes, from which a mean value was calculated. This value was considered to be the radius of a sphere, and the sphere's volume was the estimated volume of the gall. These parameters were correlated with the survival ratio of gall wasps (the ratio of emerged gall wasps/parasites), number of hatched specimens, number of gall wasps, number of parasitoids. We also analysed interspecific correlations as the gall-maker vs. inquiline, gall-maker vs. parasitoids, parasitoids vs. parasitoids. These analysis were carried out using Spearman rank-correlation coefficients.

We used Syn-Tax 5.0 (Podani 1993) and Statistica (Stat Soft, Inc. 1995) programs for computations. The identification of the species was carried out on the basis of the keys of Bouček (1991), Eady & Quinlan (1963), Erdős (1960), Graham (1969), Graham & Gijswijt (1998) and Ionescu (1973).

Results

From the collected galls 964 specimens emerged, which belong to 3 superfamilies and 6 families (table.1). From these specimens 768 were parasitoids and 196 gall-formers. The gall-former is *Diplolepis rosae* (Linneaus). There is also one inquiline species, which is *Periclistus brandtii* (Ratzeburg, 1831). These two species have their own parasitoid community, and some of the parasitoids are also hiperparasites.

Table 1.

List of reared species with number of emerged specimens.

SPECIES/GALLS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
FĂGET													
Diplolepis rosae	1	2	2	0	0	0	1	0	0	0			
Orthopelma sp.	0	7	0	0	0	0	0	0	0	14			
Gliphomerus stigma	3	9	5	4	6	0	0	0	0	0			
Torymus bedeguaris	0	9	0	0	1	0	0	0	2	11			
Torymus rubi	0	0	5	2	3	0	0	0	0	1			
Eurytoma rosae	0	0	0	1	0	0	0	0	0	0			
Pteromalus bedeguaris	0	0	3	0	0	0	0	0	0	0			
Caenacis inflexa	0	0	0	0	0	0	0	0	0	0			
Eupelmus urozunus	0	0	1	0	0	0	0	0	0	0			
Periclistus brandti	0	4	0	0	0	0	0	0	0	0			
FÂNAȚE													
Diplolepis rosae	20	0	15	94	0	10	15	3	0	1	0	0	0
Orthopelma sp.	12	1	7	30	0	0	17	0	0	0	2	4	0

Gliphomerus stigma	29	3	9	12	0	1	0	9	4	3	7	0	4
Torymus bedeguaris	20	3	12	5	0	1	6	4	0	0	6	2	0
Torymus rubi	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurytoma rosae	0	0	0	0	0	0	0	0	0	0	6	0	0
Pteromalus bedeguaris	3	0	0	1	0	0	0	0	0	0	0	0	0
Caenacis inflexa	0	0	0	0	0	0	1	0	0	0	0	0	0
Eupelmus urozunus	1	0	0	0	0	0	0	0	0	0	0	0	0
Periclistus brandti	0	0	1	0	0	0	15	0	0	16	29	1	0
TÂRGU MUREŞ													
Diplolepis rosae	0	20	0	1	2	0	5	0	0	8	8	0	0
Orthopelma sp.	1	0	7	0	0	4	0	0	3	0	9	1	17
Gliphomerus stigma	1	2	0	0	1	2	1	1	2	11	0	2	0
Torymus bedeguaris	0	2	0	0	3	0	15	0	1	1	3	2	6
Torymus rubi	0	0	0	0	1	0	0	0	0	0	0	0	0
Eurytoma rosae	0	0	0	2	2	1	0	0	0	0	2	0	3
Pteromalus bedeguaris	0	4	0	0	3	1	4	0	5	2	5	1	0
Caenacis inflexa	0	2	0	2	8	0	0	0	0	0	2	0	0
Eupelmus urozunus	0	2	0	0	0	0	0	0	0	1	2	1	0
Periclistus brandti	0	4	61	0	0	0	0	0	0	0	37	0	134
TOTAL													
10													

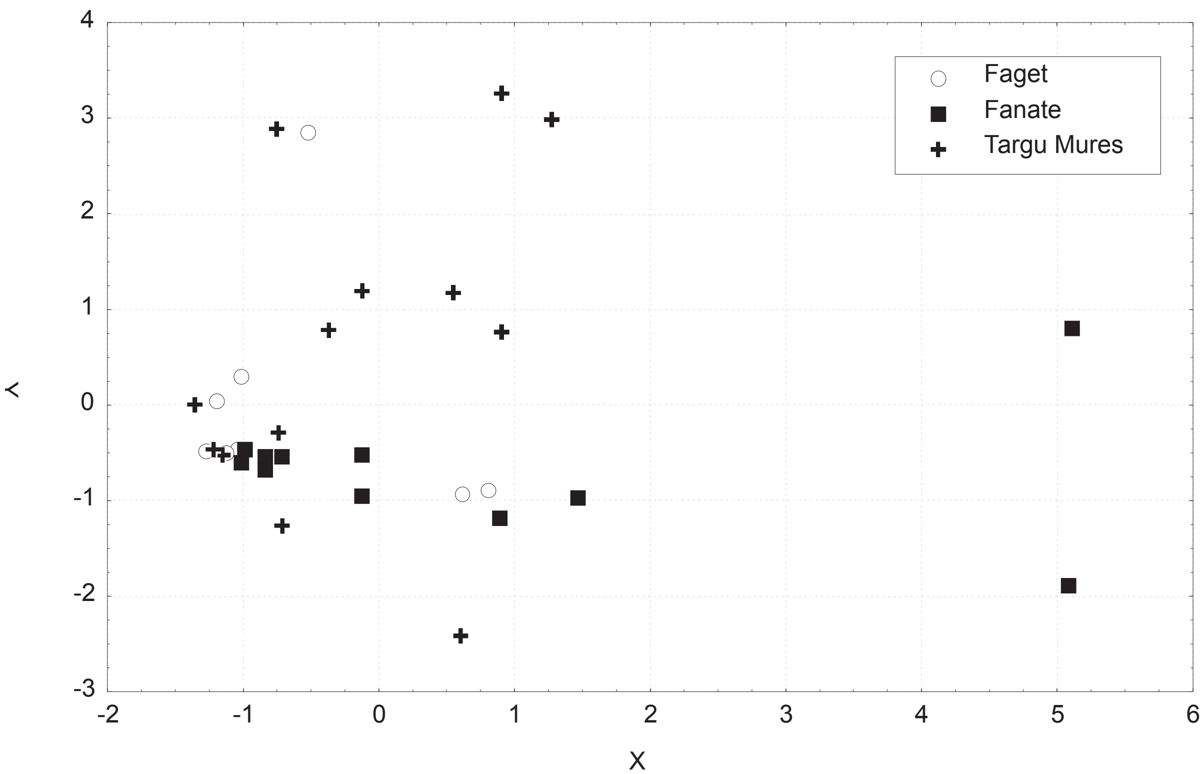

Fig.1. PCA-ordination of the three gall communities.

There were no evident differences among the three gall communities, as shown by the results of the Principal Component Analysis (PCA) (fig. 1). But galls represented by points lying outside the core group on the PCA-scatterplot, were collected mainly from heterogenous environment (roadsides, margins of forest).

Separate PCA-ordinations of species from single sites (fig. 2, 3, 4), reveal that the points representing parasitoid species of *D. rosae* (according to Nordlander 1973) are not in the central-group of the PCA scatterplot, they are more scattered than

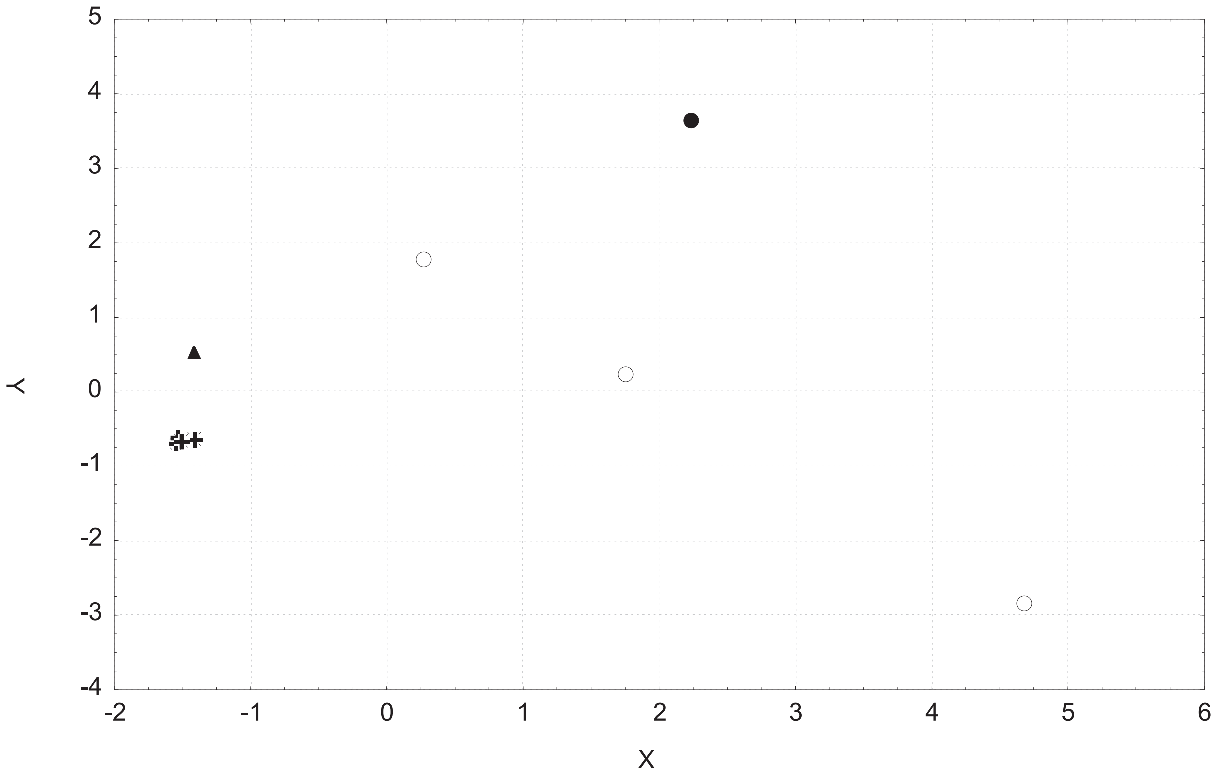

Fig. 2. PCA scatterplot of the species from Fânațe (●- gall wasp; ○-parasites of *D. rosae*; ▲- inquiline; +- parasitoids of the inquiline; ∗- common parasitoids of the gall maker, and the inquiline).

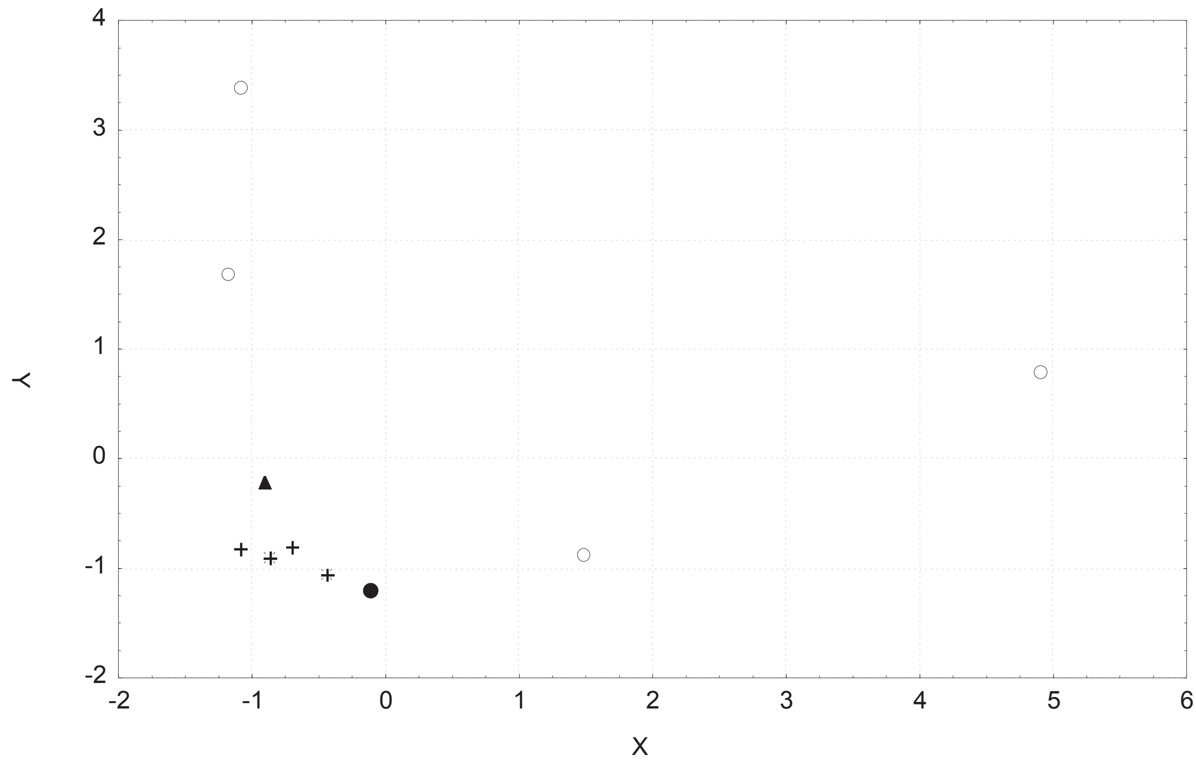

Fig. 3. PCA scatterplot of the species from Făget. (●- gall wasp; ○-parasites of *D. rosae*; ▲- inquiline; +- parasitoids of the inquiline; ∗- common parasitoids of the gall maker, and the inquiline).

the parasitoids of *P. brandtii*, which means that parasitoids belonging to *D. rosae* and *P. brandtii* behave differently.

In the case of the galls collected from Fânațe, near Cluj, (fig.2) the species *G. stigma* (Fabricius, 1793)*, Orthopelma sp.* (Taschenberg, 1865)*, T. be-*

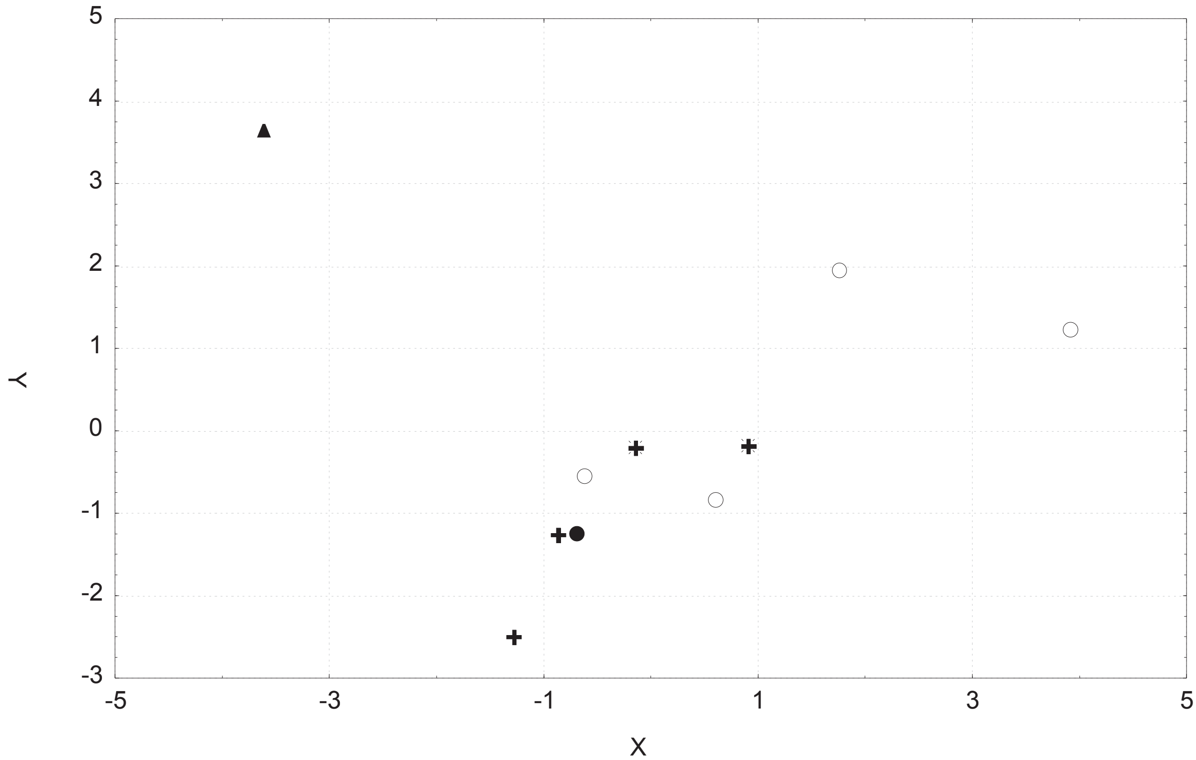

Fig. 4. PCA scatterplot of the species from Târgu –Mureş. (●- gall wasp; ○-parasites of *D. rosae*; ▲- inquiline; +- parasitoids of the inquiline; ∗- common parasitoids of the gall maker, and the inquiline).

deguaris (Linnaeus, 1758) (parasitoids of *D. rosae*) and *D. rosae* appears scattered, while the rest of the species together with *P. brandtii* form a compact group. Galls collected from the grassland of Fânațe hatched just a few gall makers, their parasitization was much higher than those collected along the roadside.

In the galls from the clearing of the beech forest (Făget) (fig.3), we found almost the same situation like above, but here *D. rosae* formed a group with *E. rosae* (Nees, 1834), *P. bedeguaris* (Thomson, 1878), *E. urozonus* (Dalman, 1820), *C. inflexa* (Ratzeburg, 1848), and the inquiline *P. brandtii*. The parasitoids *Orthopelma sp., G. stigma, T. bedeguaris*, and *T. rubi* (Schrank, 1781) were more scattered (parasitoids of *D rosae*).

The situation in the site near Târgu- Mureş (fig.4) is different from the clearing from the Făget forest, and the Fânațe, too. Here only the inquiline *P. brandtii* and the parasitoids *Orthopelma sp*., *G. stigma* are separated from the other species which forms a group.

The PCA-scatterplot on the first two axis cummulates 43,09 % of the eigenvalues in the case of gall communities, in the case of separate ordinations for the Fânațe 65,34 %, for the clearing in the Făget forest 73,36 %, and in the case of the site near Târgu-Mureş 55,35 %.

Spearman-rank correlation (table. 2) coefficients were computed for interspecific relationships. There were found significant positive correlations between the gall maker and parasitoids, which can mean that growing number of host is followed by the increase in parasitoid number. There were also other significant relationships which show that the number of the individuals of some parasitoids increases the number of other parasitoids (e.g. *Orthopelm sp.* vs. *T. bedeguaris*). There is only one case where negative correlation was found (*G. stigma* vs. *C. inflexa*).

Relationships between the gall wasp/parasitoid ratio, and volume of the galls, distance of galls from soil, and the margins of the shrubs were tested with Spearman rank-correlation (table.3). The significant positive correlations (volume of galls vs. gall wasp/parasitoid ratio, total number of emerged specimens vs. number of gall wasps; number of gall wasps vs. parasitoids) seems to underline the role of these factors, as the significant negative correlation - hatched specimens vs. distance of the galls from the soil - does, too.

Table 2.

Interspecific relationships in the gall-community (**n = 33**):

	Spearman r	t	p
D. rosae **vs.** *T. bedeguaris*	0,41	2,503	,017792
D. rosae **vs.** *P. bedeguaris*	0,415	2,539	,016345
D. rosae **vs.** **C. inflexa**	0,396	2,401	,022498
D. rosae **vs.** **Eup. urozonus**	0,403	2,455	,019898
O. sp. **vs.** *T. bedeguaris*	0,558	3,749	,000728
O. sp. **vs.** *Per. brandti*	0,474	2,993	,005380
G. stigma **vs.** *C. inflexa*	-0,365	-2,179	,036998
E. rosae **vs.** *C. inflexa*	0,421	2,584	,014702
P. bedeguaris **vs.** *Eup. urozonus*	0,669	5,005	,000021

Table 3.

Relationships between the gall-parameters, and number of emerged specimens, and other ratios (**n = 32**):

vs.	Spearman r	t	p
Gall volume **vs.** Total Hym.	0,410	2,466	,019587
Gall volume** vs.* **D. rosae*/Parasitoids ratio	***0,338***	***1,969***	***,058189***
Gall volume **vs.** **D. rosae**	0,374	2,213	,034605
Total Hym. **vs.** Gall distance from the soil	-0,424	-2,563	,015636
D. rosae **vs.** Parasitoids	0,452	2,777	,009351
Parasitoids **vs.** Gall distance from the soil	-0,475	-2,958	,005982

Discussion

The comparison of the three sites does not reveal any clear differences among the parasitoid communities of the different regions. This could be attributed to the fact that the behaviour of the gall inducer - *D. rosae* - is not strongly influenced by the different properties of these sites. According to Stille (1984), shrubs growing in ecotone zones (e.g. roadsides, forest margins) have many, or larger galls. As such, the galls collected from shrubs growing in sites with increased heterogenity, appear more unique in their quantitative characteristics than those collected from homogenous sites (e.g. grassy areas without roadsides or without margins of forests).

Separate ordinations of the emerged specimens from the three sites show the differences between the behaviour of the parasitoids of *D. rosae* and parasitoids of *P. brandtii*, which lead to the conclusion that parasitoids of *D. rosae* behave with an increased diversity, opposite to the parasitoids of *P. brandtii*. This increased numerical diversity in the case of *Orthopelma sp., T. bedeguaris, G. stigma* is due to the fact that there could be a hiperparasitic relationship: *Orthopelma sp*. could be parasited by *T. bedeguaris*, *G. stigma*, and *P. bedeguaris* (Nordlander 1973, Nieves Aldrey 1980). In the case of parasitoids of *P. brandtii* we do not have knowledge about hiperparasitic relationships. The case of *T. rubi* is more interesting, because it is the parasitoid of *Diastrophus rubii*, and we can only guess that its host is *D. rosae* in the bedeguar gall. Difference between the number of parasitoid specimens in the Fânețe and the pasture near Târgu-Mureș (where galls from increased heterogenity sites were collected) is bigger than those from Făget clearing. According to these we can hypothetize that parasitoid complexes of galls are not uniform in ecotone zones.

We would expect a significant negative correlation between *D. rosae* and *Orthopelma sp.,* because according to NORDLANDER (1973) the main parasitoid of *D. rosae* is *Orthopelma mediator* (THUNBERG 1832), which deposits the eggs even before the galls has started to develop, because in this case all the host larvae present in the gall can be reached (STILLE 1984). But this negative relationship was not supported by our results. It would be expected a negative correlation between *P. brandtii*, and *C. inflexa*, or *E. rosae*, because of hypothetized parasitic relationship, but there was none. Instead there is a negative relationship between *G. stigma*, and *C. inflexa*. But *G. stigma*, on the basis of NORDLANDER (1973), increases its number in the case of high number of *Orthopelma mediator,* and as was mentioned above, *C. inflexa* is the parasitoid of *P. brandtii*. This could be relevant if there was a negative correlation, too, between *Orthopelma sp*. and *P. brandtii*, but there was none.

The surviving ratio of *D. rosae* increases with growing gall volume. This relationship was observed by STILLE (1984) for *D. rosae* and for several other species like *Diastrophus kincaidii* (JONES 1983). We found that relative number of parasitoids decreases with increasing gall volume. The vertical distance between gall and soil seems to affect the total number of emerged specimens. The distances from margins of shrubs does not affect nor the parasitoid ratio of galls, neither the volume of the galls. So we can hypothetize that from the perspective of a female *D. rosae*, it would be better to induce larger galls on the lower branches of the shrubs in a homogenous environment in order to increase the survival probability of the offsprings.

As a conclusion: relationships between parasitoids, inquiline and gall wasps do not show differences according to the qualities of the three collecting sites. Differences are caused by discontinuous environment patches, like shrubs along roadsides, margins of thickets or forests. Degree of parasitization declines with increasing gall size. Vertical distance from the soil surface affects the number of emerged specimens, but the distance from the margin does not.

Because of the low number of the samples the above findings must be tested on larger dataset, but several points were given which refer to the possible influencing factors of parasitoid communities, and gall-size.

Acknowledgements

I wish to express my gratitude to Bálint MARKÓ, Lujza UJVÁROSI. The help of Zoltán ÁCS, George MELIKA, István MIKÓ, and Csaba THURÓCZY from the Systematic Parasitoid Laboratory (Kőszeg, Hungary) was of vital importance, and I also wish to thank for their valuable comments.

This study was supported by a grant of the Iskola Foundation (Cluj, Romania).

REFERENCES

ASKEW R. R., 1959. Some observations on *Diplolepis rosae* (L.) (Hym. Cynipidae) and its parasites. Entom. Month. Mag. **95**:191-192.

ASKEW R. R., SHAW M.R. 1986. Parasitoid communities: Their size, structure and developement, pp. 225-264. in WAAGE J., GREATHEAD D. (eds): Insect Parasitoids. Academic Press, London.

BOUČEK Z., RASPLUS. J.-Y. 1991. Illustrated key to west-Palearctic genera of Pteromalidae : Hymenoptera - Chalcidoidea. INRA, Versailles, France, p. 144.

CONSTANTINEANU I. M., SUCIU I., ANDRIESCU I., CIOCHIA V., PISICĂ C. 1956. Contribuții la studiul chalcidoidelor parazite în cinipide galicole de pe *Rosa canina* L. din R.P.R. Studii şi cercetari ştiințifice. Editura Academiei R.P.R., **8**(1): 3-27.

EADY R. D., QUINLAN J. 1963. Hymenoptera, Cynipoidea: Key to families and subfamilies and Cynipinae (including galls). Handbooks for the identification of british insects. Royal Entomological Society of London. vol. **8**(1a), p. 81.

ERDŐS J. 1960. Fémfürkészek II.- Chalcidoidea II. Fauna Hungariae. **12**(3). Akadémiai Kiadó. Budapest. p. 230.

FULMEK L. 1968. Parasitinsekten der Insektengallen Europas. Breit. Ent., **18**: 719-952.

GRAHAM M.W.R. de V. 1969. The Pteromalidae of northwestern Europe (Hymenoptera: Chalcidoidea). Bulletin of the British Museum (Natural History) Entomology, Supplement **16**: 908.

GRAHAM M.W.R. de V., GIJSWIJT M. J. 1998. Revision of the European species of *Torymus* DALMAN (s. lat.) (Hymenoptera, Torymidae). Zoologische Verhandelingen. Leiden. **317**, p. 202.

IONESCU M. A., 1973. Biologia galelor - monografie cecidologică. Editura Acad. R.S.R. Bucureşti.

JONES D. 1983. The influence of host density and gall shape on the survivorship of *Diastrophus kincaidii* Gill. (Hymenoptera, Cynipidae). Can. J. Zool. **61**: 2138- 2142.

NIEVES ALDREY J. L. 1983. Contribución al conocimiento de la fauna de himenópteros inquilinos y parásitos en las agallas de *Diplolepis mayri* (Schlechtendal) y *Diplolepis eglanteriae* (Hartig) (Hym., Cynipidae). Graellsia, **39**: 93-102.

Nieves Aldrey J. L. 1980. Datos sobre *Diplolepis rosae* (L.) (Hym., Cynipidae) y sus himenópteros parasitos en Salamanca. Bol. Asoc. esp. Entom., **4**: 107-113.

Nordlander G. 1973. Parasitic wasps in galls of *Diplolepis rosae* (L.) and *D.mayri* (Schlechtd). (Hym.,Cynipidae) (Hym., Ichneumonoidea, Chalcidoidea, Cynipoidea), Entomol. Tidskr, **94**:148-176.

Précsényi I. 2000. Alapvető kutatástervezési, statisztikai és projektértékelési módszerek a szupraindividuális biológiában. Debreceni Egyetem Kossuth Egyetemi Kiadó. Debrecen., p. 163

Pujade-Villar J. 1994. Nota sobre *Glyphomerus stigma* (Fabricius, 1793) (Hym., Chalc., Torymidae). Boll. Inst. Catalana Hist. Natur., **61**: 85-86.

Pujade-Villar J. 1994. Sobre las especies de pteromálidos (Hym., Pteromalidae) detectadas en agallas de *Diplolepis sp.* (Hym., Cynipidae) en Cataluna. Orsis, **9**: 107-108.

Pujade-Villar J., Bellido D. 1999. Especies asociadas a agallas de cinípidos del Pireneo andorrano (Hym: Cynidoidea,Chalcidoidea, Ichneumonoidea). Boln. Asoc. Esp. Ent., **23**(1-2): 277-291.

Pujade-Villar J., Bellido D. 1999. Comparación de cadenas tróficas asociadas de cinípidos (Hym.: Cynipidae) en dos ambientes distintos. Boln. Asoc. Esp. Ent., **23**(1-2): 265-275.

Podani J. 1993. Syn-Tax-pc. Computer programs for multivariate data analysis in Ecology and Systematics. Version 5.0. Scientia Publishing. Budapest.

Schröder D. 1967. *Diplolepis (= Rhodites) rosae* (L.) (Hym.: Cynipidae) and a review of its parasite complex in Europe. Tech. Bull. Commonwealth lust of Biol. Control, **9**: 93-131.

Shorthouse J. D. 1980. Modification of galls of *Diplolepis polita* by the inquiline *Periclistus pirata.* Bull. Soc. bot. Fr. - Actual. Bot., **127**(1): 79-84.

Shorthouse J. D., Brooks S. E.. 1998. Biology of the galler *Diplolepis rosaefolii* (Hymenoptera: Cynipidae), its associated component community, and host shift to the shrub rose Thérése Bugnet. The Canadian Entomologist, **130**: 357-366.

Stat Soft, Inc. 1995. Statistica for Windows (Computer program manual). Tulsa, USA.

Stille B. 1984.The effect of hostplant and parasitoids on the reproductive success of the parthenogenetic gall wasp Diplolepis rosae (Hym.,Cynipidae). Oecologia, **63**: 364-369.

Wiebes-Rijks A. A., Shorthouse J. D. 1992. Ecological relationships of insects inhabiting Cynipid galls. pp. 238-257 in Shorthouse J. D., Rohfritsch O. (eds.) Biology of insect-induced galls. Oxford University Press. 285 p.

Zoltán László
Dept. of Zoology, Univ. Babeş-Bolyai,
str. Clinicilor 5-7,
RO-3400 Cluj-Napoca
feherlofialz@yahoo.com

Received: 15.03.2002
Accepted: 4.04.2002
Printed: 24.06.2002