

CONTRIBUTION TO THE ANT FAUNA OF SLOVENIA WITH SPECIAL
REFERENCE TO THE SUBMEDITERRANEAN AND EUDINARIC REGIONS

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ABSTRACT

In a preliminary study of the ant fauna of Slovenia, 45 species were recorded at 15 sites, 12 of which are situated in the southwestern part of the country.

Key words: Hymenoptera: Formicidae, fauna, Slovenia: Submediterranean and Eudinaric regions

INTRODUCTION

The basic faunistic research is especially important in those regions, which are threatened and/or represent biodiversity "hot spots". Both criteria are valid for Slovenia: the fast social and industrial development potentially influences the country's natural or quasi-natural landscapes, which represent a high biogeographical diversity from the high Alps to the Pannonic, the Dinaric and the Submediterranean regions, which means that there are several potential "hot spots" in this country.

In a careful analysis on the red wood ants, Titovšek (1994) recorded 8 species from the subgenera of *Formica*, *Coptoformica* and *Raptiformica*. Despite his paper, no other publications are known on the ants of Slovenia.

In this report, the results of the ant samples collected in the summer of 1996 are given as the first and preliminary list of ants from the southwestern part of Slovenia. The list of species is far from complete and final one, for which more intensive sampling effort should be made at many more sites.

METHODS AND COLLECTION SITES

The ants were collected between 9th and 19th July 1996 during a field trip with Slovene and Hungarian students. They were obtained at 15 sites by hand collecting, mostly based on the sampling of the colonies. 12 sites are situated in those (Submediterranean or Eudinaric) regions of Slovenia, from where Mediterranean elements were expected. For comparison, I included the

ants from the remaining three sites, too, which are situated in the Alpine region (the zoogeographical division is after Novak *et al.*, 1995).

The individual collecting sites were as follows: (1) Kamniško-Savinjske Alpe: Logarski Kot (near the hostel, 10.07.1996); (2)-(3) Kamniško-Savinjske Alpe: Okrešelj (at two localities, 11-12.07.1996); (4) Trnovski Gozd: Mala Lazna (13.07.1996); (5) Trnovski Gozd: Paradana (in close and wider vicinity of the ice cave, 13.07.1996); (6) Trnovski Gozd: Smrekova Draga (in the dolina and the neighbouring forests, 13.07.1996); (7) Trnovski Gozd: Predmeja-Čaven, forest (different forests and forest edges by the path between the hostel at Predmeja and Čaven, 14.07.1996); (8) Trnovski Gozd: Predmeja, grassland (near the hostel at Predmeja, 14.07.1996); (9) Trnovski Gozd: Čaven, Kucelj (mountain-sides at Kucelj, 14.07.1996); (10) Kozina: Camping (15.07.1996); (11) Podpeč (a slope by the seashore, 15.07.1996); (12) Podpeč: hill (15.07.1996); (13) Podpeč: roadside (16.07.1996); (14) Strunjan: cliffs (17.07.1996); (15) Osp: limestone hill (19.07.1996) (Fig. 1).

Ants from different nests were treated separately and were preserved in 70% ethanol. 1094 ant individuals were collected as a sample.

As the majority of the collections were probably far from complete, it was necessary to compute the completeness of the sampling. I computed the completeness of the collections as follows. The sample number - species number relation was investigated by the means of linear, log-linear and log-log functions. Since the slopes of these functions (b_{lin}, b_{log-lin}, and b_{log-log}, respectively) depends on the sequence of the collections, I used

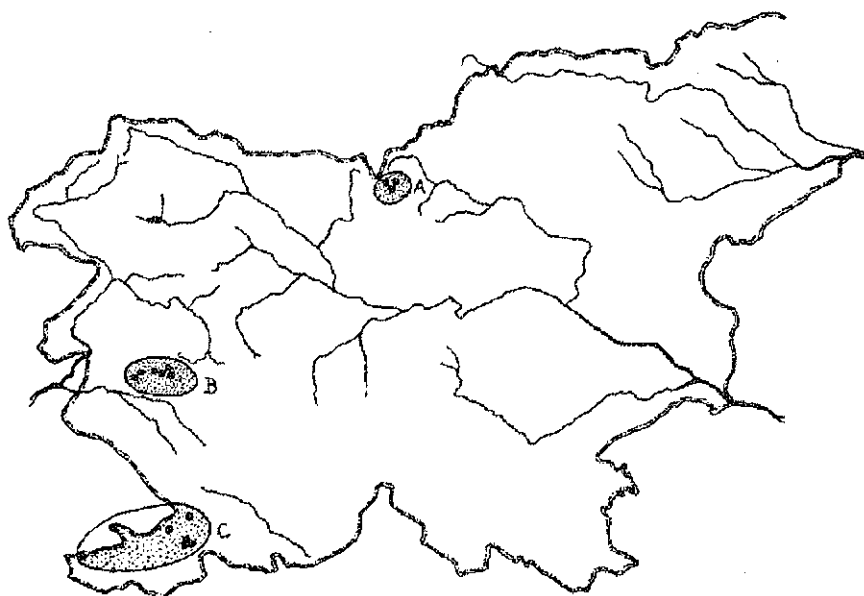


Fig. 1: Collection localities (see text for a detailed list of sites). A: sites 1-3, B: sites 4-9 and C: sites 10-15.
Sl. 1: Vzorčevalne lokalitete (natančen seznam lokalitet je v tekstu). A: lokalitete 1-3, B: lokalitete 4-9 in C: lokalitete 10-15.

the average of 50 repetition of random sequences of the original sample units for each site. The slopes of these functions can be considered useful tools in the assessment of the completeness of sampling (*i.e.* the sufficiency of the collection of the whole fauna), if they are in correlation with the number of sample units. In the cases of the linear and log-log transformed functions (*b_{lin}* and *b_{log-log}*), the correlation coefficients were significant ($p < 0.01$ in both cases), which means that these data can be taken into account for consecutive analyses. The completeness of the sampling is a negative function of the slopes mentioned above, therefore it is given as $1 - b_{lin}$ and $1 - b_{log-log}$. The products nb_{lin} and $nb_{log-log}$ (where n is the number of sample units) are obviously the measures of the diversity of the ant fauna in question.

RESULTS AND DISCUSSION

The ant species

Altogether 45 species were collected at the 15 sites. The list of species with their localities is as follows:

Fam. Formicidae

Subfam. Myrmicinae

Tribe Myrmicini

1. *Manica rubida* (Latreille 1802). Karniško-Savinjske Alpe: Logarski kot; Trnovski Gozd: Paradana.

A well known species of high mountain regions. Its presence in Trnovski Gozd shows the alpine biogeog-

raphical influence on this region.

2. *Myrmica rubra* (Linnaeus 1758). Trnovski Gozd: Mala Lazna.

This species is known as euryfrequent and eury-potent one, typical to meadows of mesophilic and moist character.

3. *Myrmica ruginodis* Nylander 1846

Karniško-Savinjske Alpe: Logarski kot; Karniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Paradana; Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Predmeja, grassland; Trnovski Gozd: Predmeja-Čaven, forest.

Being the least thermophilous *Myrmica* species in Europe (Seifert, 1988), its occurrence in the mountain areas meets the expectations.

4. *Myrmica scabrinodis* Nylander 1846. Trnovski Gozd: Mala Lazna.

This is a moderately thermophilous and hygrophilous species. Since its southern distribution boundaries are not exactly known, this occurrence in Slovenia is a contribution to the knowledge regarding the distribution of this species in Europe (see Seifert, 1988).

5. *Myrmica schencki* Emery 1895. Trnovski Gozd: Predmeja-Čaven, forest; Trnovski Gozd: Čaven, Kucelj.

A species of open areas with most thermophilous character among European *Myrmica* species. I collected it in Trnovski Gozd at a forest edge and in grassland.

6. *Myrmica lobicornis* Nylander 1846. Trnovski Gozd: Mala Lazna.

This is less thermophilous than the species above. I have found it in Hungary, mainly in mountain meadows and lowland grasslands of wet character.

Tribe Pheidolini

7. *Aphaenogaster (Attomyrma) subterranea* (Latreille 1798). Trnovski Gozd: Paradana; Podpeč: roadside; Strunjan: cliffs; Osp: limestone hill.

A species of Southern and Central Europe, Asia Minor and Caucasia, occurring at dry, warm Mediterranean and Submediterranean localities.

8. *Messor structor* (Latreille 1798). Strunjan: cliffs.

Widely distributed thermophilous species at Mediterranean and Submediterranean localities. In the southern part of Central Europe it is well associated with weedy habitats.

9. *Pheidole pallidula* (Nylander 1849). Podpeč: roadside.

A typical Mediterranean species in Europe, but can be also found in Central Asia. In South Europe it is also known as a house ant.

Tribe Crematogastrini

10. *Crematogaster (Acrocoelia) schmidti* (Mayr 1852). Podpeč: hill; Podpeč: roadside; Osp: limestone hill.

A typical ant of the Mediterranean and Submediterranean regions. Sometimes referred to as a synonymic species of *C. scutellaris* (Olivier 1791).

Tribe Solenopsidini

11. *Solenopsis (Diplorhoptum) fugax* (Latreille 1798). Podpeč: hill; Osp: limestone hill.

Widely distributed species in North Africa, Europe and Asia to Japan. Very abundant in Central European grasslands. The collected material consists of typical *fugax* specimens according to Bernard (1968).

Tribe Leptothoracini

12. *Leptothorax (Mychotorax) acervorum* (Fabricius 1793). Kamniško-Savinjske Alpe: Logarski kot; Kamniško-Savinjske Alpe: Okrešelj.

A cold tolerant species, which is common in mountain habitats in Central and South Europe, and in lowlands of the northern regions. The only ant species in the open tundra habitats in Fennoscandia.

13. *Leptothorax (Mychotorax) muscorum* (Nylander 1846). Kamniško-Savinjske Alpe: Okrešelj.

Usually rarer species than *L. acervorum*, their habitat requirements are similar.

14. *Leptothorax (Myrafant) nigriceps* Mayr 1855. Trnovski Gozd: Čaven, Kucelj.

The only worker individual I collected at Kucelj most probably belongs to this taxon.

Tribe Tetramorini

15. *Tetramorium caespitum* (Linnaeus 1758). Trnovski Gozd: Čaven, Kucelj; Podpeč; Strunjan: cliffs; Osp: limestone hill.

A thermophilous ant, which is very common in the

majority of dry and weedy habitats in Europe, in Asia and also occurs in the northern parts of Africa.

16. *Tetramorium impurum* Förster 1850. Kamniško-Savinjske Alpe: Logarski kot; Kamniško-Savinjske Alpe: Okrešelj.

A species which is rather difficult to distinguish from *T. caespitum*. It occurs in high mountain habitats.

Tetramorium sp. Trnovski Gozd: Paradana

The only individual I collected could not be identified.

Subfam. Dolichoderinae

Tribe Tapinomini

17. *Tapinoma erraticum* (Latreille 1798). Podpeč: hill.

A thermophilous species commonly occurring in South and Central Europe to Central Asia.

Subfam. Formicinae

Tribe Plagiolepidini

18. *Plagiolepis pygmaea* (Latreille 1798). Podpeč: hill; Strunjan: cliffs.

The only *Plagiolepis* species collected during the trip. At least two other species of this genus are expected in the southern part of Slovenia.

Tribe Lasiini

19. *Lasius (L.) niger* (Linnaeus 1758). Trnovski Gozd: Maia Lazna; Trnovski Gozd: Predmeja, grassland.

On the basis of the PDCL (pilosity distance on the clypeus) values (between 13.3 and 16.1) and other traits, the individuals collected at the two localities belong to *niger* in the sense of Seifert (1992). Since in a recent revision Seifert (1992) split the European ant species, formerly classified as *niger*, into two species, the distribution and the ecology of this species should be revised.

20. *Lasius (L.) platythorax* Seifert 1991. Kamniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Mala Lazna; Trnovski Gozd: Paradana.

Recently described species, its distribution and ecology not known. From the available data it seems that *platythorax* prefers woodland habitats.

21. *Lasius (L.) alienus* (Förster 1850). Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Čaven, Kucelj.

The individuals from Smrekova Draga have larger PDCL as given by Seifert (1992) for *alienus*. The specimens from Kucelj have a scape pilosity, which is more similar to *L. paralienus* Seifert 1992. The habitat is not typical of either species.

22. *Lasius (L.) psammophilus* Seifert 1992. Trnovski Gozd: Čaven, Kucelj.

On the basis of the five workers collected from Kucelj, it is the most probable species, although the soil in habitat is not sand.

23. *Lasius (L.) paralienus* Seifert 1992. Trnovski Gozd: Smrekova Draga; Podpeč: hill.

Typical specimens were collected from both localities.

24. *Lasius (L.) emarginatus* (Olivier 1791). Podpeč: hill; Strunjan: cliffs; Osp: limestone hill.

A thermophilous species with its northernmost distribution limits in Central Europe.

25. *Lasius (Cautolasius) flavus* (Fabricius 1781). Trnovski Gozd: Mala Lazna.

A common species in open habitats of Europe, with a distribution range from North America to Japan and from North Africa to Arctic (see Collingwood, 1979).

26. *Lasius (Chthonolasius) meridionalis* (Bondroit 1919)/ *balcanicus* Seifert 1988. Trnovski Gozd: Paradana.

The only female collected has a transitional character between the two species (six traits indicate *meridionalis* and six *balcanicus*). More individuals would have been necessary for positive identification.

27. *Lasius (Dendrolasius) fuliginosus* (Latreille 1798). Trnovski Gozd: Paradana.

A species with wide distribution range in Europe and Asia. In the majority of cases, this ant is nesting in trees.

Tribe Camponotini

28. *Camponotus (C.) herculeanus* (Linnaeus 1758). Kamniško-Savinjske Alpe: Logarski Kot; Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Predmeja-Čaven, forest; Trnovski Gozd: grassland.

This typical Central European mountain species occurs also in the lowlands of northern regions.

29. *Camponotus (C.) ligniperdus* (Latreille 1802). Trnovski Gozd: Predmeja-Čaven, forest.

This species has a more southern range than *C. herculeanus*. Fairly common in Central European mountain forests.

30. *Camponotus (C.) vagus* (Scopoli 1763). Podpeč: roadside; Strunjan: cliffs.

A South European species, common also in dry, lowland forests in Central Europe.

31. *Camponotus (Tanaemyrmex) aethiops* (Latreille 1798). Podpeč; Strunjan: cliffs; Osp: limestone hill.

A southern species, with the northernmost limits of its distribution in Hungary and in Slovakia.

32. *Camponotus (Myrmentoma) piceus* (Leach 1825). Kozina: Camping; Podpeč: hill; Strunjan: cliffs; Osp: limestone hill.

A thermophilous species, common in South Europe and in closed grasslands in Central Europe.

33. *Camponotus (Colobopsis) truncatus* (Spinola 1808). Podpeč: hill.

A rather common species in South and Central Europe, but absent in Poland (Pisarski, 1975).

Tribe Formicini

34. *Formica (Serviformica) gagates* Latreille 1798. Trnovski Gozd: Smrekova Draga.

South and Central European species, its presence in Trnovski Gozd shows Mediterranean influence of the

region's fauna.

35. *Formica (Serviformica) fusca* Linnaeus 1758. Kamniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Predmeja-Čaven, forest; Trnovski Gozd: grassland.

A common ant in the whole of Europe, with its distribution range over the entire Palearctic region.

36. *Formica (Serviformica) lemni* Bondroit 1917. Kamniško-Savinjske Alpe: Okrešelj; Kamniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Mala Lazna; Trnovski Gozd: Paradana; Trnovski Gozd: grassland.

This is a typical upland species, rare under 1000 m in Central and South Europe.

37. *Formica (Serviformica) cunicularia* Latreille 1798. Trnovski Gozd: Čaven, Kucelj; Kozina: campsite; Podpeč: roadside; Strunjan: cliffs; Osp: limestone hill.

One of the most common *Serviformica* species in Europe, occurring in open areas. More thermophilous than *F. rufibarbis*.

38. *Formica (Serviformica) rufibarbis* Fabricius 1793. Trnovski Gozd: Smrekova Draga; Kozina: campsite.

Similar species to *F. cunicularia*, but usually more common in wetter and urban habitats.

39. *Formica (Serviformica) balcanina* Petrov & Collingwood 1993. Kozina: campsite.

This species has been recently described from Deliblatska Peščara, near Belgrade, Yugoslavia (Petrov & Collingwood, 1993). Since then it has been found also in Rumania (Markó, 1997).

40. *Formica (F.) aquilonia* Yarrow 1955. Kamniško-Savinjske Alpe: Logarski kot; Kamniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Mala Lazna(?); Trnovski Gozd: Paradana; Trnovski Gozd: Smrekova Draga.

This is a common species in North Europe. In southern localities, however, it is restricted to high mountains. In the majority of cases, the collected specimens are typical *aquilonia*, but the Logarski kot material contains workers with poor pilosity on the eyes and gula, and in some cases the pilosity is too dense (e.g. Paradana collection). In Mala Lazna no nest was found, and as only one female was collected there is no proof that *F. aquilonia* is a constant member of the fauna. Titovšek (1994) found the species at several localities in the northern part of Slovenia.

41. *Formica (F.) pratensis* Retzius 1783. Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Paradana; Trnovski Gozd: grassland; Kozina: campsite.

A typical species of woodland margins and open areas. It is the most thermophilous *rufa* group species. After Titovšek (1994) its distribution range is similar to that of *F. rufa* L. and *F. polyctena*, but its habitat requirements are different.

42. *Formica (F.) rufa* Linnaeus 1758. Trnovski Gozd: grassland.

A typical woodland species, which prefers open forests and is not common in very dense, closed woods.

43. *Formica (F.) truncorum* Fabricius 1804. Trnovski Gozd: Smrekova Draga; Trnovski Gozd: grassland.

In Central Europe it had been regarded as an ant of high mountains (see also Titovšek, 1994). Some recent data from very dry sandy forests in the Hungarian Great Plain (Gallé, 1986; Gallé & Szönyi, 1988) modified our knowledge of its habitat requirements.

44. *Formica (Coptoformica) exsecta* Nylander 1846. Kamniško-Savinjske Alpe: Okrešelj.

This species has a distribution range from central Spain to North Europe and to Ural. More common in northern areas.

45. *Formica (Raptiformica) sanguinea* Latreille 1798. Trnovski Gozd: Predmeja-Čaven, forest.

Widely distributed species in Europe and Asia; expected from many more localities in Slovenia.

46. *Polyergus rufescens* (Latreille 1798). Kozina: campsite.

An obligate slave-making ant, with European distri-

bution, but more common at southern localities.

Collection completeness and species diversity

The two measures (1-b_{lin} and 1-b_{log-log}) of the perfection of the ant inventory of the sampled localities (Table 1) are closely correlated ($r = 0.86$, $p < 0.001$). On the basis of the values in Table 1, the Okrešelj collection is the most complete, whereas Smrekova Draga and Predmeja-Čaven Forest are the least sufficiently sampled sites. The diversity metrics used in this study (nb_{lin} and nb_{log-log}) are loosely correlated ($r = 0.504$, $p < 0.1$) and both of them are correlated with the number of recorded ant species ($r = 0.965$, $p < 0.001$ and $r = 0.674$, $p < 0.025$ respectively). On the basis of the linear ones (nb_{lin}), the ant species diversity is higher in those areas, which are under Mediterranean faunistic influence (Submediterranean sites and Trnovski Gozd), than in the Alps. The values of nb_{log-log} are not so unequivocal.

Locality	s	n	b _{lin}	1-b _{lin}	nb _{lin}	b _{log-log}	1-b _{log-log}	nb _{log-log}
Logarski Kot	6	8	0.64	0.36	5.09	0.71	0.29	5.70
Okrešelj	9	26	0.26	0.73	6.89	0.54	0.46	14.12
Mala Lazna	5	6	0.81	0.19	4.85	0.90	0.1	5.42
Paradana	8	9	0.86	0.14	7.76	0.90	0.10	8.07
Smrekova Draga	9	9	0.96	0.04	8.67	0.90	0.01	8.11
Predmeja-Čaven forest	8	8	0.99	0.01	7.90	0.96	0.04	7.67
Predmeja:grassland	6	7	0.80	0.20	5.58	0.83	0.17	5.84
Kucej	7	7	0.95	0.05	6.62	0.83	0.17	5.80
Podpeč (all habitats)	13	13	0.95	0.05	12.36	0.87	0.13	11.27
Strunjan: mountain	9	9	0.93	0.07	8.39	0.78	0.22	7.06
Osp: mountain	8	14	0.52	0.48	7.32	0.77	0.22	10.85

Tab. 1: The slope of the linear $s = f(n)$ regression function (b_{lin}), its log-log transformation (b_{log-log}) and two measures of the diversity (nb_{lin} and nb_{log-log} respectively) of the local ant faunas. s = number of collected species, n = number of collections.

Tab. 1: Smerni koeficienti linearne regresije (b_{lin}), njihove logaritemske transformacije (b_{log-log}) in dva izračuna vrstne diverzitete (nb_{lin} and nb_{log-log}) lokalne mravljinčje favne. s = število vrst, n = število zbirk.

Comparison with surrounding areas

Comparing the collected Slovene ants species with the available data from the neighbouring countries and regions, this fauna seems to be most similar to the Balkan ants (Agosti & Collingwood, 1987), as more than 91% of the present collection is represented by the Balkan species. As Agosti & Collingwood (1987) could not consider the ants described since then, this similarity could be even greater. The similarity with Hungary is also great, since no less than 86% of the ants listed in this paper have been also found in Hungary (Somfai, 1959; Gallé, 1979; 1981; 1986; 1993 and unpublished data; Gallé & Szönyi, 1988). The similarity with the Swiss fauna (Kutter, 1977) is at the same level. For Yugoslavia (80%, after Petrov, 1995) and Italy (84%, spe-

cies list after Baroni Urbani, 1971) we have very similar results. It is interesting that there is an unexpectedly high similarity with North European ant fauna (Collingwood, 1979), 65%.

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PRISPEVEK K SLOVENSKE MRAVLJINČJI FAVNI S POSEBNIM Poudarkom NA SUBMEDITERANSKEM IN EVDINARSKEM OBMOČJU

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POVZETEK

Preliminarna študija slovenske mravljinčje favne je temeljila na preučevanju mravelj julija 1996 na 15 lokalitetah, od katerih jih 12 leži v jugozahodni Sloveniji. Raziskave so bile opravljene v Kamniško-Savinjskih Alpah (3 lokalitete), Trnovskem gozdu (6 lokalitet), Kozini (1 lokaliteta), Podpeči (3 lokalitete), Strunjanu (1 lokaliteta) in Ospu (1 lokaliteta). Odkritih je bilo 45 vrst. Uporabljeni so bili posebni indeksi, da bi ocenili popolnost vzorcev in raznovrstnost favne. Na tej osnovi je bil najnatančneje raziskan Okrešelj (Kamniško-Savinjske Alpe), medtem ko je bila največja raznovrstnost mravljinčje favne zabeležena v Podpeči. Sicer pa je raznovrstnost mravljinčje favne za spoznanje večja v območjih s sredozemskim favnističnim vplivom.

Ključne besede: Hymenoptera, Formicidae, favna, Slovenija: submediteransko in evdinarsko območje

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