Entomol.rom., 6: 121-126, 2001 ISSN 1224 - 2594

Ants (Hymenoptera: Formicidae) of Stana Valley (Romania): Evaluation of the Effectiveness of a Myrmecological Survey

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Abstract

The myrmecofauna of Stana Valley is presented with an evaluation of the effectiveness of the sampling. Altogether 45 ant species were collected, which is almost the half of the known number of existing ant species in Romania. The slope of the tangent fitted to the species number - sample unit number was used to estimate the effectiveness of the sampling, as well as the Chao2 function, and the Jackknife estimate. The results show that there are no further species expected to occur in the meadow, whereas additional species are expected to occur in the forests of the valley.

The majority of the species are wide-spread in Central and Eastern Europe, however, there are some new species recorded for the Romanian fauna, like *Myrmica specioides*, *Leptothorax affinis*, *Leptothorax tuberum*, *Tetramorium impurum*, and *Lasius distinguendus*.

Rezumat

Mirmecofauna Văii Stana (Hymenoptera: Formicidae): evaluarea eficienței unei studii mirmecologice

Mirmecofauna Văii Stana este prezentată împreună cu evaluarea eficienței colectărilor. În total 45 specii de furnici au fost identificate, ceea ce înseamnă aproape jumătatea speciilor cunoscute de pe teritoriul țării. Tangentul funcției numărul speciilor raportat la numărul coloniilor inspectate a fost folosit la estimarea eficienței colectărilor, precum și indexul Chao2 și metoda de estimare Jackknife. Rezultatele arată că eficiența colectărilor făcute pe pajiști este foarte bună, însă în cazul pădurilor noi specii sunt așteptate, eficiența colectărilor este scăzută.

Majoritatea speciilor colectate sunt specii comune în Europa Centrală și de Est, dar au fost identificate și specii noi pentru fauna României, ca speciile *Myrmica specioides*, *Leptothorax affinis*, *Leptothorax tuberum*, *Tetramorium impurum* și *Lasius distinguendus*.

keywords: Formicidae, Stana Valley, Romania, new species, sampling effort

Introduction

Since the crisis of biodiversity has been globally recognized, the significance and acceptance of such studies, which contribute to any aspect of biological diversity, increased. Therefore the researches dealing with local or regional biota (flora and fauna), which were put aside from the mainstream of the biological sciences in the last decades, can get back their own rights. From the point of biodiversity conservation, such areas, which have rich local flora or fauna, are especially important. These biodiversity „hot spots" could occur at different spatial scales, from the size of a habitat to a region. The Stana Valley is such a rich, landscape level site, where an enormously diverse ant fauna was discovered. The main aim of this paper is to describe the ant fauna of Stana Valley, and to investigate, whether our sampling effort was satisfactory for the purposes of a complete myrmecological survey.

Materials and methods

Stana Valley lies at the boundary of Cluj and Sălaj counties in Transylvania, it's name comes from the nearby village of Stana, which lies about 3 km away from this valley. The valley itself is an almost closed area surrounded on one side by mixed oak, and birch forests, and bushes, on the other side, in the direction of Stana village, by shrubs. The valley is a mosaic of forests, bushes, pastures, and haylands. The wide variety of biotopes, which are not in the least uniformely distributed offers this landscape a genuinely patchy character, which allows the coexistence of several insect species.

The ants were collected by a Romanian-Hungarian myrmecological team in April 2000. We

sampled each discovered ant nest. The collected individuals were killed and preserved in 60% ethanol. The identification of the species was carried out on the basis of the keys of COLLINGWOOD (1979), KUTTER (1977), PETROV & COLLINGWOOD (1993), RADCHENKO ET AL. (1997), and SEIFERT (1988a, 1988b, 1992, 1996).

The effectiveness of sampling was tested with the similar philosophy as described by GALLÉ (1997), but in a slightly different way. We calculated the consecutive tangents' slopes of the cumulative species number against sample unit number saturation curve. We made one hundred replicates of the collections with random sequences of the sampling units. The average values of the cumulative species number against number of sample units saturation function were computed from this set of replicates. Then we calculated the consecutive targents' slopes of this saturation curve. If the final slope is zero or adjacent to it, the sampling effort is regarded satisfactory. We also characterize the sampling effort with the expected number of the additional sample units needed to obtain one more species. In the case of "ideally complete" sampling, this value is infinite.

The maximum expected number of species was calculated in three ways. First, we fitted the curve of the cumulative species number against sample unit number saturation function to its final value by eye. Besides this, we computed Chao2 function and the Jackknife estimate (SOUTHWOOD & HENDERSON 2000, LONGINO 2000). Two type of habitats were considered during this analysis: (1) **meadow** for the species collected from open areas, grasslands, forest-margins, (2) **forest** for species collected from forests. In the case of the meadow only successful sampling trials (positvie samples = samples from inhabited nests) were considered, whereas in the case of the forest the calculations were effectuated in two ways: (1) considering only the positive samples, (2) adding an additional of 50 non-successful samplint trials (negative samples = 0 species found) to the positive samples.

Survey of species

Altogether 45 species were identified. These species are listed below, as well as a short description of their habitat preferences, and distribution.

I. subfamily Myrmicinae LEPELETIER 1836

Genus *Myrmica* LATREILLE 1804

***M. rubra* (LINNAEUS 1758).** It is widely distributed all over Europe, it's the typical species of forests and wet grasslands in lowlands, inhabits marshes and wet pastures in the mountains. It was collected only from grasslands in Stana Valley.

***M. ruginodis* NYLANDER 1846.** It is widely distributed in Europe, woodland species in hilly regions, but also inhabits marshlands, and even forests in the mountains. It was collected from forests and from grasslands in Stana Valley.

***M. sabuleti* MEINERT 1860.** It is a common species, inhabits wet grasslands, forest margins, thickets. It was collected from both grasslands and forests in Stana Valley.

***M. scabrinodis* NYLANDER 1846.** It is a common European species, inhabits wet grasslands from lower altitudes to the mountain region, it can be found in high densities in wet marshlands. It was collected only from grasslands in Stana Valley.

***M. specioides* BONDROIT 1918.** Inhabits dry grasslands in Europe, and it hasn't been included in the Romanian myrmecofauna up to now, though it seems to be a common species in Romania, too (MARKÓ & CSŐSZ in print). It was collected only from grasslands in Stana Valley.

Genus *Leptothorax* MAYR 1855

***L. affinis* MAYR 1855.** New to the Romanian myrmecofauna, though it is a common species of oak and willow forests, nesting on the trees. It can be found in Europe almost everywhere. It was collected only from open areas in Stana Valley.

***L. corticalis* (SCHENK 1852).** It is an arboricol species, with patchy distribution, and it has low densities. It was collected only from open areas in Stana Valley.

***L. crassispinus* KARAVAJEV 1926.** It was formerly known as *Leptothorax slavonicus* SEIFERT. It is the most common *Leptothorax* species in Central, and Eastern Europe. Inhabits forests in lowlands, as well as bushes. It was collected from open areas and from forests in Stana Valley.

***L tuberum* (FABRICIUS 1775).** It is a new species for the Romanian fauna. It's thermohpilous, inhabits sun-exposed grasslands, where it nests under stones. It is well known from Central and Eastern Europe. It was collected only from open areas in Stana Valley.

***L. unifasciatus* (LATREILLE 1798).** Inhabits dry grasslands, it is widely distributed in Europe. It was collected only from open areas in Stana Valley.

Genus *Solenopsis* WESTWOOD 1841

***S. fugax* (LATREILLE 1798).** The common thief ant is one of the most frequent facultative cleptoparasitic ant species of Europe. It was found mainly under stones close to the nests of other ant species, but also in well-separated colonies. It inhabits grasslands from lowlands to mountains, and it has several host species. It was collected only from pastures in Stana Valley.

S. sp.1. The status of this species is not cer-

tain. There are clear morphological evidences for its separation from *S. fugax*. It was collected only from pastures in Stana Valley.

Genus *Tetramorium* Mayr 1855

***T. caespitum* (Linnaeus 1758).** This thermophilous species occurs in almost every possible habitat, excluding forests. Colonies can reach high densities especially in sunny, dry areas exposed to some kind of disturbance. It was collected only from open areas in Stana Valley.

***T. impurum* (Förster 1850).** This is a freshly identified species in the Romanian fauna. *T. impurum* mainly inhabits sun-exposed, open areas in hilly regions or even mountain slopes. It was collected only from open areas in Stana Valley.

T. sp.1. The status of this species is not certain. It is a close relative of *T. caespitum* morphologically. It was collected only from open areas in Stana Valley.

Genus *Myrmecina* Curtis 1829

***Myrmecina graminicola* (Laterille 1802).** Wide-spread in Europe, though it is never abundant. It can be found in lowlands and hilly regions both in open areas, and forests. It was collected from open areas in Stana Valley.

Genus *Messor* Forel 1890

***Messor structor* (Latrielle 1798).** It is the typical species of sun-exposed, warm grasslands, and sandy areas. It is wide-spread in the southern part of Europe, though it has a patchy distribution. It was collected from grasslands in Stana Valley.

Genus *Stenamma* Westwood 1840

***Stenamma debile* (Förster 1850).** It is well-known from forests in lowlands and hilly regions. It is not an abundant species, however wide-spread in Central Europe. It was collected in forests in Stana Valley.

II. Subfamily Dolichoderinae (Forel 1878)

Genus *Dolichoderus* Lund 1831

***D. quadripunctatus* (Linnaeus 1767).** A frequent lowland European species living on trees in open areas or in forests. It is well-known from Romania. It was collected only from open areas in Stana Valley.

Genus *Tapinoma* Förster 1878

***T. ambiguum* Emery 1925.** Markó (1997) reported this species for the first time in Romania. Nevertheless it is not a rare species. It can be found in open habitats, under stones. It was collected only from grasslands in Stana Valley.

***T. erraticum* (Latreille 1798).** Inhabits sun-exposed, dry, open areas. Common, widely distributed in Europe. It was collected only from grasslands in Stana Valley.

III. Subfamily Formicinae Lepeletier 1836

Genus *Plagiolepis* Mayr 1861

***P. vindobonensis* Lomnicki 1925.** One of the smallest ant species. Nests can be found under stones in warm, open habitats. Common, however it has patchy distribution. It was collected only from grasslands in Stana Valley.

Genus *Camponotus* Mayr 1861

***C. truncatus* (Spinola 1808).** This is a thermophilous, tree-living species, that can be found on willows or on oaks in lowlands. Common in Europe, though it has a patchy distribution in Transylvania due to its thermohpilous character. It was collected only from open areas in Stana Valley.

***C. ligniperda* (Latreille, 1802).** It is a common European species, which lives on trees. It can be found from lowland forests to 600-800 m altitudes. It was collected only from open areas in Stana Valley, mainly from forest margins.

***C. vagus* (Scopoli 1763).** Themophilous species, almost submediterranean. It inhabits open areas, nests can be found in dead, or sick trees. It has patchy distribution. It was collected only from open areas in Stana Valley.

***C. fallax* (Nylander 1850).** Relatively rare. This species inhabits forests, lives in trees. It was collected from forest margins in Stana Valley.

***C. aethiops* (Latreille 1758).** It is a rather thermophilous species, inhabits dry grasslands, sun-exposed areas. It has a patchy distribution in Transylvania, but it is not rare. It nests in the ground. It was collected only from grasslands in Stana Valley.

Genus *Lasius* Fabricius 1804

***L. fuliginosus* (Latreille 1798).** This is a common species living in trees. It inhabits sun-exposed forest margins, but also occurs in open areas. Widely distributed in Europe, and in Romania. It was collected from open areas and from forests in Stana Valley.

***L. paralienus* Seifert 1992.** As a sibling species of *L. alienus* it was omitted till Seifert's revision of the *Lasius* s. str. species (Seifert 1992). The

presence of this species was first reported by MARKÓ (1998), but from then on it has been found in several places. This species is typical for dry pastures and agricultural zones with high degree of disturbance. It was collected only from grasslands in Stana Valley.

***L. alienus* (FÖRSTER 1850).** Common European species, it can be found in open grasslands all over Europe and Romania. It was collected only from grasslands in Stana Valley.

***L. platythorax* SEIFERT 1992.** SEIFERT separated it in 1992 from *L. niger*. It mainly inhabits forests. Widely distributed. It was collected only from forest margins in Stana Valley.

***L. niger* (LINNAEUS 1758).** It is common for open habitats in Europe, but also for forest margins. Widely distributed. It was collected only from open areas in Stana Valley.

***L. brunneus* (LATREILLE 1798).** Common species, though it can't be found in high densities, like some of the former congeneric species. Lives on trees from the lowlands to hilly regions. It was collected from open areas and from forests in Stana Valley.

***L. flavus* (FABRICIUS 1781).** It is characteristic for mountain pastures in the Carpathians, where it reaches high densities. However it can be found in lowlands, too. Common. It was collected from grasslands and from forests in Stana Valley.

***L. distinguendus* (EMERY 1916).** This is its first data in Romania. Inhabits open, dry grasslands, though it is a relatively rare species. It was collected only from grasslands in Stana Valley.

L. (Chtonolasius) sp.1. The status of this species is not certain. It was collected only from grasslands in Stana Valley.

Genus *Formica* LINNAEUS 1758

***F. balcanina* PETROV & COLLINGWOOD 1993.** This species was reported for the first time by MARKÓ (1998, 1998) in Romania in 1997. Formerly it was known as *F. cinerea* MAYR 1853, though later it proved to be a separate species (PETROV & COLLINGWOOD 1993). It is a common species in arid, xerothermous areas, riverbanks, or even in urban habitats, where the degree of disturbance is high. It is known mainly from the Southern part of Eastern Europe and from the Balkans. It occurs along the railway in Stana Valley.

***F. fusca* LINNAEUS 1758.** This species is frequent in sparse lowland oak forests, or forest margins. Unlike in other regions, it is not very frequent in Transylvania. Widely distributed in Europe. It was collected in open areas in Stana Valley.

***F. gagates* LATREILLE 1798.** *F. gagates* is a submediterranean species, it can be found in warm, sparse oak forests and forest margins. It is rare in Transylvania due to its preferences. It was collected at forest margins in Stana Valley.

***F. cunicularia* LATREILLE 1798.** It is characteristic for arid areas, urban zones. One of the most widespread ants in Europe. It was collected from open areas and from forests in Stana Valley.

***F. rufibarbis* FABRICIUS 1793.** It is a close relative of the former species, it can be also found in open, dry areas from lowlands to higher altitudes. It was collected only in grasslands in Stana Valley.

***F. pratensis* RETZIUS 1783.** One of the most characteristic species of grasslands. It can be found in lowlands, and in mountain pastures, too. Common all over Romania and Central Europe. It was collected only in grasslands in Stana Valley.

***F. polyctena* FÖRSTER 1850.** Inhabits forests, and forms supercolonies in hilly regions. It was collected at forest margins in Stana Valley.

***F. rufa* LINNAEUS 1761.** It can be found mainly at the margin of forests. It is monogynous, never forms supercolonies. Relatively frequent. It was collected in open areas, and forests in Stana Valley.

Genus *Polyergus* LATREILLE 1805

***P. rufescens* (LATREILLE 1798).** The amazon ant is the only obligate Formicine slave-maker ant species in Europe. It can be found from lowlands to the slope of the mountains, but it always inhabits sun-exposed, open areas. It is well-known from Romania. It was collected only in grasslands in Stana Valley.

Statistical analysis

The species richness in the meadows is much higher that in the forests (Table 1). In the case of the meadows, the number of sample units (sampled nests) is satisfactory ($b_{min} = 0$, $n(s+1) = \infty$, Fig. 1). On the other hand, there were only a few ant species observed in the forests, and the sampling effort could only be regarded satisfactory, if we consider the non-successful sampling trials, too (Figs. 2-3). The expected maximum number of species is slightly higher than observed in meadows by both Chao2 and Jackknife estimates. In the forest the Chao2 estimate resulted in an unrealistically high expected species number.

Comments

During this study 5 new species were found for the Romanian fauna, namely *Myrmica specioides*, *Leptothorax tuberum*, *Leptothorax affinis*, *Tetramorium impurum*, and *Lasius distinguendus*, and 3 species with uncertain taxonomical state. The detailed description of the new species, and their distribution in Romania and Europe are part of a forthcoming paper by MARKÓ & CSŐSZ (in print). MARKÓ in 1999 summarized the number of known species to be 84. On the basis of the present study

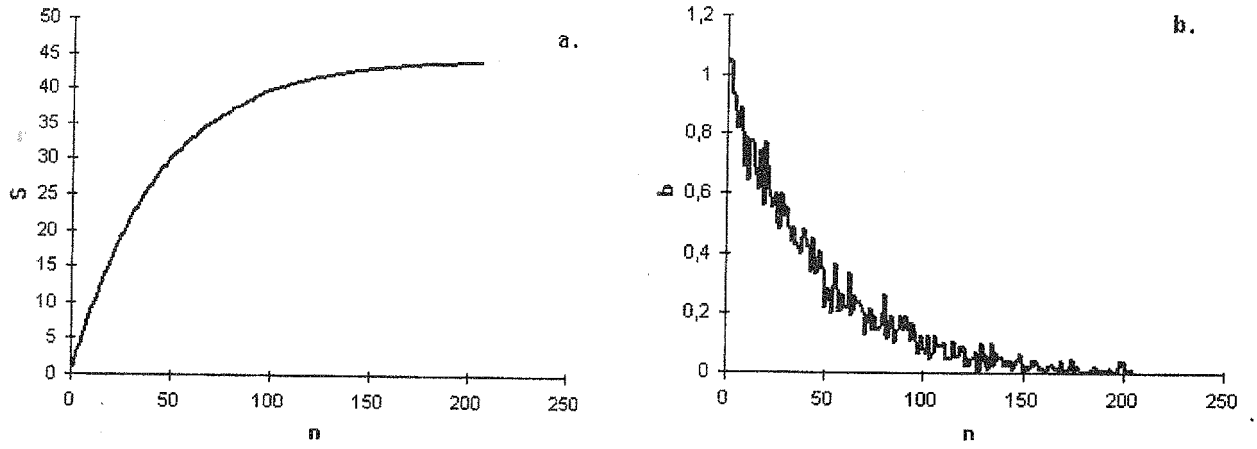

Fig. 1. The cumulative number of observed species (**a**), and the slope of this curve's tangent (**b**), plotted against the sampling effort (no of sampled nests) in the meadow.

Table. 1.

The statistics of the observed and expected species richness of Stana ant fauna. S_{obs} - observerd no. of species; b_{min} - the minimal slope of the tangent of {*sample unit number — number of observed species*} function (see Fig. 1-3); **n(s+1)** - the computed no. of sample units needed to add one more species to the observed ones; S_{exp} - expected no. of species fitting the assimptote of {*sample unit number — number of observed species*} curve by eye; S_{max} - the expected maximun no. of species on the basis of Chao2, and Jackknife estimations.

Site	S_{obs}	Sample units	b_{min}	n(s+1)	S_{exp}	S_{max} (Chao2)	S_{max} (Jackknife)
Meadow	44	206*	0	∞	44	47.06	50.96
Forest	9	13*	0.53	11	12	27.00	14.98
Forest (modified)	9	63**	0.07	87	12	27.00	13.98

** only the sample units from inhabited nests (positive sample units) are considered*

*** both positive and negative sample units are considered*

this number increases to 89. If we consider that the myrmecofauna of Hungary (GALLÉ ET AL. 1998) contains more than 100 species, and the diversity of available habitats is much lower than in Romania, a much higher number of existing Romanian ant species can be predicted.

Although the majority of the ant species in Stana Valley are common, and widely distributed in Central and Eastern Europe, we consider to be worth mentioning that almost half of the actually known Romanian fauna was found in this geographically restricted area. This fact emphasizes the specificity of this valley, where the diversity of habitats seems to be so high, that it can offer nesting place to several ant species. This number is also considered high taking account of the fact that ants are their own strongest competitors due to their social life, and this character restricts the number of simultanously occurring ant species very efficienctly. On the basis of the statistical analysis it can be concluded, that additional species are to be found in the forests of Stana Valley, whereas in the case of the open areas the probability of finding new species is very low. Thus the faunistical list of the valley is considered to be almost complete.

Upon this study we can conclude that this valley needs to be protected due to the high number

the in the frame of the "Ant fauna of the Carpathian Basin" program of the Department of Ecology, University of Szeged, Hungary.

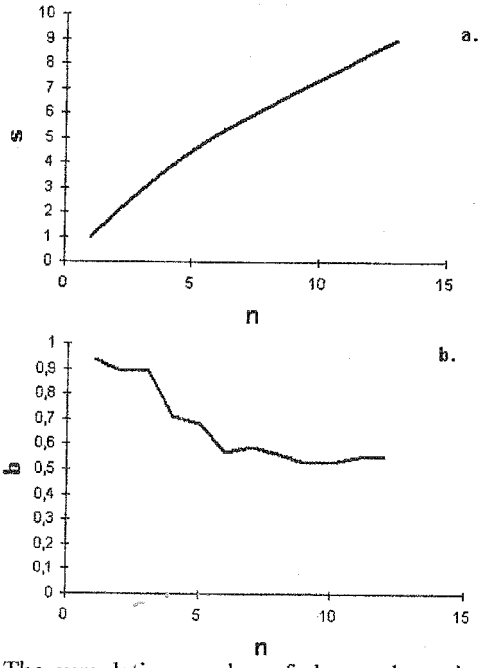

Fig. 2. The cumulative number of observed species (**a**), and the slope of this curve's tangent (**b**), as a function of the sample size (no of sampled nests) in the forest, when taking account of positive samples only.

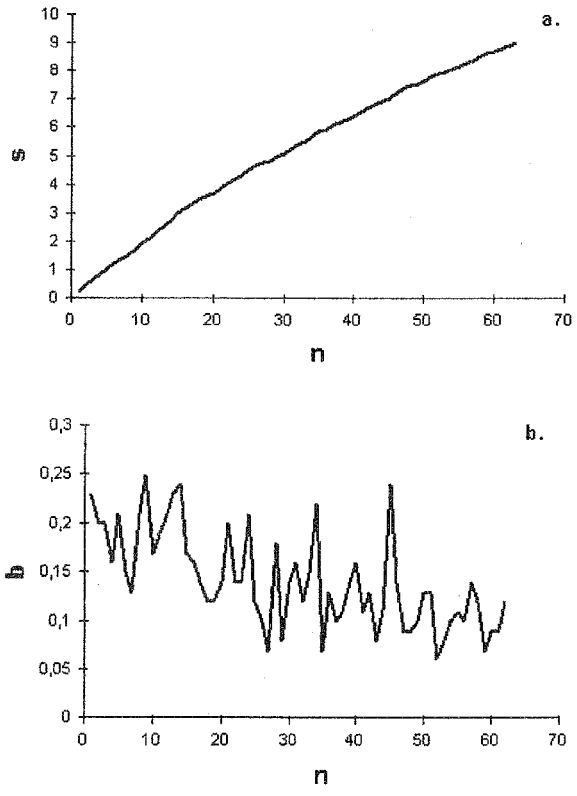

Fig. 3. The cumulative number of observed species (**a**), and the slope of this curve's tangent (**b**), as a function of the sample size (no of sampled nests) in the forest, when

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Received: 5.04.2002
Accpeted: 30.04.2002
Printed: 24.06.2002