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Ant pitfall catches in dry ecosystems of North Rhine-Westphalia

Patrick Dolle, Sascha Buchholz und Holger Sonnenburg

Abstract: Ant pitfall catches in dry ecosystems of North Rhine-Westphalia. – In general, it is rare to conduct ant surveys and thus a good way to gather data of analysing the bycatch of pitfall traps. In all, 25 study sites in 11 investigation areas were sampled continuously from August 2006 to July 2008. Altogether 5,021 individuals (4,798 workers and 223 gynes) of 27 ant species were captured. *Formica sanguinea* was the most abundant species, while other highly frequent species were *Myrmica sabuleti*, *M. ruginodis*, and *Lasius niger*. 13 species are listed in the Red List of North Rhine-Westphalia. Faunistically interesting species were *Myrmica lonae, Tapinoma ambiguum*, and *F. truncorum*. Although based on bycatches of pitfall traps only, the results of this study thoroughly improved the present faunistical ant dataset of North Rhine-Westphalia. Hence, this corroborates the assumption that an analysis of bycatch data is most valuable and therefore should be integrated in further pitfall trap studies.

Introduction

Nutrient-poor sandy grasslands and heaths are among the most endangered ecosystems in Germany (Riecken et al. 2006). During the past 50 years, the area of open sand habitats has considerably decreased due to the lack of disturbance (drifting sand, grazing, and fire) and the intensive cultivation and afforestation (Berger-Landefeldt & Sukopp 1965, Jeckel 1984, Jentsch et al. 2002, Kratochwil 2004). In north western Germany, sand habitats such as dry grasslands, heathlands, and inland dunes are restricted to small areas (Verbücheln & Jöbges 2000, Pardey 2004) and are thus endangered (Drachenfels 1996, Verbücheln et al. 1999).
Compared to the omnipresence of ants in allmost all terrestrial habitats (Hölldobler & Wilson 1990, Steiner & Schlick-Steiner 2002), so far the data collection in North Rhine-Westphalia is insufficient, which is why knowledge concerning diversity and distribution of ants is poor (Sonnenburg & Sonnenburg 2008, in press). This is a drawback since ants can play an important role within ecological studies (e.g. Dahms et al. 2005, Englisch et al. 2005, Campos et al. 2007, Mabelis 2002) as they are seen as ecosystem engineers (Folgarait 1998, Blomquist et al. 2000, Petal et al. 2003) and are moreover often closely bound to their habitat (Alonso 2000). Especially in dry sand ecosystems ants can reach a high biodiversity (Assing 1989, Sonnenburg & Hannig 2005).
Since ant surveys tend to be rarely conducted within the scope of ecology and conservation studies, a good opportunity to gather data consists of analysing the bycatch of pitfall traps. In many faunistic studies, e.g. of spiders or carabid beetles, ants are collected without special further effort. From these results, faunistic and ecological information for further research as well as distribution data can be gathered (Buchholz et al. 2011). The aim of this paper is to improve the knowledge of distribution of ants in dry ecosystems of North Rhine-Westphalia.

Material and Methods

Study area

The investigation areas lied scattered in the Westphalian Bay which forms the northwestern part of the federal state of North Rhine-Westphalia in NW Germany (elevation: 40–130 m a.s.l.) (Fig. 1). The maximum distances between the areas were about 125 km (W-E) and 75 km (N-S). The predominantly level to slightly undulating landscape is glacially formed and the ice-age top layers are fluvial and aeolic sands with dry soil conditions (Meynen & Schmithüsen 1959, Dinter 1999). The climate is sub-atlantic with a mean annual temperature of 9.5 to 10.0 °C and an annual precipitation between 700 and 750 mm. The distinct sub-atlantic character of the climate in the West weakens towards the East

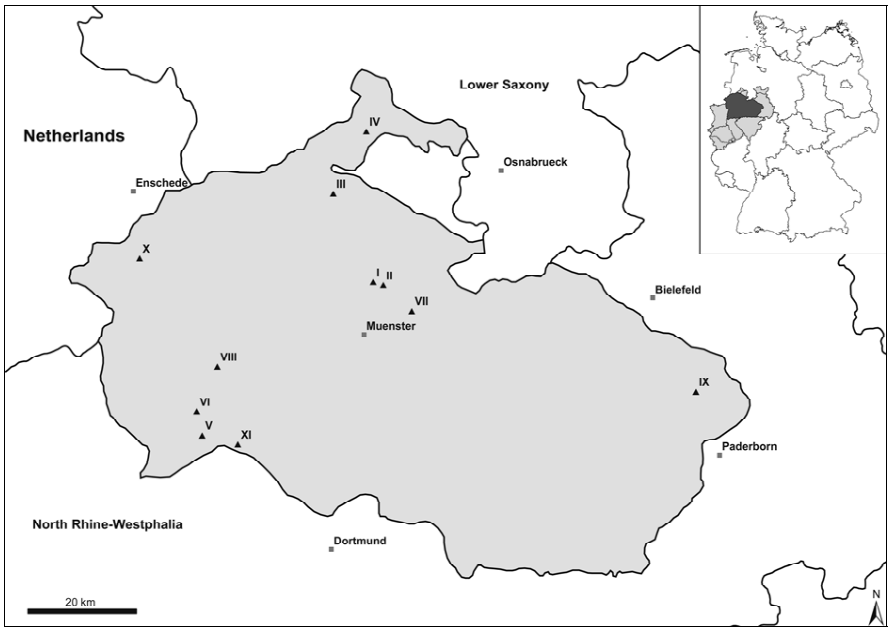

Fig. 1: Location of the study areas in the Westphalian Bay (grey) in Northwest Germany (cf. small map top right). Explanation of study areas: I = Bockholter Berge (coordinates: 52°03'30.21"N, 07°39' 39.05"E, TK25 3912-1), II = Boltenmoor (52°01'18.58"N, 07°41'10.12"E, 3912-1), III = Elter Sand (52°13'27.45"N, 07°32'02.04"E, 3711-3), IV = Heiliges Meer (52°21'12.11"N, 07°38'02.91"E, 3611-2), V = Holtwicker Wacholderheide (51°45'0.04"N, 07° 07'36.68"E, 4208-2), VI = Hülstener Wacholderheide (51°47'52.03"N, 07°06'30.24"E, 4208-2), VII = Klatenberge (52°00'16.73"N, 07°47'02.70"E, 3912-4), VIII = Letter Wacholderheide (51°53'12.09"N, 07°10'05.81"E, 4109-1), IX = Moosheide (51°51'18.71"N, 08°40'58.69"E, 4118-1/3), X = Wacholderheide Hörsteloe (52°05'45.50"N, 06°54'43. 20"E, 3907-1), XI = Westruper Heide (51°44'07.03"N, 07°14'16.47"E, 4209-3).

(MURL NRW 1989). According to Burrichter (1973), the potential natural vegetation consists of beech and oak forests (Fago-Quercetum typicum). The lowlands are used mainly by agriculture. Large extensions of the sand regions are covered by grasslands. The percentage of forest is mostly small (Dinter 1999).

Sampling design

Within a detailed investigation of diversity and ecology of spider assemblages, nearly all dry grassland habitats of northern Westphalia have been investigated. Overall, 25 study sites in 11 investigation areas were sampled from August 2006 to July 2008 (Fig. 1, Tab. 1). The whole range of habitat types representing the sand ecosystems of the study area, such as Dicrano scoparii-Juniperetum, Genisto-Callunetum, and Spergulo-Corynephoretum was considered. Furthermore, neighbouring habitats such as *Pinus sylvestris*-forests were included. Four pitfall traps were installed at each study site. The traps were 500 ml plastic cups with a 90 mm diameter that were one-fourth filled with a 4% formalin-detergent solution. The position of each trap was determined randomly but traps had a minimum distance of 5 m to each other. Emptying was carried out every four weeks. Afterwards, ants were sorted and transferred to 75% ethanol. Nomenclature, determination, and ecological classifications were based on Seifert (2007) and Seifert & Schulz (2009).

Results

Altogether 5,021 individuals (4,798 workers and 223 gynes) of 27 ant species were captured during the investigation (Tab. 2). The most abundant species was by far *Formica sanguinea* (1,530 workers, 32%). Further very frequent species were *Myrmica sabuleti* (668, 14%), *M. ruginodis* (652, 14%), and *Lasius niger* (434, 9%). All four species named

Tab. 1: Number of investigated habitat types in study areas I–XI (see Fig. 1). Abbreviations: sand = bare sand, Spe-Cor = Spergulo-Corynephoretum, Ave-Gra = *Avenella* grasland, Dia-Arm = Diantho-Armerietum, Gen-Cal = Genisto-Callunetum, Dic-Jun = Dicrano scoparii-Juniperetum.

area	**habitat types**					
	sand	Spe-Cor	Ave-Gra	Dia-Arm	Gen-Cal	Dic-Jun
I	.	2	.	.	.	.
II	.	1	.	.	.	.
III	.	1	.	.	.	1
IV	1	.	.	.	2	.
V	.	.	.	.	.	1
VI	.	.	.	.	.	1
VII	.	1	.	.	.	.
VIII	.	1	.	.	.	.
IX	2	1	.	1	1	.
X	.	1	.	.	1	.
XI	.	.	2	.	4	.

above and additionally *Formica fusca* and *Lasius umbratus* occurred in nearly all or even in all (*M. ruginodis*, *L. umbratus*) study areas. Most of the captured species (18, 64%) can inhabit open as well as shaded habitats, while only ten species (36%) are more or less restricted to open landscapes. Ten species were strictly thermophilous.

In all, 13 species are listed in the Red List of North Rhine-Westphalia. Among them *Myrmica lonae*, *Formica truncorum* and *Tapinoma ambiguum* are highly endangered (category 2). Furthermore, seven species, *Myrmica lobicornis*, *M. schencki*, *M. specioides, Lasius meridionalis*, *L. psammophilus*, *Formica clara* (Syn. = *F. lusatica*, SEIFERT & SCHULZ 2009), *F. pratensis*, are endangered (category 3), while three species (*Myrmica sabuleti*, *Formica polyctena*, *F. rufa*) are listed as pre-endangered (category V). Species richness was highest in Wacholderheide Hörsteloe (X: 21 species), which included the endangered *M. lobicornis, M. specioides, M. schencki*, and *Lasius meridionalis*, followed by Heiliges Meer (IV: 19) and Boltenmoor (II: 19). Three species, *Myrmica lonae, Tapinoma ambiguum*, and *F. truncorum*, were faunistically interesting, because they had been rarely recorded in North Rhine-Westphalia.

Discussion

All abundant species are widely distributed in Germany and common in a broad spectrum of different habitat types. However, the thermophilous *Myrmica sabuleti* clearly prefers open and more or less dry habitats (SEIFERT 2007). Remarkably, *Myrmica ruginodis* occurred in all investigated sites although this species normally inhabits wooded habitats while avoiding warm and open places (SEIFERT 2007). This might be explained by the fact that most study sites were small-sized and surrounded by woodlands and that thus forest species could invade. Furthermore, old and encroached *Calluna*-heathland may be a suitable habitat which was before shown by ASSING (1989).

Regarding the high individual sums of the eurytopic species *Formica sanguinea* (cf. SEIFERT 2007), one has to consider that nearly 50% of specimens were caught in one study area, namely Holtwicker Wacholderheide, which might be explained by the pitfall trap position near to a nest or a highly frequented path (SEIFERT 1990).

The species inventory was dominated by eurytopic species including woodland ants, while the number of thermophilous species was comparably low. This can be explained by the fact that most study sites were encroached by grasses and shrubs, while typical dry grassland and heathland sites are often restricted to small extensions. This is due to lack of disturbance and former land use practices and thus missing dynamics (KRATOCHWIL 2004, PARDEY 2004). Hence, the degradation of former open sand ecosystem habitats negatively affects the occurrence of thermo- and xerophilous species, which had been previously shown for spiders (BUCHHOLZ 2010) and grasshoppers (SCHIRMEL & BUCHHOLZ 2010).

Tab. 2: Species list (abundances for workers/queens). Abbreviations: Hab = habitat preference: E = eurytopic, M = bogs and mires, O = open biotop types, OB = semi-open biotop types, OM = mesophilous semi-open biotop types, OT = open and thermophilous biotop types, W = forests, WT = thermophilous forests; Eco = ecology: t = thermophilous; End = Endangerment (Red List North Rhine-Westphalia, SONNENBURG & SONNENBURG, in press): 2 = highly endangered, 3 = endangered, V = endangerment assumed.

species	Hab	Eco	End	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Total
Myrmica lobicornis NYLANDER, 1846	W, O	.	3	.	3/0	.	9/0	.	.	.	.	.	46/0	.	58/0
Myrmica lonae FINZI, 1926	W, M, OB	t	2	.	.	.	2/0	.	.	.	.	2/0	3/0	.	7/0
Myrmica rubra (LINNAEUS, 1758)	E	.	*	.	0/1	1/0	0/1	1/0	0/1	.	.	.	.	.	2/3
Myrmica ruginodis NYLANDER, 1846	W, M, OM	.	*	17/0	11/2	32/0	5/1	31/2	413/3	2/1	2/0	6/0	54/1	79/1	652/10
Myrmica sabuleti MEINERT, 1861	O	t	V	51/0	64/4	120/0	104/4	106/1	3/1	.	82/1	85/3	26/1	27/2	668/17
Myrmica scabrinodis NYLANDER, 1846	OM, M	.	*	6/1	4/0	.	2/1	39/5	5/0	.	.	.	13/3	1/4	70/14
Myrmica schencki EMERY, 1895	OT	t	3	1/0	17/0	1/0	36/4	10/3	.	.	.	4/1	10/0	.	79/8
Myrmica specioides BONDROIT, 1918	OT	t	3	10/0	0/1	.	6/0	7/0	.	.	1/0	.	10/0	19/3	53/4
Leptothorax acervorum (FABRICIUS, 1793)	W, M, OB	.	*	.	2/0	1/0	.	.	.	.	.	.	1/0	.	4/0
Temnothorax nylanderi (FÖRSTER, 1850)	W	.	*	.	.	.	.	.	2/0	.	.	.	.	.	2/0
Stenamma debile (FÖRSTER, 1850)	W	.	*	2/0	1/0	0/1	1/1	3/0	24/0	.	.	.	7/0	0/1	38/3
Tetramorium caespitum (LINNAEUS, 1758)	OT	t	*	.	1/0	1/0	89/1	.	35/0	.	3/0	80/3	22/0	4/1	235/5
Tapinoma ambiguum EMERY, 1925	OT	t	2	.	.	.	.	.	5/0	.	.	.	.	10/0	15/0
Lasius flavus (FABRICIUS, 1782)	O, E	.	*	.	1/0	.	.	1/1	.	.	.	0/1	.	1/0	3/2
Lasius fuliginosus (LATREILLE, 1798)	W, OB	.	*	93/2	.	0/1	0/7	0/1	0/3	.	0/1	1/1	6/2	75/1	175/19
Lasius meridionalis (BONDROIT, 1920)	OT	t	3	0/3	.	.	.	0/2	0/1	.	0/1	0/8	0/41	1/8	1/64
Lasius niger (LINNAEUS, 1758)	E	.	*	28/0	128/0	3/0	25/0	27/0	0/1	.	.	196/0	7/0	20/0	434/1
Lasius platythorax SEIFERT, 1991	W, M	.	*	3/0	1/0	.	81/1	24/0	74/0	2/0	1/0	.	75/0	2/0	263/1
Lasius psammophilus SEIFERT, 1992	OT	.	3	.	.	.	1/0	.	.	.	.	8/0	5/0	272/1	286/1
Lasius umbratus (NYLANDER, 1846)	E	.	*	0/4	0/7	0/1	0/1	0/1	0/6	0/2	0/4	0/13	2/16	1/11	3/66
Formica fusca LINNAEUS, 1758	WT, O	t	*	9/0	15/0	4/0	2/0	19/0	9/0	.	6/0	1/0	7/0	1/0	73/0
Formica clara FOREL, 1886	OT	t	3	.	.	.	.	.	.	.	.	.	.	15/0	15/0
Formica polyctena FÖRSTER, 1850	W	.	V	.	3/0	.	.	.	.	.	.	30/1	.	.	33/1
Formica pratensis RETZIUS, 1783	OT, OB	.	3	.	4/0	6/0	.	1/0	.	.	9/0	23/1	12/0	.	55/1
Formica rufa LINNAEUS, 1761	W	.	V	5/0	7/0	3/0	1/0	.	.	.	.	.	5/0	.	21/0
Formica sanguinea LATREILLE, 1798	O, OT	.	*	98/1	.	150/0	185/1	696/0	31/0	1/0	143/0	12/1	212/0	2/0	1530/3
Formica truncorum FABRICIUS, 1804	W, OB	t	2	.	23/0	.	.	.	.	.	.	.	.	.	23/0
Total															
workers/queens				323/11	285/15	322/3	549/23	965/16	601/16	5/3	247/7	448/33	523/64	530/32	4798/223
species				14	19	14	19	16	15	4	11	15	21	17	27

During the study, three rare species could be extracted from the bycatch data. *Myrmica lonae* is typical for scarcely wooded, thermophile habitats like *Juniperus* heaths or shrubs along peat bogs (SONNENBURG 2005, SEIFERT 2007). *M. lonae* is rare in North Rhine-Westphalia (10 locations), even though lately it is found more often (SONNENBURG & SONNENBURG, in press). *Tapinoma ambiguum*, which was collected in Hülstener Wacholderheide and Westruper Heide, has its main distribution in dry sand ecosystems of lowlands. Furthermore, *Calluna*-heathland and neglected grassland are preferred. The occurrence in the Westruper Heide was already known, but the discovery in the Hülstener Heide is new. This species is rare and not widespread. To date, it has been recorded in six locations in North Rhine-Westphalia (SONNENBURG & SONNENBURG, in press).
Moreover, the detection of *Formica truncorum*, which has been rarely found in North Rhine-Westphalia, is outstanding for the research of dry plains of the Westphalian Bay. Before, there were only two confirmed locations in the Senne area and one near Hiltrup.
Problems concerning the pitfall trap technique became obvious since, for example, arboricol or endogaeic species such as *Temnothorax affinis* or *Lasius flavus* might be missing (cf. MAJER 1997). In contrast, individuals of other species were caught in huge numbers, apparently indicating a trap location near to a nest or an ant trail.
In literature, different opinions prevail about using bycatch ant data. SEIFERT (1990) criticised that ant species behave differently at the pitfall traps and that the catch is therefore selective. Also, traps may lie next to a nest or a highly frequented ant path (see above) which would increase the activity dominance of these species in the catch (LAEGER & SCHULZ 2005). According to SEIFERT (1990), ant data should generally be gathered by data mining of nests and catches by hand. On the other hand, several authors stated that despite the fact that nest counting definitely generates results that differ from the ones achieved by pitfall samples, pitfall trapping might be nevertheless an appropriate technique for ecological studies or for measuring activity of foraging ants as well as distribution patterns (GREENSLADE 1973, STEINER et al. 2005, SCHLICK-STEINER et al. 2006).
Although based on bycatches of pitfall traps only, the results of this study considerably improved the present faunistical dataset. It was possible to assess a number of endangered species as well as typical inhabitants of dry sand ecosystems. On the other hand, it would obviously be misleading to draw conclusions concerning alpha-diversity and assemblage structure of ants in the investigated areas by means of bycatch data. In North Rhine-Westphalia, where only very few myrmecologists are engaged in faunistical field work, bycatch analyses already resulted in a considerable improvement of ant data during the past 15 years (SONNENBURG & SONNENBURG 2008). Consequently, together with the present study, we can confirm that an analysis of bycatch data is most valuable and should therefore be integrated in further pitfall trap studies.

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Zusammmenfassung

Bodenfallenfänge von Ameisen an Trockenstandorten Nordrhein-Westfalens. – Faunistische Erfassungen von Ameisen werden im Allgemeinen nur selten durchgeführt. Die Auswertung von Beifängen aus Bodenfallen ist daher eine gute Möglichkeit, den Datenbestand zu verbessern. In 11 Untersuchungsgebieten wurden insgesamt 25 Probeflächen von August 2006 bis Juli 2008 mit Barberfallen befangen. Die Erfassung ergab 27 Arten aus 5.021 Individuen (4.798 Arbeiterinnen und 223 Gynen). *Formica sanguinea* war die häufigste Art, weiterhin häufig waren *Myrmica sabuleti*, *M. ruginodis* und *Lasius niger*. 13 Arten werden in der Roten Liste Nordrhein-Westfalens geführt. Faunistisch interessant waren die Funde von *Myrmica lonae, Tapinoma ambiguum* und *F. truncorum*. Die Ergebnisse zeigen, dass die Auswertung der Beifänge zu einer deutlichen Verbesserung des Datenbestandes in Nordrhein-Westfalen geführt hat. Die vorliegende Studie belegt somit die Wichtigkeit von Beifangauswertungen, die in zukünftigen Bodenfallenstudien berücksichtigt werden sollten.

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Anschriften der Verfasser:

Patrick Dolle
AG Biozönologie
Institut für Landschaftsökologie
WWU Münster
Robert-Koch-Str. 26
D-48149 Münster
E-Mail: p.dolle@uni-muenster.de

Sascha Buchholz
FG Biodiversitätsdynamik
Institut für Ökologie
TU Berlin
Rothenburgstr. 12
D-12165 Berlin
E-Mail: sascha.buchholz@tu-berlin.de

Holger Sonnenburg
Biologische Station Lippe
Domäne 2
D-32816 Schieder-Schwalenberg
E-Mail: h.sonnenburg@biologischestationlippe.de