

Prey Use in two Sympatric Species of the Digger wasp Genus *Bembecinus* (Hymenoptera: Apoidea: Sphecidae)

PAMELA ZOLDA & WERNER E HOLZINGER

Received: 2002-07-15 / 2002-07-30

Accepted: 2002-08-01

ZOLDA P & HOLZINGER W E [Inst Ecol, Univ Vienna, A-1090 Vienna /Austria]: **Prey Use in two Sympatric Species of the Digger wasp Genus *Bembecinus* (Hymenoptera: Apoidea: Sphecidae).**- Entomol Gener 26(2): 101-106; Stuttgart 2002-08. --- [Note]

Prey use and prey spectrum in the sympatric digger wasps *Bembecinus hungaricus* (Frivaldzky 1876) and *B. tridens* (Fabricius 1781) was investigated by field studies in north eastern Austria. Both species hunted for adult leafhoppers, mainly of the family Cicadellidae. Both wasp species prey upon leafhoppers of the same body size. Comparison of prey taxa demonstrated little overlap in prey utilization. Significant differences in the choice of prey species resulted from different hunting habitats: *B. hungaricus* shows a preference for arboricolous leafhopper species, while *B. tridens* mainly provisioned with pratricolous taxa. No significant sexual bias of prey was observed.

Key words: *Bembecinus hungaricus* (Frivaldzky 1876) - *Bembecinus tridens* (Fabricius 1781) - prey spectrum - host plants

ZOLDA P & HOLZINGER W E [Inst Ökol, Univ Wien, A-1090 Wien]: **Beutewahl zweier sympatrisch auftretender Arten der Grabwespen-Gattung *Bembecinus* (Hymenoptera: Apoidea: Sphecidae).**- Entomol Gener 26(2): 101-106; Stuttgart 2002-08. --- [Mitteilung]

Das Beutespektrum und die Beutewahl von zwei sympatrisch lebenden Grabwespen-Arten *Bembecinus hungaricus* (Frivaldzky 1876) und *Bembecinus tridens* (Fabricius 1781) im östlichen Niederösterreich wird dokumentiert. Beide Arten tragen adulte Zikaden ähnlicher Größe ein, die hauptsächlich zur Familie Cicadellidae gehören. Das Beutespektrum der Arten überschneidet sich kaum. Signifikante Unterschiede in der Beutewahl ergaben sich durch die Nutzung von unterschiedlichen Jagdplätzen: *B. hungaricus* erbeutet hauptsächlich arborikole Zikadenarten von Laubbäumen, während *B. tridens* die Brut vornehmlich mit pratricolen Arten der nahen Wiesenflächen versorgte. Präferenzen für ein bestimmtes Geschlecht der Beutetiere wurden nicht ermittelt.

Schlüsselbegriffe: *Bembecinus hungaricus* (Frivaldzky 1876) - *Bembecinus tridens* (Fabricius 1781) - Beutespektrum - Futterpflanzen

1 Introduction

Digger wasps feed in their larval stage on insects or spiders. Adults, which mainly consume nectar, are predatory in that they hunt to provide their offspring. When foraging, the female wasps are more or less prey specific. The existence of distinct prey preferences among sympatric species is interpreted as the result of spatial variation between populations, spatial and temporal variability in prey availability, phylogenetic relationship or even competitive exclusion [O'NEILL & EVANS 1982; O'NEILL 2001].

This study is to describe the prey spectrum of the digger wasp species, *Bembecinus hungaricus* (Frivaldzky 1876) and *B. tridens* (Fabricius 1781), occurring sympatrically on sand dunes in Lower Austria. Its further objective is to investigate the prey use of these two species, with special regard to taxonomic category, host plants and sex ratio.

Bembecinus tridens is reported from several locations northeast of Vienna [WIESBAUER & MAZZUCO 1997; DOLLFUSS 1991; ZETTEL 2000], whereas the investigated population of *B hungaricus* is the only one reported for Austria. *B hungaricus* forms dense aggregations at sites with bare and friable sand [ZOLDA et al 2001]. Some specimens of *B tridens* nest solitarily in close proximity to such *B hungaricus*-pseudocolonies, but most individuals form small aggregations on sandy ground with a vegetation coverage up to 50%. In general, each *Bembecinus* species shows only little diversity in activity, burrow construction and provisioning behavior [LÜPS 1973; KARSAI 1989]. Like other members of the genus, *B hungaricus* and *B tridens* practice progressive provisioning with leafhoppers, in which prey is provided over an extended period of time and the offspring pass through several larval instars before the final prey item is presented and the cell sealed. Prey records for *B tridens* have been published by GRANDI [1930] and LÜPS [1969].

2 Material and Methods

The study was carried out in summer 1998 and 1999 on sand dunes along the March River near the village Drösing, about 65 km north of Vienna. The wasps nested within a 20 ha large site that is dominated by *Pinus sylvestris*. The major vegetation of a clear-cut of 5 ha within the pine stand consists of the grasses *Calamagrostis epigejos* and *Corynephorus canescens*. Open, sandy habitats are only found along forest roads and within an adjacent sandpit. Three neighboring habitats, where both wasp species were found nesting, were investigated: a 5 m² plot of a sandy road next to a pine forest, a 10 m² plot of bare sand in the middle of a grassland and a 150 m² sand pit surrounded by young trees of various *Populus* and *Salix* species. Further descriptions of the sites are given by ZOLDA [2001].

Samples of the prey were obtained by taking the leafhoppers from marked female wasps as they returned from foraging flights. The completely paralyzed prey items were coded and identified. Differences in the range of prey species were examined by Chi-square test and Spearman's rank correlation.

3 Results

3.1 Prey taxon

Together, these two species used members (4 to 8 mm long) of 24 Auchenorrhyncha species of 5 families (Cixiidae, Delphacidae, Tropiduchidae, Cercopidae, Cicadellidae). In addition, two Psyllidae (Sternorrhyncha) were recorded as prey of *B hungaricus*. A complete species list and number of all leafhoppers taken by *B hungaricus* and *B tridens* and their host plants is shown in Tab 1. The Chi-square value for the comparison of the wasps' prey species was 37,53 (df=1), which was significant at a level well below 0.001. The taxonomic niche overlap value of prey species using the MacArthur-Levins formula (LAWLOR, 1980) for *B hungaricus* / *B tridens* was 0.043.

3.2 Source of prey

The use of leafhoppers differed significantly between the two *Bembecinus* species. *B hungaricus* provisioned its offspring with arboricolous leafhoppers that feed on tree foliage, whereas *B tridens* preyed upon grass feeding species (Tab 2). Most of the prey species are mono- or oligophagous (Fig 1). 69 % of the *B hungaricus* prey feed on *Populus*, *Salix* and *Alnus* trees of the floodplain forest along the March River. Poplars and willows occurred in various growth forms: large trees along the water course, smaller trees and shrubs smaller than 1.5 m provided optimal conditions for leafhoppers. *B hungaricus* mainly collected prey species that feed exclusively on deciduous trees, although coniferous trees like *Pinus sylvestris* were abundant nearby.

Tab 1: Generic prey records and their hostplants for prey of two sympatric *Bembecinus* species occurring at Drösing / Lower Austria [Hymenoptera: Sphecidae]

Species	Family	Host plant	No of individuals caught by	
			<i>B hungaricus</i> N=69	<i>B tridens</i> N=25
<i>Idiocerus stigmatalis</i> Lewis 1834	Cicadellidae	<i>Salix</i> spp	28	1
<i>Oncopsis alni</i> (Schrank 1801)	Cicadellidae	<i>Alnus</i> spp	6	3
<i>Populicerus albicans</i> (Kbm 1868)	Cicadellidae	<i>Populus alba</i>	6	
<i>Iassus laniio</i> (von Linné 1761)	Cicadellidae	<i>Quercus</i> spp	6	
<i>Allygus modestus</i> Scott 1876	Cicadellidae	deciduous trees	5	
<i>Euides speciosa</i> (Boheman 1845)	Delphacidae	<i>Phragmites australis</i>	3	
<i>Populicerus populi</i> (von Linné 1761)	Cicadellidae	<i>Populus tremula</i>	3	
<i>Macropsis graminea</i> (Fabricius 1798)	Cicadellidae	<i>Populus nigra</i>	3	
<i>Rhytidodus decimus-quartus</i> (Schrank 1776)	Cicadellidae	<i>Populus nigra</i>	2	
Sternorrhyncha: Psyllidae, indet			2	
<i>Metidiocerus elegans</i> (Flor 1861)	Cicadellidae	<i>Salix</i> spp	1	
<i>Kybos populi</i> (Edw 1908)-group	Cicadellidae	<i>Populus</i> spp	1	
<i>Allygidius abbreviatus</i> (Leth 1878)	Cicadellidae	herbs and deciduous trees	1	
<i>Allygus mixtus</i> (Fabricius 1794)	Cicadellidae	deciduous trees	1	
<i>Aphrodes bicinctus</i> (Schrank 1776)-group	Cicadellidae	grasses, herbs	1	1
<i>Cixius cunicularius</i> (von Linné 1767)	Cixiidae	shrubs, deciduous trees		1
<i>Doratura impudica</i> Horváth 1897	Cicadellidae	<i>Calamagrostis niveolis</i>		1
<i>Doratura stylata</i> (Boheman 1847)	Cicadellidae	grasses		1
<i>Cicadula</i> sp indet	Cicadellidae			1
<i>Errastunus ocellaris</i> (Fallén 1806)	Cicadellidae	grasses		2
<i>Macropsis fuscula</i> (Zetterstedt 1828)	Cicadellidae	<i>Rubus</i> spp		2
<i>Trypetimorpha occidentalis</i> Huang & Bourgoin 1993	Tropiduchidae	<i>Stipa</i> spp		2
<i>Neophilaenus lineatus</i> (Linnaeus 1758)	Cercopidae	grasses		3
<i>Philaenus spumarius</i> (Linnaeus 1758)	Cercopidae	grasses, herbs		7

B. tridens captured its prey in open and dry meadow habitats within the clear cut. Prey specialization by several individuals was observed: *B. hungaricus* females (N=16) provisioned to 38 % with a single species of prey and 25 % with two species of prey. Three *B. tridens* females were observed provisioning with a single species of prey over a period of two weeks and even successive nests of individual wasps were provisioned with the same species of prey. The sex ratio of the leafhoppers was determined from a sample of 67 leafhoppers for *B. hungaricus* and of 25 leafhoppers for *B. tridens* (Tab 2) and no sexual bias of the prey was observed for either wasp species.

Tab 2: Location and sex of prey for two species of the digger wasp genus *Bembecinus* occurring at Drösing / Lower Austria [Hymenoptera: Sphecidae].

Prey of	Arboricolous	Praticolous	Female	Male
<i>B. hungaricus</i> (Grivaldsky 1876) N=67	63	4	46	21
<i>B. tridens</i> (Fabricius 1781) N=25	5	20	13	12

A correlation between availability of host plants around the study sites (100 m radius) and the species of prey was only found in the case of reed-feeding taxa ($r_s = 0.968$; $p < 0.01$; $N = 20$). Thus the main prey spectrum is independent from the vegetation around the wasp's nesting sites and the females don't seem to bother travelling longer distances with prey.

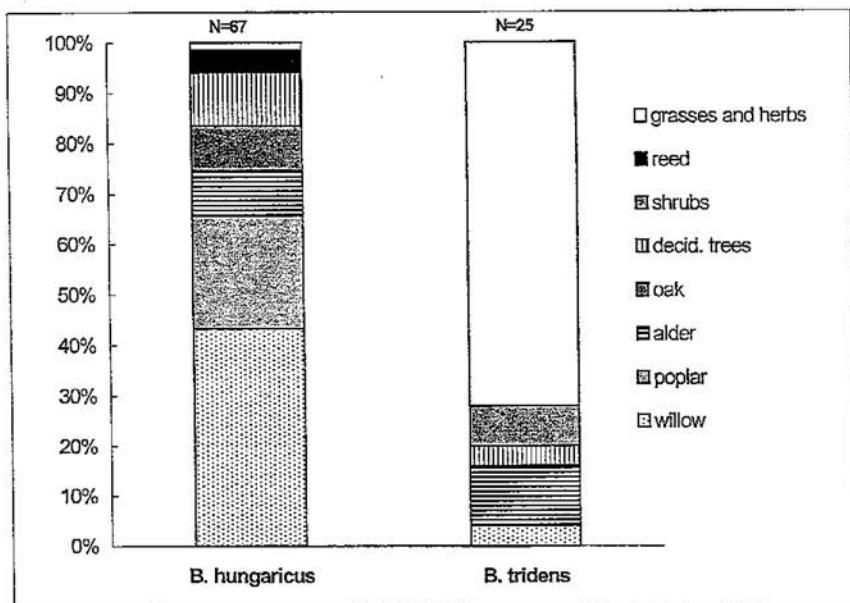
4 Discussion

The genus *Bembecinus* is known to prey upon Homoptera. Some species are specialized on Cicadellidae [EVANS 1955; O'NEILL & EVANS 1986], some use a variety of homopteran families [EVANS & O'NEILL 1986], and two South African species even take Diptera as prey [GESS & GESS 1975]. Like *B. quinquespinosus* and *B. agilis* [EVANS & O'NEILL 1986], *B. hungaricus* seems to be specialized on the family Cicadellidae. This results in little taxonomic niche overlap with *B. tridens*, that captured Homoptera of four families. Other published records confirm the variety of prey use in this species [GRANDI 1930; EVANS 1955; LÜPS 1969].

To find their prey, digger wasps make restricted searches in particular habitats where prey may occur, and some species may search first for conspicuous landmarks associated with prey, such as host plants [O'NEILL 2001].

B. hungaricus exclusively hunted at sites where young trees of poplars and willows were abundant. Coniferous trees, although nearby, were clearly not utilized by the wasps. One explanation might be the position of the crown region of *Pinus sylvestris* in approximately 4 m height. No specimen of *Bembecinus* in Drösing was seen flying higher than 2 m and we assume that the wasps hunt primarily in lower tree regions or small trees.

Fig 1: Host plants of leafhopper prey taken by *Bembecinus hungaricus* and *B. tridens* [Hymenoptera: Sphecidae].- Grasses and herbs mainly refer to *Calamagrostis epigejos*; decid. trees pertain to leafhopper species, that are polyphagous on a wider range of deciduous trees including oak, alder, willow and poplar.



The hunting sites of *B. tridens* were dry habitats and meadows. The dry character of such habitats was underlined by the presence of *Trypetimorpha occidentalis*, a leafhopper feeding on *Stipa* spp.. The host plants of the leafhoppers preyed upon correspond with the chosen hunting sites of both wasps: *B. hungaricus* exclusively took prey feeding on hardwoods, whereas *B. tridens* preferred leafhoppers feeding on various grasses.

Female wasps can learn locations with high prey availability very well and are thus able to find a prey item very reliably, a behavior which would optimize utilization of spatially separated prey populations [STROHM & LINSSENMAIR 1998]. The present results support this: 6 out of 10 investigated females of *B. hungaricus* favored one distinct prey species, and *B. tridens* provisioned successive nests with a single species of prey [see also GRANDI 1930]. In fact, the individuals of both species are at least temporarily specialized, while the population has a broad spectrum of prey species. Female wasps should prefer female prey items because of their higher nutritional content [HASTINGS 1986]. No preference for either sex of leafhoppers was observed in both *Bembecinus* species.

Although the taxonomic category of prey is only one qualitative aspect of prey use between species [O'NEILL & EVANS 1982] and sample size, variations across seasons can influence the prey spectrum, *B. hungaricus* and *B. tridens* partially seem to partition their prey niche by utilizing different hunting habitats.

5 References

- DOLLFUSS H [1991]: Bestimmungsschlüssel der Grabwespen Nord- und Zentraleuropas (Hymenoptera, Sphecidae), mit speziellen Angaben zur Grabwespenfauna Österreichs.- *Stapfia* 24: 001-247; Linz / Österreich.
- EVANS H E [1955]: An ethological study of the digger wasp *Bembecinus neglectus*, with a review of the ethology of the genus.- *Behavior* 7: 287-303; Nederland.
- EVANS H E & O'NEILL . [1986]: Reproductive and nesting biology of *Bembecinus nanus strenuus* (Mickel) (Hymenoptera, Sphecidae).- *Proc Entomol Soc Wash.* 88(4): 628-633; Washington, DC / USA.
- GESS F W & GESS S K [1975]: Ethological studies of *Bembecinus cinguliger* (Smith) and *B. oxydorcus* (Handl.) (Hymenoptera: Sphecidae), two southern African turret building wasps.- *Ann Cape Prov Mus (Nat Hist)* 11(2): 21-46; South Africa.
- GRANDI G [1930]: Contributi alla conoscenza biologica e morfologica degli Imenotteri Melliferi e Predatori.- *XI Boll Lab Ent Bologna* 3: 310-316. Bologna / Italia.
- HASTINGS J [1986]: Provisioning by female western cicada killer wasps, *Sphecius grandis* (Hymenoptera: Sphecidae) -. Influence of body size and emergence time on individual provisioning success.- *J Kans Entomol Soc* 59(2): 262-268; Lawrence / USA.
- KARSAI I [1989]: Factors affecting diurnal activities of solitary wasps (Hymenoptera: Sphecidae and Pompilidae).- *Entomol Gener* 14(3/4): 223-232; Schweizerbart, Stuttgart / Deutschland.
- LAWLOR L R [1980]: Overlap, similarity, and competition coefficients.- *Ecology* 61(2): 245-251; Washington, DC / USA.
- LÜPS P [1969; 1966-1968]: Die Grabwespe *Bembecinus tridens* (Fabricius) (Hymenoptera, Sphecidae).- *Jahrbuch Naturhist Mus Stadt Bern* 3: 201-215, 1pl; Bern / Schweiz.
- LÜPS P [1973]: Beobachtungen an *Bembecinus tridens* (Fabricius) (Hymenoptera, Sphecidae).- *Mitt Schweiz Entomol Ges* 46: 131-139; Zürich / Schweiz.
- O'NEILL K M & EVANS H E [1982]: Patterns of prey use in four sympatric species of *Philanthus* (Hymenoptera: Sphecidae) with a review of prey selection in the genus.- *J Nat Hist* 16: 791-801; London / Britain.
- O'NEILL K [2001]: Solitary wasps: behavior and natural history.- Cornell University Press, USA [406 pp], New York / USA
- STROHM E & LINSENMAIR E [1998]: Temperature dependence of provisioning behaviour and investment allocation in the European beewolf *Philanthus triangulum* F.- *Ecol Entomol* 23: 330-339; Oxford / Britain.
- WIESBAUER H & MAZZUCCO K [1997]: Dünen in Niederösterreich. Ökologie und Kulturgeschichte eines bemerkenswerten Landschaftselementes.- *Fachberichte des NÖ Landschaftsfonds Nr 6/97. St Pölten* [90 pp]. Eigenverlag NÖ Landesregierung St Pölten / Österreich.
- ZETTEL H [2000]: Seltene und bemerkenswerte Grabwespen (Hymenoptera: Spheciformes) aus Österreich.- *Beitr Entomofaunistik* 1: 19-33; Eigenverlag NHM Wien / Österreich.
- ZOLDA P, ORTEL J & WAITZBAUER W [2001]: Observations on the nesting behaviour of the digger wasp *Bembecinus hungaricus* in Austria (Hymenoptera: Sphecidae).- *Entomol Gener* 25(2): 107-114; Schweizerbart, Stuttgart / Deutschland.
- ZOLDA P [2001]: The behaviour and ecology of *Bembecinus hungaricus* Friv. (Hymenoptera: Sphecidae) in Austria.- *Beitr Entomofaunistik* 2: 03-14; Eigenverlag NHM Wien / Österreich.

Acknowledgements: The authors wish to thank Jürgen Herler for his help during field work and Irene Zweimüller for her help with statistics. The research was supported by a grant from the University of Vienna (PZ) and an APART grant of the Austrian Academy of Science (WH).

Anschriften der Verfasser: Dr Pamela Zolda, Institut für Ökologie und Naturschutz, Universität Wien, Althanstraße 14, A-1090 Wien, Österreich. Dr Werner Holzinger, Oekoteam - Institut für Faunistik und Tierökologie, Bergmannsgasse 22, A-8010 Graz, Österreich.