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Non-random Size Differences between Sympatric Species of the Ant Genus *Leptothorax* (Hymenoptera: Formicidae)

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In temperate and boreal forests, ants of the widely distributed genus *Leptothorax* may occur in extremely high densities. In most areas, two, occasionally three or more species nest in close proximity. It appears that competition between sympatric species is minimized by morphological differences. Workers from 15 sympatric species pairs differed more strongly in caput width than randomly chosen pairs of allopatric species. Co-occurring species also differed considerably in thorax length. In *Leptothorax* communities, nest sites rather than food are thought to be the most limited resource. In two pairs of species nesting in preformed cavities in wood, non-random size differences indeed were positively correlated with differences in the average volume of the nest site. Competition for nest sites might therefore influence individual size of *Leptothorax* species.

Key words: *Leptothorax* Mayr 1855 - *Leptothorax (Myrafant)* Smith 1950 - Myrmicinae - body size - character displacement - interspecific competition

FOITZIK S & HEINZE J [Inst Zool I, Univ Erlangen-Nürnberg, D-91058 Erlangen]: Größenunterschiede zwischen sympatrischen Arten der Ameisengattung *Leptothorax* (Hymenoptera: Formicidae).- Entomol Gener 24(2): 065-074; Stuttgart 1999-08. - - - [Abhandlung]

Ameisen der weitverbreiteten Gattung *Leptothorax* können in Wäldern der gemäßigten und borealen Zone extrem hohe Nestdichten erreichen. In den meisten Gegenden kommen dabei zwei, gelegentlich drei oder mehr Arten auf engem Raum nebeneinander vor. Zwischenartliche Konkurrenz scheint durch morphologische Unterschiede vermieden zu werden. Arbeiterinnen von 15 sympatrisch vorkommenden Artpaaren unterschieden sich in ihrer Caput-Breite signifikant stärker als Paare allopatrischer Arten. Sympatrische Arten waren auch in der Thorax-Länge stärker unterschiedlich. Für *Leptothorax*-Species scheinen Nistmöglichkeiten stärker limitierend zu sein als Nahrung. Bei zwei Paaren sympatrisch vorkommender, holzbewohnender Arten waren Unterschiede in der Körpergröße mit Unterschieden im mittleren Volumen der Nistmöglichkeit korreliert. Konkurrenz um Nistmöglichkeiten könnte daher die Unterschiede in der Körpergröße zwischen sympatrischen *Leptothorax*-Species erklären.

Schlüsselbegriffe: *Leptothorax* Mayr 1855 - *Leptothorax (Myrafant)* Smith 1950 - Myrmicinae - interspezifische Konkurrenz - Kontrastbetonung - Körpergröße

1 Introduction

Ant species of the genus *Leptothorax* Mayr 1855 occur in most major biogeographical regions [BOLTON 1994]. In boreal and temperate woodlands, populations of species belonging to the subgenera *Leptothorax* (*Leptothorax*) Smith 1950 and *L* (*Myrafant*) Smith 1950 may be extraordinarily dense, and locally more than 10 nests per m² can be found [FOITZIK & HEINZE 1998]. *Leptothorax* workers are typically inconspicuous and forage solitarily for small insect prey, honey dew, nectar etc. When encountering larger, more aggressive ants, such as *Formica* or *Lasius*, they behave submissively [DOBRZANSKI 1966, SEIFERT 1986, SAVOLAINEN & VEPSÄLÄINEN 1989].

In many habitats, several *Leptothorax* species co-occur in close proximity [SEIFERT 1986], but little is known about whether and how they compete. Indirect evidence suggests competition for nest sites both within [HERBERS 1986, HEINZE et al 1996, FOITZIK & HEINZE 1998] and between species [BRIAN 1952, SEIFERT 1986, YAMAGUCHI 1992, HERBERS & BANSCHBACH 1995]. Field and laboratory studies directly aimed at the detection of competition in *Leptothorax* gave surprisingly different results. Whereas in the field, European *L acervorum* and *L nylanderi* gently carried conspecific intruders away from their own nests [DOBRZANSKI 1966, HEINZE et al 1996], colonies of Nearctic *Leptothorax* (s.str.) were observed to engage in deadly combat with their neighbors in arena experiments [ALLOWAY 1980, STUART & ALLOWAY 1982, 1983].

Selection to avoid competition between closely related species which live in the same habitat and use similar resources often leads to striking differences in overall morphology or at least in certain morphological traits of the respective species [HUTCHINSON 1959]. Sympatric species diverge more strongly in size than randomly chosen pairs of allopatric species. For example, sympatric bird-eating hawks were found to differ considerably in body size and presumably also in their feeding preferences [SCHOENER 1984], and in desert seed-harvesting ants, sympatric species differed either in their foraging strategy or in worker size, which again was correlated with seed size [DAVIDSON 1977].

Though six or more *Leptothorax* species have been collected in certain areas, rarely more than two species can be found utilizing the same microhabitat. For example, of six *Leptothorax* species living in an oak-pine forest in Sommerhausen near Würzburg, only two commonly occur in rotting wood in the leaf litter. Two other species were restricted to the hottest and coldest parts of the forest, respectively, and two species were strictly arboreal and presumably did not compete with the litter dwelling species [HEINZE et al 1996]. Similarly, in many other habitats, only two *Leptothorax* commonly use the same microhabitat (e.g., *L (M) longispinosus* and *L (M) ambiguus* in New England [HERBERS 1989]; *L (s.str) acervorum* and *L (s.str) muscorum* in Palaearctic coniferous forests [LIPSKI et al 1992]; *L (s.str) sp A* and *L (s.str) cf canadensis* in Quebec [HEINZE 1993]).

According to field observations, workers of sympatric species pairs of *Leptothorax* often differ conspicuously in size (e.g., the "large black" and "small brown" *Leptothorax* (s.str) in North America [BUSCHINGER 1982, HEINZE 1989]). This study is to examine in more detail whether thorax length and caput width of sympatric *Leptothorax* diverge more strongly than expected and investigate whether competition for nest sites might be the ultimate cause for size differences.

2 Material and methods

Complete colonies of syntopic pairs of *Leptothorax* species were collected with an aspirator from their nests in wood, rock crevices, hollow acorns, etc in 15 collecting sites in North America, Europe, and Asia (Tab 1). Several species appear more than once in Tab 1 because in different localities they live in sympatry with different species.

Thus, *L acervorum* and *L nylanderi* are included three times, *L unifasciatus*, *L retractus*, *L* sp-A and *L recedens* twice each; the total number of different species examined therefore is 22. Mean worker sizes were determined separately for each population. In each species and population, caput width and thorax length was determined in up to 40 workers from as many different colonies as available (5 - 40). Only colonies which contained more than 15 workers when collected were included to eliminate 'minims', i.e., the small workers which are produced by queens during colony founding.

Tab 1: Collection site, mean and standard deviation of caput width and thorax length of workers from co-occurring species of the ant genus *Leptothorax* Mayr 1855 [Hymenoptera: Formicidae]. The statistical significance of size differences between sympatric species was determined by two-tailed t-tests and corrected according to Bonferroni. The degrees of freedom in the t-tests equal the sum of the number of workers examined in both species minus 2.

Location	Species	N	Caput width ± SD [mm]	t-test	Thorax length ± SD [mm]	t-test
Nürnberg Reichswald, Bavaria, Germany	<i>L (s.str) muscorum</i>	40	0.549 ± 0.023	t = -21.2	0.791 ± 0.026	t = -31.7
	<i>L (s.str) acervorum</i>	40	0.678 ± 0.031	p < 0.0001	1.038 ± 0.042	p < 0.0001
	<i>L (M) unifasciatus</i>	40	0.557 ± 0.028	t = -1.82	0.768 ± 0.038	t = -3.4
	<i>L (M) nigriceps</i>	40	0.570 ± 0.033	p = ns	0.797 ± 0.039	p < 0.02
	<i>L (M) nylanderi</i>	40	0.584 ± 0.032	t = -12.0	0.766 ± 0.036	t = -23.2
	<i>L (s.str) gredleri</i>	40	0.662 ± 0.026	p < 0.0001	0.967 ± 0.041	p < 0.0001
	<i>L (M) affinis</i>	40	0.660 ± 0.025	t = -14.5	0.905 ± 0.037	t = -14.5
	<i>L (M) corticalis</i>	40	0.578 ± 0.025	p < 0.0001	0.790 ± 0.034	p < 0.0001
	<i>L (M) nylanderi</i>	40	0.582 ± 0.027	t = -20.2	0.734 ± 0.041	t = -32.1
	<i>L (s.str) acervorum</i>	40	0.715 ± 0.032	p < 0.0001	1.034 ± 0.043	p < 0.0001
Maligne Canyon, Alberta, Canada	<i>L (s.str) species C¹</i>	40	0.563 ± 0.019	t = -10.3	0.803 ± 0.030	t = -10.4
	<i>L (s.str) retractus</i>	40	0.634 ± 0.020	p < 0.0001	0.869 ± 0.026	p < 0.0001
	<i>L (s.str) species A¹</i>	20	0.560 ± 0.023	t = -9.7	0.783 ± 0.027	t = -10.2
	<i>L (s.str) retractus</i>	12	0.631 ± 0.014	p < 0.0001	0.876 ± 0.021	p < 0.0001
	<i>L (s.str) species A¹</i>	40	0.571 ± 0.021	t = -13.8	0.815 ± 0.039	t = -11.8
	<i>L (s.str) canadensis</i>	40	0.650 ± 0.030	p < 0.0001	0.932 ± 0.049	p < 0.0001
	<i>L (M) cf. exilis</i>	16	0.476 ± 0.024	t = -9.9	0.676 ± 0.040	t = -13.6
	<i>L (T) recedens</i>	40	0.546 ± 0.024	p < 0.0001	0.827 ± 0.036	p < 0.0001
	<i>L (M) species I</i>	40	0.519 ± 0.026	t = -11.9	0.733 ± 0.035	t = -13.6
	<i>L (M) species II</i>	29	0.593 ± 0.025	p < 0.0001	0.850 ± 0.036	p < 0.0001
Mount Monadnock, New Hampshire, USA	<i>L (T) recedens</i>	40	0.552 ± 0.025	t = -10.6	0.777 ± 0.055	t = -18.5
	<i>L (M) unifasciatus</i>	40	0.620 ± 0.031	p < 0.0001	0.975 ± 0.040	p < 0.0001
	<i>L (M) ambiguus</i>	40	0.505 ± 0.031	t = -16.2	0.653 ± 0.036	t = -13.6
	<i>L (M) longispinosus</i>	40	0.598 ± 0.019	p < 0.0001	0.766 ± 0.038	p < 0.0001
	<i>L (M) parvulus</i>	40	0.508 ± 0.037	t = -14.1	0.658 ± 0.046	t = -13.8
Güllüce, Bursa, Turkey	<i>L (M) nylanderi</i>	40	0.611 ± 0.027	p < 0.0001	0.794 ± 0.043	p < 0.0001
	<i>L (M) rugatulus</i>	40	0.535 ± 0.033	t = -14.1	0.766 ± 0.042	t = -16.8
	<i>L (s.str) species F¹</i>	40	0.634 ± 0.029	p < 0.0001	0.971 ± 0.064	p < 0.0001
	<i>L (M) slavonicus</i>	40	0.606 ± 0.026	t = -20.1	0.810 ± 0.036	t = -30.1
Chiricahua Mts., Arizona, USA	<i>L (s.str) acervorum</i>	40	0.732 ± 0.030	p < 0.001	1.077 ± 0.043	p < 0.001

¹ Species of the *Leptothorax* 'muscorum' complex in North America [HEINZE 1989]

Measurements were taken at 40x magnification under a binocular microscope. Caput width was measured in frontal view directly behind the eyes. For the definition of thorax length see [HEINZE & BUSCHINGER 1987]. The statistical significance of the size difference between sympatric species was tested with t-tests. The p-values were corrected for multiple-testing using the Bonferroni-method.

We further investigated whether sympatric species differed more in size than expected using a procedure described by SCHOENER [1984]: A species pool was formed from the mean worker sizes of each species. For species investigated in several populations, only one mean size was used, chosen at random from the three populations studied. From this species pool, the size ratio of the larger and the smaller species was calculated for all sympatric and allopatric species combinations. In this way a null distribution was generated, which then was compared with the distribution of size differences of actually found pairs of sympatric species with a Kolmogorov-Smirnov two-sample test.

To determine the direction of the difference between the null distribution and the distribution of empirically found values, we counted how many empirical ratios were above and below the median of the null distribution. The significance of the deviation of the observed frequency of values above and below the median from an equal distribution of values was tested with a two-tailed Fisher's exact test. We did not use a χ^2 -test as suggested by SCHOENER [1984] because of the smaller sample size of $N = 15$.

The size of nest sites was determined in two sympatric species pairs of *Leptothorax*, which inhabit cavities in fallen branches, pieces of bark, acorns, grass stems, etc. As a measure of size, the approximate volume V of the complete nest site was crudely estimated from its diameter r and its length l , assuming that nest sites are more or less cylindrical in shape ($V = \pi r^2 l$). The volume of the nest cavity was not measured itself, because workers are capable of enlarging the typically preformed nest cavity to some extent [A BUSCHINGER, pers comm]. Nest volume is therefore a constantly changing parameter. All four investigated species occasionally nest under bark at the foot of living trees and in tree stumps. However, when we investigated the size of inhabited nest sites we did not find colonies in these places, though they were thoroughly searched.

3 Results

Mean thorax length and caput width of the investigated *Leptothorax* and the standard errors of the means are given in Tab 1. With one exception (caput width of *L unifasciatus* and *L nigriceps*), thorax length and caput width differed considerably between workers of sympatric species pairs. The empirically found distribution of ratios of caput widths of sympatric species pairs was significantly different from the null distribution of size ratios from all possible pairs of studied species (Fig 1a, Kolmogorov-Smirnov test, $D = 0.475$, $P < 0.01$, $n_1 = 15$, $n_2 = 286$).

The observed median ratio was 1.14, i.e., the heads of workers from the larger of two sympatric species were on average 14% wider than those of workers from the smaller species. Of a total of 15 found caput width ratios of sympatric species pairs of *Leptothorax*, 14 were larger than the median of the null distribution (1.11) and only one was smaller. The null hypothesis that the observed size ratios are randomly distributed was therefore rejected (two-tailed Fisher's exact test: $P < 0.02$).

The observed and expected distributions of ratios of thorax lengths of sympatric species did not differ significantly (Fig 1b, Kolomogorov-Smirnov-test, $D = 0.304$, $P > 0.05$, $n_1 = 15$, $n_2 = 286$). Nevertheless, three of the 15 empirical ratios were smaller than the median of the null distribution (1.14) and 12 were larger (Fisher's exact test, two-tailed: $P = 0.14$). The median ratio of thorax lengths of workers from sympatric species pairs was 1.21.

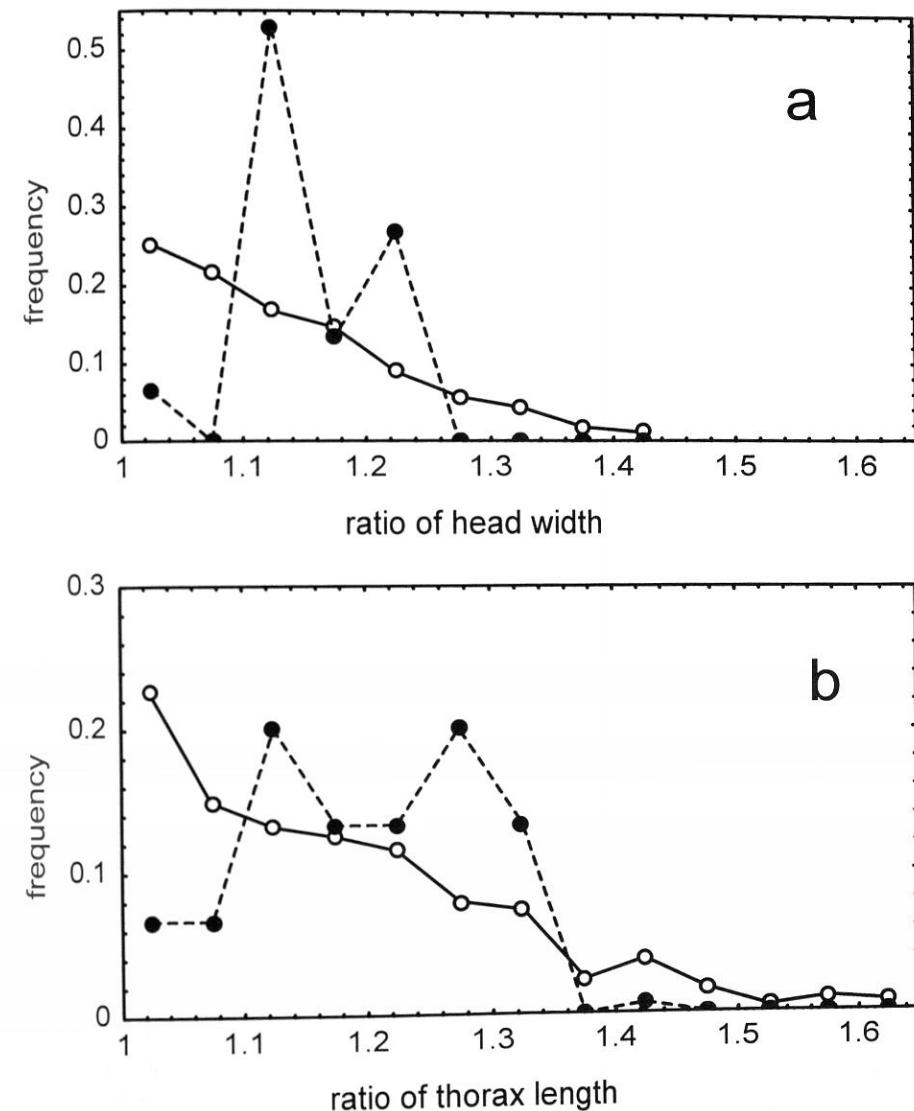


Fig 1: Frequency distribution of the ratios of caput width (a) and thorax length (b) between workers from two sympatric ant species of the genus *Leptothorax* Mayr 1855 from 15 localities (---, $n = 15$), and the expected frequency distribution (—, $n = 286$) [Hymenoptera: Formicidae].- For the expected distribution, the ratios of workers were calculated for all sympatric and allopatric pairs of examined species. The distributions differ significantly in caput width (a: Kolmogorov-Smirnov test: $p < 0.01$), but not in thorax length (b: Kolmogorov-Smirnov-test, $p > 0.05$).

In the two localities where the size of nest sites were investigated, the larger species on average inhabited nest sites with a significantly larger volume (Mann-Whitney U-test: Sommerhausen: *L gredleri* vs *L nylanderii*, $U=2417.0$, $P < 0.008$; $n_1=300$, $n_2=24$; Nürtinger Reichswald: *L acervorum* vs *L muscorum*, $U=203.0$, $P < 0.0001$, $n_1=21$, $n_2=54$; Fig 2).

In both sites there was considerable overlap of nest sizes used by the respective species. In *L. gredleri* (24 colonies) and *L. nylanderi* (300 colonies), colony size (number of workers) was positively correlated with nest size (*L. gredleri*: Spearman rank-test: $r_s = 0.75$, $p < 0.0001$, for *L. nylanderi* see [FOITZIK & HEINZE 1998]). In an interspecific comparison, nest site volume was found to be influenced strongly by colony size but less so by species (two-way ANOVA: colony size: df 4, $p < 0.0001$; species: df = 1, $p < 0.08$). This might be due to the limited amount of data for *L. gredleri*.

4 Discussion

Workers of sympatric species of the ant genus *Leptothorax* appear to be considerably more different in caput width than expected from the distribution of size ratios of all investigated species. The heads of workers of the larger of two sympatric species were typically 1.1 - 1.2 times as wide as heads of workers from the smaller species. Sympatric species also differed slightly, but not significantly more than expected in thorax length: the thorax of workers of the larger species was from 1.1 - 1.4 times longer than the thorax of the smaller species.

The here presented results are reminiscent of the suggestion by HUTCHINSON [1959] that pairs of related, sympatric species often differ strongly in size. This hypothesis has repeatedly been corroborated using appropriate statistics [SCHOENER 1984, DAYAN et al 1990, 1989, DAYAN & SIMBERLOFF 1994], though the claim that a minimal size ratio of approximately 1.3 is necessary to enable two species to co-occur in different niches but at the same level of a food-web [HUTCHINSON 1959] has been refuted [SIMBERLOFF & BOECKLEN 1981, ROTH 1981, SCHOENER 1984].

Non-random size differences like those observed in our study have been interpreted as evidence for selection for the avoidance of competition (but see [TONKYN & COLE 1986, EADIE et al 1987]). Related species, which are similar in size, might compete more strongly for the same limited resource, e.g., food, whereas more dissimilar species might utilize different size classes of food. In ants, large size differences among workers from sympatric species in seed-harvesting desert ants were found to be correlated with differences in preferred seed size [DAVIDSON 1977]. Similarly, it was suggested that different body size of ants from juniper-oak woodland in Arizona [CHEW & DEVITA 1980] reflects specialization on different prey sizes or on different foraging behavior. The body size of individual ants might also determine their resistance to predation, desiccation and high temperatures, and thus could lead to size-related differences in the day time of foraging [CHEW & DEVITA 1980; see CERDÁ & RETANA 1997 for an intraspecific case].

The meaning of non-random size differences in sympatric *Leptothorax* ants is not yet completely clear. The observed pattern can not be explained by phylogeny. The studied species belong mainly to the two subgenera *Leptothorax* (s. str) and *Leptothorax* (*Myrafant*). Species pairs differed strongly in size, regardless of whether they belong to the same subgenus or to different subgenera. Assuming that phylogenetically close species are more similar in size than less closely related species, we would expect the observed distribution of size ratios to be similar to the null distribution, because in 9 of the 15 investigated species pairs, both belonged to the same subgenus.

Though caput width differs more strongly than thorax length, it is unlikely that different species of *Leptothorax* prefer different food particles or prey of different size classes. In contrast, according to the few observations on foraging behavior, *Leptothorax* are generalists which feed on dead insects and honey dew and occasionally carry live

Collembola and small insect larvae [STITZ 1939, DOBRZANSKI 1966, BUSCHINGER 1968, own observations]. Especially with respect to decaying insect corpses and honey dew it is difficult to imagine how the pronounced difference in caput width between sympatric *Leptothorax* could help to avoid competition for food.

Differences in worker size are presumably also not a correlated response to disruptive selection on the size of sexuals. Especially in those six pairs where species belonged to different subgenera, the observed pattern is not reflected in the size of virgin queens and males. Caste dimorphism is much less pronounced in the subgenus *Leptothorax* (s.str.) than in *L. Myrafant*.

Furthermore, the reproductive strategies are very different, with sexual calling in most species of *L. (s. str)* and mating flights in *L. (Myrafant)* [BUSCHINGER et al 1980, PLATEAUX 1984]. Different species of *Leptothorax* appear to be isolated predominantly by showing sexual activity at different day times. According to PLATEAUX [1984, 1987], sympatric, closely related species belonging to the same subgenus show extremely different times of sexual activity (e.g., *L. nylanderi* at 17°-20°, *L. parvulus* at 6°-9°).

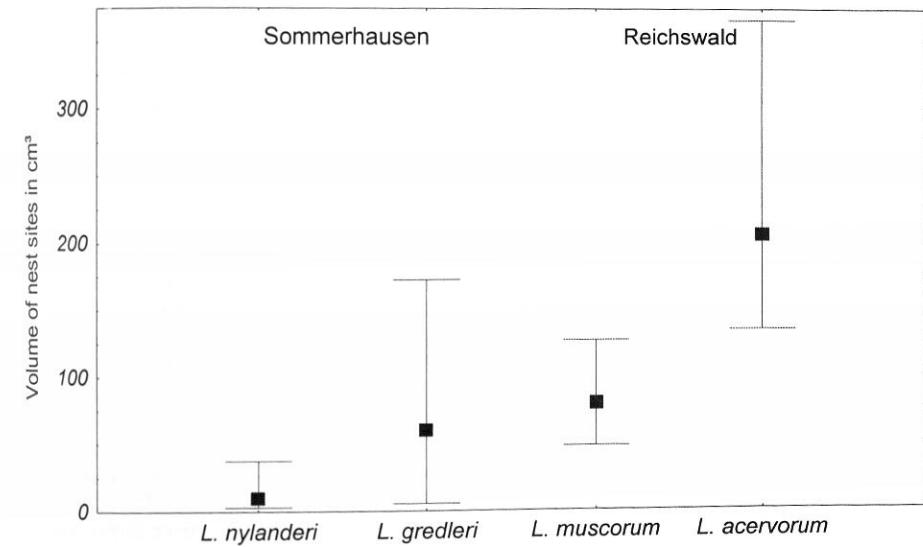


Fig 2: Volume of nest sites inhabited by colonies of two sympatric ant species of the genus *Leptothorax* Mayr 1855 [Hymenoptera: Formicidae], each in two different collecting sites (Mann-Whitney U-test); Sommerhausen: *L. gredleri* vs *L. nylanderi*, $U = 2417.0$, $P < 0.008$; $n_1 = 300$, $n_2 = 24$; Nürnberger Reichswald: *L. acervorum* vs *L. muscorum*, $U = 203.0$, $P < 0.0001$, $n_1 = 21$, $n_2 = 54$). The larger species tends to inhabit nest sites with a larger volume.

Nest sites appear to be the most limited resource for cavity-dwelling *Leptothorax* species (e.g., *L. longispinosus* [HERBERS 1986]; *L. nylanderi* [FOITZIK & HEINZE 1998]). Several studies also document competition for nest sites between *Leptothorax* and other ant species [BRIAN 1952, SEIFERT 1986, YAMAGUCHI 1992, HERBERS & BANSCHBACH 1995]. According to data from two collecting sites, the larger of two sympatric *Leptothorax* species tends to inhabit larger nest sites.

This might be due to smaller ant species actively choosing smaller nesting sites, as shown in an experiment with *Myrmica punctiventris* and *Leptothorax longispinosus* [HERBERS & BANSCHBACH 1995]. Competition between sympatric species of cavity-dwelling ants for nest sites might thus be minimized if species were of different size and preferred different nest sizes.

However, the stability of nest sites appears to depend on their size. We have shown that in a temperate forest habitat with *L. gredleri* and *L. nylanderi*, many small nest sites, such as hollow acorns, hazelnuts, and grass stems did not persist for longer than 10 weeks in summer, whereas larger nest sites, such as fallen branches, were much more durable.

The inhabitants of small nest sites were thus forced to search for, acquire and move into new nests despite apparent nest site limitation and high predation risk during moving [FOITZIK & HEINZE 1998]. Besides, cavities in larger nest sites can be enlarged once the colony grows and needs more space. It therefore appears unlikely that the smaller of two sympatric *Leptothorax* species 'voluntarily' chooses smaller and consequently more fragile nest sites. Observations on intraspecific competition in *L. nylanderi* suggest that more populous colonies may take over the nest of a smaller colony [FOITZIK & HEINZE 1998], leading to a strong positive correlation between colony size and the size of their nest site. Seasonal and geographical fluctuations in colony composition and the enormous intraspecific variability of colony size make it difficult to judge whether colonies of sympatric *Leptothorax* species consist on average of a similar number of workers. If so, larger individual size might give an advantage in interspecific competition. It needs to be experimentally tested, however, whether a larger ant species is indeed capable of expelling colonies of the smaller species from more voluminous and stable nest sites.

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YOUNG D: **Die Entdeckung der Evolution.**- Nach der unter dem Titel „The Discovery of Evolution“ im National Museum, London 1992 erschienenen englischsprachigen Originalausgabe übersetzt von RIEDLE K.- [284 S, 103 Schwarzweiß-, 20 Farabb., 19 Strichzeichn, 250 x 190 mm, Hartkart-Ebd / Schutzhumschl].- **Publ:** Birkhäuser Verlag Basel-Boston-Berlin 1994; ISBN: 3-7643-2951-3; **Pr:** DM 78,- / öS 608,40 / sFr 68,-... ----- [EGR-Nr 2293]

Chronologisch aufgebaut, von den ersten Zweifeln an der Schöpfungsgeschichte bis zu den aktuellen Forschungen, behandelt das Buch von DAVID YOUNG ein spannendes Kapitel Wissenschaftsgeschichte. ARISTOTELES, CARL LINNAEUS, JEAN BAPTISTE LAMARCK, CHARLES DARWIN und GREGOR MENDEL, das sind nur einige der großen Naturwissenschaftler, deren Entdeckungen, Folgerungen und Verlautbarungen für die Evolutionstheorie von großer Bedeutung sind, und deren Forschungen der Verfasser dieses Sachbuches hier würdigt. Kaum ein anderes deutschsprachiges Buch bietet seinen Lesern einen derart fachlich umfassenden und zugleich reich bebilderten Überblick zur Geschichte der Evolutionsforschung, eines Wissensgebietes und seiner Vertreter, die sich mit einem derart aufregenden Bereich der Biologie befaßt haben. Selbst schwierige Sachverhalte aus den einbezogenen Spezial- und Hilfswissenschaften wie Genetik, Molekularbiologie oder Paläontologie, die zum Verständnis des Evolutionsprozesses wichtige Beiträge geleistet haben, werden in einer auch für Laien verständlichen Weise beschrieben. Der Verfasser versteht es vorzüglich, den Leser mit seiner Begeisterung für die Evolution, die er als eines der bedeutendsten und zukunftsweisenden Konzepte versteht, das jemals unseren Gesichtskreis erweitert hat, mitzureißen. Zusammen mit den zahlreichen Abbildungen regt der lebendig geschriebene Text zum Lernen und Nachdenken an und besitzt zugleich einen gehobenen Unterhaltungswert

Englischsprachige Forscher wie DARWIN, HUXLEY, MORGAN und WALLACE gehörten zweifellos zu den hervorragenden Vertretern dieser Wissenschaft und haben einen gebührenden Platz in dieser Abhandlung gefunden. Bei der Besprechung vieler Erkenntnisse, die von weniger bekannten Fachvertretern belegt worden sind, werden aber ebenfalls englischsprachige Vertreter in den Vordergrund gestellt, obwohl zumindest gleichwertige Ergebnisse und Nachweise auch von Forschern anderer Sprache beigebracht worden sind. Seiner Entstehung gemäß ist diese Einheitlichkeit verständlich, wenngleich sie immer mehr „üblich“ wird. Sie könnte jedoch beim deutschsprachigen Leser, der zu geringe fachliche Vorbildung besitzt, und die tatsächlichen Erkenntniszugevinne nicht zu übersehen vermag, zu Fehlschlüssen führen. In dieser Hinsicht unbedingt zu verurteilen ist auch, daß Übersetzer, Herausgeber und Verleger der deutschsprachigen Ausgabe es nicht für nötig befunden haben, zumindest die englischsprachigen Tabellen und englischsprachigen Bezeichnungen und Erklärungen in den Abbildungen ins Deutsche zu übertragen. Oder sollen englische Fachbegriffe wie z.B. „Limestone“ oder „Meckel's Cartilage“ auch in die deutsche Fachsprache Eingang finden, ihr aufgezwungen werden? Mit einem sechsseitigen Schriftenverzeichnis wird dem Leser ein umfassender Zugang zur englischsprachigen Fachliteratur eröffnet; die Anführung von lediglich 22 französischen und 11 deutschen Titeln entspricht dabei nicht dem tatsächlich geleisteten Forschungsanteil. Gegenüber der Originalfassung hätten hier für den mit der Übersetzung angesprochenen Leserkreis Ergänzungen vorgenommen werden müssen. Für den unvorigenommenen deutschen Leser stellen diese nicht notwendigen oder nachlässigen Handhabungen eine Gefahr dar: Sie mögen zumindest zu falschen Einschätzungen verführen. Sie mindern jedenfalls den Gebrauchswert dieses ansonsten vorbildlichen Sachbuches.- [Teils Verlagswerbeangaben, teils AWS]