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COMPETITION AND MORPHOLOGICAL SIMILARITY: THE CASE OF
THE "SNAKE-LIKE" LIZARDS *ANGUIS FRAGILIS* (ANGUIDAE) AND
CHALCIDES CHALCIDES (SCINCIDAE)

Dario CAPIZZI¹, Claudio ANIBALDI², Lorenzo RUGIERO³, Luca LUISELLI⁴

INTRODUCTION

Evolutionary theory suggests that morphological convergence can occur between phylogenetically unrelated organisms when they occupy the same niche (Williams, 1966). There are several spectacular cases of morphological convergence among reptiles (e.g. see Shine, 1980), especially among Squamates (lizards and snakes). In most cases, convergence is shown by species living in allopatry (e.g. the Australian elapid snake *Acanthophis antarcticus* resembling viperid species of the old world, cf. Shine, 1980), but there are also some interesting cases of species living in the same geographic regions which show this kind of morphological adaptation. When such species are sympatric, a potentially strong interspecific competition could be hypothesized (Williams, 1966).

In western Europe, an interesting case of morphological similarity is found between the widespread Anguid lizard *Anguis fragilis* and the Scincid lizards of the genus *Chalcides*. Both these taxa are characterized by elongated "snake-like" shape with an extremized reduction of leg size (e.g. *Chalcides chalcides*) or without legs at all (*A. fragilis*), and by similar dorsal colouration based on a series of longitudinal stripes on a lighter background (Arnold & Burton, 1978). Moreover, both these taxa are live-bearing, thus showing even identical reproductive modes (Arnold & Burton, 1978; Capula *et al.*, 1992; Rugiero, 1997). This convergence can be explained as an evolutionary response to their partially subterranean behaviours, as both taxa are fossorial over much part of the year (cf. Capula & Luiselli, 1993; Rugiero, 1997). However, it is likely that the "snake-like" shape of *Anguis* depends exclusively on its fossorial habits, whereas that of *Chalcides* also on the need of fast moving through grass. Despite the biogeo-

¹ Istituto Nazionale per la Fauna Selvatica, via Ca' Fornacetta 9, I-40064 Ozzano dell'Emilia, Bologna (Italy).

² Centro Ittiologico "Oceano", viale Regina Margherita 249/a, I-00198 Rome (Italy).

³ Via Domenico Cimarosa 13, I-00198 Rome (Italy).

⁴ Institute of Ecology (NSF), No 4 Adak Uko Street, Calabar, Cross Rivers State (Nigeria). Address in Italy: via Olona 7, I-00198 Rome (Italy).

Reprint requests to: Dr D. Capizzi.

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graphic origin of the two taxa is different (*A. fragilis* is a mid-European taxon, and *Chalcides* is a typically Mediterranean taxon), there are several regions in the Mediterranean area where *A. fragilis* and at least one species of *Chalcides* are sympatric (e.g. see Doria & Salvidio, 1994). Thus, an interesting point of discussion is to establish whether these taxa are competitors or not in such areas of sympatry.

In this paper we aim to verify whether *A. fragilis* and *C. chalcides* are in competition in the areas where they are sympatric. To test this, we examined (i) food habits, (ii) daily activity patterns, and (iii) habitat requirements of several populations of these two species. To be more precise, we examined:

1) the taxonomical composition of the diet of both *A. fragilis* and *C. chalcides* from areas where these taxa are sympatric and from areas where only one species is present, to test whether the prey spectrum of the one species can shift in presence or in absence of the potential competitor;

2) the daily activity rhythms of both species in experimental conditions (outdoor enclosures). To test whether the presence of the one species can modify the daily activity rhythm of the other species, we compared the rhythms of the two species in cages housing them singly with the rhythms exhibited by the two species in a cage where both the taxa were available together;

3) the habitat requirements in several woodlots of central Italy where both the species were potentially present.

Then, based on the evidences emerging from all these topics, we try to present some general statements on the potentiality for competition between these morphologically convergent lizards.

MATERIALS AND METHODS

STUDY AREAS

Data given here were collected in seven different localities of peninsular Italy. In three of these localities *A. fragilis* was the only species present, whereas in two localities *C. chalcides* was the only species present, and in two localities both *A. fragilis* and *C. chalcides* were present. The place-name, geographic coordinates, environmental type, general climate, presence or absence of the two studied species, and pertinent reference for the data source used, are presented in Table I.

METHODS

This paper is based on both original data and already published literature information, coming from previous studies of the writers. Data relative to *A. fragilis* from Tarvisio and Sella Nevea were already given in Luiselli *et al.* (1994), and data relative to *C. chalcides* in Tor Lupara were already presented in Rugiero (1997). Thus, for precise information regarding methods employed and time of study, see these original papers. Data relative to all the other populations of both *A. fragilis* and *C. chalcides* were entirely original, and collected during spring and summer, 1997.

TABLE I

The seven study areas used for dietary analyses, including geographic coordinates, environmental type, general climate, presence or absence of the two studied species, and pertinent reference for the dietary data used.

Locality	Elevation (m.a.s.l.)	UTM coordinates	Climate	Habitat	Species present	Data source
Tarvisio	900	lat 5.158.140 lon 852.190	Alpine	<i>Abieti-Fagetum</i> forest	<i>A. fragilis</i>	Luiselli <i>et al.</i> , 1994
Sella Nevea	1 100	lat 5.149.420 lon 847.890	Alpine	Alluvional cone with <i>Pinus mugo</i>	<i>A. fragilis</i>	Luiselli <i>et al.</i> , 1994
Mendelpass	700	lat 5.152.180 lon 675.100	Alpine	<i>Picea excelsa</i> forest	<i>A. fragilis</i>	This study
Vejo	60	lat 4.659.820 lon 778.350	Mediterran.	Deciduous oak coppice	<i>A. fragilis</i> <i>C. chalcides</i>	This study
Settebagni - Tor Lupara	40	lat 4.656.110 lon 794.450	Mediterran.	Deciduous oak coppice	<i>A. fragilis</i> <i>C. chalcides</i>	This study & Rugiero, 1997
Villa Ada-Rome	30	lat 4.650.090 lon 787.040	Mediterran.	Green urban area	<i>C. chalcides</i>	This study
Tor San Lorenzo	5	lat 4.608.300 lon 795.490	Mediterran.	Farmland	<i>C. chalcides</i>	This study

Diets. - Dietary data were collected only from free-ranging animals. Several specimens were found already dead in the field (cf. Luiselli *et al.*, 1994), whereas several others were captured alive and processed for any food item ingested. The specimens found dead in the field (normally squashed by cars or killed by farmers and excursionists) were dissected, and the stomach contents were analysed under a binocular microscope. The specimens captured alive were placed in small cages until defaecation occurred, and then, the faeces were examined in the laboratory for any food item. No specimen was specifically killed for this study, and no faeces were collected from the soil. The proportion of specimens found dead in the field varied in each population between 13 and 21 %, this being not dependent on the species or on the population (ANOVA, $F = 0.376$, $P = 0.56$). Thus, eventual differences in the prey composition of the various populations reflected true interpopulation differences in food habits and not sample distortion due to different methods of dietary analyses used.

Daily activity rhythms. - Daily activity was studied in outdoor enclosures, as it was impossible to maintain a constant sampling effort in the field throughout the whole 24 hours of the day. Three outdoor enclosures were built in Colle Romito (province of Rome, about 20 m asl), a locality where both the species were present in the wild. All the cages were provided with grass, wood pieces, stones, and leaves, thus resembling the natural habitat of the studied species. The disposition of the various landscape elements (grass, leaves, etc) was identical in all the three enclosures. Arthropods and earthworms were housed in the cages. In the cage "A" (3 × 2 m surface) we placed ten *C. chalcides* (five adult males and five adult

females), in the cage "B" (3 × 2 m surface) we placed ten *A. fragilis* (five adult males and five adult females), and in the cage "C" (6 × 2 m surface) we placed ten *C. chalcides* and ten *A. fragilis* (five adult males and five adult females for each of the two species). All the specimens housed in the terraria were approximately of the same size, and there were no remarkable differences in the relative density of the animals in the three cages. Each enclosure was surveyed during April 1997, for exactly three hours in each daily period, which means that the total surveying effort was 72 hours for each cage. We considered "active" all the individuals of a given species that were not hidden under stones, leaves or other objects, i.e. all those specimens that were visible to external observers without removing any ground object.

Habitat requirements. - Data on habitat requirements of *A. fragilis* and *C. chalcides* were collected during surveys conducted, in June-November 1995 and in March-June 1996, in a wide territory of northern Latium (province of Viterbo, central Italy), for studying the effects of habitat loss and fragmentation on snake distribution and abundance (Luiselli & Capizzi, 1997). This territory, about 517 km² surface, includes 134 forested fragments interspersed with wide cultivations, roads and villages. Thirty different woodlots (i.e. 22.4 % of the total number of forested fragments of the area) were surveyed in this study. The various wooded fragments differed each other in terms of (i) surface (size range 1.7-84 ha), (ii) degree of isolation and (iii) vegetation characteristics.

Considering the whole study area, the total amount of habitat loss (*sensu* Andrén, 1994) was 78.1 %. For each wood fragment we measured five isolation-related variables: (i) total wooded surface (TWS), (ii) number of fencerows (NF) irradiating from the forested fragment, (iii) linear distance (in km) from the closest wood fragment (DCW), and (iv) residual habitat (RH, *sensu* Andrén, 1995) in one kilometer of radius from the woodlot barycentre. Moreover, in each woodlot we selected five sampling transects well representative of the whole environmental characteristics. Each transect was 25 m long and 4 m width, thus accounting for 100 m² surface. In every transect we measured the following variables: (i) tree species diversity (assessed with Simpson's (1949) index) composition (TSC), (ii) total density per ha of tree stems (DTS), (iii) mean height of trees (MHT, measured by means of an Haga altimeter to the nearest ± 0.5 m), (iv) mean diameter of trees (MDT, measured at 1.3 m from the ground), (v) number of vegetation strata (NVS, recorded in ten randomly selected sites within each transect, by checking for presence or absence of vegetation at different heights from the ground: respectively 0.5 m, 1 m, 2 m, 4 m, 8 m, 16 m), (vi) undergrowth shrub species diversity (USD, assessed with Simpson's (1949) index), (vii) total number of shrub branches (NSB), and percent occurrence of three key species of shrubs: (viii) *Rubus* sp. (POR), (ix) *Cytisus scoparius* (POC), and (x) *Phillyrea latifolia* (POP).

Statistical analyses. - Food niche overlap was calculated by using a Pianka's (1986) symmetric equation, with values ranging from 0 (no overlap) to 1 (total overlap). The food niche breadth was calculated by a Simpson's (1949) modified index.

The statistical analyses were performed by SPSS (version for Windows), all tests being two tailed and with alpha set at 5 %. Whether a variable was normally distributed was verified by using Kolmogorov-Smirnov test. If we failed in obtaining a normal data distribution, then we used nonparametric tests.

RESULTS

BODY SIZES

Analysis of means of body lengths (SVL, to the nearest 0.1 cm) indicated that *A. fragilis* was longer than *C. chalcides* in every studied population (one-way ANOVAs, $P < 0.01$ to 0.0001), as expectable from data given elsewhere (cf. Bruno & Maugeri, 1984).

FOOD HABITS

The summary of the dietary data obtained from the different populations of *A. fragilis* and *C. chalcides* studied in this paper are given in Table II. Both species fed almost exclusively upon a wide variety of arthropods and other invertebrates, but in one of the Alpine populations of *A. fragilis* there was a case of predation upon a small vertebrate (the amphibian *Salamandra atra*). Based on the analysis of the data available in Table II, we can note that:

- 1) earthworms (Oligochaeta) constituted the main prey category for *A. fragilis* in both Alpine and Mediterranean localities;
- 2) Pulmonata gastropods constituted the main secondary prey category for *A. fragilis* in both Alpine and Mediterranean localities;
- 3) the proportion of Arthropoda eaten by *A. fragilis* was generally lower than the proportion of non-arthropod invertebrates eaten. However, this was not true in the Sella Nevea population, where Arthropods constituted 76.3 % of the total diet;
- 4) spiders constituted the main prey category for the various populations of *C. chalcides*;
- 5) terrestrial Coleoptera larvae constituted the main secondary prey category for *C. chalcides*;
- 6) *C. chalcides* fed essentially upon Arthropods (over 90 % of the total diet in every study site), and other types of invertebrates were rarely observed in this species' stomachs;
- 7) Isopoda were a relatively important prey group for both *A. fragilis* and *C. chalcides*;
- 8) the relative proportion of occurrence of arthropod and non-arthropod prey was significantly different between *A. fragilis* and *C. chalcides* (one-way ANOVA: $F_{1,7} = 24.855$, $P < 0.002$).

In general, the values of food niche breadth obtained from the various studied populations (see Table II) indicate that the taxonomic composition of the diet is wider in *A. fragilis* than in *C. chalcides*, but the interspecific difference was not statistically significant (one-way ANOVA: $F_{1,7} = 0.625$, $P > 0.45$). The food niche breadth of a given population was not significantly different if the two species cohabited in one locality or if that given population was living alone (one-way ANOVA: $F_{1,7} = 0.527$, $P > 0.49$).

The values of food niche overlap between the various populations of *A. fragilis* and *C. chalcides* are presented in Table III. The overlap values were significantly higher in intraspecific comparisons of both *A. fragilis* and *C. chalcides* than in interspecific comparisons (one-way ANOVA: $F_{2,33} = 38.851$,

TABLE II

Summary of the dietary data collected from the studied populations of *Anguis fragilis* and *Chalcides chalcides*. Data relative to *A. fragilis* in the localities Tarvisio and Sella Nevea were already reported by Luiselli et al. (1994), whereas data relative to *C. chalcides* in Tor Lupara were already reported by Rugiero (1997). Food niche breadth, measured by Simpson's (1949) index, are given for each population.

	<i>Anguis fragilis</i>					<i>Chalcides chalcides</i>			
	Tarvisio	Sella Nevea	Mendola	Tor Lupara	Veio	Colle Romito	Villa Ada	Tor Lupara	Veio
<i>Salamandra atra</i>	0	1	0	0	0	0	0	0	0
Oligochaeta	19	6	16	13	11	0	1	0	0
Pulmonata	28	7	16	3	4	0	3	1	2
Isopoda	6	17	11	5	4	6	7	16	9
Scorpiones	0	0	0	0	0	3	0	0	0
Araneidae	2	11	2	3	3	26	15	45	30
Chilopoda	0	0	0	1	3	0	0	0	0
Coleoptera adults	1	2	4	0	1	8	1	4	6
Coleoptera larvae	1	0	0	5	4	3	4	16	9
Hymenoptera	0	3	1	0	0	9	2	6	2
Diptera	0	3	1	0	0	0	1	3	0
Lepidoptera	0	2	0	0	0	0	1	0	0
Homoptera	3	0	2	0	0	0	0	3	0
Blattoidea	0	2	0	0	0	0	0	2	1
Orthoptera	0	0	0	0	0	7	3	0	3
Mantoidea	0	0	0	0	0	1	0	0	0
Dermaptera	2	5	0	0	0	0	1	0	0
Unidentified	4	8	5	7	5	5	4	10	7
Total	66	67	58	37	35	68	43	106	69
Simpson's index	3.58	7.30	4.92	4.77	5.75	4.87	5.55	4.14	4.09

$P < 0.000001$, see Figure 1). A Tukey honestly significant post-hoc test revealed that all the three groups of comparisons (i.e. *A. fragilis*, *C. chalcides*, and *A. fragilis* versus *C. chalcides*) were significantly different each from the others.

A UPGMA (Unweighed Pair-Group Method using Arithmetic averages on a euclidean distance matrix) dendrogram on the similarity of taxonomic dietary composition confirmed the validity of the differences observed at above, and clustered the two species well separately, apart for the *A. fragilis* population of Sella Nevea that, because of its tendency to forage on Arthropoda, was clustered together with *C. chalcides* (Figure 2). Computing a discriminant function analysis (9 cases processed), we obtained an highly significant discriminant function between the diets of the two species in the various localities (Wilks' $\lambda = 0.00059$, canonical correlation = 0.999, $\chi^2 = 26.04$, $df = 7$, $P = 0.0005$).

Unfortunately, the procedure employed in this research (analysis of faeces, other than dissection on a smaller amount of found-dead specimens) did not allow exact measurements of the prey size. This is an important shortcoming, as prey size could be an important niche dimension in lizard studies published to date (cf. Schoener, 1968; Pianka, 1973, 1986; Barbault, 1981; Vicente *et al.*, 1995).

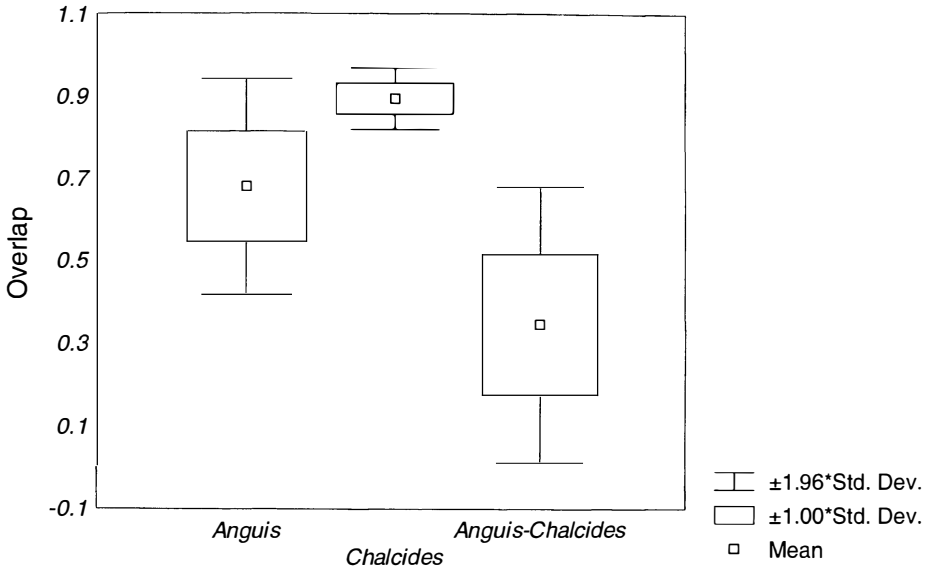


Figure 1. — Box and whisker plot showing averages and dispersion measures of trophic niche overlap values between (i) different populations of *Anguis fragilis*, (ii) different populations of *Chalcides chalcides*, and (iii) different populations of *Anguis fragilis* compared with different populations of *Chalcides chalcides*. For more details, see text.

TABLE III

Values of food niche overlap, calculated according to Pianka's (1986) symmetric equation, on the taxonomical composition of the diet of the various populations of *Anguis fragilis* and *Chalcides chalcides* studied in the present paper.

	<i>A. fragilis</i> Sella Nevea	<i>A. fragilis</i> Mendelpass	<i>A. fragilis</i> Tor Lupara	<i>A. fragilis</i> Vejo	<i>C. chalcides</i> Tor San Lorenzo	<i>C. chalcides</i> Villa Ada	<i>C. chalcides</i> Tor Lupara	<i>C. chalcides</i> Vejo
<i>A. fragilis</i> Tarvisio	0.511	0.906	0.630	0.699	0.092	0.283	0.132	0.158
<i>A. fragilis</i> Sella Nevea	****	0.666	0.517	0.544	0.566	0.712	0.624	0.608
<i>A. fragilis</i> Mendelpass		****	0.715	0.770	0.197	0.373	0.226	0.245
<i>A. fragilis</i> Tor Lupara			****	0.837	0.236	0.395	0.338	0.322
<i>A. fragilis</i> Vejo				****	0.282	0.424	0.357	0.353
<i>C. chalcides</i> Tor S. Lorenzo					****	0.836	0.873	0.882
<i>C. chalcides</i> Villa Ada						****	0.919	0.912
<i>C. chalcides</i> Tor Lupara							****	0.943

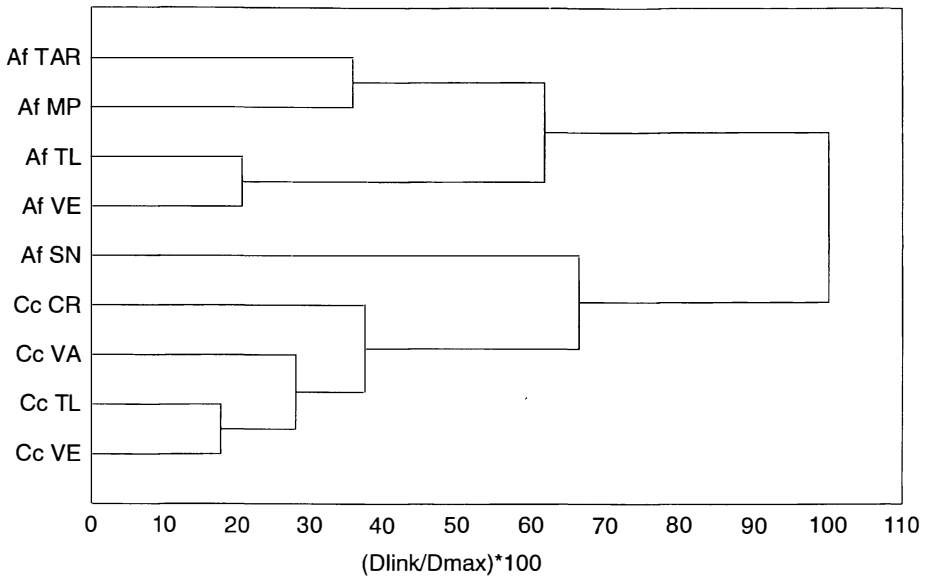


Figure 2. — UPGMA dendrogram (maximum linkage distance standardized to 100%) on the taxonomical composition of the diet of the populations of *Chalcides chalcides* (Cc) and *Anguis fragilis* (Af) studied in this paper. Symbols: TAR = Tarvisio; MP = Mendelpass; TL = Tor Lupara; VE = Vejo; SN = Sella Nevea; CR = Colle Romito; VA = Villa Ada.

However, our evidences suggest that *A. fragilis* took larger prey than *C. chalcides*, as the former species preyed frequently upon earthworms, and in one occasion even on a salamander. Conversely, most of the prey eaten by *C. chalcides* were small arthropods.

DAILY ACTIVITY RHYTHMS

Our experimental analysis of lizards maintained in outdoor cages indicated that *C. chalcides* and *A. fragilis* were strongly different as far as daily activity rhythm is concerned. In fact *C. chalcides* was exclusively diurnal, whereas *A. fragilis* was crepuscular and nocturnal, with only sporadic activity during the daylight hours (Figure 3). When housed together in the same enclosure (cage “C”), the two taxa maintained their clear-cut differences in daily activity pattern (see Figure 3), thus showing that the presence of one species in the same enclosure of another species did not modify the daily activity pattern shown by the two species when maintained alone (respectively in cage “A” and in cage “B”). In fact, the daily activity pattern of *C. chalcides* did not change significantly if it was alone or with *A. fragilis* (Mann-Whitney *U*-test, $U = 71.5$, $Z = -0.029$, $P = 0.98$), and the same was true for the daily activity pattern of *A. fragilis* in presence or absence of *C. chalcides* in the same cage (Mann-Whitney *U*-test, $U = 66.0$, $Z = -0.346$, $P = 0.73$).

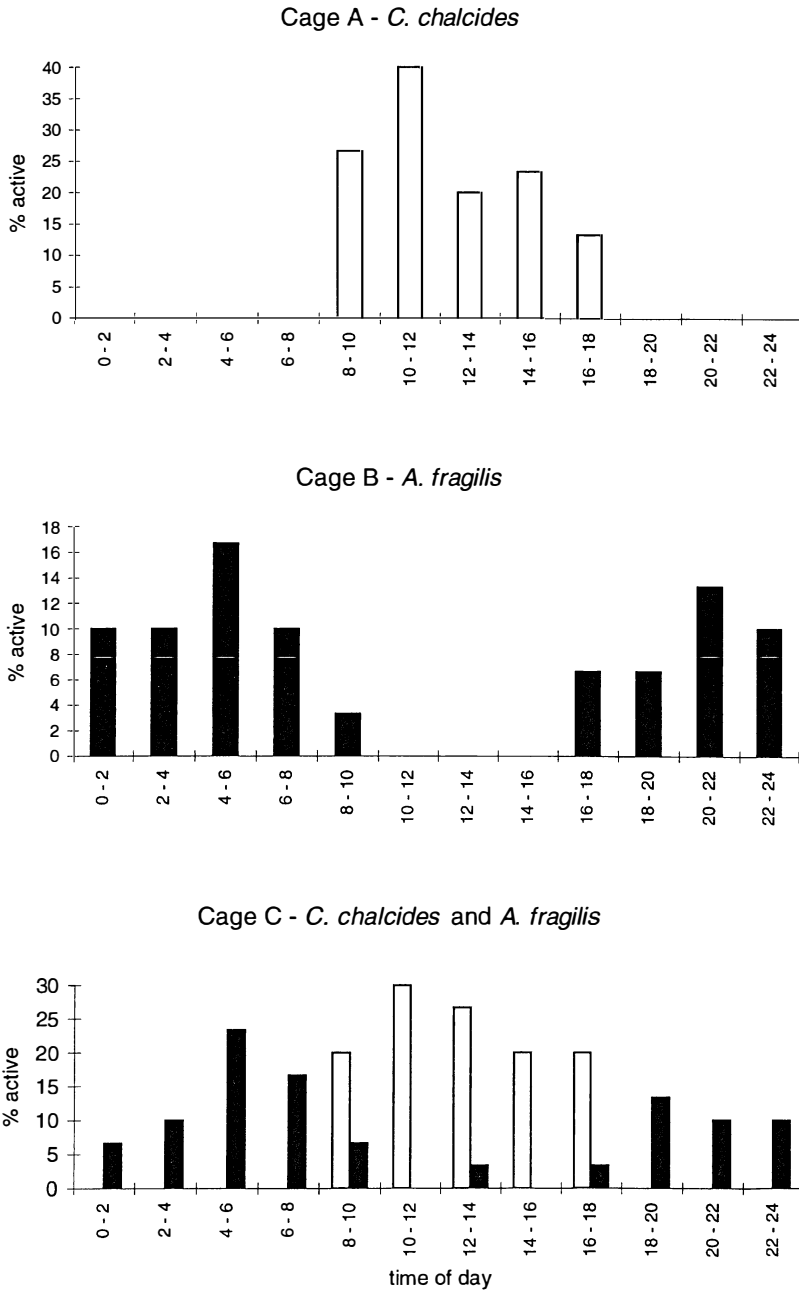


Figure 3. — Daily activity rhythms of *Chalcides chalcides* (white bars) and *Anguis fragilis* (black bars) maintained in outdoor enclosures. For more details, see text. Note that the presence of both taxa in the same enclosure (cage “C”) did not modify significantly the daily activity pattern shown by the two species when maintained alone (respectively in cage “A” and in cage “B”).

The intersexual differences in daily activity rhythms were not statistically significant both in *A. fragilis* and in *C. chalcides*, either when the species were housed separately or when they were housed together (in all cases, at least $P > 0.4$, Mann-Whitney U -test).

HABITAT REQUIREMENTS

A. fragilis was found in 11 of the surveyed woodlots (36.7 %), whereas *C. chalcides* was found in 22 of the surveyed woodlots (73.3 %). The two species were found together in 8 of the studied woodlots (26.7 %), and both of them were absent from 5 woodlots (16.7 %). Among the various variables examined in each woodlot, only POR significantly influenced the presence / absence of *C. chalcides* (ANOVA with $df = 1,27$, $P = 0.04$; see Table IV), whereas the presence / absence of *A. fragilis* was significantly influenced by TWS (ANOVA with $df = 1,27$, $P = 0.05$) and USD (ANOVA with $df = 1,27$, $P = 0.004$), and tended to be influenced even by TSC (ANOVA with $df = 1,27$, $P = 0.09$) and NF (ANOVA with $df = 1,27$, $P = 0.07$) (see Table IV).

TABLE IV

Results of one-way ANOVA performed on environmental parameters recorded in 30 woodlots grouped by presence/absence of Chalcides chalcides and Anguis fragilis (in all cases $df = 1,27$).

Variables	<i>Chalcides chalcides</i>		<i>Anguis fragilis</i>	
	<i>F</i> value	<i>P</i> level	<i>F</i> value	<i>P</i> value
<i>NSB</i>	0.10	0.76	0.55	0.46
POR	4.40	0.05	1.05	0.31
POC	1.94	0.17	1.55	0.22
POP	0.74	0.40	0.05	0.82
USD	0.61	0.44	9.82	0.004
TSC	0.27	0.61	2.96	0.10
MHT	0.65	0.43	1.12	0.30
DTS	1.14	0.29	0.82	0.37
MDT	1.51	0.23	0.24	0.63
NVS	0.02	0.89	0.02	0.88
TWS	0.03	0.87	4.24	0.05
DCW	0.41	0.53	1.90	0.18
NF	2.27	0.14	3.52	0.07
RH	0.24	0.63	2.06	0.16

DISCUSSION

Previous researches on subterranean or fossorial reptile assemblages suggested that these kinds of assemblages are generally depauperate in both temperate

and in semiarid/arid zones (cf. Henle, 1989a), and that there is a very low upper limit (two to four taxa) to the number of fossorial species which can coexist in any climate or habitat, possibly because of a strong interspecific competition (Pianka, 1986; Henle, 1989a, 1989b). Thus, in theory, the basic conditions for the occurrence of a strong interspecific competition between *A. fragilis* and *C. chalcides* seem to be present in the areas where these two taxa live in sympatry. However, our study has highlighted that *A. fragilis* differed from *C. chalcides* in so many niche aspects that we really doubt about the existence of such an interspecific competition.

To begin with, *A. fragilis* attained on average larger body sizes (Snout-Vent Length) than *C. chalcides*. Even if these size differences were not extremely relevant, it is still obvious that their size difference allows a reduction of the overlap of their food niches and favours the coexistence of the two species, as previously demonstrated in other lizard studies (Vicente *et al.*, 1995). Snout-Vent Length is of course less important than body mass and head size for determining the potentiality of a given “snake-like” morphotype organism to access to a given prey type, and, thus, is not the best size parameter for assessing interspecific competition. However, since (i) Snout-Vent Length and body mass are highly positively correlated in both *A. fragilis* and *C. chalcides* (in all cases, $r > 0.65$, $P < 0.001$), and (ii) Snout-Vent Length and head size are highly positively correlated in both *A. fragilis* and *C. chalcides* (in all cases, $r > 0.8$, $P < 0.0001$), it seems reasonable that Snout-Vent Length differences can be reliable operational parameters for assessing interspecific competition in the study case.

The taxonomic composition of the diet, and very probably even the mean prey size, were very different between the two species, which also allow a reduction in the potential for interspecific competition. Moreover, neither the diet composition nor the food niche breadth of any of the two species did significantly change when the potential competitor was available in the environment, which also suggests that the two taxa were not in fact competitors.

A. fragilis and *C. chalcides* were very different in terms of daily activity rhythms, and their activity patterns did not change significantly if the one species was alone or with the potential competitor. Although these species-specific activity differences may contribute to reduce competition between sympatric *A. fragilis* and *C. chalcides* (e.g. by differentiating diets of coexisting predators, cf. Capizzi & Luiselli, 1996), it should be noted that activity time is not really a niche difference, and that temporal separation do not necessarily reduce exploitation competition (Jaksic, 1982).

The habitat requirements even indicated some differences between the two species, with *A. fragilis* more linked to wooded areas than *C. chalcides*, and due to this reason even more influenced by habitat loss and forest isolation. However, the two species occurred together in several areas within the studied territory. As a general trend, however, *C. chalcides* appeared more abundant and adaptable than *A. fragilis*, at least in the Mediterranean regions of central Italy. The situation may be different in cooler regions (e.g. the Alpine ones), where *A. fragilis* is often very abundant even in suburban areas.

Thus, since the potential for interspecific competition seems to be low between the two studied species, we are led to think that probably a strong intraspecific competition regulates the abundance of each of the populations (Vicente *et al.*, 1995), but more data are needed to test this later hypothesis.

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SUMMARY

Anguis fragilis and *Chalcides chalcides* are phylogenetically unrelated, morphologically similar, elongated "snake-like" shaped lizards, which are frequently sympatric in Mediterranean Europe. The potential for competition between these two species was studied in several localities of northern and central Italy. Results show that: (1) *A. fragilis* was longer than *C. chalcides* in every studied population; (2) the taxonomic composition of the diet, and very probably even the mean prey size, were very different between the two species; (3) neither the diet composition nor the food niche breadth of any of the two species did significantly change when the potential competitor was available in the environment; (4) *A. fragilis* and *C. chalcides* were very different in terms of daily activity rhythms, and their activity patterns did not change significantly if the one species was alone or with the potential competitor; (5) the habitat requirements were different between the two species, *A. fragilis* being more linked to wooded areas than *C. chalcides*. However, the two species occurred together in several areas within the studied territory. The potential for interspecific competition, thus, seems to be low.

RÉSUMÉ

Anguis fragilis et *Chalcides chalcides* sont des lézards phylogénétiquement distincts, morphologiquement similaires, serpentiformes, et qui vivent fréquemment en sympatrie en Europe méditerranéenne. Les potentialités de compétition entre ces deux espèces ont été étudiées en diverses localités du nord et du centre de l'Italie. Les résultats montrent que (1) *A. fragilis* est plus long que *C. chalcides* dans chaque population étudiée; (2) la composition taxinomique du régime alimentaire, et probablement même aussi la taille moyenne des proies, est très différente entre les deux espèces; (3) chez les deux espèces, ni la composition du régime alimentaire ni la largeur de la niche pour la dimension trophique ne changent significativement quand le compétiteur potentiel est présent dans le milieu; (4) *A. fragilis* et *C. chalcides* sont très différents en termes de rythmes d'activité, et leurs patrons d'activité ne changent pas de manière significative si l'espèce est seule ou avec son compétiteur potentiel; (5) les exigences en matière d'habitat sont différentes entre les espèces, *A. fragilis* étant plus lié aux zones boisées que *C. chalcides*. Néanmoins, les deux espèces vivent ensemble dans plusieurs endroits du territoire étudié. Les potentialités de compétition interspécifique paraissent donc faibles.

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