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**Food collection by *Cataglyphis iberica* (EM.) (Hymenoptera,
Formicidae)**

[With 3 figures and 3 tables in the text]

Abstract. *Cataglyphis iberica* is an ant that lives in hot dry places and forages individually. Its staple food are arthropods, mainly insects. The range of food items taken by the workers was determined using two methods: the analysis of the remains found in the middens of the nests and that of the prey brought by the foragers. Even though the main groups that make up the diet are the same in both cases (ants, *Coleoptera*, *Hemiptera*), there are some differences because the soft prey (*Orthoptera*, *Diptera*, larvae) is more scarce in the middens.

INTRODUCTION

Cataglyphis iberica (EMERY, 1906) is an endemic species of the Iberian Peninsula and its distribution area is limited to Spain and Portugal (COLLINGWOOD and YARROW 1969). So far studies have been carried out on the foraging activity (DE HARO 1982, 1983, CERDA 1986) and on the social carrying between nests (DE HARO 1981, 1983, DE HARO and CERDA 1984, CERDA 1986). As a new step to the understanding of the ecology of this species, the present work deals with the dietary spectrum.

Cataglyphis iberica nests in very dry locations, characteristically very sunny and with scant vegetation. Usually the societies are monogynic and polycalic (with several nests related by social carrying and only one of which has a queen) (DE HARO and CERDA 1984). The workers reveal a monophasic polymorphism (Fig. 2b) in the sense of WILSON (1953), and the size ranges between 4 and 7 mm in length. This species has strictly diurnal activity and is very thermophilous: its maximum activity coincides with the hours of greatest heat and insolation (DE HARO 1982, CERDA 1986).

The study area, located close to the campus of the Autònoma University of Barcelona (Bellaterra, Barcelona, NE Spain) is characterized by a Xerorthent type soil and a very scant vegetation dominated by *Inula viscosa* accompanied by *Foeniculum vulgare*, *Rubus fruticosus* and dry short grass. The climatic regime of the area (Vallés Occidental) is subhumid Mediterranean (LOPEZ SORIA 1979).

MATERIAL AND METHOD

In the study of the trophic regime of *Cataglyphis iberica* we have used two different procedures: the analysis of the remains found in the middens (subterranean area in which the workers leave the food remains), and the analysis of the prey taken from the workers that were returning to the colony.

Remains of the middens¹

The remains of the middens were taken during the excavation of the nests. They are found in the upper part of the nest, around a horizontal and superficial gallery.

Together with these remains, we also picked up the surrounding dirt, since due to the humidity it was hard to separate the two in the field. In the laboratory the material was desiccated in an oven (120°C for 24 h). The dirt was distinguished from the remains by floating in water and after drying in the air, the remains were observed with a stereomicroscope (Nikon 9-40 ×).

In order to quantify the results and to avoid counting the same individual twice (because of different body parts), only the cephalic capsules were counted, as this is the body fragment that lasts longer and therefore the most abundant. In some cases this criterium was modified because cephalic capsules were more scarce than other parts of the body; for example, in the *Orthoptera* the right hind limbs, and in the *Coleoptera* the right elytra were counted.

We have not taken into account the plant remains nor the snails because they are also found in the dirt in areas far from the middens and we cannot know whether they are or not remains of the feeding of the colony.

Preys gathered

During six summer days (July 15 and 16, August 9 and 10, September 4 and 5) in 1985, we took the items from the foraging workers returning to the nest. Identification under the stereomicroscope and measurement with a Zeiss micrometer were carried out later in the laboratory.

¹ A part of these results was presented in Coll. Intern. Ethol. SFECA by ROBLES and CERDA (1984).

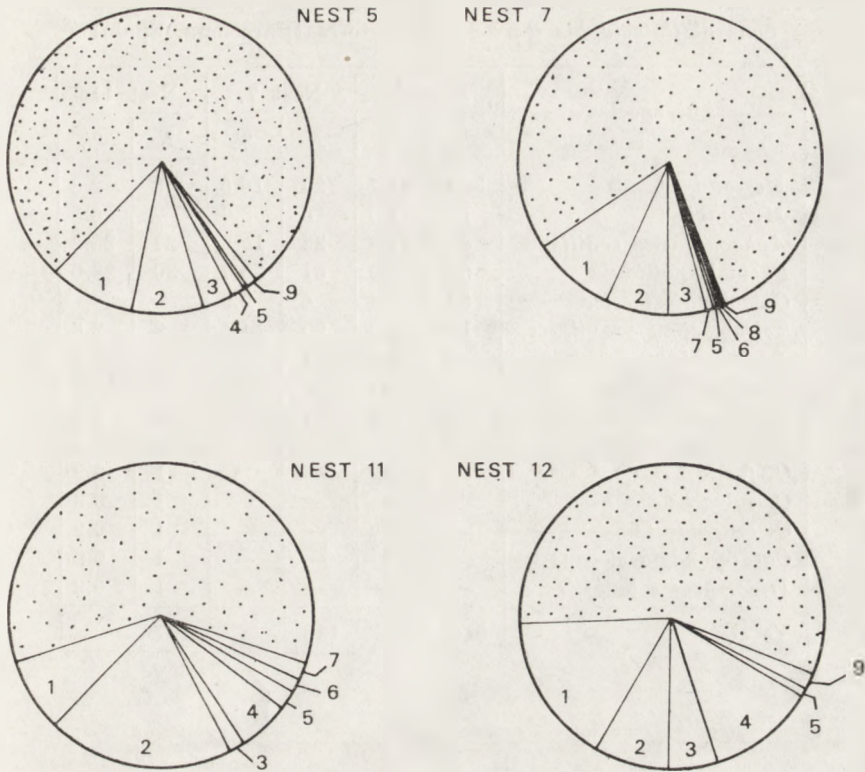


Fig. 1. Composition of the animal remains found in the middens of four nests of *Cataglyphis iberica* excavated in Bellaterra (Barcelona, Spain) in October 1983. Stippled — ants, 1 — *Hemiptera*, 2 — *Coleoptera*, 3 — other *Hymenoptera*, 4 — *Diptera*, 5 — *Orthoptera*, 6 — other Insects, 7 — *Arachnida*, 8 — *Isopoda*, 9 — unidentified remains.

RESULTS

Remains from the middens

After analyzing the middens of four nests (totalling 2172 remains) we found a similar proportion of the main groups (see Fig. 1). More than half of the remains correspond to other ant species and they are followed, though in lesser number, by *Hemiptera* and *Coleoptera*. There is considerable variability in the more rare groups. The differences between middens are not significant (PEARSONS chi-squared test, $P = 0.1$).

Identification to the species level of an ant sample from the middens (Tab. 1) reveals that they are found in varying quantities and proportions according to the nest. In any case the main species are *Messor barbarus*, *Pheidole pallidula* and *Aphaenogaster senilis*, followed by *Tetramorium caespitum* and *Proformica nasuta* in some of the nests. These differences are related to location: the proxi-

Table 1. Percentage of the different ant species found in the mid-dens of *Cataglyphis iberica* in Bellaterra (Barcelona, Spain)

Ant species	Nest 5		Nest 7		Nest 11	
	N	%	N	%	N	%
<i>Messor barbarus</i>	380	61.7	23	16.5	3	2.8
<i>M. bouvieri</i>	12	1.9	5	3.6	7	6.5
<i>Aphaenogaster senilis</i>	88	14.3	22	15.8	27	25.2
<i>Pheidole pallidula</i>	61	9.9	51	36.7	30	28.0
<i>Cataglyphis iberica</i>	52	8.4	4	2.9	—	—
<i>Tetramorium caespitum</i>	18	2.9	20	14.4	3	2.8
<i>Lasius niger</i>	2	0.3	7	5.0	1	0.9
<i>Proformica nasuta</i>	—	—	—	—	21	19.6
<i>Tapinoma nigerrimum</i>	2	0.3	7	5.0	9	8.4
<i>Camponotus aethiops</i>	—	—	—	—	1	0.9
<i>C. foreli</i>	1	0.2	—	—	1	0.9
<i>C. sylvaticus</i>	—	—	—	—	1	0.9
<i>C. cruentatus</i>	—	—	—	—	1	0.9
<i>Cardiocondyla elegans</i>	—	—	—	—	1	0.9
<i>Iridomyrmex humilis</i>	—	—	—	—	1	0.9
Total	616		139		107	

Table 2. Prey types gathered by the workers of *Cataglyphis iberica* in Bellaterra (Barcelona, Spain) during the summer of 1985 (July 15 and 16, August 9 and 10, September 4 and 5).

Prey	N	%
<i>Formicidae</i>	151	37.2
<i>Hemiptera</i>	29	7.1
<i>Coleoptera</i>	23	5.7
<i>Orthoptera</i>	29	7.1
<i>Diptera</i>	19	4.7
<i>Hymenoptera non Formicidae</i>	19	4.7
<i>Lepidoptera</i>	10	2.5
<i>Blattidae</i>	8	2.0
<i>Mantidae</i>	3	0.7
<i>Aranei</i>	12	3.0
soft larvae	9	2.2
<i>Acarida</i>	1	0.2
<i>Isopoda</i>	1	0.2
<i>Gastropoda</i>	35	8.6
Unidentified animal remains	34	8.4
Seeds	20	4.9
Vegetal remains	3	0.7
Total	406	

mity of the colonies of other species is reflected in the diet of each nest. Thus we see that nest 11 was close to one of *Proformica*, and therefore its workers picked up many bodies of this species which is not found in the middens of other nests. The same situation is observed for *Tetramorium* in nest 7 and *Messor barbarus* for nest 5 (both of these species are less frequent in the middens of other nest).

Preys taken by workers

The spectrum of 406 items taken from the *Cataglyphis iberica* workers is similar, at least in the main groups, to that of the remains found in the middens: the ants, *Hemiptera* and *Coleoptera* are the most frequent groups. However, other groups that are not so often present in the middens now increase in importance, like the *Orthoptera*, *Diptera* or *Hymenoptera* (non *Formicidae*) (Tab. 2).

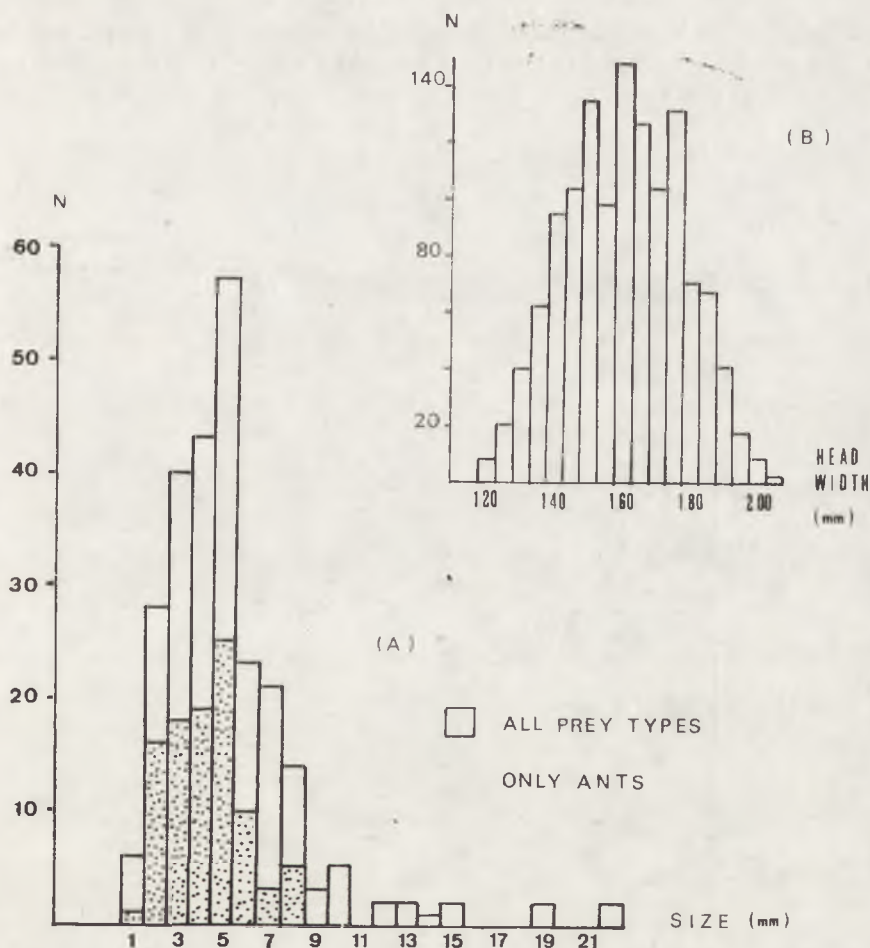


Fig. 2. A — Histogram depicting the length of the prey of *Cataglyphis iberica* gathered in Bellaterra (Barcelona, Spain). B — Histogram of the head width of the *Cataglyphis iberica* workers ($N = 1244$) of one colony excavated in Bellaterra.

As far as the ant species are concerned (Tab. 3) some that are not found in the middens appear, but in low proportion (*Hypoponera eduardi*, *Messor structor*, *Myrmecina graminicola*). The most important species are still *Messor barbarus*, *Pheidole pallidula* and *Aphaenogaster senilis*. *Tapinoma nigerrimum*, *Camponotus foreli* and *Messor bouvieri*, very infrequent in the middens are now more abundant.

The length size of the preys also shows considerable variation: from 1 mm to almost 23 mm (Fig. 2A). However, as we can see in Fig. 2A, 90% of the prey are found in a more narrow range: between 2 and 8 mm. The large preys are few in number and usually correspond to Mantid wings or *Orthoptera* limbs, only in two cases these sizes correspond to whole bodies: that of a small grasshopper and that of a fly of the genus *Eristalis*. The large preys weigh very little and therefore, despite their length, they can be carried by an individual worker. The reason why we have measured the lengths instead of the weights is because it was not possible to register the latter in the field and in the laboratory the fresh weights would have been modified because of the high temperatures of the field; in contrast, the length is much less variable.

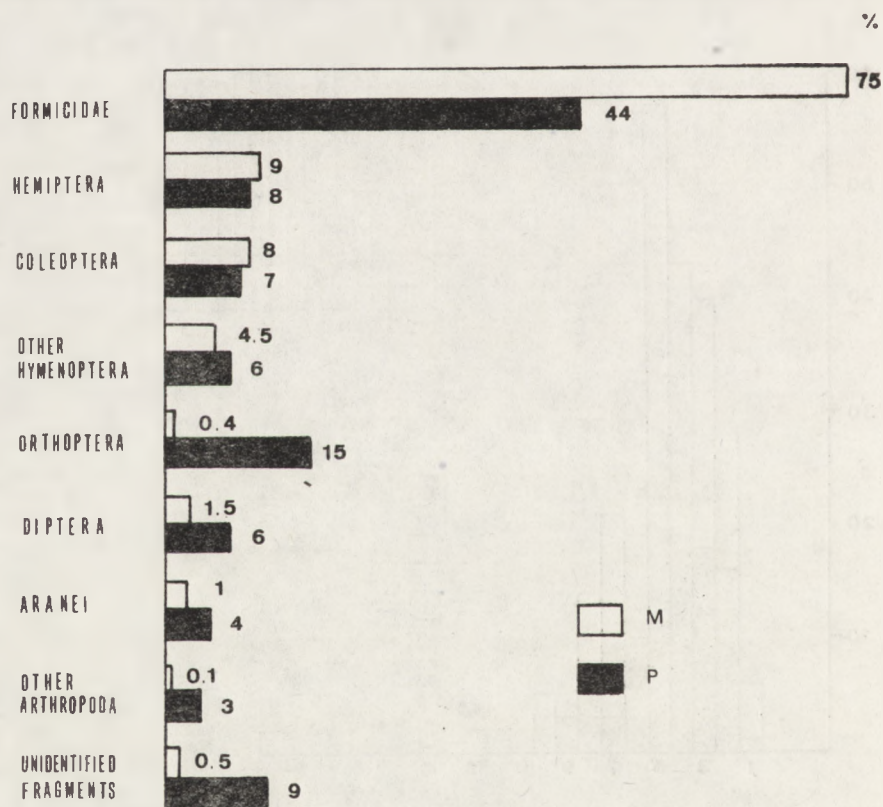


Fig. 3. Comparison between the prey types taken from the workers (P) and the remains found in the middens (M) of *Cataglyphis iberica* in Bellaterra (Barcelona, Spain).

If the large prey are not taken into account, the average size of the preys brought to the nest by the workers of *Cataglyphis iberica* is $4.64 \text{ mm} \pm 1.96$ ($N = 240$). The average size of the ants taken as prey is $4.22 \text{ mm} \pm 1.63$ ($N = 97$); these ants are almost in the form of whole bodies (as are most of the preys of intermediate or small size).

Comparison of the results of both methods

Even though the main groups are the same, the dietary spectrum obtained using the two methods (analysis of the middens and analysis of the preys) are significantly different (PEARSONS chi-square test $P > 0.01$). The main difference is the increased proportion of soft bodied groups, headed by *Orthoptera*, among the prey taken from the workers (Fig. 3). This is due to the fact that these preys (*Orthoptera*, *Diptera*, larvae) last less time in the middens, while those with a hard exoskeletons (ants, *Coleoptera*, *Hemiptera*) resist better the passing of time. In fact this difference between preys and fragments found in the middens was also observed by BRIESE and MACAULEY (1981) when studying the diet of several Australian ants with both methods.

DISCUSSION AND CONCLUSIONS

Despite the differences found in the diet depending on the method used, it is evident that *Cataglyphis iberica* feeds on the corpses of insects and other arthropods (predation on live prey has not been observed). Zoonecrophagy is frequent in species of the genus *Cataglyphis*: *C. albicans* (BERNARD 1958, DELYE 1968), *C. bombycina* (DELYE 1968), *C. bicolor* (HARKNESS and WEHNER 1977, HARKNESS 1979, WEHNER et al. 1983) and *C. cursor* (RETANA et al. 1986, BOSCH et al. in press) are some examples.

The main food of *Cataglyphis iberica* is other ant species, as is the case in some of the above mentioned species, like *C. cursor* and *C. bicolor*. This is due to the fact that ants are the most abundant insect group in the study area (wich has a poor entomofauna because of its scarce vegetation and the harsh environmental conditions). Furthermore, the fact that ants are social insects wich live in colonies with great number of individuals, increases the likelihood of finding dead ants in the surroundings of the nests. HARKNESS and HARKNESS (1986) observe a similar case with *Cataglyphis bicolor* foraging mainly on corpses of *Messor wasmanii* (whose nests are not-randomly distributed). The other insect groups, on the other hand, either because they do not form societies or because they fly, do not tend to concentrate in any specific area and thus they are gathered in similar proportions in nests of *Cataglyphis iberica*, independently of the location.

There is however an important limitation in the collection of preys: size. As is common in the genus, the workers of *C. iberica* forage and collect preys individually and only rarely there is cooperation between more than one of

them. Therefore prey size is limited to what a worker can carry by itself. The workers are 4 to 7 mm long and the preferred prey size is 2–8 mm suggesting that a worker usually carries an equivalent to its own size. In the case of *Cataglyphis bicolor* in Greece, where the weights have been measured, WEHNER et al. (1983) have found that prey are smaller (5.8 mg) than workers (9.7 mg).

Table 3. Ant species taken to the nest by *Cataglyphis iberica* workers in Bellaterra (Barcelona, Spain) during the summer of 1985 (July 15 and 16, August 9 and 10, September 4 and 5).

Ant species	N	%
<i>Messor barbarus</i>	26	17.2
<i>M. bouvieri</i>	13	8.6
<i>M. structor</i>	4	2.6
<i>Aphaenogaster senilis</i>	15	9.9
<i>Pheidole pallidula</i>	38	25.2
<i>Lasius niger</i>	1	0.7
<i>Tapinoma nigerrimum</i>	12	7.9
<i>Tetramorium caespitum</i>	1	0.7
<i>Myrmecina graminicola</i>	8	5.3
<i>Cardiocondyla elegans</i>	1	0.7
<i>Camponotus sylvaticus</i>	1	0.7
<i>C. foreli</i>	12	7.9
<i>Cataglyphis iberica</i>	5	3.3
<i>Hypoponera eduardi</i>	1	0.7
Unidentified remains	13	8.6
Total	151	

Because of the type of food gathered (insect bodies) the workers of *Cataglyphis iberica* are not always successful in their foraging. Considering foraging efficiency as the percentage of the workers that return to the nest with a prey in the mandibles in reference to the total number of collectors that return during this time period (WEHNER et al. 1983, RETANA et al. 1986), we obtain average values of 27% (nest 4) and 16% (nest 5). These are definitively low values, very similar to those obtained for *Cataglyphis cursor* by RETANA et al. (1986). CARROLL and JANZEN (1973) justify the low foraging efficiency of the insectivorous ants in virtue of the unpredictability of their food source, location and quantity. However, another species of the genus, *Cataglyphis bicolor*, which is also zoonecrophagous shows efficiencies up to 90% in Greece, but only of about 50% in Tunisia (WEHNER et al. 1983). These variations within the same genus and even the same species show that foraging efficiency is a highly variable parameter on which many factors have an influence, especially the environmental factors which dictate the foraging activity (CERDA 1986), and the area, as far as the richness of resources is concerned.

In conclusion, *Cataglyphis iberica* gathers insect remains as food staple and this conditions great part of its foraging activity, both in the strategy of the species and in the success of its outings. The fact that this ant displays its maximum activity at the hours of greatest heat (with ground temperatures in the sun of up to 60°C) allows it to avoid competition for these resources with other species of the area that also use them, such as *Aphaenogaster senilis*. The high temperatures may also favour the death of other insects, which can be gathered advantageously by *Cataglyphis*, as MARSH (1985) suggests for another ecologically similar species, *Ocymyrmex barbiger*.

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STRESZCZENIE

[Tytuł: Skład pokarmu *Cataglyphis iberica* (EM.) (*Hymenoptera, Formicidae*)]

Pokarm *C. iberica* badano 2 metodami: wykopując komory zawierające odpadki pokarmu oraz odbierając robotnicom pokarm przynoszony przez nie do gniazda. Wyniki otrzymane tymi metodami wykazują pewne różnice, prawdopodobnie wynikające głównie z niejednakowego stopnia zachowania się, jak i możliwości identyfikacji, resztek pokarmowych pochodzących z różnych grup taksonomicznych.

C. iberica występuje w środowiskach suchych o skąpej roślinności, odżywia się martwymi stawonogami. Robotnice furają pojedynczo, co ogranicza rozmiary zdobyczy przynoszonej do gniazda (Fig. 2). Pokarm *C. iberica* stanowią głównie inne gatunki mrówek (Fig. 3), wśród których najliczniejsze są z rodzaju *Messor*. W diecie tego gatunku duży procent stanowią także inne grupy owadów, jak: *Hemiptera, Coleoptera, Orthoptera*.

РЕЗЮМЕ

[Заглавие: Состав пищи *Cataglyphis iberica* (EM.) (*Hymenoptera, Formicidae*)]

Питание *C. iberica* было исследовано 2 методами: путем откапывания гнезд, содержащих остатки пищи, а также путем отбирания у рабочих пищи, которую они несут в гнездо. Полученные результаты несколько отличаются друг от друга.

Но это проистекает, видимо, главным образом из разной степени сохранности, как и возможности определения остатков пищи, происходящих из разных таксономических групп.

C. iberica встречается в ксеротермных биотопах со скудной растительностью, питается мертвыми членистоногими. Рабочие приносят пищу в гнездо каждый самостоятельно, что ограничивает величину добычи (рис. 2). Пищу *C. iberica* составляют главным образом другие виды муравьев (рис. 3), среди которых наиболее многочисленны виды из рода *Messor*. Значительный процент в питании обсуждаемого вида составляют также такие группы насекомых, как: *Hemiptera*, *Coleoptera*, *Orthoptera*.
