

1 **ABUNDANCE AND DIVERSITY OF SOIL ARTHROPODS IN OLIVE GROVE**
2 **ECOSYSTEM (PORTUGAL): EFFECT OF PITFALL TRAP TYPE**

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15 **Running title:** soil arthropods of the olive grove

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26 **Abstract**

27 Soil arthropod biodiversity is an indicator of soil quality and can be studied using pitfall
28 trapping. In this research, olive grove edaphic fauna was assessed at different sampling dates
29 by comparing two different diameters (7 and 9 cm) and three different contents (empty, water
30 and preservative) of pitfall traps in order to determine which type of pitfall trap is more
31 efficient. Considering all pitfall trap types and sampling times, a total of 12937 individual
32 edaphic arthropods belonging to 11 taxa were recovered. Smaller traps with preservative
33 collected significantly more individuals than the other pitfalls tested. Larger and empty traps
34 collected significantly more spiders and traps with preservative collected more beetles.
35 Smaller and empty traps collected fewer individuals than the other trap types. Both Shannon's
36 diversity and Pielou's evenness indexes were higher in the larger and empty traps and
37 richness was higher in the smaller traps filled with water. The study of myrmecocenosis was
38 emphasised because olive grove soil fauna was numerically dominated by Formicidae (56.6%
39 of all organisms captured) belonging to 12 genera and 24 species; *Tapinoma nigerrimum*,
40 *Messor barbarus*, *Cataglyphis hispanicus*, *Tetramorium semilaeve*, *Cataglyphis ibericus*,
41 *Messor bouvieri* and *Camponotus cruentatus* were the most abundant ant species. Traps with
42 preservative reached the highest accumulation of species for a small number of pitfalls when
43 compared with the other pitfalls studied and a sampling effort of 20 samples is apparently
44 sufficient to sample the greater part of the ant species of the olive grove. From this study, it
45 seems that traps with preservative are the best choice to use in further studies concerning the
46 epiedaphic fauna of the olive grove.

47

48 Keywords: Epigeic arthropods; Olive grove; Trap type; Diversity; Formicidae

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51 **1. Introduction**

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53 In Trás-os-Montes (north-east of Portugal) the olive tree (*Olea europaea* L.) has a great
54 economic and social importance and soil fauna is an important component of this
55 agroecosystem. Edaphic organisms have important ecological functions such as
56 decomposition of organic matter, mineralization of nutrients and also as agents of biological
57 control of the olive pests that spend a period of their life cycle in the soil [6, 14]. The olive
58 fruit fly (*Bractocera oleae* (Gmelin.)) pupates in the olive grove floor [1, 8, 13] where it is
59 exposed to different groups of predators such as ants, ground beetles and spiders.

60 Among edaphic organisms, ants typically dominate the community in less disturbed
61 groves [14, 21] and several authors suggested that these organisms are potentially important
62 natural pest-control agents and biological indicators of soil condition in agroecosystems [9,
63 18, 21, 24]. Therefore, they should be an easily and reliably indicator used by farmers to
64 monitor soil quality [9]. Ants are important in below ground processes through the alteration
65 of the physical and chemical environment and through their effects on plants,
66 microorganisms, and other soil organisms. In the olive grove, ant biodiversity is high and
67 these organisms are very responsive to human impact, which can change its richness [21].
68 Some agricultural practices, like the application of pesticides and tillage, disturb ground
69 habitat structure and abundance and diversity of beneficial soil species can be reduced [12,
70 23].

71 The sampling procedure commonly used to study epiedaphic fauna is pitfall trapping
72 [23]. This technique has some advantages: it is simple, economic and works continuously
73 through day and night, allowing many samples to be taken [9]. However, the efficiency of
74 capture is affected by factors such as the diameter and the trap filling and the catch rate is a
75 result of abundance, activity and species catch ability [7]. Pitfall traps with preservative may

76 act as an attractive leading to an overestimating of some groups of arthropods. The choice of
77 the pitfall fill liquid and the diameter is important and must be done bearing in mind the goal
78 of the study. The objective of this study was to know the biodiversity of edaphic fauna in
79 olive grove, especially the ant community. To assess biodiversity, two different sizes and
80 three different contents of pitfall traps were used in order to determine which type of pitfall
81 trap is more efficient to use in further studies.

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83 **2. Materials and methods**

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85 **2.1. Study site**

86 The study area was located in an olive grove (>50 years old) near Mirandela (Portugal) (41°
87 32' 38" N, 7° 7' 29" W). The predominant olive cultivar is Cobrançosa (representing 80% of
88 the total) followed by Verdeal Transmontana, Madural and Borrenta cultivars. The grove
89 covers an area of 5 ha and the planting density is of 9 × 9 meters. Since 2001, the plant
90 protection has followed the Integrated Pest Management guidelines [5], and the grove was
91 ploughed superficially with a scarifier two to four times a year and fertilized with organic and
92 mineral nutrients. The trees are pruned every two or three years; no irrigation or phytosanitary
93 treatments were done during the experiments.

94

95 **2.2. Sampling method**

96 The sampling occurred monthly between April and July of 2004 and each month, 120 pitfall
97 traps, 30 of each type, were laid at soil level and collected after 24 hours. This time period
98 comprises the period of maximum arthropod activity in this biotope [19]. Two different types
99 of plastic pitfall traps were selected: *Trap A* with 16 cm height and 9 cm diameter and *Trap B*
100 with 9 cm height and 7 cm diameter. The influence of the trap content in the number of

101 individuals captured was tested using only the *Trap B* size. Thus, three traps with different
102 fills were performed namely, *Trap B1*– which remain empty; *Trap B2* – which was filled half
103 way with water and *Trap B3* – which was filled half way with a mixture of 70% ethanol, and
104 2% glycerine. *Trap A* and *Trap B1*, which remained both empty, were used to study the
105 influence of pitfall trap size on the efficiency of capture (number of individual caught *per*
106 trap). Traps were laid randomly in the field in the south side of the canopy at 80 cm from each
107 tree trunk. All trapped individuals were preserved in 70% ethanol, sorted, identified and
108 counted under binoculars to Classes, Orders or Families taxa. Ants were identified to species
109 according to Collingwood and Price [2].

110

111 **2.3. Data analysis**

112 Statistical analyses were performed using the Statistica Statistical Package, Version 6.0 [22].
113 Data were evaluated for normality and homogeneity of variances with Kolmogorov-Smirnov
114 test and Bartlett or *F* test, respectively. When necessary, the transformation $\text{Log}(X+1)$ was
115 used to normalise the data [26]. The number of individuals captured by pitfall traps at
116 different times was compared by a one-way ANOVA. Post hoc comparisons of means was
117 done using the Tukey test with $\alpha = 0.05$.

118 The information obtained on samples in the different times was cumulated into 4 groups
119 (*Trap A*, *Trap B1*, *Trap B2* and *Trap B3*). For each group, taxa and species diversity and
120 evenness were calculated following Shannon and Pielou indexes respectively. Richness index
121 (S) was also calculated based on the number of different taxa per trap [11]. One-way ANOVA
122 was used to compare differences between mean richness, diversity and evenness of taxa and
123 ant species between trap size and among trap fill and post hoc comparisons of means was
124 done using the Tukey test.

125 Ant species accumulation curves were used to estimate species richness in the olive grove
126 agroecosystem. This method illustrates the rate at which new species are added to the
127 inventory within a defined area [11]. As the number of samples increases, an increasing
128 number of species are sampled reaching a plateau [4]. The resulting diagram shows the
129 cumulative number of species recovered according to the increase number of pitfall traps
130 considering the last sampling period (July) where more species were captured. The software
131 program EstimateS [3] was used to calculate species accumulation curves for each pitfall trap.
132 Estimates of species richness for each sample were randomized 50 times.

133

134 **3. Results**

135

136 **3.1. Abundance and diversity of edaphic fauna**

137 Pitfall traps in the olive grove captured a total of 12937 edaphic arthropods belonging to 11
138 different taxa: Formicidae, Coleoptera, Araneae, Acari, Collembola, Hemiptera, Chilopoda,
139 Diplopoda, Dermaptera, Isopoda, and Orthoptera (Table 1). Besides those taxa, pitfall traps
140 captured 486 adult individuals belonging to the taxa Diptera, Hymenoptera (wasps), Odonata,
141 and Thysanoptera which are not true soil inhabitants and were not considered in the analysis.
142 Soil fauna was numerically dominated by Formicidae (56.6% of all organisms captured),
143 Collembola (15.7%), Coleoptera (13.5%), Acari (9.9%) and Araneae (1.2%). Hemiptera,
144 Chilopoda, Diplopoda, Dermaptera, Isopoda, Orthoptera and unidentified larvae collectively
145 accounted for 3.0% of the total collected.

146 Considering the size of the trap, significant differences were found between traps for total
147 abundance ($F = 10.31$; $df = 1, 238$; $P = 0.001$) and for spiders ($F = 6.54$; $df = 1, 238$; $P = 0.01$)
148 that were more collected in larger diameter traps (*Trap A*) than in *Trap B1* (Figure 1).
149 Relatively to the trap fill, significant differences among traps were found for ants ($F = 7.18$; df

150 = 2, 357; $P < 0.001$) and beetles ($F = 25.20$; $df = 2, 357$; $P < 0.001$). Post hoc comparisons of
151 trap fill showed significant differences between *Trap B1* and the other two trap types for ants,
152 and significantly more beetles were caught in trap with preservative - *Trap B3* - than in the
153 other two trap types studied. For total abundance, differences were found among all the trap
154 types ($F = 28.35$; $df = 2, 357$; $P < 0.001$), collecting the *Trap B3* significantly more
155 individuals than pitfall traps *B1* and *B2*.

156 In a general way, pitfall *Trap B3* was more efficient in terms of percentage of individuals
157 captured (41% of the total organisms recovered) followed by *Traps B2* and *A* which captured,
158 respectively 23% and 21% of all organisms and finally, *Trap B1* was the less efficient (15%).
159 Richness was higher for *Trap B2* and lower for *Trap B1*. Both diversity and evenness indexes
160 were higher for *Trap A*, than for *Traps B* (Table 1), however no significant differences were
161 found between sizes or trap fills.

162

163 **3.2. Abundance and diversity of ants.**

164 During the four times of pitfall trapping, a total of 7326 ants were obtained, belonging to 12
165 genera and 24 species (Table 2), which were for order of abundance: *Tapinoma nigerrimum*
166 (Nylander 1856), *Messor barbarus* (Linnaeus 1767), *Cataglyphis hispanicus* (Emery 1906),
167 *Tetramorium semilaeve* André 1883, *C. ibericus* (Emery 1906), *M. bouvieri* Bondroit 1918,
168 *Camponotus cruentatus* (Latreille 1802), *Formica subrufa* Roger 1859, *Aphaenogaster*
169 *iberica* Emery, 1908 and *Crematogaster scutellaris* (Olivier, 1792). The other species had
170 less than 20 individuals.

171 In this olive grove, myrmecocenosis is largely dominated by *T. nigerrimum*, with 55.4% of
172 relative abundance. *M. barbarus*, was the second more abundant species, with 23.3%,
173 followed by *C. hispanicus* with 6.4% of ants recovered. However, considering the occurrence

174 of those two species *C. hispanicus* was present in more pitfall traps (48.5%) than *M.*
175 *barbarus*, present in 44.7% of total traps.

176 When abundance in each trap type is analysed separately by sampling month, the *Trap B3*
177 captured more individuals than the other trap types in three out of four sampling months
178 (Figure 2). However, in April it was the *Trap B2* that reached the highest abundance. One-
179 way ANOVA showed significant differences between trap size in April ($F = 4.56$; $df = 1, 58$;
180 $P = 0.04$). For the trap fill, significant differences were found between *Trap B3* and *Traps B1*
181 and *B2* in May ($F = 7.08$; $df = 1, 87$; $P = 0.014$) and between *Trap B1* and *Trap B3* in June (F
182 $= 6.98$; $df = 1, 87$; $P = 0.015$). Richness was higher in July in all trap types. In May, *Trap A*
183 captured more species than the other traps, but in the other months it was the *Trap B3* that
184 captured more species. Both diversity and evenness were higher in *Trap A* than in the other
185 trap types in three of four sampling months. Only in July, *Trap B3* reached the highest
186 diversity and evenness indexes. No significant differences were found between traps in all
187 sampling months for richness and diversity and evenness indexes. In general, *Trap B3* was the
188 richest when compared with the other pitfall traps, although the observed “lower” diversity
189 value seems to misfit the data set. These values are caused by the decrease in evenness as a
190 consequence of a high abundance of some particular species (e. g. *Tapinoma nigerrimum*),
191 thus reflecting the high sensitivity of the index to distribution of individuals among species.

192 When ant species accumulation curves were plotted for each trap, pitfall *Trap B3* caught more
193 species for a lower number of samples than the other trap types studied and had the greatest
194 species accumulation after 30 samples, in contrast, pitfall *Trap A* and *Trap B1* had the least
195 species accumulation curves. Both were very similar in terms of number of species
196 accumulated except in the beginning of the curve where *Trap B1* had a slower rate of increase
197 than *Trap A*. For pitfall traps type *B2* and *B3*, the species accumulation curves were still rising

198 after 30 samples indicating that the survey was not completed, but pitfalls *Trap A* and *B1*
199 showed a tendency to reach a plateau after 30 samples (Figure 3).

200

201 **4. Discussion**

202

203 In this study, the olive grove supported an abundant and diverse group of edaphic arthropods
204 that was numerically dominated by ants.

205 Most studies reported in the literature concern with arthropods of the olive tree canopy but
206 little is known about the composition and structure of edaphic arthropods. In the study
207 conducted by Morris and Campos [14] in a Spanish olive grove, the composition of soil fauna
208 is similar to that obtained in our study, i.e., the most abundant epigeic taxa are Formicidae and
209 Coleoptera. The presence of other groups is heterogeneous and depends on the localisation of
210 the olive grove, the management regime and the surrounding vegetation [14].

211 Considering pitfall traps fill, *Trap B3* with ethanol captured considerably more specimens.
212 According authors like Luff [10] the trap fill liquid might act as attractive or repulsive. In our
213 study, ethanol probably had an attractive effect on Formicidae and Coleoptera. On the other
214 hand, an empty trap (*Trap B1*) or a trap filled with a liquid that doesn't kill immediately the
215 animal (*Trap B2*) may facilitate the escape or the predation between captured arthropods
216 resulting in biased counts. Regarding the size of pitfall traps, the largest diameter of *Trap A*
217 obtained a higher diversity index than the minor diameter of *Trap B1*. It seems that the taxon
218 Araneae was affected by the diameter of pitfall traps because they were more captured in the
219 largest traps (*Trap A*) and the lower height of pitfall trap *B1* probably facilitates the leak of
220 the spiders. Different results were obtained by Work *et al.* [25], concerning Coleoptera. Those
221 authors studied different diameter pitfall traps ranging from 4.5 to 20 cm and found that
222 beetles and spiders were more abundant in larger sized traps. The choice of the pitfall trap

223 type (size and fill liquid) might be done carefully and having in mind the goal of the study and
224 the taxonomic group to survey because species are affected in different ways and the results
225 obtained may lead to an overestimation or an underestimation of the population's effectiveness
226 [16]. Small sized traps caught the dominant fauna as well as larger traps although they are
227 easy to handle. Traps with preservative captured a significant high number of individuals and
228 have the advantage to kill immediately stopping animal's escape.

229 Morris *et al.* [17] and Pereira *et al.* [19] studied ant communities associated with olive tree
230 canopy and both authors found that *T. nigerrimum* was the most abundant species in the olive
231 groves. These results coincide with that obtained in our study even concerning soil captures.
232 *T. nigerrimum* is a very aggressive species being considered an important predator of the
233 olive moth, *Prays oleae* (Bern.), an olive pest [14]. On the other hand, it can have a negative
234 effect in the natural control of this pest by predated Chrysopid eggs [15] and *Trichogramma*
235 wasps [20]. *M. barbarus*, appears in this study as the second most abundant species. Its
236 distribution is very heterogeneous in the different olive groves cited in the literature.
237 According to Redolfi *et al.* [21], species like *M. barbarus*, *M. bowieri*, *M. lusitanicus*, *C.*
238 *hispanicus* and *C. ibericus* appears in open areas between trees and are very sensitive to
239 ploughing. If olive grove is frequently disturbed then sensitive species will be progressively
240 eliminated and communities will be dominated by resistant and resilient species.

241 The relation between pitfall trap type and the number of samples led to the estimation of
242 different ant species accumulation curves. Empty pitfalls (A and B1) reached the saturation
243 with a lower number of species than fill pitfall traps and the accumulation curves were
244 equivalent. *Trap B3* reached the highest accumulation of species for a small number of
245 pitfalls. In this case, 5 pitfall traps were sufficient to reveal the presence of the dominant ant
246 species on the olive floor and 20 to sample the greater part of the ant species.

247 In conclusion, in order to minimize the sampling effort of the study while still sufficiently
248 reflecting the actual soil assemblages, 20 pitfall traps of smaller size half-filled with
249 preservative seems to be a potentially good sampling method to be used in future studies
250 concerning olive grove epiedaphic fauna.

251

252 **Aknowledgements**

253

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258 **References**

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260 [1] M. Civantos, Olive pest and disease management, Conseil Oleicole International, Madrid,
261 1999.

262 [2] C. Collingwood, A. Price, A guide to ants of continental Portugal, Supplement nº 5,
263 Boletim da Sociedade de Entomologia, 1998.

264 [3] R.K. Colwell, EstimateS, Version 7.5: Statistical Estimation of Species Richness and
265 Shared Species from Samples (Software and User's Guide). Freeware for Windows and Mac
266 OS, 2004 (<http://viceroy.eeb.uconn.edu/EstimateS>).

267 [4] R.K. Colwell, J.A. Coddington, Estimating terrestrial biodiversity through extrapolation,
268 Phil. Trans. R. Soc. Lond. B. 345, (1994) 101-118.

269 [5] H.B. Gomes, M. Cavaco, Protecção Integrada da Oliveira – Lista dos produtos
270 fitofarmacêuticos e níveis económicos de ataque, Ministério da Agricultura, Desenvolvimento
271 Rural e Pescas – Direcção Geral de Protecção das Culturas, Oeiras, 2003 55 pp.

- 272 [6] J.E. Herrick, Soil quality: an indicator of sustainable land management. *Appl Soil Ecol.* 15
273 (2000) 75-83.
- 274 [7] J.M. Holland, S Smith, Sampling epigeal arthropods: an evaluation of fenced pitfall trap
275 using mark-release-recapture and comparisons to unfenced pitfall traps in arable crops,
276 *Entomol Exp Appl.* 91 (1999) 347-357.
- 277 [8] P. Katsoyannos, Olive pests and their control in the Near East. Food and Agriculture
278 Organization of the United Nations, FAO Plant Production and Protection Paper 115. (1992)
279 178pp.
- 280 [9] L.A. Lobry de Bruyn, Ants as bioindicators of soil function in rural environments, *Agr.*
281 *Ecosyst. Environ.* 74 (1999) 425-441.
- 282 [10] M.L. Luff, Some features influencing the efficiency of pitfall traps, *Oecologia.* 19 (1975)
283 345-357.
- 284 [11] A.E Magurran, *Measuring Biological Diversity*, Blackwell Publishing, Oxford, 2004 192
285 pp.
- 286 [12] C.R. Mathews, D.G. Bottrell, M.W. Brown, Habitat manipulation of the apple orchard
287 floor to increase ground-dwelling predators and predation of *Cydia pomonella* (L.)
288 (Lepidoptera: Tortricidae), *Biol. Control.* 30 (2004) 265- 273.
- 289 [13] S. Michelakis, Influencia de los insectos y de las enfermedades en la cantidad y en la
290 calidad del aceite de oliva, *Olivae.* 30 (1990) 38-40.
- 291 [14] T. Morris, M. Campos, Predatory insects in olive-grove soil. *Zool. Baetica.* 10 (1999)
292 149-160.
- 293 [15] T.I. Morris, M. Campos, M.A.M. Jervis, P.K. McEwen, N.A.C. Kidd, Potencial effects
294 of various ants species on green lacewing (*Chrysoperla carnea*) egg numbers, *J. Appl.*
295 *Entomol.* 122 (1998) 401-403.

296 [16] T.I. Morris, M. Campos, N.A.C. Kidd, M.A. Jervis, W.O.C. Symondson, Dynamics of
297 the predatory arthropod community in Spanish olive groves, *Agr. Forest. Entomol.* 1 (1999)
298 219-228.

299 [17] T.I. Morris, W.O.C. Symondson, N.A.C. Kidd, M. Campos, The effect of different ant
300 species on the olive moth, *Prays oleae* (Bern.), in Spanish olive orchard, *J. Appl. Entomol.*
301 126 (2002) 224-230.

302 [18] S.L. Peck, B. McQuaid, C.L. Campbell, Using ant species (Hymenoptera: Formicidae) as
303 a biological indicator of agroecosystem condition, *Environ. Entomol.* 27 (1998) 1102-1110.

304 [19] J.A. Pereira, A. Bento, D. Sousa, M. Campos, L. Torres, Estudo preliminar sobre
305 formigas (Hymenoptera: Formicidae) associadas ao olival da Terra Quente transmontana
306 (nordeste de Portugal), *Bol. San. Veg. Plagas.* 28 (2002) 357-365.

307 [20] J.A. Pereira, A. Bento, J.E. Cabanas, L.M. Torres, A. Herz, S.A. Hassan, Ants as
308 predators of the egg parasitoid *Trichogramma Cacoeciae* (Hymenoptera: Trichogrammatidae)
309 applied for biological control of the olive moth, *Prays oleae* (Lepidoptera: Plutellidae) in
310 Portugal, *Biocontrol Sci. Techn.* 14 (2004) 653-664.

311 [21] I. Redolfi, A. Tinaut, F. Pascual, M. Campos, Qualitative aspects of myrmecocenosis
312 (Hym., Formicidae) in olive orchards with different agricultural management in Spain, *J.*
313 *Appl. Ent.* 123 (1999) 621-627.

314 [22] StatSoft, Inc., 2004. STATISTICA (data analysis software system), version 7.
315 www.statsoft.com.

316 [23] T.R.E Southwood, *Ecological methods with special reference of insect populations*,
317 Chapman and Hall, London, 1978 391 pp.

318 [24] C. Wang, J. Strazanac, L. Butler, Abundance, diversity, and activity of ants
319 (Hymenoptera: Formicidae) in oak-dominated mixed Appalachian forests treated with
320 microbial pesticides, *Environ Entomol.* 29 (2000) 579-586.

321 [25] T.T. Work, C.M. Buddle, L.M. Korinus, J.R. Spence, Pitfall trap size and capture of
322 three taxa of litter-dwelling arthropods: implications for diversity studies, *Environ. Entomol.*
323 31 (2002) 438-448.

324 [26] J.H. Zar, *Biostatistical Analysis*, 4th ed., Prentice Hall, London, 1998 929 pp.

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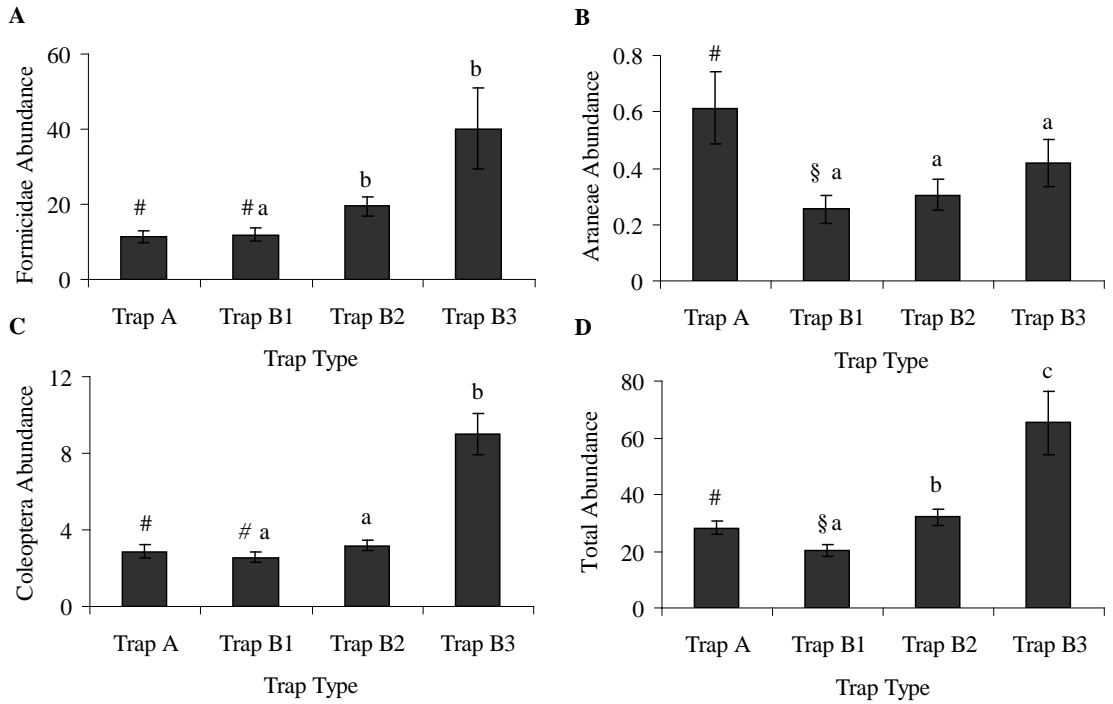
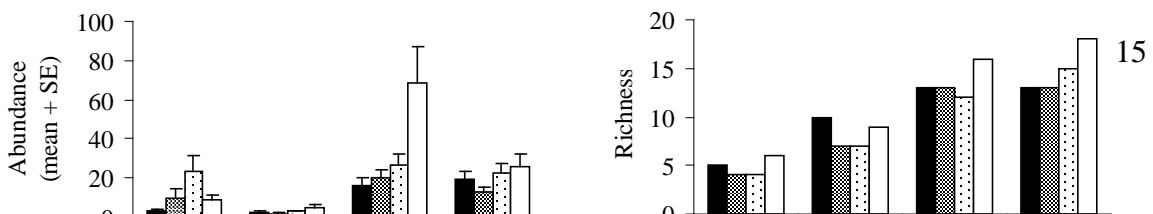


Figure 1. Comparison of mean captures (\pm SE) by the four pitfall trap types for Formicidae (A), Araneae (B), Coleoptera (C), and Total Abundance (D). Bars sharing the same symbol are not significantly different at $P > 0.05$ for pitfall trap size; bars sharing the same letter are not significantly different at $P > 0.05$ for pitfall trap filling.



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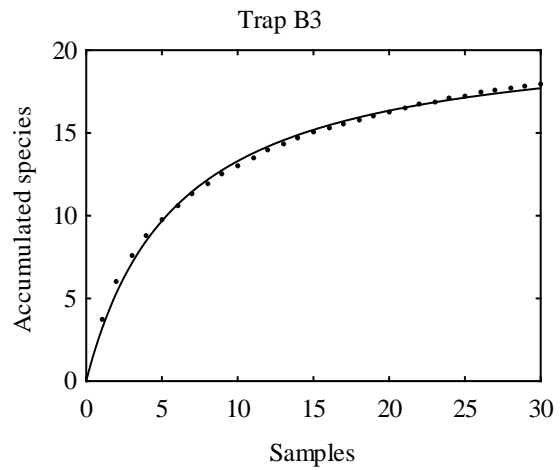
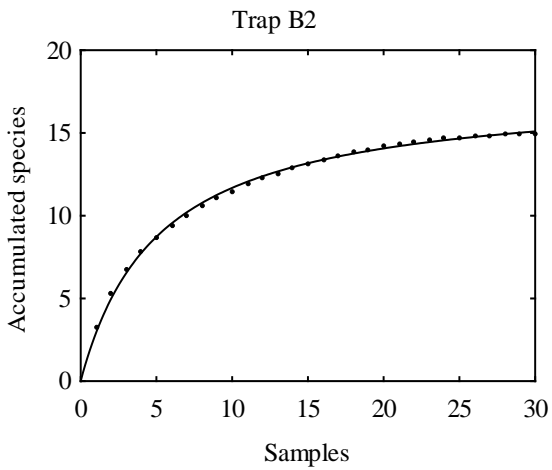
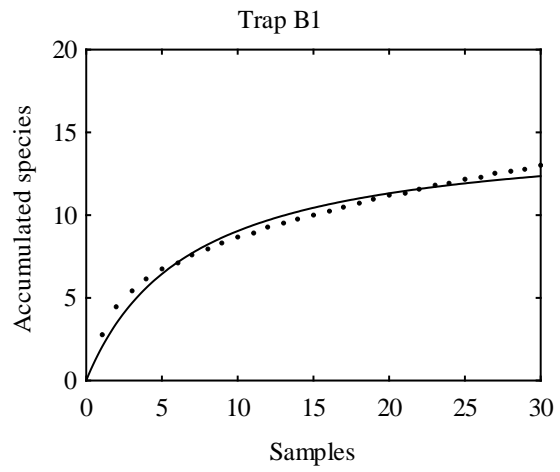
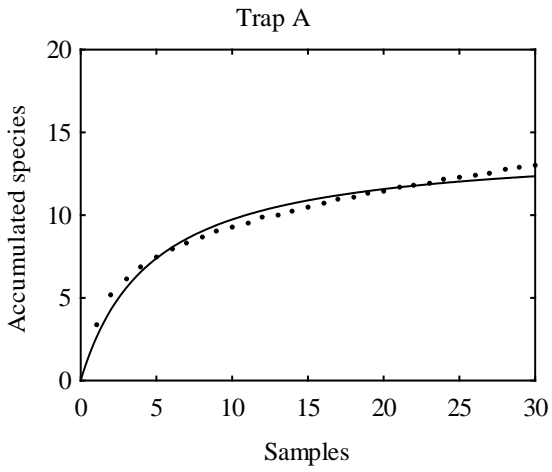
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367 Figure 2. Abundance (mean + standard error of the mean), species richness and Shannon's
368 diversity and Pielou's evenness indexes for ant community in the different pitfall traps types
369 and in the four sampling months.

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374 Figure 3. Species accumulation curves for the four pitfall trap types studied: *Trap A*, *Trap B1*,
 375 *Trap B2*, and *Trap B3*. Each point represents the mean of 50 randomizations. Solid-lines
 376 represent the estimated species accumulation.

377

378 Table 1. Total number of individuals, richness, diversity and evenness of edaphic arthropods
 379 community captured in the different pitfall trap types studied (n = 480).

Group	<i>Trap A</i>	<i>Trap B1</i>	<i>Trap B2</i>	<i>Trap B3</i>
Araneae	62	25	29	42
Acari	558	212	274	243
Formicidae	1182	1167	1857	3120
Coleoptera	289	250	302	909
Collembola	582	232	393	820
Hemiptera	25	7	17	33
Dermaptera	0	0	2	0
Orthoptera	1	0	0	0
Isopoda	0	0	1	2
Chilopoda	0	2	1	1
Diplopoda	2	0	0	0
Unidentified larvae	28	41	82	144
Total	2729	1936	2958	5314
Richness	9	8	10	9
Shannon's diversity index	0.624	0.535	0.520	0.528
Pielou's evenness index	0.654	0.592	0.520	0.553

380 Samples and time were cumulated.

381

382 Table 2. Species of Formicidae captured in the total number of pitfall traps (n = 480).

Subfamily and species of ants	N	%	<i>f</i>	%O
Subfamily Dolichorinae				
<i>Tapinoma nigerrimum</i> (Nylander, 1856)	4062	55.44	258	53.8
<i>Tapinoma</i> sp.	108	1.47	20	4.2
Subfamily Formicinae				
<i>Camponotus aethiops</i> (Latreille, 1798)	6	0.08	5	1.0
<i>Camponotus cruentatus</i> (Latreille, 1802)	56	0.76	29	6.0
<i>Camponotus fallax</i> (Nylander, 1856)	4	0.05	3	0.6
<i>Camponotus foreli</i> Emery, 1881	5	0.06	5	1.0
<i>Camponotus piceus</i> (Leach, 1825)	10	0.13	8	1.7
<i>Camponotus</i> sp.	12	0.16	10	2.1
<i>Cataglyphis hispanicus</i> (Emery, 1906)	467	6.37	191	39.8
<i>Cataglyphis ibericus</i> (Emery, 1906)	272	3.71	148	30.8
<i>Formica cunicularia</i> Latreille, 1798	9	0.12	7	1.5
<i>Formica subrufa</i> Roger, 1859	24	0.32	14	2.9
<i>Lasius niger</i> (Linnaeus, 1758)	2	0.02	2	0.4
<i>Plagiolepis pygmaea</i> (Latreille, 1798)	7	0.09	5	1.0
Subfamily Myrmicinae				
<i>Aphaenogaster iberica</i> Emery, 1908	23	0.31	12	2.5
<i>Crematogaster auberti</i> Emery, 1869	5	0.07	3	0.6
<i>Crematogaster scutellaris</i> (Olivier, 1792)	23	0.31	14	2.9
<i>Gonionmma</i> sp.	1	0.01	1	0.2
<i>Leptothorax angustulus</i> (Nylander, 1856)	11	0.15	9	1.9
<i>Messor barbarus</i> (Linnaeus, 1767)	1710	23.34	176	36.7
<i>Messor bouvieri</i> Bondroit, 1918	163	2.22	26	5.4
<i>Messor lusitanicus</i> Tinaut, 1985	2	0.03	2	0.4
<i>Tetramorium semilaeve</i> André, 1883	280	3.82	96	20.0
<i>Tetramorium</i> sp.	64	0.87	26	5.4

383 (N) Total number of captured individuals, (%) Relative abundance of each species relating to
 384 the total number, *f* - Number of samples where the species were trapped and O – occurrence
 385 (in percentage) in total sampled traps.

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