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Cataglyphis floricola nov. sp. new species for the genus *Cataglyphis* FÖRSTER, 1850 (Hymenoptera, Formicidae) in the Iberian Peninsula

A. TINAUT

Department of Animal Biology and Ecology, University of Granada, 18071 Granada, Spain

Cataglyphis floricola, nov. sp. is described and a number of peculiarities such as the double colouration are discussed. Some ant nests contain only black individuals whereas others have bicoloured (red and black) individuals. Geographic and biometric parameters suggest that these two types constitute a single species

This species, known at the moment only in the Doñana National Park (Huelva), is phylogenetically close to *C. emmae* (FOREL, 1909), a species living in Saharan deserts. This relationship is analysed taking into account paleogeographic evidence to discuss the presence of this group of species in the south of the Iberian Peninsula.

Keywords: *Cataglyphis floricola*, new species, taxonomy, biometry, Formicidae, Iberian Peninsula

INTRODUCTION

In the present work, *Cataglyphis floricola* nov. sp,. a new species for the genus *Cataglyphis* FÖRSTER, 1850, is described. The distribution of this species appears to be restricted to the terminal portion of the Guadalquivir Basin, an area which today includes the Doñana National Park (Huelva). This species is peculiar in a number of ways, including the circumstances surrounding its discovery. Revising the genus *Cataglyphis* for the Iberian Peninsula (TINAUT & PLAZA, 1989; TINAUT, 1990a and b), the author examined both museum material and specimens collected personally from numerous locations, including Doñana. In addition, reports on ants collected in Doñana National Park (DE HARO & COLLINGWOOD, 1977; TINAUT, 1991) cited only *C. iberica* (EMERY, 1906) and *C. rosenhaueri* (EMERY, 1906). Furthermore, among the six species recorded for the entire Iberian Peninsula, the species described in this work evidently did not appear, nor was it even suspected.

This new species was discovered in a series of unidentified *Cataglyphis* workers collected in Doñana by Dr. ESPADALER (Barcelona). After reviewing our own specimens from this area, and finding none which could be attributed to this species, we collected new material, which, surprisingly, showed a high frequency of this species in some zones of Doñana. Afterwards, we studied specimens from the same area collected by Soledad CARPINTERO (University of Córdoba) and Dr. Xim CERDÀ (University of Paris Nord), and found that *C. floricola* nov. sp. was indeed the major component.

Consequently, it is particularly striking that until now a species in such a conspicuous genus should have escaped notice. This oversight could be due to its similarity in size and colour with *C. iberica* (EMERY) and *C. rosenhaueri* (EMERY).

Another peculiarity of *C. floricola* nov. sp. is its dual colouration: one form is a monotone black or dark grey; the other is bicoloured, with the head and thorax red, and the gaster black. This dual colouration, appearing in a considerable number of species in the genus *Cataglyphis,* at times shows a tonal gradation - from black to bicolour - attributable to either latitude, as in *C. bicolor* (Fabricius, 1793) (Wehner *et al.*, 1983), or altitude as in *C. velox* Santschi, 1929 (Tinaut, 1990a). In some other species, differences in such colour types are more pronounced, without clear transition, leading to the distinction of different species based exclusively on colour criteria (Tinaut & Plaza, 1989). In our case, having found no distinguishing morphological characteristics other than colour, we consider both colour types found among the specimens from Doñana to belong to the same species: *C. floricola* nov. sp.

The name for this species derives from the proclivity of this ant to gather flower petals (see Cerda *et al.*, 1992).

MATERIALS AND METHODS

From this species we have studied approximately 400 workers from 5 nests, 4 females and 9 males caught in pit-fall traps near the nests of this species, and specimens collected by X. Espadaler, X. Cerdà, S. Carpintero, C. Herrera and the author.

For comparisons we have also studied specimens from other closely related species, including several workers, males and females of *C. emmae* (Forel, 1909) from Algeria (Delye leg.), males and workers of *C. bombycinus* (Roger, 1859) from Morocco (Tinaut, leg.) and one female and two workers of *C. sabulosa* Kugler, 1981, from Saudi Arabia (Collingwood, leg.).

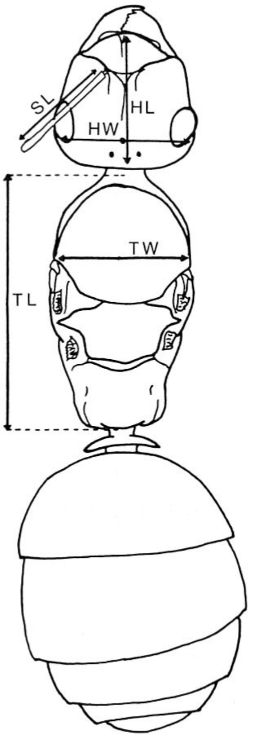


Fig. 1. Parameters measured in each specimen.

For the biometric study we considered the following parameters (Fig.1): head length (HL); head width (HW); scape length (SL); thorax length (TL); in the case of the sexual castes we also considered thorax width (TW) and wing length (WL). From among the most commonly used indices (BOLTON, 1987), we chose the cephalic index (CI) and the scape index (SI), calculated from the equations: CI= HW x 100/HL and SI=SL x 100/HW. For the analytic comparison between the different nests we used an ANOVA, and Scheffé's test for comparisons between two samples (ZAR, 1984).

Cataglyphis floricola nov. sp.

Material

Holotype worker. Spain: Doñana, Huelva, dunes of Matalascañas, nest 3, 28.4.1992, A. TINAUT (In the author's collection.)

Paratypes 4 females, 9 males, 350 workers. Same data as holotype. Specimens deposited in the collection of the National Museum of Natural History in Madrid, Museum of Natural History in Geneva, National Museum of Natural History in Paris, British Museum of Natural History in London and in the collections of Dr. DELYE and Dr. ESPADALER.

Description

Holotype worker (Fig. 2 - A, D, G): HL: 1.30, HW: 1.22, SL: 1.52, TL: 2.05, CI: 93.84, SI: 124.50. Colour black, with dense microsculpture somewhat less distinct on the gaster; consequently the tegument is mat except on the slightly shinier gaster. Abundant pubescence, but not obscuring the texture of the tegument.

Head rectangular, smooth occipital edge and uniformly arched. Surface densely microsculptured, including the frontal triangle. Compound eyes large and situated in the lower half. Tiny ocelli at the level of the lower edge of the compound eyes. Clypeus with ridge in the centre, arched and with 6 or 7 long hairs on the front edge. Mandibles slightly striated, with 6 teeth, the apical one most pointed, the preapical somewhat less and the rest small and irregular. Maxillary palps as long as the head, with two types of hair, curved and semi-erect, with a length similar to the diameter of the third article. The third and fourth articles almost equal in length, each somewhat longer than the fifth and sixth together, these being nearly equal to each other in length. Scape projecting half its length beyond the occipital edge.

Thorax typical of the genus, epinotum uniformly convex, slightly flat on the dorsal side. Surface without hairs, with a light, shiny pubescence. Large appendages with reddish tarsus and scale-like petiole thick and covered with pubescence.

Gaster slightly shiny due to lighter microsculpture. Long hairs only in the ventral region and around the anus. Very sparse dorsal pubescence.

Paratype workers: Two types of colouration occur: 1) monotone-black or dark grey; or 2) bicoloured-with reddish thorax and legs, and black gaster. Each of the two types shows considerable uniformity (Table 2), and the only apparent differences between individuals of the first type are in the number of mandibular teeth, which vary between 5 and 6, and the colour, which can range from black to dark grey. Among the workers of the bicoloured type, differences also appear in the number of teeth, between 5 and 6, and in the frequent presence of two sub-erect hairs in the occipital region.

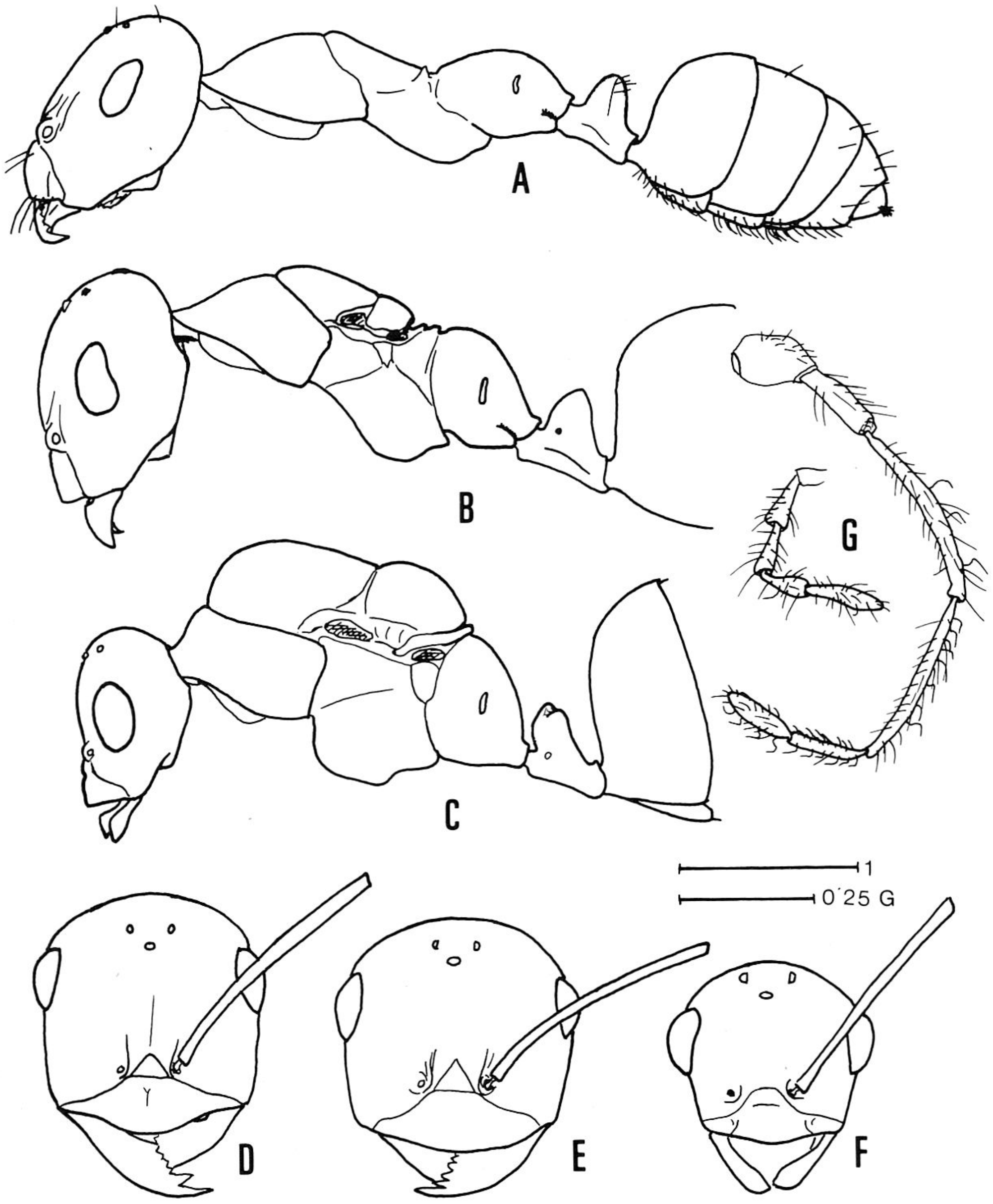


Fig. 2. *Cataglyphis floricola* nov. sp. Worker: A) profile, D) head, G) labial and maxillary palps. Female: B) profile, E) head. Male: C) profile, F) head (scale in mm).

Paratype females (Fig. 2- B, E; Table 4): Colour dark grey, almost black. Antennae, tibia and tarsals lighter in colour. Silvery pubescence abundant on the thorax, somewhat sparser on the head and absent on the gaster. Thorax stenonotal. Size similar to that of workers.

Head almost rectangular, lateral edges straight, occipital edge rounded on the sides. Surface microsculptured with silky shine. Some long hairs on the edge of the clypeus; sparse, uniformly distributed pubescence. Mandibles with apical tooth more pointed and developed, the other four teeth short. Scape projecting somewhat more than a third of its length beyond the occipital edge. Eyes compound and ocelli normal. Thorax little developed, with the scutum and scutellum very small. Traces of the wing base and tegules, suggesting brachyptery. Silvery pubescence over entire pronotum, metanotum and pleurae.

Thick, scale-like petiole slightly pointed at the apex. Gaster similar to that of the worker in size, colour and texture.

Variability: Same dual colouration as in worker. The differences in this caste occur in the degree of development of the mesonotum, apparent in a possible reduction in the scutellum size, with disappearance of the sutures and wing loss leaving only stumps.

Paratype males (Fig. 2- C, F; Fig. 3; Table 4): Head, pronotum and scutum black, the rest of the body dark grey; antennae, petiole and legs lighter. Wings somewhat darker with strongly marked nervation. Tegument microsculptured, especially on scutum.

Head ovoid, surface microsculptured, with some pubescence and silky shine. Mandibles with only one tooth and without striations. Maxillary palps with the last two articles equal in length and together the same length as the fourth. Scape projecting half its length beyond the occipital edge, funiculus of twelve very similar cylindrical articles. Eyes compound, situated in the posterior half of the genae. Ocelli normal.

Thorax massive, as wide as the head. Scutum and scutellum well developed, metanotum small. Some short hairs on the scutum, sparse pubescence. Petiole scale-like, thick and with indented apex. Gaster microsculpted and with light pubescence.

Genitalia: stipites elongated and oval; most characteristic are finger-like processes at the external base of stipites. The volsellas and lacinias also very elongated, the volsella slightly flanged at the end. The terminal end of the sagitta in the form of a curved peak, on the border appearing 6 or 7 small teeth, separate and triangular. The subgenital plate concave with a slight elevation in the center of the depression.

Variability: two males from bicolour nests were bicoloured, but in reverse pattern to the workers, i.e. red gaster and legs, and the rest black. Apart from size, as will be discussed later, the only appreciable variation in general appearance is in the mandibular tooth, which can be very small. The genitalia are very uniform, differences appearing only in the number of sagittal teeth, which can reach a total of eleven. The other variation is found in the subgenital plate, in which the central elevation can be absent.

Affinities

Based on the type of petiole and the male genitalia, *C. floricola* nov. sp. is included in the *emmae*-group (AGOSTI, 1990) composed by *C. emmae* and an undescribed species from Pakistan (AGOSTI, 1990). The most important differences to *C. emmae* are that workers of *C. floricola* are monomorphic and their tegument is mat. The females are smaller (HL=1.29 (*C. floricola* = *C.f.*), 1.75 (*C.emmae* = *C.e.*); TL= 2.24 (*C.f.*), 2.78 (*C.e.*)) and they are brachypterous or wingless. Finally, the males are also smaller (HL= 1.16 *(C.f.)*, 1.31 (*C.e.*); TL= 2.4 (*C.f.*), 2.55 (*C.e.*)), and differ in the genitalia, mainly in the sagitta, volsella and lacinia (Figs 2, 3 and 4).

With regard to species which are geographically closer, the only species with which this one might be confused (and confusion seems to have occurred on many occasions, as discussed above) are *C. rosenhaueri* and *C. iberica*. In both cases the workers can be easily distinguished by their low, nodiform petioles (Fig. 4 - L, M). In addition the micro-punctuated texture of *C. floricola* and its silky, muted shine can help distinguish this species, but this difference is more evident between the

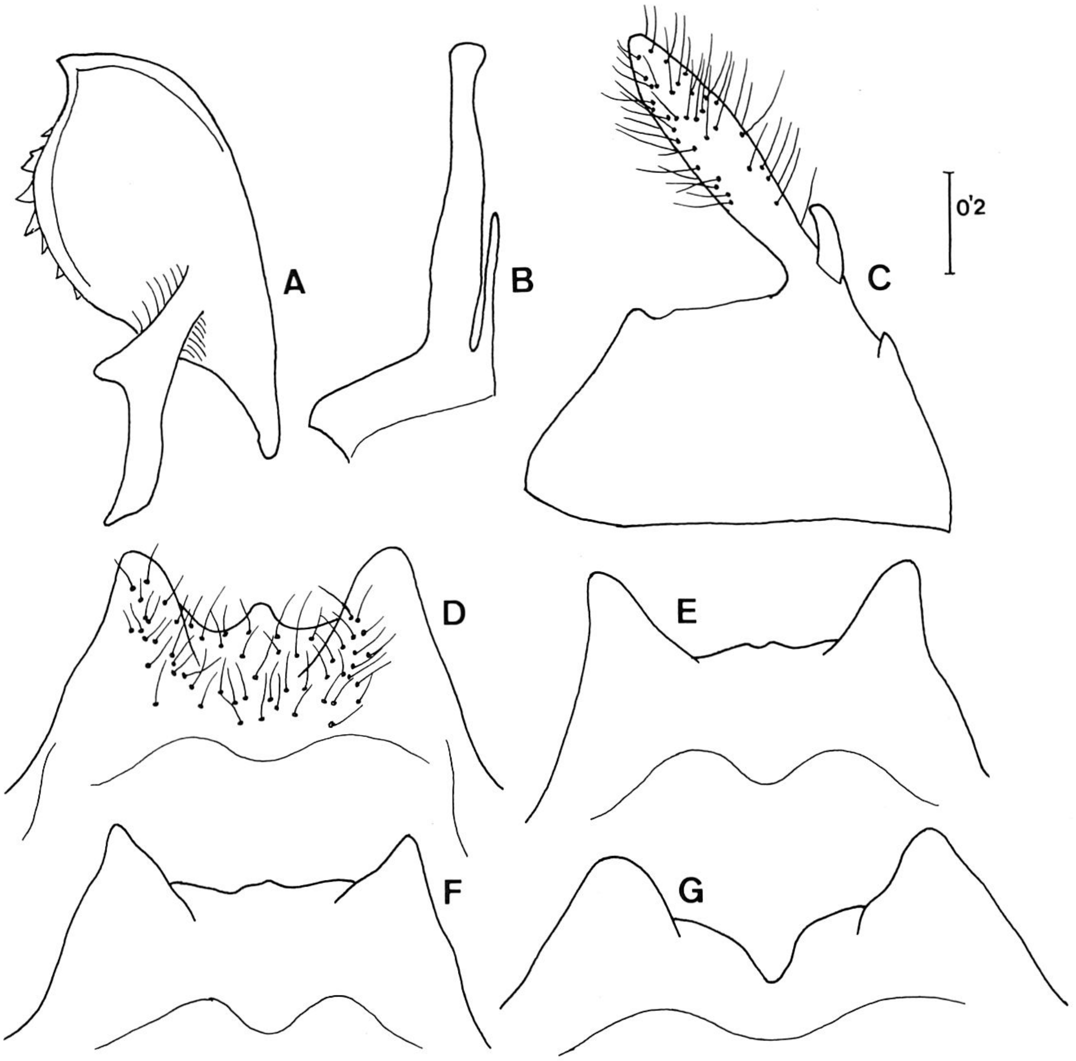


Fig. 3. *Cataglyphis floricola* nov. sp.. Male genitalia: A) sagitta, B) volsella and lacinia, C) squamula and stipite, D-G) variation in the subgenital plate (scale in mm).

black form of *C. floricola* and *C. iberica*, though not as obvious as the distinction between the bicoloured form of *C. floricola* and *C. rosenhaueri*. In the case of the sexual castes, both in size and genitalia (Figs. 3 and 4), there is little chance of confusion with any of the species known for the Iberian Peninsula.

DISCUSSION

Intraspecific differences

The most important differences found between specimens of *C. floricola* concern the different dual-coloration patterns. In *C. iberica* and *C. rosenhaueri* (TINAUT & PLAZA, 1989) colour alone was found not to be an adequate taxonomic characteristic. Nevertheless, in the case of *C. floricola* there are, at least in the workers, slight characteristics linked to colour differences, such as two sub-erect hairs in the occipital region, a more polished and shiny gaster, and a relatively larger size

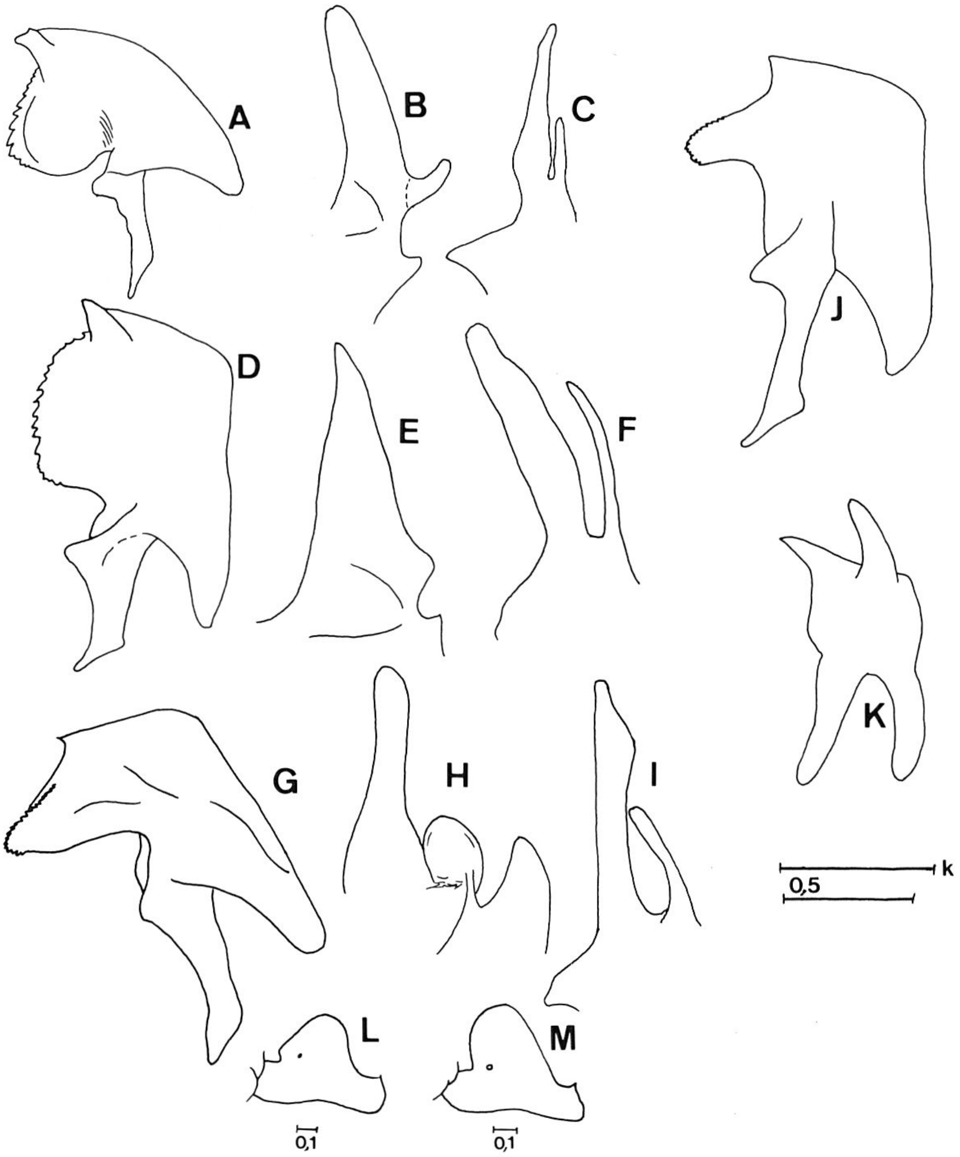


Fig. 4. Male genitalia. A-C) *C. emmae,* D-F) *C. bombycinus*, G-I) *C. cursor*, J) sagitta of *C. velox,* K) sagitta of *C. iberica*, L) petiole of *C. rosenhaueri*, M) petiole of *C. floricola* nov. sp. (scale in mm).

among bicoloured types. Male genitalia, however, are very similar in males of both types of colouration, especially in the structures most important for establishing the phylogeny, such as the stipites, sagittas, volsellas and lacinias. Differences appear only in the number of sagittal teeth and in the structure of the subgenital plate, facts not linked to colouration and therefore of no taxonomical value in this case.

A biometric particularity of *C. floricola* is its marked monomorphism, with head length and width as well as thorax length, being far less variable than in *C. iberica* or *C. rosenhaueri,* two species of similar size (Tab. 1) and ecology. Interestingly, the closest species (see below), *C. emmae*, is characterized by a marked polymorphism, with soldier-type workers (Delye, 1962).

If in fact this uniformity can be applied to the entire species (Tab. 2), or directly to each of the forms, there are slight but significant differences between the two

Table 1. Coefficient of variation for head length (HL), head width (HW) and thorax length (TL) - calculated dividing the maximum value by the minimum value for each parameter in each species.

	H L	H W	T L
C. floricola	1.21	1.31	1.18
C. rosenhaueri	1.84	1.84	1.64
C. iberica	1.62	0.77	1.62
C. emmae	2.35	2.83	3.89

Table 2. Most important aspects of each parameter, measuring 75 specimens belonging to the two colour types. (HL= head length, HW= head width, SCL= scape length, TL= thorax length, FL= femur III length, CI= cephalic index, SI= scape index. In mm.)

	Mean	St. Dev.	Mínim.	Maxim.
HL	1.262	0.064	1.150	1.400
HW	1.186	0.060	1.025	1.350
SL	1.486	0.050	1.350	1.625
TL	2.038	0.068	1.850	2.200
FL	2.027	0.069	1.850	2.275
CI	94.031	3.117	74.545	98.182
SI	125.513	5.789	111.111	148.780

forms (Tab. 3). There are also significant morphological differences between nests of the same type of colouration, e.g. nests H4B, HRB and H5B, where all the ants are bicoloured. Conversely, differences between nests of different types do not occur in all the cases (Tab. 3). Similar results were obtained by PLAZA (1987) with a biometric comparison of *C. iberica* and *C. rosenhaueri.*

We also obtained similar result for sexuals, and despite the small number studied, we maintain our belief that the differences are not exclusive to any type of colouration (Table 4).

Both forms have been detected in a relatively limited area, the Doñana National Park and the dunes between Matalascañas and Mazagón. On this geographical scale these two types might be considered to be sympatric; however, on a more reduced scale the two forms do not co-exist and do not appear to be mixed. This spatial separation could be attribuitable to a speciation process. Another possibility is that microclimatic factors could cause the development of this dual colouration.

Phylogenetic relationship

The main problem in the genus *Cataglyphis* is in differentiating the species level. Nevertheless, the separation between species-group is easier (see AGOSTI, 1990).

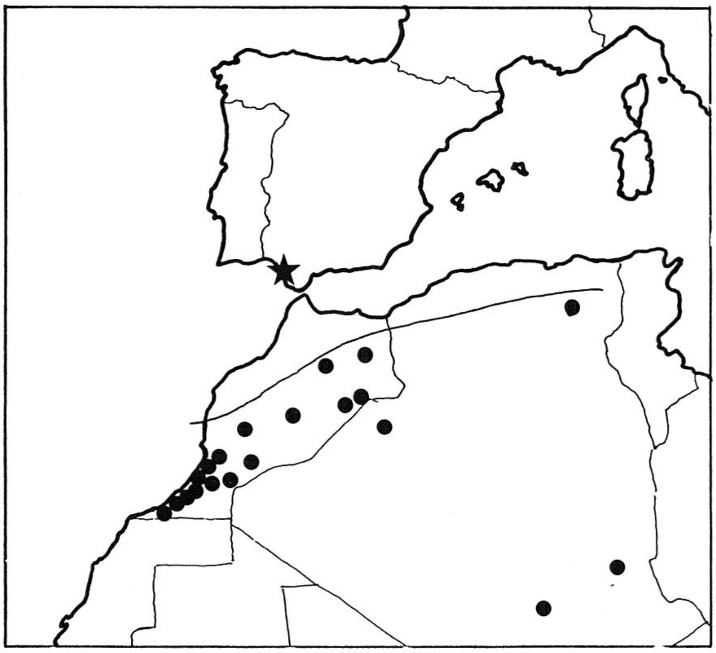
Table 3. Scheffé-test value comparing the populations of black and bicolour forms, by overall grouping and by nest; H2 and H3 belong to the black form, H4B, HRB, and H5B the bicolour form (*=significant differences 95%).

Nest	HL	HW	SL	TL	FL	CI	SI
black- bicolor	32.28*	13.97*	1.96*	8.51*	4.17*	4.05*	31.66*
H2 - H3	0.05	0.06	1.34	0.02	0.72	0.01	0.13
H2 - H4B	1.45	0.96	0.63	0.03	0.10	0.01	3.90*
H2 - HRB	7.16*	2.04	1.48	2.59*	7.99*	1.54	0.77
H2 - H5B	4.77*	2.40	1.23	0.84	0.24	0.26	8.51*
H3 - H4B	0.96	0.54	1.89	0.11	0.28	0.04	4.36*
H3 - HRB	6.01*	1.40	0.40	3.08*	3.91*	1.77	0.98
H3 - H5B	3.85*	1.70	2.86*	1.12	0.13	0.36	9.19*
H4B - HRB	2.17	0.20	4.03*	2.03	6.27*	1.31	1.21
H4B - H5B	0.96	0.33	0.10	0.54	0.03	0.17	0.89
HRB - H5B	0.24	0.02	5.41*	0.48	5.48*	0.53	4.17*

Table 4. Measurements in mm. of sexuals castes of *C. floricola* nov. sp. (TW= thorax width, WL= wing length, the rest as in Tab. 2)

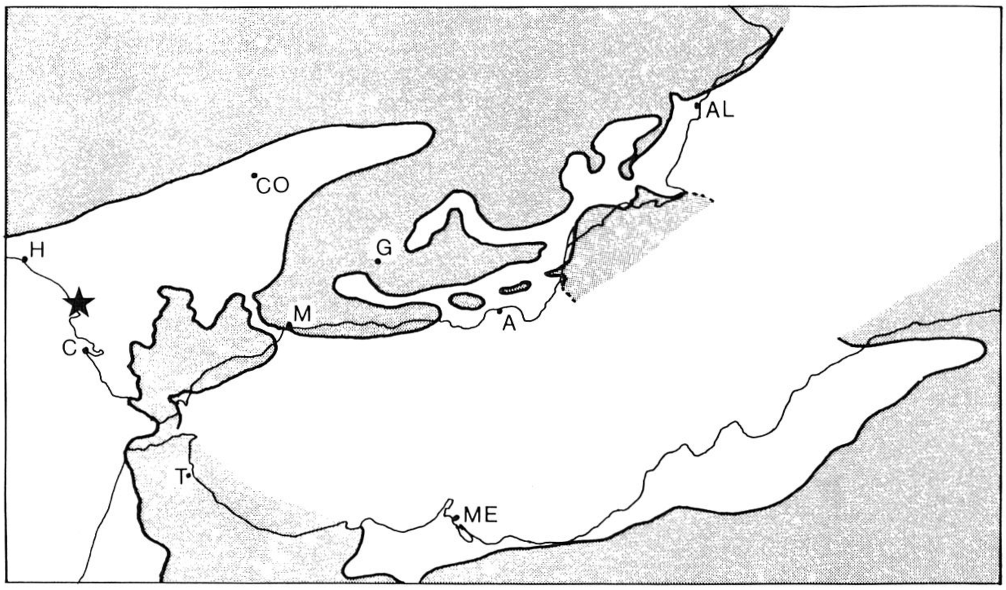
SEX	HL	HW	SL	TL	TW	WL
Female	1.27	1.27	1.38	2.12	0.55	—
Female	1.33	1.27	1.33	2.23	0.57	—
Female	1.27	1.12	1.27	2.12	0.47	—
Female	1.30	1.30	—	2.50	0.95	—
Male	1.10	0.98	1.35	2.17	1.30	3.20
Male	1.15	1.10	1.45	2.28	1.30	3.64
Male	1.10	0.98	1.35	2.12	1.00	3.56
Male	1.15	1.05	1.33	2.40	1.02	3.56
Male	1.12	1.02	1.38	2.30	1.15	3.40
Male	1.15	1.02	1.43	2.25	1.25	3.28
Male	1.23	1.18	1.43	2.85	1.50	4.40
Male	1.33	1.20	1.55	2.83	1.65	4.68

Taking into account only the workers characteristics such as the scale-like petiole and the type of maxillary palps, *C. floricola* could be classified near such different species as *C. pallidus* MAYR, 1877, *C. sabulosa* KUGLER, 1981, or even *C. cursor* (FONSCOLOMBE, 1846). The monomorphism of the workers, the brachyptery of the females and the dentition of the males are also characteristics which could cause errors in classification. Nevertheless, the type of sagitta (punctuated discoidal with a curved serrate edge and with wide-based teeth), the finger-like process at the base of the stipites and the elongated lacinia and volsella, are practically identical to those of *C. emmae*, a species which we consider closely related to *C. floricola*. Especially the tip of the sagitta and the stipes differentiate *C. floricola* from any others cited above (Fig. 4), whereas the workers of these species bear a certain resemblance.



Map 1. Distribution of *C. emmae* (●) and of *C. floricola* nov. sp. (★).

Despite the close phylogenetic relationship between *C. floricola* and *C. emmae*, there are striking differences in their geographical distribution. *C. emmae* is known from the south of the Atlas Mountains, Saudi Arabia and Pakistan (AGOSTI, 1990). In North Africa this species lives in the wet valleys south of the Moroccan Atlas Mountains and the Tellian Atlas (Map 1), although to the west it reaches the coastal dunes south of Agadir (DELYE, 1962; DELYE & BONARIC, 1973a and b). The brachyptery and aptery of *C. floricola* female suggest that it is a more recent species than *C. emmae*, descending from the latter or from some common ancestor. The monomorphism could also be a derived character given the strong dimorphism that exists in *C. emmae* or in *C. bombicynus*, two closely related species. This monomorphism may have been produced by a dropout of one of the segregated caste of a polymorphic ancestor (WILSON, 1978, p. 134). The possibility of a more recent origin of *C. floricola* is strengthened by the fact that the area currently occupied by this species is of very recent post-orogenic sedimentary origin, having formed the line of coastal dunes in the recent Quaternary, about 40,000 years ago during the Würm III (VELA, 1984) and forming in the last 2,000 years the "Lacus Ligustinus" of the Romans, where the Donaña National Park is located (MENANTEAU & CLEMENTE, 1977).



Map 2. Reconstruction of the situation of the Strait of Gibraltar during the Mesiniense (modified from MONTENAT, 1977), (–) present-day Mediterranean coastline; (▬) Mediterranean coastline during the Mesiniense, (★) location of the Donaña National Park. (A= Almería, AL= Alicante, C= Cádiz, CO= Córdoba, G= Granada, H= Huelva, M= Málaga, ME= Melilla, T= Tetuán)

It is known that the Mediterranean Sea last opened during the Pliocene and that the African and Iberian plates have not closed again. Therefore, any common area for these two species, or one with breachable separations, must predate the Pliocene (Map 2). The paleogeology of this westernmost part of the Mediterranean is extremely complex, due to the origin of its elements and the successive connexions and ruptures between the North African and the Iberian plates (HSÜ, 1978; HSÜ *et al.*, 1973; MONTENAT, 1977), but this complexity does not preclude the existence of Atlantic coastal dunes which could have constituted a common area for *C. emmae* or for the ancestor of both species. The appearance of brachypterous and apterous females with limited dispersion capacity, together with the opening of the Mediterranean must have contributed to the isolation of these populations and thereby to the origin of *C. floricola* nov. sp., which probably would already have occupied the dunes of the Atlantic Iberian coast.

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RÉSUMÉ

Une nouvelle espèce de fourmi, *Cataglyphis floricola* nov. sp. est décrite. Certaines particularités intéressantes que montre cette espèce sont discutées, notamment l'existance d'un double type de coloration. Des considérations de natures biométriques et géographiques nous amènent à considérer que les deux types de colorations appartiennent à une seule et même espèce.

L'espèce décrite dans le présent travail n'a été capturée que dans le Parc National de Doñana (Huelva) et elle se trouve phylogénétiquement liée à *C. emmae* (FOREL, 1909), espèce propre au désert du Sahara. Cette relation est étudiée en tenant compte de données paléogéographiques qui expliquent la présence de ce groupe d'espèces dans le sud de la Peninsule Ibérique.

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