Mem. Soc. entomol. ital., 77: 317-357 *31 marzo 1999*

Matthias SANETRA, Robert GÜSTEN & Andreas SCHULZ

On the taxonomy and distribution of Italian *Tetramorium* species and their social parasites (Hymenoptera Formicidae)

Abstract - New data on tetramoriine ants in southern Italy are presented, based on recent collections from Sardinia, Sicily, Calabria, Lucania, Apulia and Abruzzi. Numerous records of the socially parasitic genera *Strongylognathus* and *Anergates* lead to significant extensions of the known range for several species. *S. alpinus*, found in Abruzzi, Calabria and Sicily, is new for the Italian fauna. *A. atratulus* is recorded in Lucania and Sicily for the first time. New life history information, including new host species records for *A. atratulus* (*T. diomedeum*), *S. huberi* (*T. impurum*) and *S. testaceus* (*T. brevicorne*), is also provided.
Characterization of species limits through both morphological and enzyme electrophoretic investigations allows several new taxonomic arrangements. *S. cecconii* Emery, 1916 and *S. emeryi* Menozzi, 1921 proved to be synonyms of *S. destefanii* Emery, 1915. Four new synonyms in *Tetramorium* are also established. *T. punctatum* Santschi, 1927 is elevated to species rank, and species status is reinstated for *T. diomedeum* Emery, 1908. Lectotypes of *T. brevicorne* Bondroit, 1918 and *T. punctatum* are designated. A *Tetramorium* species hitherto unrecognized in Italy is reported but not named. Available literature records of the species concerned are critically reviewed, and the resulting distribution patterns in Italy and adjacent regions are discussed.

Riassunto - *Tassonomia e distribuzione delle specie italiane di Tetramorium e dei loro parassiti sociali (Formicidae Myrmicinae).*
Vengono qui segnalati nuovi dati sulle formiche della tribù Tetramoriini sulla base di nuove raccolte in Sardegna, Sicilia, Calabria, Basilicata, Puglia e Abruzzo. Numerosi ritrovamenti dei generi parassiti sociali *Strongylognathus* e *Anergates* hanno portato a significative estensioni dell'areale noto di varie specie. *S. alpinus*, trovato in Abruzzo, Calabria e Sicilia, risulta nuovo per la fauna italiana. *A. atratulus* è stato rinvenuto in Basilicata e Sicilia per la prima volta. Vengono poi fornite nuove informazioni sui costumi di vita e nuove specie ospiti per *A. atratulus* (*T. diomedeum*), *S. huberi* (*T. impurum*) e *S. testaceus* (*T. brevicorne*).
La caratterizzazione dei limiti specifici attraverso studi sia morfologici che elettroforetici ha consentito nuove sistemazioni tassonomiche. *S. cecconii* Emery, 1916 e *S. emeryi* Menozzi, 1921 sono stati dimostrati sinonimi di *S. destefanii* Emery, 1915. Vengono anche stabilite quattro nuove sinonimie nel genere *Tetramorium*. *T. punctatum* Santschi, 1927 viene elevato a specie distinta e viene rivalutato a buona specie *T. diomedeum* Emery, 1908. Vengono poi designati i lectotipi di *T. brevicorne* Bondroit, 1918 e di *T. punctatum*. Una specie ancora inedita di *Tetramorium* dell'Italia meridionale viene qui citata ma non descritta. I dati di letteratura riguardanti le specie qui trattate vengono rivisti criticamente e le distribuzioni in Italia e regioni adiacenti vengono quindi discusse.

Key words: Formicidae, *Tetramorium*, *Strongylognathus*, *Anergates*, Italy, taxonomy, ecology, distribution, social parasites

INTRODUCTION

The myrmicine ant tribe Tetramoriini is best represented in the Old World Tropics, but a considerable number of species have successfully adapted to temperate conditions within the Palaearctic biomes. Only a few species occur in the New World. The extre-

mely diverse genus *Tetramorium* Mayr encompasses the great majority of described taxa, while the other six genera presently recognized play a less important role with respect to species numbers (Bolton, 1976). A complete cladistic analysis of tetramoriine ants may well reveal that these additional genera, three or four of them established for social parasites, in fact are ingroups relative to *Tetramorium* The usually large colonies of *Tetramorium* can be found in virtually all kinds of terrestrial habitats, and a number of arboreal species is also known from tropical rainforests. Bolton (1976, 1977, 1979, 1980) revised the taxonomy of *Tetramorium* in all faunal regions except the Palaearctic, where systematics of the genus still remain in complete disarray. Over 130 names assignable to *Tetramorium* (including many infrasubspecific entities and other unavailable names) have been erected for Palaearctic forms, 55 of which were listed by Bolton (1995) as currently residing in species rank. It has been predicted that after a taxonomic revision the number of valid *Tetramorium* species will be about 25 in the Palaearctic (Bolton, 1980), but this will certainly prove considerably underestimated. Schulz (1996) gave an estimate of approximately 100 species distributed in the Palaearctic region.

Tetramoriine ants of Italy have received little attention after their treatment in comprehensive works on the ant fauna of this country by Emery (1916) and Baroni Urbani (1971). Occasionally a few faunistic papers dealing with the region have contributed some useful information to the knowledge of this taxonomically difficult group (Casewitz-Weulersse, 1974; Le Moli & Rosi, 1991; Mei, 1995; Poldi, 1980, 1994; Rigato & Sciaky, 1989; Scupola, 1994). The large number of 17 availably named *Tetramorium* forms reported from Italy (Baroni Urbani, 1971; Poldi et al., 1995; Mei, 1995) gives rise to questions about their taxonomic validity. In addition, Italy is comparatively rich in social parasites that depend upon the workers of free-living *Tetramorium* species. Whereas most of these parasites are slave-raiders of the genus *Strongylognathus* Mayr, one of them, *Anergates atratulus* (Schenck, 1852), is found as a rare inquiline in *Tetramorium* nests. The tribal placement of the latter species has been a subject of debate. Recently Baur et al. (1996) provided evidence based on DNA studies that the genus *Anergates* Forel is best placed in Tetramoriini, as are the other social parasites associated with *Tetramorium* hosts. No less than eight described species of *Strongylognathus* have been considered to belong to the Italian fauna (Poldi et al., 1995). However, it still remains an open question how many of these are distinct taxa, since partial revisions of the *S. huberi* group (sensu Bolton, 1976) by Pisarski (1966) and Baroni Urbani (1969) did not sufficiently clarify the taxonomy of the genus.

We report here on recent collections of *Tetramorium* species and some of their social parasites from southern Italy dating mainly from 1993 and 1994, including 20 new records of *Strongylognathus* and two of *Anergates*. The data were collected from the regions Sardinia, Sicily, Calabria, Lucania, Apulia and Abruzzi, but some additional findings of socially parasitic species from other parts of Italy are included. This new material together with studies of previous collections sheds new light on taxonomic problems regarding the *Tetramorium* and *Strongylognathus* fauna of the country.

ORGANIZATION OF SPECIES ACCOUNTS

Lists of synonyms are mainly composed of names attributed to Italian forms.

Rather than giving all citations for the relevant names (this has been done by Baroni Urbani, 1971), we confine our compilation to synonyms and elevations in rank. Usually, large samples of several nests were taken, so only the locality was listed and no counts of individuals are shown. The samples were collected by the three authors except when otherwise indicated. In many cases, sexuals of *Tetramorium* were reared in the laboratory from pupae or prepupae extracted from the nests. As females (rarely also males) are often indispensable for species determination, this technique deserves to become more widely applied. Males were investigated only incidentally in the present study; little taxonomically useful information about this morph can be gained from the literature as yet. We also list additional specimens investigated by us, including type material of many questionable taxa from NHMB, MCG, MCV, MHNG and MCZ (for abbreviations see below).

In the main text, we summarize both morphological and biochemical characters important for species recognition. The determination of *Tetramorium* species on a morphological basis is extremely complicated. It still appears difficult to establish a satisfactory key for the Italian *Tetramorium* species, and for now we have refrained from the attempt. A previous study revealed the potential usefulness of isozyme electrophoresis in taxonomic investigations on the Tetramoriini (Sanetra et al., 1994). Polymorphic loci detected in that work were examined and used as additional characters (Tab. 4 pag.333). The designation of enzyme electromorphs follows Sanetra et al. (1994), and new variants are assigned accordingly. We found that in *Tetramorium* diagnostic electromorphs are often present that permit species distinction more reliably than morphology. Unfortunately, electrophoretic patterns in *Strongylognathus* are rather uniform and do not aid in detecting species boundaries within the *S. huberi* group (see also Sanetra et al., 1994).

As far as possible we provide information about ecology and biology of each species. Further, the known range of each species, with emphasis on Italy, is commented with reference to the available literature data. For the social parasites, short statements on nest composition, host species and habitat structure accompany each record.

ABBREVIATIONS

a) Museums

NHMB	Naturhistorisches Museum, Basel, Switzerland
MCG	Museo Civico di Storia Naturale "Giacomo Doria", Genova, Italy
MCV	Museo Civico di Storia Naturale, Verona, Italy
MHNG	Muséum d'Histoire Naturelle, Genève, Switzerland
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge (Mass.), USA

b) Enzyme systems

Gpi	glucose-6-phosphate isomerase
G3pdh	glycerol-3-phosphate dehydrogenase
Idh	isocitrate dehydrogenase
Mdhp	malate dehydrogenase (NADP+)
Mdh	malate dehydrogenase (NAD)
Pgm	phosphoglucomutase

c) Measurements

PW	width of petiolus

PPW width of postpetiolus
ML length of mesosoma
HW head width

COMMENTED LIST OF *TETRAMORIUM* SPECIES

Tetramorium caespitum (Linnaeus, 1758) [Figs. 1, 13]

Tetramorium caespitum caespitum var. *fusciclava* Emery, 1925 (unavailable name)
Tetramorium caespitum v. *fusciclavum* Consani & Zangheri, 1952: **syn. nov.**

In the first description, Emery (1925) does not state which of the mentioned features of var. *fusciclava* are suitable for distinction from typical *T. caespitum*. Indeed all characters given clearly fall within the range of variation observable in that species. The first use as subspecies *fusciclavum* by Consani & Zangheri (1952) represents only a listing without any morphological information. Not surprisingly, the taxon was found upon examination of two syntypes to be a straightforward synonym of *T. caespitum*.

COLLECTING DATA:
Sardinia - Prov. Sassari, Lago del Coghinas 10 km NW Oschiri, ca. 200m, 2.V.1994, M. Sanetra leg. [tentatively identified as *T. caespitum*]; Prov. Sassari, Monte Limbara, 1000-1100m, 3.V.1994, M. Sanetra leg.;

Sicily - Prov. Messina, Monti Nebrodi, road N. 289 Cesaró-S. Fratello, Portella Femmina Morta, ca. 1500m, 12.V.1994, M. Sanetra leg. [host of *S. alpinus*];

Calabria - Prov. Reggio di Calabria, 2 km W Melito di Porto Salvo, 14.V.1994; Prov. Reggio di Calabria, Aspromonte, Montalto summit, 1950m, 16.V.1994 [host of *S. alpinus*]; Prov. Cosenza, Sila Grande, S shore Lago Arvo, ca. 1200m, 18.V.1994 [host of *S. testaceus*]; Prov. Cosenza, Sila Grande, Monte Pettinascura 6 km NW Germano, ca. 1600m, 18.V.1994; Prov. Cosenza, Sila Grande, Monte Botte Donato, ca. 1800m, 18.V.1994; Prov. Cosenza, Capo Trionto 3 km NW Mirto Crosía, 20.V.1994; Prov. Cosenza, Monte Pollino, 4 km NW Morano Calabro, 1000-1100m, 21.V.1994.

OTHER INVESTIGATED MATERIAL: Sicily, M. Etna, 1450m, 30.III.1924, H. Kutter leg. 3☿☿ (NMB) [filed as *T. semilaeve*]; Emilia-Romagna, Riccione near Rimini, L. Emery leg. 2☿☿ (MCG), syntypes of *T. caespitum fusciclavum* Consani & Zangheri.

This common species is widespread throughout Eurasia, though nothing detailed is known about the eastern populations. In central Europe it generally prefers lowland habitats mostly with sandy soil (Cammaerts et al., 1985; pers. obs.) and is almost absent above 1500m, where only its probable sibling species, *T. impurum*, occurs. From the information available it is clear that *T. caespitum* is obligatorily monogynous (see also Kutter, 1977).

Among the Italian species, *T. caespitum* and *T. impurum* are immediately recognizable by their large females (see Tab. 3) with the mesonotum strongly bulging, thereby obscuring the pronotum in dorsal view (Fig. 13). *T. caespitum* workers show extreme variability both between and within populations so that much confusion arises in determination. Specifically, we have been unable to distinguish *T. semilaeve* from small, weakly sculptured *T. caespitum* on worker morphology. López (1991) has commented on this problem and provided useful characters, especially the different shape of the petiolus (see Figs. 1, 3, and Fig. 2 in López

1991). These are nevertheless difficult to apply and have not extensively been studied outside the Iberian Peninsula. As in other parts of Europe, southern Italian *T. caespitum* are clearly characterized by male morphology and a unique *Mdhp* electromorph (Tab. 4 pag. 333). Details of differentiation from *T. brevicorne* of Sardinia are given in that species account.

The distribution pattern of *T. caespitum* in Calabria and Sicily evident from our samples is much different from that observed in central Europe. The species occurs either on cultivated land near the coast, with workers very large in size, or on mountain meadows above 1000m, there replacing *T. impurum* from farther north. It seems well possible that the coastal form is a recent colonizer which can compete with autochthonous species, like *T. semilaeve*, only in severely altered habitats.

Among the surveyed colonies from the southern mountains, we found three which deviated from all other electrophoretically investigated *T. caespitum* by exhibiting a unique *Mdh* electromorph (Tab. 4 pag. 333). Such colonies were collected from the Nebrodi mountains (Sicily), the Sila Grande, and the M. Pollino area (Calabria), occurring syntopically with usual *T. caespitum* at least at the two first mentioned localities. The apparent absence of heterozygotes suggests that a cryptic species may be involved, but further study is needed.

The presence of *T. caespitum* in Sardinia was questioned by Emery (1916) and Baroni Urbani (1971) who asserted that it is completely replaced by *T. brevicorne*. Hence, the latter author listed all previous records from Sardinia under "*T.* prope *caespitum*". However, confirmed by genital morphology and electrophoresis our investigations clearly show the existence of *T. caespitum* on that island, even though it appears uncommon there. Its discovery in a remote undisturbed place at Monte Limbara renders unlikely that the species has been newly introduced to Sardinia in historical times. The apparent fixation of a *G3pdh* electromorph in that population different from the one on the mainland (Tab. 4) further supports this point of view.

Tetramorium impurum (Förster, 1850)

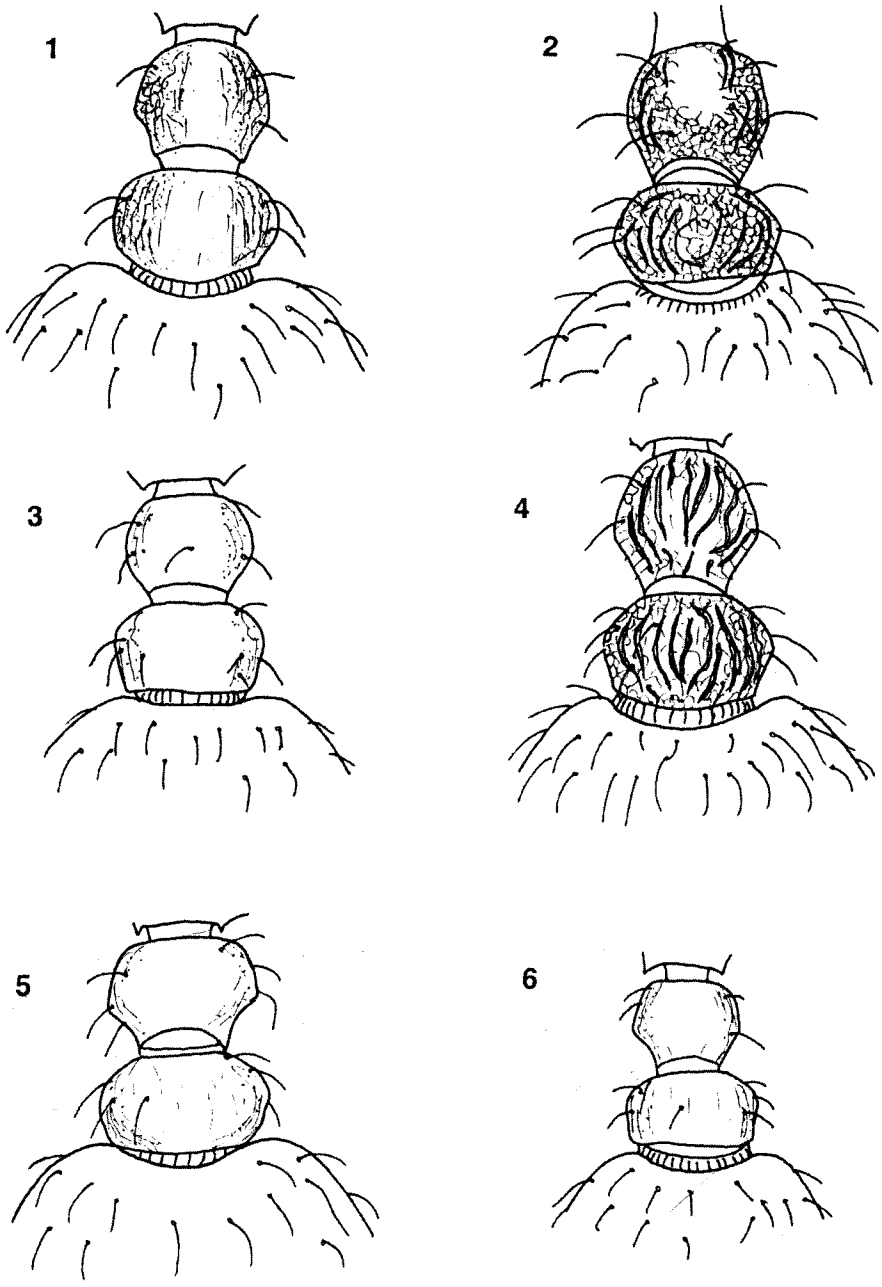
Tetramorium caespitum v. *penninum* Santschi, 1927: **syn. nov.**

The syntype ☿☿ of *T. caespitum* v. *penninum,* from a colony infested by Strongylognathus alpinus, show morphological features more typical for *T. impurum* than for *T. caespitum* (comparatively strong and extensive rugosity particularly on the nodes, as already pointed out in the original description). As explained below, ☿ morphology alone is not sufficient to completely exclude possible synonymy with *T. caespitum* in this case. However, intensive collecting by the authors and others have proven that, in the Alps, *T. caespitum* only exceptionally occurs at the altitude of the type locality of v. *penninum* and does not serve as host species for *Strongylognathus alpinus* in this area (see also *S. alpinus* section).

COLLECTING DATA:

Calabria - Prov. Cosenza, Monte Pollino, 4 km NW Morano Calabro, 1000-1100m, 21.V.1994 [host of *S. testaceus* and *S. huberi*];

Lucania - Prov. Potenza, Monte Pollino, near Rifugio De Gasperi, ca. 8 km SE Rotonda, ca. 1600m, 21.V.1994 [host of *A. atratulus*];



Figs. 1-6. Petiolar nodes (dorsal view) of *Tetramorium* ☿☿: 1 - *T. caespitum;* 2 - *T. brevicorne;* 3 - *T. semileave;* 4 - T. sp. "Gargano"; 5 - *T. diomedeum;* 6 - *T. punctatum.* Drawings by A. Schulz; scale bar 0.3 mm.

Apulia - Prov. Foggia, Gargano, road N. 528, ca. 2 km NE intersection to Carpino, ca. 700m, 23.V.1994, R. Güsten & M. Sanetra leg. [host of *S. huberi*]; Prov. Foggia, Gargano, road Monte S. Angelo-Carpino 1,5 km NW intersection to Vico del Gargano, ca. 700m, 24.V.1994, R. Güsten & M. Sanetra leg. [host of *S. destefanii*];
Abruzzi - Prov. L'Aquila, Gran Sasso, ca. 6 km NE Castel del Monte, ca. 1600m, 30.V.1994, M. Sanetra leg. [host of *S. alpinus*].

Other investigated material: Switzerland, Zermatt, ca. 1600m, W.M. Wheeler leg. 4☿☿ (NMB), syntypes of *T. caespitum penninum* Santschi [host of *S. alpinus*].

The species is locally frequent in central Europe and the Alps, where it prefers higher elevations and more clayey or loamy soils than *T. caespitum*. Like that species, it is monogynous, though there is one record of polygyny from the Alps (Buschinger, 1974). *T. impurum* is probably widely distributed in other parts of the Palaearctic but the actual range remains insufficiently known for several reasons: its status as a distinct species has been confirmed as late as about twenty years ago (Kutter, 1977; Cammaerts et al., 1985), and workers of *T. impurum* are still very difficult to distinguish from those of *T. caespitum*. The latter are generally less strongly sculptured with much intraspecific variation and transition to *T. impurum*. Morphometric characters and differences of sculpture elaborated recently (Seifert, 1996), though constituting a progress, do not identify all samples correctly and appear to be less useful outside central Europe. Females of *T. impurum* are said to possess a slightly less bulging mesonotum, stronger sculpture and to be somewhat smaller and lighter in colour (Kutter, 1977; Cammaerts et al., 1985). These differences, however, are statistical and apparently of little value for species distinction in southern Italy. Therefore reliable assignment of our samples to either *T. caespitum* or *T. impurum* had to be based on the readily distinguishable male genitalia (see Fig. 1 in Cammaerts et al., 1985) and different electromorphs for *Mdhp* (Tab. 4 pag. 333; see also Sanetra et al., 1994).

T. impurum was first mentioned for Italy by Poldi (1980) from Piedmont, but the record, being based on a single worker, seems very doubtful. Indeed it still stands as the only published Italian record of the species. Nevertheless, Poldi et al. (1995) include north and south Italy and potentially Sicily in its stated range. Even in central Europe, *T. impurum* shows a decidedly montane distribution compared to *T. caespitum*, and our new records suggest that south of the Alps, typical *T. impurum* are confined to high elevations. In the Alps and probably also the Appennines, it is the only *Tetramorium* species occurring above 1500m. However, in the mountains of Calabria and Sicily, a form assignable to *T. caespitum* seems to replace *T. impurum* ecologically, and for this reason we question the reported presence of *T. impurum* in Sicily (Poldi et al., 1995).

Individuals from three nest samples from central Gargano Peninsula are close to *T. impurum* in worker morphology and electrophoresis at the loci presented in Tab. 4 pag. 333. However, climatic conditions on the Gargano strongly differ from the high altitude sites typically inhabited by *T. impurum*. Electrophoretic patterns obtained from a recently examined hexokinase locus were not concordant with those of *T. impurum*, though there are not yet enough data to evaluate the taxonomic significance of these electromorphs. Certain samples collected at the island of Elba at similar heights probably belong to the same entity. More detailed studies are required to determine if *T. impurum*

is ecologically more adaptable than evident at present, or if the mentioned records belong to a separate, yet unrecognized, species.

Tetramorium diomedeum Emery, 1908 [Figs. 5, 9]

Tetramorium caespitum var. *diomedea* Emery in Cecconi, 1908
Tetramorium diomedaea[sic] Emery: Schembri & Collingwood, 1981
Tetramorium caespitum var. *bariensis* Forel, 1911: syn. by Emery, 1916

COLLECTING DATA:
Sicily - Prov. Siracusa, 5 km NE Canicattini Bagni, ca. 300m, 17.V.1993, M. Sanetra leg. [host of *A. atratulus*]; Prov. Siracusa, ca. 5 km NE Floridia, ca. 100m, 11.V.1994, M. Sanetra leg.; Prov. Catania, M. Etna, ca. 5 km N Ragalna 1000-1200m, 12.V.1994, M. Sanetra leg.;

Calabria - Prov. Reggio di Calabria, near Roghudi, 25 km E Reggio di Calabria, 600-700m, 15.V.1994; Prov. Catanzaro, Terme Caronte, ca. 2 km NW Sambiase, 200-300m, 17.V.1994; Prov. Crotone, 3 km E Savelli, ca. 700m, 19.V.1994; Prov. Crotone, 2 km NW Umbriatico, ca. 350m, 19.V.1994; Prov. Cosenza, Monte Pollino, 4 km N Morano Calabro, ca. 800m, 21.V.1994; Prov. Cosenza, Monte Pollino, 1 km NW Frascineto, ca. 500m, 21.V.1994.

OTHER INVESTIGATED MATERIAL: Sicily, Pellegrino/Palermo, III.1924 (probably H. Kutter leg.) 3☿☿ (NMB); Sicily, V.1926 (probably H. Kutter leg.) 3☿☿ (NMB); Calabria, Sambiase, IV.1920, C. Menozzi leg. 6☿☿, 1♀ (NMB); Apulia, Tremiti Islands, Capraia, G. Cecconi leg. 2☿☿, 2♀♀, 1♂ (MCG), syntypes of *T. caespitum diomedeum* Emery; Apulia, Bari, A. Forel leg. 5 ☿☿ (NMB), syntypes of *T. caespitum bariense* Forel.

The description of this taxon (commonly incorrectly spelled "*diomedaeum*") was based upon material from the Tremiti Islands (Apulia). In the original account, it was placed close to *T. ferox* Ruzsky, 1903 from eastern Europe because of the wide and short petiolar nodes in females. Whereas Schembri & Collingwood (1981) and Agosti & Collingwood (1987) treated *T. diomedeum* as a distinct species, others (e.g., Radchenko, 1992b) relegated it into synonymy with *T. ferox*. Comparisons of typical *T. diomedeum* from southern Italy with female syntypes of *T. ferox* (in MHNG and MCG) revealed some differences, several

Tab. 1: Differences between ☿☿ of *T. diomedeum* and *T. semilaeve*

	PW/ML	PPW/ML
T. diomedeum	0.316 ± 0.009	0.360 ± 0.014
T. semilaeve	0.281 ± 0.008	0.323 ± 0.009

(for both species, based on 2 specimens each from 5 localities in Sicily and Calabria)

east European localities, probably belonging to *T. ferox* (in NMB), strongly differed from 2 syntype workers of *T. ferox* (in MCG) strongly differed from Italian material, especially in sculpture. We therefore consider *T. diomedeum* a valid species, a conclusion which is additionally supported by electrophoretic data.

It does usually not pose any problem to identify *T. diomedeum* among its southern Italian congeners. The enlarged petiolar nodes in females (Fig. 9) are found otherwise only in *T. meridionale*, but less marked (Fig. 10). Moreover, the latter species is easily recognizable by transverse striations on the occiput. The nodes in *T. diomedeum* workers also are somewhat wider than in the similar species (see Tab. 1 and compare Figs. 3, 5, 6). Workers are large and very weakly sculptured, appearing robust and more shiny in comparison with *T. semilaeve*. While sometimes single workers of these two species are not safely assignable without taking measurements of the petiolar nodes, differentiation of field nests is possible for the experienced myrmecologist in most cases. Levels of enzyme divergence among *T. diomedeum, T. meridionale* and *T. semilaeve* are low. However, *T. diomedeum* shows a phenomenon here referred to as "fixed heterozygosity". At three loci certain alleles were always found together in all individuals studied (Tab. 4 pag. 333), producing the typical heterozygous banding patterns. This peculiarity, though not yet understood, appears to be a species-characteristic feature.

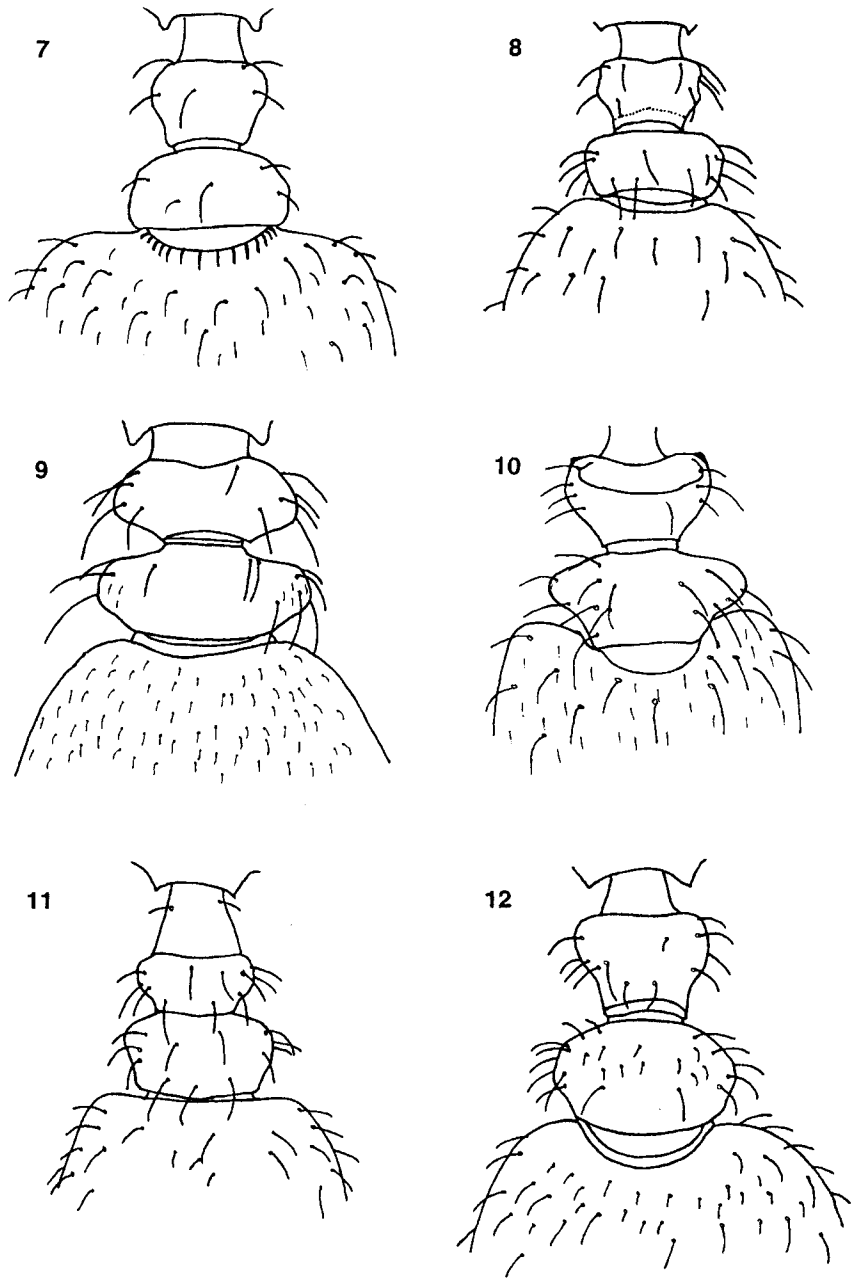
It has been stated (Baroni Urbani, 1964, 1968a, 1971) that samples of the *T. ferox* group (sensu Radchenko, 1992a) from Apulia, Sicily and Malta constitute taxa distinct from each other and from nominotypical *T. diomedeum*. Both morphological and electrophoretic results of our investigations yielded no reasons to recognize more than one species of this group in southern Italy, which most probably extends to Malta without noticeable differentiation (worker material studied, including electrophoresis, from the island of Gozo, Malta, M. Sanetra leg.). Consequently, the synonymy of var. *bariensis* Forel, 1911 from Apulia with *T. diomedeum* established by Emery (1916) should be upheld.

The distribution of *T. diomedeum* in Italy comprises at least the southern regions Sicily, Calabria and Apulia, and although there are no present records, the species, nearly with certainty, can be expected to occur in Campania and Lucania, too. As evident for some other species confined to the southern Mediterranean, there exists a northern outpost at M. Cònero near Ancona (Marche) on the Adriatic coast (Baroni Urbani, 1968b). The single record from Sardinia by Krausse (1912) is highly doubtful in that the species has never been found on the island since then. Possibly for that reason, Poldi et al. (1995) ignored the record in their recent checklist of Italian ants. *T. diomedeum* is a characteristic ant species of the Mediterranean garrigue, only moderately common in general but abundant locally. On one occasion a nest containing two dealate females was discovered, suggesting that the species might be oligogynous.

Apart from Italy, *T. diomedeum* has been cited for Greece (Agosti & Collingwood, 1987), Israel and the Middle East (Schembri & Collingwood, 1981). We have found that female and worker material from Greece (Peloponnese) and western Turkey (A. Schulz leg.) cannot be told apart from Italian samples. *T. ferox* var. *laevior* Menozzi, 1936 from the European part of Turkey, also recorded from Rhodes (Greece), will probably prove to be a synonym. Thus, *T. diomedeum* may well be of Pontomediterranean origin.

Tetramorium meridionale Emery, 1870 [Fig. 10]

COLLECTING DATA:
Sardinia - Prov. Sassari, Lago del Coghinas ca. 10 km NW Oschiri, ca. 200m, 2.V.1994, M. Sanetra leg.; Prov. Nuoro, ca. 5 km S Bitti, ca. 600m, 4.V.1994, M. Sanetra leg.; Prov. Nuoro, Lago



Figs. 7-12. Petiolar nodes (dorsal view) of *Tetramorium* ♀♀ (sculpture omitted): 7 - *T. semilaeve*; 8 - *T. punctatum* (lectotype); 9 - *T. diomedeum*; 10 - *T. meridionale*; 11 - *T. brevicorne* (lectotype); 12 - *T.* sp. "Gargano". Drawings by A. Schulz; scale bar 0.3 mm.

Alto del Flumendosa near Stazione di Villagrande, ca. 800m, 5.V.1994, M. Sanetra leg.; Prov. Nuoro, ca. 5 km W Seúlo, 700-800m, 6.V.1994, M. Sanetra leg.

OTHER INVESTIGATED MATERIAL: Sardinia, Sorgono, 14.III.1913, collector not given, 3☿☿ (MCG), mislabeled as *T. brevicorne*.

This comparatively distinct species has never been involved in the huge taxonomic difficulties concerning the Palaearctic *Tetramorium*, since females and workers bear an unmistakable transversal striation on the occiput. However, as found out by López (1988), in a minority of workers from some colonies this feature is absent, making them look very similar to *T. semilaeve*. Hints of transversal rugosity may also be traced on the heads of single workers in some other species, including *T. semilaeve* (we have two such samples from Sardinia; see also López, 1988). The investigation of larger samples from the same colony is recommended in such cases. Females differ strongly from *T. semilaeve* in having the petiolar nodes enlarged (though not quite as much as in *T. diomedeum*: Figs. 9, 10). Differentiation in electromorphs at the investigated loci is of low value for species identification (Tab. 4 pag. 333).

T. meridionale shows a patchy distribution in the Mediterranean region. Records are so far available from the Spanish mainland, the Baleares (López, 1988; Tinaut, 1989; Schulz, unpubl.), southern France and Corsica (Bondroit, 1918; Casewitz-Weulersse, 1990). There are also scattered reports of the species from localities in eastern Europe and the Middle East which appear highly doubtful. In Italy, *T. meridionale* has been quoted from Sardinia, most islands of the Tuscanian Archipelago and few localities on the mainland (Emery, 1916; Baroni Urbani, 1971; Le Moli & Rosi, 1991; Schulz, unpubl.). The southernmost records stem from Sambiase di Calabria (Menozzi, 1921) and the island of Pantelleria (Mei, 1995), but no record from Sicily is presently at hand. On the mainland the species is generally both local and rare. Interestingly, it is much more common and evenly distributed on some islands of the Mediterranean, dominating over *T. semilaeve* in Sardinia and Elba in many places (Sanetra, unpubl.). Explanations for this peculiar distribution pattern are not yet known. As a striking biological feature *T. meridionale* displays a marked polygyny: up to ten queens were extracted from some colonies of Sardinia and Elba.

Tetramorium semilaeve André, 1883 [Figs. 3, 7]

Tetramorium caespitum var. *semilaeve* André, 1883

Tetramorium semilaeve André: de Dalla Torre, 1893

Tetramorium semilaeve André v. *siciliense* Santschi, 1927: **syn. nov.**

COLLECTING DATA:

Sardinia - Prov. Sassari, Fiume Coghinas, ca. 8 km NE Perfugas, ca. 100m, 2.V.1994, M. Sanetra leg.; Prov. Nuoro, ca. 5 km S Bitti, ca. 600m, 4.V.1994, M. Sanetra leg.; Prov. Nuoro, road N. 125 Dorgali-Baunei, ca. 13 km NW Punta Genna Coggina, 800-900m, 4.V.1994, M. Sanetra leg.; Prov. Nuoro, Lago Alto del Flumendosa, near Stazione di Villagrande, ca. 800m, 5.V.1994, M. Sanetra leg.;

Sicily - Prov. Catania, Acireale, 30m, 29.V.1993, M. Sanetra leg.; Prov. Catania, ca. 5 km W Ramacca, ca. 400m, 10.V.1994, M. Sanetra leg.; Prov. Catania, M. Etna, ca. 5 km N Ragalna 1000-1200m, 12.V.1994, M. Sanetra leg.; Prov. Siracusa, 5 km NE Canicattini Bagni, ca. 300m,

17.V.1993 & 11.V.1994, M. Sanetra leg. [host of *S. destefanii*]; Prov. Siracusa, ca. 5 km NE Floridia, ca. 100m, 11.V.1994, M. Sanetra leg. [host of *S. destefanii*];

Calabria - Prov. Reggio di Calabria, ca. 4 km N Bova, ca. 1100m, 14.V.1994; Prov. Reggio di Calabria, near Roghudi, 25 km E Reggio di Calabria, 600-700m, 15.V.1994; Prov. Catanzaro, Terme Caronte, ca. 2 km NW Sambiase, 200-300m, 17.V.1994; Prov. Crotone, 3 km E Savelli, ca. 700m, 19.V.1994 [host of *S. destefanii*]; Prov. Crotone, 2 km NW Umbriatico, ca. 350m, 19.V.1994; Prov. Cosenza, Monte Pollino, ca. 8 km E Mormanno, 1200-1300m, 20.V.1994; Prov. Cosenza, Monte Pollino, 1 km NW Frascineto, ca. 500m, 21.V.1994 [host of *S. destefanii*].

OTHER INVESTIGATED MATERIAL: Eolian Islands, Lipari, III.1924, H. Kutter leg. 3☿☿ (NMB) [tentatively identified as *T. semilaeve*]; Sicily, locality "V", V.1926, H. Kutter leg. 2☿☿, 1☿ (NMB), syntypes of *T. semilaeve siciliense* Santschi; Sicily, Segesta, III.1924, H. Kutter leg. 3☿☿ (NMB) [tentatively identified as *T. semilaeve*]; Sicily, Segesta, III.1924, H. Kutter leg. 2☿☿ (NMB), determined as *T. semilaeve siciliense* by Santschi [host of "*S. huberi* st. *cecconii* v. *kutteri* Santschi", 1 out of 2☿☿ mounted with parasites]; Sicily, Palermo, III.1924 (probably H. Kutter leg.) 3☿☿ (NMB), determined as "*T. caespitum* st. *semilaeve* var. *ernesti* Santschi" by Santschi; Calabria, Sambiase, IV.1920, C. Menozzi leg. 6☿☿, 1♀ (NMB); Apulia, Tremiti Islands, G. Cecconi leg. 3☿☿ (MCG) [host of *S. huberi cecconii* Emery, mounted with parasites]; Apulia, Tremiti Islands, Capraia, VI., G. Cecconi leg. 2☿☿ (MCZ) [host of *S. huberi cecconii* Emery, mounted with parasites]; Apulia, Gargano Peninsula, Manfredonia, 10.X.1961, C. Baroni Urbani leg. 7☿☿ (MCV) [host of *S. huberi cecconii* Emery as determined by Baroni Urbani]; Apulia, Gargano Peninsula, Pèschici, 12.X.1961, C. Baroni Urbani leg. 3☿☿ (MCV) [host of *S. huberi cecconii* Emery as determined by Baroni Urbani]; France, Var, Foret du Dom, Parker leg. 7☿☿ (NMB), determined as *T. semilaeve siciliense* by Santschi; France, Var, Mt. Ferovillet, Parker leg. 3☿☿ (NMB), determined as *T. semilaeve siciliense* by Santschi.

Even though this is the most commonly cited *Tetramorium* species of the Mediterranean, the precise identity and distribution of the taxon has not yet satisfactorily been clarified. André (1883), in the original description, gave "Europe, Africa and Mediterranean Asia" as the range of var. *semilaeve*. According to Emery (1925) the worker material constituting the type series embodies several different taxa. Bondroit (1918) and Emery (1925) treated specimens from Banyuls-sur-Mer (Pyrénées-Orientales, France) as the typical *T. semilaeve*, but no lectotype has been formally designated.

Females of *T. semilaeve* can be distinguished at first sight from those of *T. caespitum* and *T. impurum* by smaller size (compare Tab. 2, 3) and absence of a bulging mesonotum and from *T. diomedeum* and *T. meridionale* by the narrower petiolar nodes (Fig. 7). Their particularly weak to absent rugosity on the mesonotum allows differentiation from *T. brevicorne* and *T.* sp. "Gargano". *T. punctatum* females are very similar to *T. semilaeve* in body shape and structure but are much smaller (see Tab. 2). Intracolonial variability in *T. semilaeve* is specifically pronounced and, in many nests, strikingly dimorphic worker forces are produced. Therefore, much difficulty is encountered during the determination of single workers which may be very similar to those of *T. punctatum*, in particular to the larger specimens. Workers of *T. caespitum*, if small, pale and weakly sculptured, may also not be securely distinguished from *T. semilaeve* (see also López, 1991). Yet, combined electrophoretic data from *G3pdh* and *Idh* loci enable the separation of *T. semilaeve* from the other Italian *Tetramorium* species except *T. meridionale* and *T.* sp. "Gargano" (Tab. 4 pag. 333). For further information on dif-

ferentiation from other congeneric species consult the appropriate sections.

Electrophoretic comparisons of *T. semilaeve* from Banyuls-sur-Mer with our Italian samples revealed only minor deviations in allele frequencies at two loci (Sanetra, unpubl.), which confirm our inclusion of the Italian populations in typical *T. semilaeve*. In Italy, no less than five varieties of *T. semilaeve* have been taxonomically separated from the typical one. Three of them described by Santschi (1927) were stated to be Sicilian endemics. Recently this unrealistic subdivision was uncritically reinforced by Poldi et al. (1995) by listing four different subspecies of *T. semilaeve* for Italy alone. Such a treatment is surely incompatible with a modern subspecies concept, and we try to elucidate the status of these forms as far as possible. *T. semilaeve siciliense* Santschi, 1927 easily emerges as a synonym of *T. semilaeve* upon examination of the syntypes. Other workers filed as *T. siciliense* by Santschi originated from Sicily (Segesta) and France (Var), obviously all typical *T. semilaeve*. *T. semilaeve* var. *jugurtha* Menozzi, 1932, elevated to species rank by Poldi et al. (1995), was also reported from Sicily (Palermo) by Santschi (1921). However, applying this name to Italian material seems highly doubtful, since it is not even known how this North African taxon relates to others in that region.

The range of *T. semilaeve* purportedly covers the entire Mediterranean region. Nevertheless, it seems likely that there exists at least some divergence between a "western" and an "eastern" form, the latter often referred to as *T. punicum* (Smith, 1861) originally described from Israel. Given the insufficiency of the original description along with the types apparently being lost (Santschi, 1920), there is hardly any way to determine to which species the name *punicum* really applies. Thus, *T. punicum* may best be treated as a *nomen dubium*. Specimens assignable to the "eastern" form share a *Gpi* electromorph which is obviously lacking in the western Mediterranean populations and also an *Idh* electromorph very rare in samples from farther west (Sanetra, unpubl.). A borderline might be situated between the Balkan Peninsula and the Middle East, but much more research into this problem has to be done. According to some authors (e.g., Radchenko, 1992b) the species is presumed to be more widely distributed in Transcaucasia and even Central Asia. An electrophoretically investigated sample from Crimea, however, seems to represent a species different from the typical *T. semilaeve* of the Mediterranean.

The majority of localities sampled in southern Italy were dominated by *T. semilaeve*. However, due to its affinity to very warm and dry places it seldom occurs above 1000m. Queens were rarely collected, and thus we regard *T. semilaeve* as monogynous at least in Italy. It often shares its habitat with *T. diomedeum* and sometimes with *T. punctatum* in Sicily and Calabria which likewise are very thermophilous species. The published records suggest (Baroni Urbani, 1971) that *T. semilaeve* becomes increasingly uncommon and localized towards the north, since there have been very few findings north of the Appennines. Given the possibility of confusing *T. semilaeve* workers with *T. caespitum*, all available records from north of the Alps (Santschi, 1927; Werner, 1989; Schulz, 1991) must be regarded as dubious, unless substantiation by the unmistakable sexuals is provided.

***Tetramorium punctatum* Santschi, 1927, stat. nov. [Figs. 6, 8, 15]**

Tetramorium semilaeve André v. *punctatum* Santschi, 1927

Tetramorium semilaeve André v. *liparaeum* Santschi, 1927: **syn. nov.**

Our investigations of types from the Santschi collection at NMB revealed several specimens corresponding to our concept of *T. punctatum* outlined below. Among them there were syntype ☿☿of *T. semilaeve liparaeum* Santschi, 1927 (very small and pale, outside the range of variation observed in *T. semilaeve*) and a syntype ♀ of *T. semilaeve punctatum* Santschi, 1927 identical to ♀ ♀ from our collections. The syntype ☿☿ of *T. punctatum* originated from a different locality and year than the ♀ type and cannot be excluded to represent *T. semilaeve*. Therefore, we here designate the aforementioned ♀ as lecto type of *T. semilaeve punctatum*. Acting as first revisers according to Art. 24a of the Code (ICZN, 1985), we select *punctatum* as senior synonym over *liparaeum* because the ♀ caste allows species identification more reliably than the ☿☿.

COLLECTING DATA:
Sicily - Prov. Messina, Lipari (Eolian Islands), IV.1993, J. Heinze leg.; Prov. Messina, Francavilla di Sicilia, ca. 300m, 3.VI.1993, M. Sanetra leg.; Prov. Catania, ca. 5 km W Ramacca, ca. 400m, 10.V.1994, M. Sanetra leg.; Prov. Siracusa, near Carlentini, ca. 200m, 10.V.1994, M. Sanetra leg.; **Calabria** - Prov. Reggio di Calabria, ca. 4 km N Bova, ca. 1100m, 14.V.1994; Prov. Crotone, 3 km E Savelli, ca. 700m, 19.V.1994; Prov. Crotone, 2 km NW Umbriatico, ca. 350m, 19.V.1994.

OTHER INVESTIGATED MATERIAL: Lectotype ♀ of T. semilaeve punctatum Santschi (hereby designated; Figs. 8, 15): labeled "Type [red print]"/"T. semilaeve And v. punctatum Sant ♀ [probably Santschi's handwriting] Santschi det. 19 [printed]"/"Sizilien V-26 [handwritten]"/"23 [handwritten]"/"Sicile (Kutter) [handwritten]"/ "LECTOTYPUS *Tetramorium semilaeve punctatum* Santschi det. M. Sanetra, R. Güsten, A. Schulz 1996 [printed on red cardboard]"/"Sammlung Dr. F. Santschi Kairouan [printed]" (NMB); Sicily, Siracusa, III.1924, H. Kutter leg. 2 ☿☿ (NMB), paralectotypes of *T. semilaeve punctatum* [only tentatively identified as *T. punctatum*]; Eolian Islands, Lipari, I.1924, H. Kutter leg. 3☿☿ (NMB), syntypes of *T. semilaeve liparaeum* Santschi; Sicily, Engalos[?]/Siracusa, III.1924, H. Kutter leg. 3☿☿ (NMB), labeled as "types" of "*T. semilaeve* v. *syracusium* Sant." [name never published, but specimens listed as "légère variation" of *liparaeum* in SANTSCHI (1927)].

T. punctatum represents the only distinct taxon that should be recognized among SANTSCHI's (1927) varieties of *T. semilaeve* described from Sicily. It is well characterized by the very small sexuals and the similarly minute and shiny workers. Females resemble those of *T. semilaeve* but are much smaller (see Tab. 2). Apparently there are also subtle structural differences, which, however, we have not thoroughly investigated. In the field it is usually possible, with some experience, to distinguish *T. punctatum* colonies from *T. semilaeve* even without any optical equipment. Yet, conserved samples without sexuals can sometimes be confused with small and pale *T. semilaeve*. The application of biochemical characters proved helpful in this case, since a *G3pdh* electromorph unique among Italian *Tetramorium* species appears fixed

Tab. 2: Differences between ♀ ♀ of *T. punctatum* and *T. semilaeve*

	HW (mm)	ML (mm)
T. punctatum	0.84 ± 0.02	1.31 ± 0.05
T. semilaeve	1.13 ± 0.05	1.90 ± 0.05

(for both species, based on 10 specimens from different localities in Sicily and Calabria; includes lectotype ♀ of *T. punctatum*: HW 0.84 mm, ML 1.28 mm)

in *T. punctatum* (Tab. 4). From all listed sites, except the island of Lipari, samples were electrophoretically surveyed with consistent results.

T. punctatum is not a frequent species compared to *T. semilaeve* and *T. diomedeum* whose ecological requirements appear very similar. Despite the very small females, the species most likely is oligo- or even monogynous, as we never discovered any queens within the nests. *T. punctatum* inhabits Sicily, the Eolian Islands and Calabria. It remains unknown if its range extends farther north. Some of the literature records deemed to be *T. semilaeve* may actually pertain to *T. punctatum*. Nonetheless, it is almost impossible to trace these from the scarce publication data alone.

We have seen a number of specimens from Greece and Turkey (A. Schulz leg.) that exhibit only minor morphological differences in all morphs compared with Italian *T. punctatum*. Some published species-group epithets in *Tetramorium* from eastern regions (in particular *lucidulum* Menozzi, 1933 and *nitidissimum* Pisarski, 1967) possibly refer to comparable forms, but none of them would have precedence over *punctatum* Santschi, 1927. It is therefore almost certain that *T. punctatum* will stand as the valid name for the taxon, even after a complete taxonomic revision of the Palaearctic *Tetramorium*. Further, we are unaware of any comparable samples from northern Africa despite our collecting activities in Tunisia and Morocco.

Tetramorium brevicorne Bondroit, 1918 [Figs. 2, 11, 16]

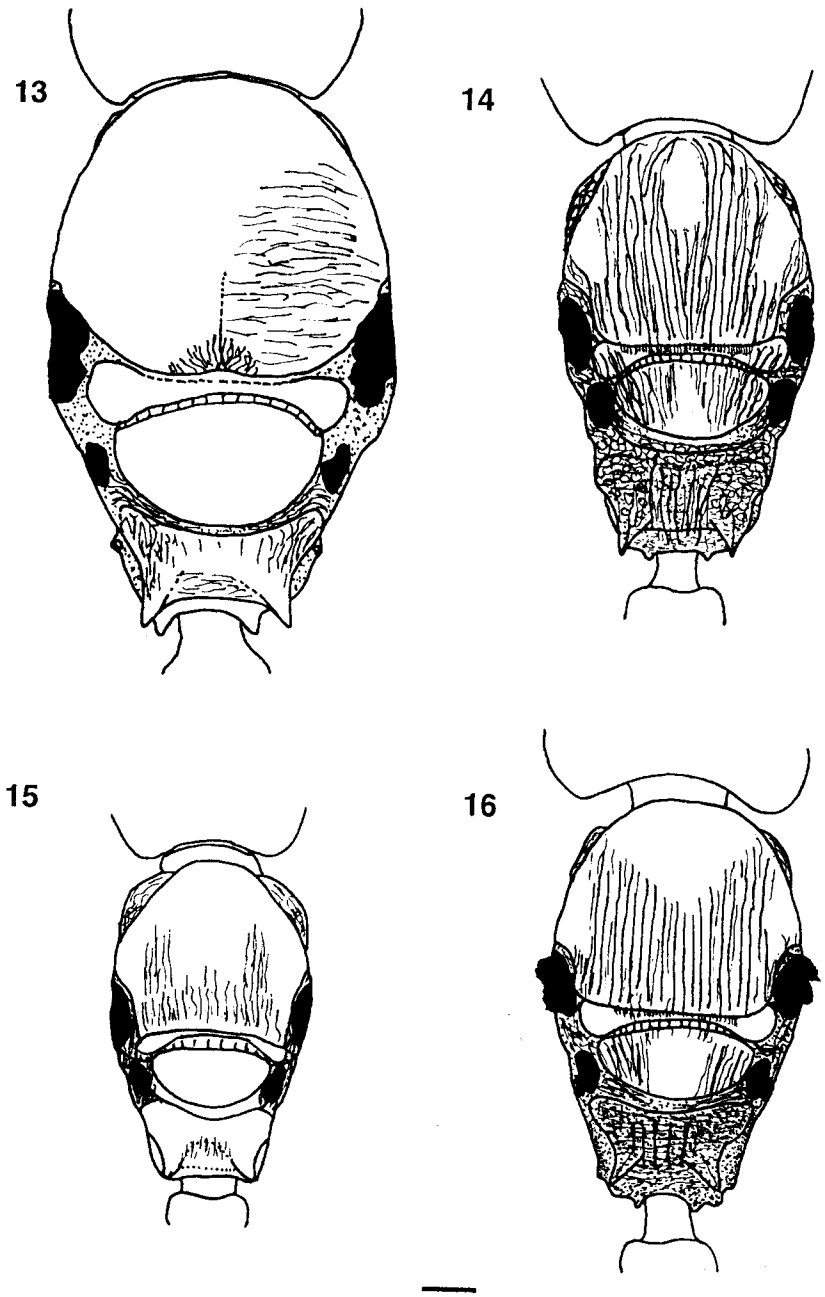
Tetramorium caespitum caespitum var. debilis Emery, 1909 (*partim*; unavailable name)
Tetramorium caespitum subsp. *caespitum var. brevicornis* Emery, 1916 (unavailable name)
Tetramorium caespitum var. *brevicorne* Bondroit, 1918
Tetramorium brevicorne Emery: Baroni Urbani, 1964

We follow the interpretation by Taylor (1986) that the types of a name made available by elevation from infrasubspecific rank are those specimens designated as the so-called "types" when the infrasubspecific entity was first published, except if the author elevating the name explicitly states otherwise. This procedure seems well supported by the Code in Art. 72(b)(iv), which regulates type designation of names made available by "bibliographic reference to a description associated with an unavailable name" [Art. 12(b)(1)] - a wording clearly applicable to the case in question.

Thus the types of *T. caespitum brevicorne* Bondroit, 1918 are those specimens on which "*T. caespitum* subsp. *caespitum var. brevicornis* Emery, 1916" was based. In MCG, one pin with 8☿☿, 2♀♀ and 2♂♂ from Corsica was found which are to be interpreted as syntypes of *T. caespitum brevicorne* Bondroit. These are all in good accord with our samples from Sardinia. We selected one of the ♀♀ (easier to identify to species than ☿☿) as lectotype and remounted it on a new cardboard on a separate pin with the original labels. The other specimens remain associated on a pin with copies of the labels and were designated paralectotypes. 6☿☿ from Asuni (Sardinia) in coll. Emery constitute additional paralectotypes.

There were three more specimens in MCG filed as "*T. brevicorne*". These ☿☿ from Sorgono (Sardinia) were found to represent *T. meridionale*, a fact already denoted on two associated labels by B. Poldi and J. Casevitz-Weulersse, respectively. These specimens do not match the original description of *T. brevicorne* and are thus excluded from the type series.

COLLECTING DATA:



Figs. 13-16. Mesosoma (dorsal view) of *Tetramorium* ♀♀: 13 - *T. caespitum*; 14 - *T.* sp. "Gargano"; 15 - *T. punctatum* (lectotype); 16 - *T. brevicorne* (lectotype). Drawings by A. Schulz; scale bar 0.3 mm.

Sardinia - Prov. Sassari, Lago del Coghinas 10 km NW Oschiri, ca. 200m, 2.V.1994, M. Sanetra leg.; Prov. Sassari, Monte Limbara, 700-1100m, 3.V.1994, M. Sanetra leg.; Prov. Nuoro, road N. 125 Dorgali-Baunei, ca. 13 km NW Punta Genna Coggina, 800-900m, 4.V.1994, M. Sanetra leg. [host of *S. testaceus*]; Prov. Nuoro, road N. 198 Seui-Ussássai, Cant. Arquerí, 980m, 6.V.1994, M. Sanetra leg.

OTHER INVESTIGATED MATERIAL: Lectotype ♀ of *T. caespitum brevicorne* Bondroit (hereby designated; Figs. 11, 16): labeled "Corse var. Revel[?] [probably Emery's handwriting]"/"brevicorne teste Emery [handwritten]"/"LECTOTYPUS *Tetramorium caespitum brevicorne* Bondroit det. M. Sanetra, R. Güsten, A. Schulz 1996 [printed on red cardboard]"/"Museo Civico di Genova [printed]"/"Collezione Emery [printed]" (MCG); same labels (copied) as lectotype 8☿☿, 1♀, 1♂, part of 1♂ (MCG), paralectotypes of *T. caespitum brevicorne* Bondroit; Sardinia, Asuni, probably A. Krausse leg. 6☿☿ (MCG), paralectotypes of *T. caespitum brevicorne* Bondroit; Sardinia, Sorgono, A. Krausse leg. 3☿☿ (NMB); France, Corsica, Evisa, IX.1922, collector not given, ☿☿ (NMB).

Emery (1916) described this taxon from Sardinia and Corsica as part of a series he had formerly assigned to "*T. caespitum caespitum* var. *debilis* Emery, 1909" from Egypt. Later, Emery (1925) classified *brevicorne* as a variety of *T. biskrense* Forel, 1904 from North Africa and placed these taxa into a morphologically defined group in which the pronotum angles of the females are clearly visible from above. Though this character is found in several not necessarily related species, it allows one to distinguish unambiguously between *T. caespitum* and *T. brevicorne* in Sardinia and Corsica (compare Figs. 13, 16). In addition, the females of the latter are distinctly smaller (Tab. 3). Other distinguishing

Tab. 3: Differences between ♀♀ of *T. brevicorne* and *T. caespitum*

	HW (mm)	ML (mm)
T. brevicorne	1.06 ± 0.02	1.64 ± 0.05
T. caespitum	1.24 ± 0.02	2.18 ± 0.02

(based on Sardinian specimens, 10 for *T. brevicorne* and 4 for *T. caespitum*)

characters are conspicuous longitudinal rugae on the mesonotum (Fig. 16) and cross-meshed sculpturing on the occiput in *T. brevicorne* females.

Workers of *T. brevicorne* have repeatedly been stated to have shorter scapes than those of *T. caespitum* (Emery, 1916; Baroni Urbani, 1964; Casevitz-Weulersse, 1990). This difference, however, is slight at best and does not seem to be practical for species identification. In workers, separation can be better achieved by investigation of the sculpture of the petiolar nodes. A reticulate microsculpture is more or less evenly distributed on the postpetiolus in *T. brevicorne*, sometimes with a tendency to weaken towards the dome but never with a completely unsculptured and shining part of the surface (Fig. 2). In contrast, *T. caespitum* has this microsculpture restricted to the more basal part of the node becoming much weaker dorsally and usually leaving at least a small area completely without sculpture (Fig. 1). Similar but less obvious differences concern the petiolus. It seems worth noting that the main rugosity of the petiolar nodes is very variable in *T. brevicorne* and, though usually stronger than in *T. caespitum*, is not a useful character. In many but not all *T. brevicorne* workers the rugosity on the occiput is developed into a

conspicuous arched pattern never seen to this extent in *T. caespitum*.

As can be inferred from electrophoretic data, *T. brevicorne* has attained greater genetic distance to *T. caespitum* than might be expected from their morphological similarity *T. brevicorne* completely deviated from sympatric *T. caespitum* in Sardinia at four of the investigated loci (Tab. 4). At the loci *Gpi* and *Mdhp*, *T. brevicorne* appears fixed for certain electromorphs occurring, but rarely, in two other Italian species, *T. meridionale* and *T. diomedeum*. We used electrophoretic data to securely assign to either *T. caespitum* or *T. brevicorne* those samples containing workers only, especially the two colonies which were found in association with *S. testaceus*. At least one *T. brevicorne* sample containing sexuals (reared in the laboratory) was available from each collecting locality listed above.

T. brevicorne is quite common in the mountains of Sardinia where it was much more regularly collected than *T. caespitum*. Only rarely, single queens were detected inside the nests of *T. brevicorne*, so monogyny may be presumed notwithstanding the relatively small size of females. We suggest the species to be confined to Corsica and Sardinia, even though it has been quoted twice from Sicily (Donisthorpe, 1926; Baroni Urbani, 1964). These two records were established on worker material only, and might thus be due to determination errors. Poldi et al. (1995) also omitted Sicily from the range given for *T. brevicorne* but without any comment.

Tetramorium sp. "Gargano" [Figs. 4, 12, 14]

COLLECTING DATA:
Calabria - Prov. Crotone, 2 km NW Umbriatico, ca. 350m, 19.V.1994; Prov. Cosenza, Monte Pollino, 1 km NW Frascineto, ca. 500m, 21.V.1994;
Apulia - Prov. Foggia, Gargano, road N. 528, ca. 2 km NE intersection to Carpino, ca. 700m, 23.V.1994, R. Güsten & M. Sanetra leg.

Specimens from three localities in Calabria and M. Gargano could not be clearly assigned to any of the described *Tetramorium* taxa of the western Mediterranean region. As a consequence, it appears to us that these samples represent a species not yet recognized in Italy, but possibly having close relatives elsewhere in the Mediterranean. The new entity is provisionally referred to as *T.* sp. "Gargano" until new information will eventually allow a more definite treatment. Morphologically it mostly resembles the Tyrrhenian *T. brevicorne*, and differential characters are not markedly developed. Workers of *T.* sp. "Gargano" show a strong, mainly longitudinal, rugosity over the whole surface of the petiolar nodes (Fig. 4), approaching (but not reaching) the condition observed, for example, in *T. moravicum* Kratochvil, 1941 and *T. forte* Forel, 1904 (see Fig. in Schulz, 1996: 408). The mentioned sculptural elements are variable but clearly weaker and more restricted in *T. brevicorne*. Nevertheless, some specimens of the latter approach *T.* sp. "Gargano" in distinctness of the rugae but not in extent, as they are invariably absent (in contrast to the reticulate microsculpture) from the center of the nodes in *T. brevicorne*. In females, mesonotal rugosity is apparently both more extensive and slightly stronger developed in *T.* sp. "Gargano" than in *T. brevicorne* (Figs. 14, 16). Additionally, the petiolar nodes appear of a slightly different shape and are more broadly

Tab. 4: Isozyme electrophoretic results of tetramoriine ants from southern Italy at seven informative loci. Variants are assigned due to their migratorial velocity towards the anode from slow to fast in the order *a, e, v, s, m, f, x, u.* "A/ indicates fixed heterozygosity" in *T. diomedeum.* n: number of colonies investigated

Species/Locus	*Gpi*	*G3pdh*	*Idh*	*Mdhp*	*Mdh-1*	*Pgm-1*	*Pgm-2*	n
T. caespitum	*f*	*f*	*x*	*s*	*s*	*v, s, m*	*m, f*	9
T. caespitum Sardinia	*f, x*	*s*	*x*	*s*	*s*	*s*	*m*	2
T. caespitum Si, Ca partim	*f*	*f*	*x*	*s*	*e*	*e, s*	*m*	3
T. impurum	*f*	*f*	*x*	*f*	*s*	*v, s, m*	*e, m, f*	7
T. cf. *impurum* (Gargano)	*f*	*f*	*x*	*f*	*s*	*s*	*e, m*	3
T. diomedeum	*f, x*	*s/f*	*s/f*	*f, u*	*s/f*	*s, m*	*s, m*	9
T. meridionale	*m, f*	*f*	*s, m*	*f, u*	*s*	*s, m, x*	*m*	5
T. semilaeve	*v, f*	*f*	*s, f*	*f*	*s*	*s, m*	*m, f*	22
T. punctatum	*f*	*x*	*s, m*	*f*	*s*	*s*	*m*	5
T. brevicorne	*m*	*f*	*v, m*	*u*	*s*	*s, m*	*m, f*	6
T. sp. "Gargano"	*a, e*	*f*	*e, s*	*f*	*s*	*v, s*	*m*	2
S. huberi	*f*	*f*	*f*	*m*	*s*	*s*	*f*	1
S. alpinus	*f*	*f*	*f*	*m*	*s*	*s*	*f*	6
S. destefanii	*m, f*	*f*	*f*	*m*	*s*	*s*	*f*	6
S. testaceus	*f*	*f*	*f*	*f*	*s*	*s*	*f, x*	5

rounded in *T.* sp. "Gargano" (Figs. 11, 12).

Isozyme electrophoresis yielded more reliable differences between *T.* sp. "Gargano" and *T. brevicorne*. Individuals of these two entities were found to exhibit different electromorphs at three loci (Tab. 4) which strengthens our arguments against conspecificity. Electromorphs at the *Idh* locus compared well to some morphologically similar samples from Greece and Cyprus (SANETRA, unpubl.), indicating affinities to eastern Mediterranean rather than to Tyrrhenian or North African species. The abovementioned samples are probably close to *T. sarkissiani* Forel, 1911 and *T. syriacum* Emery, 1922, respectively. In worker morphology, too, *T.* sp. "Gargano" exhibits close similarities to this loosely defined group of eastern Mediterranean species. Among these not necessarily closely related species, morphological differences in both workers and females appear particularly subtle and will have to be worked out much more meticulously. However, there exist differences at the *Gpi* locus between that group and *T.* sp. "Gargano", and it thus seems possible that this interesting south Italian ant will have to be described as a new species once more information will be obtained. The morphological study of females from all three localities and electrophoresis gave hints to some geographical variation in *T.* sp. "Gargano".

The species appears to be generally uncommon and occurs more frequently only in the center of the Gargano Peninsula (for short description of habitat see *Strongylognathus huberi* section, locality 2a). With so little information available, no meaningful assumptions can be made about habitat preferences and biology.

COMMENTED LIST OF SOCIAL PARASITES

Strongylognathus huberi Forel, 1874 [Figs. 18, 20, 22, 24]

COLLECTING DATA:

Calabria - Prov. Cosenza, Monte Pollino, 4 km NW Morano Calabro, 1000-1100m, 21.V.1994; **Apulia** - Prov. Foggia, Gargano Peninsula. a: road N. 528, ca. 2 km NE intersection to Carpino, ca. 700m, 7.X.1990, A. Buschinger, P. Douwes & R. Schumann leg. and 23.V.1994, R. Güsten & M. Sanetra leg. b: road Monte S. Angelo-Carpino 1,5 km NW intersection to Vico, ca. 700m, 7.X.1990, A. Buschinger, P. Douwes & R. Schumann leg.

OTHER INVESTIGATED MATERIAL: Switzerland, Valais, Fully, A. Forel leg. 3☿☿, 3♀♀, 3♂♂ (MHNG), syntypes; same data 3☿☿, 1♀ (NMB), syntypes; Veneto, Settimo near Verona, 25.X.1957 & 28.V.1959, C. Baroni Urbani leg. 51☿☿ (MCV); Spain, Sierra de l'Aguila, Puerto de Monrepós, V.1967, G. Osella leg. 11☿☿ (MCV), determined as *S. caeciliae* Forel by Baroni Urbani.

Since the discovery of *S. huberi* in Switzerland, very few accounts have further contributed to the knowledge of its biology and distribution. According to literature data the species appears to occur in local pockets scattered through the southern alpine region, the northern Mediterranean and the Iberian Peninsula (e.g., Consani, 1947; Baroni Urbani, 1962; Acosta & Martinez, 1982). Here we highlight three new records from the Gargano Peninsula and one from M. Pollino, which are clearly referable to this species as revealed by comparison with the types. A map (Fig. 24) shows the presently known distribution of this rare parasite in Italy and areas close by.

S. huberi is one of the more characteristic species of the genus and comparatively easy to separate from its congeners. Both females and workers exhibit a strong punctate-reticulate microsculpture on the petiolar nodes which makes these look entirely matt (Fig. 18). The rather shiny appearance of the nodes in *S. alpinus* and *S. destefanii* females is caused by a weaker development of that microsculpture (Figs. 17, 19). Rugosity on the nodes is nonetheless more distinct in *S. alpinus* than in *S. huberi* while entirely absent in *S. destefanii*. On the head and mesosoma *S. huberi* females again appear completely dull owing to conspicuous microsculptural elements. A small frontal area of the mesonotum remains the only shiny surface (Fig. 22). In the two other species, head and mesosoma have the microsculpture reduced in extent, being almost absent on the dorsal mesonotum where only longitudinal rugosity is obvious (e.g. Fig. 23). Surface sculpture in workers of *S. alpinus* and *S. destefanii* is very variable, but as in females the petiolar nodes are more shiny than in *S. huberi*. Additionally, the latter show a smaller unsculptured, shiny portion of the head and mesosoma surface, which, however, is subject to considerable variation.

In the field, workers of *S. huberi* may be recognized by their characteristic slender appearance, due to narrower petiolar nodes, a narrow mesosoma and a different head shape compared with other *Strongylognathus*. The head tends to be parallel-sided with the occipital margin being almost straight (Fig. 20), while in the other two species discussed here, head sides are distinctly convex and the occiput appears appreciably concave (e.g. Fig. 21). In *S. huberi*, heads of females narrow behind the eyes towards the occipital margin which is not the case in the other two species (compare Figs. 6, 7 in Baroni Urbani (1969) for *S. huberi* and *S. alpinus*).

In southern Italy *S. huberi* has not been found at elevations below 700m, but some of the more northerly records originated from the lowlands (Po valley; Marseille). The

species was most commonly collected from *T. caespitum* nests, whereas in southern Italy we found it together with hosts classified as *T. impurum*. This new host record supports the idea that *S. huberi* and *S. destefanii* have different preferences of host species and altitudinal range, though their geographic distributions overlap. The observed syntopic occurrence at a locality on central Gargano appears as an exception.

Locality 1 - Calabria, Monte Pollino

Only five workers of *Strongylognathus* could be extracted from the soil under a limestone rock on a north-facing slope in the southern M. Pollino area. The site was covered by herbaceous vegetation and scattered shrubs and trees. The hosts as determined by electrophoresis belonged to *T. impurum*. Additionally, *S. testaceus* was also found twice at the same spot.

Localities 2a, b - Apulia, Gargano

These two localities at M. Gargano, clearings covered with cultivated grassland and limestone rocks not far south of the Foresta Umbra Reserve, were explored by Buschinger, Douwes & Schumann for the first time. During this excursion one nest of *S. huberi* was found at each site (one containing few alate females). We conducted searches some years later at the very same places and also found two *Strongylognathus* colonies. Remarkably, one of them proved to be *S. destefanii*. The hosts were consistently a form assignable to *T. impurum*.

Strongylognathus alpinus Wheeler, 1909 [Figs. 19, 25]

Strongylognathus huberi alpinus Wheeler, 1909

Strongylognathus alpinus Wheeler: Bondroit, 1918

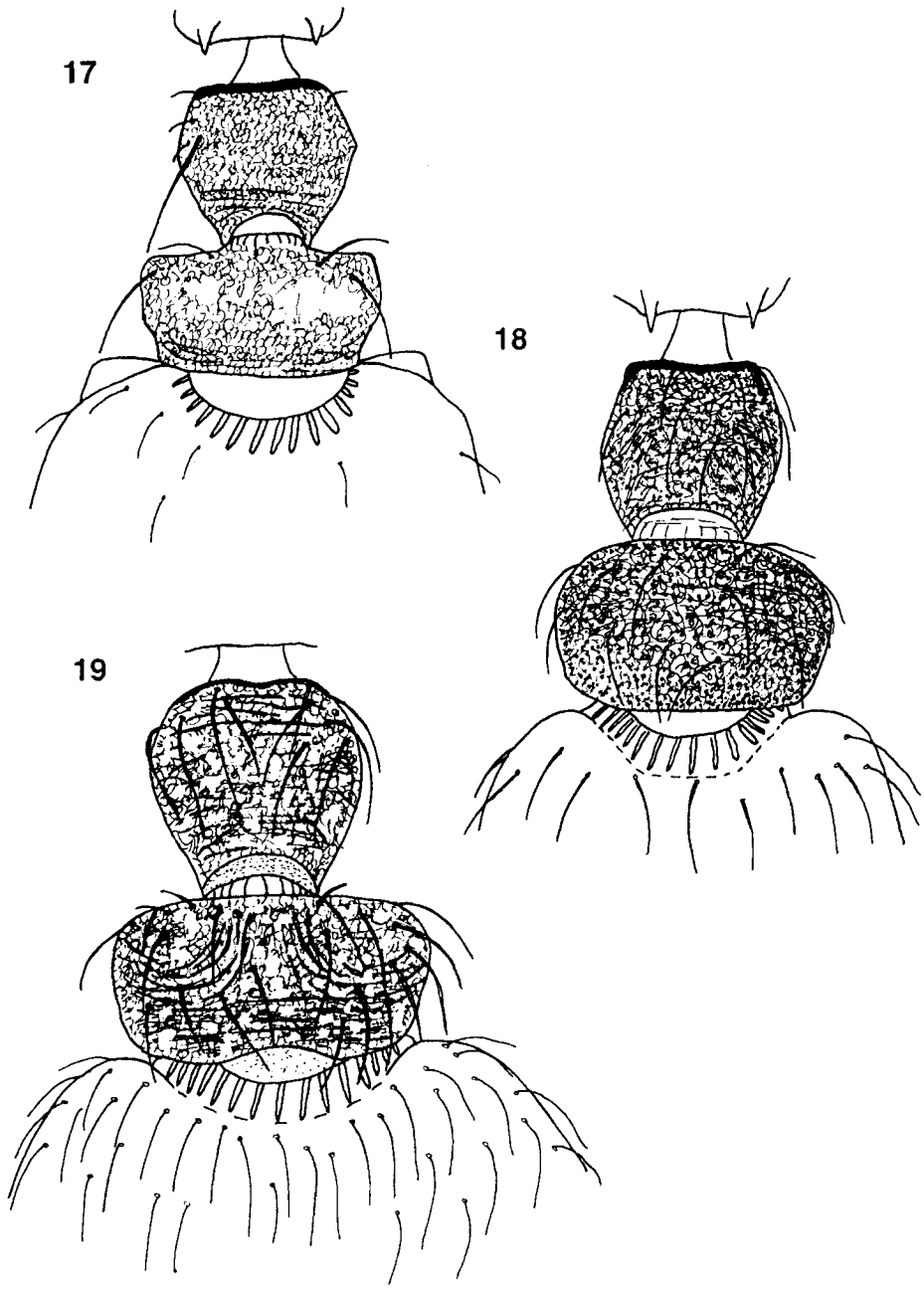
COLLECTING DATA:

Sicily - Prov. Messina, Monti Nebrodi, road N. 289 Cesarò-S. Fratello, Portella Femmina Morta, ca. 1500m, 12.V.1994, M. Sanetra leg.

Calabria - Prov. Reggio di Calabria, Aspromonte, Montalto summit, 1950m, 16.V.1994.

Abruzzi - Prov. L'Aquila, Gran Sasso. a: Campo Imperatore, ca. 1900m, 4.X.1990, A. Buschinger, P. Douwes & R. Schumann leg. b: ca. 2 km W Vado di Sole, ca. 1800m, 4.X.1990, A. Buschinger, P. Douwes & R. Schumann leg. c: Prov. L'Aquila, Gran Sasso, ca. 6 km NE Castel del Monte, ca. 1600m, 30.V.1994, M. Sanetra leg.

The south Italian records presented here greatly extend the known range of *S. alpinus*, thus far exclusively known from the southwestern Alps (Fig. 25). The species was described from Valais (Switzerland) and first recorded in France by Buschinger et al. (1981). At present there are no records from the Italian Alps, where the species is very likely to occur. We were able to study females and workers from the Gran Sasso and could not find any differences from alpine populations distinguishable against the considerable individual variation. Only workers were available from the Calabrian and Sicilian localities. These show weaker sculpturing in general than those from the Alps and Appennines, but are very similar in other respects, and we do not hesitate to assign them to *S. alpinus*. Sicilian samples investigated by Poldi (in litt.) nevertheless show some resemblance to *S. pisarskii* Poldi, 1994, the affinities of



Figs. 17-19. Petiolar nodes (dorsal view) of *Strongylognathus* ♀♀: 17 - *S. destefanii*; 18 - *S. huberi*; 19 - *S. alpinus*. Drawings by A. Schulz; scale bar 0.3 mm.

which are treated in the discussion chapter.

In view of strongly differing habitats, *S. alpinus* and *S. destefanii* are surprisingly difficult to distinguish morphologically. Females are usually distinctly larger in *S. alpinus*, though extreme individuals of either species may be comparable in size. As for *S. huberi*, the most reliable characters for species identification are found in the surface sculpture of the petiolar nodes. In *S. alpinus* females, there are always conspicuous transverse rugae on the postpetiole (Fig. 19), while those of *S. destefanii* usually completely lack these and show only punctate reticulation (not unlike *S. huberi* but much weaker, the surface appearing shiny: Fig. 17). Differences regarding the sculpturing of the petiolus are similar but less obvious. Generally, the value of the structure of the petiolar nodes for species distinction is less reliable in workers than in females. At least some regular, continuous longitudinal rugosity is present in *S. alpinus* workers on the often very shiny surface. In contrast, this is weakly, irregularly and discontinuously developed to almost absent in *S. destefanii* with the microsculpture usually more pronounced. Other differences concerning colour, size and structure are present but of limited importance. Note that the development of the propodeal spines shows specifically pronounced variation, rendering it less useful for distinction than implied in available keys (Baroni Urbani, 1969; Poldi, 1994).

S. alpinus is essentially a high altitude species, reported in Italy between 1500 and 2000m and in the Alps from 1700 to 2000m. According to all we know *T. impurum* is the sole host species in the Alps; previous records of *T. caespitum* must be considered erroneous. However, the hosts of Sicilian and Calabrian *S. alpinus* are indeed assignable to *T. caespitum* which replaces *T. impurum* in the southern mountains, the latter cold-adapted species being recorded only as far south as M. Pollino.

Locality 1 - Sicily, Monti Nebrodi

The record is very interesting in that it shows a hitherto unknown existence of a further *Strongylognathus* species on Sicily which inhabits distinctly higher altitudes than the long known *S. destefanii*. On a southwest-facing slope of the Nebrodi mountains the species was fairly common and three nests could be found within a few hours. The host species at that site is *T. caespitum*. In addition, an aggressive conflict between two *Tetramorium* colonies, one of which was infested by *Strongylognathus*, was observed in the field, but characteristic slave-raiding behaviour could not be seen.

Locality 2 - Calabria, Montalto

On the very summit of the Montalto two *Strongylognathus* colonies were discovered on a clearing in a montane beech forest also containing scattered specimens of Silver Fir (*Abies alba*). Both samples were collected relatively close to each other but were ascertained as belonging to different colonies. *T. caespitum* was identified as the host species, by electrophoresis.

Localities 3a, b, c - Abruzzi, Gran Sasso

The presence of *S. alpinus* in the Gran Sasso massif was first discovered during an excursion by Buschinger, Douwes & Schumann. On this mountain plateau the species occurred in rather high population densities, and four nests were found on one day

(Buschinger, pers. com.). Two samples each were taken from site 'a' and 'b'. Surprisingly, one of the former was simultaneously parasitized by both *S. alpinus and S. testaceus* which raises interesting questions about the life history of these species. Some years later, one of us detected only one colony in a nearby locality (site 'c') at somewhat lower elevation despite considerable collecting efforts. Electrophoretic results at the *Mdhp* locus from slaves of the latter sample revealed *T. impurum* as host species, which is certainly true for the other samples as well. Investigation of males from a neighbouring colony confirmed this host species determination.

Strongylognathus destefanii Emery, 1915 [Figs. 17, 21, 23, 26]

Strongylognathus huberi subsp. *rehbinderi* var. *cecconii* Emery in Cecconi, 1908 (unavailable name)
Strongylognathus huberi subsp. *cecconii* Emery, 1916: **syn. nov.**
Strongylognathus cecconii Emery: Baroni Urbani, 1969
Strongylognathus emeryi Menozzi, 1921: **syn. nov.**
Strongylognathus huberi st. *cecconii* v. *kutteri* Santschi, 1927 (unavailable name): material referred to *destefanii* by Baroni Urbani, 1964

COLLECTING DATA:

Sicily - Prov. Siracusa, near Lentini, 300-400m, V.1986, A. Schulz leg.; Prov. Messina, Francavilla di Sicilia, ca. 300m, 2.V.1986, A. Schulz leg.; Prov. Siracusa, 5 km NE Canicattini Bagni, ca. 300m, 17.V.1993 & 11.V.1994, M. Sanetra leg.; Prov. Siracusa, ca. 5 km NE Floridia, ca. 100m, 11.V.1994, M. Sanetra leg.;
Calabria - Prov. Crotone, 3 km E Savelli, ca. 700m, 19.V.1994; Prov. Cosenza, Monte Pollino, 1 km NW Frascineto, ca. 500m, 21.V.1994;
Apulia - Prov. Foggia, Gargano, road Monte S. Angelo-Carpino 1,5 km NW intersection to Vico, ca. 700m, 24.V.1994, R. Güsten & M. Sanetra leg.

OTHER INVESTIGATED MATERIAL: Sicily, near Palermo, T. De Stefani leg. ♀ (MCG), holotype of *S. destefanii* Emery; Sicily, Segesta, III.1924, H. Kutter leg. 2☿☿ (NMB), "types" of "*S. huberi* st. *cecconii* v. *kutteri* Santschi"; Apulia, Tremiti Islands, G. Cecconi leg. 3☿☿ (MCG), syntypes of *S. huberi cecconii* Emery; Apulia, Tremiti Islands, Capraia, VI., G. Cecconi leg. 2☿☿ (MCZ), syntypes of *S. huberi cecconii* Emery; Apulia, Gargano Peninsula, San Marco in Lamis, 8.X.1961, C. Baroni Urbani leg. 3☿☿ (MCV), determined as *S. huberi cecconii* by Baroni Urbani; Apulia, Gargano Peninsula, Manfredonia, 10.X.1961, C. Baroni Urbani leg. 6☿☿, 18♀♀ (MCV), determined as *S. huberi cecconii* by Baroni Urbani; Apulia, Gargano Peninsula, Pèschici, 12.X.1961, C. Baroni Urbani leg. 8☿☿, 5♀♀ (MCV), determined as *S. huberi cecconii* by Baroni Urbani.

A single *Strongylognathus* female collected in the environs of Palermo by T. De Stefani around 1885 was the first record of this genus from Italy, on which the description of *S. destefanii* was later founded (Emery, 1915). Later on, the species was discovered at various other localities throughout Sicily (summarized by Baroni Urbani, 1971; see also Fig. 26). Menozzi (1921) erected the taxon *S. emeryi* from mainland southern Italy being based on a lone female from Sambiase di Calabria. *S. cecconii* Emery, 1916 remained known only from its type locality on the Tremiti Islands (Apulia) and the adjacent Gargano Peninsula (Baroni Urbani, 1962). We here place all three taxa in synonymy. The

holotype of *S. emeryi* could not be examined, but evaluation of extensive material from Sicily and Calabria showed no important morphological differences except in female size, which, however, was not geographically correlated. The mentioned material included the holotype of *S. destefanii*, a female from M. Pollino and the hitherto unknown workers from Calabria which can quite safely be assumed conspecific to *S. emeryi*. Among the investigated specimens from Apulia, those from coastal areas of the Gargano are completely comparable to Sicilian and Calabrian samples, while material from central Gargano and the Tremiti Islands differ by somewhat stronger sculpture on the petiolar nodes and subtle details of head shape and striation. Nonetheless, we regard these differences as insufficient to uphold *S. cecconii* as a separate taxon. Fig. 26 depicts the presently known distribution of *S. destefanii* resulting from the above taxonomic conclusions.

Electrophoretic data are available for three *S. destefanii* colonies from Sicily, two from Calabria and another one from Gargano. Calabrian samples deviated from the others by possessing a different *Gpi* allele in homozygous condition. The number of investigated colonies is too limited, however, to determine whether different populations indeed are fixed for alternate alleles. Heterozygote deficiency in parasites may well result from local inbreeding coupled with small population sizes. Heterozygous genotypes comprising these two *Gpi* alleles have been found to expected degrees in *S.* cf. *silvestrii* Menozzi, 1936 from Crete, a species closely related to *S. destefanii* (Sanetra, unpubl.). These minor genetic differences give no reason to treat *S. emeryi* as a valid taxon. Rather, a pronounced population substructuring can be inferred.

In the majority of nests studied, *T. semilaeve* served as host for *S. destefanii*. Though Emery (in Cecconi, 1908) recorded *T. diomedeum* as slaves of *S. cecconii* at the type locality, we found that host workers associated with the *S. cecconii* types in MCG in fact belong to *T. semilaeve*. There remains one citing of *T. diomedeum* as host of *S. destefanii* by Donisthorpe (1927) who reported two mixed colonies together with *T. diomedeum* and one with *Aphaenogaster semipolita* (Nylander, 1856). Since the latter observation certainly is a misinterpretation, Donisthorpe's host records should generally be treated with caution. In numerous habitats where *T. semilaeve* and *T. diomedeum* occurred together, we found consistently only the former species parasitized by *S. destefanii*, and *T. diomedeum* has otherwise never been reported as host of any other *Strongylognathus* species. Exceptionally, one colony from central Gargano contained host workers assignable to *T. impurum*.

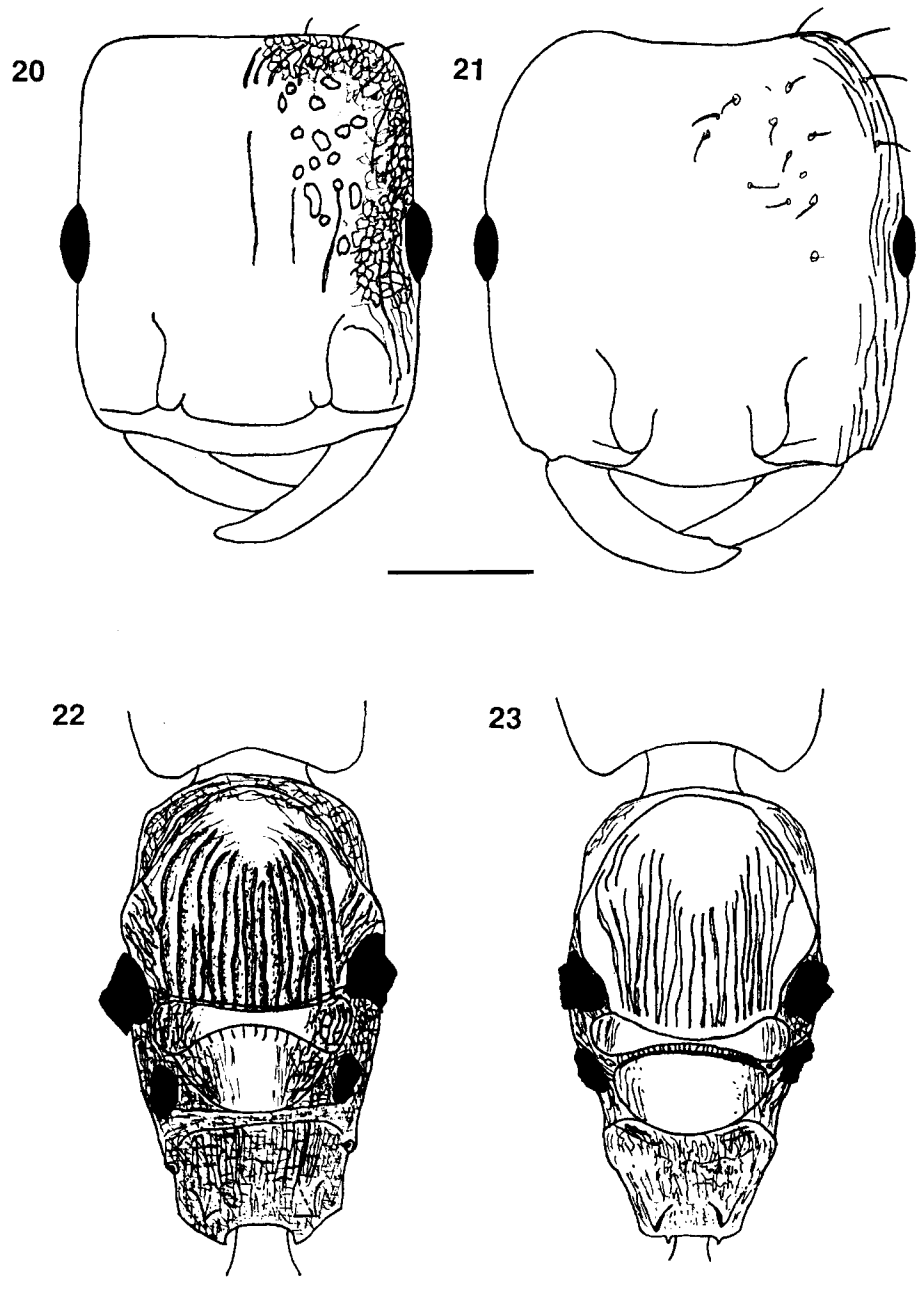
Localities 1, 2 - Sicily, Lentini & Francavilla

One nest each was found at these two localities containing numerous workers of *Strongylognathus* together with *T. semilaeve* hosts.

Locality 3 - Sicily, Canicattini Bagni

The single nest was located under a rock in pastured grassland with degraded garrigue vegetation. The numerous *Strongylognathus* workers were mixed with *T. semilaeve*. Most probably the same colony was rediscovered one year later, although the place had intensively been grazed by cows.

Locality 4 - Sicily, Floridia



Figs. 20-23. *Strongylognathus Spp.* from Gargano Peninsula. Head (frontal view): 20 - *S. huberi* ☿; 21 - *S. destefanii* ☿; Mesosoma (dorsal view): 22 - *S. huberi* ♀; 23 - *S. destefanii* ♀. Drawings by A. Schulz; scale bar 0.3 mm.

Two colonies were discovered in a typical Mediterranean lowland habitat similar to that recorded before. One sample also contained the *Strongylognathus* queen which had only one antenna and four legs left and died after about four weeks of maintenance in an artificial nest. In both colonies *T. semilaeve* served as host species, though *T. diomedeum* was common at this site.

Locality 5 - Calabria, Savelli

This is the first record of *Strongylognathus* in Calabria since the collection of the single *S. emeryi* female more than 70 years ago. The host species at Savelli was *T. semilaeve*, while *T. diomedeum* was also common there. Despite the comparatively high elevation, this site on the east slope of the Sila Grande showed strong Mediterranean influence with typical vegetation and fauna.

Locality 6 - Calabria, Monte Pollino

Many workers of *S. destefanii* were found in a mixed colony together with *T. semilaeve*. In addition, a dealate *Strongylognathus* female was collected which was most probably the functional queen.

Locality 7 - Apulia, Gargano

S. destefanii was recorded here at a locality where *S. huberi* had been discovered some years earlier. Workers show some morphological peculiarities in comparison with samples from farther south, which, however, are also observed in specimens from the Tremiti Islands. The host species has been classified as *T. impurum*.

Strongylognathus testaceus (Schenck, 1852) [Fig. 28]

COLLECTING DATA:

Sardinia - Prov. Sassari, Monte Limbara, 1000-1100m, 3.V.1994, M. Sanetra leg.; Prov. Nuoro, road N. 125 Dorgali-Baunei, ca. 13 km NW Punta Genna Coggina, 800-900m, 4.V.1994, M. Sanetra leg.;
Calabria - Prov. Cosenza, Sila Grande, S shore Lago Arvo, ca. 1200m, 18.V.1994; Prov. Cosenza, Monte Pollino, 4 km NW Morano Calabro, 1000-1100m, 21.V.1994;
Abruzzi - Prov. L'Aquila, Gran Sasso. a: Campo Imperatore, ca. 1900m, 4.X.1990, A. Buschinger, P. Douwes & R. Schumann leg. b: ca. 2 km W Vado di Sole, ca. 1800m, 4.X.1990, A. Buschinger, P. Douwes & R. Schumann leg.

Characteristic features of this species are the strongly protruding occipital corners in the female castes, low numbers of workers in the infested *Tetramorium* colonies and the absence of dulotic behaviour. The species is thus set apart from the others in the genus, and Bolton (1976) placed it together with the doubtfully distinct *S. karawajewi* Pisarski, 1966 in a species group of its own.

There are quite a number of records of this parasite from mainland Italy coming mostly from north of the Po river (summarized in Baroni Urbani, 1971). In southern Italy, the species has already been known from Apulia and Sardinia (Fig. 28). We are able to present further findings, including some from southern areas (Fig. 28), and a new

host record here.

Locality 1 - Sardinia, Monte Limbara

The existence of *S. testaceus* in Sardinia was first reported by Poldi (1974) and Casewitz-Weulersse (1974). At Monte Limbara, where the species was found again by one of the authors, very few workers of *Strongylognathus* were detected besides the newly recorded host species *T. brevicorne*. Sexual brood of *S. testaceus* could be reared in the laboratory and eclosed in the middle of August.

Locality 2 - Sardinia, Genna Coggina

The nest sample contained a female of *T. brevicorne* and one of *Strongylognathus*. When transferred into an artificial nest, both lived together without visible aggression and often in close association. This situation persists four years after collection. Because both females were confirmed to be functional queens, this observation provides first unequivocal evidence that *S. testaceus* indeed represents the often presumed status of a queen-tolerant inquiline.

Locality 3 - Calabria, Lago Arvo

The colony was found at the southern lake shore close to the edge of a montane pine forest. As revealed by electrophoresis, host workers are assignable to *T. caespitum*. Since *S. testaceus* has already been recorded from Apulia (Baroni Urbani, 1962), its presence in Calabria is not unexpected. However, this record provides further support for the species' extensive range in Europe which is an uncommon feature in permanently socially parasitic ants.

Locality 4 - Calabria, Monte Pollino

Two nests were found together with *T. impurum* as host species within a short time span, suggesting that *S. testaceus* is common at certain heights in the M. Pollino area. This is of interest as we also detected another *T. impurum* colony infested by the slave-maker *S. huberi* in close vicinity.

Localities 5a, b - Abruzzi, Gran Sasso

Two colonies were collected at site 'a' and another one at site 'b', one of the former containing *S. alpinus* in addition. These new records show that *S. testaceus* can occur up to about 2000m in the Mediterranean basin. We know of findings at similar elevations from the French Pyrenees and southern Spain. In the Alps the species has never been recorded from above 1500m as yet. Further, the new sites in the Gran Sasso give reason to believe that there is no distributional gap between the southern and northern Italian populations (Fig. 28).

Anergates atratulus (Schenck, 1852) [Fig. 29]

COLLECTING DATA:
Sicily - Prov. Siracusa, 5 km NE Canicattini Bagni, ca. 300m, 17.V.1993, M. Sanetra leg.;
Lucania - Prov. Potenza, Monte Pollino, near Rifugio De Gasperi, ca. 8 km SE Rotonda, ca. 1600m, 21.V.1994.

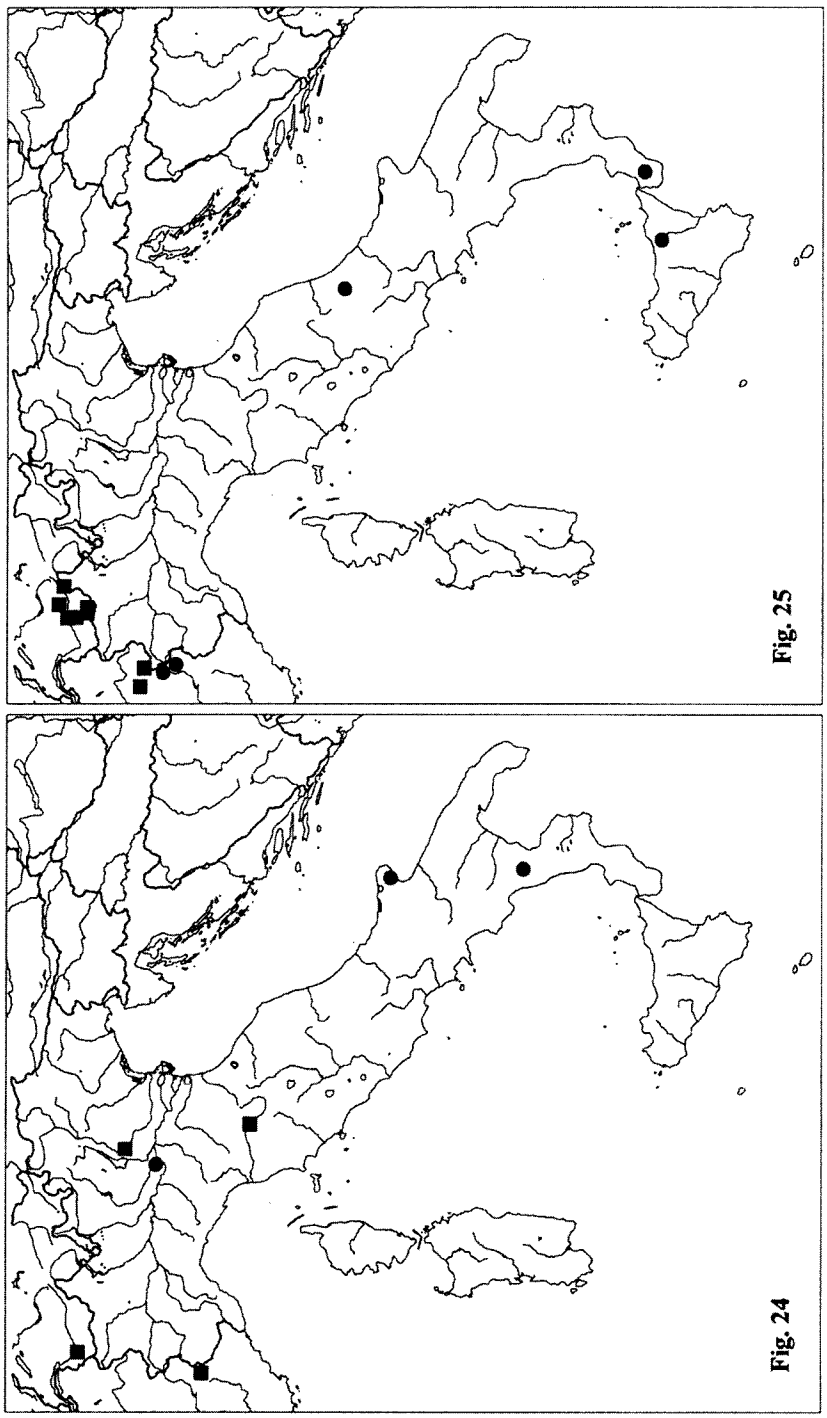
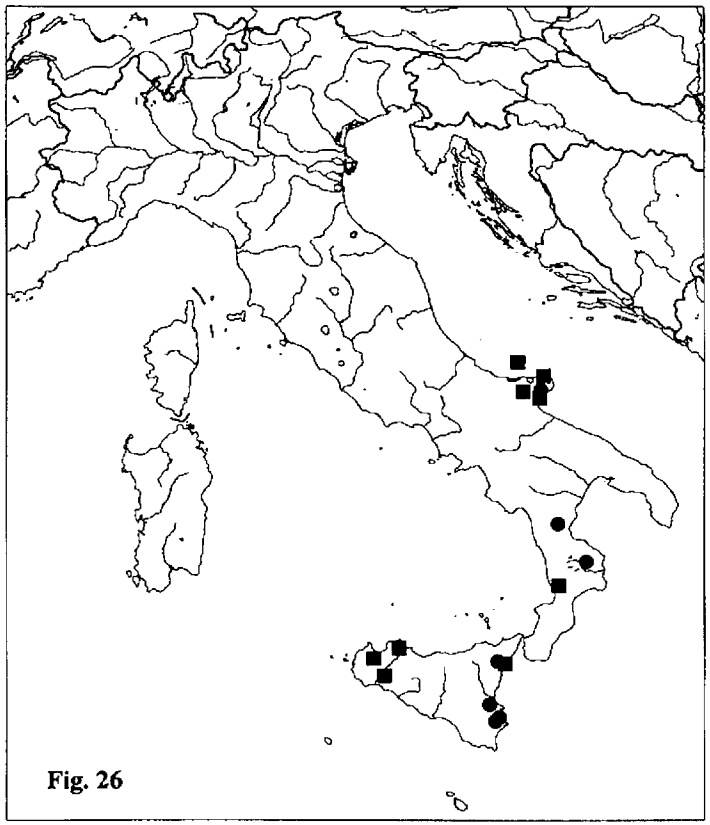


Fig. 24. Distribution of *Strongylognathus huberi* Forel, 1874 in Italy and neighbouring areas. Squares: literature data; circles: new records. Further localities are known in France, Spain and Portugal. Fig. 25. Known distribution of *Strongylognathus alpinus* Wheeler, 1909. Squares: literature data; circles: new records.



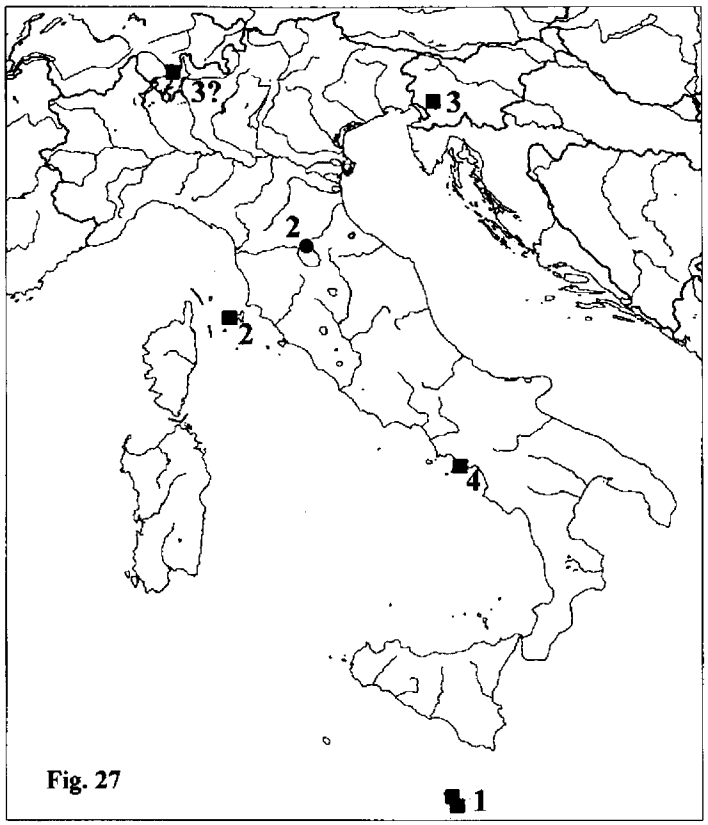


Fig. 26. Known distribution of *Strongylognathus destefanii* Emery, 1915. Squares: literature data; circles: new records. Fig. 27. Records of four described *Strongylognathus* species in Italy and neighbouring areas. Squares: literature data; circle: new record. 1: *Strongylognathus insularis*; 2: *Strongylognathus italicus*; 3: *Strongylognathus alboini*; 3?: *Strongylognathus alboini* (according to Baroni Urbani, 1969); 4: *Strongylognathus pisarskii*.

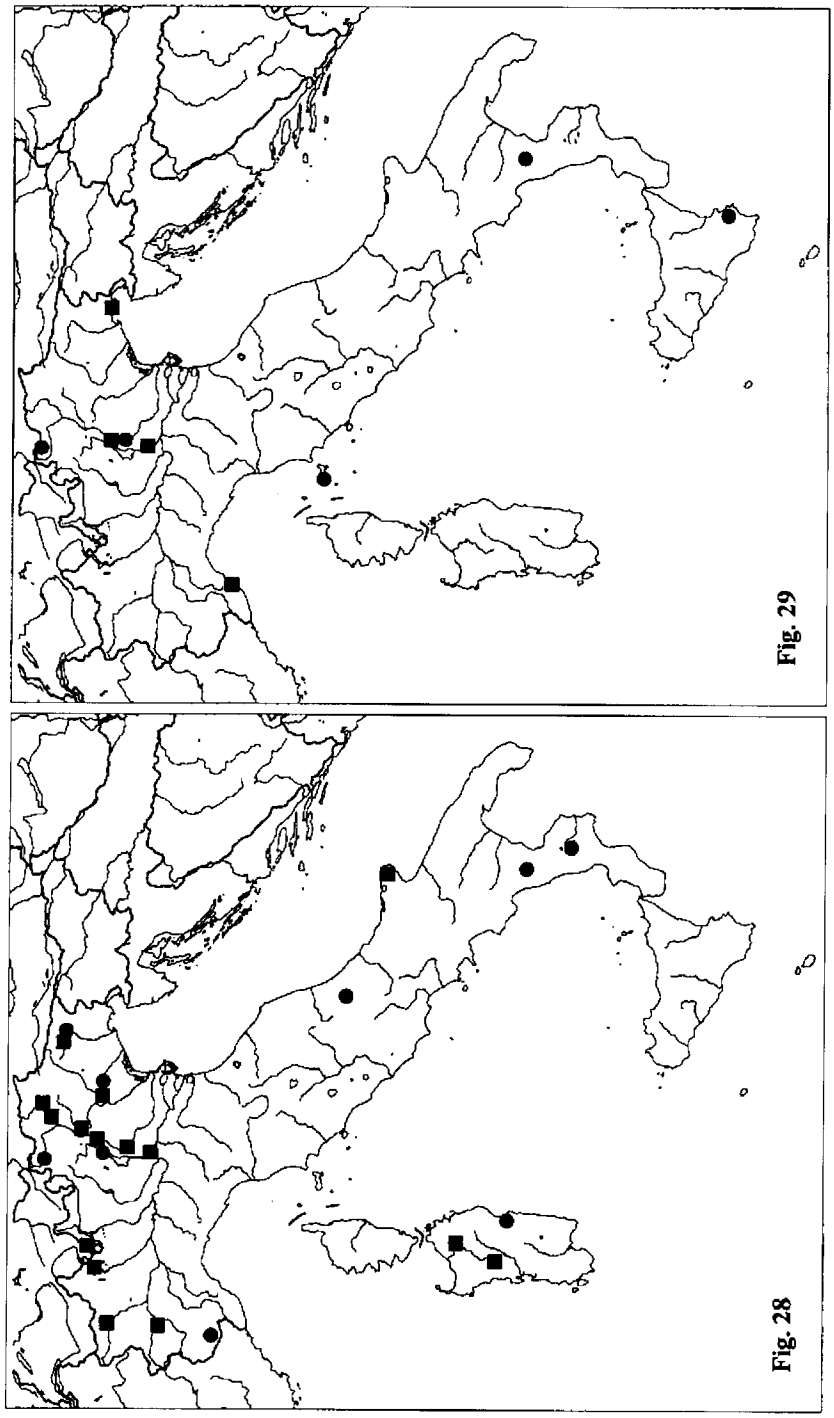


Fig. 28. Records of *Strongylognathus testaceus* (Schenck, 1852) in Italy. Squares: literature data; circles: new records. Localities outside Italy within the map area are not reported. Fig. 29. Records of *Anergates atratulus* (Schenck, 1852) in Italy. Squares: literature data; circles: new records. Localities outside Italy within the map area are not reported.

Although this extreme inquiline has a very wide Palaearctic distribution, in Italy it has so far been known from only three northern localities (Stäger, 1928; Scupola, 1994). The first findings from southern Italy are presented here. Further, there exist some additional records from the Italian Alps and the island of Elba known to us (see Fig. 29 and next chapter).

Locality 1 - Sicily, Canicattini Bagni

Many dealate *Anergates* females, apparently on the way to become physogastric, were retrieved from the nest chambers. Inside the collecting tube considerable egg-laying of these females could be observed. Additionally, male and female pupae of the host species *T. diomedeum* were present. It is surprising that this probably oligogynous species can serve as host of *Anergates*, and the presence of sexual brood of the host is a rather unusual feature, too. Other available information on the life history of *Anergates* hint towards colony foundation in orphaned host colonies.

Locality 2 - Lucania, Monte Pollino

The nest sample contained three physogastric queens and many last instar larvae of *Anergates*, but no *Tetramorium* brood at all. The collected sexual brood of *Anergates* could be reared in the laboratory. The host species was electrophoretically determined as *T. impurum*. Thus, this sample shows the same properties as typical *Anergates* colonies from central Europe and the Alps.

FURTHER RECORDS OF SOCIAL PARASITES

In the following we enumerate some additional new records of *Strongylognathus* and *Anergates* originating from northern parts of Italy and adjacent regions. These are depicted in the maps and referred to in the discussion, but are not treated in the chapter 'Commented list of social parasites'.

Strongylognathus huberi

Lombardy - Prov. Mantova, near Gazzuolo, bank of Oglio river, 23.V.1963, B. Poldi leg.

Strongylognathus alpinus

Switzerland - Valais, Lötschental, ca. 1 km NE Blatten, ca. 1650m, 1.VIII.1992, A. Buschinger, M. Sanetra, R. Güsten leg. [host: *T. impurum*];
France - Hautes-Alpes, ca. 7 km N Chantemerle near Briançon, 1770m, 27.VII.1994, A. Buschinger, M. Sanetra, R. Schumann, R. Güsten leg. [host: *T. impurum*]; Hautes-Alpes, ca. 1 km E ArvieuxSE Briançon, 1700-1800m, 29.VII.1994, A. Buschinger, M. Sanetra, R. Schumann, R. Güsten leg. [host: *T. impurum*].

Strongylognathus italicus Finzi, 1924

Tuscany - Prov. Livorno, Isola d'Elba, Monte Maolo, ca. 200m dir. Monte Capanne, 700-800m, 21.V.1996, M. Sanetra leg. [host: *T.* cf. *impurum*]; Prov. Firenze, Passo della Consuma, 1050m, 20.VIII.1981, V. Assing leg. [host: *T.* cf. *impurum*].

Strongylognathus testaceus

Lombardy - Prov. Brescia, Lago di Garda, Limone sul Garda, ca. 100m, 18.VII.1991, R. Schumann leg. [host: *T. caespitum*];
Veneto - Prov. Treviso, Nervesa della Battaglia near Conegliano, ca. 100m, 25.VII.1991, M. Sanetra leg. [host: *T. caespitum*];
Trentino-Alto Adige - Prov. Bolzano, Val Venosta (Etschtal), Adige riv., Tanas, ca. 1600m, VII.1991, A. Buschinger leg. [host: *T. impurum*];
Piedmont - Prov. Cuneo, Val Gesso near Valdieri, ca. 600m, 10.VII.1992, M. Sanetra leg. [host: *T. caespitum*];
Friuli-Venezia Giulia - Prov. Udine, Monte S. Simeone near Bordano, ca. 300m, 31.V.1996, M. Sanetra leg. [host: *T. caespitum*].

Anergates atratulus
Veneto - Prov. Verona, ca. 5 km N Fumane near Verona, ca. 100m, 26.VII.1991, M. Sanetra leg. [host: *T. caespitum*];
Trentino-Alto Adige - Prov. Bolzano, Val di Senáles (Schnalstal), Maso Corto (Kurzras), ca. 2100m, VII.1991, A. Buschinger leg. [host: *T. impurum*];
Tuscany - Prov. Livorno, Isola d'Elba, Monte Maolo, ca. 200m dir. Monte Capanne, 700-800m, 21.V.1996, M. Sanetra leg. [host: *T.* cf. *impurum*].

Discussion

In the recent past little information has been added to the knowledge of tetramoriine ants in southern Italy. Our extensive morphological and biochemical investigations presented here led to the recognition of eight different species of *Tetramorium* and four species of socially parasitic *Strongylognathus* in the studied regions Sardinia, Sicily, Calabria, Lucania, Apulia and Abruzzi. The rare inquiline *Anergates atratulus* was recorded from Lucania and Sicily for the first time. Other researchers who have dealt with the ant fauna of these regions, like Baroni Urbani (1971) and Poldi et al. (1995), provided inadequate taxonomic concepts for the genera *Tetramorium* and *Strongylognathus*, which make absolute comparisons of species numbers difficult. However, we discovered at least one *Tetramorium* species, *T.* sp. "Gargano", which has not been recognized before and is thus considered new to the Italian ant fauna. Within the range of the otherwise clearly defined species, we have detected some problematic populations which are mainly characterized by different enzyme phenotypes, for example *T. caespitum* from Sardinia. We reject, however, the conclusion by de Haro et al. (1995) that such differences in itself warrant recognition of a population as a separate species.

In Sardinia we noted *T. brevicorne*, *T. meridionale* and *T. semilaeve* as frequent species, while *T. caespitum* was recorded with certainty only from a single locality at Monte Limbara. *T. brevicorne* most commonly inhabits the higher altitude sites. On the other hand, *T. semilaeve* and *T. meridionale* have a more coastal and lower montane distribution. In contrast to its scarcity on the mainland, *T. meridionale* dominates in many places up to elevations of about 800m. The presence of these four *Tetramorium* species in Sardinia is concordant with those listed by Poldi et al. (1995), and an isolated record of *T. diomedeum* (Krausse, 1912) should be interpreted as a misidentification. All of the Sardinian species but *T. brevicorne* are also known from the Italian mainland. For the neighbouring island of Corsica, Casevitz-Weulersse (1990) reports the same four species, plus *T. forte* Forel, 1904, *T. punicum* (Smith, 1861) and an unidentified species. As

far as can be deduced from the given descriptions, these further species are likely to be based on intraspecific variants of the taxa herewithin confirmed for the Tyrrhenian. We suggest that the species composition of Corsica and Sardinia is probably the same.

Sicily and Calabria show great similarities to each other with regard to their *Tetramorium* fauna. Up to about 1000m, the circummediterranean *T. semilaeve* abounds in various types of habitats primarily consisting of xerophilous garrigue and pseudo-steppe formations. *T. diomedeum* often shares these habitats, but generally occurs at much lower population densities. In a few places, however, *T. diomedeum* predominates over *T. semilaeve*. A further species, *T. punctatum*, which is confined to similar ecological surroundings, occurs irregularly in Calabria and Sicily. In southern Italy, the well known *T. caespitum* shows differential preference to either anthropogenically influenced habitats near the coast or alpine meadows in the mountains. Omitting the doubtful records of *T. bicorne* and *T. jugurtha* from the Sicilian species list, we get a total of four *Tetramorium* species distributed on that island with certainty.

Calabria as the southernmost region of the Italian mainland harbours three additional species that have not yet been found in Sicily. A hitherto undetected species, provisionally named *T.* sp. "Gargano", appears to be very scarce. Only two colonies could be obtained from different sites during appreciable collecting efforts in Calabria. Concerning *T. meridionale*, there exists a single citation from Sambiase di Calabria by Menozzi (1921), and the species can therefore be presumed to be very local in mainland southern Italy. Our new record of *T. impurum* at M. Pollino may be situated at the species' southern limit of distribution. Further south, it seems to be replaced by *T. caespitum* in the mountains. We do not expect *T. impurum* to be discovered in Sicily in the future, whereas the two formerly mentioned species may be present in Sicily, but probably local and rare.

In Apulia we have studied only the Gargano Peninsula more thoroughly and could report two species from there, namely *T.* sp. "Gargano" and a form probably belonging to *T. impurum*. It seems also possible that the latter variant constitutes a separate species specifically adapted to submediterranean environments contrasting with those typically inhabited by *T. impurum*. Amazingly enough, in this relatively well explored small area we collected, within a short time span, more problematic taxa than in Sardinia, Sicily and Calabria combined. There are indications from enzyme studies that *T.* sp. "Gargano" may have affinities to the eastern European and Asian fauna, which seems conceivable since the Gargano Peninsula was formerly linked to the Balkan region by a land bridge in the middle Miocene (Azzaroli & Guazzone, 1980). After compilation of the published records, at least five *Tetramorium* species can be reliably ascribed to the Apulian fauna. *T. diomedeum* and *T. semilaeve* are reported from the Tremiti Islands and a few localities along the coast (Baroni Urbani, 1971). Various records listed by Baroni Urbani (1971), some possibly dubious, pertain to *T. caespitum*.

In the region Abruzzi, *T. impurum* could be ascertained for the first time to occur in the Gran Sasso massif. This species seems to be restricted to elevations above 1000m in the Appennine mountains, probably reflecting a climatically induced retreat after the last glaciation, as is known from other cold-adapted species in southern Europe. Two further species, *T. caespitum* and *T. semilaeve*, have been reported from Abruzzi (Baroni Urbani,

1971). Such a species composition, sometimes including *T. meridionale* as additional element, appears characteristic for the northern Mediterranean region.

The Italian *Tetramorium* fauna as a whole is nearly complete with the species treated in this work for the southern part of the country. A recent survey of the ant fauna of the Pelagian Islands and Pantelleria in the channel between Sicily and Tunisia indicated North African affinities (Mei, 1995). Additional *Tetramorium* taxa reported from there that may be different from those occurring on the southern mainland and Sicily are *T. biskrense* Forel, 1904 (given as ssp. *kahenae* Menozzi, 1934 by Mei, 1995) and *T. pelagium* Poldi in Mei, 1995. However, without a revision of the North African *Tetramorium* species nothing can be said about the value of these assignments. As regards northern Italy, *T. semilaeve italicum* Menozzi, 1932 from Tuscany is probably a synonym of *T. semilaeve* or *T. caespitum*. "*T. scalenum* Le Moli & Rosi, 1991" (ascribed to Poldi in litt.) cited for the central Italian Appennines clearly is a *nomen nudum*, for no description is provided in the published account. "*T.* sp. prope *caespitum*" reported by Rigato & Sciaky (1989) from the Maritime Alps of Italy most probably is *T. rhenanum* Schulz, 1996 from the adjacent French Alps (Schulz, 1996), a taxon close to *T. moravicum* Kratochvil, 1941. For all we know, this is the only distinct species from the northern mainland not yet recorded from southern Italy.

The large amount of new material along with our subsequent studies revealed that southern Italy harbours four valid species of *Strongylognathus* which are *S. huberi*, *S. alpinus*, *S. destefanii* and *S. testaceus*. We attempted to work out differences between these species by showing and describing typical features rather than creating a possibly misleading key. It appears that, in *Strongylognathus*, the application of standard taxonomic measurements as employed by Baroni Urbani (1969) and Poldi (1994) suffers from the restricted number of available nest series and the large amount of intraspecific variation. We are quite convinced that worker size, scapus length and width of nodes upon which these authors based their taxonomic conclusions are not valuable characters at least regarding the material presently available. The same applies to colour of petiolar nodes, size of epinotal spines and structure and extent of propodeal rugosity used in the keys to Italian *Strongylognathus* species in the above-mentioned works. In these as well as in Poldi et al. (1995) the arrangement of species differs from our concept with respect to the taxa *emeryi* and *cecconii*, which we consider synonyms of *S. destefanii*.

Three more species of *Strongylognathus* have been cited for the Italian fauna (Poldi et al., 1995), and a further one from Malta (Fig. 27). The latter, *S. insularis* Baroni Urbani, 1968 is closely allied to *S. destefanii* and *S. afer* Emery, 1884 from North Africa, but more information is required to evaluate the status of these three taxa relative to each other. The other reported forms, *S. italicus* Finzi, 1924, *S. alboini* Finzi, 1924 and *S. pisarskii* Poldi, 1994, have primarily been compared with *S. alpinus*. Worker material of *S. italicus* from Elba (see the preceding chapter), though showing close affinities to *S. alpinus*, cannot be ascribed to any of the clearly defined species listed in the present study. Thus, *S. italicus*, described from a single female (Finzi, 1924a), is probably valid. A new mainland record of *Strongylognathus* near Florence (see preceding chapter and Fig. 27) also represents this species, which obviously differs from *S. alpinus* in its ecological preferences. The relations of the other two forms mentioned above cannot presently be determined with certainty.

Nonetheless, the attribution of *S. alboini* to the Italian fauna (Baroni Urbani, 1971; Poldi et al., 1995) is erroneous: the two reported localities for this species (Finzi, 1924b; Kutter, 1952) are in Slovenia and Switzerland, respectively (see Fig. 27).

S. testaceus appears to be the sole representative of *Tetramorium*'s social parasites extending to Sardinia. Neither a species of the *S. huberi* group nor *A. atratulus* has ever been discovered on that island (e.g., Baroni Urbani, 1971). In Sicily and Calabria *S. destefanii* and *S. alpinus* can be found, but each species depends on clearly different climatic conditions. *S. alpinus* is known exclusively from upper montane to subalpine grasslands above 1500m whereas *S. destefanii* typically prefers lowland habitats near the coast, even inhabiting cultivated land. In southern Calabria *S. testaceus* has been found as an additional species at moderate elevations of about 1000m. Passing northwards to M. Pollino there are three species of *Strongylognathus* that occur sympatrically, *S. testaceus*, *S. huberi* and *S. destefanii*. The latter two show obvious differences in their vertical distribution, *S. huberi* occurring in the same range as *S. testaceus*. Moreover, it seems even possible that *S. alpinus* will be discovered at higher elevations as the fourth *Strongylognathus* species of the M. Pollino. A quite similar pattern of differential niche specificity is observable at the Apulian M. Gargano. Here, *S. huberi* and *S. testaceus* are known to live exclusively in the mountainous region in the center of the peninsula, whilst *S. destefanii* mainly inhabits the coastal strip but also penetrates into the mountains. *S. destefanii* has adapted to very dry and warm places and the Gargano area might be the northern limit of its range. More detailed observations from these contact zones between different *Strongylognathus* species promise to be of high interest.

Considering all our present knowledge about the distribution of different *Strongylognathus* species the picture emerges that the inquiline *S. testaceus* can cohabit with every species of the *S. huberi* group. In contrast, different species of the latter group have only been found on one occasion to occur syntopically. It can be imagined that resource competition on host species nests is much stronger among slave-makers than between slave-makers and inquilines. A further example is provided by a finding of *S. destefanii* and *A. atratulus* in Sicily where both species had established their nests only few meters apart. On the Gran Sasso at a height of about 1800m, *S. alpinus* and *S. testaceus* have even been found within the same *Tetramorium* colony. Since *S. testaceus* is a queen-tolerant inquiline, we suggest that *S. alpinus* had conducted a slave-raid on the *S. testaceus* colony that was afterwards incorporated into the slave-makers' society. As observed during laboratory experiments, host colony incorporation is perhaps not an unusual outcome of *Strongylognathus* slave raids (Sanetra & Buschinger, 1996). Another case of coexistence of a slave-maker and an inquiline has recently been detected in the mountains of Elba where *S. italicus* and *A. atratulus* inhabited the same nest of *T.* cf. *impurum* (see preceding chapter).

In accordance with different patterns of vertical distribution, species of *Strongylognathus* have obviously acquired several specializations in host use. As shown previously, climatic parameters prevailing at certain altitudinal ranges strongly influence the composition of the *Tetramorium* fauna. *T. semilaeve*, predominant in the lowland, probably constitutes the sole host species of *S. destefanii* in Sicily as well as in Calabria. *S. alpinus* exploits nests of *T. caespitum* in Sicily and Calabria and *T.*

impurum in the Gran Sasso, which are the only hosts available at the elevation inhabited. Similarly, *S. testaceus* has always been found together with one of these two host species (except for *T. brevicorne* in Sardinia) and thus apparently becomes a species of higher altitudes in the south. However, it remains an open question whether it can also survive in mixed colonies together with *T. semilaeve*. Records of *S. huberi* are very scarce at present and do not justify any general conclusions. The hosts recorded by us and other authors for Italy, however, consistently belong to the *T. caespitum* group (sensu Radchenko, 1992a).

Owing to lack of information the usual pattern of host use of *A. atratulus* in southern Italy cannot be elucidated. It seems likely that this inquiline most frequently depends upon *T. caespitum* and *T. impurum* due to its preference for higher elevations as known from other regions, especially the Alps (pers. obs.). Furthermore, its probable dependence on orphaned host colonies should favour exploitation of monogynous host species which are prone to provide such kind of target colonies. In Calabria we found *A. atratulus* together with *T. impurum* at 1600m on M. Pollino. The single colony discovered in Sicily at 300m contained *T. diomedeum*, as new host species. The composition of the infested colony with developing sexual brood of the host species raises many questions. As colonies being parasitized by *Anergates* usually contain no *Tetramorium* brood at all, this population may have developed different life habits. However, the possibility cannot be ruled out that *Anergates* had accidentally been adopted into this colony, despite the presence of one or more host queens. In the lowlands, *A. atratulus* might be more adaptable to monogynous *T. semilaeve*, though no such records are presently available.

The findings of *A. atratulus* in southern Italy presented in this study are the only two records from this region thus far (see Fig. 29). Yet, there are reasons to believe that the species occurs throughout Italy without considerable gaps. As a workerless inquiline *A. atratulus* can be easily detected only within a limited period from June to August when winged females are present in the nests. Since most of the social parasites like *Anergates* are usually both local and rare, new records have always been difficult to obtain. As a consequence, many of the existing populations still await to be discovered. Further collecting activities and detailed field studies will be necessary to improve our understanding of distribution, habitat requirements and biology of these fascinating ants.

ACKNOWLEDGEMENTS

We sincerely thank the following persons who enabled us to see relevant material from different museums and were all very helpful: Valter Raineri (Genova), Lorenzo Sorbini† and Roberta Salmaso (Verona), Stefan P. Cover (Cambridge), Michel Brancucci (Basel) and Ivan Löbl (Genève). We are also very grateful to Bruno Poldi (Mantova) for examining some of our material and letting us use his unpublished record of *Strongylognathus huberi*. Alfred Buschinger (Darmstadt), Per Douwes (Lund), Ralf Schumann (Darmstadt), Jürgen Heinze (Erlangen) and Volker Assing (Hannover) also shared records and material from their excursions. A. Buschinger (Darmstadt) is additionally thanked for helpful suggestions on the manuscript. The distribution maps were created using the program DMAP for Windows by Alan Morton (Windsor) who was also very helpful in solving some problems with the maps. Ward Tomlinson (Darmstadt) kindly improved the English. Parts of the studies were supported by a grant of the Deutsche Forschungsgemeinschaft to A. BuschingerBu 310/26-1. Two referees made very profitable comments on the manuscript.

REFERENCES

ACOSTA F.J. & MARTINEZ M.D., 1982 - Consideraciones sobre la dulosis en el género *Strongylognathus* Mayr, 1853. (Hym. Formicidae). Boletín de la Asociación Española de Entomologia, 6: 121-124.

AGOSTI D. & COLLINGWOOD C.A., 1987 - A provisional list of the Balkan ants (Hym. Formicidae) and a key to the worker caste. I. Synonymic list. Mitteilungen der Schweizerischen entomologischen Gesellschaft, 60: 51-62.

ANDRÉ E., 1883 - Les fourmis, pp 281-344. In: E. André (ed.). Species des Hyménoptères d'Europe et d'Algérie, 2, Edm. André, Beaune.

AZZAROLI A. & GUAZZONE G., 1980 - Terrestrial mammals and land connections in the Mediterranean before and during the Messinian. Palaeogeography, Palaeoclimatology, Palaeoecology, 29: 155-167.

BARONI URBANI C., 1962 - Studi sulla mirmecofauna d'Italia. I. Redia, 47: 129-138.

BARONI URBANI C., 1964 - Studi sulla mirmecofauna d'Italia. II. - Formiche di Sicilia. Atti dell' Accademia Gioenia di Scienze Naturali di Catania, 16 (6): 25-66.

BARONI URBANI C., 1968a - Studi sulla mirmecofauna d'Italia. IV. La fauna mirmecologica delle Isole Maltesi ed il suo significato ecologico e biogeographico. Annali del Museo Civico Storia Naturale "Giacomo Doria", 77: 408-559.

BARONI URBANI C., 1968b - Studi sulla mirmecofauna d'Italia. V. Aspetti ecologici della Riviera del M. Cònero. Bolletino di Zoologia, 35: 39-76.

BARONI URBANI C., 1969 - Gli *Strongylognathus* del gruppo *huberi* nell'Europa occidentale: saggio di una revisione basata sulla casta operaia (Hymenoptera Formicidae). Bolletino della Società Entomologica Italiana, 99-101: 132-168.

BARONI URBANI C., 1971 - Catalogo delle specie di Formicidae d'Italia (Studi sulla mirmecofauna d'Italia X). Memorie della Società Entomologica Italiana, 50: 5-287.

BAUR A., SANETRA M., CHALWATZIS N., BUSCHINGER A. & ZIMMERMANN F.K., 1996 - Sequence comparisons of the internal transcribed spacer region of ribosomal genes support close relationships between parasitic ants and their respective host species (Hymenoptera: Formicidae). Insectes Sociaux, 43: 53-67.

BOLTON B., 1976 - The ant tribe Tetramoriini (Hymenoptera: Formicidae). Constituent genera, review of smaller genera and revision of *Triglyphothrix* Forel. Bulletin of the British Museum (Natural History), Entomology, 34: 281-379.

BOLTON B., 1977 - The ant tribe Tetramoriini (Hymenoptera: Formicidae). The genus *Tetramorium* Mayr in the Oriental and Indo-Australian regions, and in Australia. Bulletin of the British Museum (Natural History), Entomology, 36: 67-151.

BOLTON B., 1979 - The ant tribe Tetramoriini (Hymenoptera: Formicidae). The genus *Tetramorium* Mayr in the Malagasy Region and in the New World. Bulletin of the British Museum (Natural History), Entomology, 38: 129-181.

BOLTON B., 1980 - The ant tribe Tetramoriini (Hymenoptera: Formicidae). The genus *Tetramorium* Mayr in the Ethiopian zoogeographical region. Bulletin of the British Museum (Natural History), Entomology, 40: 193-384.

BOLTON B., 1995 - A New General Catalogue of the Ants of the World. Harvard University Press, Cambridge (Mass.), 504 pp.

BONDROIT J., 1918 - Les Fourmis de France et de Belgique. Annales de la Société Entomologique de France, 87: 1-174.

BUSCHINGER A., 1974 - Monogynie und Polygynie in Insektensozietäten, pp. 862-896. In: G.H. Schmidt (ed.). Sozialpolymorphismus bei Insekten, Wissenschaftliche Verlagsgesellschaft, Stuttgart.

BUSCHINGER A., EHRHARDT W. & FISCHER K., 1981 - *Doronomyrmex pacis*, *Epimyrma stumperi* und *E. goesswaldi* (Hym., Formicidae) neu für Frankreich. Insectes Sociaux, 28: 67-70.

CAMMAERTS R., PASTEELS J.M. & ROISIN Y., 1985 - Identification et distribution de *Tetramorium caespitum* (L.) et *T. impurum* (Foerster) en Belgique (Hymenoptera Formicidae). Actes des Colloques Insectes Sociaux, 2: 109-118.

CASEVITZ-WEULERSSE J., 1974 - Fourmis récoltées en Corse et en Sardaigne. Annales de la Société Entomologique de France (N.S.), 10: 611-621.

CASEVITZ-WEULERSSE J., 1990 - Étude systématique de la myrmécofaune corse (Hymenoptera, Formicidae) (Deuxième partie). Bulletin du Muséum National d'Histoire Naturelle (Paris) A, 12: 415-442.

CECCONI G., 1908 - Contributo alla fauna delle Isole Tremiti. Bolletino dei Musei di Zoologia ed Anatomia Comparata della Reale Università di Torino, 23(583): 1-53.

CONSANI M., 1947 - Reperti corologici sulle formiche italiane. Redia, 32: 179-182.

CONSANI M. & ZANGHERI P., 1952 - Fauna di Romagna. Imenotteri - Formicidi. Memorie della Società Entomologica Italiana, 31: 38-48.

DE DALLA TORRE C.G., 1893 - Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus. Formicidae (Heterogyna), 7, G. Engelmann, Leipzig, 289 pp.

DE HARO A., COLLINGWOOD C.A. & DOUWES P., 1995 - Nota preliminar sobre sistemática molecular gen-aloenzimática de algunas formas españolas y marroquíes del grupo *albicans* del género *Cataglyphis* (Hym., Formicidae). Orsis, 10: 73-81.

DONISTHORPE H., 1926 - The Ants (Formicidae), and some Myrmecophiles, of Sicily. The Entomologist's Record and Journal of Variation, 38: 161-165.

DONISTHORPE H., 1927 - The Ants (Formicidae), and some Myrmecophiles, of Sicily [concluded]. The Entomologist's Record and Journal of Variation, 39: 6-9.

EMERY C., 1915 - Contributo alla conoscenza delle formiche delle isole Italiane. Descrizioni di forme mediterranee nuove o critiche. Annali del Museo Civico di Storia Naturale di Genova, (3)6[=46]:244-270.

EMERY C., 1916 - Fauna Entomologica Italiana. I. - Hymenoptera.- Formicidae. Bolletino della Società Entomologica Italiana, 47: 79-275.

EMERY C., 1925 - Notes critiques de Myrmécologie. XI. *Tetramerium* [sic] *caespitum* (L.). Annales de la Société Entomologique de Belgique, 64[1924]65: 177-191.

FINZI B., 1924a - Formiche dell'Isola d'Elba e Monte Argentario. Bolletino della Società Entomologica Italiana, 56: 12-15.

FINZI B., 1924b - Secondo contributo alla conoscenza della fauna mirmecologica della Venezia Giulia. Bolletino della Società Entomologica Italiana, 56: 120-123.

ICZN (INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE), 1985 - International Code of Zoological Nomenclature, 3rd edition. International Trust for Zoological Nomenclature, London, 338 pp.

KRAUSSE A. H., 1912 - Ueber sardische Ameisen. Archiv für Naturgeschichte A, 78 (7): 162-166.

KUTTER H., 1952 - Myrmekologische Beobachtungen 1951. Bulletin de l'Union Internationale pour l'Étude des Insectes Sociaux, 1: 21-27.

KUTTER H., 1977 - Hymenoptera: Formicidae, 298 pp. In: W. Sauter (ed.). Fauna Insecta Helvetica, 6, Schweizer entomologische Gesellschaft, Zürich.

LE MOLI F. & ROSI M. R., 1991 - Ricerche corologiche sulla mirmecofauna dell'Umbria. I. L'Appennino Spoletino. Atti della Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano, 132: 25-40.

LÓPEZ F., 1988 - Aproximación al estudio del género *Tetramorium* Mayr, 1855 en la Peninsula Ibérica (Hymenoptera, Formicidae). PhD thesis, Universidad Complutense, Madrid, 295 pp.

LÓPEZ F., 1991 - Variabilidad morfológica y problemas taxonómicos en *Tetramorium caespitum*

(Linné, 1758) y *Tetramorium semilaeve* André, 1881 (Hym., Formicidae). Boletín de la Asociación Española de Entomologia, 15: 65-78.

MEI M., 1995 - Hymenoptera Formicidae (con diagnosi di due nuove specie). In: B. Massa (ed.). Arthropoda di Lampedusa, Linosa e Pantelleria (Canale di Sicilia, Mar Mediterraneo). Il Naturalista Siciliano, 19 (Suppl.): 753-772.

MENOZZI C., 1921 - Formiche dei dintorni di Sambiase di Calabria. Bolletino del Laboratorio di Zoologia generale e agraria della Reale Scuola superiore d'Agricoltura in Portici, 15: 24-32.

PISARSKI B., 1966 - Étude sur les fourmis du genre *Strongylognathus* Mayr (Hym.: Formicidae). Annales Zoologici (Warszawa), 23: 509-523.

POLDI, B., 1974 - Contributo alla conoscenza dei Tetramoriini (Hymenoptera Formicidae) di Sardegna. Atti del X Congresso Nazionale Italiano di Entomologia, Sassari, 20-25 Maggio 1974: 227.

POLDI B., 1980 - Imenotteri Formicidi della brughiera di Rovasenda (Piemonte), pp. 7-19. In: Quaderni sulla "Struttura delle zoocenosi terrestri". 1. La brughiera Pedemontana, Vol. 3. Serie AQ/1/110. Collana del programma finalizzato "Promozione della qualità dell'ambiente", Consiglio Nazionale delle Ricerche, Roma.

POLDI B., 1994 - *Strongylognathus pisarskii* species nova (Hymenoptera, Formicidae). Memorabilia Zoologica, 48: 187-191.

POLDI B., MEI M. & RIGATO F., 1995 - Hymenoptera Formicidae, pp. 1-10. In: A. Minelli, S. Ruffo & S. La Posta (eds.). Checklist delle specie della fauna italiana, 102, Calderini, Bologna.

RADCHENKO A.G., 1992a - Ants of the genus *Tetramorium* (Hymenoptera, Formicidae) in the fauna of the USSR. Part 1 [In Russ.]. Zoologicheskii Zhurnal, 71 (8): 39-49.

RADCHENKO A.G., 1992b - Ants of the genus *Tetramorium* (Hymenoptera, Formicidae) in the fauna of the USSR. Part 2 [In Russ.]. Zoologicheskii Zhurnal, 71 (8): 50-58.

RIGATO F. & SCIAKY R., 1989 - Contributo alla conoscenza della mirmecofauna della Val Gesso (Alpi Marittime) (Hymenoptera Formicidae). Bollettino del Museo Regionale di Scienze Naturali di Torino, 7: 427-442.

SANETRA M. & BUSCHINGER A., 1996 - Slave raiding behaviour in socially parasitic *Strongylognathus* ants (Hymenoptera: Formicidae). Proceedings of the XX International Congress of Entomology, Firenze, 25-31 August 1996: 399.

SANETRA M., HEINZE J. & BUSCHINGER A., 1994 - Enzyme polymorphism in the ant genus *Tetramorium* Mayr and its social parasites (Hymenoptera: Formicidae). Biochemical Systematics and Ecology, 22: 753-759.

SANTSCHI F., 1921 - Notes sur les fourmis paléarctiques. I. Quelques fourmis du nord de l'Afrique et des Canaries. Real Sociedad Española de Historia Natural, Tomo extraordinario del 50. aniversario.: 424-436.

SANTSCHI F., 1927 - A propos du *Tetramorium caespitum* L. Folia Myrmecologica et Termitologica, 1: 52-58.

SCHEMBRI S.P. & COLLINGWOOD C.A., 1981 - A revision of the myrmecofauna of the Maltese Islands (Hymenoptera, Formicidae). Annali del Museo Civico di Storia Naturale "Giacomo Doria", 83: 417-442.

SCHULZ A., 1991 - *Tetramorium semilaeve* (Hym.: Formicidae, Myrmicinae) und *Bothriomyrmex gibbus* (Hym.: Formicidae, Dolichoderinae) neu für Österreich sowie über die Verbreitung von *Leptothorax sordidulus* (Hym.: Formicidae, Myrmicinae). Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen, 43: 120-122.

SCHULZ A., 1996 - *Tetramorium rhenanum* nova species (Hymenoptera: Formicidae) vom "Mittleren Rheintal", Deutschland. Linzer Biologische Beiträge, 28: 391-412.

SCUPOLA A., 1994 - Contributo alla mirmecofauna Italiana (Hymenoptera Formicidae). Annali del Museo Civico di Storia Naturale di Verona, 18: 133-136.

SEIFERT B., 1996 - Ameisen beobachten, bestimmen. Naturbuch Verlag, Augsburg, 352 pp.

STÄGER R., 1928 - *Anergates atratulus* Schenck am Mittelmeer (Hym., Formic.). Zeitschrift für Insektenbiologie, 23: 159-162.

TAYLOR R.W., 1986 - The quadrinominal infrasubspecific names of Australian ants (Hymenoptera: Formicidae). General and Applied Entomology, 18: 33-37.

TINAUT A., 1989 - Contribución al estudio de los formícidos de la región del estrecho de Gibraltar y su interés biogeográfico (Hym., Formicidae). Graellsia, 45: 19-29.

WERNER P., 1989 - Formicoidea. In: J. Sedivy (ed.). Enumeratio Insectorum Bohemoslovakiae. Check List of Czechoslovak Insects III (Hymenoptera), Acta Faunistica Entomologica Musei Nationalis Pragae, 19: 153-156.

Author's addresses

M. Sanetra, R. Güsten, Technische Universität Darmstadt, Institut für zoologie, Schnittspahnstrasse 3, D-64287 Darmstadt, Germany

A. Schulz, Feldstrasse 18, D-42799 Leichlingen, Germany