

# The Mediterranean-southern African disjunct distribution pattern in the scarab beetles: a review (Coleoptera Scarabaeoidea)

GIUSEPPE MARIA CARPANETO

*Dipartimento di Biologia Ambientale, Università degli Studi Roma Tre,  
viale G. Marconi 446, 00146 Roma, Italy;  
e-mail: carpanet@uniroma3.it*

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## SUMMARY

A survey of the distribution ranges currently shown by the scarab beetles was conducted by a review of literature data, in order to find clues or evidence of a Mediterranean-southern African distribution pattern, through a phylogeographic discussion. The results of the survey showed that the questioned distribution pattern in the scarab beetles was mainly referred to incorrect hypothesis of relationships due to convergence in morphological characters.

## INTRODUCTION

A taxon with a disjunct distribution includes two or more groups that are phylogenetically related but widely separated from each other geographically. Such a model can be applied to isolated populations of a single species or to allopatric species of a single genus and so on, according to the rank of the taxon considered.

Disjunct distributions among taxa have intrigued biologists for decades. Most authors have invoked both dispersal and vicariance models to explain disjunct distribution. However, a disjunct distribution can be erroneously suggested by either an incorrect hypothesis of relationship due to convergence in morphological characters or a gap of knowledge in the geographical distribution of the taxa. An appropriate approach to test the model is to use molecular phylogenetic methods with an appropriate taxon sampling. Many molecular phylogenetic studies on several taxonomic groups of animals with disjunct

distribution suggested that morphological convergence may be quite common. Therefore, the rational way in studying disjunct distributions is to determine if the observed pattern is real (true disjunction), nor due to convergence i.e., an artefact of incorrect taxonomy (false disjunction).

In many taxonomic groups of plants and animals, there are cases of disjunct distribution which show a clear discontinuity in the geographic range of apparently closely related taxa occurring in Europeo-Mediterranean countries and in tropical Africa respectively, with a wide gap throughout the Saharo-Sahelo-Arabic arid zone. This pattern is easily explainable by desertification which brought to extinction population and/or species of these taxa. On the other hand, some taxonomic groups show an extremely reduced version of this common distribution pattern because their occurrence is limited to the Mediterranean belt of Africa and to the southern end of the continent (de Winter, 1971). Such a polarized north-south distribution has been recorded in several groups of Coleoptera belong to different families (cf. Balthasar, 1963; Endrody-Younga, 1978; Holm, 1978, 1979).

The aim of this paper is to make a survey of the distribution ranges currently shown by the scarab beetles, in order to find clues or evidence of a Mediterranean-southern African distribution pattern, through a phylogeographic discussion.

## The model

A comparison between the geographic range of many animals and plants, allowed to recognize four major distribution patterns of the Mediterranean-south African distribution pattern:

species with a disjunct Mediterranean-south African distribution pattern;

genera or supraspecific taxa with a disjunct Mediterranean-south African distribution pattern;

genera or supraspecific taxa with most species occurring in Mediterranean and south African areas, but also few (usually rare or localized) representatives in Eastern Africa;

genera or supraspecific taxa with species occurring from the Mediterranean areas to the Middle East of Asia (sometimes up to Central Asia), and in the arid corridor of eastern and southern Africa, from Somalia to Namibia.

The first pattern includes species which show a very clear disjunct pattern, with populations spread around the Mediterranean basin, sometimes extended to the Near and Middle East Asia. This pattern is very rare and may be explained by a recent event of dispersal from southern Africa to the Mediterranean basin (or vice versa), followed by the entire or partial extinc-

tion of populations in the intermediate areas, i.e. the East African provinces. A false disjunct pattern may be also suggested for species liable to be introduced by man.

The second pattern is a replicate of the first one at a higher taxonomic rank. It may be explained by vicariance followed by speciation events and then extinction of taxa from the intermediate areas of the generic range, i.e. from the East African provinces.

The third pattern is a particular case of the second one: a rational explanation of this model assumes the extinction from Eastern Africa of most the species assigned to the group. The few, often rare, survived species bear witness to the biogeographic history of the genus and represent a track of its past distribution.

The fourth pattern differs from the third one for the enlargement of the involved area to the Palearctic Region and the possibility of either an African or Asiatic origin, followed by dispersion from each continent to the other one. This pattern fits well to species adapted to a wide range of arid environments, from dry savannas to steppic highlands, that used the Arabic peninsula as a bridge.

### **The scarab beetles**

The scarab beetles (Coleoptera Scarabaeoidea) are one of the most successful groups of beetles and includes approximately 27,800 species described throughout the world (Ratcliffe & Jameson, 2004), most of them living in subtropical and tropical areas. They are a conspicuous component of the biological communities and play different roles in the dynamics and structure of terrestrial ecosystems of all the continents, feeding on plants, organic decaying matter (rotten wood, humus, dung, carrion), mushrooms, and other invertebrates.

In this paper we attempted to trace the Mediterranean-south African model in the scarab beetles through the examination of their current distribution patterns, and to relate these with the climatic changes which affected the African environments and the dispersion routes for the animals during the Cenozoic Era (last 65 My). The main scope of the present paper is to screen all the scarab genera or species groups that show this distribution pattern and to gather the information available on their taxonomy and phylogeny with the aim to review all information on this subject in order to assess the contribution of this group to the model testing and to work out focuses for future research. A special attention was given to the groups which underwent a reliable systematic revision by cladistic or molecular approaches, in order to avoid generic assemblages due to morphological homoplasy. Disjunct patterns were considered

doubtful and discussed whenever modern phylogenetic analysis rendered questionable the monophyly of the taxonomic groups.

## MATERIAL AND METHODS

All the existing literature on Palaearctic and Afrotropical scarab beetles was used to obtain a detailed information on taxonomy and chorology of the investigated taxa, in order to outline the geographic ranges of genera and species. The bibliographic sources include both the taxonomic revisions of species groups, genera, tribes or subfamilies, and the comprehensive reviews of regional scarab faunas of single countries or broader areas. In the separate sections of this paper, each dedicated to a single taxonomic group, the reader will find the references containing information on the taxa discussed.

The palaeogeographic and palaeoecological scenario of the Cenozoic Era (mainly from Miocene to Pleistocene period) were deduced by several authors e.g.: Axelrod & Raven, 1978; Croizat, 1968; Jürgens N. 1997; La Greca, 1970, 1990; Livingstone, 1975; Moreau, 1952, 1963; Pickfort & Senut, 1999; Quezel P., Barbero M. 1993; van Zinderen Bakker, 1978; Vermeij, G. 1992; Williamson, 1985.

## RESULTS

The Mediterranean-southern African disjunct distribution pattern was suggested among few taxonomic groups of scarab beetles, but some of them are currently considered polyphyletic, after modern systematic revisions. In the following review we deal with both monophyletic (true disjunct pattern) and polyphyletic (false disjunct pattern) groups, as they were considered in the literature.

### **The Pachysomina subtribe, i.e. the flightless species of the genus *Scarabaeus***

The name *Pachysoma* MacLeay, 1821, and *Neopachysoma* Ferreira, 1953 have been used to name a stock of African Scarabaeini characterized by aptery, absence of humeral callus, semicontiguous mesocoxae, and short mesosterna (cf. Ferreira, 1953, 1966). These two genera included several flightless species, all geographically isolated and occurring in pockets of discontinuous populations on coastal sands from Walvis Bay, Namibia, to Cape Town, South Africa. They were traditionally linked to *Neomnematum* Janssens, 1938, with a single species endemic to the desert areas of southern Madagascar, and to *Mnematum* MacLeay, 1821, that included four allopatric species occurring respectively in southern Angola, Somalia, northern Africa (Tunisia and Libya) and some areas of the Near East (viz. Sinai, Iraq, Syria). The four genera were

grouped together to form the subtribe Pachysomina, of the tribe Scarabaeini (Ferreira, 1953, 1966, 1969). Such a taxonomic arrangement led some authors (e.g. Balthasar, 1963) to consider the group as a clear case of Mediterranean-south African disjunct distribution, referable to the third of the distribution patterns defined in the introduction of this paper.

However, a series of systematic evaluations (Holm & Scholtz, 1979; Mostert & Holm, 1982) brought to the conclusions that the characters used to separate these genera and those shared by them were due to convergence for adaptation to dry habitats. For this reason, Holm & Scholtz (1979), proposed to synonymize *Neopachysoma* and *Mnematum* with *Pachysoma*, while Mostert & Holm (1982) reduced the latter to a subgenus of *Scarabaeus* Linnaeus, 1758, and *Neomnematum* to a synonym of the latter. The last revision (Harrison et al., 2003) and phylogenetic analysis (Harrison & Philips, 2003; Forgie et al.,

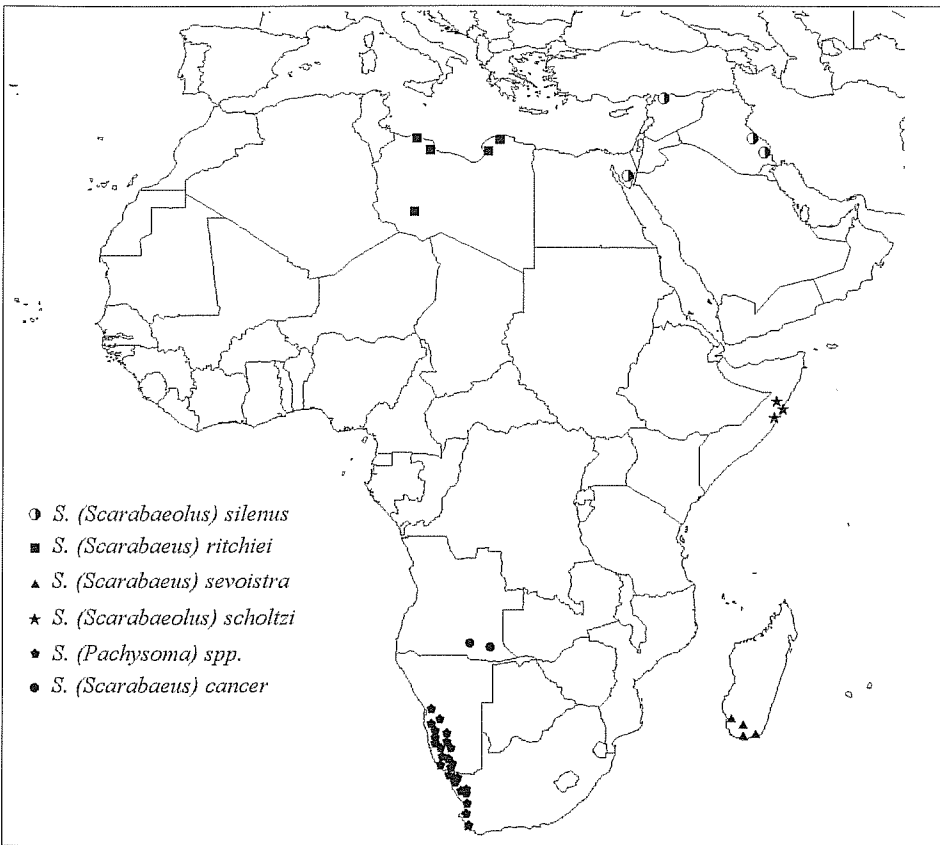


Fig. 1. - A case of false disjunct distribution: distribution of the flightless species of the genus *Scarabaeus* (ex subtribe Pachysomina). Data and taxonomic arrangement from Harrison et al. (2003).

Tab. I. - Taxonomic and chorological account of the old group "Pachysomina", i.e. the flightless species of *Scarabaeus*, according to Harrison et al. (2003). According to Sole et al. (2007) the ancient separation of the clade *Pachysoma* from *Scarabaeus* and its monophyly confirmed by molecular analysis warrant the reinstatement of *Pachysoma* to its former full generic rank.

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**Checklist of the species of *Scarabaeus (Pachysoma)* Mackleay, 1821: 13 species**

*Scarabaeus (Pachysoma) aesculapius* Olivier, 1789 (S Africa: W Cape)  
*Scarabaeus (Pachysoma) bennigeni* (Felsche, 1907) (Namibia, S Africa: N Cape)  
*Scarabaeus (Pachysoma) denticollis* (Péringuey, 1888) (Namibia) (ex: *Neopachysoma*)  
*Scarabaeus (Pachysoma) endroedyi* Harrison, Scholtz and Chown, 2003 (S Africa: W Cape)  
*Scarabaeus (Pachysoma) fitsimonsi* (Ferreira, 1953a) (Namibia)  
*Scarabaeus (Pachysoma) gariepinus* (Ferreira, 1953a) (Namibia, S Africa: N Cape)  
*Scarabaeus (Pachysoma) glentoni* Harrison, Scholtz and Chown, 2003 (S Africa: W Cape)  
*Scarabaeus (Pachysoma) hippocrates* (MacLeay, 1821) (S Africa: W Cape)  
*Scarabaeus (Pachysoma) rodriguessi* (Ferreira, 1953a) (Namibia) (ex: *Neopachysoma*)  
*Scarabaeus (Pachysoma) rotundigenus* (Felsche, 1907) (Namibia) (ex: *Neopachysoma*)  
*Scarabaeus (Pachysoma) schinzi* (Fairmaire, 1888) (Namibia)  
*Scarabaeus (Pachysoma) striatus* (Castelnau, 1840) (S Africa: N Cape)  
*Scarabaeus (Pachysoma) vaefflorae* (Ferreira, 1953a) (Namibia)

**Checklist of the flightless species of *Scarabaeus (Scarabaeolus)* Balthasar, 1965: 2 species**

*Scarabaeus (Scarabaeolus) scholtzi* Mostert and Holm, 1982 (Somalia)  
*Scarabaeus (Scarabaeolus) silenus* (Gray, 1832) (Sinai, Syria, Iraq) (ex: *Mnematium, Pachysoma*)

**Checklist of the flightless species of *Scarabaeus (Scarabaeus)* Linnaeus, 1758: 3 species**

*Scarabaeus (Scarabaeus) cancer* (Arrow 1919) (Angola) (ex: *Mnematium, Pachysoma*)  
*Scarabaeus (Scarabaeus) ritchiei* (MacLeay, 1821) (Tunisia, Lybia) (ex: *Mnematium, Pachysoma*)  
*Scarabaeus (Scarabaeus) sevoistra* (Alluaud, 1902) (Madagascar) (ex: *Neomnematium*)

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2006) showed that *Pachysoma* forms a distinct clade within *Scarabaeus* and confirmed its status of subgenus of the latter. Moreover, the same studies showed that there are not close relationships between *Pachysoma* and the other previously recognized genera (*Mnematium* and *Neopachysoma*), because they derived from distinct lineages of the genus *Scarabaeus*. These phylogenetic implications made the subtribe *Pachysomina* meaningless. According to Sole et al. (2005), who combined molecular phylogenetic with geochronological data, the subgenus *Pachysoma* appears to have arisen approximately 2.9 millions years ago, and is relatively young in comparison with the age of the Namib Desert, which dates back to the Miocene (ca. 15 Mya) (Pickfort & Senut, 1999). Moreover, trees obtained from both morphological and molecular analysis by Sole et al. (2007), led us to suggest that monophyly, unique morphology and biology of *Pachysoma* are worth to restore its previous generic level, recovering a sister relationship to *Scarabaeus*. However, as the other flightless species (formerly assigned to *Mnematium*, occurring in North Africa and the Near East), underwent an independent evolution from different lineages of *Scarabaeus*, "Pachysomina" is a polyphyletic group and cannot be used to support the disjunction model investigated here.

## The genus *Cheironitis*

According to the current taxonomic arrangement, still untested by a molecular approach, the genus *Cheironitis* Lansberge, 1875 appeared a candidate to support the Mediterranean-southern African model, namely suggesting the fourth of the distribution patterns defined in the introduction of this paper. The genus *Cheironitis* (= *Chironitis*, see Branco & Ziani, 2005) includes 23 species within a wide range that extends from western Europe to central Asia and southern Africa. The distribution patterns of these species can be ordered as follows: East African (from Somalia to Tanzania): 7 species; Southern African: 4 species; Sahelo-Sudanian: 1 species; Sahelo-Sindhian: 1 species; Mediterranean: 3 species; Centralasiatic: 7 species (Tab. II). The genus appears to have two major centres of endemism: the Afrotropical region and western-central Asia. However, taxonomy is still poor and needs a sound revision. Even the Mediterranean and Middle Asiatic species are still questionable (cf. Martin Piera, 1986; Kababov,

Tab. II. - Taxonomic and chorological account of the genus *Cheironitis* Lansberge, 1875.

### E African species

- C. benningeni* Felsche, 1907 (Tanzania, Kenya)
- C. dentifemoralis* Ferreira, 1976 (Kenya)
- C. flabellatus* Boucomont, 1923 (Somalia)
- C. imitator* Balthasar, 1963 (Sudan, Ethiopia, Kenya)
- C. muelleri* Janssens, 1943 (Ethiopia, Kenya)
- C. socotranus* Gahan, 1900 (Socotra)
- C. viridicans* Gillet, 1918 (Somalia)

### S African species

- C. scabrosus* Fabricius, 1776 (S Africa)
- C. damarensis* Felsche, 1907 (Namibia)
- C. hoplosternus* Harold, 1868 (S Africa)
- C. indicus* Lansberge, 1875 (S Africa)

### Sahelo-Sudanian species

- C. asbenicus* Gillet, 1909 (Niger, Chad, Mauretania)

### Sahelo-Sindhian species

- C. osiridis* Janssens, 1943 (Pakistan, Arabia, Egypt, Sudan, Chad)

### Mediterranean species

- C. furcifer* Rossi, 1792 (Mediterranean)
- C. hungaricus* Herbst, 1789 (SE European)
- C. irroratus* Rossi, 1790 (W Mediterranean)

### Middle Asiatic species

- C. arrowi* Janssens, 1937 (Pakistan, India, Afghanistan, Arabia)
- C. candezei* Lansberge, 1875 (Irak, Turkmenia, Iran)
- C. haroldi* Ballion, 1870 (Caucasia, Transcaspia, Turkestan, Iran, Afghanistan, Cyprus)
- C. moeris* Pallas, 1781 (Southeast Ukraine, Turkestan, Turkmenistan)
- C. pamphilus* Menetries, 1849 (Siria-Mongolia)
- C. phoebus* Reitter, 1892 (E Ukraina- Turkestan)
- C. sterculius* Ballion, 1870 (Turkestan)

2000, 2006). For instance, a recent review of this genus in Russia and neighbouring countries (Kabakov, 2000) brought to synonymy two Palearctic species. As for the Afrotropical species, the taxonomic arrangement of the whole tribe Onitini is very weak and confused, notwithstanding the revisions by Janssens (1937) and Ferreira (1978). The validity of the genus *Pseudochironitis* Ferreira, 1977 should be checked, as well as the identity of some African species of the genus *Onitis* Fabricius, 1798, that could be moved to *Cheironitis* after a careful investigation. Unluckily, many species of Onitini are rare or localized, often with a restricted phenology. Probably, a detailed morphological revision of the whole tribe could change the current scenario enriching the synonymy of *Cheironitis* and adding new species to the latter. A combined morphological-cladistic and molecular approach could resolve the phylogeny of this genus and verify if a new taxonomic arrangement will be adequate to support the disjunction model, at least for some eventually emerging species groups.

### The genus *Bordatius*

The genus *Bordatius* was established by Pittino and Mariani (1986) during a comprehensive revision of some genera of Old World Rhyssellini, a tribe of sand dwelling scarab beetles of the subfamily Aphodiinae. The genus includes only four species (Tab. III) and was defined basing on the following characters, whose synapomorphy is questionable: flightless due to microptery, short and strongly convex body, short metasternum with reduced sculpture, very small scutellum, coalescent elytra, slender hind femur and distinct vestiges of oblique ridges on both middle and hind tibia (Pittino, & Mariani, 1986; Pittino 1996).

The members of this genus are very rare and localized: all the species are known only from the type specimens. A cladistic approach, based on both morphological and molecular data, should be applied in order to test the phylogenetic relationships between the three southern African species and the unique moroccan member of the genus. If monophyly will be ascertained, this genus could represent the most evident example of the Mediterranean-southern African model among the scarab beetles.

Tab. III. - Taxonomic and chorological account of the genus *Bordatius* Pittino & Mariani, 1986.

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#### N African species

*Bordatius tingitanus* Pittino & Mariani, 1986 (Morocco)

#### S African species

*Bordatius australis* Pittino & Mariani, 1986 (South Africa: Transkei)

*Bordatius capensis* Pittino & Mariani, 1986 (South Africa: Cape)

*Bordatius muelleriae* Pittino, 1996 (South Africa: Cape)

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## The genera *Ammoecius* and *Ammoecioides*

For a long time, *Ammoecius* Mulsant, 1842, was considered one of the most easily recognizable 'genus groups' within *Aphodius* Illiger, 1798. In the old classification proposed by Mulsant (1842), *Ammoecius* was the unique representative of the taxon named 'Ammoeciates' one of the three major groups recognized by this author within Aphodiinae. The species belonging to this taxonomic group show a convex body, black colour and a peculiar shape of clypeus. According to classic taxonomic arrangement, based on morphology, 38 species have been assigned to *Ammoecius*, most ranging from Mediterranean countries, but few localized in southern Africa and North America (cf. Dellacasa, 1987). In the last decades, several taxonomic changes as the description of new species in southern and eastern Africa, and the establishment of several synonyms, in the framework of a morphological approach focused on phylogenetic relationships, led some authors (Bordat, 1985, 1990, 1999; Dellacasa et al., 2002) to redefine and split the genus as follows: 1) the Palearctic species and few Southern African species remained to represent the genus *Ammoecius*; 2) a cluster of African species was included in a genus apart, *Ammoecioides* Bordat, 1999; 3) the Nearctic species were removed from the genus and considered *incerta sedis* (Dellacasa et al., 2002). The genus *Ammoecioides* consists of ten species, almost all ranging south of the Fortieth Parallel, from Malawi to the Cape region; only one species reaches northwards Ethiopia but is very rare and localized. On the contrary, the 21 species of the redefined genus *Ammoecius* show four distribution patterns (Tab. IV):

- 1) W Mediterranean (mainly from north-western Africa): 10 species;
- 2) E-Mediterranean with extension to Middle East (from Turkey to Iran): 5 species;
- 3) Southern African (from Namaqualand to the former Transvaal): 4 species;
- 4) Sibero-European (widespread): 1 species;
- 5) Eastern Palearctic (endemic to Japan): 1 species.

Apart from the strange case of *A. yamato* Nakane, 1960, from Japan, and *A. brevis* Erichson, 1848, which shows a widespread Palearctic range, the other species give the genus a typical Mediterranean-southern African distribution pattern. Only *A. brevis* shows a widespread Palearctic range. The phylogenetic relationships within this genus and with *Ammoecioides* need to be tested by a molecular approach, widened to all the Aphodiini. It will be an arduous task because of either the high number of species of this tribe or the rareness of these southern African species.

Tab. IV. - Taxonomic and chorological account of the related genera *Ammoecius* Mulsant, 1842, and *Ammoecioides* Bordat, 1999.

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*Ammoecius* Mulsant, 1842 (21 species)

W Mediterranean (10 species)

- Ammoecius amplicollis* Peyerimhoff, 1949 (Morocco)  
*Ammoecius dentatus* Schmidt, 1908 (Spain, Portugal, Morocco)  
*Ammoecius dogueti* Baraud, 1980 (Algeria)  
*Ammoecius elevatus* Olivier, 1789 (South-western Europe: Portugal, Spain, southern France, northwestern Italy (western Liguria), Mediterranean Africa: Morocco, Algeria, Tunisia, Libya)  
*Ammoecius felscheanus* Reitter, 1904 (Algeria)  
*Ammoecius franzi* Petrovitz, 1964 (Morocco)  
*Ammoecius frigidus* Brisout, 1866 (Spain, Portugal, Morocco?)  
*Ammoecius lusitanicus* Erichson, 1848 (Spain, Portugal, Morocco?)  
*Ammoecius numidicus* Mulsant, 1851 (Morocco, Algeria, Tunisia)  
*Ammoecius rugifrons* Aube, 1850 (Algeria, Tunisia, Sicily, Sardinia)

E Mediterranean (including their relatives of the Near East) (5 species)

- Ammoecius eli* Petrovitz, 1961 (Iraq)  
*Ammoecius meurguesae* Clement, 1975 (Iran, Azerbaijan)  
*Ammoecius muchei* Petrovitz, 1963 (Turkey)  
*Ammoecius naviauxi* Baraud, 1971 (Syria)  
*Ammoecius satanas* Carpaneto, 1976 (Turkey)

S African (4 species)

- Ammoecius incultus* Petrovitz, 1961 (South Africa)  
*Ammoecius lugubris* Boheman, 1857 (South Africa)  
*Ammoecius minus* Perringuey, 1901 (South Africa)  
*Ammoecius terminatus* Harold, 1869 (South Africa)

E Palearctic (1 species)

- Ammoecius yamato* Nakane, 1960 (Japan)

Widespread Palearctic (1 species)

- Ammoecius brevis* Erichson, 1848 (Europe: northwards up to Sweden, south from Spain to Georgia, Turkmenistan, Mongolia, Siberia: Irkutsk region)

*Ammoecioides* Bordat, 1999 (10 species)

- Ammoecioides adventicius* Bordat, 1999 (South Africa)  
*Ammoecioides davisianus* Bordat, 1999 (South Africa)  
*Ammoecioides facetus* Bordat, 1999 (South Africa)  
*Ammoecioides insidiosus* Bordat, 1999 (South Africa)  
*Ammoecioides kovacsi* Bordat, 1990 (Ethiopia, Kenya, Malawi)  
*Ammoecioides mulanje* Bordat, 1985 (Malawi, Transvaal)  
*Ammoecioides nyika* Bordat, 1999 (Malawi, South Africa)  
*Ammoecioides sparsepunctatus* Petrovitz, 1964 (South Africa)  
*Ammoecioides spectabilis* Perringuey, 1901 (South Africa)  
*Ammoecioides uitsoekensis* Bordat, 1999 (South Africa)
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## The *Omaloplia* and *Pleophylla* clade

In the last years, the research activity of Ahrens and colleagues (Ahrens, 2004, 2006, 2007; Rossner & Ahrens, 2004; Ahrens & Vogler, 2008) began to enlight-

en the phylogenetic relationships within the tribe Sericini (Scarabaeidae: Melolonthinae) and made it suitable for phylogeographical speculations. A Mediterranean-southern African distribution pattern may be observed in the clade formed by the genera *Omaloplia* Schönherr, 1817 (Western Palaearctic) and *Pleophylla* Erichson, 1847 (southern African) which have been found to be sister groups (Ahrens, unpublished data) based on a preliminary analysis of molecular and morphological data. The first genus is widespread in Europe and central Asia, while the second one is restricted to southern Africa (from Natal to Cape), with a few single occurrences in the east African mountain arc. The sister relationships between these two genera need a confirmation from an analysis with a wider taxon sampling to establish if the pattern represents a case of disjunct distribution or a gap of knowledge.

## CONCLUSIONS

The scarab beetles did not provide study cases suitable to reflect a disjunct Mediterranean-southern African distribution pattern. Among the four groups analyzed, we found the following case histories:

1) a group previously considered as a proper examples of the model (the ex-subtribe Pachysomina), whose biogeographic significance was recently reinterpreted on the ground of modern taxonomic revision and thus represents an artefact of incorrect taxonomy (false disjunction);

2) a seemingly copybook case of the model (*Bordatius*) which however was never tested by a phylogenetic analysis (it deals with a recently defined genus, scarcely investigated, including very uncommon species whose geographic range could be still insufficiently known);

3) a widespread taxonomic group (*Cheironitis*) that still needs a phylogenetic revision based on either morphological or molecular approaches (some Mediterranean representatives of this genus may be related to some southern African ones but this hypothesis needs a confirmation in the frame of a proper phylogenetic analysis with a subgeneric subdivision);

4) two groups that roughly fit the model (*Ammoecius* and the cluster *Omaloplia/Phleophylla*) but include some representatives widely spread into Eurasia (e.g. *Ammoecius brevis* and *Omaloplia nigromarginata*). In any case, both these groups need a sound phylogenetic analysis.

Therefore, the occurrence of a Mediterranean-southern African disjunct distribution pattern in the scarab beetles is in major part still limited to phenotypical similarity rather than true phylogenetic relationships (except the case of Sericini). We conclude that the support for any biogeographical speculations is low and needs further phylogenetic work; nevertheless, more cases of disjunction of clades may be discovered from future cladistic analyses.

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