

DISTRIBUTION PATTERNS IN THE TENEBRIONIDAE OF THE SAHARA DESERT (INSECTA : COLEOPTERA)

Martin LILLIG*

ABSTRACT

The climatic changes that have taken place in North Africa since the Tertiary have had a profound influence on the composition of the flora and fauna, and the present day distribution patterns of the Tenebrionidae are based on both historical and recent ecological processes. In order to explain these patterns, the intensity of the investigations and the state of taxonomic knowledge must be known. These two parameters are the subject of this paper. An example is given of a distribution pattern (taxa in the marginal areas of the Red Sea) as well as of a faunal divide and a migration road (the River Nile as a faunal divide and a migration road).

Keywords : Coleoptera, Tenebrionidae, Sahara desert, distribution patterns, dispersal centers.

RÉSUMÉ

Les changements climatiques qui sont intervenus en Afrique du nord depuis le Tertiaire ont eu une influence profonde sur la composition de la flore et de la faune, et les modèles actuels de distribution des Tenebrionidae sont basés sur des processus écologiques et historiques récents. Afin d'expliquer ces modèles, l'intensité des investigations et l'état de la connaissance taxonomique doivent être connus. Ces deux paramètres sont le sujet de cet article. Il y a un grand nombre de types de répartition des Coléoptères Ténébrionides au Sahara. Un exemple est décrit : les taxa des côtes de la mer Rouge. En outre une frontière faunistique et une route de migration (le Nil a les deux fonctions) sont présentées.

Mots-clés : Coléoptères, Tenebrionidae, Sahara, types de répartition, centres de dispersion.

INTRODUCTION

The climate in the present day Sahara has changed many times since the Tertiary (BALLAIS, 1992). Dune systems on the southern margin of the Sahara and in the Sahel have been found to have been formed around 40,000 BP, the period between 20,000 and 12,000 BP, between 8,000 and 7,000 BP, and since 4,500 BP (PROGNON, 1987). During the African pluvials, between 14,800 and 5,500 BP, there were several arid periods. In the early Holocene, there was rain in both summer and winter, and the Sahara was largely green. Around 8,200 BP there was a short but strikingly arid phase, and a further, less strongly developed arid phase occurred around 4,000 BP. The African pluvial period ended in about 5,500 BP in the western Sahara and around 4,500 BP in the eastern Sahara (HEINE, 2002).

These fluctuations in the aridity influenced the floral and faunal composition of the Sahara, and so the

distribution patterns of the Tenebrionidae now living in the Sahara provide information about the refugia in which species were able to survive climatic conditions that were otherwise unfavourable for them. Tenebrionidae are particularly suitable for such an investigation. They are well represented, by close on 450 species, and almost all the Saharan species are flightless so that their dispersal ability is very restricted. In the main they are unspecialised phytophages, which also feed on detritus, and they are therefore not dependent on the occurrence of particular plants or animals.

INFORMATION REGISTER

In order to interpret the patterns of distribution, the following information must be available: the intensity of the investigations must be known, and the level of taxonomic knowledge must be high.

*Krämersweg 55, 66123 Saarbrücken, Germany, martin.lillig@t-online.de
Institut für Natur-, Landschafts- und Umweltschutz (NLU) / Biogeographie St.Johanns-Vorstadt 10, CH-4056 Basel, Switzerland

Intensity of the collecting

Data from published sources form the basis of the information register (fig. 1). In addition, collections from a student expedition to Tunisia and Algeria as well as a small amount of museum material was also used.



Fig. 1 - Information register: localities for Tenebrionidae in North Africa

There are some striking gaps in the information register. In the western Sahara they are to be found in northern Mali, eastern Mauritania and south-west Algeria. The entire Libyan desert east of 20°E is virtually unknown, apart from the oases of Augila, Kufra, Siwa, Bahariya, Farafra and Dakhla and the Mediterranean area. The states on the southern edge of the Sahara are only well known in the Sahel region and in the mountains. Knowledge of individual localities such as those in the Ténéré derive mostly from unsystematic collections made by passing travellers or by soldiers of the former colonial powers who were stationed there.

The areas of North Africa that have been intensively investigated for their Coleoptera are mostly along the edge of the Sahara. These include the entire Maghreb, the Mediterranean coast, the Nile Valley, large areas of the Sahel, and the western Sahara which is under the influence of the Atlantic Ocean. In addition, the mountain ranges of the central Sahara exercised a particular fascination for expeditions, and so the Tenebrionidae of Ahaggar, Tassili n'Ajjer, Air, Tibesti and Ennedi are among the best studied faunas. In the former French areas, prolonged stays in research stations and expeditions into the surrounding regions produced a more profound knowledge of the local natural world of Morocco and Algeria. At the beginning of the 1940s, several entomological expeditions worked in the western Sahara from which only occasional beetles had previously been known these being almost exclusively from coastal localities. Some parts of Libya had been very well explored since the Rolf Expedition of 1878-79. This applies to Tripolitania,

Fezzan and Cyrenaica.

Figure 2 shows the varying level of the intensity of the collecting effort in the different regions of North Africa, based on a 1° grid. The area around the pyramids of Gizah appears to be the most species-rich area of the Sahara, with 108 species. It should, however, be noted that this is also the most frequently collected area. Its proximity to the Nile has also undoubtedly been one factor contributing to this high number of species. On the other hand, there are 109 of the some 400 grid squares from which only a single species has been recorded, although considerably more species can be expected (LILLIG, 1988)

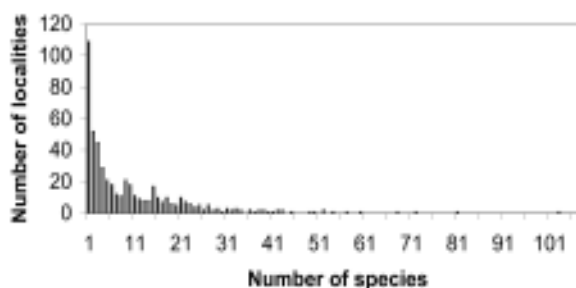


Fig. 2 - Number of species per grid square

The level of taxonomic knowledge

In recent decades only a few species have been described as new to science. A few names have been placed in synonymy with others. It can therefore be taken as read that the Tenebrionidae of the Sahara are rather well known, but there has been very little ecological and phylogenetic work.

DISTRIBUTION PATTERNS

Analysis of the distribution maps shows that there are a number of distribution types and some lines of faunal division among the darkling beetles of the Sahara. One example of each of these is given here. Further types will be discussed in future publications.

1. Taxa in the marginal area of the Red Sea

Some 26 species are endemic to the region around the Red Sea. Only eight of these live on the coastal plain as well as in the adjacent mountains. Table 1 shows the faunistic differences. Only those taxa that are restricted to the Red Sea or to the mountains are listed. The reason for the different composition of the fauna of the mountains and of the coastal plain lies in the changes in the recent climatic conditions.

Jebel Elba, rising to 1594 m a.s.l., receives so much precipitation, as does the entire mountain range, that a dense vegetation is able to develop. In the valleys, there is a vegetation consisting mainly of acacias with numerous lianas (SIMONS, 1971). By contrast, in the highly arid coastal zone, the Egyptian Hurghada receives an annual mean precipitation of some 3 mm. It is some five to ten kilometres wide, or even in some places 20 kilometres wide. The vegetation on the Red Sea aerea is therefore confined mainly to the wadis and coastal swamps (SIMONS, 1971). Among the Tenebrionidae of this coastal plain, there are three species that belong to the beach and dune fauna, *Diphyrrhynchus aenescens*, *Phaleria prolixa* and *Trachyscelis tenuestriatus*.

Ten species are restricted to the mountains (or nine if the presumed synonymy of *Adelostoma abyssinicum* and *A. hirsutum* is confirmed), and six to the coastal plain. This is more than in the Jebel Marra, but two mountain endemics are known from there.

2. The Nile as a faunal divide and as a migration route

Numerous deserticolous species are to be found exclusively to the east of the Nile, including *Adesmia montana parallela* Miller, 1861, *Tagenostola seriepilosa muelleri* Reitter, 1916, *Mitotagena priesneri* Andres, 1931, *Blaps schweinfurthi* Seidlitz, 1893, *Prodilamus boehmi* (Reitter, 1904), *P. ferrantei* (Reitter, 1908), *Cnemeplatia atropos atropos* Costa, 1847, *Gonocephalum patrizii* Gridelli, 1948. Many such species also occur in Egypt as well as along the lower reaches of the Nile without being able to cross the Nile. The river also forms a barrier to the dispersal of some of the species living to the west of the Nile. For example, *Pimelia senegalensis* Olivier, 1795, has only been found on the left side of the Nile in spite of intensive subsequent searches by Prof. Dr. H.J. Bremer. GREDLER (1878) recorded this species from Khartoum. Naturally, it is possible that this published locality also covers captures to the west of the Nile. Some 30 species reach the western limit of their distribution at the Nile, whilst for some ten species the river is the eastern limit of their distribution. The river can thus be considered to be a faunal divide.

This faunal divide seems to have been in existence for a long time, for drainage systems running from the Sudan to Egypt are known to have existed since the late Cretaceous. The Nile between Ethiopia and the Mediterranean Sea has existed in its present form since the early Quaternary (WILLIAMS & WILLIAMS, 1980). This geologically brief period is enough for the separation of populations and therefore for speciation, which can lead to the formation of a faunal divide. MÜLLER (1973) has shown that a period of 6,000 to 11,000 years was sufficient for the formation of sub-

species in the Neotropical mountain forest and island fauna. According to NAGEL (1987), a separation of some 6,000 years within the superspecies complex of *Paussus sphaerocerus/dissimilator* (Carabidae, Paussinae) was enough for complete genetic isolation. The age of the Nile is therefore sufficient to have brought about a separation of the faunas on the left and right banks of the river.

The large number of species that are unable to cross the Nile is surprising, as one of the oldest human cultures developed in the Nile Valley. From very early times the river was used for boat journeys, and so the transport of species from one bank to the other by human traffic has always been a probability. The conclusion from this is that the number of species that occur on only one side of the Nile would have been even greater without the effects of human activity. Even wingless species are able to overcome very serious obstacles without the assistance of humans. Some species live on both the African and the European sides of the Strait of Gibraltar. Many species of beetle have crossed the Bab el Mandab between Djibouti and the Yemen.

The Nile does not function only as a faunal divide but also as a connection between faunas. Certain Ethiopian Amphibia have reached the Nile delta through the Nile valley, for example the Egyptian Toad (*Bufo regularis*), Degen's Toad (*B. vittatus*) and the Mascarene Frog (*Rana mascariensis*). Even Ethiopian reptiles use the valley for the expansion of their distribution range (*Tarentola annularis*, *Mabuya quinquetaenica*, *Naja nigricollis* etc.). Some Palaearctic species have moved up the Nile and far to the south (NIETHAMMER, 1971). The Nile Valley offers the more hygrophilous Ethiopian species living conditions that are similar to those of the savannahs.

Centorus aegyptiacus (Zoufal, 1893), *Stenosis l. lateralis* Reitter, 1886, *Pogonobasis ornata* Solier, 1836, *Zidalus corvinus* (Mulsant & Rey, 1853), *Z. erythraeus* (Gridelli, 1940), *Dilamus pictus* Baudi, 1881, *Sclerum orientale orientale* (Fabricius, 1775), *Gonocephalum controversum* Gridelli, 1948, *Cyrtus aegyptiacus* (Mulsant & Rey) and *Cechenosternum rufulum* (Motschulsky, 1873) are among the Tenebrionidae that belong to this distribution type. None of these species except for *Sclerum o. orientale* is found north of the Nile. The Nile is therefore of greater importance as a migration route for southern species than it is for northern species (LILLIG & BREMER, 2002).

REFERENCES

- BALLAIS J.-P. (1992) – Variations de l'environnement et industries préhistoriques au Pléistocène supérieur terminal au Maghreb oriental pré-saharien. *Actes du 116^e congrès national des Sociétés Savantes (Chambéry, 29-30 avril 1991) (Déserts: Passé, Présent, Futur)*, Paris, p. 41-53.
- GREDLER V. (1878) – Zur Käfer-Fauna Central-Afrikas. *Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien*, Wien, 27, p. 501-522.
- HEINE K. (2002) – Sahara and Namib/Kalahari during the late Quaternary – inter-hemispheric contrasts and comparisons. *Zeitschrift für Geomorphologie, Supplementband 126 (Research in Deserts and Mountains of Africa and Central Asia)*, Berlin, Stuttgart, p. 1-29.
- LILLIG M. (1988) – Verbreitungstypen der Sahara. Thesis. FR Biogeographie, Univ. d. Saarlandes, Saarbrücken, p. 122 + appendix, ca. 500 pp. (unpublished).
- LILLIG M. & BREMER H. J. (2002) – Tenebrionidae der nördlichen Provinzen der Republik Sudan. (Coleoptera: Tenebrionidae). *Coleoptera*, Schwanfeld, 6, p.35-90.
- MÜLLER P. (1973) – The Dispersal Centres of Terrestrial Vertebrates in the Neotropical Realm. – *Biogeographica*, Den Haag, 2, p. 1-244.
- NAGEL, P. (1987) – Arealsystemanalyse afrikanischer Fühlerkäfer (Coleoptera, Carabidae, Paussinae). Ein Beitrag zur Rekonstruktion der Landschaftsgenese. 233 pp., Stuttgart.
- NIETHAMMER G. (1971) – Die Fauna der Sahara. In: SCHIFFERS, H. (ed.): Die Sahara und ihre Randgebiete Bd.1: Physiogeographie. München, p. 499-603.
- PROGNON P. (1987) – Les phases d'aridité du Pléistocène supérieur et de l'Holocène au Sahara; arguments sédimentologiques. *Palaeoecology of Africa*, Rotterdam, 18, p. 111-133.
- SIMONS P. (1971) – Die Nil-Wüste. In: SCHIFFERS, H. (ed.): Die Sahara und ihre Randgebiete Bd. 3. Regionalgeographie. München, p. 433-535.
- WILLIAMS M. A. J. & WILLIAMS, F. M. (1980) – Evolution of the Nile Basin. In: WILLIAMS, M. A. J. & H. FAURE: The Sahara and the Nile. Rotterdam, p. 207-224.

Taxon	Mountains	Coastal zone	Asiatic side
<i>Zophosis bicarinata ghiliani</i> DEYROLLE, 1867		x	
<i>Tentyrina duplicata ? manzonii</i> GRIDELLI, 1929		x	
<i>Oxycara brevisculum</i> FAIRMAIRE, 1892		x	
<i>Oxycara hegetericum</i> (REICHE & SAULCY, 1857)		x	
<i>Oxycara nageli</i> LILLIG, 2001		x	
<i>Scaurus pevelingi</i> LILLIG, 1995		x	
<i>Oxycara peyerimhoffi</i> LILLIG, 2001		x	X
<i>Diphyrhynchus aenescens</i> FAIRMAIRE, 1892		x	X
<i>Trachyscelis temuestriatus</i> FAIRMAIRE, 1885		x	X
<i>Zophosis silfverbergi</i> ARDOIN, 1972	X		
<i>Thraustocolus priesneri</i> KOCH, 1934	X		
<i>Oxycara aethiopium sudanicum</i> ARDOIN, 1972	X		
<i>Oxycara aethiopium andreinei</i> GRIDELLI, 1939	X		
<i>Adelostoma abyssinicum</i> HAAG-RUTENBERG, 1875	X		
<i>Adelostoma hirsutum</i> KOCH, 1935	X		
<i>Stenosis gestroi</i> REITTER, 1886	X		
<i>Vieta ovalis</i> ALLARD, 1874	X		
<i>Thriptera gastralis</i> KWIETON, 1978	X		
<i>Sclerum sudanicum</i> (KOCH, 1935)	X		
<i>Mesostena picea agilis</i> (GESTRO, 1881)	X	x	
<i>Oxycara aethiopium dubia</i> GRIDELLI, 1939	X	x	
<i>Adesmia reticulata basimargo</i> REITTER, 1916	X	x	
<i>Vieta costata</i> ALLARD, 1874	X	x	
<i>Storthocnemis a. abyssinica</i> (HAAG-RUTENBERG, 1876)	X	x	
<i>Pimelia r. raffrayi</i> SÉNAC, 1882	X	x	
<i>Drosocrus costatus elegans</i> (BAUDI, 1881)	X	x	

TABL. 1 - Distribution on the Red Sea