

# Tiger beetle fauna (Coleoptera: Carabidae, Cicindelinae) of Morocco: distribution, phenology and list of taxa

Radomir Jaskuła, Tomasz Rewicz & Kajetan Kwiatkowski

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The diversity and distribution of Cicindelinae in Morocco, including new unpublished data, is summarized and discussed. In total 17 species are reported from the country. *Cicindela campestris campestris* is excluded from the Moroccan fauna while the occurrence of *Myriochila mirei* is doubtful and should be confirmed by new data. The area adjacent to the Mediterranean Sea and Atlantic Ocean coastlines holds the highest species diversity, while mountainous regions are characterized by lower diversity but also by high level of species endemism. Grouped on the basis of their chorotypes, Moroccan Cicindelinae fall into six different groups: West Mediterranean (44% of Cicindelinae species), Maghreb endemics (22%), Mediterranean (11%), Saharian (11%), Mediterranean-Westturanian (6%) and Afrotropico-Indo-Mediterranean (6%). According to their phenology, the Moroccan tiger beetles can be divided into three groups: 1) spring active species, 2) spring-summer active species, and 3) summer active species.

*R. Jaskuła, Department of Invertebrate Zoology & Hydrobiology, University of Łódź, Banacha 12/16, 90-237 Łódź, Poland; E-mail: radekj@biol.uni.lodz.pl*  
*T. Rewicz, Department of Invertebrate Zoology & Hydrobiology, University of Łódź, Banacha 12/16, 90-237 Łódź, Poland; E-mail: tomek.rewicz@gmail.com*  
*K. Kwiatkowski, Department of Invertebrate Zoology & Hydrobiology, University of Łódź, Banacha 12/16, 90-237 Łódź, Poland; E-mail: rozchodnik@interia.pl*

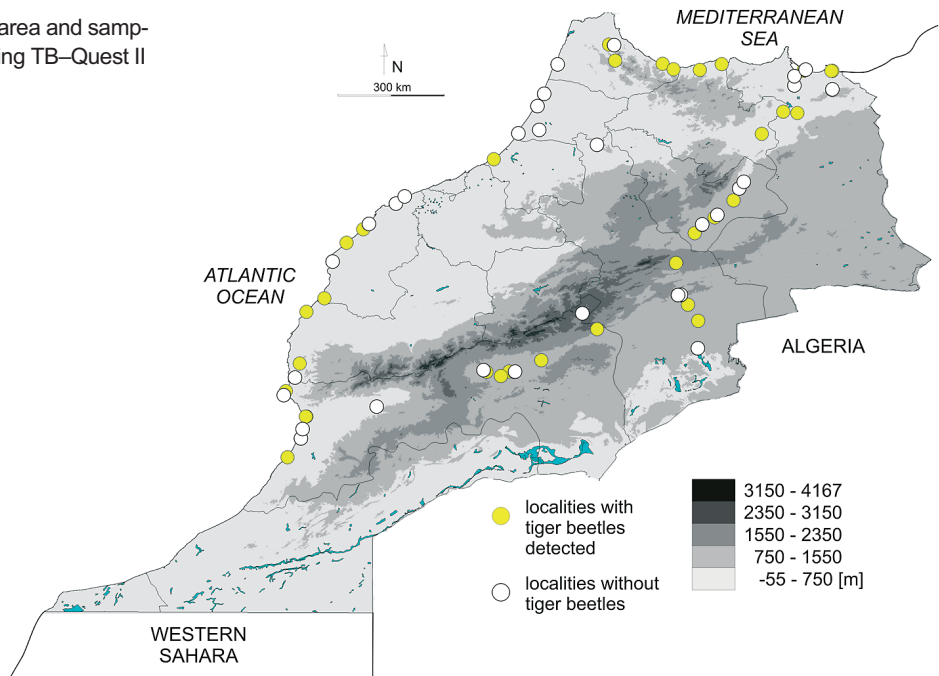
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## 1. Introduction

The first data on the tiger beetle species of Morocco come from papers by Fabricius (1787, 1801) who described three new species from this country: *Cicindela lunulata* (now known as *Calomera lunulata*), *C. littoralis* (now known as *Calomera littoralis*) and *Cicindela maroccana*. Later, until the beginning of the 20<sup>th</sup> century, new taxa of Cicindelinae were described from this country by Dejean (1829, 1831), Faimaire

(1868), Lallemand (1868), and Bedel (1903). The next taxon discovered and described from the area of Morocco was *Platydelia coquereli theryi* (Alluaud 1930). Except the above mentioned taxonomical descriptions, only Horn (1924), Alluaud (1925), Antoine (1933), Kocher (1938) and Paulian & Villiers (1939) provided additional faunistic data on Moroccan tiger beetles before World War II. The next three decades expanded the knowledge upon distribution of particular species (Antoine 1940, 1950, 1955,

Fig. 1. Study area and sampling effort during TB-Quest II Expedition.



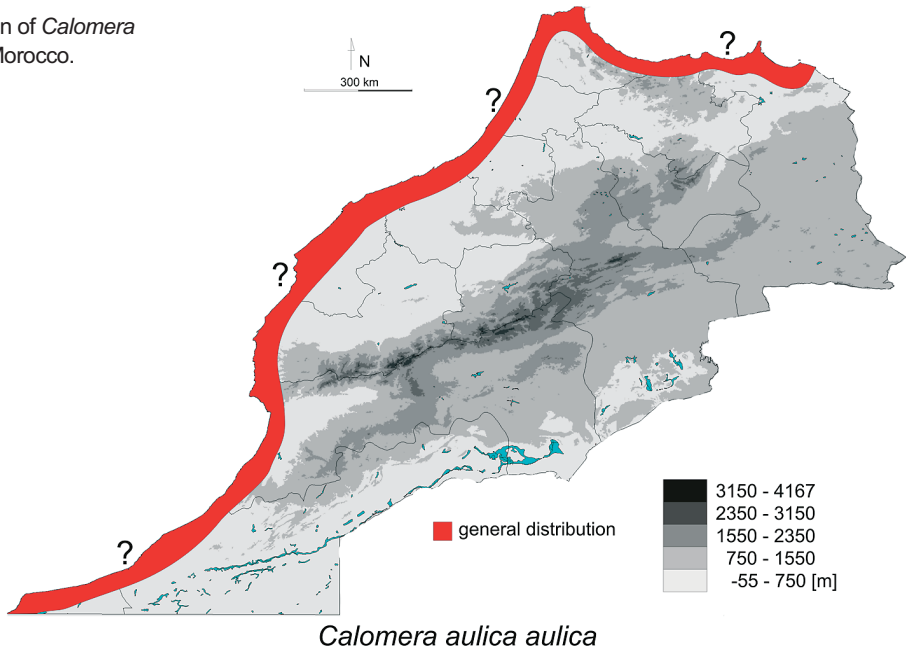
Peyerimhoff 1944, Kocher 1949, 1963, Rivalier 1950, Reymond & Reymond 1953, Pardo Alcaide 1955, Reymond 1955, Iablokoff 1966, Jeanne 1967). All these faunistic data were later summarized by Cassola (1973) in the first comprehensive distributional checklist of Moroccan tiger beetles. After that paper only single records of Cicindelinae were provided by Mandl (1981), Gebert (1991, 1996), Wiesner (1992), Maachi and Radouani (1993), and Werner (1992, 2000b). Finally, Putchkov and Matalin (2003) listed in the Catalogue of Palaearctic Coleoptera 16 species (two with two subspecies) from Morocco; unfortunately they omitted the paper of Chavanon and Richoux (1999), reporting also *Neolaphyra truquii* from this country. As a result of all these studies, and because *Cicindela campestris campestris* is excluded from fauna of this country in the present study, the Moroccan fauna is known to include 17 species of tiger beetles (one with two subspecies).

The aim of our paper is to summarize the up-to-date state of knowledge upon the diversity and distribution of Moroccan Cicindelinae, including both literature and new unpublished data. We also summarize knowledge on the phenological activity of each taxa occurring in this country.

## 2. Study area

The Kingdom of Morocco is located in North Africa. The state borders with Algeria on the east and with Western Sahara on the south. On the north and west, the country has natural borders formed, respectively, by the Mediterranean Sea and the Atlantic Ocean coastlines. It is one of the most mountainous African countries with some 75% of its area (more than 450,000 km<sup>2</sup>) composed of mountainous and upland terrains. The only narrow range of plains extends along the Atlantic and Mediterranean coast (Michard *et al.* 2008). These areas are mostly represented by the tidal wetlands, consisting of several lagoon complexes, bays, numerous estuaries and Atlantic or Mediterranean strip of shores (Dakki 1995). The northeast region (the Rif Mountains) has a cliff coast from the Mediterranean side, while the Atlantic coast is sandy. The massive chain of the Atlas Mountains extends along the entire country and is divided into three parallel strands: the High Atlas, the Middle Atlas and the Anti-Atlas. In its northwestern part the Middle Atlas passes into a highland, the Moroccan Meseta (Michard *et al.* 2008). The southern and south-eastern areas of the country, a part of Sahara, are occupied by

Fig. 2. Distribution of *Calomera aulica aulica* in Morocco.



steppes, semi-deserts and sandy and rocky deserts crossed by the wadi valleys. Rivers, taking their origin in the Atlas Mountains, occur mainly in the northern and western parts and the majority of them have estuaries flowing to the Atlantic Ocean. Lower courses of some rivers formed marshes in the past, but now they are dried as a result of the excessive exploitation of these terrains. Around 20 permanent natural lakes, bogs and 38 water reservoirs are located mainly in the Atlas Mountains (Dakki 1995). The territory of Morocco is administratively divided into 14 regions.

Morocco belongs to the Mediterranean climate type of the subtropical zone, characterized by regional variation. This variation is a result of differences in physical geography of this terrain. Because of existing marine boundaries of the north and west areas, the coastal lowlands are characterized by milder climate than those located to the south and east, where climatic conditions are more severe. This is a consequence of natural barrier formed by the Atlas Mountains, restraining the mitigating influence of ocean currents.

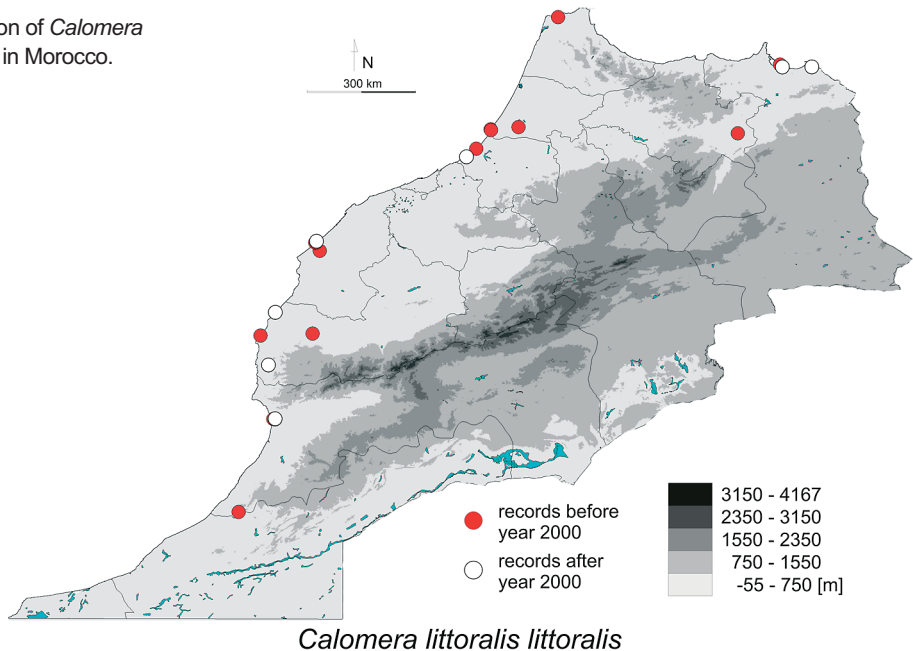
### 3. Materials and methods

Most of the new tiger beetle material mentioned in this study was collected during the II<sup>nd</sup> TB-Quest Expedition in March and April 2009 (Fig. 1). Adult beetles were sampled using entomological hand net in different sandy habitats typical for this group of insects (e. g. sandy marine beaches, sandy river banks, salt marshes). Moreover, in a single case larvae of Cicindelinae were also collected; using spades, they were sampled directly from the tunnels they built in the ground. All this material is presently deposited in the first author's collection. For each sampling site the GPS coordinates, altitude and habitat type were noted.

Additionally, we included material of Cicindelinae deposited in the entomological collection of the Natural History Museum in Vienna (NMV), Austria.

Data on the general distribution of tiger beetle species are provided mainly after Putschkov and Matalin (2003) and Werner (2000b), while macrohabitat types are defined after Jaskula (2015). Data on phenology and elevational distribution of each species were summarized on the basis of all the available published papers on Moroccan Cicindelidae as well as on new unpublished records. In the case of the literature data,

Fig. 3. Distribution of *Calomera littoralis littoralis* in Morocco.



Google Earth software was used to clarify the altitude and localization for each record.

*Habitat.* No data from Morocco.

*Phenology.* No data from Morocco.

#### 4. List of Moroccan tiger beetle species

Below, the specimens collected by the authors are denoted by RJ, TR & JH leg.

##### 4.1. *Calomera aulica aulica* (Dejean, 1831)

*Literature data.* Distributional map covering Atlantic Ocean and Mediterranean Sea coasts of Morocco (Werner 2000b).

*General distribution.* Algeria, Arab Emirates, Bahrain, Chad, Djibouti, Egypt, Eritrea, Greece, Guinea Bissau, Iran, Iraq, Israel, Jordan, Lebanon, Libya, Morocco, Oman, Pakistan, Saudi Arabia, Senegal, Somalia, Sudan, Syria, Tunisia, Yemen (Werner 2000b, Putschkov & Matalin 2003).

*Distribution in Morocco* (Fig. 2). No detailed localities are known from Morocco.

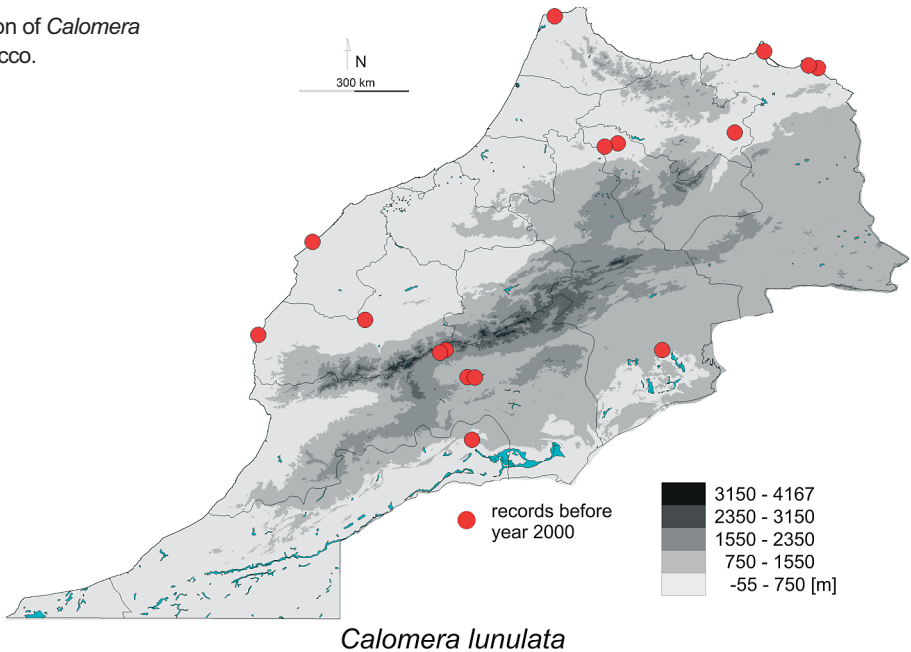
*Altitudinal range.* No detailed data from Morocco are known, but based on the distributional map provided by Werner (2000b), the species occurs on beaches located along the sea coast.

##### 4.2. *Calomera littoralis littoralis* (Fabricius 1787)

*Literature data.* Doukkala-Abda: Ain-Rhor [=Ain el Rhor] (Cassola 1973, Wiesner 1992); Oualidia (Cassola 1973, Wiesner 1992); Gharb-Chrarda-Béni Hssen: mouth of Oued Sebou (Kenitra) (Cassola 1973); Kenitra (Mandl 1981, Wiesner 1992); Merja Bokka (Sidi Yahya-du-Rharb) (Cassola 1973, Wiesner 1992); Marrakesh-Tensift-El Haouz: Mogadir [=Essaouira] (Wiesner 1992); Sidi-Moussa (Cassola 1973) Oriental: sandy beach of Bou-Areg (Nador region) (Maachi & Radouani 1993); Rabat-Salé-Zemmour-Zaer: mouth of Oued Yquem (Rabat) (Cassola 1973); Rabat (Cassola 1973, Wiesner 1992); Souss-Massa-Drâa: Agadir (Mandl 1981); Oued Noun (Kocher 1963, Wiesner 1992); Tangier-Tétouan: Tanger (Wiesner 1992); Taza-Al Hoceima-Taounate: Guercif (Mandl 1981, Wiesner 1992); Barbary coast (present day Morocco) without detailed data (Fabricius 1787 – *locus typicus* for *Cicindela littoralis*).

*New material.* For all RJ, TR & JH leg.

Fig. 4. Distribution of *Calomera lunulata* in Morocco.



Doukkala-Abda: near Oualidia, 32.74602°N/9.02294°W, 10 m, 22.IV.2009, 4♂♂ 3♀♀; Marrakesh-Tensift-El Haouz: 3 km W from Maglate, 31.08910°N/9.66635°W, 159 m, 21.IV.2009, 2♂♂ 4♀♀; 5 km SW from Drier, 31.79747°N/9.57471°W, 1 m, 21.IV.2009, 7♂♂ 5♀♀; Oriental: Kariat Arkmane, 35.10370°N/2.74772°W, 1 m, 8.IV.2009, 3♂♂ 5♀♀; 3 km E from Oued Haddou, 35.10343°N/2.35040°W, 2 m, 8.IV.2009, 2♂♂ 2♀♀; Rabat-Salé-Zemmour-Zaer: near Skhirat 33.89304°N/7.00168°W, 8 m, 23.IV.2009, 4♂♂ 3♀♀; Souss-Massa-Drâa: 5 km S from Dakhla, 30.36245°N/9.57548°W, 4 m, 20.IV.2009, 5♂♂ 3♀♀; 6 km S from Dakhla, 30.36317°N/9.58335°W, 9 m, 20.IV.2009, 8♂♂ 3♀♀.

**General distribution.** Algeria, Libya, Morocco, Portugal, Spain, Tunisia (Putchkov & Matalin 2003).

**Distribution in Morocco** (Fig. 3). At present, the species is known from the following administrative regions: Doukkala-Abda, Gharb-Chrarda-Béni Hssen, Marrakesh-Tensift-El Haouz, Oriental, Rabat-Salé-Zemmour-Zaer, Souss-Massa-Drâa, Tangier-Tétouan, and Taza-Al Hoceima-Taounate.

**Altitudinal range.** Noted in Morocco from 0 m to 458 m a.s.l. (Fig. 18).

**Habitat.** Marine sandy beaches, river banks, salt marshes.

**Phenology.** In Morocco, the species has been collected as adult from the beginning of April to the third week of October (Fig. 19).

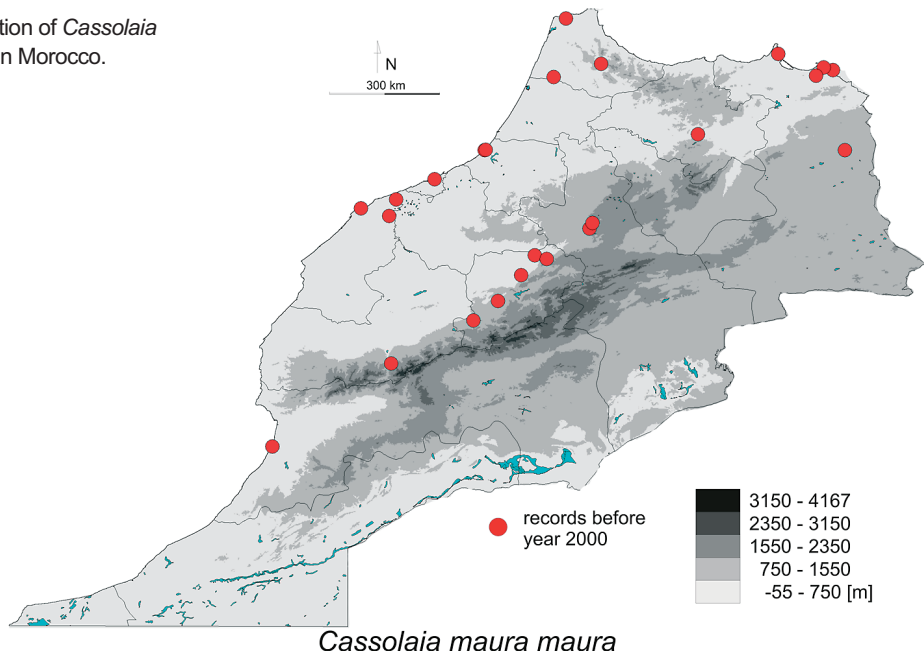
#### 4.3. *Calomera lunulata* Fabricius, 1781

**Literature data.** Doukkala-Abda: Oualidia (Mandl 1981); Fès-Boulemane: vicinity of Fez (Fabricius 1781 – *locus typicus* for *Cicindela lunulata*); Douyet near Fres (Antoine 1940); Guelmim-Es Semara: Foug Zguid (Kocher 1963); Marrakesh-Tensift-El Haouz: Mogadir [=Essaouira] (Mandl 1934, Mandl 1981); Oued Tensift near Marrakech (Antoine 1940); Meknès-Tafilalet: Risani (Kocher 1963); Oriental: Melilla (Cassola 1973); beach of Saidia (Oujda region, Eastern Mediterranean (Alluaud 1925); valley of Oued Moulouya (East Mediterranean coast, East of Nador (Pardo Alcaide 1955); Souss-Massa-Drâa: surroundings of Telouet (Haut Atlas, near Tizi-n-Tichka) (Cassola 1973, Mandl 1981); Telouet (Wiesner 1992); Tangier-Tétouan: Tanger (Mandl 1934, Mandl 1981); Taza-Al Hoceima-Taounate: Guercif (Mandl 1981).

**New material.** Souss-Massa-Drâa: Quarza-



Fig. 5. Distribution of *Cassolaia maura maura* in Morocco.



zate, 12–13.V.1991, 7♂♂ 8♀♀, P. Zabransky leg. [NMV]; Seeufer bei Quarzazate, 12.V.1991, 1♂ 1♀, H. Zeittel leg. [NMV]; Tangier-Tétouan: Tanger, 7.1894, 4♂♂ 3♀♀, Hauser leg. [NMV].

*General distribution.* Morocco, Algeria, Tunisia, Libya, Italy (Sicily) (Putchkov & Matalin 2003).

*Distribution in Morocco* (Fig. 4). At present the species is known from the following administrative regions: Doukkala-Abda, Fès-Boulemane, Guelmim-Es Semara, Marrakesh-Tensift-El Haouz, Meknès-Tafilalet, Oriental, Souss-Massa-Drâa, Tangier-Tétouan, Taza-Al Hoceima-Taounate.

*Altitudinal range.* Noted in Morocco from the sea level up to 1,768 m a.s.l. (Fig. 18).

*Habitat.* Marine sandy beaches, salt marshes, river banks.

*Phenology.* In Morocco, the species has been collected from second week of May to the end of July (Fig. 19).

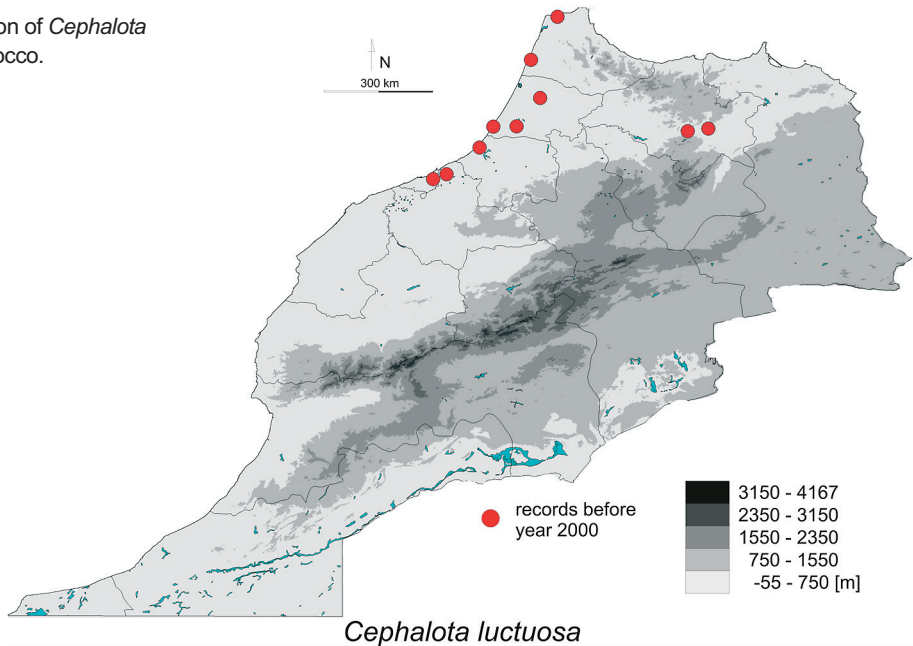
#### 4.4. *Cassolaia maura maura* (Linnaeus, 1758)

*Literature data.* Chaouia-Ouardigha: Sidi Machou [=Sidi Said Machou] (Cassola 1973); Doukkala-Abda: Bir Jdid (Cassola 1973);

Mazagan (El Jadida) (Cassola 1973); Grand Casablanca: Casablanca, marais de Renata (Werner 1992); Meknès-Tafilalet: Aguelmane Azigza (1800 m) (Kocher 1963); Sources de l'Oum er Ribia (Cassola 1973); Oriental: Melilla (Cassola 1973); beach of Saidia (Oujda region, Eastern Mediterranean (Alluaud 1925); Berguent (Kocher 1963); mouth of Moulouya (Kocher 1963); Granja Moulouya (Kebdana) (Cassola 1973); Mazuza (Melilla) (Cassola 1973); Rabat-Salé-Zemmour-Zaer: Rabat (Cassola 1973); Rabat, Bon Regreg barr. (Werner 1992); Souss-Massa-Drâa: Oued Massa (S from Souss) (Kocher 1963); Tadla-Azilal: Beni Mellal (Antoine 1933); Ksiba (Tadla) (Kocher 1963); Oued Oum-er Rbia (Farih-Ben-Salah) (Cassola 1973); Tangier-Tétouan: Yebel Magó, Xauen (Iablokoff 1966); Taza-Al Hoceima-Taounate: Taza (Reymond & Reymond 1953).

*New material.* Marrakesh-Tensift-El Haouz: El Djema, Oued Gron, 9.VI.1968, 2♂♂ [NMV]; Ouirgane, 1,000 m, 2.VII.1974, 1♂, Guichard & Else leg. [NMV]; Tadla-Azilal: Demnat, 8.1936, 2♂♂, Antoine leg. [NMV]; Cascades d'Ouzoud, 7.VI.1994, 1,500 m, 1♀, Oto Majzlan leg. [NMV]; Tangier-Tétouan: Ksar el Kelir, Tanger, 14.VI.1967, 1♀, A. Senglet leg. [NMV]; Tanger env., 12.IX.1909, 1♂ 1♀ [NMV]; Tanger,

Fig. 6. Distribution of *Cephalota luctuosa* in Morocco.



12.VI.1933, 1♀, Zervy leg. [NMV]; Tanger, 8.VI.1979, 1♀, Schlifelner leg. [NMV].

*General distribution.* Algeria, Italy, Morocco, Portugal, Spain (Putchkov & Matalin 2003).

*Distribution in Morocco* (Fig. 5). Until now the species was known from the following administrative regions: Chaouia-Ouardigha, Doukkala-Abda, Grand Casablanca, Meknès-Tafilalet, Oriental, Rabat-Salé-Zemmour-Zaer, Souss-Massa-Drâa, Tadla-Azilal, Tangier-Tétouan, Taza-Al Hoceima-Taounate. Here we provide the first record of this beetle from Marrakesh-Tensift-El Haouz.

*Altitudinal range.* Noted in Morocco from 0 m to 1,504 m a.s.l. (Fig. 18).

*Habitat.* Salt marshes, river banks.

*Phenology.* In Morocco, the species has been noted as imago from the beginning of May to mid-September (Fig. 19).

#### 4.5. *Cephalota (Cephalota) luctuosa* Dejean, 1831

*Literature data.* Chaouia-Ouardigha: Boulhaut (Antoine 1955, Wiesner 1992); Gharb-Chrarda-Béni Hssen: Merja-Bokka (Kocher 1963,

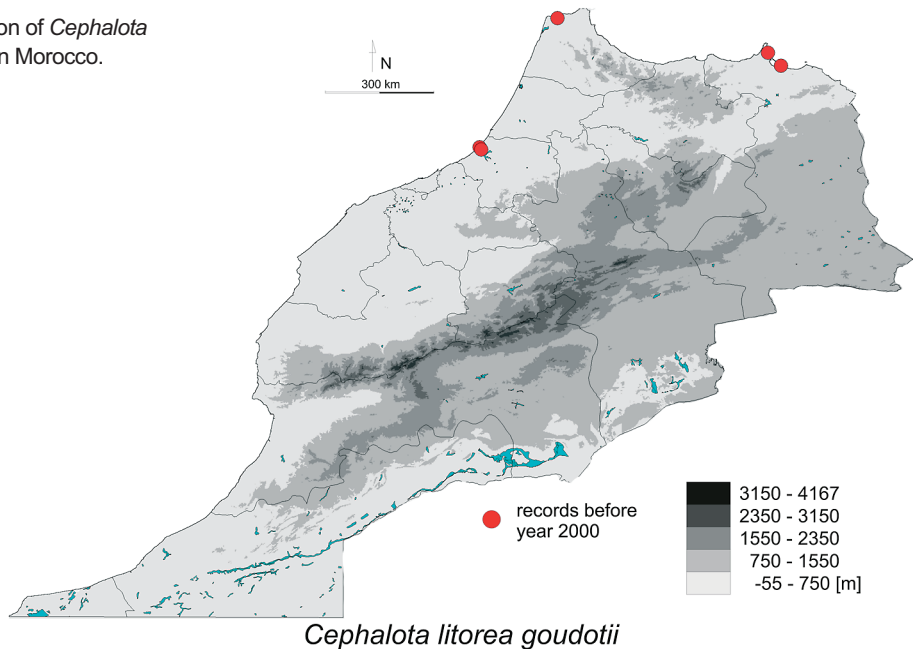
Wiesner 1992); Oued Sebou (Kenitra) (Cassola 1973); Rharb (Kocher 1963, Wiesner 1992); Grand Casablanca: Casablanca (Kocher 1963, Wiesner 1992); Rabat-Salé-Zemmour-Zaer: Rabat (Kocher 1963, Wiesner 1992); Rabat-Chellach (Kocher 1963, Wiesner 1992); Tangier-Tétouan: Larache (Kocher 1963, Wiesner 1992); Tanger (Kocher 1963, Wiesner 1992); Taza-Al Hoceima-Taounate: Msoun (Kocher 1963, Wiesner 1992); Taza (Kocher 1963, Wiesner 1992); Morocco (Dejean 1831 – *locus typicus* for *Cicindela luctuosa*) with no detailed data.

*New material.* Fès-Boulemane: Fez, 5.1979, 1♂, leg.V. Olivella [NMV]; Gharb-Chrarda-Béni Hssen: Kenitra, 20.V.1993, 0–3 m, 1♂ 1♀ [NMV]; Rabat-Salé-Zemmour-Zaer: Rabat, Mamora, 08.VI.1930, 1♂ 2♀♀, leg. Ebner [NMV]; Tangier-Tétouan: Tanger, 6.1893, 5♂♂ 5♀♀ [NMV].

*General distribution.* Morocco (Putchkov & Matalin 2003).

*Distribution in Morocco* (Fig. 6). Until now the species was known from the following administrative regions: Chaouia-Ouardigha, Gharb-Chrarda-Béni Hssen, Grand Casablanca, Rabat-Salé-Zemmour-Zaer, Tangier-Tétouan, Taza-Al Hoceima-Taounate. Here we provide the first record of this tiger beetle from Fès-Boulemane.

Fig. 7. Distribution of *Cephalota litorea goudotii* in Morocco.



*Altitudinal range.* Noted in Morocco from 0 m to 507 m a.s.l. (Fig. 18).

*Habitat.* Salt marshes.

*Phenology.* In Morocco, imagines of this species have been collected from May to the end of June (Fig. 19).

#### 4.6. *Cephalota (Taenidia) litorea goudotii* (Dejean, 1829)

*Literature data.* Oriental: Bou-Areg (Maachi & Radouani 1993); Melilla (Kocher 1963, Wiesner 1992); Rabat-Salé-Zemmour-Zaer: surroundings of Rabat (Mandl 1935); Tangier-Tétouan: Tanger (Dejean 1829 – *locus typicus* for *Cicindela litorea* var. *goudotii*; Antoine 1955, Wiesner 1992); beach in Tanger (Paulian & Villiers 1939); Embouchure (Gebert 1991) with no detailed data – this locality is unclear as the word “Embouchure” in French means “mouth of a river”; Maghreb (Wiesner 1992).

*General distribution.* Algeria, Italy (Sicily, Sardinia), Morocco, Portugal, Spain, Tunisia (Putchkov & Matalin 2003).

*Distribution in Morocco* (Fig. 7). Known only from two administrative regions on the Atlantic coast: Oriental and Tangier-Tétouan. The

occurrence of this species on the Atlantic coast reported by Mandl (1935) should be confirmed by new data.

*Altitudinal range.* Noted in Morocco from 1 m to 15 m a.s.l. (Fig. 18).

*Habitat.* Salt marshes.

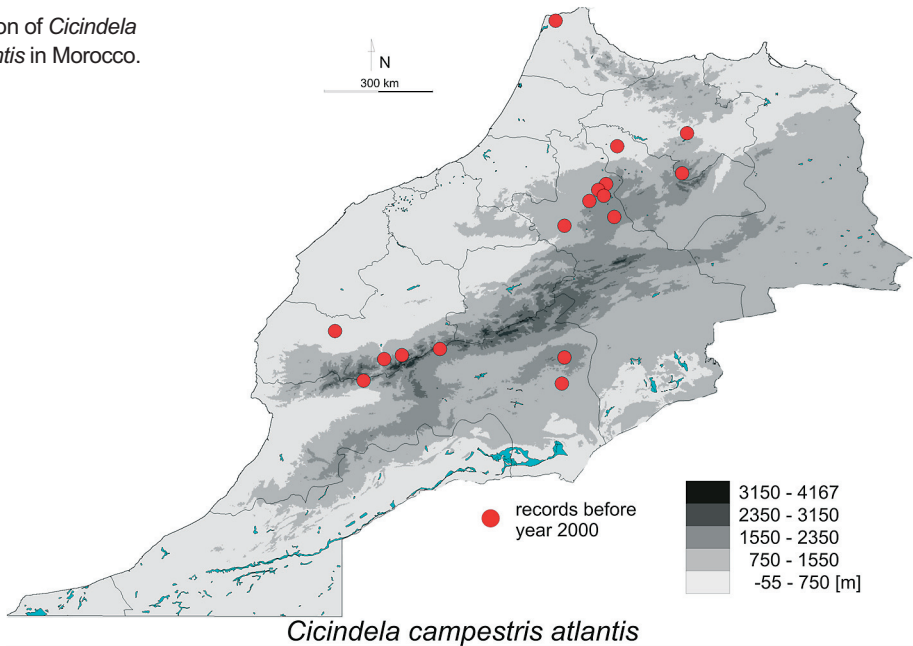
*Phenology.* Most probably active in Morocco only during summer period (Fig. 19).

#### 4.7. *Cicindela (Cicindela) campestris atlantis* Mandl, 1944

*Literature data.* Fès-Boulemane: Fez (Kocher 1963); Marrakesh-Tensift-El Haouz: Chichaoua (Kocher 1963); Oukaimeden (Cassola 1973); Tagadirt n’Bourd (Antoine 1940); Meknès-Tafilalet: Ain Leuh (Antoine 1950); Azrou (Antoine 1940); Djebel Hebri (Antoine 1940); Ifrane (Antoine 1940); Kehnifra (Galián and Vogler 2003); Lac du Bou Anguer (Antoine 1940); Souss-Massa-Drâa: Djebel Sarhro (Kocher 1949); Iknioun (Kocher 1949); Tizi-n-Test (Antoine 1940); Tizi-n-Tichka (Cassola 1973); Tangier-Tétouan: Tanger (Lallemant 1868 – *locus typicus* for *Cicindela campestris* var. *tangeriana*, Wiesner 1992); Taza-Al Hoceima-Taounate: Bou Iblane (Antoine 1940);



Fig. 8. Distribution of *Cicindela campestris atlantis* in Morocco.



Ras-el-Ma de Taza (Cassola 1973). Localities without detailed data: “regions montagneuses du Haut- et du Moyen Atlas” (Antoine 1940); Rif (Wiesner 1992).

*General distribution.* Algeria, Morocco, Spain, Tunisia (Putchkov & Matalin 2003).

*Distribution in Morocco* (Fig. 8). Known from the following administrative regions: Fès-Boulemane, Marrakesh-Tensift-El Haouz, Meknès-Tafilalet, Souss-Massa-Drâa, Tangier-Tétouan, Taza-Al Hoceima-Taounate.

*Altitudinal range.* In Morocco the species has been collected between 59 m and 3,029 m a.s.l. (Fig. 18).

*Habitat.* River banks.

*Phenology.* In Morocco the species was collected from the end of May to the end of September (Fig. 19).

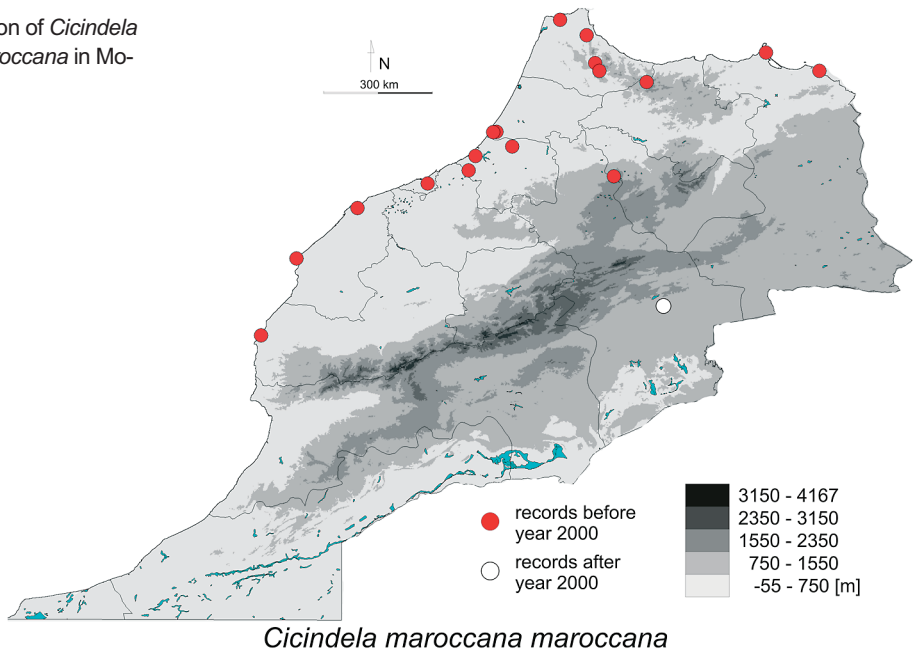
*Remarks.* In the Catalogue of Palearctic Coleoptera, Putchkov and Matalin (2003) included also the nominative subspecies of *Cicindela campestris* Linnaeus, 1758 in the fauna of Morocco. In our opinion this taxon should be excluded from the Moroccan checklist of tiger beetles as it is restricted to East, Central and partly also Western Europe and its occurrence in the entire North Africa is usually questioned and needs to be confirmed by new material. Moreover, at

least in some cases (e.g. Galián & Vogler 2003), the authors did not provide data on the subspecific name while – according to its locality – the material should be classified as *C. campestris atlantis*.

#### 4.8. *Cicindela (Cicindela) maroccana maroccana* (Fabricius, 1801)

*Literature data.* Doukkala-Abda: Cap Beddouza (Safi) (Kocher 1963, Wiesner 1992); El Jadida (Cassola 1973); Gharb-Chrarda-Béni Hssen: Port-Lyutey (Antoine 1950); Kenitra (Antoine 1950, Wiesner 1992); Grand Casablanca: Casablanca (Antoine 1950, Kocher 1963, Wiesner 1992); Marrakesh-Tensift-El Haouz: Mogador [=Essaouira] (Antoine 1950); Oriental: Saidia (Antoine 1950); Melilla (Cassola 1973, Wiesner 1992); Rabat-Salé-Zemmour-Zaer: Mamora (Antoine 1950); Mamora Forest (Kocher 1963), Zaer Forest (Kocher 1963, Wiesner 1992); Mamora Forest, Rabat (Werner 1991); Temara Forest (Cassola 1973); Tangier-Tétouan: Djebel Oukta (Antoine 1950); Yebel Utka (Kocher 1963, Novoa and Baselga 1999); Fifi (Jeanne 1967, Wiesner 1992); near Bab-Taza (Jeanne 1967); Tanger (Antoine 1950); (Rivalier 1950),

Fig. 9. Distribution of *Cicindela maroccana maroccana* in Morocco.



Tanger, Dar Chaouir (Lallemant 1868, Werner 1991, Wiesner 1992); Taza-Al Hoceima-Taounate: Isaguen (=Ketama) (Iablokoff 1966, Novoa & Baselga 1999); Morocco without detailed data (Fabricius 1801 – *locus typicus* for *Cicindela maroccana*).

*New material.* Meknès-Tafilalet: Ksar Kasba Lakdima, 31.89592°N/4.33171°W, 988 m, 11.IV.2009, 3♂♂ 1♀, RJ, TR & JH leg.; Dayet Aouaoua, 17 km NNE Ifrane, 1,378 m, 13.V.1961, 1♂, P.N. Lawrance leg. [NMV].

*General distribution.* Morocco, Portugal, Spain, Tunisia (Putchkov & Matalin 2003).

*Distribution in Morocco* (Fig. 9). The species was known from the following administrative regions: Doukkala-Abda, Gharb-Chrarda-Béni Hssen, Grand Casablanca, Marrakesh-Tensift-El Haouz, Oriental, Rabat-Salé-Zemmour-Zaer, Tangier-Tétouan. Here we provide the first record of this tiger beetle from Meknès-Tafilalet.

*Altitudinal range.* Noted in Morocco from 14 m to 1,484 m a.s.l. (Fig. 18).

*Habitat.* Different sandy areas from lowland to mountains.

*Phenology.* Most of the Moroccan specimens have been collected from March to June, but there are also single records from January (Fig. 19).

#### 4.9. *Cylindera (Eugrapha) trisignata trisignata* Latreille et Dejean, 1822

*Literature data.* Gharb-Chrarda-Béni Hssen: mouth of Oued Sebou (Kenitra) (Cassola 1973); Kenitra (Wiesner 1992); Grand Casablanca: Casablanca (Antoine 1955, Wiesner 1992); Marrakesh-Tensift-El Haouz: beaches in Mogador (Essaouira) (Kocher 1963); Essaouira (Wiesner 1992); Oriental: sandy beach of Bou-Areg (Nador region) (Maachi & Radouani 1993); beach of Saidia (Oujda region, Eastern Mediterranean) (Alluud 1925, Kocher 1963); Rabat-Salé-Zemmour-Zaer: mouth of l'Oued Yquem (Rabat) (Cassola 1973); Rabat (Wiesner 1992); Skhirat (Cassola 1973, Wiesner 1992).

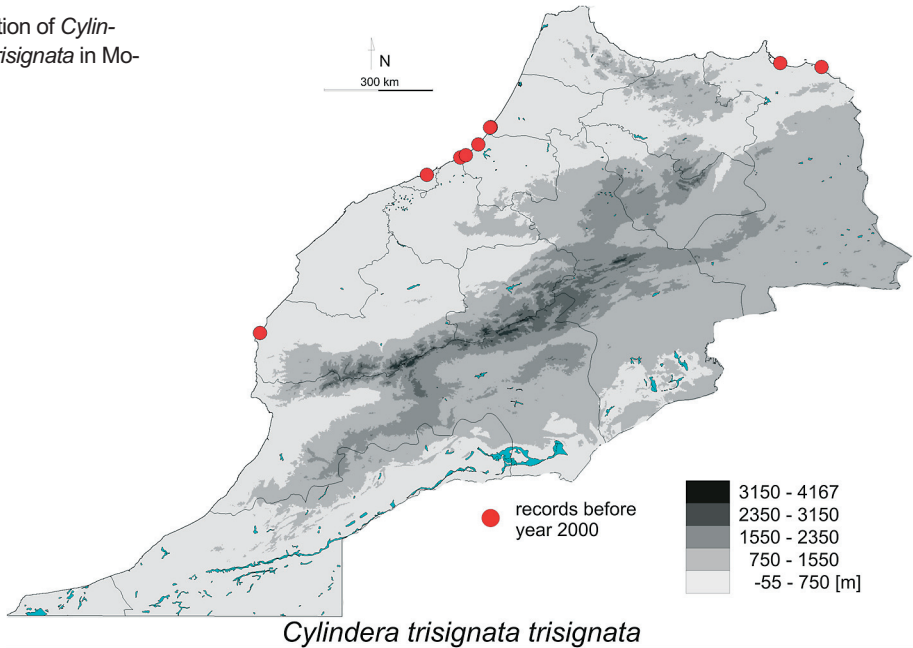
*General distribution.* Albania, Algeria, Greece, Montenegro, Morocco, Portugal, Spain, Italy, Turkey (Putchkov & Matalin 2003, Franzen 2005, Jaskuła *et al.* 2005).

*Distribution in Morocco* (Fig. 10). The species is known from the following administrative regions: Gharb-Chrarda-Béni Hssen, Grand Casablanca, Marrakesh-Tensift-El Haouz, Oriental, Rabat-Salé-Zemmour-Zaer.

*Altitudinal range.* Noted in Morocco from the sea level up to 9 m a.s.l. (Fig. 18).

*Habitat.* Marine sandy beaches, salt marshes.

Fig. 10. Distribution of *Cylindera trisignata trisignata* in Morocco.



**Phenology.** In Morocco the species has been collected as imago in May-June (Fig. 19).

#### 4.10. *Habrodera leucoptera leucoptera* (Dejean, 1825)

**Literature data.** Chaouia-Ouardigha: Khouribga (Kocher 1965, Wiesner 1992 – most probably doubtful locality); Souss-Massa-Drâa: Agadir (Gebert 1996); Oued Souss (Inezgane), Agadir (Jaskula & Cassola 2005).

**General distribution.** Gambia, Guinea Bissau, Morocco, Senegal, West Sahara (Werner 2000b, Putschkov & Matalin 2003, Jaskula & Cassola 2005).

**Distribution in Morocco** (Fig. 11). The only confirmed Moroccan localities of this species are placed in Souss-Massa-Drâa administrative division (surroundings of Agadir). The locality in Khouribga provided by Kocher (1963) is most probably doubtful as there are no habitats typical for this species in that area (Cassola 1973).

**Altitudinal range.** Noted in Morocco from 0 m to 5 m a.s.l. (the locality in Khouribga at 751 m a.s.l. was not taken into consideration as the record is questionable) (Fig. 18).

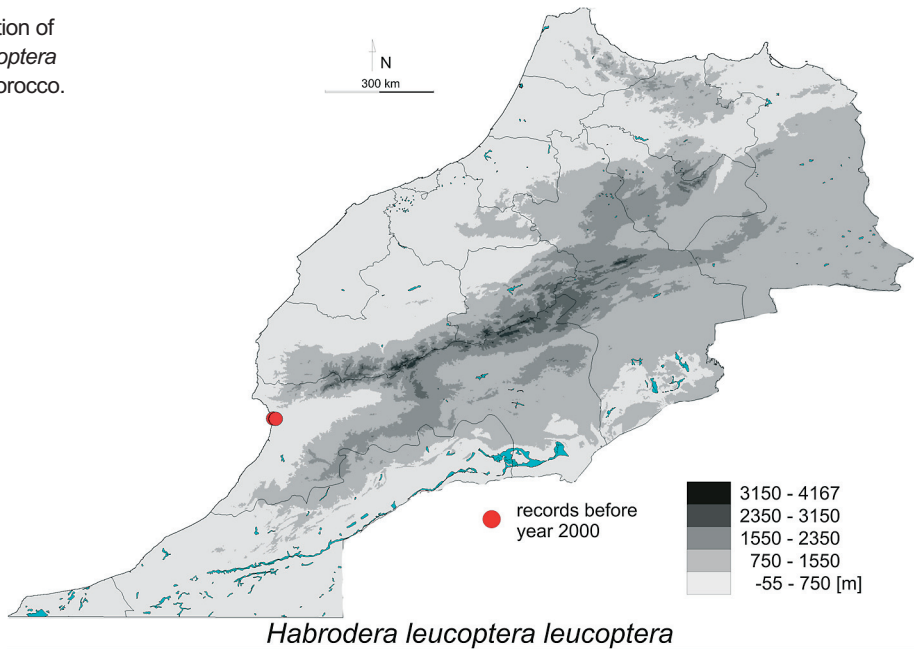
**Habitat.** Sandy beaches.

**Phenology.** In Morocco, adults of the species are active in July and August. Only one specimen provided by Kocher (1963) from Khouribga was collected in May (Fig. 19).

#### 4.11. *Lophyra (Lophyra) flexuosa flexuosa* (Fabricius, 1787)

**Literature data.** Gharb-Chrarda-Béni Hssen: Oued Sebou (Kenitra) (Cassola 1973); S. Slimane (Gharb) [=Sidi Slimane] (Cassola 1973); Guelmim-Es Semara: Tissint (Antoine 1942); Marrakesh-Tensift-El Haouz: 5 km S Essaouira (Arndt & Putschkov 1994); Asni, Haut Atlas (Arndt & Putschkov 1994); Asni, Oued Reraya (Cassola 1973); Bou-Areg (Maachi & Radouani 1993); Marrakech, Oued R'Mat (Cassola 1973); Mogador [=Essaouira] (Cassola 1973); Taddert (Cassola 1973); Meknès-Tafilalet: Ksar-es-Souk (Antoine 1942); Rich, Oued Ziz (Cassola 1973); Source de l'Oum er Rbia (Kocher 1963); Oriental: beach of Saidia (Oujda region, Eastern Mediterranean) (Alluaud 1925); Figuig (Kocher 1963); Melilla (Cassola 1973); valley of Oued Moulouya (East Mediterranean coast, East of Nador (Pardo Alcaide 1955); Rabat-Salé-Zemmour-Zaer: Bouches de l'Oued Yquem (Rabat) (Cassola 1973); Souss-

Fig. 11. Distribution of *Habrodera leucoptera leucoptera* in Morocco.



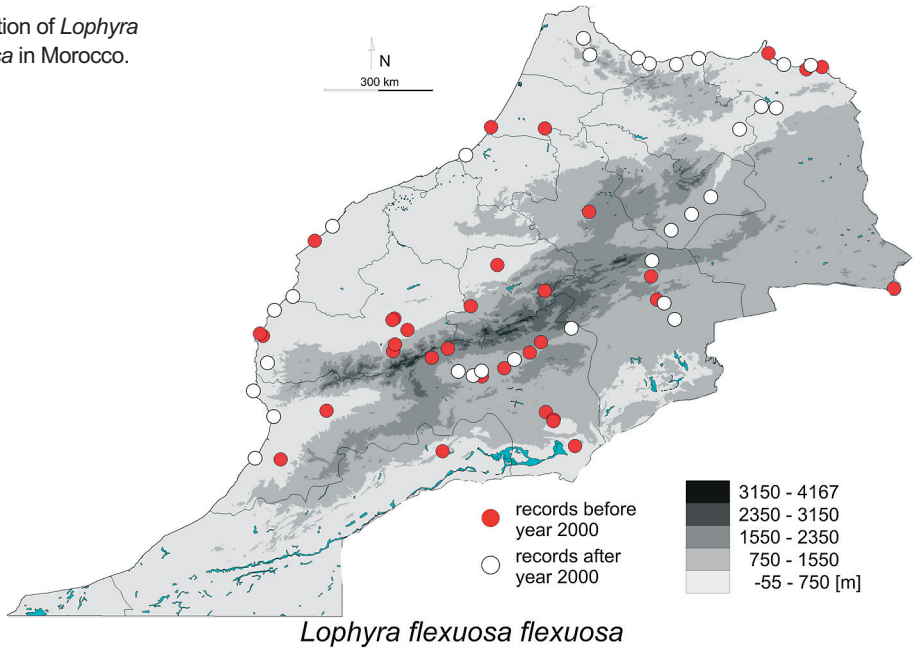
Massa-Drâa: Agouim, Oued Asif Iminni (Cassola 1973); Boumalne (Antoine 1955); El-Kelaa-des-Mgouna (Cassola 1973); Oued Dades (Sidi-Flah) (Cassola 1973); Oued Massa (Tiznit) (Cassola 1973); Oued Ouarzazate (Cassola 1973); Oulad Atmane, Oued Draa (Cassola 1973); Tagounite, Oued Draa (Cassola 1973); Taraudannt (Cassola 1973); Telouet (Haut Atlas) (Cassola 1973); Zagora (Peyerimhoff 1944); Tadla-Azilal: Ait-Anergui [=Anergui] (Kocher 1938); Oued Oum er Rbia (Fkih Ben Salah) (Cassola 1973); Tanannt, Oued Kakhdar (Cassola 1973).

*New material.* For all, if not mentioned otherwise, RJ, TR & JH leg. Doukkala-Abda: Morocco, Oalidia N de Safi, 11.II.1961, 1♀, Lindberg leg. [NMV]; Dehar ben Zite, 31.98276°N/9.32667°W, 12 m, 21.IV.2009, 11♂♂ 9♀♀; Oued Rahou, 32.93012°N/8.79314°W, 4 m, 22.IV.2009, 12♂♂ 11♀♀; near Skhirat, 33.89304°N/7.00168°W, 8 m, 23.IV.2009, 12♂♂ 8♀♀; Fès-Boulemane: Kasba Oulad el Bekri, 33.09332°N/3.96598°W, 892 m, 10.IV.2009, 14♂♂ 9♀♀; Outat el Haj, 33.32981°N/3.70678°W, 768 m, 10.IV.2009, 4♂♂ 3♀♀; 15 km NE from El Ksabi, 32.87912°N/4.23980°W, 982 m, 10.IV.2009, 11♂♂ 11♀♀; Marrakesh-Tensift-El Haouz: 3

km W from Maglate, 31.08910°N/9.66635°W, 159 m, 21.IV.2009, 9♂♂ 8♀♀; 3 km N from Akermoud, 31.79747°N/9.57471°W, 1 m, 21.IV.2009, 13♂♂ 7♀♀; Meknčs-Tafilalet: Aït Harou, 32.46998°N/4.49573°W, 1,588 m, 11.IV.2009, 3 larvae; Aoufous, 31.67369°N/4.19086°W, 880 m, 11.IV.2009, 10♂♂ 11♀♀; Oriental: Kariat Arkmane, 35.11579°N/2.72510°W, 1 m, 8.IV.2009, 9♂♂ 12♀♀; Ouled Haddou, 35.10631°N/2.36095°W, 2 m, 8.IV.2009, 13♂♂ 9♀♀; 9 km N from Sfisif, 34.52728°N/2.82964°W, 378 m, 9.IV.2009, 7♂♂ 14♀♀; Melga el Ouidane, 34.54452°N/3.02568°W, 236 m, 9.IV.2009, 12♂♂ 8♀♀; Souss-Massa-Drâa: Dra Tal, Zagora, 28.VI.1973, 1♂, de Frcina leg. [NMV]; near Bou Soun, 29.80286°N/9.83609°W, 5 m, 19.IV.2009, 9♂♂ 12♀♀; 4 km W from Tamri, 30.71072°N/9.85691°W, 3 m, 21.IV.2009, 11♂♂ 8♀♀; 5 km S from Dakhla, 30.36317°N/9.58335°W, 9 m, 20.IV.2009, 7♂♂ 12♀♀; Ait Baha Tizgui, 31.55908°N/5.57976°W, 1,385 m, 12.IV.2009, 12♂♂ 9♀♀; 20 km NE from Skoura, 31.13540°N/6.34711°W, 1,294 m, 13.IV.2009, 11♂♂ 9♀♀; 23 km SW from Skoura, 30.97698°N/6.78775°W, 1,123 m, 14.IV.2009, 9♂♂ 10♀♀; Kazba, 30.91518°N/6.904889°W 1,115 m, 14.IV.2009, 1♂, RJ leg.; Tazentout,



Fig. 12. Distribution of *Lophyra flexuosa flexuosa* in Morocco.



30.97515°N/7.10165°W, 1,210 m, 14.IV.2009, 7♂♂ 9♀♀; Tangier-Tétouan: 4 km S from Dar Ben Karih, 35.46514°N/5.41840°W, 124 m, 6.IV.2009, 12♂♂ 8♀♀; near Dhar Amzadj, 35.20274°N/4.68136°W, 4 m, 7.IV. 2009, 8♂♂ 9♀♀; 4 km N from AguerCIF, 35.12823°N/4.53106 °W, 154 m, 7.IV.2009, 12♂♂ 11♀♀; Kchebbache, 35.24829°N/ 5.33286°W, 3,140 m, 6.IV.2009, 4♂♂ 9♀♀; Taza-Al Hoceima-Taounate: Guercif, 34. 24173°N/3.31964°W, 353 m, 9.IV. 2009, 7♂♂ 10♀♀; 3 km SE from Taounil, 35.11776°N/ 4.17240°W, 241 m, 7.IV. 2009, 5♂♂ 7♀♀; 2 km E from Azghar, 35.19909°N/3.86987°W, 3 m, 8.IV.2009, 11♂♂ 7♀♀.

**General distribution.** Algeria, Andorra, Egypt, France, Israel, Italy, Libya, Morocco, Portugal, Spain, Switzerland, Syria, Tunisia (Putchkov & Matalin 2003).

**Distribution in Morocco** (Fig. 12). Until now the species was noted from the following administrative regions: Gharb-Chrarda-Béni Hssen, Guelmim-Es Semara, Marrakesh-Tensift-El Haouz, Meknès-Tafilalet, Oriental, Rabat-Salé-Zemmour-Zaer, Souss-Massa-Drâa, Tadla-Azilal. Here we provide first record of this tiger beetle from Doukkala-Abda, Fès-Boulemane, and Tangier-Tétouan regions.

**Altitudinal range.** In Morocco, the species was recorded from 1 m to 1,731 m a.s.l. (Fig. 18).

**Habitat.** River banks, oases, salt marshes.

**Phenology.** In Morocco, adult beetles were collected from April to end of July (Fig. 19).

**Remarks.** Larva of this species was described by Arndt and Putchkov (1994).

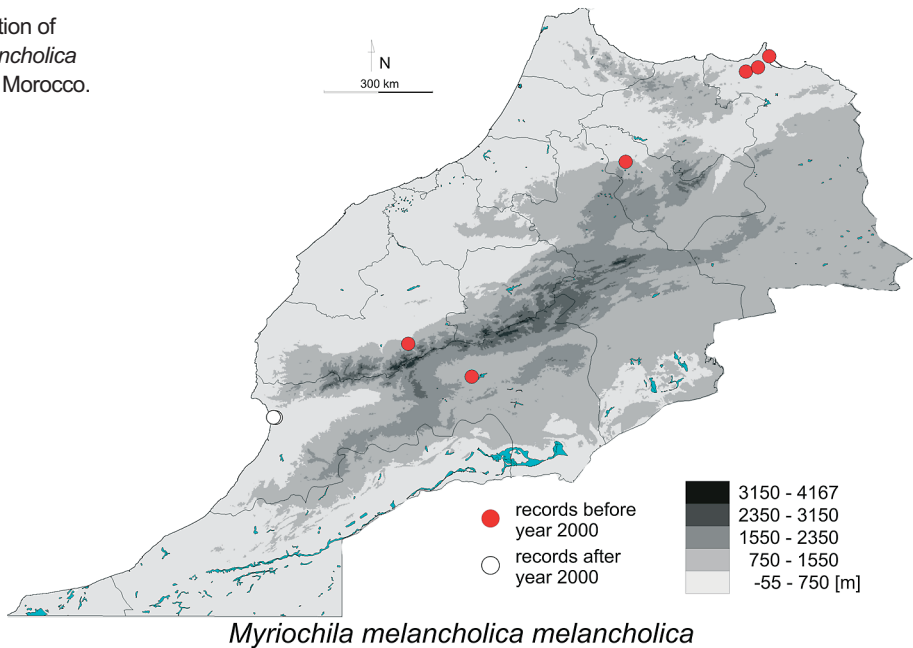
#### 4.12. *Myriochila (Myriochila) melancholica melancholica* (Fabricius, 1798)

**Literature data.** Fès-Boulemane: Sefrou (Kocher 1963); Oriental: surroundings of Melilla (Antoine 1955); Kandousi (Metalza) (Cassola 1973); Ras Meddua (Beni Sidel) (Cassola 1973); southern Morocco with no detailed data (Antoine 1955).

**New material.** Marrakesh-Tensift-El Haouz: Haut Atlas, Dar-Caid-Ouriki, 950 m, 31°23'N/7°46'W, 1.VIII.1977, 2♂♂, H. & U. Aspöck, H. & R. Rausch, P. Ressler leg.; Souss-Massa-Drâa: Haut Atlas, (S. Abfall), SE Quarzazate, 1,300 m, 30.57°N/6.50°W, 3.-4.VI.1977, 1♂, H. & U. Aspöck, H. & R. Rausch, P. Ressler leg.; 5 km S from Dakhla, 30.36245°N/9.57548°W, 4 m, 20.IV.2009, 3♂♂ 2♀♀, RJ, TR & JH leg.; 6 km S from Dakhla, 30.36317°N/9.5833°W, 9 m,



Fig. 13. Distribution of *Myriochila melancholica melancholica* in Morocco.



20.IV.2009, 2♂♂ 4♀♀, RJ, TR & JH leg.

**General distribution.** Afghanistan, Algeria, Angola, Arab Emirates, Armenia, Azerbaijan, Bahrain, Burkina Faso, Cameroun, Central African Republic, Chad, China (Xinjiang), Congo, Cyprus, Egypt, Equatorial Guinea, Ethiopia, France, Georgia, Ghana, Greece, Guinea, Guinea Bissau, India (Uttar Pradesh), Iran, Iraq, Israel, Italy, Ivory Coast, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Kuwait, Lebanon, Libya, Madagascar, Malawi, Malta, Morocco, Mozambique, Namibia, Nigeria, Oman, Pakistan, Portugal, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Spain, Sudan, Syria, Tadjikistan, Tanzania, Togo, Tunisia, Turkmenistan, Turkey, Uzbekistan, Yemen, Zaire (Werner 2000b, Putschkov & Matalin 2003, Guéorguiev 2007, Jaskuła 2007, Cassola & Jaskuła 2008).

**Distribution in Morocco** (Fig. 13). Until now the species was known from the following administrative regions: Fès-Boulemane, Oriental and generally from southern part of country. Here we provide first records of this tiger beetle from Marrakesh-Tensift-El Haouz and Souss-Massa-Drâa regions.

**Altitudinal range.** Noted in Morocco from the sea level up to 1,117 m a.s.l. (Fig. 18).

**Habitat.** River banks, salt marshes.

**Phenology.** In Morocco, adults were collected from April to August (Fig. 19).

#### 4.13. *Myriochila (Monelica) mirei* Rivalier, 1961

**Literature data.** Species mentioned from Morocco by Werner (2000b) and later by Putschkov and Matalin (2003) but without any detailed localities.

**General distribution.** Algeria, Chad, Morocco, Niger, Senegal (Werner 2000b, Putschkov & Matalin 2003).

**Distribution in Morocco.** No detailed records are known from Morocco.

**Altitudinal range.** No data from Morocco.

**Habitat.** No data from Morocco.

**Phenology.** No data from Morocco.

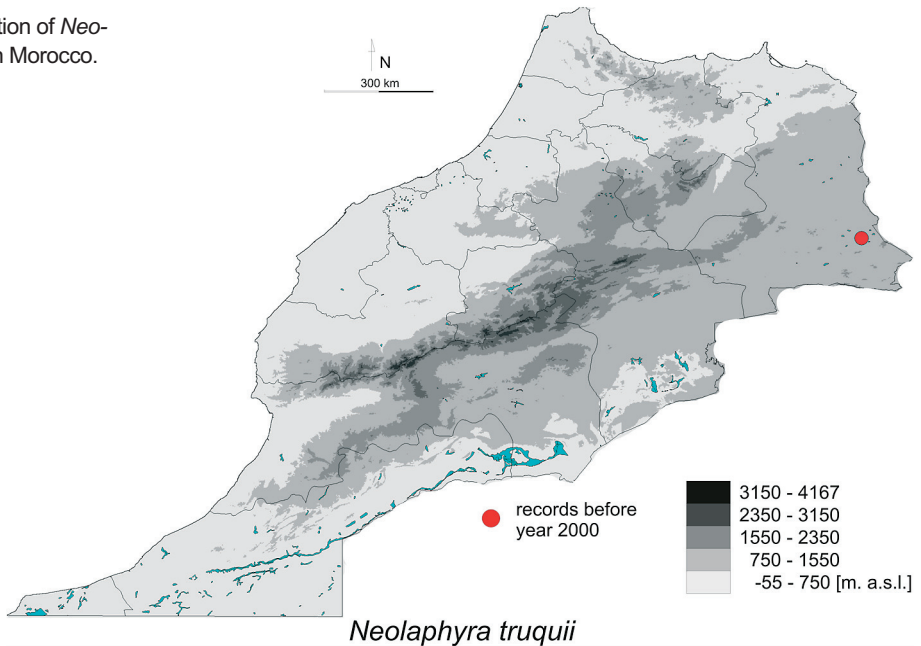
#### 4.14. *Neolaphyra truquii* (Guérin-Méneville, 1855)

**Literature data.** Oriental: 35 km NE from Bouarfa (Chavanon & Richoux 1999).

**General distribution.** Algeria, Morocco, Tunisia (Chavanon & Richoux 1999, Putschkov & Matalin 2003).

**Distribution in Morocco** (Fig. 14). The only

Fig. 14. Distribution of *Neolaphyra truquii* in Morocco.



presently known locality of this species from Morocco is in the Oriental region.

*Altitudinal range.* Noted in Morocco only in one locality at 1,152 m a.s.l. (Fig. 18).

*Habitat.* Sandy steppe overgrown mainly by *Stipa tenacissima* L.

*Phenology.* The only three Moroccan specimens known to us have been collected in April and May (Fig. 19).

#### 4.15. *Platydelia coquereli* (Fairmaire, 1868)

##### 4.15.1. *Platydelia coquereli coquereli* (Fairmaire, 1868)

*Literature data.* Chaouia-Ouardigha: Boulhaut (Wiesner 1992); Meknčs-Tafilalet: Ito (Antoine 1933, Wiesner 1992); Azrou (Antoine 1933, Wiesner 1992); Rass-el-Ma (Antoine 1933, Wiesner 1992); Rabat-Salé-Zemmour-Zaer: Oued Zem (Antoine 1933, Wiesner 1992); Rabat (Fairmaire 1868 – *locus typicus* for *Cicindela coquereli*, Wiesner 1992); Sale (Wiesner 1992); Tadla-Azilal: Azilal (Wiesner 1992); Taza-Al Hoceima-Taounate: Sker [=Zrizer], cerca de Taounate (Kocher 1963), Sker [=Zrizer] (Antoine 1933, Wiesner 1992).

*New material.* Meknčs-Tafilalet: Azrou, 15.II.1977, 1♂ 1♀, V. Olivella leg. [NMV]; Djebel Zerhoun, 5.IV.1981, 1♀ [NMV].

*General distribution.* Morocco (Putchkov & Matalin 2003).

*Distribution in Morocco* (Fig. 15). As for now the species is known from the following administrative regions: Chaouia-Ouardigha, Meknčs-Tafilalet, Rabat-Salé-Zemmour-Zaer, Tadla-Azilal, Taza-Al Hoceima-Taounate.

*Altitudinal range.* Noted in Morocco from 3 m to 2,086 m a.s.l. (Fig. 18).

*Habitat.* Sandy areas in mountains.

*Phenology.* Adult beetles were collected from February to April (Fig. 19).

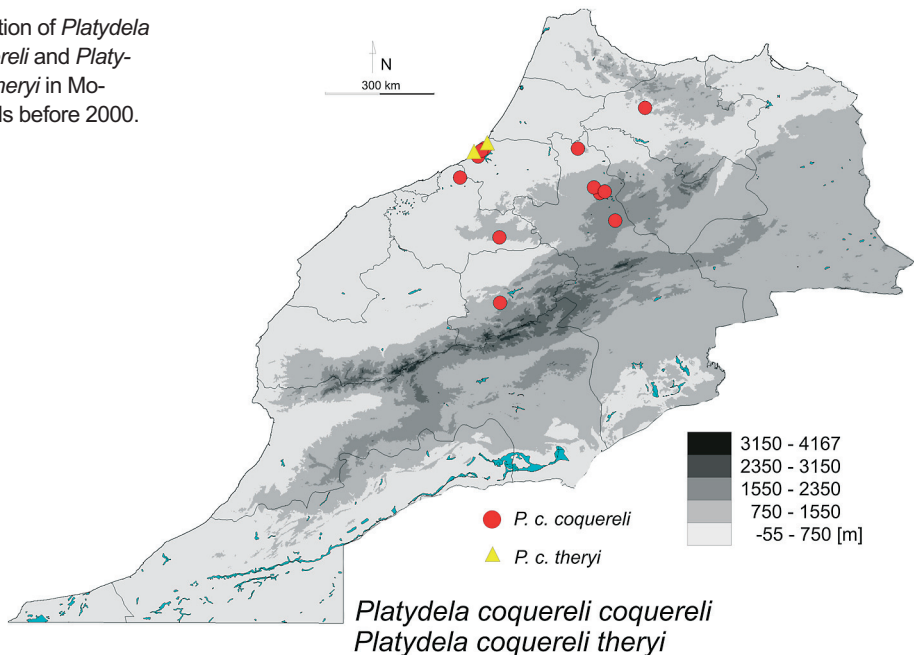
##### 4.15.2. *Platydelia coquereli theryi* (Alluaud, 1930)

*Literature data.* Rabat-Salé-Zemmour-Zaer: Dradek (Antoine 1933); Rabat (Antoine 1933). Localities without detailed data: Foucaud (route de Casa a Si-Said achou sur l'Oum er Rbia (Antoine 1933).

*General distribution.* Morocco (Putchkov & Matalin 2003).

*Distribution in Morocco* (Fig. 15). Known presently from Rabat-Salé-Zemmour-Zaer region.

Fig. 15. Distribution of *Platydelia coquereli coquereli* and *Platydelia coquereli theryi* in Morocco. All records before 2000.



**Altitudinal range.** Species noted in Morocco from the sea level up to 600 m a.s.l. (Fig. 18).

**Habitat.** Until now this taxon is known from Rabat-Salé-Zemmour-Zaer region.

**Phenology.** Most probably the species has spring activity (Fig. 19).

**Remarks.** Analysis of the distributions of *P. coquereli coquereli* and *P. coquereli theryi* clearly shows (Fig. 15) that the taxonomical status of these “subspecies” needs to be clarified as most probably they are either morphological varieties of a single species or should be classified as separate species.

#### 4.16. *Platydelia segonzaci* (Bedel, 1903)

**Literature data.** Fès-Boulemane: surroundings of Boulemane (Cassola 1973, Wiesner 1992); Marrakesh-Tensift-El Haouz: Amizmiz (Horn 1924, Wiesner 1992); Meknès-Tafilalet: Ras-el-Ma (Antoine 1933, Wiesner 1992); Col du Zad (Moyen Atlas) (Cassola 1973); Ain Leu (Wiesner 1992); Ito (entre Azrou er Meknes) (Antoine 1933); Aguelmane Sidi Ali [=Aguelmane de Sidi Ali] (Antoine 1933) 2,100 m, Lac Sidi Ali, (Wiesner 1992); Asru [=Azrou] (Antoine 1933) 1,100 m, Wiesner 1992); Bekrit (Wiesner 1992); Tadla-Azizal: Foret Haouanet pres Taguelft

[=Foret d’el Haounet] (Kocher 1965, Wiesner 1992); Col de Tarzeft [=Tasreft] (Antoine 1933, Wiesner 1992); Taza-Al Hoceima-Taounate: Beni M’guild (Antoine 1933, Wiesner 1992); Sker (Antoine 1933). Localities without detailed data: Central Atlas (Bedel 1903 – *locus typicus* for *Cicindela segonzaci*); “Grand Atlas central” (Cassola 1973); Moyen Atlas (Cassola 1973).

**New material.** Meknès-Tafilalet: Col du Zad, 14.IV.1992, 1♂ 1♀, Makovec leg. [NMV]; Souss-Massa-Drâa: Morocco, Taroudannt, 21.IV.1992, 1♂, V. Biša & Z. Kóšťal leg. [NMV].

**General distribution.** Morocco (Putchkov & Matalin 2003).

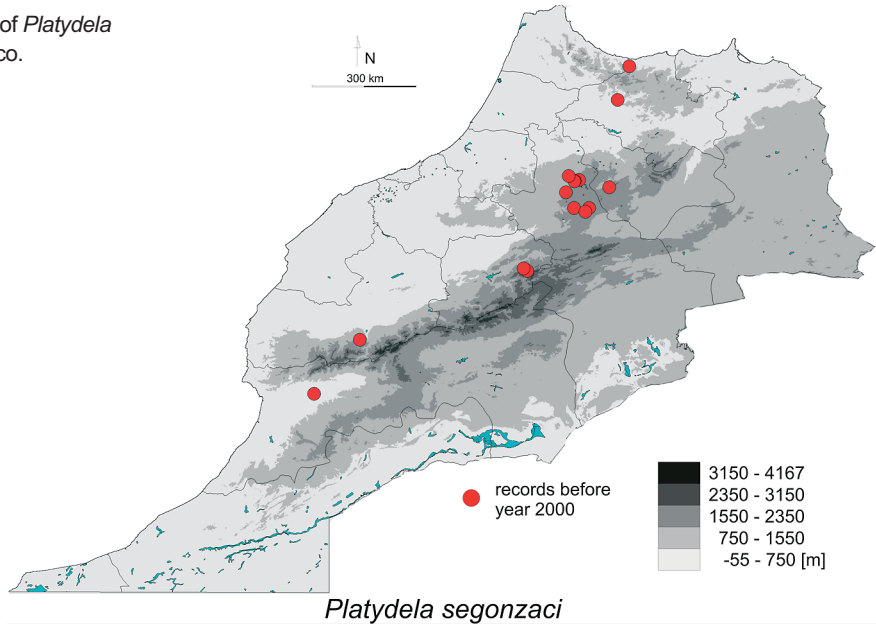
**Distribution in Morocco** (Fig. 16). Until now the species was known from the following administrative regions: Marrakesh-Tensift-El Haouz, Meknès-Tafilalet, and Taza-Al Hoceima-Taounate. Here we provide first record of this tiger beetle from Souss-Massa-Drâa.

**Altitudinal range.** Noted in Morocco from 229 m up to 2,214 m a.s.l. (Fig. 18).

**Habitat.** Sandy places in mountainous areas.

**Phenology.** Adult beetles of this species were collected from the beginning of April to the end of May (Fig. 19).

Fig. 16. Distribution of *Platydelia segonzaci* in Morocco.



**4.17. *Grammognatha euphratica euphratica* (Dejean, 1822)**

*Literature data.* Chaouia-Ouardigha: Sidi Abd-el-Nebi (= ? Zaouia Sidi Abd en Nebi) (Cassola 1973); Fès-Boulemane: Outat-el-Haj (Reymond 1955, Wiesner 1992); Guelmim-Es Semara: Foum Zguid (Kocher 1963, Wiesner 1992); Ori-

ental: mouth of Moulouya: Cabo de Agua (Reymond 1955); mouth of Moulouya: Mar Chica (Antoine 1955); Melilla (Wiesner 1992); salt marshes near Nador (close to Melilla) (Reymond 1955); Souss-Massa-Drâa: Mhamid (Cassola 1973, Wiesner 1992). Locality without detailed data: Moulouya [one of the longest rivers in Morocco] (Wiesner 1992).

Fig. 17. Distribution of *Grammognatha euphratica euphratica* in Morocco.

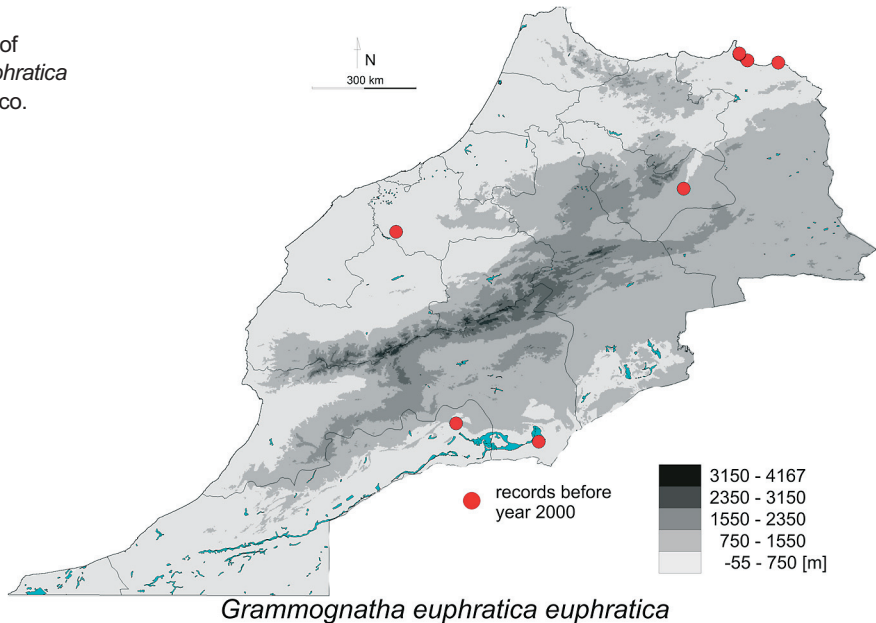


Table 1. Distribution of tiger beetle taxa in administrative regions of Morocco. Open circle = data before 2000, black dot = data after 2000.

Taxon	Chorotype <sup>a</sup>	Administrative regions of Morocco <sup>b</sup>													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
<i>Calomera</i>															
<i>aulica aulica</i>	M	?	?	?	?	?	?	?	?	?				?	?
<i>littoralis littoralis</i>	WM		○●	○		○●	○●		○●	○●				○	○
<i>lunulata</i>	WM	○	○			○	○			○		○	○	○	○
<i>Cassolaia</i>															
<i>maura maura</i>	WM		○		○	○	○	○	○	○	○	○	○	○	○
<i>Cephalota</i>															
<i>luctuosa</i>	WM			○	○			○	○				○	○	○
<i>litorea goudotii</i>	WM							○		○					○
<i>Cicindela</i>															
<i>campestris atlantis</i>	WM		○			○						○	○	○	○
<i>maroccana maroccana</i>	WM			○		○	○	○	○	○		●			○
<i>Cylindera</i>															
<i>tresignata trisignata</i>	WM			○		○	○	○	○						
<i>Habrodera</i>															
<i>leucoptera leucoptera</i>	S		○		○?										
<i>Lophyra</i>															
<i>flexuosa flexuosa</i>	M	○	○●	○		○●	○●		○	○●	○	○●	●	○●	●
<i>Myriochila</i>															
<i>melancholica melancholica</i>	AIM		○●			○	○						○		
<i>mirei</i>	S	?	?	?	?	?	?	?	?	?	?	?	?	?	?
<i>Neolaphyra</i>															
<i>truquii</i>	ME							○							
<i>Platydelia</i>															
<i>coquereli coquereli</i>	ME				○				○		○	○		○	
<i>coquereli theryi</i>	ME									○					
<i>segonzaci</i>	ME		○			○					○	○	○	○	
<i>Grammognatha</i>															
<i>euphratica euphratica</i>	MW	○	○		○		○						○		
<b>Total</b>		<b>3</b>	<b>9</b>	<b>5</b>	<b>4</b>	<b>9</b>	<b>10</b>	<b>4</b>	<b>9</b>	<b>5</b>	<b>4</b>	<b>7</b>	<b>7</b>	<b>8</b>	<b>8</b>

a) Chorotypes based on Vigna Taglianti *et al.* 1999: AIM – Afrotropico Indo-Mediterranean, M – Mediterranean, ME – Maghreb endemics, MW – Mediterranean-Westturanian, S – Saharian, WM – West Mediterranean.

b) 1 – Guelmim-Es Semara, 2 – Souss-Massa-Dra, 3 – Gharb-Chrarda-Béni Hssen, 4 – Chaouia-Ouardigha, 5 – Marrakech-Tensift-El Haouz, 6 – Oriental, 7 – Grand Casablanca, 8 – Rabat-Salé-Zemmour-Zaer, 9 – Doukkala-Abda, 10 – Tadla-Azilal, 11 – Meknès-Tafilalet, 12 – Fès-Boulemane, 13 – Taza-Al Hoceima-Taounat, 14 – Tangier-Tétouan.

*General distribution.* Algeria, Arab Emirates, Cyprus, Djibouti, Egypt, Greece (Rhodes, Crete), Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Saudi Arabia, Spain, Syria, Tunisia, Turkey, West Sahara, Yemen (Werner 2000a, Putchkov & Matalin 2003).

*Distribution in Morocco* (Fig. 17). Noted until now from the following administrative regions of Morocco: Chaouia-Ouardigha, Fès-Boulemane, Guelmim-Es Semara, Oriental, and Souss-Massa-Drâa.

*Altitudinal range.* In Morocco the species was

collected from the sea level up to 757 m a.s.l. (Fig. 18).

*Habitat.* Salt marshes.

*Phenology.* In Morocco the species is active most probably from late spring to summer period (Fig. 19).

## 5. Distributional patterns of Cicindelinae of Morocco

The Moroccan tiger beetle fauna consists of 17 known species, one species with two subspecies,



grouped in eleven genera (Table 1). As it is shown on the distributional maps (Figs 2-17) and on the elevation graph (Fig. 18), almost 78% of tiger beetle species (14) occurring in Morocco can be found in lowland areas (up to 200 m a.s.l.). Moreover, almost half of these species can be found only in a very narrow zone of the Mediterranean Sea and the Atlantic Ocean coasts. This number could be even higher because there are no detailed data on localities of *C. aulica* and *M. mirei* in this country. The former species was noted from Morocco only on a distributional map by Werner (2000b) as occurring on sea coasts, while the latter species was recorded without any details on its locality by Werner (2000b) and Putschkov and Matalin (2003). The main types of habitats occupied by Cicindelinae in lowland areas are salt marshes, sandy sea beaches and river banks. At least the occurrence of six of them (35% of all Moroccan tiger beetle species) is more or less restricted only to these terrains and habitats located in lowland areas (*C. maroccana maroccana*, *C. littoralis littoralis*, *C. trisignata trisignata*, *C. litorea goudotii*, *C. luctuosa*, *H. leucoptera leucoptera*; probably also *C. aulica*

should be classified in this group). Three additional taxa (18%, *G. euphratica euphratica*, *M. melancholica melancholica*, *P. coquereli theryi*) occur mainly on lowlands but can be found also in highland areas where they usually live close to the water reservoirs like rivers, lakes, and salt marshes (chotts located in desert areas). The next group is composed of the species with their distribution restricted mainly to the mountainous areas (here defined together as highlands and mountains). Five species can be classified to this group, including one widely distributed one in the Mediterranean Region (*L. flexuosa flexuosa*) as well as Moroccan or Maghreb endemics (*C. campestris atlantis*, *N. truquii*, *P. coquereli coquereli*, *P. segonzaci*).

Following Vigna Taglianti et al. (1999), the Moroccan tiger beetles can be included into six different groups according to their chorotypes (Table 1, Fig. 20). The main groups are composed of West Mediterranean taxa (44% of all Moroccan tiger beetle species and subspecies) and Maghreb endemics (22% of Cicindelinae). Both Mediterranean and Saharian species constitute 11% of Moroccan tiger beetle fauna, while

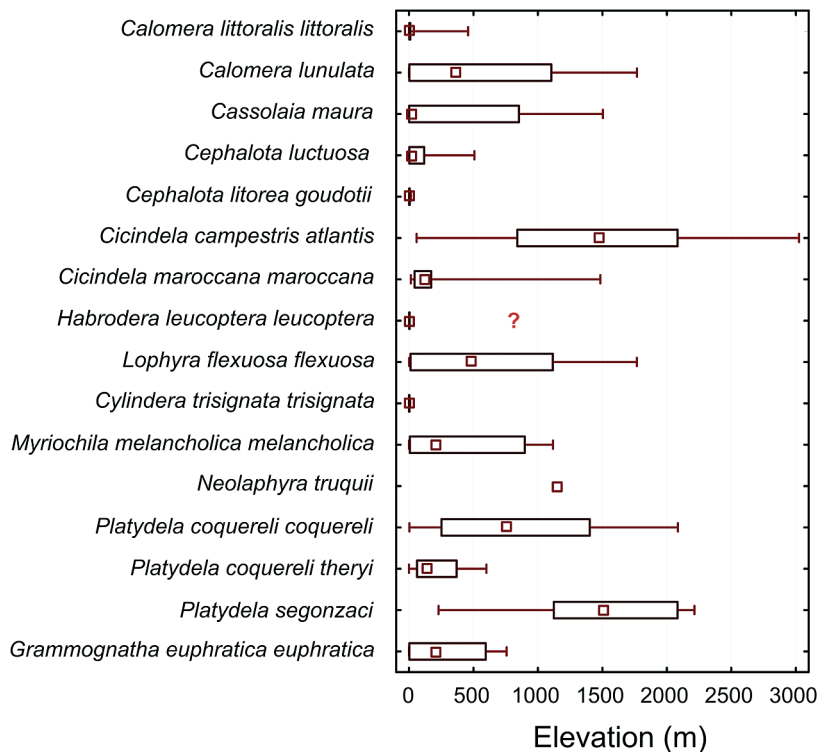


Fig. 18. Altitudinal distribution of tiger beetle species in Morocco. Boxes represent 25<sup>th</sup>–75<sup>th</sup> percentiles, upper and lower whisker extends minimum and maximum data point. Square inside box indicate median.

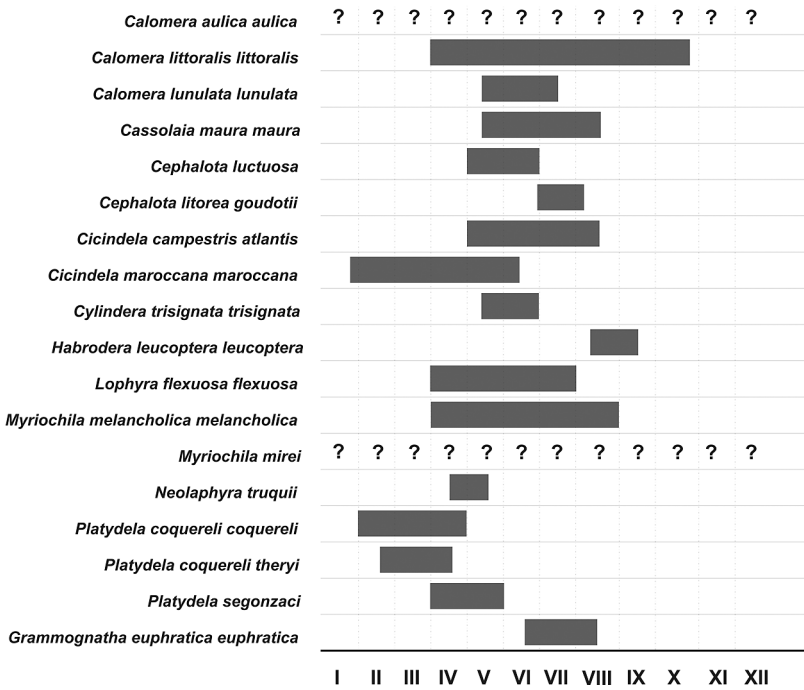


Fig. 19. Phenology of tiger beetles in Morocco based on literature data and new material. Question mark means lack of phenological data for the species from this country.

Afrotropico Indo-Mediterranean and Mediterranean-Westturanian taxa represent only 6% each.

### 6. Phenology of Moroccan tiger beetles

Based on the literature data as well as on new records presented in this paper we classified the Moroccan tiger beetles to three phenological groups (Fig. 19). The first one includes typical spring active taxa (*C. maroccana maroccana*, *N. truquii*, *P. coquereli coquereli*, *P. segonzaci*). These species have been observed as imagines mainly between March and May, except *C. maroccana maroccana* and *P. coquereli coquereli* which were collected occasionally even in February. The second group includes typically summer active species, noted in the field in July and September. Among Moroccan tiger beetle species only *H. leucoptera leucoptera* belongs to this group. The third and largest group is composed of species that can be characterized by a long activity period in the adult stage, starting in the spring and ending at the end of summer. Such type of phenology is found in *C. littoralis littoralis*, *C. lunulata*, *C. maura maura*, *C. luctu-*

*osa*, *C. campestris atlantis*, *C. trisignata trisignata*, *L. flexuosa flexuosa*, and *M. melancholica melancholica*. For two species, *M. mirei* and *C. aulica aulica*, there are no data on activity of adult beetles from Morocco.

### 7. Discussion and conclusions

The Maghreb region is known as a very important biodiversity hot spot for Cicindelinae in the Mediterranean Region and in the entire Palaearctic realm (Jaskuła 2015). About 68% (17 species, one with two subspecies) of all tiger beetle species recorded from the entire Maghreb region can be found in Morocco which makes this country to house the highest tiger beetle diversity in North Africa (Putchkov & Matalin 2003, Jaskuła 2015). Actually, many of these taxa occur both in southern Europe and in northern Africa (all Moroccan species of *Calomera* and *Cephalota*, *C. maroccana maroccana*, *C. trisignata trisignata*, *L. flexuosa flexuosa*, *M. melancholica melancholica*, and *G. euphratica euphratica*) (Putchkov & Matalin 2003) or both in Palaearctic part of Africa and its Afrotropical regions (*H. leucoptera leucoptera*, *M. melancholica melancholica*, *M.*

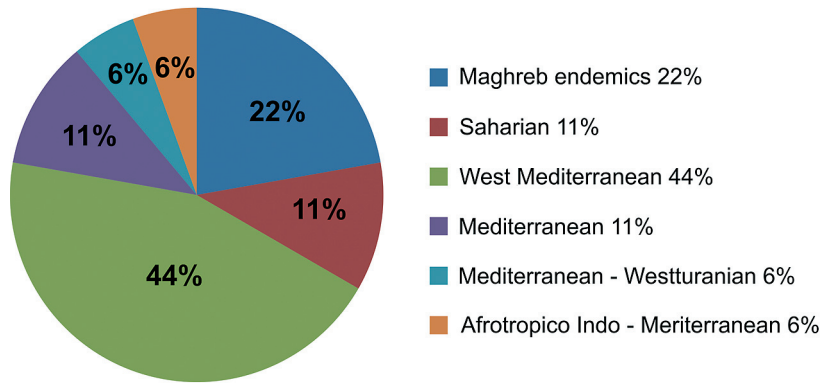


Fig. 20. Relative zoogeographical structure of Moroccan tiger beetle fauna, based on Vigna Taglianti *et al.* 1999.

*mirei*) (Werner 2000a, b). Similar biogeographical patterns have been noted also among many other groups of invertebrates and vertebrates (e.g. Alvarez *et al.* 2000, Cosson *et al.* 2005, Cox *et al.* 2006, Habel *et al.* 2008, Skog *et al.* 2009, Rewicz *et al.* 2014) as well as in plants (Thompson 2005, Delforge 2006).

The patterns of diversity and distribution of tiger beetles in Morocco are more or less typical to this group and clearly correspond to those observed both in other regions of Maghreb (Jaskuła 2015, Jaskuła & Rewicz 2015) as well as in other parts of the Mediterranean Region, including Italian Peninsula (Cassola 1970, Lisa 2002), Balkan Peninsula (Jaskuła 2011) and at least some parts of Levant region (Jaskuła & Rewicz 2014). Moreover, similar trends in diversity and distribution can be found by comparing the Moroccan tiger beetle fauna with that of Australia (Pearson & Cassola 1992) or India (Pearson & Ghorpade 1989). In all these cases the highest diversity and species richness of tiger beetles can be observed in lowland areas, where the highest mosaic of habitats attractive for this beetle group can be found (marine sandy beaches, salt marshes, sandy and muddy banks of river and lakes, etc.). Moreover, very often the highest level of endemism of tiger beetles can be observed at higher altitudes while lowlands are usually occupied by widely distributed species (Cassola 1970, Lisa 2002, Jaskuła 2011).

As it is shown on the distributional maps (Figs. 2-17), knowledge of the distribution of most of the species within the country is generally far from satisfying. Besides the fact that no taxa are known from many regions, it should be also

noted that in the case of several species (eg. all *Platyleda*, *G.euphratica euphratica*) most of the records are old or even very old, with data collected before 1970 or even earlier (Table 1). As a result, most of these records have rather historical value and should be treated with caution when discussing the present distribution of particular taxa in Morocco. Moreover, for two species (*C. aulica aulica* and *M. mirei*) new material is needed to confirm their occurrence in Morocco. For the former species, only a general distributional map covering the coasts of the Mediterranean Sea and the Atlantic Ocean is known (Werner 2000b) while the latter species was included in the fauna of Morocco without any details on its localities in the country (Werner 2000b, Putchkov & Matalin 2003).

We also conclude that the status of *P. coquerelii* needs to be revised by detailed studies including molecular analysis. The reason is that the two recognized “subspecies” of this beetle (ssp. *coquerelii* and ssp. *theryi*; Putchkov & Matalin 2003) have an interweaved distribution within the area of Morocco (Fig. 15), which suggests that they can be only morphological varieties of one species, with no significant taxonomical value (as it was suggested by Cassola (1973)), or they are two separate species.

According to the phenology, most of the lowland species are characterized by relatively long period of activity as imagines (most of the Moroccan Cicindelinae have spring-summer activity). These species are usually widely distributed in Morocco, Maghreb or in Mediterranean region. In opposite, typically spring and much shorter activity of adult beetles was noted for Mo-

roccan and/or Maghreb endemics occurring at higher altitudes. Very similar data have been provided also for Tunisian Cicindelinae by Jaskuła & Rewicz (2015), so we can expect that such phenological strategy can be more or less characteristic for tiger beetles in the Maghreb region, at least.

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