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## **The Nolidae of Jordan: Distribution, Phenology and Ecology**

**Günter C. MÜLLER, Vasily D. KRAVCHENKO, Edita E. REVAY, Wolfgang SPEIDEL,  
Josef MOOSER, Sefedin BEREDIN & Thomas WITT**

### **Abstract**

The distribution, flight period and abundance of the 17 Jordanian Nolidae species are summarized. *Meganola gigantula*, *Nola squalida*, *N. subchlamydula*, *N. chlamitulalis*, *Earias syriacana*, *E. biplaga*, *Bryophilopsis roederi*, and *Garella nilotica* are new records for the Jordanian fauna. Only one species previously recorded, *Microxestis wutzdorffi*, was not collected during this survey. The distribution, phenology, ecology, abundance and the association to the main phyto-geographical zones of Jordan is discussed.

### **Zusammenfassung**

Verbreitung, Flugzeit und Häufigkeit von 17 jordanischen Nolidae-Arten werden zusammenfassend dargestellt. *Meganola gigantula*, *Nola squalida*, *N. subchlamydula*, *N. chlamitulalis*, *Earias syriacana*, *E. biplaga*, *Bryophilopsis roederi* und *Garella nilotica* sind Neunachweise für die jordanische Fauna. Nur eine früher gemeldete Art,

*Microxestis wutzdorffii*, wurde bei der Untersuchung nicht festgestellt. Verbreitung, Phänologie, Ökologie, Häufigkeit und Zugehörigkeit zu den hauptsächlich phyto-geographischen Zonen Jordaniens werden diskutiert.

**Key words:** Zoogeography, Palaearctic, Near-East, Levant, Jordan, Mediterranean, Irano-Turanian, Saharo-Arabian, Lepidoptera, Nolidae, fauna.

## Introduction

The Hashemite Kingdom of Jordan is situated in the eastern Mediterranean and the north-western part of the Arabian Peninsula. In contrast to the more uniform and monotonous morphology of most of the Arabian peninsula, the territory of Jordan is morphologically distinctive and can be divided into six regions (KOSSWIG, 1955):

- Western Mountain Range and Northern Highlands east of the Rift
- Southern Mountain Desert
- Central Plateau, (including the Al-Jafr and Al-Azraq Wadi as-Sirhan basin)
- Northern Basalt Plateau
- North-Eastern Plateau
- Wadi al-Arabah-Jordan Rift

The most remarkable physical feature of the country is the depression of the Jordan Rift Valley, which extends all along the western border of Jordan from the Gulf of Aqaba, through the Dead Sea region to the Sea of Galilee. East of the Rift Valley, the land rises steeply to a plateau with an average altitude of about 800 m and with peaks rising to over 1500 m in the south of the Western Mountain Range (ORNI & EFRAT, 1980).

Jordan is part of the Mediterranean climatic zone, characterized by a rainy winter season and pronounced droughts during the summer months. In winter, Jordan is under the influence of the temperate latitudinal climatic belt, with moist, cool air moving eastward from the Mediterranean over the area (BIEL, 1944). More than 80% of the annual rainfall occurs from December to March. In the summer months, the area lies within the subtropical high-pressure belt with hot dry air; temperatures are relatively high and rainfall does not occur (ASHBEL, 1951). High rainfall zones coincide with the higher mountain ranges and a marked rain shadow is common in the foot of the hills. In the Western Mountain Range, temperatures frequently drop below freezing, and snow falls occasionally during most winters. The highest rainfall occurs over the major mountain blocks of the Western Highlands, with a mean annual rainfall ranging between 200 to 600 mm. Precipitation decreases rapidly towards the Jordan Valley, the Dead Sea, and the Wadi Araba to less than 100 mm and 50 mm respectively. In most of the Central Plateau and in the Eastern Desert, where the land slopes gently to the Arabian Desert, the mean annual rainfall drops to less than 50 mm. The rainfall varies from year to year; the range being most pronounced in the Central Plateau and in the southern part of the Western Highlands. Here, extreme records of a few millimeters to more than 200 mm per year, are common (ORNI & EFRAT, 1980; JAFFE, 1988).

Jordan lies in a transitional zone between the Mediterranean climate in the west and the arid and hyper arid climate of the Syrian and Arabian Deserts to the north-east and south (DELATTIN, 1967). The plants of Jordan belong to four major phyto-geographic regions

(EIG, 1926; ZOHARY, 1962, 1966). On the Jordanian side of the Rift Valley, the Mediterranean zone stretches about 150 km further south than on the western counter part in Israel. Mediterranean vegetation is typical for those areas of the Western Mountain Range and the Northern Highlands, which receive an annual average precipitation of 350 mm or more. These areas have been intensively managed by man since historical times and large areas are cultivated fields or orchards. The woodland in Jordan is a mosaic of areas that have been influenced by different human activity over the last few thousand of years. Accordingly, no natural formations are left and maquis, reforested pines, domesticated trees and trees surviving at the margins of cultivated land show the former woodland boundaries. In the southern parts and at lower altitude of the zone, park forests are common. Usually, forest density increases from south to the north. Semi-shrubs and their companions are common on abandoned soil.

The Irano-Turanian zone stretches from its south west border in Jordan through Iran, and inner Asia to the Gobi Desert. It is a semi-arid area with average annual rainfall of 200-300 mm during winter only. In Jordan this zone is often a transition between the Mediterranean and the desert areas. Low brush or dwarf bush communities, often with *Artemisium* plant associations, are characteristic of these dry and desert steppes.

From the grassland there is a gradual transition to the more arid Saharo-Arabian zone. In this true desert, which is centered in the Arabian Peninsula, vegetation prevails often with much less than 200 mm of annual rainfall. Nevertheless, depending on soil and water dozens of plant communities can still be found here. In the driest parts of the desert, the vegetation is concentrated in wadis and on rocky slopes.

The Ethiopian tropical zone is situated in the Wadi al-Arabah-Jordan Rift. Here, in many locations, small streamlets from the hills, as well as springs and underground water feed different types of oases. The dominant elements are several species of thermophilic Sudanian trees and date palms. Some of the oases are situated in or near swampy marshes. These pockets are surrounded by extreme desert or halophytic vegetation. In the Jordan Valley, north of the Dead Sea, there is a very intensive agriculture that depends on irrigation (ZOHARY & ORSHANSKY, 1949).

Owing to its geographical position, the topography and the pronounced climate, Jordan is a meeting point for fauna and flora from as widely distant origins as Western Europe, Inner Asia and North and East Africa. Many species find their furthest point of distribution in Jordan (FURTH, 1975).

The family Nolidae includes nine subfamilies, 308 genera, and about 1,400 species which have been recorded worldwide (HEPPNER, 1991; KRISTENSEN, 1999), basing the definition of the family and subfamilies on HOLLOWAY (1998). Most of the species are found in the tropics. Europe is home to only 35 species, of which 21 species are Nolinae, 9 species Chloephorinae, and 5 species Eariadinae (DEFREINA & WITT, 1987; FIBIGER & HACKER, 2005). The most known species are the cotton pests of the genus *Earias*, like the Spiny bollworms *E. insulana* and *E. biplaga*. The other species are often scarce and local. The Nolinae have been for a long time 'taxonomically shuffled' between the Arctiidae and Noctuidae and only recently have synapomorphic characters of the Nolidae been recognized (SPEIDEL, FÄNGER & NAUMANN, 1996; KRISTENSEN, 1999; SCOBLE, 1992).

## Material and methods

Intensive collections in the field were conducted from 1998-2009 as a part of the German-Israeli project for the study of the Middle Eastern Lepidoptera fauna. This project was a joint effort of the Hebrew University and Tel Aviv University in Israel and the Zoologische Staatssammlungen and Museum Witt, München in Germany (MÜLLER, et al., 2005b)

Lepidoptera were collected during a period of 10 years totaling about 450 nights of mobile light traps powered by generator (250 Watt bulbs HQL & ML) and about 900 nights of mobile light trap systems powered by batteries (12Volt 8 Watt & 20Watt, 6 Volt 4 Watt Black light UVB tubes) moved on a daily basis. Additionally several permanent light traps (220V 20W Black light UVB & UVC tubes) were maintained over several years. Traps were relocated on an annual basis. From year to year 4 to 6 traps were operated.

## Faunistic Survey

### Subfamily Noctuidae

#### *Meganola togatulis* (HÜBNER, 1796)

New record for the fauna of Jordan.

General distribution pattern. Mediterranean. From Northern Africa (coastal Tunisia and Libya), through Southern and temperate Europe to Turkey and the Levant.

Distribution in the Levant. Syria, Lebanon, Israel and Jordan.

Distribution in Jordan. Widespread in the temperate regions of the Western Mountain Range and Northern Highlands. The species is more common in the north, becoming increasingly rare towards the south.

Habitat. Restricted to the Mediterranean zone, found in all kind of woodland with oaks *Quercus* (Fagaceae) and Rosaceae trees and bushes, also in parkland and gardens.

Phenology. Adults observed from mid-April to the end of October but only common from May to August. The species has at least two overlapping generations, possibly a partial third generation in lower altitudes.

Host-plants. Larvae have only been observed once so far in Jordan, on *Crataegus azarolus* Rosaceae. Larvae were also recorded in Israel feeding polyphagous on bushes and trees of *Quercus* (Fagaceae) and a variety of Rosaceae species.

Remarks. Most of the records were from miniature UV light traps.

#### *Meganola gigantula* (STAUDINGER, 1878)

New record for the fauna of Jordan.

General distribution pattern. Mediterranean-Iranian. From the Balkans to Turkey and the Levant.

Distribution in the Levant. Israel and Jordan (probably also Lebanon, but so far no records)

Distribution in Jordan. Relatively rare, found locally in the temperate region restricted to the northernmost parts of the Western Mountain Range and Northern Highlands.

Habitat: Restricted to the Mediterranean zone, both locations were carstic, south exposed slopes with sparse grassy vegetation and some small *Quercus* sp., *Rosa* sp., and *Crataegus* sp. bushes.

Phenology. The three records from spring (early May to late May) and two records from summer (late July to mid-August) suggest that two generations of this species are spawned annually.

Host-plants. Unknown.

Remarks. Only recorded with miniature light traps.

### ***Antennola impura* ssp. *wiltshirei* (WARNECKE, 1939)**

New record for the fauna of Jordan.

General distribution pattern. East-Mediterranean-Turanian. From northern Greece to Turkey and Iran towards Central Asia, in the south to the Levant.

Distribution in the Levant. Syria, Lebanon, Israel and Jordan.

Distribution in Jordan. Rare and local in the temperate region, from the northern parts of the Western Mountain Range and Northern Highlands as far south as Amman, penetrating the Irano-Turanian zone in the upper Jordan Valley.

Habitat. In all kind of xerotherm, forested grassland, bushland and steppes with annual precipitation above 40mm.

Phenology. At least in two generations from April till early October. Most records are from late April and May, July and August with a partial third peak September and October. In the Irano-Turanian zone records started in early March. The combined data of Israel and Jordan suggest that this species might have three generations in the Levant with the highest population density in the second generation.

Host-plants. Unknown.

Remarks. All records were from miniature light traps which were usually collected around mid-night or later.

### ***Nola harouni* (WILTSHIRE, 1951)**

General distribution pattern. East-Mediterranean-Iranian. From Greece to Turkey and Iran to the Levant and the Arab Peninsula.

Distribution in the Levant. Lebanon, Israel and Jordan.

Distribution in Jordan. Uncommon in the Western Mountain Range and Northern Highlands, increasingly rare towards the east reaching the Northern Basalt Plateau, the North-Eastern Plateau and the Central Plateau, (including Al-Jafir and Al-Azraq). The numbers gradually decrease steadily towards the south, with the species becoming rare and local in the Wadi al-Arabah-Jordan Rift areas.

Habitat. This species was widespread in the Mediterranean zone and penetrated locally into the Irano-Turanian zone. In the arid zone in the east and south the species was restricted to large natural oases. The habitats ranged widely from shady narrow canyons with dense vegetation to south exposed slopes with sparse vegetation cover in the north, to subtropical oases and salt marshes with tamarix stands in the south.

Phenology. In Jordan recorded from March to early October without a pronounced peak, probably multivoltine.

Host-plants. In Jordan unknown, recorded from WILTSHIRE (1962, 1990), to feed in captivity on Papilionaceae, in nature polyphagous on Mimosaceae, Fabaceae, and unspecified herbs.

Remarks. Material which was collected by MÜLLER & KOTITSA north of the Sea of Galilee from the River Jordan Park in Israel, early June 1987, was published by HACKER & SCHREIER (2001a) as a record for Israel. In a further publication about the Levant the same specimen was attributed by HACKER (2001) to Jordan, declaring it absent from Israel. The species was previously recorded in Jordan based on material of KLAPPERICH collected in the 1960's (HACKER & SCHREIER, 2001b).

### ***Nola squalida* (STAUDINGER, 1870)**

New record for the fauna of Jordan.

General distribution pattern. Paleotropical. From the Mediterranean through the Middle East to India and South-East Asia.

Distribution in the Levant. Lebanon, Israel and Jordan.

Distribution in Jordan. This species was widespread but rare in all locations, which included the Western Mountain Range and Northern Highlands east of the Rift to the Northern Basalt Plateau, the North-Eastern Plateau, the Central Plateau to the Wadi al-Arabah-Jordan Rift as far south as Aqaba covering most of the Mediterranean, Irano-Turanian and Sudanian.

Habitat. Ubiquitous, but always close to water. In the arid region restricted to larger oases.

Phenology. Above sea level from mid-March to November at Mediterranean sites; in the Rift Valley below sea level it was found all year round. Multivoltine.

Host-plants. In Jordan unknown; in Israel in the Mediterranean zone foliage of *Quercus* species; in Europe lichens (deFREINA & WITT, 1987, WILTSHIRE, 1957) suggested foliage of *Tamarix* sp.

Remarks. Most of the records were from miniature UV light traps.

### ***Nola subchlamydula* (STAUDINGER, 1870)**

New record for the fauna of Jordan.

General distribution pattern. Mediterranean. From Northern Africa through temperate Europe and Turkey to the Levant.

Distribution in the Levant. Lebanon, Israel and Jordan.

Distribution in Jordan. In the Western Mountain Range and Northern Highlands east of the Rift and the northern part of the Jordan Valley widespread but always uncommon.

Habitat. In the Mediterranean the species was found in all types of scattered natural broad leafed forests, bush, and grassland, whereas in the Irano-Turanian zone it was only observed in shady canyons and oases with water. This species seems to be rather unspecific, although it was never found in the Saharo-Arabian zone including oases in the southern Rift Valley.

Phenology. From mid-March to late October with well pronounced peaks in April mid-May, early July to mid-August and a partial peak, only in lower altitude, around October.

Host-plants. In the Levant unknown; in Europe *Teucrium*, *Salvia* and *Lavandula* species.

Remarks. Most of the records were from miniature UV light traps.

### ***Nola chlamitulalis* (HÜBNER, 1813)**

New record for the fauna of Jordan.

General distribution pattern. Mediterranean. From the Mediterranean to Turkey and the Levant.

Distribution in the Levant. Lebanon, Israel and Jordan.

Distribution in Jordan. Rare and local in the northern parts of the Western Mountain Range and Northern Highlands east of the Rift and the northern part of the Jordan Valley

Habitat. In the Mediterranean in all kind of broad leafed forests and grassland, in the Irano-Turanian zone penetrating along streamlets in deep canyons which drain into the Jordan River.

Phenology. From end of February to early October with a pronounced peak in March April and in September.

Host-plants. In Jordan unknown; polyphagous on herbaceous plants.

## **Subfamily E a r i a d i n a e**

### ***Earias insulana* (BOISDUVAL, 1833)**

General distribution pattern. Palaeotropical. Widespread in the Tropics of the Old World and Subtropics, the Mediterranean and temperate Europe, introduced into parts of the Americas.

Distribution in the Levant. Syria, Lebanon, Israel, Jordan and Egypt.

Distribution in Jordan. Common and wide spread all over the country, but in the semi-Arid and Arid zones concentrating in oases and settlements.

Habitat. In Jordan generally a ubiquitous species in the temperate region including all types of open habitats. In the semi-arid and arid regions the species is mainly found in natural and agricultural oases.

Phenology. In Jordan multivoltine, found almost all year round at low altitudes, while in higher altitudes the species is absent in the cold winter months. The highest rate of occurrence is from late April to June and from August to October.

Host-plants. Mainly Malvaceae, the larvae prefer the reproductive organs like buds, flowers and seed pods. In Jordan, to our best knowledge, this species is not considered a pest.

Remarks. In many African countries know as "the spiny boll-worm" – a pest of Okra, Cotton, Hibiscus, and to a smaller extent also rice and maize, in Israel a pest of cotton (BODENHEIMER, 1930; HALPERIN & SAUTER, 1991).

### ***Earias syriacana* BARTEL, 1903**

New record for the fauna of Jordan.

General distribution pattern. Endemic to the Levant.

Distribution in the Levant. Syria, Lebanon, Israel and Jordan.

Distribution in Jordan. Rare and very local, restricted to the northern part of the Western Mountain Range, only once collected north of Irbid.

Habitat. A single record from a small canyon densely forested with winter deciduous trees and bushes.

Phenology. Collected only once in Jordan during early June; in Israel probably bivoltine, with the highest occurrence in May and October.

Host-plants. In Jordan unknown, in Israel flowers of *Malva nicaensis* (Malvaceae).

Remarks. Most of the records were from miniature UV light traps.

### ***Earias chlorophyllana* STAUDINGER, 1892**

General distribution pattern. Pan-Eremic. From Northern Africa (Morocco to Libya) and Sudan to the Arabian Peninsula, the Levant, south-eastern Turkey and Turkmenistan.

Distribution in the Levant. Israel and Jordan.

Distribution in Jordan. Rare and local, restricted to the northern part of the Western Mountain Range.

Habitat. In xerotherm habitats in forested and un-forested grassland and semi-shrub communities.

Phenology. In Jordan bivoltine with the highest rate of occurrence in April and September.

Host-plants. In Jordan unknown, the only records are from Israel where larvae were observed in October in seed buds of *Alcea setosa* (Malvaceae).

Remarks. Most of the records were from miniature UV light traps.

### ***Earias biplaga* WALKER, 1866**

New record for Jordan.

General distribution pattern. Afrotropical. All over tropical Africa, India, the Levant, and in some oases of the Arab Peninsula.

Distribution in the Levant. Israel and Jordan.

Distribution in Jordan. Rare and very local with a single record from the Wahat al Azraq oasis located on the Central Plateau.

Habitat. A single record from fallow fields near human habitation.

Phenology. Collected only once in Jordan during mid-April; in Israel collected in December; in the tropics multivoltine.

Host-plants. in Jordan unknown; in African countries a major cotton pest, also a pest of Malvaceae and cacao (Rivnay, 1962).

Remarks. it is not clear if this species is in Jordan an introduced emerging pest or an isolated relic population, the only record was from a miniature UV light trap.

## **Subfamily Chloephorinae**

### **Tribe Chloephorini**

#### ***Bena bicolorana* (FUESSLY, 1775)**

General distribution pattern. Mediterranean-Iranian. From Europe (except of its northernmost parts) to Turkey, the Levant and eastwards to Iran.

Distribution in the Levant. Syria, Lebanon, Israel and Jordan.

Distribution in Jordan. Rare and local, restricted to the northern part of the Western Mountain Range.

Habitat. In Jordan a sylvicolous species, in oak (*Quercus*) forests often in shady canyons and on north facing slopes.

Phenology. In Jordan so far only collected from April to May, in Israel bivoltine, with the highest rate of occurrence in May and October.

Host-plants. In Jordan unknown; in Europe monophagous on *Quercus* sp.

#### ***Arcyophora dentula* (LEDERER, 1870)**

General distribution pattern. Irano-Turanian. From Iran to Iraq, Afghanistan and Pakistan, northwards as far as Turkmenistan, eastwards to India, in the south-west reaching the Levant.

Distribution in the Levant. Israel and Jordan.

Distribution in Jordan. Rare and local, restricted to the northern and central part of the Western Mountain Range.

Habitat. In the Mediterranean in forested and un-forested grassland; in the Irano-Turanian zone in shrub-steppes.

Phenology. In Jordan collected from January to April and October; in Israel so far only in December; in the low lands of Iran and Iraq, along the Persian Gulf multivoltine.

Host-plants. Unknown; WILTSHIRE (1952) suggested fruit-tree foliage.

Remarks. Most of the records were from miniature UV light traps.

***Microxestis wutzdorffi* (PÜNGELER, 1907)**

General distribution pattern. Probably East Eremic. A widespread but rare species. Presently only known from the border area of Israel and Jordan in the lower Jordan Valley, in Northern Egypt from the Nile Delta and Alexandria, and in Saudi Arabia from the Asir mountains.

Distribution in the Levant. Known only from the lower Jordan Valley in the border area of Israel and Jordan.

Distribution in Jordan. Only collected in the border area of Israel and Jordan at the northern part of the Dead Sea.

Habitat. Probably an oasis dwelling species.

Phenology. In Jordan in mid-March, the type specimens were collected in April and May; in Egypt in September; in Saudi Arabia in April.

Host-plants. Unknown.

Remarks. Since the type specimens were collected from Wadi Kelt (Georgskloster) in the 1930s there are no more records from the Levant (MÜLLER et al., 2005a).

**Tribe Sarrothripini**

***Bryophilopsis roederi* (STANDFUSS, 1892)**

New record for the fauna of Jordan.

General distribution pattern. Irano-Turanian. From Southeast Turkey to the Levant, Iraq, Iran, Afghanistan, Turkmenistan and Kirghizia.

Distribution in the Levant. Only known from Jordan and Israel.

Distribution in Jordan. Rare and local, restricted to the northern part of the Western Mountain Range from there penetrating into the Jordan Valley.

Habitat. In Jordan observed in xerotherm forested grassland and shrub-steppe.

Phenology. Probably bivoltine, in Jordan collected in April and September; in Israel observed in May.

Host-plants. Unknown.

Remarks. Most of the records were from miniature UV light traps.

***Nycteola asiatica* (KRULIKOVSKY, 1904)**

General distribution pattern. Palearctic. From temperate and southern Europe, throughout temperate Asia as far east as Japan. In the Near and Middle East from Turkey to the Levant, Iraq, Iran, Afghanistan and Pakistan.

Distribution in the Levant. Israel and Jordan.

Distribution in Jordan. Rare and local, restricted to the northern and central part of the Western Mountain Range.

Habitat. In Jordan only observed along water with willows and poplar tree thickets, mainly along the River Jordan, to a smaller extent along its tributaries; in Israel clearly a wetland species.

Phenology. Probably bivoltine, in Jordan collected in April, June and September; in Israel observed from May to June.

Host-plants. Unknown.

### ***Garella nilotica* (ROGENHOFER, 1882)**

New record for the fauna of Jordan.

General distribution pattern. Paleotropical. All over the Tropics of the Old World. In Europe known from Greece, Crete and Italy, possibly only as a migrant.

Distribution in the Levant. Lebanon, Israel and Jordan.

Distribution in Jordan. Wide spread along the arid part of the Rift Valley, but only fairly common in the Dead Sea area.

Habitat. In Jordan an oasis-dwelling species living in any kind of *Tamarix* thicket including stands in wet Salinas.

Phenology. In Jordan multivoltine, with the highest rate of occurrence from late April to May and from September to October.

Host-plants. In Jordan unknown; in Israel larvae were observed inside unidentified galls on mature *Tamarix nilotica* trees during June and October; in Saudi Arabia in galls on *Tamarix aphylla* caused by acarid mites (WILTSHIRE, 1990).

Remarks. Most of the records were from miniature UV light traps. The species has been transferred from the genus *Characoma* to *Garella* by HOLLOWAY (2003).

## **Results and Discussion**

At the present time 17 species of the family Nolidae are known from Jordan, seven of which are in sensu stricto Nolidae, six belong to the subfamily Eariadinae and four to the Chloephorinae. About half (8) of the observed species have never been recorded in Jordan (*M. gigantula*, *N. squalida*, *N. subchlamydula*, *N. chlamitulalis*, *E. syriacana*, *E. biplaga*, *B. roederi*, *G. nilotica*). Only one species which was previously recorded, *M. wutzdorffii*, was not observed in this survey. This very rare species was not collected in the Levant in the last 80 years (AMSEL, 1933, 1935a, b; MÜLLER et al., 2005a).

Nolidae were mainly collected with the help of miniature light traps. Only a few records were obtained with light sources of 20Watt or more. This could be one of the reasons why only few species, always in low numbers, were collected in the past. Nevertheless most of the species were rare (13/17) and local (11/17) only two species *M. togatalalis* and *E. insulana* were common, *G. nilotica* was fairly common and *N. subchlamydula* was uncommon during this widespread survey. Seven of the 17 Nolidae of Jordan show a Mediterranean distribution type (Circum Mediterranean (3), Mediterranean-Iranian (3) and Mediterranean-Turanian (1)). Six species are more widely distributed, especially in the tropics (Paleotropical (3), Afrotropical (1)), only one species is palearctic. Only one

species, *E. syriacana* is endemic, while two have an eremic distribution pattern; The pan-eremic *E. chlorophyllana*, and *M. wutzdorffii* which is east-eremic. The distribution of the Nolidae was found to be associated with the four major phyto-geographical zones in Jordan. The following geo-botanical zones terminology were developed by ZOHARY (1973) and later elaborated by DANIN (1988). These major zones are Mediterranean, Irano-Turanian, Saharo-Arabian and Ethiopian.

The Mediterranean temperate Zone covers those areas which receive an annual average precipitation of 350mm or more (ZOHARY, 1962). Maquis shrublands dominate the Mediterranean zones with higher precipitation (about 500-700mm) (BIEL, 1944). The bulk of the species belonging to all insect families in the Levant, including the Lepidoptera, are found in the Mediterranean zone (AVIDOV & HARPAZ, 1969, KRAVCHENKO et al., 2007). Accordingly also in Jordan most species (14/ 17) were found in the Mediterranean, but only three species (*M. togatulis*, *M. gigantula* and *B. bicolorana*) were clearly restricted to it. An additional three species (*A. impura wiltshirei*, *N. harouni* and *E. chlorophyllana*) were centered in the Mediterranean but penetrated the Irano-Turanian zone along streamlets and canyons.

The Irano-Turanian Zone, a semi arid area, is a dry steppe or desert steppe which stretches from its south west border in Israel, Jordan and Sinai through Iran, Turkistan and inner Asia to the Gobi desert. The average annual rainfall is between 200-300mm, occurring exclusively during the winter. Low brush or dwarf bushes with Artemisum plant associations are characteristic for this region (ORNI & EFRAT, 1980; ZOHARY, 1972). Four species (*N. subchlamydule*, *A. dentula*, *B. roederi* and *N. asiatica*) were equally established in both the Irano-Turanian and the Mediterranean zones. No species were exclusive to this region.

The Saharo-Arabian eremic zone is a true desert which centers on the Arabian Peninsula. Winter rainfall of less than 200mm is followed by a short period of blooming, followed by rapid death due to dessication (BODENHEIMER, 1935). Vegetation is very sparse, averaging one plant per one to ten square meters over large areas in the region (KUGLER, 1988). Only few Nolidae are found in the arid areas of the Arab Peninsula and the Levant (WILTSHIRE, 1948; 1951; 1952). None of the Jordanian species was centered in Saharo-Arabian eremic zone, and only few species (*N. squalida*, *E. insulana* and *G. nilotica*) were sporadically observed there.

The Ethiopian tropical zone in Jordan is only represented in small enclaves in the lower Jordan valley, the Dead Sea area, and the Wadi al-Arabah-Jordan Rift where they are surrounded by extreme desert or halophytic vegetation (BYTINSKI-SALZ, 1961). High temperature, abundant fresh water and rich soil conditions are typical of these oases (BODENHEIMER, 1939; ZOHARY & ORSHANSKY, 1949). Only three species (*E. biplaga*, *M. wutzdorffii* and *G. nilotica*) were predominantly/ only found in oases, the last also penetrated into the Irano-Turanian zone with a few sporadic records from the desert.

Two species (*N. squalida* and *E. insulana*) were ubiquitous and found in all four phyto-geographical zones nevertheless records from the desert habitats were uncommon.

**Tab. 1:** The distribution and abundance of Nolidae in Jordan associated with the major phyto-geographical zones.

| Species<br>status, distribution & abundance |   |   |     | Major Phyto-geographical Zones |                    |                    |           |
|---|---|---|-----|--------------------------------|--------------------|--------------------|-----------|
|   |   |   |     | Medi-<br>terranean             | Irano-<br>Turanian | Saharo-<br>Sindian | Ethiopian |
| <i>M. togatalis</i>                         |   |   | +++ | XXX                            |                    |                    |           |
| <i>M. gigantula</i>                         | N | L | R   | XXX                            |                    |                    |           |
| <i>A. impura wiltshirei</i>                 |   | L | R   | XXX                            | XX                 |                    |           |
| <i>N. harouni</i>                           |   |   | R   | XXX                            | XX                 |                    | X         |
| <i>N. squalida</i>                          | N |   | R   | XXX                            | XXX                | X                  | XXX       |
| <i>N. subchlamydula</i>                     | N |   | +   | XXX                            | XXX                |                    |           |
| <i>N. chlamitulalis</i>                     | N | L | R   | XXX                            | XX                 |                    |           |
| <i>E. insulana</i>                          |   |   | +++ | XXX                            | XXX                | X                  | XXX       |
| <i>E. syriacana</i>                         | N | L | R   | XXX                            | ?                  |                    |           |
| <i>E. chlorophyllana</i>                    |   | L | R   | XXX                            | XX                 |                    |           |
| <i>E. biplaga</i>                           | N | L | R   |                                |                    |                    | ?         |
| <i>B. bicolorana</i>                        |   | L | R   | XXX                            |                    |                    |           |
| <i>A. dentula</i>                           |   | L | R   | XXX                            | XXX                |                    |           |
| <i>M. wutzdorffi</i>                        |   | L | R   |                                |                    |                    | XXX       |
| <i>B. roederi</i>                           | N | L | R   | XXX                            | XXX                |                    |           |
| <i>N. asiatica</i>                          |   | L | R   | XXX                            | XXX                |                    |           |
| <i>G. nilotica</i>                          | N |   | ++  |                                | XX                 | X                  | XXX       |

*New record for Jordan:* N; *Distribution within phyto-geographical zone:* XXX = Main area of distribution; XX = Area of penetration; X = Sporadic records; *Abundance & Distribution:* +++ = Common (100 to 500 specimens recorded per year); ++ = Fairly common (20 to 100 specimens recorded per year); + = Uncommon (5 to 20 specimens recorded per year); R = Rare (less than 5 specimens recorded per year); L = Local (only in one Zone and there in 3 or less locations collected).

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Authors' addresses:

Günter C. MÜLLER, Department of Parasitology, Kuvim Centre for the Study of Infectious and Tropical Diseases, The Hebrew University – Hadassah-Medical School, Jerusalem, Israel.

Vasilij D. KRAVCHENKO, Department of Zoology, Tel Aviv University, Tel Aviv, Israel.

Edita E. REVAY, Bruce Rappaport Faculty of Medicine, Technion, Haifa, Israel.

Wolfgang SPEIDEL: Museum WITT, Tengstr. 33, D-80796 München, Germany.

Josef MOOSER, Seilerbrücklstr. 23, D-85354 Freising, Germany.

Sefedin BEREDIN, Ethiopian Institute of Agricultural Research, Institute of Plant Protection Centre in Ambo (APPRC), Ethiopia.

Thomas J. WITT, Museum WITT, Tengstr. 33, D-80796 München, Germany.

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Wolfgang SCHACHT, Scherrerstraße 8, D-82296 Schöngöising;  
Johannes SCHUBERTH, Mannertstraße 15, D-80997 München;  
Wolfgang SPEIDEL, MWM, Tengstraße 33, D-80796 München;  
Thomas WITT, Tengstraße 33, D-80796 München.

Adresse: Entomofauna, Redaktion und Schriftentausch c/o Museum Witt, Tengstr. 33, 80796 München, Deutschland, E-Mail: [thomas@witt-thomas.com](mailto:thomas@witt-thomas.com); Entomofauna, Redaktion c/o Fritz Gusenleitner, Lungitzerstr. 51, 4222 St. Georgen/Gusen, Austria, E-Mail: [f.gusenleitner@landesmuseum.at](mailto:f.gusenleitner@landesmuseum.at)

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