
**Faculty of Graduated studies**

# Systematic Study, Ecology and Geographic Distribution of Land Snails (Mollusca) From the Occupied Palestinian Territories (West Bank)

# دراسة تصنيفة، بيئية، ودراسة التوزيع الجغرافي للحلزونات الأرضية في الضفة الغربية من فلسطين

**This Thesis was submitted in partial fulfillment of the requirements for the Master's Degree in Environmental Biology from the Faculty of Graduate Studies at Birzeit University, Palestine.**

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**By**

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**List of Abbreviations:**

**EQA:** Environmental Quality Authority

**GIS:** Geographic information system

**GPS:** Global Positioning System

**IT:** Irano Turanian

**M:** Mediterranean

**MOA:** Ministry of Agriculture

**OPT:** Occupied Palestinians Territories

**PMNH:** Palestine Museum of Natural History

**S:** Sudanian penetration

**SA:** Saharo Arabia

**WZU:** Wadi Zarqa Al-Ulwi

# دراسة تصنيفية، بيئية، ودراسة التوزيع الجغرافي للحلزونات الأرضية في الضفة الغربية من فلسطين

تم اجراء دراسة مسحية للحلزونات الارضية في الضفة الغربية من فلسطين، حيث تم خلال هذه الدراسة زيارة اكثر من 140 موقع في في الضفة الغربية تمثل المناطق الجغرافية النباتية الاربع في فلسطين ( منطقة البحر الابيض المتوسط، منطقة الصحراء العربية، منطقة الطور الايراني، ومنطقة الطور السوداني). تم خلال هذه الدراسة جمع 41 نوع من الحلزونات الارضية تتبع 24 جنس وتمثل 13 عائلة في الضفة الغربية من فلسطين و تم خلال هذه الدراسة جمع معلومات حول علاقة هذه الانواع بالبيئة المحيطة مع عمل خرائط للتوزيع بناء على معدلات هطول الامطار وخريطة المناطق الجغرافية النباتية في الضفة الغربية.

تم خلال هذه الدراسة العثور على 83% من الانواع في منطقة البحر الابيض المتوسط وخمس من هذه الانواع وجدت في جميع المناطق النباتية. 46% من الانواع تم ايجادها في منطقة الطور الايراني واحد هذه الانواع لم يتم اجاده إلا في هذه المنطقة، 34% من الانواع وجدت في منطقة الصحراء العربية و39% تم ايجادها في منطقة الطور السوداني. تباينت العوامل المؤثرة على تنوع الحلزونات الارضية في الضفة الغربية وهي نوع التربة، الرطوبة، الارتفاع عن سطح البحر، الاشعاعات، الغطاء النباتي، معدل هطول الامطار، القرب من البحر الابيض المتوسط بالاضافة الى بعض العوامل البشرية.

كما اظهرت هذه الدراسة وجود بعض التهديدات التي قد تهدد تنوع الحلزونات الارضية و تتضمن التوسع العمراني، الرعي الجائر، الحرائق، استخدام المبيدات، جمع الانواع الكبيرة من قبل الانسان، مياه المجاري بالاضافة الى التغير المناخي الذي يهدد بشكل كبير التوزيع والانتشار لانواع الحلزونات الارضية في الضفة الغربية من فلسطين. اغنى منطقة بالحلزونات الارضية كانت محمية وادي الزرقا العلوي باحتوائها على 19 نوع من الحلزونات الارضية متضمنة بعض الانواع الدخيلة.

# Systematic Study, Ecology and Geographic Distribution of Land Snails (Mollusca) From the Occupied Palestinian Territories (West Bank)


## Summary

A survey was done of land snails from the occupied Palestinian territories (West Bank), which covers more than 140 locations from different areas in the West Bank and represent four phytogeografical zones (Mediterranean zone, Saharo Arabia, Irano-Turanian, and Sudanian penetration). A total of 41 species of land snail belongs to 13 families and 24 genera were found in the West Bank. Data were also gathered for habitat relation and other ecological observation for each species with distribution map showing the relation of each species with elevation and rainfall precipitation. The distribution of land snails was addressed both locally and in relation to phytogeographical zones. 83% of the species were found in the Mediterranean zone, five of them (*Granopupa granum*, *Sphinctreochila fimbriata*, *Xerocrassa langloisiana*, *Xerocrassa simulate* and *Helix engaddensis*) were found in all four phytogeographic zones. 46% if the species were noted in theIrano-Turanian zone *Bulimunus diminutus* was only found in this zone. 34% of the species were noted in the Saharo Arabian zone and 39 % of the species in the Sudanian zone. The factors that impact distribution included soil type, humidity, altitude/elevation, radiation, vegetation, rainfall, closeness to Mediterranean Sea, and anthropogenic factors. The report also highlights threats that could affect the land snails population including urbanization, overgrazing, fire, insecticides and pesticides, over collecting, waste water and climate change. The richest locality noted was Wadi Zarqa Al-Ulwi protected area with 19 species of land snails including endemic forms.

## 1. Introduction

Palestine has high diversity of fauna and flora because of its location between three continental (Asia, Europe and Africa) and its geology and geography (Qumsiyeh, 1996). Palestine's unique and varied geography includes high mountains (1000 meter above the sea level) in the north and low depressions (400 meter below sea level) in the Dead Sea area (Qumsiyeh, 1996, Isaac, 2002). Palestine has an amazing geologic formation caused by the tectonic plate friction between the Arabian and African plate (Blake and Goldschmidt, 1947). The dominant kind of stone is limestone ($CaCO_3$) and there are lakes and rivers of rich fauna and flora including Lake Tiberius (Lake of Galilee) and Lake Hula (Hudleston, 1883). Palestine thus had four biogeographical zones (Mediterranean, Irano-Turanian, Saharo-Arabia and Sudanese) (Fig. 1) in a small area of roughly 27,000 $km^2$ (Zohary, 1947; Whyte, 1950) thus resulting in rich biodiversity (Qumsiyeh, 1996; Handal et al., 2015; Handal et al., 2016, Abu Serhan et al., 2016, Abu Serhan et al., 2018).

Gastropod, second only behind insects in number of species, play an important role and also as a bioindicator in the environment including for climate change studies (Goodfriend and Magaritz, 1987; Magaritz and Heller, 1980; Swaileh and Ezzughayyar, 2000; 2001).

Research in the Palestinian Territories is lagging behind nearby areas (Qumsiyeh and Isaaq, 2012). The invertebrate fauna of the Palestinian territories are particularly poorly studied. Studies on the land snails of historical Palestine date back as far as 1850's (Bourguignat 1852; 1857; Benson 1859; Tristram, 1865). These studies described the

species names that are still in use today. By the turn of the 20th century, French Zoologists contributed to the Mollusca fauna of Greater Syria, including Palestine (Germain, 1921; Pallary, 1929 & 1939). Further descriptions of species also came in the last century. In particular, Heller (1971a and b, 1974, 1975, 1979, 2009) published a series of papers on the land snails of "Israel" (Palestinian areas occupied in 1948), including on systematics, distribution and zoogeography. In total 105 species of land snails that known form historic Palestine and the occupied Golan Heights of Syria (Heller, 2009). Only two studies of Gastropoda of the West Bank are available (Ezzughayyar, 1996; Handal et al. 2015).

The establishment of the Palestine Museum of Natural History (PMNH) makes it possible to focus on taxonomical studies in the West Bank in ways never possible before (Qumsiyeh et al., 2017). PMNH studied invertebrates such as butterflies (AbuSerhan et al., 2016), grasshoppers (AbuSerhan et al., 2017), scorpions (Qumsiyeh et al., 2013; 2014), and dragonflies (Adawi et al., 2017). Snails as indicated above are key invertebrates which help understand habitat changes and other issues of relevance to biodiversity conservation. This study aims to document the distribution of the land snail fauna of the Palestinian Territories and provides taxonomic and habitat information for all recorded species with notes on their ecology and zoogeographical affinities.

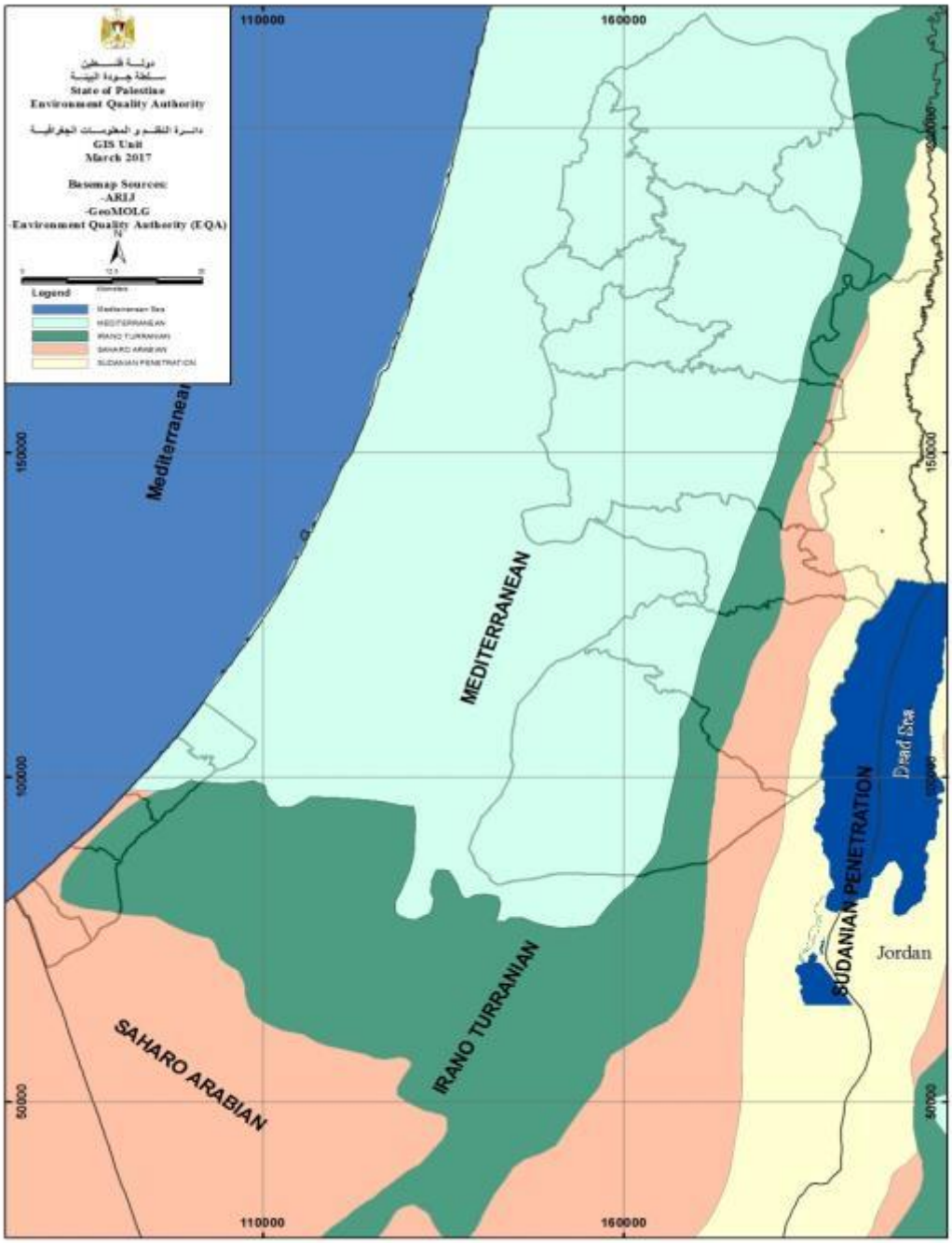


Figure 1. Classical biogeographic zones map of the West Bank.

## 2- Literature Review

### 2.1 Ecology of Palestine

Palestine is located between Europe, Asia and Africa with an area of 27000 $km^2$ in the western part of the Fertile Crescent where humans first developed agriculture (Qumsiyeh, 1996). The unique geography and geology gave Palestine more biological diversity than some countries ten times its size. The diverse habitats cover five ecozones: the central highlands, the semi-coastal region, the eastern slope, the Jordan valley and the coastal region. Palestine also spans four biogeographical regions (Mediterranean, Irano-Turanian, Saharo-Arabia and Sudanese) (Whyte, 1950; Zohary, 1945).

Climate is varied from cold winters with semi-permanent frost in mountains 1000 meter above sea level (Mount Hermon) to semi-tropical climate in the lowest point on earth in the Dead Sea region at 400 meter under the sea level. Rainfall is between 1000 mm in the highest mountains to less than 50 mm in arid regions. Temperatures also vary from freezing to over 35 C in summer months in the Wadi Araba areas (Issac, 2002, Qumsiyeh, 1996).

The Mediterranean Zone flora is characteristic maquis forest with trees like oaks and pistacia. The plant cover then decreases proportionally and includes different species as we head south and east into Irano-Turanean, Saharo-Arabian and then Ethiopian-Sudanese flora. This creates diverse habitats and results in distinct assemblages of animals such as land snails (Amr et al., 2018).

## 2.2 Gastropods

Gastropoda is a class that includes snails and slugs classified under the phylum Mollusca (Barnes, 1987; Heller and Arad, 2009). Gastropoda includes snails (freshwater, marine water and land) and slugs of all kinds; altogether some 721 families (around 245 are extinct) (Bouchet et al., 2017). This large and diversified group contains more than 70,000 described species (Bouchet et al., 2005) but there are estimates of over one million species worldwide (thus most to be described). Gastropods are found in different habitats and ecological zones (Heller and Arad, 2009).

## 2.3 Studies on Land Snails

Land snails which is the common name for what scientifically known "terrestrial gastropod" differ from slugs in having a shell on it back that it can at least partially retreat into (Hyman, 1940; Vaught, 1989; Heller and Arad, 2009). Most land snails are herbivores (Barnes, 1987; Heller and Arad, 2009). Land snails studies in Palestine were started by interested Europeans in who came on short excursions to what is considered the Holy Land. Bourguignat (1852) descrbided *Helix fimbriata* (*now Sphincterochila fimbriata*) from around the Dead Sea and *Helix prophetarum* (*=Sphincterochila prophetarum*) from Jerusalem. Roth (1855) described *Tornatellina hierosolymarum* (*=Calaxishierosolymarum*) from near Jerusalem along the road to Bethlehem. *Bulimus episomus* (*=Paramastus episomus*) was described from the neighborhood of Nazareth by Bourguignat (1857). Benson (1859) described *Bulimusbenjamiticus (=Turanena benjamitica*) from near Jerusalem. Mousson (1861) described *Pupa choudriformis* (*=Euchondrus chondriformis*) and *Buliminus labrosus* var. *diminutus* (*=Buliminus diminutus*) near Jerusalem and *Buliminus carneus* var. *glabratus* (*=Buliminus glabratus*)

from Es-Zenore.Tristram (1865) listed over 100 species from Palestine and Syria. Another list appeared in Fauna of Western Palestine by Tristram (1884) done under the auspices of the Palestine Exploration Fund. Westerlund (1887) then described *Buliminus marsabensis* from Mar Saba.

Later, a number of species were described; *Truncatellina haasi* from Aquabella, W Jerusalem (Venmans, 1957), *Cristataria haasi* (Nordsieck, 1971), *Cecilioides genezarethensis* from Wadi Mandaj, near Huleh lakeand *Euchondrus pseudovularis* from Dimona (Forcart, 1981). In 1993, Dr. Joseph Heller published a book summarizing his life-long research (e.g. Heller 1971a,b, 1974, 1975, 1979) on land snails in Historic Palestine with distribution maps of each species. Ezzughayyar (1996) mentioned six species of land snails in Tell/Jenin area. In total more than 100 species of land snails were thus described form Palestine (summarized in Heller 1975, 1988, 1993; Heller and Arad, 2009).

Freshwater snails in the West Bank were studied by Handal et al. (2015) and in other parts of Palestine by Milstein et al. (2012). 52 gastropods snail are invasive to our land and 33 of them are terrestrial added to our species list comes by humans or migratory animals like birds (Roll et al., 2009). Table 1 shows the diversity of land snail species in nearby countries (Lebanon, Jordan, and Arabian Peninsula).

Table 1. Species number of nearby countries.

| *Country* | *# Land snails species* | *Referance* |
|---|---|---|
| Jordan | 45 | Neubert et al., 2015 |
| Lebanon | 33 | Neubert and Bariche, 2013 |
| Arabian Peninsula | 70 | Neubert, 1998 |

## 2.4 Land Snail Life Cycle

Land snails are phytophagous species that feed on plants but it is not conceders as dangerous pests while few are carnivorous (Steneck and Watling, 1982). Land snails in our region become active in winter season were the increase of humidity let it start awake from it hibernation and start to feed and reproduce (Heller, 2009). With both male and female genitalia, land snails are hermaphrodite and thus can reproduce alone without partner though exchange of sperm is common (Baur, 1989; Takeda, 1989).

Figure 2 it shows a typical land snail life cycle. Normally juveniles have the look of adult species but not identical and it may be difficult to identify juveniles who have yet to develop key adult characteristics especially around the lip of the shell (Heller, 2009).

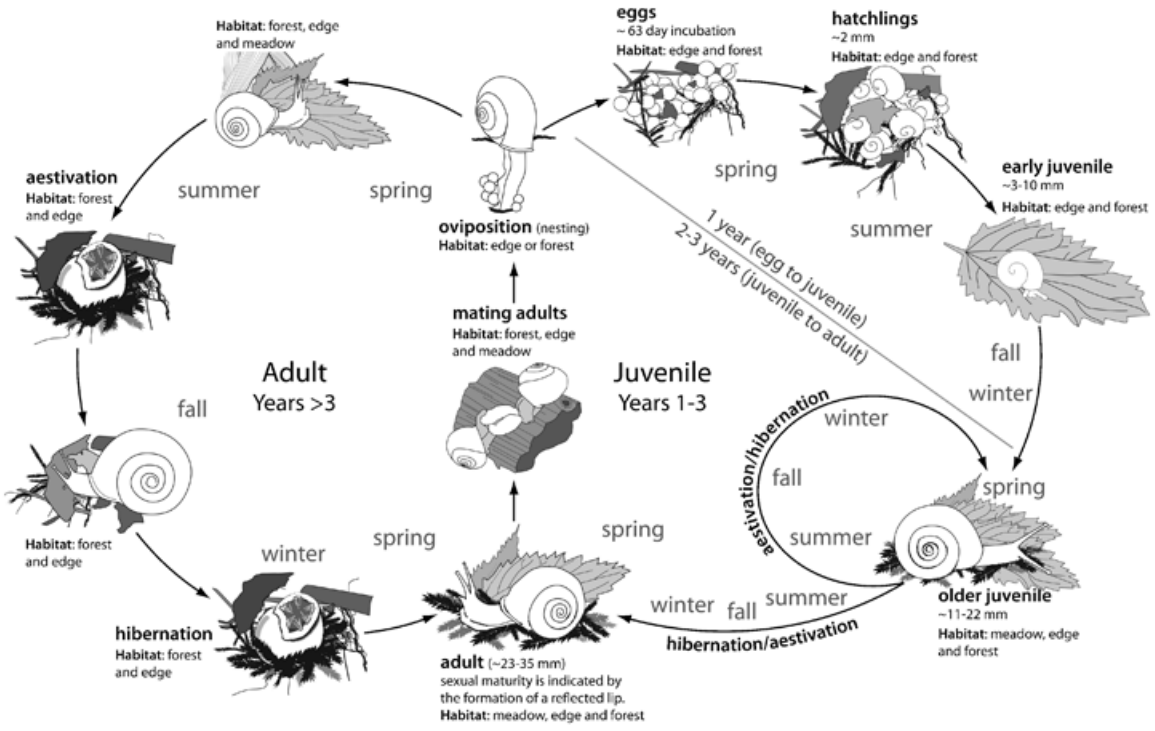


Figure 2. Life cycle of land snails during the year (Steensma et al., 2009).

## 2.5 Snails as Indicators for Environmental Health

Land snails depend on rain, vegetation, and minerals to build their bodies and grow and so are excellent indicators for environmental conditions (Magaritz and Heller, 1980). Land snails shell formation could be used to understand changes in the environment such as rain acidification (Gärdenfors et al., 1995). Isotope analysis of land snail shell carbonates was correlated with rain fall and thus can be used as indicative of climatic conditions (Goodfriend and Magaritz, 1987; Magaritz and Heller, 1980).

Preliminary studies on the accumulation of heavy metals in land snails in the West Bank shows potential as indicators for environmental health (Swaileh et al., 2001 ; Swaileh and Ezzughayyar, 2000 ; Swaileh and Ezzughayyar, 2001).

## 3. Materials and Methods

### 3.1 Study Area

Palestine is located between Europe, Asia and Africa with an area of 27000 $km^2$ in the western part of the Fertile Crescent where humans first developed agriculture (Qumsiyeh, 1996). The West Bank of Jordan or the occupied Palestinian territories is an area of land that is roughly 5,655 $km^2$ and encompassed four biogeographical zones (Mediterranean, Irano-Turanian, Saharo Arabian, and Sudanian zone) (Zuhary, 1947).

### 3.2 Collection Sites

Field trips were done in the OPT (West Bank) from 2010 to 2017 by the Palestine Museum of Natural History team (PMNH). Table 2 shows the 134 localities visited / sampled in the course of this study. Many specimens were collected before this master thesis ensued but most specimens were collected in 2015-2017.

Table 2. The visited location with the coordination data.

| Location | N | E | Location | N | E |
|---|---|---|---|---|---|
| Abood | 32° 0' 47.2392" | 35° 3' 56.2062" | Jabal Al Fredees | 31° 40' 5.1846" | 35° 14' 25.2348" |
| Ain Adas | 32° 5' 4.2972" | 35° 9' 46.4364" | Jabal Al Masateeh | 31°55'35.60" | 35° 4'14.82" |
| Ain Al Auja | 31° 57' 28.0578" | 35° 27' 50.85" | Jabal Qufeen | 34° 59' 45.7686" | 35° 6' 21.4302" |
| Ain Al Fawar | 31° 50' 17.1774" | 35° 21' 12.8694" | Jayoos | 32° 11' 53.6634" | 35° 2' 1.2624" |
| Ain Al Helwa | 32° 19' 4.4862" | 35° 29' 49.5024" | Jenin | 32°27'43.55" | 35°18'7.95" |
| Ain Kenya | 31° 55' 31.1154" | 35° 9' 6.1236" | Jericho-Dead Sea intersection | 31° 47' 58.794" | 35° 27' 1.7202" |
| Ain Nonqor | 31° 30' 39.8118" | 35° 4' 10.4196" | Jericho-Ramallah intersection | 31° 48' 18.7524" | 35° 19' 32.4474" |

| | | | | | |
|---|---|---|---|---|---|
| Ain Samya | 31° 58' 34.9032" | 35° 20' 26.8296" | Jerusalem | 31° 45' 33.2748" | 35° 16' 16.5462" |
| Ain Yabroud | 31° 57' 2.1882" | 35° 15' 3.006" | Jinsafut | 32° 11' 4.8906" | 35° 8' 3.0114" |
| Ajul | 32° 1' 18.501" | 35° 10' 40.9836" | Khallet Saleh | 31° 25' 0.4542" | 35° 7' 30.0288" |
| Al Aroub | 31° 37' 13.5474" | 35° 8' 46.0386" | Khursa | 31° 26' 24.7482" | 34° 59' 45.7686" |
| Al Auja | 31° 56' 49.254" | 35° 28' 48.0108" | Kishda | 32° 18' 33.3072" | 35° 20' 37.6434" |
| Al Berka | 31° 25' 25.608" | 35° 8' 5.6754" | Kufr Al Deek | 32° 3' 37.8432" | 35° 5' 10.9824" |
| Al Doha | 31° 42' 29.4258" | 35° 10' 59.214" | Kufr Kud | 32° 27' 20.9262" | 35° 13' 39.8892" |
| Al Fasayel | 32° 1' 31.2528" | 35° 26' 39.4728" | Kufr Raa'i-I'llar | 32° 22' 13.9038" | 35° 7' 44.2416" |
| Al Jaba’ah | 31° 40' 19.5744" | 35° 4' 40.3926" | Kufr Zibad | 32°13'34.15" | 35° 4'14.18" |
| Al Jiftlik | 32° 8' 30.3936" | 35° 29' 56.2992" | Maksar Qa'adan | 31° 31' 8.8464" | 35° 22' 35.3706" |
| Al Jitha | 31° 52' 45.4584" | 35° 24' 45.8424" | Maksar Qa'adan-1 | 31° 33' 6.8292" | 35° 22' 8.7954" |
| Al Mazra'h Al Sharqeyeh | 32° 0' 11.16" | 35° 15' 53.373" | Maksar Qa'adan-2 | 31° 32' 53.6634" | 35° 22' 8.1762" |
| Al Qarn | 31° 37' 5.5452" | 35° 7' 24.4668" | Mar Saba | 31° 42' 15.1704" | 35° 19' 52.5324" |
| Al Rashaydah | 31° 34' 1.4334" | 35° 14' 12.0228" | Marah Rabah | 31° 37' 56.3952" | 35° 11' 8.793" |
| Al Rashaydah-1 | 31° 32' 21.642" | 35° 15' 55.227" | Marj Na'jah | 32° 10' 57.1794" | 35° 32' 19.3626" |
| Al Rashaydah-2 | 31° 31' 30.0576" | 35° 17' 38.1192" | Matahen Al Sokkar | 31° 52' 50.4732" | 35° 26' 24.7956" |
| Al Rashaydah-3 | 31° 30' 1.548" | 35° 18' 30.6504" | Modarajat Jericho | 31° 54' 45.1146" | 35° 22' 49.584" |
| Al Rawabi | 32° 0' 51.7788" | 35° 11' 18.063" | Masafer Yatta | 31° 24' 27.18" | 35° 6' 51.7134" |
| Al Tairah | 31°52'12.27" | 35° 7'32.24" | Nabi Mousa | 31° 44' 49.1676" | 35° 24' 33.4038" |
| Al Twan | 31° 24' 32.454" | 35° 9' 11.3754" | Nabi Saleh | 32° 0' 55.7028" | 35° 7' 32.6532" |
| Al Walaja | 31° 43' 46.308" | 35° 9' 38.5668" | Nablus | 32° 12' 45.8964" | 35° 15' 54.918" |
| Al Z'iem | 31° 47' 2.0976" | 35° 15' 52.7544" | Nahaleen | 31° 40' 55.9626" | 35° 6' 57.2754" |
| AL Zawya | 32° 5' | 35° 2' | Ni'lin | 31° 56' | 35° 1' |

| | | | | | |
|---|---|---|---|---|---|
| | 33.3312" | 19.8024" | | 52.6524" | 20.4738" |
| Artas | 31° 41' 13.3182" | 35° 11' 10.6" | Ni'mah 1 | 31° 53' 20.8098" | 35° 27' 13.4598" |
| Beit Bassa | 31° 41' 22.8" | 35° 14' 13.3182" | Ni'mah 2 | 31° 54' 22.719" | 35° 27' 28.2918" |
| Beit Fajar | 31° 37' 10.8078" | 35° 9' 21.8808" | Qumran | 31° 44' 15.1872" | 35° 27' 15.933" |
| Beit Illo | 31°58'36.15" | 35° 6'50.85" | Sabastia | 32° 16' 43.7082" | 35° 11' 51.126" |
| Beit Lid | 32° 15' 37.6992" | 35° 7' 49.8036" | Sa'ir | 31° 35' 4.1244" | 35° 8' 51.6006" |
| Beit Sahur | 31° 41' 45.4632" | 35° 13' 43.287" | Sinjil | 32° 2'6.03" | 35°15'50.22" |
| Beit Sera | 31°53'17.21" | 35° 2'42.04" | Sakka | 31° 29' 22.6284" | 34° 56' 42.3852" |
| Beit Wazan | 32° 13' 46.6644" | 35° 12' 54.468" | Salfit | 32° 5' 0.6396" | 35° 10' 49.3248" |
| Bal’a | 32°19'55.48" | 35° 6'35.82" | Seris | 32° 18' 55.242" | 35° 18' 22.6152" |
| Bani Na'im | 31° 30' 35.6538" | 35° 10' 1.434" | Surda | 31° 56' 31.0128" | 35° 12' 14.2992" |
| Bardala | 32° 23' 4.2828" | 35° 28' 29.3196" | Tel Al Asour | 31° 58' 40.0218" | 35° 18' 31.2654" |
| Battir | 31° 43' 41.577" | 35° 8' 25.0296" | Tamoun | 32° 16' 35.7996" | 35° 23' 15.54" |
| between Kufr Ra’I and-Ilar | 32° 22' 3.1434" | 35° 8' 2.7816" | Tarqumia | 31° 34' 49.2738" | 35° 0' 56.0664" |
| Bir Zait | 31° 58' 23.106" | 35° 12' 9.3558" | Tayaseer | 32° 19' 56.3736" | 35° 24' 4.9746" |
| Bruqeen | 32° 4' 11.3622" | 35° 5' 53.6202" | Ubeidiya | 31° 43' 24.024" | 35° 17' 41.5212" |
| Daheyat Al Rayhan | 31° 56' 8.25" | 35° 9' 49.0716" | Um Al Tut | 32° 26' 3.8862" | 35° 20' 5.046" |
| Dayr Al Ghousoon | 32° 21' 2.8794" | 35° 4' 27.1056" | Wadi Abu Al Alayek | 31° 51' 17.7624" | 35° 25' 51.4236" |
| Dayr Ballout | 32° 3' 25.275" | 35° 1' 21.093" | Wadi Al Auja | 31° 56' 16.188" | 35° 27' 36.7122" |
| Dayr Hijla | 31° 49' 4.4868" | 35° 30' 9.432" | Wadi Al Bathan | 32° 15' 22.2006" | 35° 19' 16.9212" |
| Dayr Nizam | 32° 0' 2.1702" | 35° 6' 53.2584" | wadi Al Daraja | 31° 34' 38.4486" | 35° 23' 6.8856" |
| Dayr Qurntul | 31° 52' 25.6764" | 35° 25' 51.4236" | Wadi Al Daraja-2 | 31° 34' 52.665" | 35° 22' 26.7168" |
| Dayr Razeh | 31° 28' 13.6698" | 35° 2' 35.25" | Wadi Al Daraja-3 | 31° 35' 8.9844" | 35° 22' 1.3794" |

| | | | | | |
|---|---|---|---|---|---|
| Dura | 31° 30' 9.3456" | 35° 1' 30.363" | Wadi Al Harameye | 31° 59' 51.8316" | 35° 13' 46.995" |
| East Jericho | 31° 51' 35.4096" | 35° 29' 33.432" | Wadi Al Heker | 31° 21' 41.097" | 35° 8' 55.9278" |
| Ethna | 31° 33' 19.2384" | 34° 59' 10.0818" | Wadi Al Makhrour | 31° 43' 3.7308" | 35° 9' 28.062" |
| Ezz Al Din Forest | 32° 28' 15.9018" | 35° 16' 13.4574" | Wadi Al Matwy | 32° 3' 51.7464" | 35° 11' 6.3198" |
| Farkha | 32° 4'11.61" | 35° 8'50.09" | Wadi Al Qarn Reserve | 31° 37' 9.5154" | 35° 7' 38.6796" |
| Halhul | 31° 34' 41.6094" | 35° 5' 42.5004" | Wadi Al Qelt | 31° 49' 19.02" | 35° 22' 52.9818" |
| Hasasah | 31° 30' 51.9876" | 35° 20' 49.0776" | Wadi Al Quff | 31° 34' 39.1152" | 35° 2' 8.6784" |
| Hasasah-1 | 31° 30' 28.2774" | 35° 21' 24.9186" | Wadi Al Taa'mrah | 31° 40' 4.9218" | 35° 16' 22.7274" |
| Hasasah-2 | 31° 30' 10.3644" | 35° 22' 17.4468" | Wadi Fukeen | 31° 42' 19.569" | 35° 6' 15.2526" |
| Hasasah-3 | 31° 30' 30.9126" | 35° 22' 13.7388" | Wadi Qana | 32° 9' 7.0056" | 35° 8' 3.3966" |
| Hasasah-4 | 32' 18.9024" | 35° 22' 21.1548" | Wadi Sareda | 32° 2' 39.4656" | 35° 4' 32.6676" |
| Hasasah-5 | 31° 32' 31.5456" | 35° 22' 10.6494" | Yabroud | 31° 58' 29.6574" | 35° 14' 36.3588" |
| Husan | 31° 42' 42.174" | 35° 7' 47.9496" | Yatta | 31° 26' 0.1356" | 35° 4' 18.7602" |
| Illar | 32° 22' 12.2772" | 35° 6' 36.2622" | Zababdeh | 32° 23' 10.896" | 35° 18' 54.7482" |
| Izbat Al Tabeeb | 32° 10' 48.4932" | 35° 2' 12.6954" | Zarb Khryan | 31° 41' 1.1214" | 35° 26' 14.751" |

### 3.3Collection Methods

Specimens were collected from the field by hand. Most specimens collected were dead land snail shells found under the rocks or between the stone walls in the field. Live specimens were collected mostly in early winter. Brelase funnel was also used to collect small land snail from leaf letter, dissecting microscope used to examine soft soil collected from the field near archeological sites and soils that exist on the rocky mountains.

### 3.4 Specimen Preservation

All specimens were preserved in the Palestine Museum of Natural History and are catalogued with serial number starting with the letter “M” referring to the class Mollusca. Land snails were cleaned by using and ultrasound sonicator (see Figure 3) and hot water, cleaning by tooth brush, and syringe and then dried. Smaller snails were placed in small plastic containers (See Figure 4) and other specimens preserved in 15 ml tubes or urine cups. Live specimens of snails were sometimes preserved in 70% Ethyl alcohol.


Figure 3. The sonicator used for cleaning land snails shells.

### 3.5 Specimens Identifications and photography

Specimens were identified by using the published keys (Heller, 1975; 2009; Neubert et al., 1998; 2015) under dissecting microscope at the PMNH labs.

Photographs of snail shells were done by using Canon 60D professional camera, and Canon 100mm f2.8 macro lens.

Figure 4. Plastic containers used to preserve land snails shells.

**3.5 Other field data collected and analyzed in the lab**

Data were collected from each location visited by the PMNH team using a GPS devise (Garmin Etrex 20), and longitude and latitude. Other data collected f included host plants, micro and macro habitats, and interaction with other species (including predators). Overlaying species distribution on both a topographic map and a rainfall map helps us understand and discuss distribution patterns (see results and discussion).

# 4. Results

## 4.1 Summary of Species Collected

A total of 41 species of land snails belonging to 13 families and 24 genera are hereby reported in the Occupied Palestinian Territories (OPT) of the West Bank:

1) Pomatiidae with one species (*Pomatis glaucum*)

2) Orculidae with one species (*Pilorcula raymindi*)

3) Chondrinidae with two species (*Granopupa granum, Rupestrella rhodia*)

4) Vertiginidae with one species (*Truncatellina haasi*)

5) Enidae with twelve species belong to five genera, which the species *B. labrosus* include three subspecies and the genus *Euchondrus* with four species (*Buliminus diminutus, Buliminus labrosus labrosus, Buliminus labrosus jiftliki, Buliminus labrosus sporectinus, Buliminus marsabensis, Buliminus glabratus, Buliminus therinus, Paramastus episomus, Pene bulimoides, Euchondrus septemdentatus, Euchondrus chondriformis, Euchndrus pseudovularis, Euchondrus saulcyi, Turanena benjamitica*)

6) Clausilidae with one endemic species (*Cristataria haasi*)

7) Ferussaciidae with three species (*Calaxis hierosolymatum, Cecilioides acicula, Cecilioides genezarethensis*)

8) Subulinidae with one species (*Rumina decollate*)

9) Oxychilidae with one species (*Eopolita protensa jebustica*)

10) Sphincterochilidae with four species belong to the genus *Sphinctrochila (Sphinctreochila fimbriata, Sphinctreochila prophetarum, Sphincterochila zonata zonata, Sphincterochila cariosa*)

11) Cochlicellidae with one species (*Cochicella acuta*)

12) Hygromiidae with nine species belong to four genera which the genus *Monacha* have three species and genus *Xerocrassa* four species (*Monacha obstructa, Monacha syriaca, Monacha crispulata, Metafruticicola fourousi, Xerocrassa seetzenii, Xerocrassa tuberculosa, Xerocrassa langloisiana, Xerocrassa simulate, Xeropicta krynickii*)

13) Helicidae with four species (*Levantina caesareana, Levantina lithophaga, Helix engaddensis, Conus aspersum*)

**4.2 Habitats where snails were collected**

Our Field trips in the OPT the West Bank shows the variety of habitat and vegetation in our environment. The Mediterranean zone that shows the thik vegetation with different maquis forests of oak which is the original Palestinian trees like in Seris and Wadi Al Makhrour (Figure 5) that need more than 500mm rain fall per year, which shows the variety of land snail species. On the other hand we have the shrub parts of the Mediterranean zones that destroyed by having over grazing and other threats (Qumsiyeh and Amr, 2016), like in Deir Ballout, Brukin and Wadi Qana.

The arid and semi-arid area includes three biogeographical zones (Irano-Turanian, Saharo Arabian, and Sudanian zones) and are relatively dry areas with less than 300 mm of rain fall/year. In the areas near Jordan Valley and the southern area getting down to 150 mm of rain or less in many areas (Figure 6). The Irano-Turanian zones is the area that

separates the Mediterranean from the Saharo Arabia zone. The annual rainfall is between 150-300 mm and the soil includes brown lithosols and loessial arid brown soil to brown and pale rendzinas. The vegetation includes semi-steppe batha dominant by *Artemisia sieberi* and *Noaea mucronata* (Zohary 1947; Danin 1988). The Saharo Arabia zone is the area with average of 50-250 mm rainfall per year. The dominant soil is brown lithosols and loessial serozems and the vegetation is dominated by *Anabasis articulata*, S*alsola inermis, Stipa tortilis* and *Atriplex parvifolia* (Zohary 1947; Danin 1988). The Sudanian penetration zone in the Jordan valley has 50-100 mm rainfall per year and the most dominant vegetation for this habitat are as *Acacia tortilis, Calotropis procera, Ziziphus spina-christi*, and *Balanites aegyptiaca* (Zohary 1947; Danin 1988).


Figure 5: Habitats within the Mediterranean zone. A. Wadi Al Quff pine forest. B. Seris oak forest, habitat from which *M. crispulata* was collected. C. WadiQana. D. Wadi Al Makhrour near Bethlehem. E. Karst formation in Brukin, habitat for 14 species including *Cristataria haasi*. F. Dayr Ballut area, dominated by lime stone and Terra Rosa soil.


Figure 6: Arid habitats in the Palestinian Territories. A. Bani Na'im area in the southern part representing the Saharo-Arabian zone. B. Wadi Al Ta'amreh, east to Bethlehem, showing elements of the Irano-Turanian zone. C. Wadi Al Qelt, with a mixture of both the Sudanian penetration and the Saharo-Arabian zones. D. Northern shores of the Dead Sea, representing the Sudanian penetration area. E. Al Jiftlik area, the most northern limit of the Irano-Turanian zone. F. Zarb Khryan with rock formations suitable for *Sphincterochila zonata.*

### 4.3 A Case Study Shows the Variation of Land Snails in a Single Locality

Wadi Al Zarqa Al Ulwi (WZU) protected area is a valley located southwest Salfit on the border with Ramalla district. This valley was studied intensively and we noted 19 species of land snails (PMNH, 2018). Wadi Zarqa area is as an example of a Mediterranean habitat in the northern part of the West Bank and close to the coastal areas. Typical plants include oak, pistacia, carob, Pine, terbinth, strawberry tree, spiny hawthorn and olive trees. Here we collected *P.glaucum. G. granum, R. rhodia, E. chondriformis, E. septemdentatus, P. eposomus, B. labrosus, P. bulimoides, C. haasi, X. krynickii, M. syriaca, S. cariosa, M. fourousi, T. haasi, C. hirosolymarum, E. protensa, L. caesareana* and *H. engaddensis*. This shows the richness of land snails in this type of Mediterranean habitat with rain fall reash 500-700 mm. *C. haasi* is an endemic species found in few places at the WZU and specimens of *P. glaucum* found alive for the first time in the West Bank.

### 4.4 Species Collected

**Family Pomatiidae**

***Pomatias glaucum* (Sowerby, 1843) (Fig. 7 & 8)**
1846 *Pomatias olivieri*
**Materials examined:** M214 (14), Brukeen, 4.3.2016. M1483 (32), Abood, 31.10.2016.M1708 (6), Abood, 21.1.2017. M2047 (11), Kufr Al Deek. 10.2.2017. M2020 (4), Dayr Ballut, 2.2.2017.

**Remarks**: This species is distributed along the coastal mountainous areas east of the Mediterranean in Palestine, Syria and Lebanon. It was previously reported as far soth of its range in Mount Carmel (Rankevich et al., 1996; Heller, 2009). Bar (1975) reported on range expansion of this Mediterranean species further south. Neuburt (In pepartion) considered *Pomatias olivieri* (Pfeiffer, 1846) is a junior synonym of *Pomatias glaucum*. All previous records of *P. olivieri* along the western Mediterranean countries should be treated as *P. glaucum.*
**Habitat:** Specimens were collected at karstic boulders and stones in four localities in the northwestern part of the West Bank (Fig. 7). Specimens collected from Brukeen, Abood and Kufr Al Deek consists of dead shells, while only those from Dayr Baloot were alive.

In Abood it we found large numbers eaten by rodents in places including near mounds of mole rat *Spalax leucodon*. Brukeen area has an elevation of 425m asl about 34 km from the Mediterranean Sea. This species was found along with several species including *Cristataria haasi, Rupestrella rhodia, Granopupa granum, Pene bulimoides, Paramastus episomus, Euchondrus septemdentatus, Euchondrus chondriformis, Cecilioides acicula, Sphincterochila cariosa, Monacha syriaca, Levantina caesareana* and *Helix engaddensis.* Pavlíček et al. (2008) recorded 26 species of gastropods at the 'Evolution Canyon' at lower Nahal Oren, Mount Carmel.

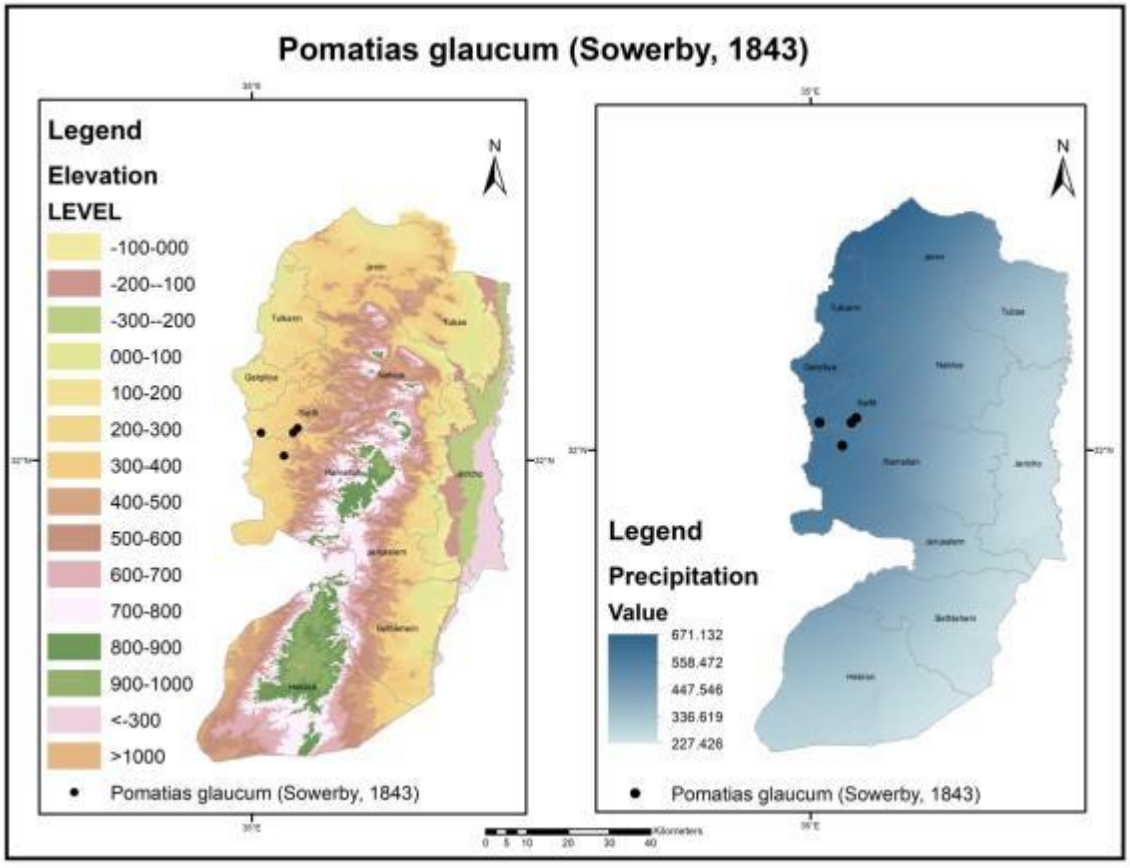


Figure 7. Distribution map for *P. glaucum* in the West Bank.

Figure 8. *Pomatias glaucum*, Scale Bar = 5mm.

**Family Orculidae**

***Pilorcula raymondi* (Bourguignat, 1863) (Fig. 9 & 10)**

1863 *Puparaymondi* Bourguignat,Mollusques Nouvuveaus, Litigieux ou peu Connus, 20: 48-49, Pl. VI. f. 10-13.

1912*Orclla* (*Pilorcula*) *Raymondi* Bourguignat,Germain,Mollusques terrestres et fluviatiles de l'Asie Antérieure. 5e note. Catalogue des gastéropodes de la Syrie et de la Paléstine. -Bulletin du Muséum National d'Histoire Naturelle18 (7): 440-452. Paris.P. 448

**Materials examined:** M194 (4), Ajul,11.3.2016.M1294, Wadi Al Harameyeh, 13.3.2016. M1295, Ajul, 18.3.2016.M1392, Ajul, 28.2.2017.

**Remarks**: This species was originally described from Beyrouth (=Beirut) river mouth, Lebanon (Bourguignat, 1863). Its distribution is confined to Lebanon and Palestine. Bößneck (2011) did not recover further specimens from Lebanon. Several species of the genus *Pilorcula* are known from the Caucasus, southern states of the former Soviet Union and Turkey (Şeşen & Schütt, 2004; Egorov, 2008).

**Habitat**: This species was found in leaf-litter of oak trees and between mosses. The two localities indicated in this study, both are within areas of high rainfall reaching up to 700 mm annually.

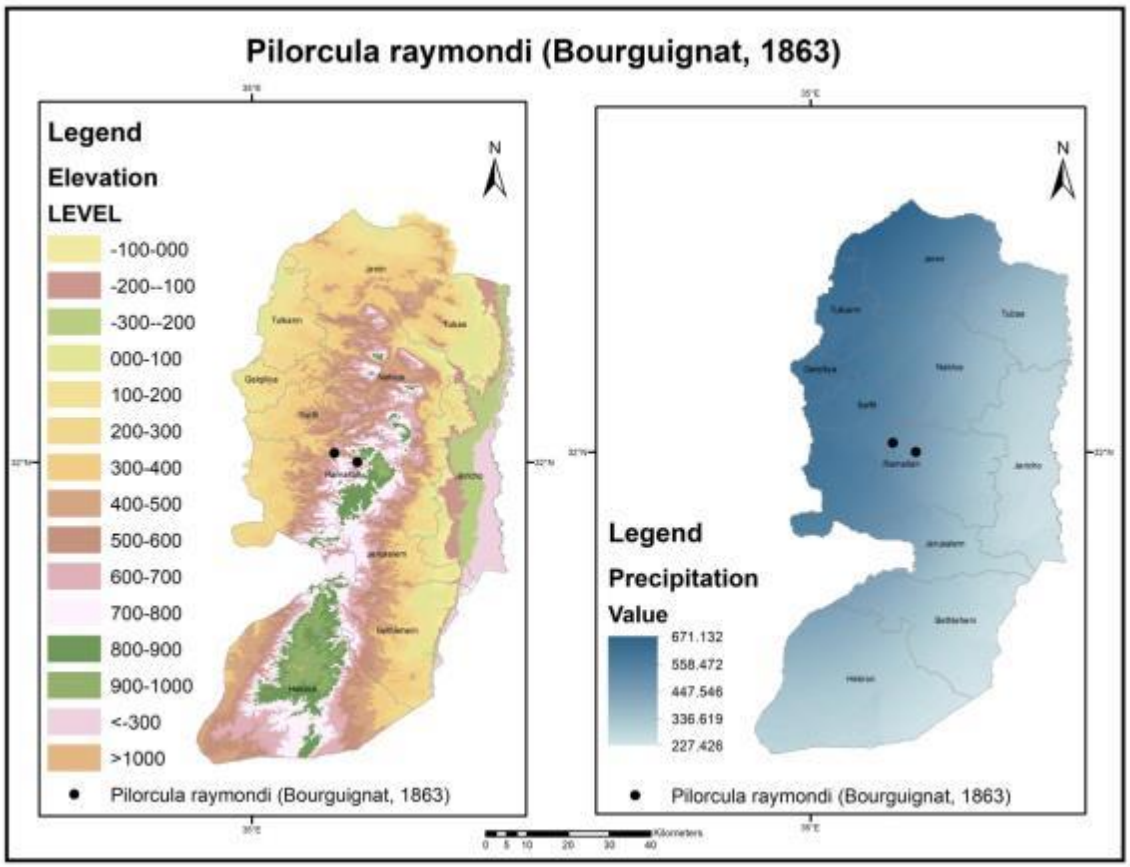


Figure 9. Distribution map for *P. raymondi* in the West Bank.


Figure 10. *Pilorcula raymondi,* Scale Bar = 5mm.

**Family Chondrinidae**

***Granopupa granum* (Draparnaud 1801) (Fig. 11 & 12)**
1801 *Pupa granum* Draparnaud, Tableau des mollusques de la France: 59
**Materials examined:** M327 (6), Mar Saba, 14.12.2015. M1245 (1), Wadi Fukeen, 7.3.2016. M1308 (2), Brukeen, 30.11.2015. M1309, Mar Saba, no date. M1318 (1), Dayr Qurntul, 28.3.2016. M1319 (32), Mar Saba, 14.12.2015. M1320 (26), Brukeen, 3.4.2016. M1321(9), Between Kufr Raa'i-I'llar, 4.3.2016. M1322 (8), Um Al Tout,4.3.2016. M1338 (2), Ain Nonqor, 18.6.2016. M1523 (22),Al Jiftlik, 21.3.2016.M1357 (5), Wadi Al Makhrour, 18.5.2016.M1557 (1), Marj Na'jah, 10.10.2016.M1605 (1), Wadi Sareda, 19.9.2016.M1811 (1), Hasasah-3, 25.1.2017.M1813 (1), Al Rashaydah-2, 25.1.2017.M1822 (4), Hasasah-2, 25.1.2017. M1823 (2), Hasasah-5, 25.1.2017. M1833

(4), Hasasah-5, 25.1.2017. M1891 (3), Maksar Qa'adan-2, 25.1.2017. M2029 (13), Dayr Ballout, 2.2.2017. M2044 (31), Kufr Al Deek, 10.2.2017. M2167 (1), Tamoun, 7.4.2017. M2175 (2), Mzra'a Al Zeer, 25.3.2017. M2178 (32), Al Twan, 25.3.2017. M2179 (9), Wadi Al Hour/Yatta, 8.4.2017.M2181 (1), Al Qardia, 8.4.2017. M2182 (1), Khelat el Daba', 25.3.2017.M2205 (19), Ain Yabroud, 3.3.2017.

**Remarks**: This species is found in arid regions and is wide-spread in the western Palearctic region (Neubert 1998). Its distribution also extends from the Mediterranean region to the Arabian Peninsula to Somalia in the south and east to Afghanistan (Neubert et al., 2015).
**Habitats**: This a widespread species inhabiting a wide variety of habitats ranging from the Mediterranean forests to arid deserts in the south and the humid Jordan Valley. It was found in crevices and under rocks.

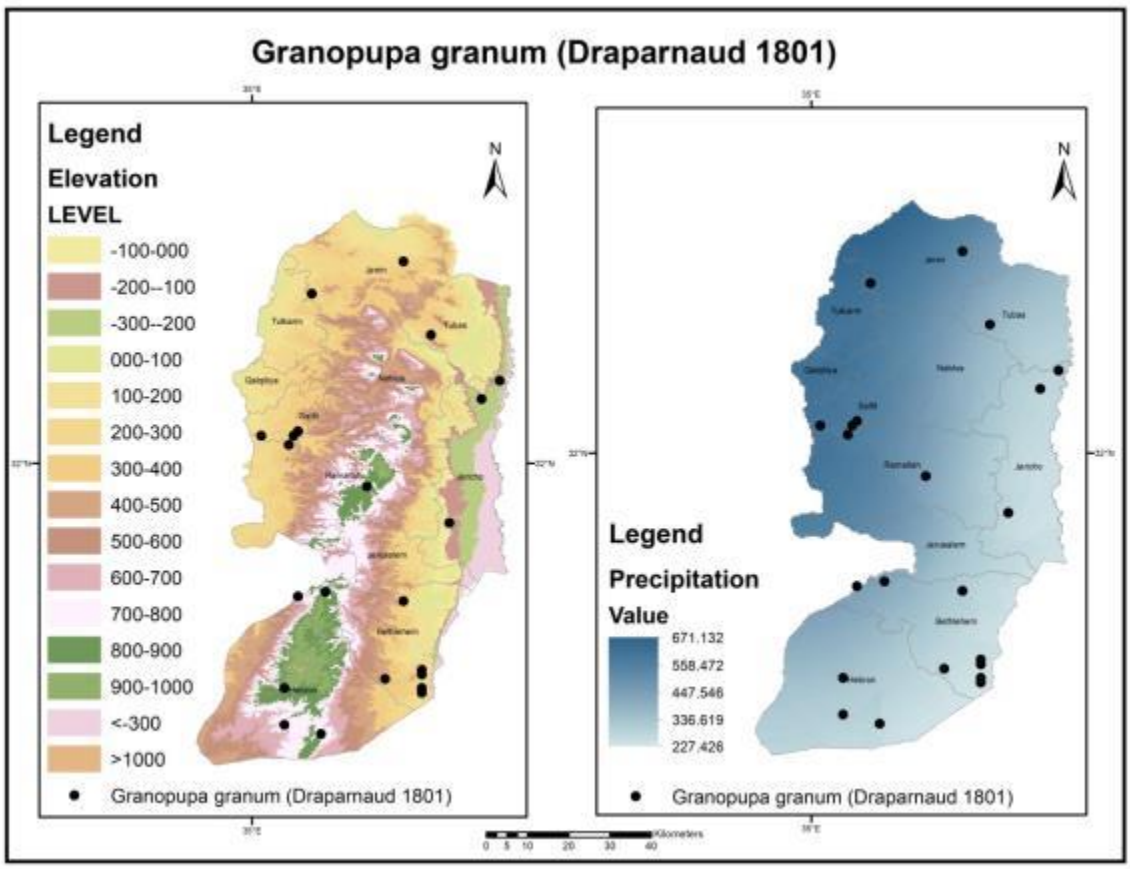


Figure 11. Distribution map for *G. granum* in the West Bank.

Figure 12. *Granopupa granum,* Scale Bar = 5mm**.**

***Rupestrella rhodia* (Roth 1839) (Fig. 13 & 14).**

1839 *Pupa rhodia* Roth, Molluscorum species, quas in itinere per Orientem facto comites clariss. Schubert doctores M. Erdl et J.R. Roth collegerunt: 19, pl. 2 fig. 4 [In insula Rhodo, lecta de humidis rupibus].

**Materials examined:**M1264 (50), Ajul, 18.3.2016. M1315 (9), Between Kufr Raa'i-I'llar, 4.3.2016. M1316 (3), Brukeen, 4.3.2016.M1317, Wadi Al Harameyeh, 13.3.2016. M1494, Ain Nonqor, 18.5.2016.M1670 (2), Surda, 8.10.2016.M1730 (5), Ain Yabroud, 21.1.2017.M2011 (1), Battir, 8.2.2017.M2043 (2), Kufr Al Deek, 10.2.2017.M2013 (1), Wadi Al Hour, 8.4.2017.

**Remarks**: This species is distributed along the Greek Islands of the Mediterranean, Crimea, Turkey, Lebanon, Jordan and Palestine (Şeşen & Schütt, 2004; Triantis et al., 2005; Heller, 2009; Neubert et al., 2015).
**Habitats**: This is a strictly Mediterranean species we collected from forested and rocky areas with annual rainfall exceeding 500 mm but only on the western facing mountain ranges (hills of Samaria and Jerusalem and Hebron). They were found in crevices with soft soil. Live specimens were collected during May and June.

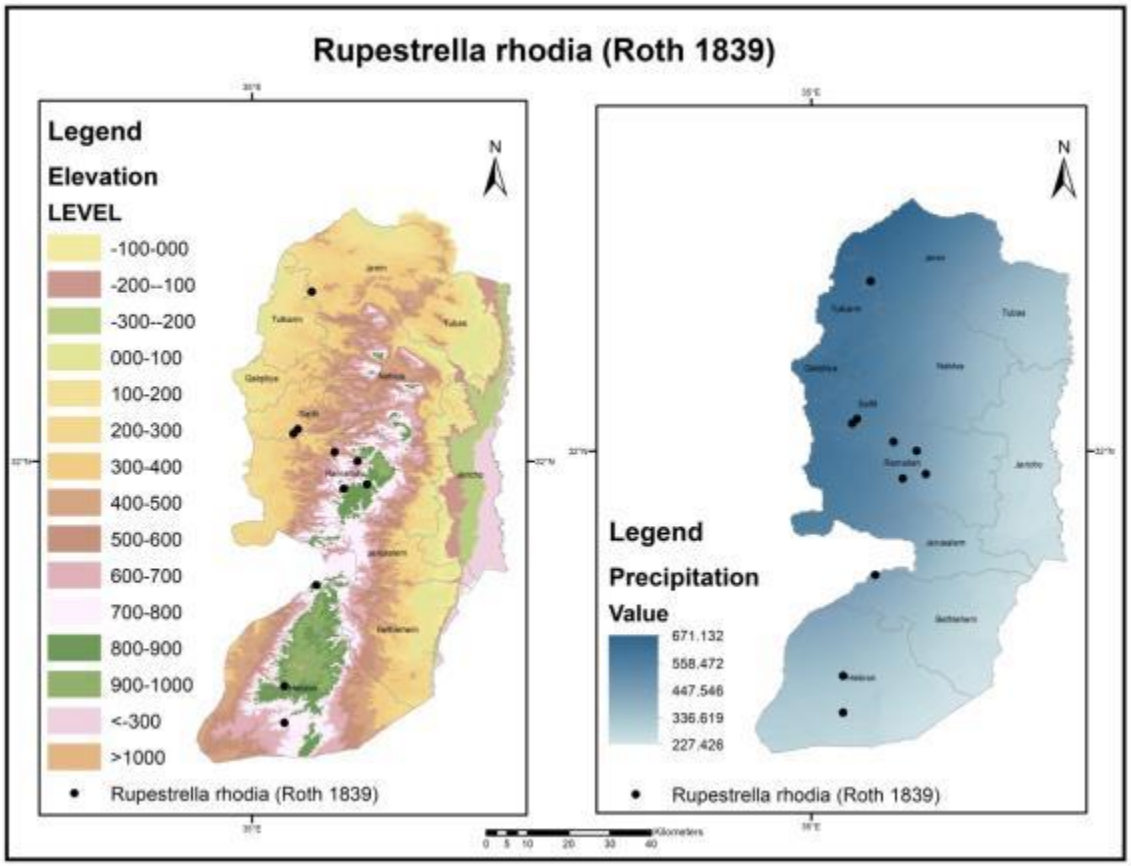


Figure 13. Distribution map for *R. rhodia* in the West Bank.

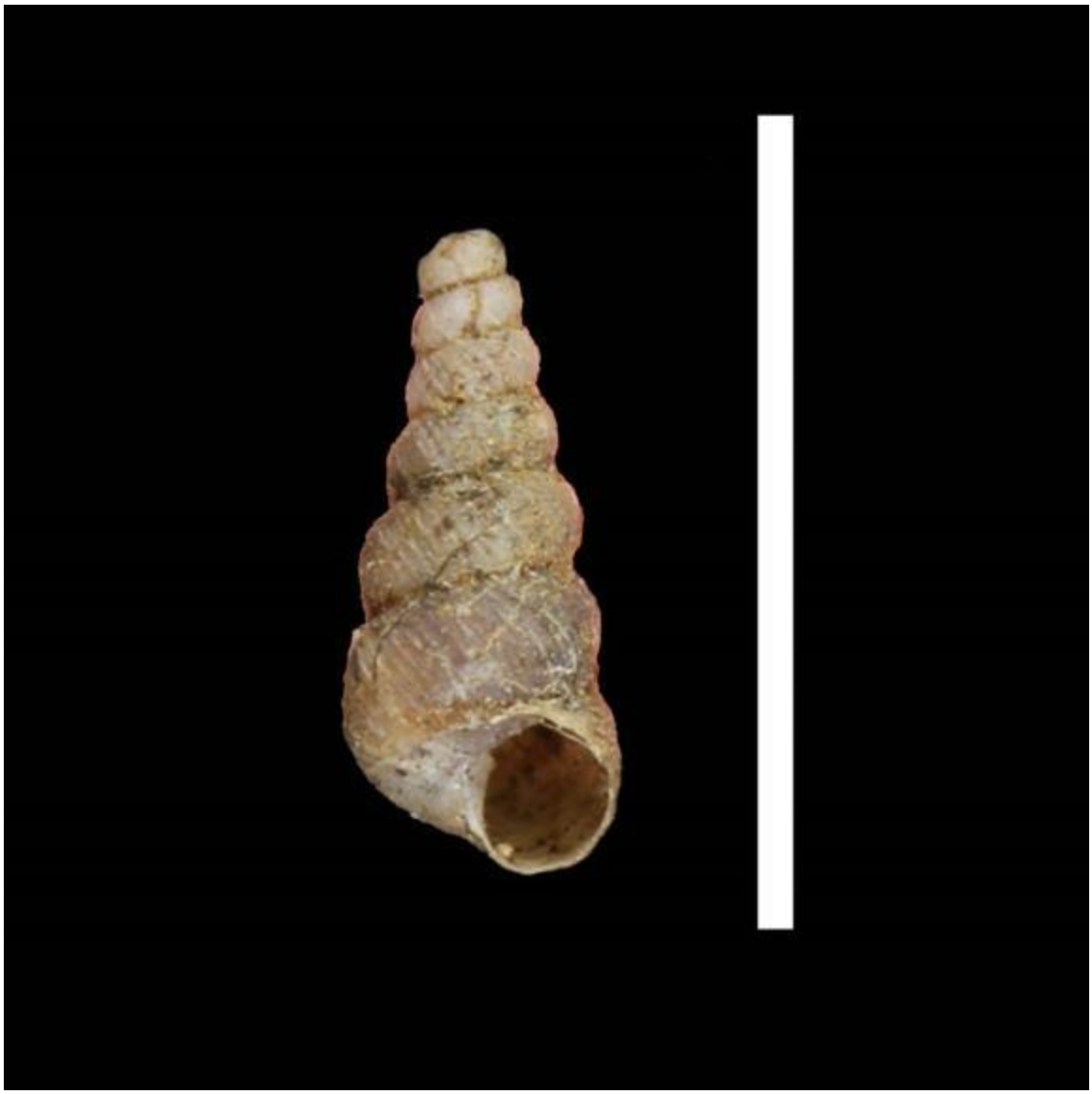

Figure 14. *Rupestrella rhodia*, Sacle Bar = 5mm.

**Family Vertiginidae**

***Truncatellina haasi* Venmans, 1957 (Fig. 15 & 16)**

**Materials examined:**M1296 (2), Kufr Raa'i-Illar, 4.3.2016.2209 (1), Ain Yabroud, 3.3.2017.2217 (6),Wadi Al Qarn Reserve, 26.2.2017.2223 (1), Jenin, 15.6.2016.2224 (1), Wadi Al Harameyeh, 7.5.2016.M2225 (6), Wadi Al Quff, 2.5.2016.M226 (1), Battir, 6.5.2016.M2227 (), Wadi Qana, 1.6.2016. M1412 (1), Nahaleen, no date.

**Remarks**: This species was originally described from Aquabella, W Jerusalem (Venmans, 1957). It considered as an endemic species with known distribution in Jordan and Palestine (Venmans, 1957; Heller, 2009; Neubert et al., 2015). Snails of the genus*Truncatellina*are distributed in the Palaearctic region in some parts of Africa (Pilsbry, 1920- 21), with about thirty described species (Cardona, 2010). Another species

of the genus *Truncatellina*; *Truncatellinacylindrica* (Férussac, 1807) occurs in Mount Carmel and NW Galilee (Heller, 2009).

**Habitats**: This is another leaf-litter dwelling species associated with the Mediterranean zone.

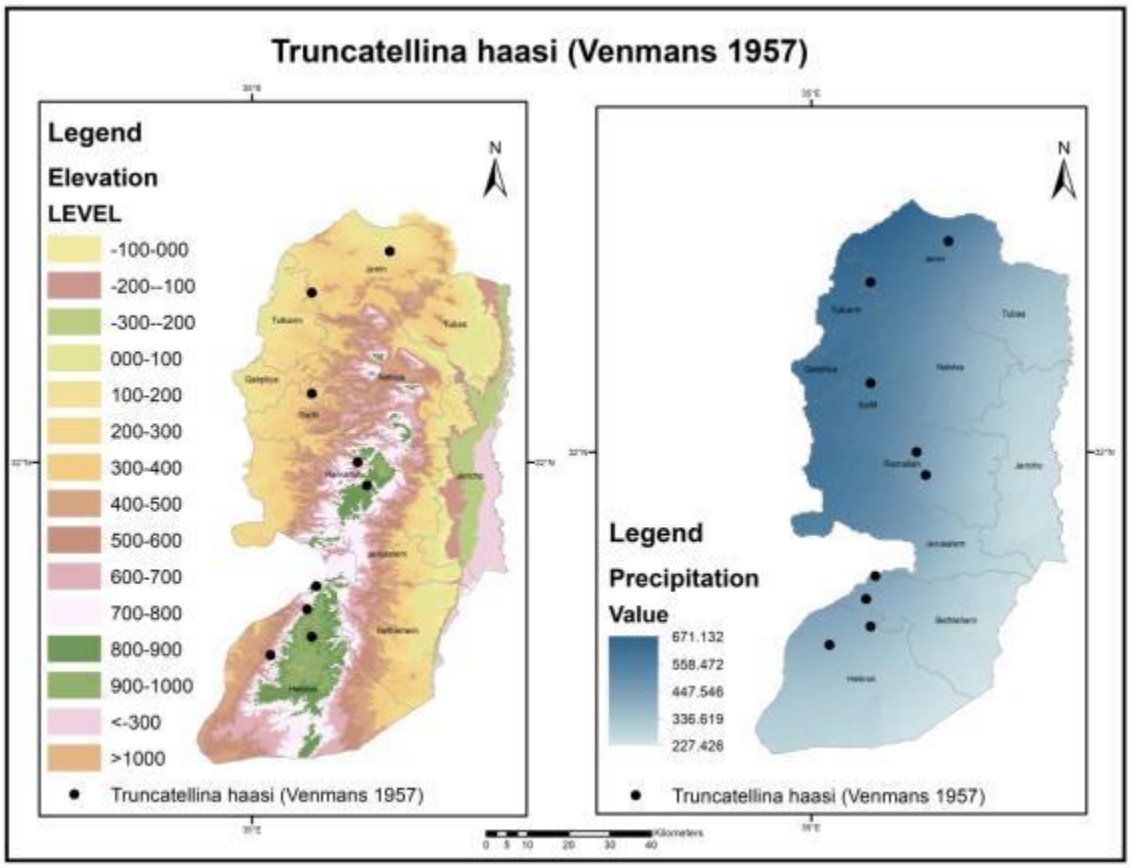


Figure 15. Distribution map for *T. haasi* in the West Bank.


Figure 16. *Truncatellina haasi*, Scale Bar = 5mm.

## Family Enidae

***Buliminus diminutus*** (Mousson1861)

1861 *Buliminus labrosus* var. *diminutus* Mousson, Vierteljahresschrift der Naturforschenden Gesellschaft Zürich, 6: 126 [Jerusalem ex Roth, from label in coll. Mousson].

**Materials examined:** M228, Dayr Qurontul, 1.2.2016.

**Remarks**: Preston (1907) described *Petraeus skies* from the vicinity of Jericho, which was later assigned as *Buliminus diminutus.*It is only known from Jordan and Palestine (Heller, 1975; Neubert et al., 2015). All previous records are around Wadii Al Qelt, near the Dead Sea basin (Heller, 1975).

**Habitats**: It was found only in one locality: rocky areas around Dayr Qurontul near Jericho.

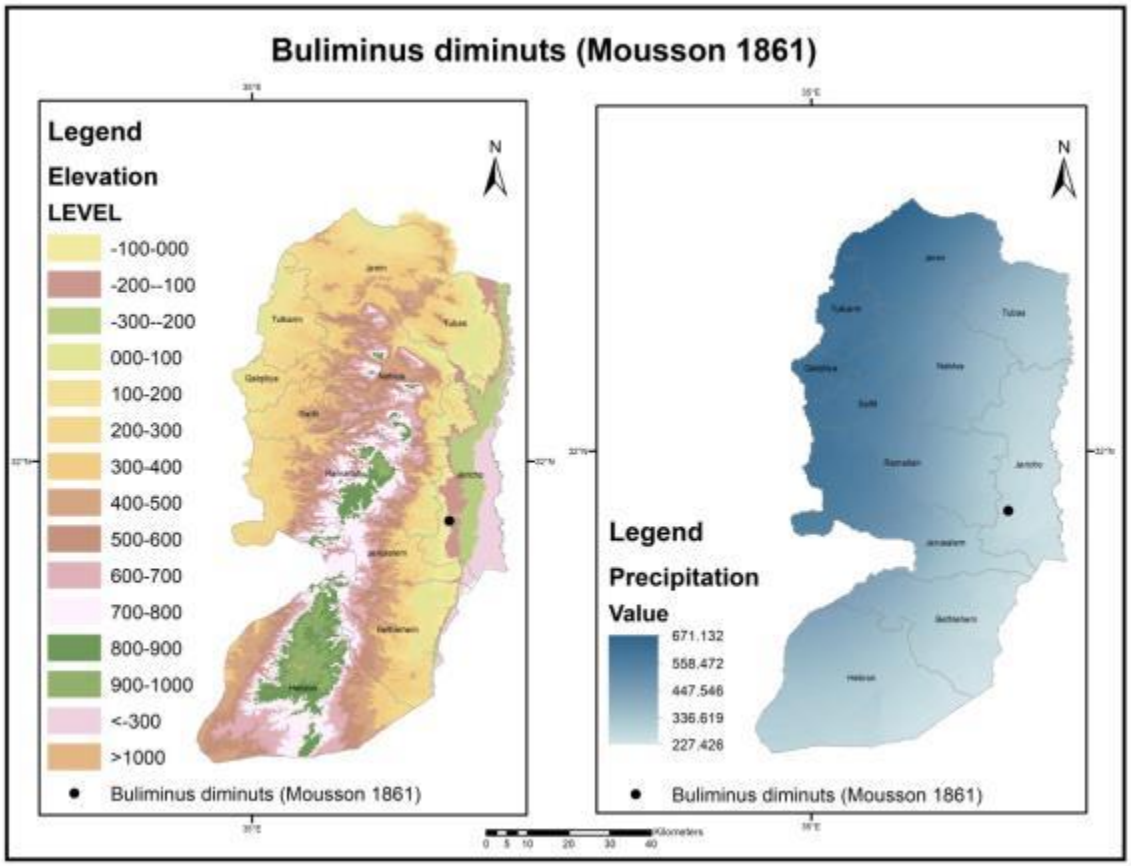


Figure 17. Distribution map for *B. diminuts* in the West Bank.

***Buliminus labrosus labrosus* (Olivier 1804) (Fig. 18 & 19)**

**Materials examined:** M90 (1), Nabi Saleh, 3.5.2013. M91 (1), Jabal Al Fredees, 10.3.2016. M126 (6), Bait Fajar, 6.1.2014. M127 (1), Wadi Al Auja, no date. M136 (1), Husan, 29.5.2013. . M139 (1), Kufr Zibad, 17.5.2013. M156 (1), Farkha, 20.11.2015. M158 (6), Artas, 12.1.2014. M159 (2), Husan, 17.6.2013. M171 (2), Al Walaja, 24.11.2013. M195 (2), Wadi Al Makhrour, 2.1.2014. M224 (9), Ajul, 11.3.2016. M233 (2), Nablus, 2010. M237 (2), Al Walaja, 9.8.2014.M241 (3), Marah Rabah, 15.3.2014. M248 (1), Bir Zait, 11.4.2013. M255 (3), Bir Zait, 11.4.2013.M262 (5), Dayr Ballout, 10.8.2015. M264 (1), Salfit, 30.5.2012. M274, Bait Lid, 1. 2.2014. M275, Wadi Al Quff, April 2015. M276, Artas, 12.1.2014. M278 (5), Wadi Al Makhrour, 23.1.2015. M282 (2), Al Walaja, 24.11.2013. M291 (2), Al Auja, 4.11.2013. M301 (2), Izbat Al Tayeb, 18.3.2015.M302 (14), Wadi Fukeen, 18.01.2014.M305 (1), Bir Zait, 2.9.2015.M306 (19), Wadi Fukeen, 29.7.2015.M307 (7), Wadi Al Makhrour, 23.11.2015.M329 (8), Dayr Ballout, 10.8.2015.M339 (4), Jin Safut, 18.3.2015. M571 (3), Ajul, 18.3.2016. M572 (15), Wadi Al Harameyah, 13.3.2016. M573 (6), Kufr Raa'i-I'llar, 4.3.2016. M575, Battir, 16.2.2014. M577 (8), Day Baloot, 10.8.2015. M578 (7), Jenin, 2.2.2014.M579 (4), Ain Kenya, 15.8.2014.M581(2), Bala'a, 2.2.2014.M585 (6), Wasdi Fukeen, 9.8.2014. M721 (2), Wadi Fukeen, 27.8.2015. M723 (1), Ain Yabroud, 6.3.2014.M908, Bardalla, 18.4.2014. M909, Zababdeh, 6.2.2014. M914, Bait Lid, 1.2.2014. M917 (2), Artas,

12.1.2014. M920, Wadi Al Makhrour, 12.1.2015. M932 (1), Nablus, 2010. M936 (1), Wadi Fukeen, 29.7.2015. M941 (2), Bait Lid, 1.2.2014. M943 (2), Artas, 12.01.2014. M946 (3), Wadi Al Taa'mrah, 3.6.2015. M947 (3), Wadi Fukeen, 29.8.2014. M949, Al Auja, 11.4.2013. M950 (11), Illar, 02.02.2014.M1070 (2), Yatta, 29.1.2013. M1351 (1), Wadi Soraydah, 13.9.2016.M1355 (1), Wadi Al Makhrour, 18.5.2016.M1358 (6), Bait Illo Reserve, 1.8.2016.M1381 (1), Al Jaba'ah, 25.5.2016.M1407 (9), Yabroud, 27.7.2016.M1417 (1), Wadi Qufeen, 7.4.2016.M1420 (1), Tall Al Asour, 27.7.2016.M1446 (2), Wadi Qufeen, 7.4.2016.M1490 (29), Abood, 31.10.2016.M1516 (6), Bir Zait, 2.4.2016.M1539 (2), Al Fasayel, 21.3.2016.M1560 (6), Wadi Al Makhrour, 26.11.2016.M1573 (3), Al Mazra'h Al Sharqeyeh, 10.8.2016.M1576 (1), Bethlehem, 28.7.2016. M1580 (5), Daheyat Al Rayhan, 18.8.2016.M1586 (3), Wadi Al Makhrour, 16.1.2016. M1626 (3), Al Rawabi, 3.8.2016.M1638 (9), Ain Kenya, 12.1.2017.M1641 (2), Battir, 11.5.2016.M1666 (9), Ajul, 11.3.2016.M1667 (4), Battir, 8.1.2017.M1703 (2), Dayr Nizam, 21.1.2017.M1717 (4), Abood, 21.1.2017.M1723 (3), Ain Yabroud, 21.1.2017.M1913 (1), Tall Al Asour, 27.7.2016.M 1989 (6), Wadi Al Matwy, 2.2.2017.M 2002 (1), Wadi Qaffen, 7.4.2014.M 2006 (2), Battir,8.2.2017.M 2018 (9), Dayr Ballout, 2.2.2017.M 2050 (17), Kufr Al Deek, 10.2.2017.M 2127 (3), Al Qarn Reserve, 9.2.2017.M 2130 (4), Tyasser, 10.2.2017.M 2146 (1), Brukeen, 2.2.2017.

**Remarks**: This is one of the most common collected species inhabiting the Mediterranean region. Neubert et al. (2015) gave a detailed account on the systemtics of this species in the region, and concluded that it is absent in Jordan.

**Habitat**: This is a rock dwelling species found mostly in Mediterranean areas of the Palestinian Territories. We noted it in different microhabitats from very humid areas near sheltered water sources to drier areas. In many cases, it was associated with presence of *Levantina caesareana* or *Levantina lithophaga*..

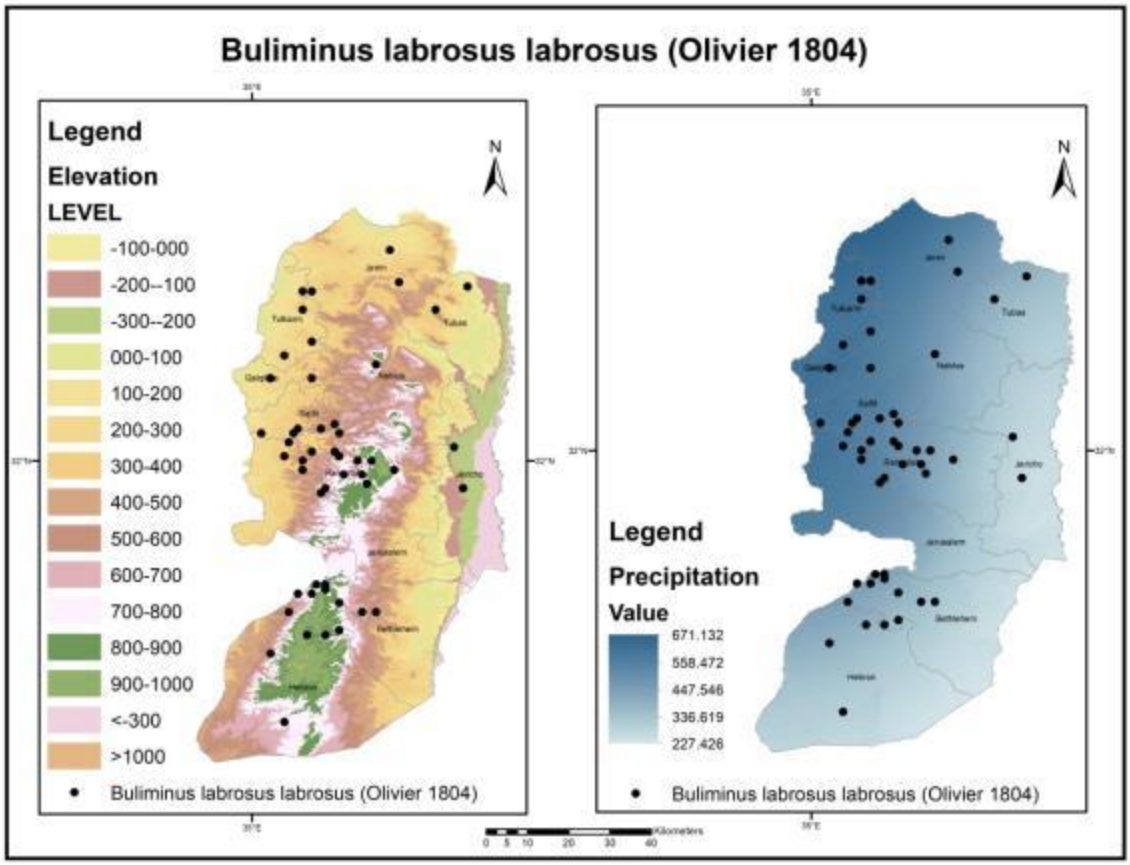


Figure 18. Distribution map for *B. l. labrosus* in the West Bank.

Figure 19, *Buliminus labrosus labrosus*, Scale Bar = 5mm.

***Buliminus labrosus jiftliki*** **Heller, 1975 (Fig. 20)**
**Materials examined:** M1415 (7), Al Jiftlik,21.3.2016.

**Remarks**: This subspecies is characterized by its non-granulated shell, with smooth striated surface and with a thick peristome (more than 1.8 mm). It was described from Al Jiftlik, upper Jordan Valley (Heller, 1975)**.**
**Habitat:** It was collected from rocky outcrops along with *Cecilioides genezarethensis*, *Granopupa granum*, *Helix engaddensis*, *Levantina caesareana* and *Sphincterochila fimbriata.*

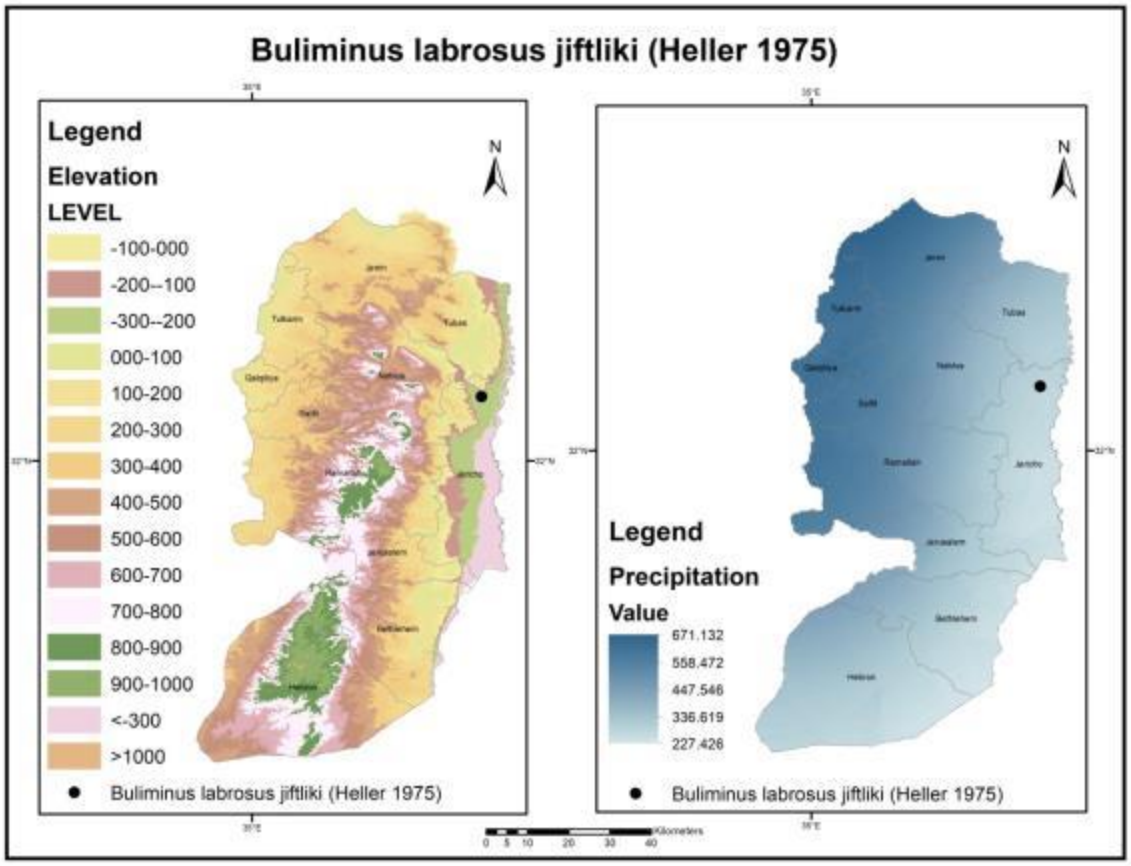


Figure 20. Distribution map for *B. l. jiftliki* in the West Bank.

***Buliminus labrosus spirectinus* (Bourguignat, 1879) (Fig. 21)**
**Materials examined:** M128 (1), Nahaleen, 8.6.2015.M141 (2), Nahaleen, 2.5.2013. M720 (1), Nahaleen, 8.6.2015.

**Remarks**: This species differs from *Buliminus labrosus labrosus* by its small mouth height as compared to its shell height (Heller, 1975). Its distribution is confined to more arid regions of the Mediterranean.

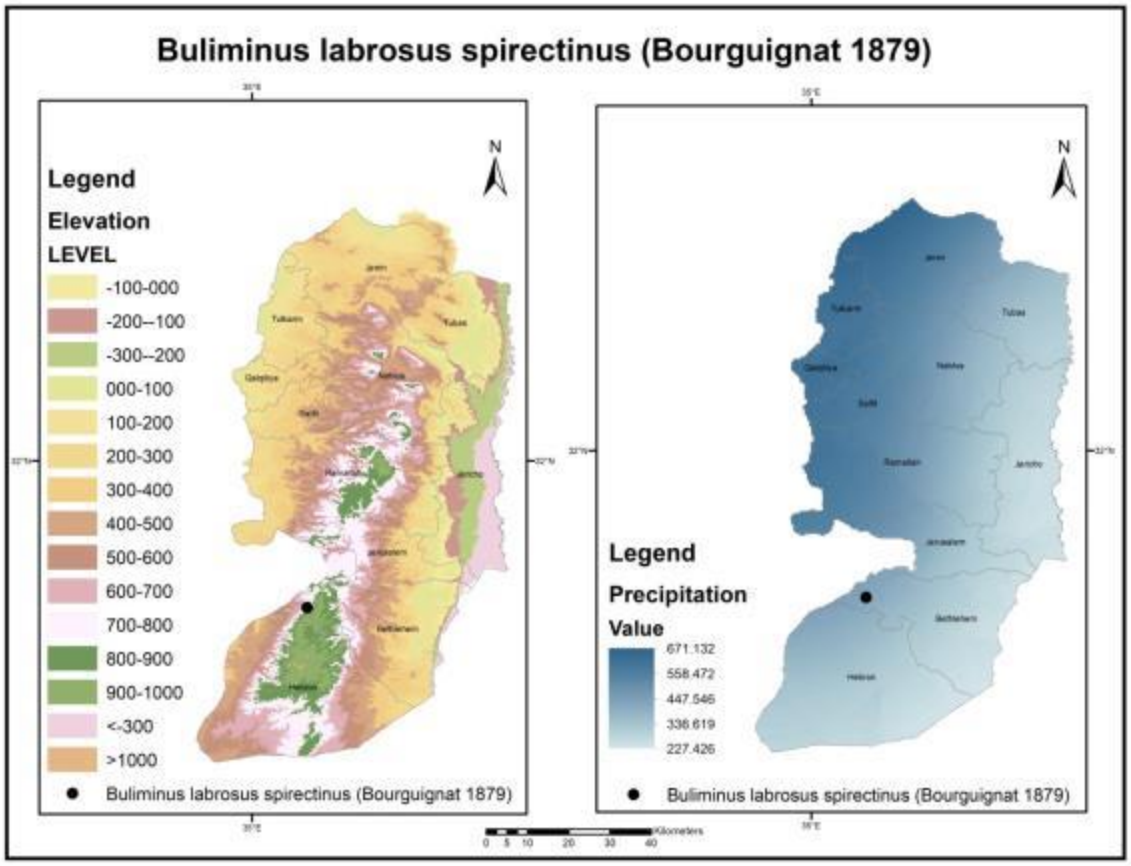


Figure 21. Distribution map for *B. l. spirectinus* in the West Bank.

***Buliminus marsabensis* Westerlund, 1887 (Fig. 22 & 23)**
**Materials examined:** M724 (1), Nabi Mousa, 2.2.2014.M948 (7), Mar Saba, 13.1.2014.M1345 (19), Wadi Daraja, 3.9.2016.M1551 (3), Mar Saba, 14.12.2015.

**Remarks**: This species described initial from the area of the monster of Deir Mar Saba and has been also recorded from other rocky arid regions around the Dead Sea basin (Heller 1975). Neubert et al. (2015) gave a detailed account on the systematics of this species and draws attention to its confusion with other sister taxa (*Buliminus alepensis* and *Buliminus amascensis*).
**Habitat:** This species was collected from arid rocky habitats near Mar Saba, Nabi Mousa, and Wadi Daraja.

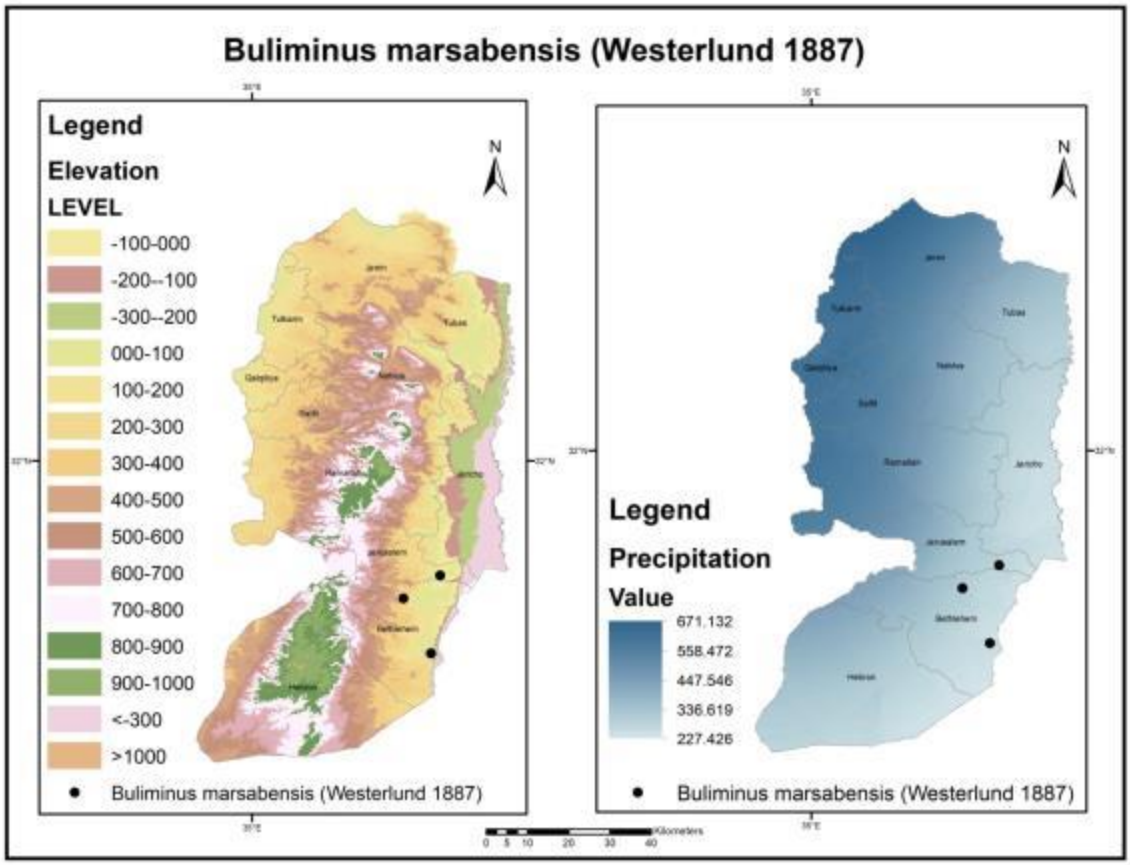


Figure 22. Distribution map for *B. marsabensis* in the West Bank.

Figure 23. *Buliminus marsabensis*, Scale Bar = 5mm.

***Buliminus glabratus* (Mousson, 1861) (Fig. 24 & 25)**
1861 *Buliminus carneus* var. *glabratus* Mousson, 37.

**Materials examined:** M1818 (5), Wadi Al Daraja, 25.1.2017.M1894(5), Maksar Qa'adan, 25.1.2017.M2135 (1), Msafer Yatta/ Khalet Bayoud, 31.3.2017. M2177 (7), Msafer Yatta, 15.4.2017.M2183 (1), Msafer Yatta, 5.4.2017
**Remarks**: Heller (1975) presented morphological evidences that separates *Buliminus carneus* described from Turkey and *B. glabratus* that has a very marked callus that is lacking in *B.carneus.* Thus we consider *glabratus* to be endemic to Palestine.
**Habitat**: It is distributed in the western side of the Dead Sea and to the west reaching as far as Yatta. It is associated with arid steep rocky areas with minimal vegetation. It was found along with *B. therinus.*

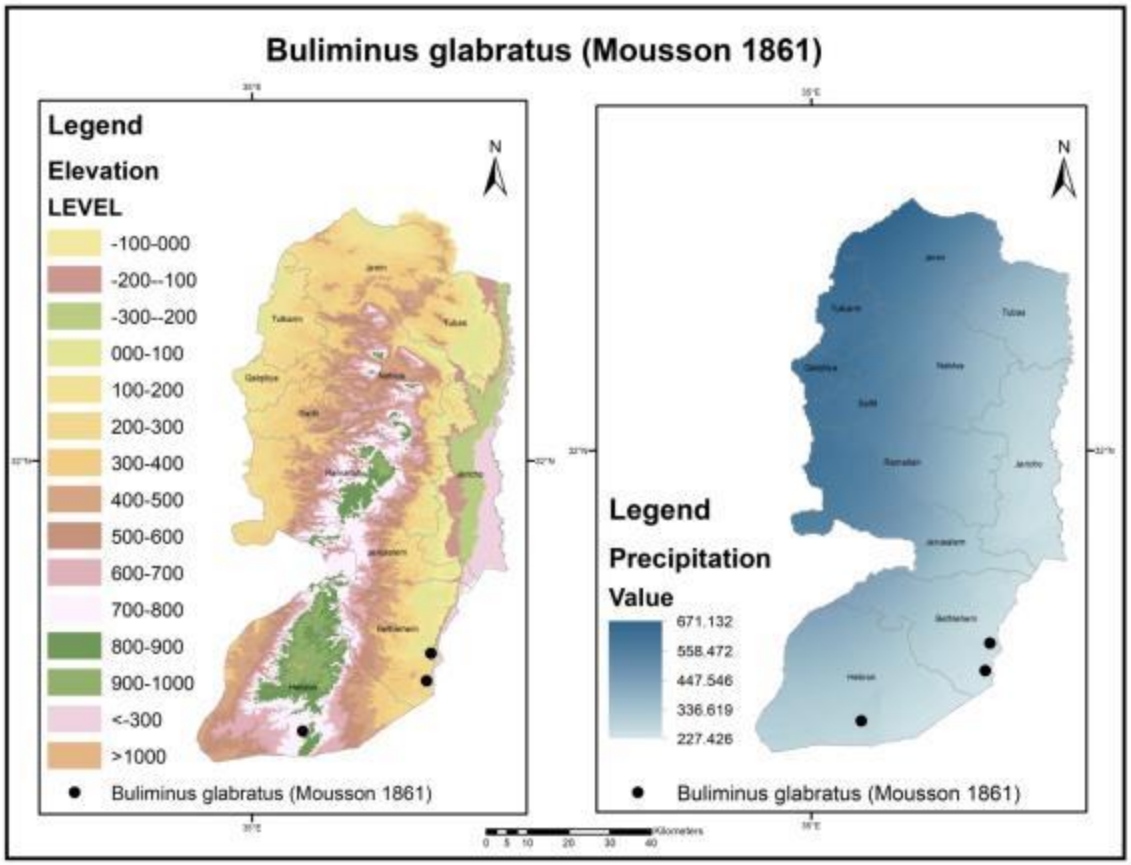


Figure 24. Distribution map for *B. glabratus* in the West Bank

Figure 25. *Buliminus glabratus*, Scale Bar = 5mm.

***Buliminus therinus* (Bourguignat, 1876) (Fig. 26 & 27)**

1876 *Bulimus therinus* Bourguignat,: 5. Type locality "Vallee du Liban, Syrie".
1861 *Bulimus halepensis* Mousson,: 6. From Marsaba.
1921 *Buliminus (Petraeus) carneus* var. *reconditus* Germain,. From the environs of Jerusalem.
1929 *Petraeus therinus:* Pallary: 15; pl. 1, fig. 22.

**Materials examined:** M215 (18), Qumran, 16.3.2016.M223 (6), Dayr Qurntul, 29.2.2016.M340 (30), Nea'mah, 21.3.2016.M717 (1), Wadi Fukeen, 18.1.2014.M1421 (1), Al Auja, 21.3.2016.M1676 (6), Modrajat Jericho, Feb. 2016.M1754 (32), Al Jitha, 12.12.2016. M1809 (15), Zarb Khryan, 25.1.2017.M1814 (1), Hasasah-4, 25.1.2017.M1817 (10), Al Rashaydah-2, 25.1.2017.M1829 (1), Hasasah-1,

25.1.2017.M1831 (4), Hasasah-3, 25.1.2017.M1890 (11), Wadi Al Daraja-3, 25.1.2017.M2186 (5), Msafer Yatta, 5.4.2017.M2187 (5), Msafer Yatta, 15.4.2017.

**Remarks**: This species is known from Lebanon, Iraq and Turkey (Heller, 1975). Its distribution extends along the Jordan Valley reaching the Dead Sea and to the west near Yatta.

**Habitat:** This is a true Irano-Turanian species confined to relatively rocky arid regions of the Jordan Valley and around the Dead Sea.

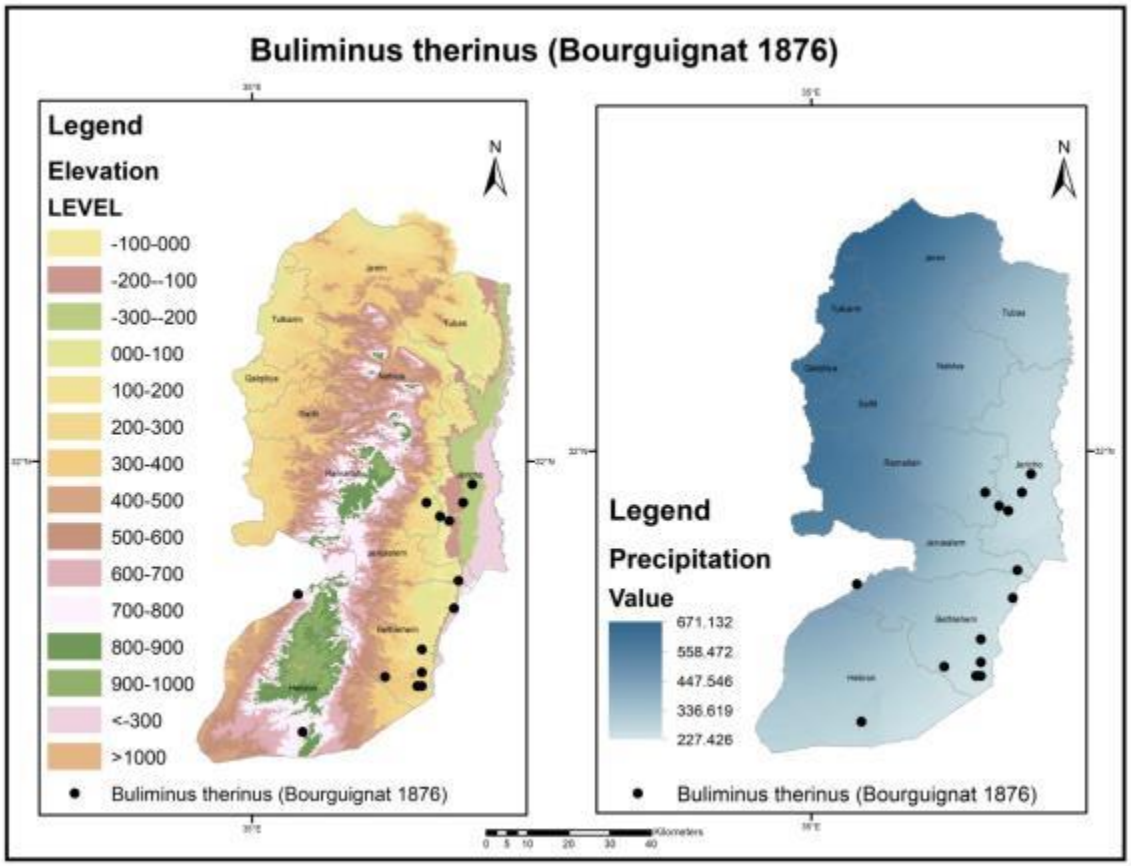


Figure 26. Distribution map for *B. therinus* in the West Bank.

Figure 27. *Buliminus therinus*, Scale Bar = 5mm.

***Paramastus episomus* (Bourguignat 1857) (Fig. 28 & 29)**

**Materials examined:** M227 (12), Ain Yabroud, 19.3.2016. M574 (9), Brukeen, 30.11.2015. M584 (2), Ajul, 19.3.2016. M712 (1), Wadi Qana, 1.2.2014.M714 (1), Wadi Fukeen, 18.1.2014.M1227, Kufr Raa'i -Illar, 4.3.2016. M1276, Al Walaja, 9.8.2014. M1277, Wadi Al Harameyah, 13.3.2016. M1278 (2), Farkha, 20.11.2015. M1279, Artas, 13.8.2014. M1280, Wadi Al Quff, 8.3.2014. M1281, Brukeen, 4.3.2016. M1312, Brukeen, 30.11.2015. M1330 (2) Dayr Al Ghosoun, 4.3.2016. M1331, Wadi Al Quff, 28.11.2015. M1332 (2), Wadi Al Makhrour 16.1.2016. M1333 (3), Ajul, 11.3.2016.M1334 (2), Um Al Tout, 4.3.2016. M1335, Jenin, 2.2.2014.M1400 (4), Ain Yabroud, 12.4.2016. M1419 (3), Tall Al Asour, 27.7.2016. M1427 (13), Ain Yabroud, 1.4.2016. M1488 (11), Abood, 31.10.2016.M1496 (6), Ain Yabroud, no date. M1500 (1), Ain Yabroud, 19.3.2016.M1501 (2), Zababdeh, March 2016.M1604 (1), Wadi Sareda, 19.9.2016.M1624 (1), Al Rawabi, 3.8.2016.M1630 (2), Daheyat Al Rayhan,

18.8.2016.M1646 (2), Battir, 11.5.2016.M1917 (2), Tall Al Asour, 27.7.2016.M1978 (2), Ain Yabroud, 10.2016.M2021 (5), Wadi zarqa/Dayr Ballout, 2.2.2017.M2040 (9), Wadi zarqa/ koffr Al Deek, 10.2.2017.M2129 (8), Ain Yabroud, 3.3.2017.

**Remarks**: This species is distinguished from the family Ebidae by the pointerd protoconoch with two smooth whorls, its diameter is less than half the shell high (Heller, 2009). The observed color of this species of land snail is olive green to yellow with dark apex. This species found in Palestine, Lebanon, Jordan and perhaps in Syria and consider a forest species (Neubert et al., 2015).

**Habitat:** This is a Mediterranean species found near the oak trees, this species found in areas with 500 mm rain fall and its seems need for it survival (Neubert et al., 2015).

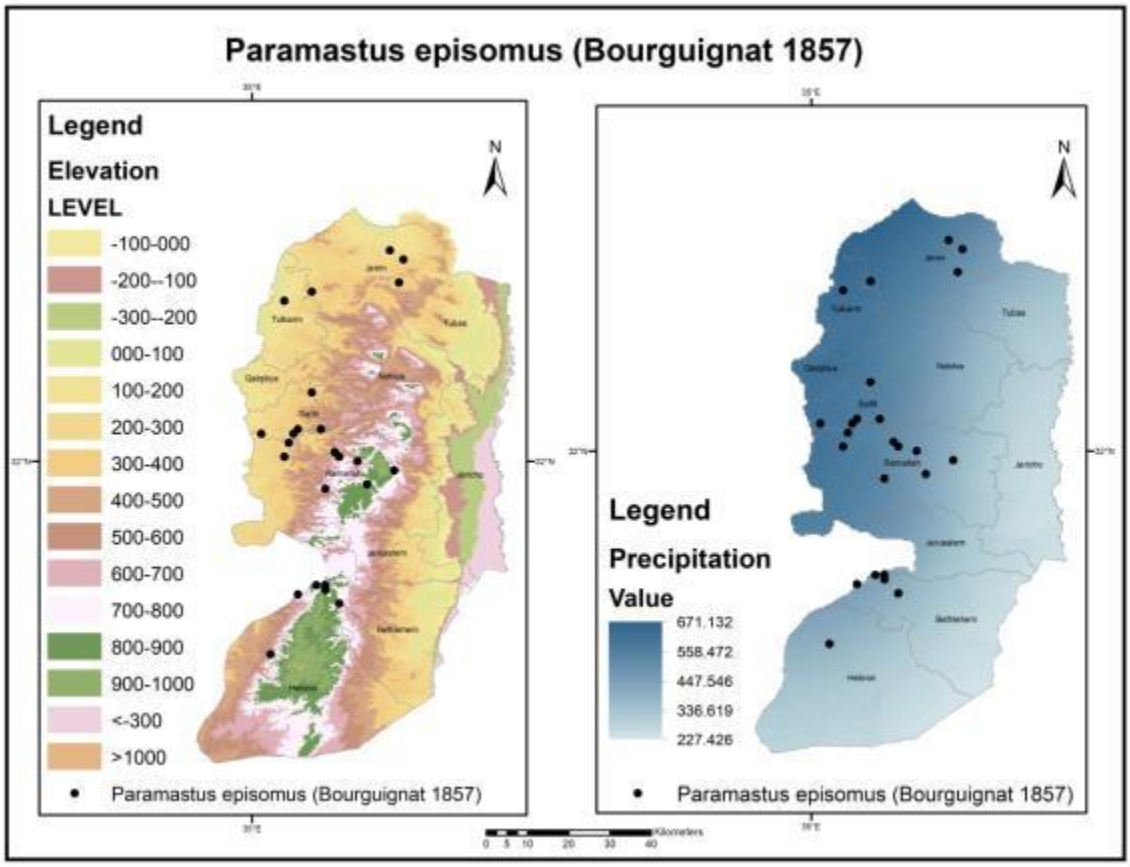


Figure 28. Distribution map for *P. episomus* in the West Bank.

Figure 29. *Paramastus episomus*, Scale Bar = 5mm.

***Pene bulimoides* (L. Pfeiffer 1842) (Fig. 30 & 31)**

1821 *Helix* (*Cochlogena*) *sidoniensis* Férussac, Tabl syst. limaçons (= "Prodrome"): 56 (Quarto edition) [Folio edition: 60] ["Seyde", nomen nudum].

1842 *Pupa bulimoides* L. Pfeiffer, Symbolae and historiam Heliceorum, 2: 53 [type locality: unknown].

1847 *Bulimus sidoniensis* Charpentier, Zeitschrift für Malakozoologie, 4 (9): 141 [In der Umgegend von Beirut, am Fusse der Felsen].

**Materials examined:** M207 (4), Battir, 8.2.2017. M211 (3), Ajul, 19.3.2016.M310 (4), Wadi Qana, 1.2.2014. M317 (10), Wadi **Fukeen**, 7.3.2016. M1270 (4),Ajul, 1.3.2016.M1271 (1), Wadi Al Makhrour, 16.1.2016. M1272(1), Bait Fajar, 6.1.2014. M1273(1), Bait Lid, 1.2.2014. M1274 (6), Wadi Fukeen, 18.1.2014. M1275 (4), Bir Zait,

2.9.2015. M1404 (1), Ain Yabroud, 12.4.2016. M1414 (4), Bir Zait, 24.3.2016.M1435 (1), Ain Yabroud, 27.7.2016. M1456 (5), Nahaleen, 22.5.2016. M1448 (4), Nahaleen, 25.5.2016. M1461 (20), Al Doha, 30.3.2013. M1482 (1), Abood, 31.10.2016. M1570 (1), Wadi Al Makhrour, 26.11.2016. M1595 (1), Al Mazra'h Al Sharqeyeh, 10.8.2016.M1603 (1), Bir Zait, 17.1.2017.M1636 (5), Wadi Al Makhrour, 15.1.2017.M1718 (1), Abood, 21.1.2017.M1915 (2), Tall Al Asour, 27.7.2016.M2039 (2), Wadi zarqa/ kufr Al Deek, 10.2.2017.M2121 (1), Brukeen, 2.2.2017.M2126 (6), Ain Yabroud, 3.3.2017. M2163 (1), Nahaleen, 8.3.2017.

**Remarks**: This species has a cylindrical elongated shape composed of 8- 10 whorls and height varies from 13-19 mm (Heller, 2009 ; Neubert et al., 2015). Heller (1979) shows its distribution as southern Anatolia to the Levant. This is a rocky dwelling species that inhabits rocks with deep crevices. It's color when alive varies from dark brown to light brown and dead specimens appear white.
**Habitat:** this is a Mediterranean, species found on hills over 400m USL, found only on limestone. This species found associated with *Bulimunas labrusus* (Neubert et al., 2015).

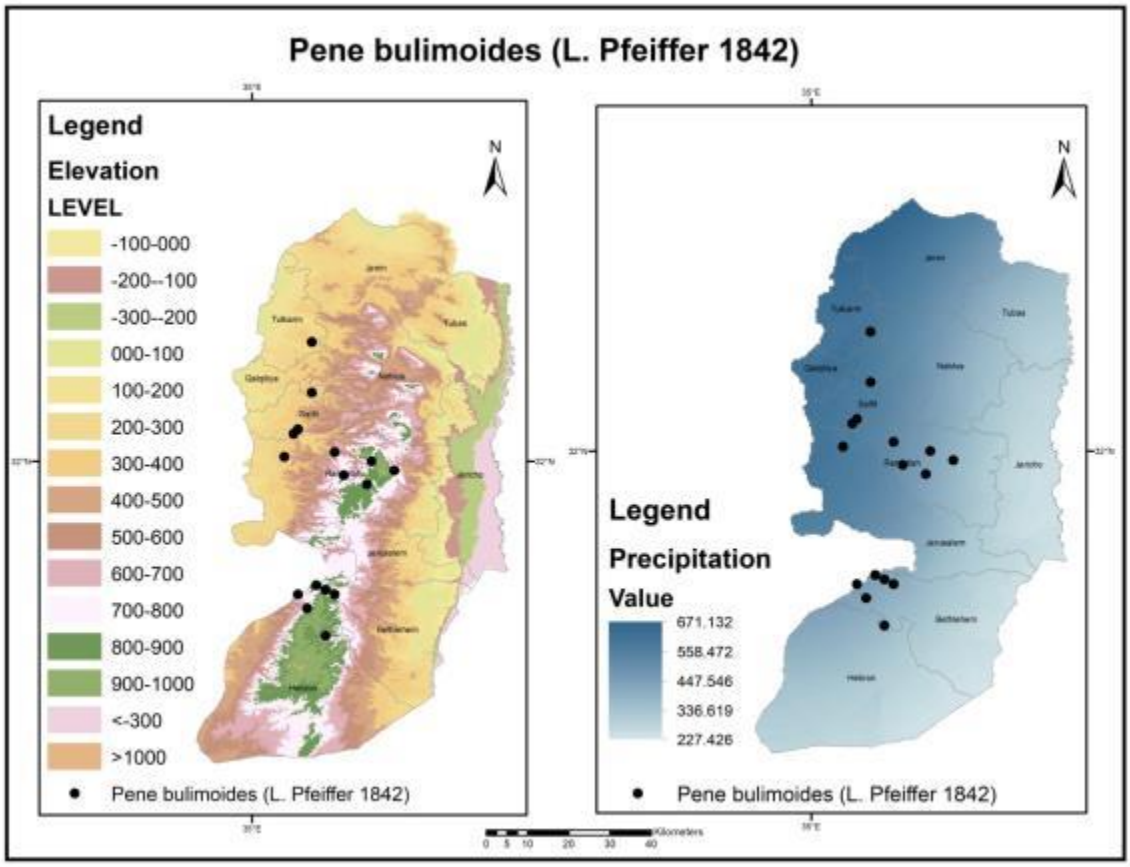


Figure 30. Distribution map for *P. bulimoides* in the West Bank.

Figure 31. *Pene bulimoides*, Scale Bar = 5mm.

***Euchondrus septemdentatus* (Roth, 1839) (Fig. 32 & 33)**

**Materials examined:** M218 (84), Wadi Al Makhrour, 1.2.2014.M219 (12), Ain Yabroud, 19.3.2016.M220 (27), Wadi Al Quff, 28.11.2015.M228 (6), Zababdeh, 6.2.2014.M232 (8), Wadi Al Makhrour, 23.11.2015.M304, Al Auja, 2.1.2014.M312 (8), Wadi Fukeen, 7.3.2016. M313 (4), Um Al Tout, 4.3.2016.M315 (7), Bait Wazan, 19.3.2016. M316 (2), Dayr Al Ghousoon, 4.3.2016. M319 (10), Wadi Al Quff, 28.11.2015. M321 (2), Bait Lid, 2.1.2014.M324 (20), Tayra, 3.8.2015. M326 (20), Sabastia, 1.2.2014.M328, Nahaleen, 3.3.2015.M331 (9), Ajul, 19.3.2016.M332 (5), Battir, 24.11.2013. M353 (4), Dayr Al Ghousoon, 4.3.2016.M354 (8), Jabal Al Fredees, no date. M355 (7), Kufr Ra'i and Illar, 4.3.2016. M482, Sikka, 14.3.2016.M568 (1), Wadi Sa'id, 14.3.2016.M633 (14), Halhul, 14.3.2016. M638 (6), Halhul, no date.M800

(1), Al Za'iem, 13.5.2013.M905 (1), Bait Sahur, 20.5.2013.M786, Marah Rabah, 15.3.2014. M998, Bethlehem, 1.8.2014.M1001, Bethlehem, 15.9.2014.M1002 (1), Nahaleen, 2.5.2013.M1010 (1), Nabi Saleh, 4.5.2013. M1012, Jabal Al Masateeh, no date.M1013, Wadi Mikhmas, no date.M1014 (1), Husan, 17.6.2013.M1018 (3), Wadi Fukeen, 29.7.2015.M1019 (3), Ain Adas, No date. M1120 (2), Bethlehem, 14.3.2016. M1228 (5), Jenin, 2.2.2014. M1229 (1), Wadi Qana, 1.2.2014.M1230 (9), Bethlehem, January 2014.M1231 (7), Al Auja, 4.11.2013.M1232 (2), Sabastia, 1.2.2014.M1234, Dayr Hijla, 19.2.2014.M1235 (5), Bait Fajar, 6.1.2014.M1236 (19), Artas, 12.1.2014.M1237 (16), Dayr Al Ghousoon, 4.3.2016.M1238 (24), Um Al Tout, 4.3.2016.M1239 (65), Wadi Al Makhrour, 23.11.2015.M1248 (263), Ethna, no date.M1246 (12), Broqqen, 4.3.2016. M1250 (25), Wadi Al Quff, 22.3.2014.M1251 (10), Artas, 13.8.2014.M1252 (6), Nahaleen, 8.6.2015.M1253 (2), Bait Lid, 1.2.2014.M1254 (6), Wadi Fukeen, 9.8.2014.M1255 (4), Al Walaja, 8.6.2014.M1257, Illar, 2.12.2014.M1258 (15), Wadi Mikhmas, 20.3.2014.M1259 (6), Marah Rabah, 15.3.2014.M1260 (29), Al Auja, 2.1.2013.M1268 (8), Wadi Al Makhrour, 23.11.2015.M1269 (6), Zababdeh, 6.2.2014.M1282 (3), Wadi Mikhmas, 20.3.2014.M1283 (20), Wadi Al Quff 24.1.2015.M1284 (7), Wadi Al Quff, 22.3.2014.M1285 (5), Nablus, 30.5.2012.M1286 (8), Battir, 27.5.2015.M1287 (6), Wadi Al Makhrour, 23.1.2015.M1339 (2), Ain Nonqur, 18.5.2016.M1353, Wadi Al Makhrour, 18.5.2016.M1366 (6), Bait Illo, 1.8.2016.M1382 (12), Al Jaba'ah, 27.5.2016.M1385 (5), Ain Yabroud, 12.4.2016.M1392 (13), Kufr Nea'mah, 26.5.2016.M1413 (3), Yabroud, 27.7.2016.M1415 (3), Bir Zait, 24.3.2016.M1418 (27), Ain Yabroud, 1.4.2016.M1472 (63), Doha, 30.3.2016. M1475 (34), Nahaleen, 22.5.2016.M1481 (79), Abood, 31.10.2016. M1502 (20), Zababdeh, March 2016.M1511 (11), Al Mazrah Al Sharqeyeh, 10.8.2016.M1512 (29), Wadi Mikhmas, 7.11.2016.M1310 (1), Brukeen, 2015.M1447 (7), Wadi Qifeen, 7.4.2016. M1550 (20), Mar Saba, 14.2.2015. M1581 (7), Wadi Al Harameyeh, 13.3.2016. M1591 (10), Artas, 13.11.2016. M1596 (1), Wadi Mikhmas, 7.11.2016. M1615 (1), Nahaleen, 22.5.2016. M1618 (2), Tall Al Asour, 27.7.2016. M1620 (1), Jabal Qefen, 7.4.2014.M1622 (5), Al Rawabi, 3.8.2016.M1633 (10), Wadi Al Makhrour, 15.1.2017.M1643 (2), Battir, 11.5.2016.M1704 (4), Dayr Nizam, 21.1.2017.M1712 (12), Abood, 21.1.2017.M1720 (9), Ain Yabroud, 21.1.2017.M1721 (3), Al Twan, 22.1.2017.M1764 (1), Al Qarn Reserve, 2.1.2017.M1820 (4), Al Rashaydah-1, 25.1.2017.M1888 (1), Jayoos, 24.1.2017.M1918 (21), Tall Al Asour, 27.7.2016.M1979 (2), Al Qarn Reserve, 10.2016.M1981 (8), Ain Yabroud, 10.2016.M1994 (1), Nahaleen, 8.2.2017.M2001 (5), Wadi Qaffen, 7.4.2014.M2012 (1), Battir, 8.2.2017.M2028 (5), Wadi zarqa/Dayr Ballout, 2.2.2017.M2046 (5), Wadi zarqa/ koffr Al Deek, 10.2.2017.M2119 (5), Ain Yabroud, 3.3.2017.M2133 (1), Al Qarn Reserve, 9.2.2017.M2134 (1), Msafer Yatta, 15.4.2017.M2136 (2), Dayr Razeh, 17.3.2017.M2151 (2), Nahaleen, 8.3.2017.M2153 (27), Wadi Bhour/Yatta, 8.4.2017.M2164 (5), Tamoun7.4.2017.M2165 (4), Ain Yabroud, 3.3.2017.M2168 (5), Yatta/ Kaled Saleh, 10.2.2017.M2169 (6), Mazrat Zeer/Yatta, 25.3.2017.M2170 (4), Twan/Yatta, 25.3.2017.M2174 (7), Msafer Yatta, 15.4.2017.M2176 (1), Twan/Yatta, 25.3.2017.M2185 (2), Al Qardia/ Yatta, 8.4.2017.

**Remarks**: This is one of the most common species in Palestine. This is a widespread species in the eastern Mediterranean, including southern Turkey across Syria and

Lebanon to Jordan and Palestine (Gümüş & Neubert, 2012). Our own observations shows variation on size of this species and it is always found in huge number, they found in stone walls and under rocks.

**Habitats***:* It was found in all types of Mediterranean habitats as well as the Jordan Valley associated with rocky areas.

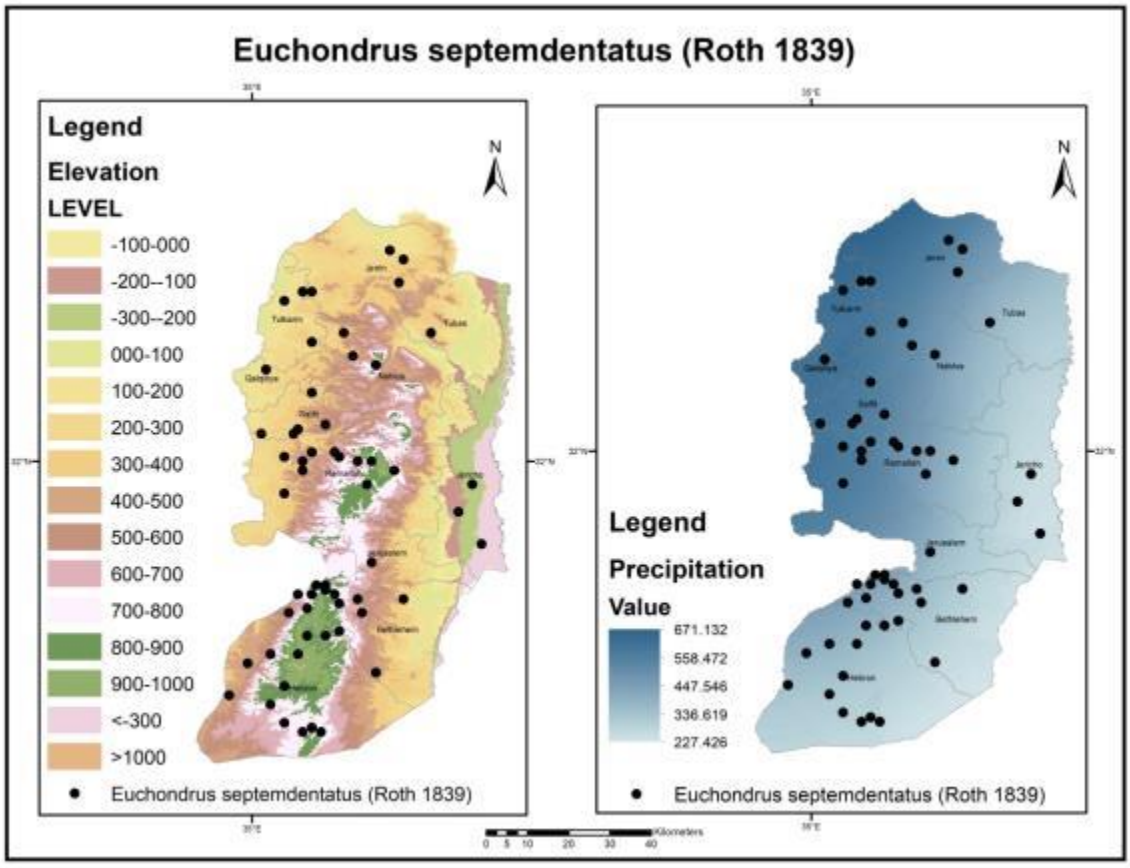


Figure 32. Distribution map for *E. septemdentatus* in the West Bank.


Figure 33. *Euchondrus septemdentatus*, Scale Bar = 5mm.

***Euchondrus chondriformis* (Mousson1861) (Fig. 34 & 35)**

1861 *Pupa chondriformis* Mousson, Vierteljahresschrift der Naturforschenden Gesellschaft Zürich, 6 (2): 138–139 [environs de Jérusalem ....fréquente" (ex Roth)].

**Materials examined**: M1302, Wadi Mikhmas, 20.3.2014. M1297(22), Brukeen, 4.3.2016. M1298 (7), Between Kufr Raa'i and I'llar, 4.3.2016. M1301, Mar Saba, no date. M1300 (2), Dayr Al Ghousoon, 4.3.2016. M1299 (7), Um Al Tout, 4.3.2016. M1484 (32), Abood, 31.10.2016. M1261 (4), Ajul, 18.3.2016.M1265, Wadi Al Makhrour, 23.11.2015. M1266 (7), Ain Yabroud, 19.3.2016. M1429, Bir Zait, 24.2.2016. M318 (2), Wadi Fukeen, 7.3.2016.

**Remarks**: This is an endemic species known to occur in Jordan and Palestine. It was originally described from the neighborhood of Jerusalem (Mousson, 1861). Bar (1974)

gave an account on its distribution, with several localities within the central West Bank, north and coastal areas.

**Habitat**: This is a rock-dwelling species, it was found along *Euchondrus septemdentatus* with other species, however in lower numbers.

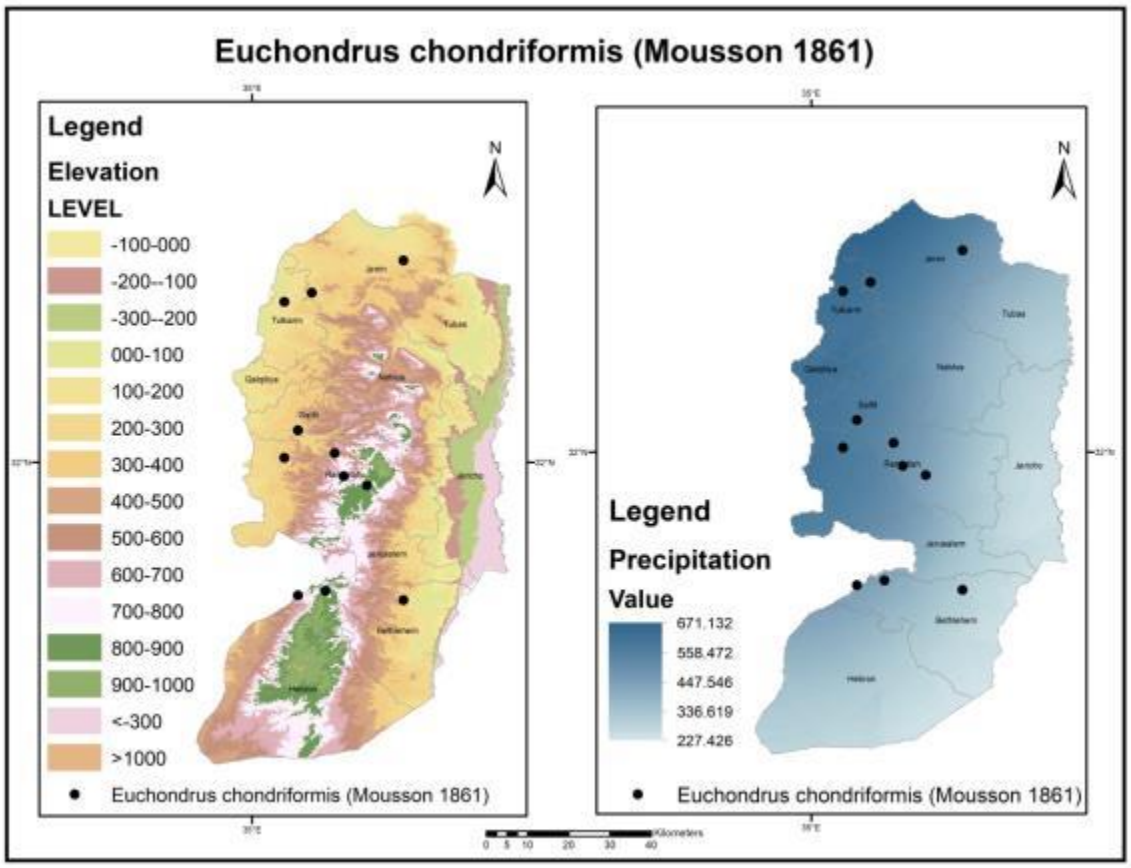


Figure 34. Distribution map for *E. chondrifoomis* in the West Bank.

Figure 35. *Euchondrus chondriformis*, Scale Bar = 5mm.

***Euchondrus pseudovularis* Forcat, 1981 (Fig. 36)**
**Material examine**: Yatta, March 2017.

**Remarks**: Bank et al. (2015) gave a comprehensive account on the systematics and distribution of this species, and it is an endemic to Palestine. The current record expands the distribution of this species further north from the Naqab desert into the extreme south of the West Bank. According to Heller (2009) this species is rare in the Historic Palestine.
**Habitat:** This species can be found in the Mediterranean zones and recorded from al Naqab Area in the semi-arid areas (Heller, 2009). It is curious that we only found it in one locality in the S West Bank (at Yatta) and nowhere else.

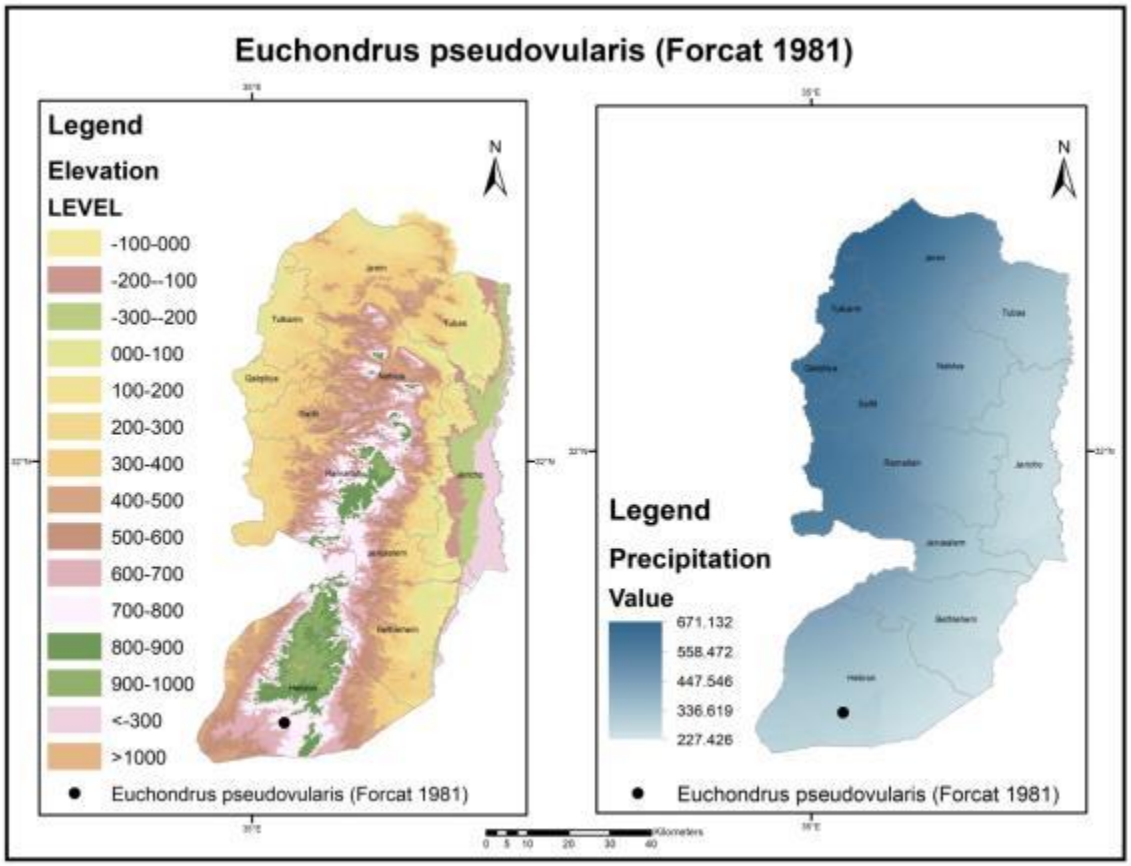


Figure 36. Distribution map for *E. pesudovularis* in the West Bank.

***Euchondrus saulcyi* (Bourguignat 1852) (Fig. 37)**

1852 *Bulimus saulcyi* Bourguignat, Testacea novissima quae Cl. DeSaulcy in itinere per Orientem annis 1850 et 1851 collegit: 18 [Syriam, circa Nazareth, sub lapidius in statione Khan-el-Bedaouieh].

1861 *Chondrus saulcyi* var. *impressus* Mousson, Vierteljahresschrift der Naturforschenden Gesellschaft Zürich 6: 136 [Jerusalem (Roth)].

**Materials examined**: M1233 (1), Zababdeh, 2.6.2014.

**Remarks**: This is an endemic species to Jordan and Palestine. It was originally described from near Nazareth (Bourguignat, 1852). Heller (2009) showed several localities for this species in northern Palestine and around the Dead Sea area. It was recorded from northern parts of the Jordan Valley in Jordan (Neubert et al., 2015).

**Habitat**: A single specimen was collected from Zababdeh in an area of rocky habitat. It was found along with *B. labrosus, E. protensa, E. septemdentatus, H. engaddensis, L. caesareana, M. syriaca, P. episomus, S. cariosa,* and *X. krynickii*.

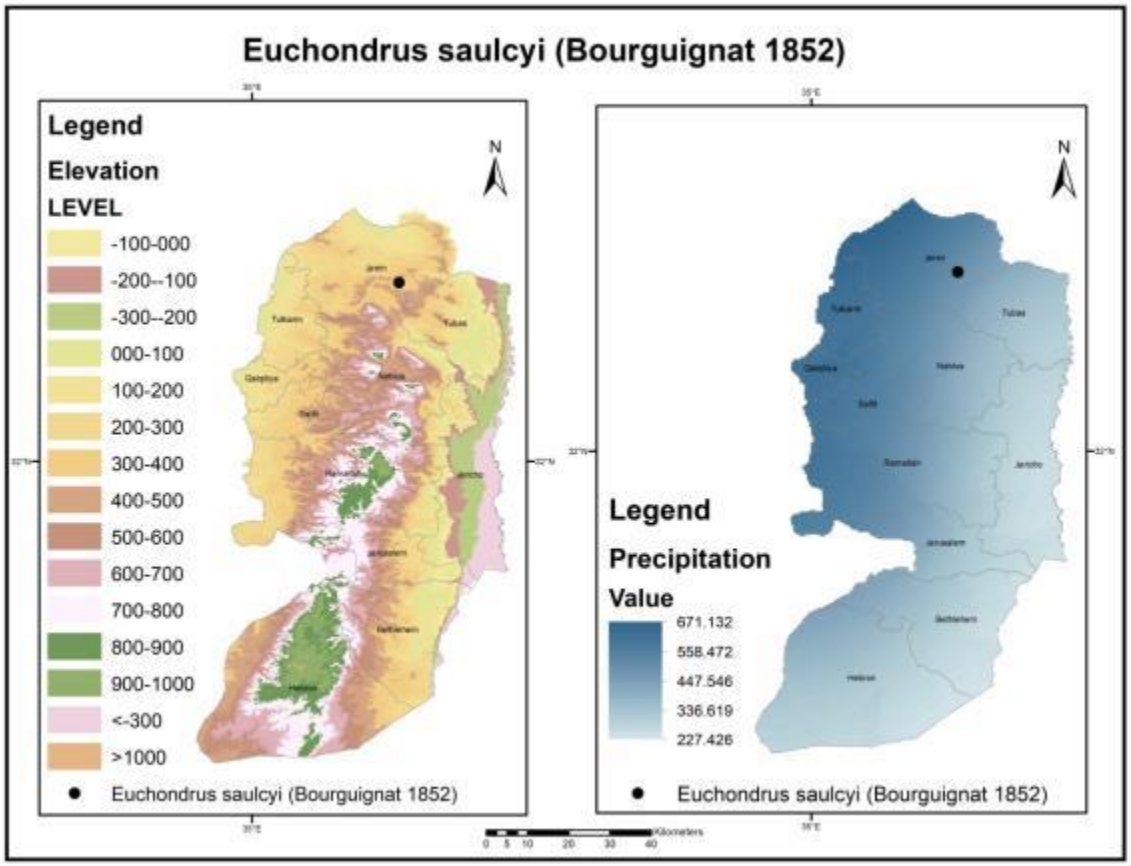


Figure 37. Distribution map for *E. saulcyi* in the West Bank.

***Turanena benjamitica* (Benson, 1859) (Fig. 38 & 39)**

1859 *Bulimusbenjamiticus*, Description of a new *Bulimus* from Jerusalem. Annals and Magazine of Natural History, 3:393-394.

1885 *Bulimus benjamiticus* Benson, The Survey of Western Palestine. The Fauna and Flora of Palestine. The Committee of the Palestine Exploration Fund, I, Adam Street, Adelphi, London, W.C., P. 191.

1971 *Ena benjamiticus*,*Ena benjamiticus* (Benson) in Galilee, Argamon, 2:95-96.

1981 *Ena* (*Turanena*) *benjamitica* (Benson), Neubeschreibungen von Landschnecken aus Palästina, Basteria 45: p. 99, Fig. 2.

**Materials examined:** M1313 (2), Ain Yabroud, 19.3.2016.

**Remarks**: Benson (1859) described *Bulimus benjamiticus (=Turanena benjamitica*) from near Jerusalem. It was recorded from the Galilee (Heler, 1971), Lebanon (Bößneck, 2011) and the Nimrod Fortress on Mount Hermon (Mienis et al., 2012). The genus *Turanena*is represented by several species extending from the Greek Islands, Turkey, Iran, Uzbekistan, Tajikistan and Kyrgyzstan (Bank and Butot, 1990; Bank & Menkhorst, 1992; Gittenberger, 1996). Besides this species in our region there is *Turanena hermonensis*, an endemic species described from Mount Hermon (Forcart, 1981).

**Habitats:** Specimens of this species were collected from one site within the Mediterranean areas characterized by high rainfall. Specimens were found in depressions within the rocks covered with mosses and leaf litter. It was associated with 16 other species of land snails in this locality of Ain Yabroud.

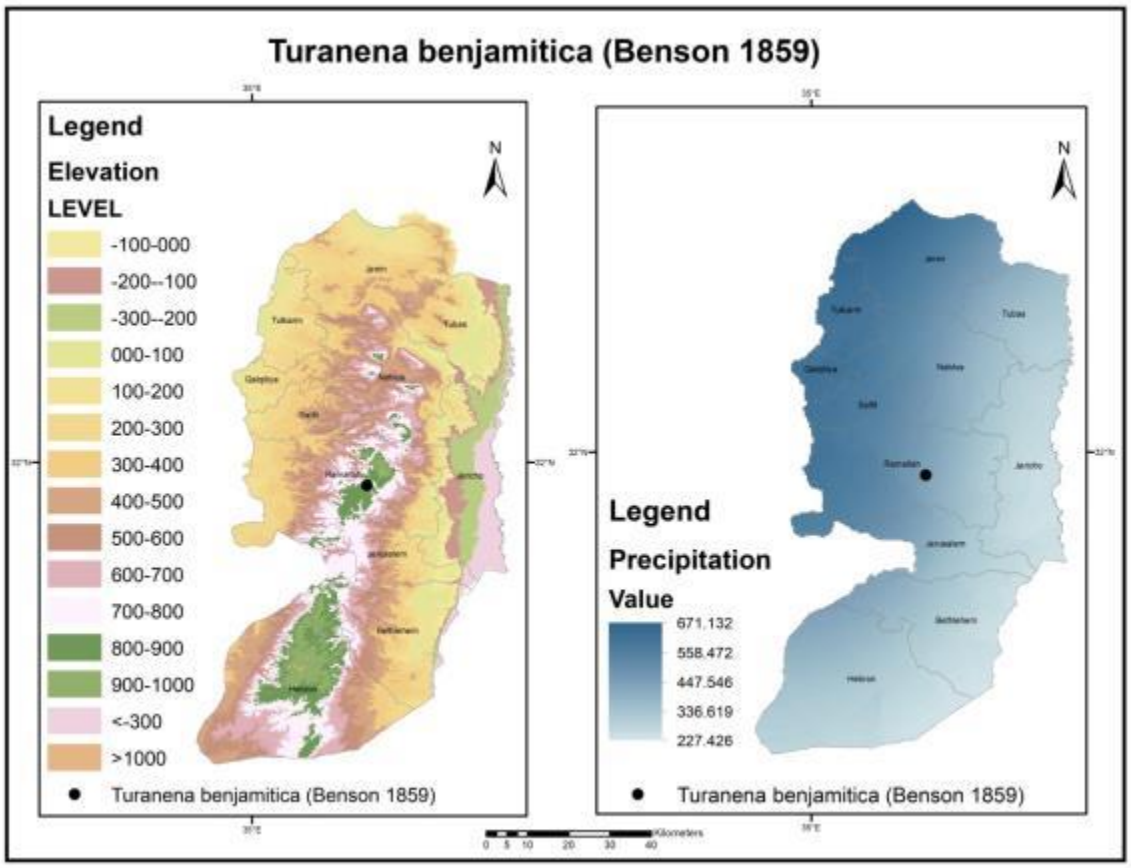


Figure 38. Distribution map for *T. benjamitica* in the West Bank.

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Figure 39. *Turanena benjamitica,* Scale Bar = 5mm.

**Family Clausiliidae**
***Cristataria haasi* (Fig. 40 & 41)**
*Cristataria elonensis* (Haas 1951), Israel
*Cristataria genezerethana haasi* Nordsieck 1971, Israel
*Cristataria haasi kharbatensis* Nordsieck, 1971
Nordsieck, H. 1971. Zur Nomenklatur der *Cristataria*-Arten Palästinas. Archiv für Molluskenkunde, 101 (1/4): 89-90.
1971. Zur Anatomie und Systematik der Clausilien, X. Zur Kenntnis des Genus *Cristataria* Vest 1867, I. — Archiv für Molluskenkunde, 101 (5/6): 237-261, Taf. 14-16.

**Material examined**: M1329 (70), Brukeen, 4.3.2016. M1486 (100), Abood, 31.10.2016. M1493 (10), Nabi Saleh, 11.10.2016.M1371 (2), Bait Illo, 4.3.2016.M1693(3), Abood, 21.1.2016.M1702(20), Dayr Nizam, 21.1.2017.M1714(1), Abood, 21.1.2017.M1889(2),Jayoos, 24.1.2017.M2000 (8), Wadi Al Matwy, 2.2.2017.M2030 (1), Dayr Ballout, 2.2.2017.M2049 (35), Kuffr Al Deek, 10.2.2017.M2156 (10), Brukeen, 2.2.2017.M2207 (1), Msafer Yatta, 15.1.2017.

**Remarks**: This is an endemic species known so far from Palestine never found in other areas. It is varied in length between 12-18 mm height and its diameter between 2.5-3 mm (Heller, 2009). Two subspecies of this endemic species found *C. h. haasi* and *C. h. kharbatensis* need to revise (Forcart, 1975; Hass, 1951).

**Habitat:** it is a Mediterranean species found the semi costal ecological zone, it is found in area with rain fall more than 500mm. This species lives on Karst formation stones and its observed feed on moss.

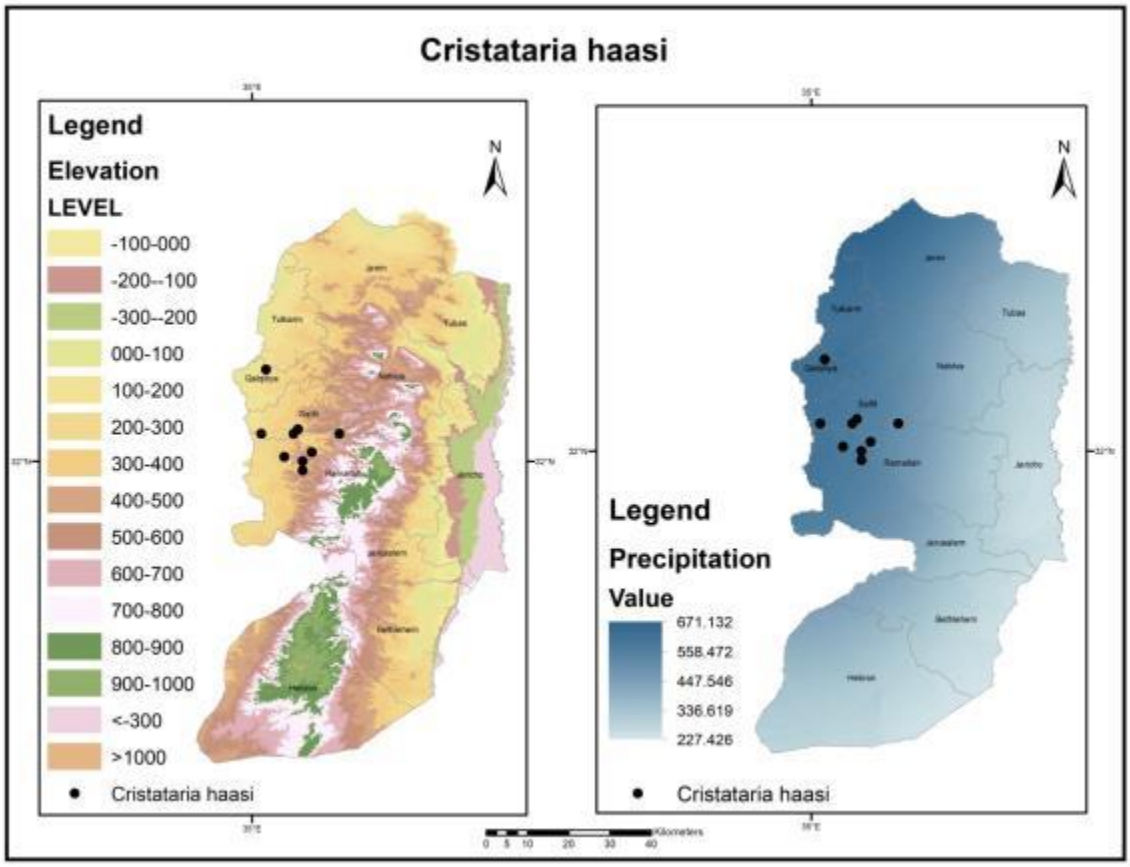


Figure 40. Distribution map for *C. haasi* in the West Bank.

Figure 41. *Cristataria haasi*, Scale Bar = 5mm.

**Family Ferussaciidae**

***Calaxis hierosolymarum* (Roth 1856) (Fig. 42 & 43)**

**Material examined**: M1305 (1), Brukeen, 4.3.2016. M1306 (5), Mar Saba. no date. M1307 (7), Between Kufr Rai and Illar, 4.3.2016. M1324 (1), Jabal Al Fredees, No date.M1325 (7), Um Al Tout, 4.3.2016. M1326 (13), Dayr Qorontol, 29.2.2016. M1327 (10), Wadi Al Alayek, 29.2.2016. M1733 (1), Al Twan, 22.1.2017.M2051 (1), koffr Al Deek, 10.2.2017.

**Remarks**: This transparent species of snails considered as a small land snail, it is an elongated species reach up to 7.5 mm height and 2-3mm in diameter (Heller, 2009). It is range of distribution start from south east turkey, Cyprus cross the Levant ending in south Egypt (Neubert et al., 2015).

**Habitat:** This species found in the Mediterranean, Irano-Turanian, Sudanian zones in the West Bank and it is found in the dark soft soil, and it is found in the old ruins.

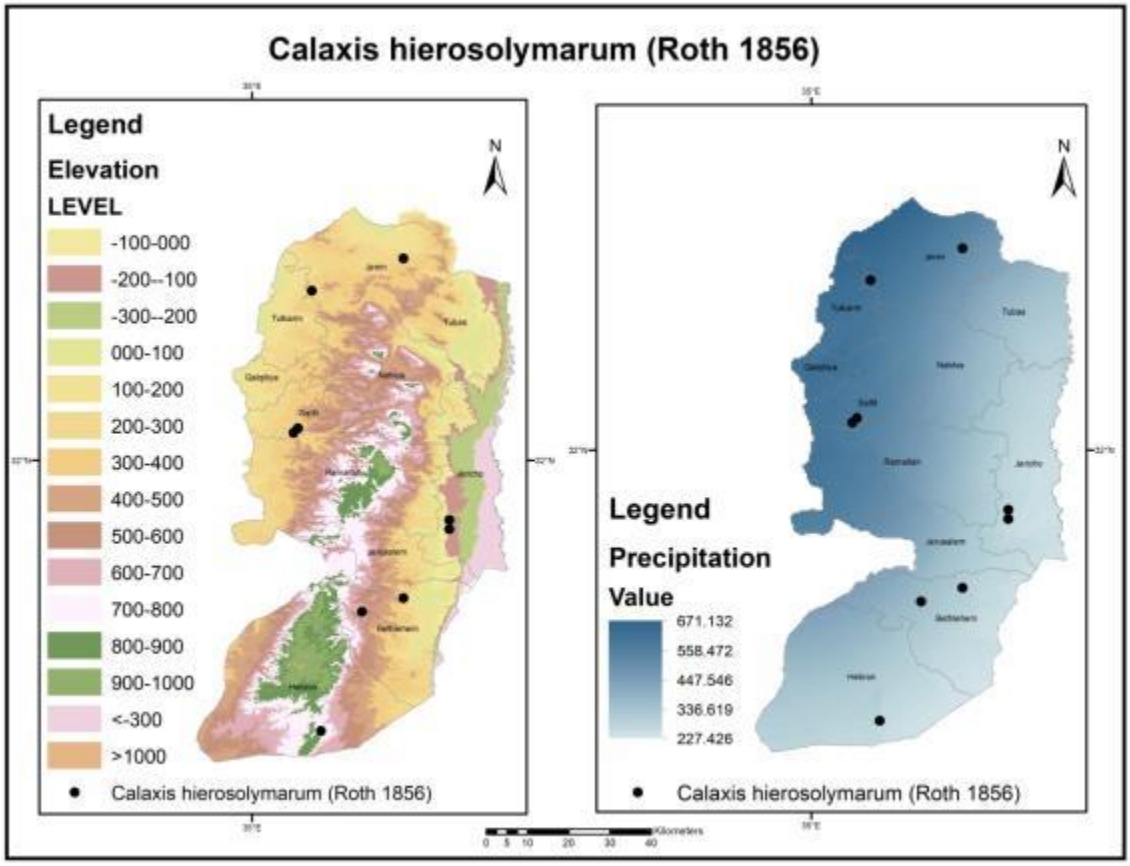


Figure 42. Distribution map for *C. hierosolymarum* in the West Bank.

Figure 43. *Calaxis hierosolymarum,* Scale Bar = 5mm.

***Cecilioides acicula* (O. F. Müller 1774) (Fig. 44 & 45)**

**Material examined:** M1262 (1), Ajul, 19.3.2016.M1303 (1), Al Fasayel, no date.M11524 (2), Dayr Qarantal, 29.2.2016. M1323 (3), Mar Saba, 14.12.2015.
M1812 (3), Al Rashaydah-1, 25.1.2017.M1821 (1), Al Rashaydah-2, 25.1.2017.M2198 (6), Msafer yatta - khalet Bayoud, 31.3.2017. M2201 (1), Khelat el Daba'/ Yatta, 25.3.2017.M2218 (1), Ain Yabroud, 3.3.2017.M2222 (11), Wadi al Heker-Yatta, 25.3.2017.

**Remarks:** This species with feature without teeth like other species of the same family is a rare species found in the Judain mountins (Heller, 2009). This is a wide spread species

in the Mediterranean area (Neubert et al., 2015), and consider an introduces species in the central and northwest Europe, south Africa, New Ziland, Australia and some parts of America (Forsyth et al., 2008).

**Habitat:** This species is found in Mediterranean area generally and it is recorded in both Mediterranean and Irano-Turanian zones, and most of the locations it is found in the south of the West Bank.

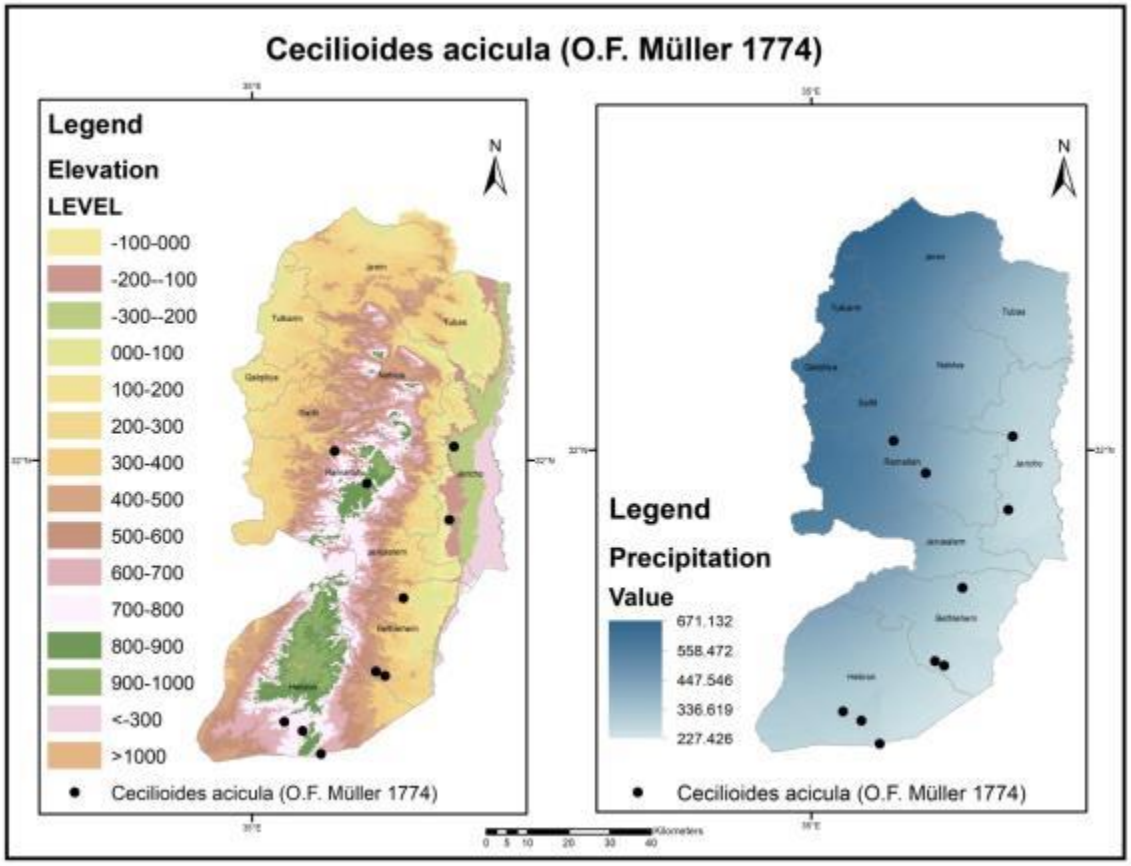


Figure 44. Distribution map for *C. acicula* in the West Bank.

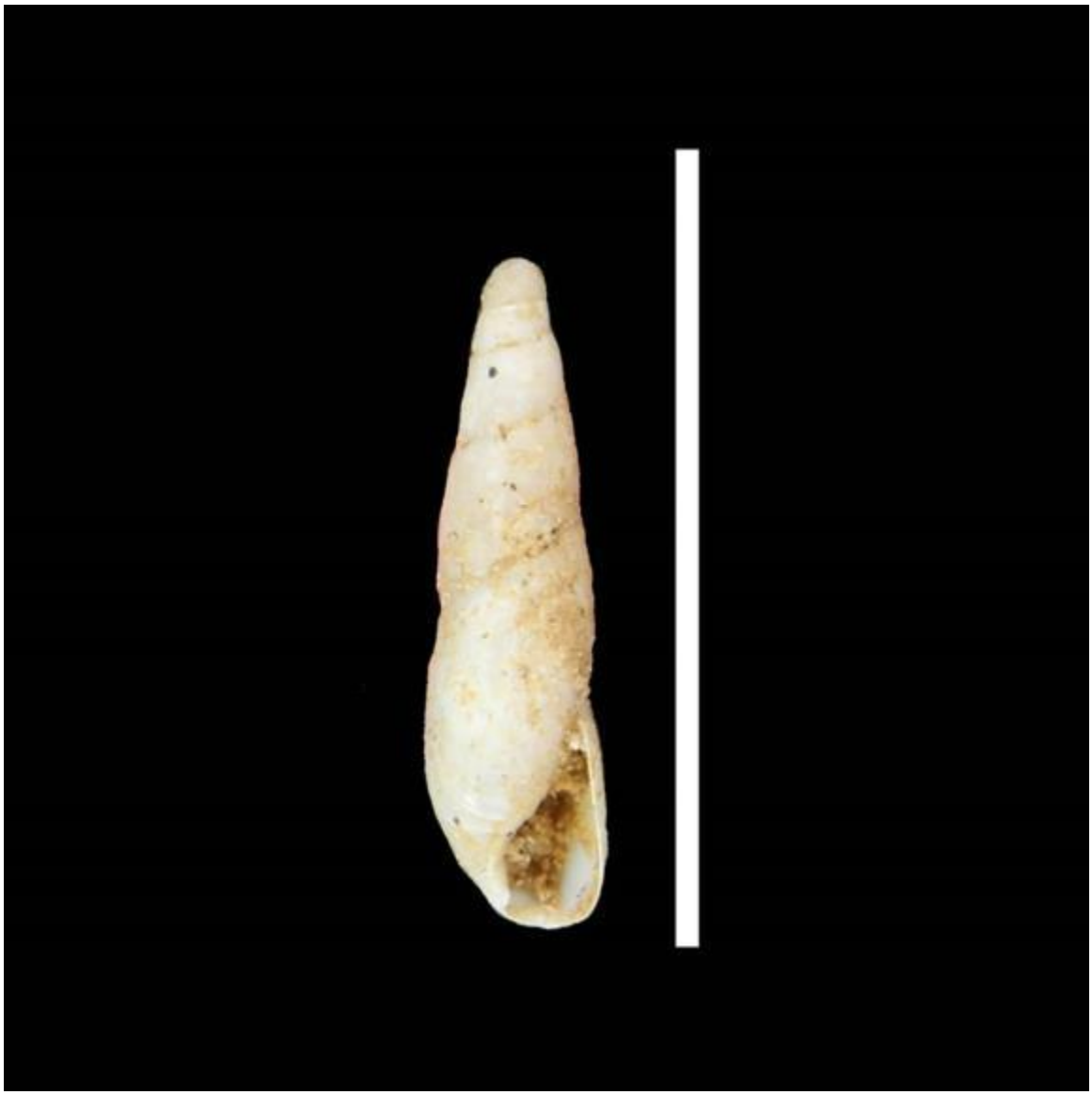

Figure 45. *Cecilioides acicula*, Scale Bar = 5mm.

***Cecilioides genezarethensis* Forcart 1981 (Fig. 46 & 47)**

1981 *Cecilioides genezarethensis* Forcart, Basteria, 45 (4– 5): 103, fig. 9 [Israel, Huleh Lake, Wadi Mandaj].

**Material examined:** M1304 (5),Al Jiftlik, 21.3.2016.M1328 (3), Um Al Tout, 4.3.2016.M1544 (3), Marj Na'jah, 10.10.2016.M1609 (3), Wadi Sareda, 19.9.2016.M2196 (1), Al Berka/ Yatta, 25.3.2017.M2197 (1), Msafer Yatta-Khalet Bayoud, 31.3.2017.M2200 (1), Al Berka/ Yatta, 25.3.2017.M2203 (4), Ain Yabroud, 3.3.2017.M2211 (7), Wadi Al Hour/Yatta, 8.4.2017.M2220 (1), Twan/Yatta, 25.3.2017.

**Remarks**: This is a difficult species to found alive, all our record for this species comes from dead old shells found in soft dark soil (Neubert et al., 2015). This species only

found alive in karstic cave near Ma'ale Efraim in 1989 which is located northwest Ain Fassayl in the West Bank (Heller et al., 1991).

**Habitat:** This species has been found in many areas in the West Bank from the south to the north, and it is found in the Mediterranean and Sudanian penetration zones.

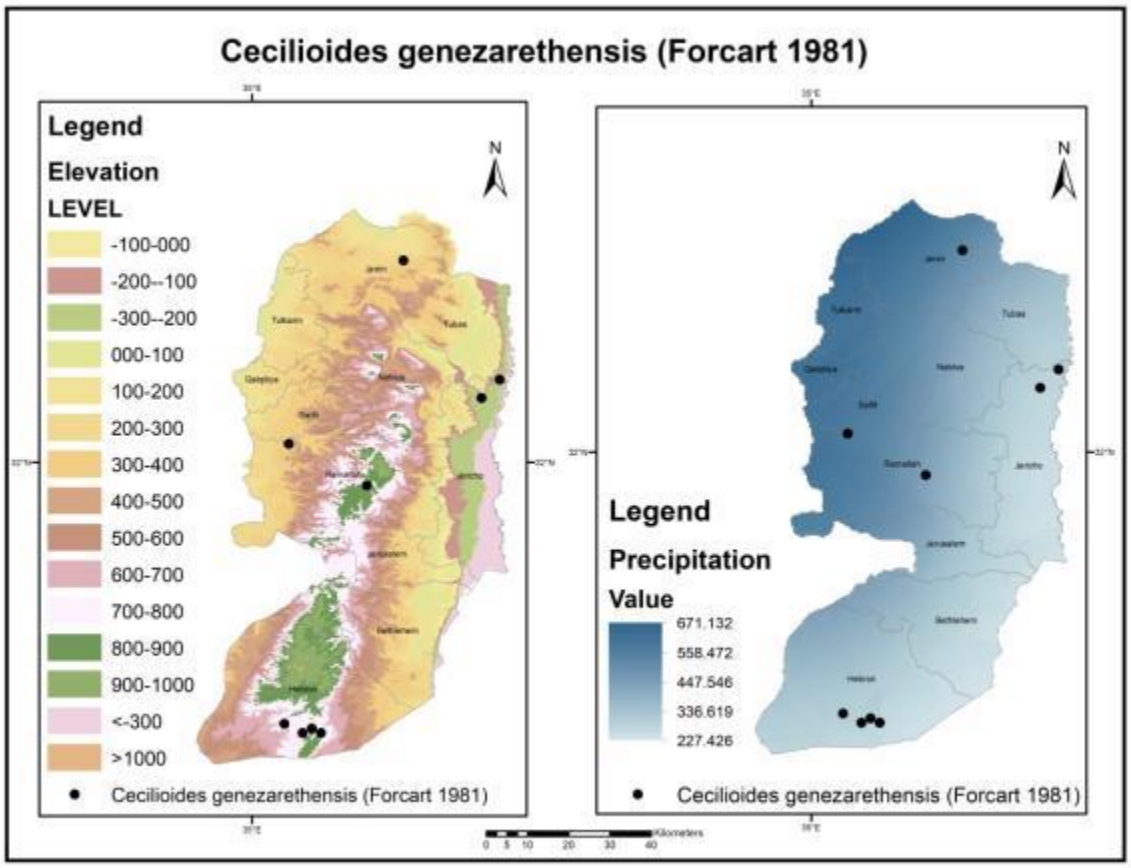


Figure 46. Distribution map for *C. genezarehensis* in the West Bank.


Figure 47. *Cecilioides genezarethensis*, Scale Bar = 5mm.

**Family Subulinidae**

***Rumina decollata* (Linnaeus1758) (Fig. 48)**
1758 *Helix decollata* Linnaeus, Systema Naturae, ed. 10: 773.
**Material examined:** M1988 (2), Bethlehem, 16.2.2017.

**Remarks**: This is an invasive species found only from one location – Bethlehem- in the West Bank. Fisher and Orth, (1985) mentions that this species is introduced to the Mediterranean region and can dominate other species of land snails. This invasive species has even reached the USA (Neubert et al., 2015).
**Habitat:** It is found in the found in house gardens in moderate Mediterranean areas like Bethlehem University garden wee we collected it near rose flowers in moderate numbers (no other land snails were noted around the same bushes).


Figure 48. *Rumina decollate*, Scale Bar = 5mm.

**Family Oxychilidae**

***Eopolita protensa jebusitica* (Roth 1855) (Fig. 49 & 50)**

1855 *Helix jebusitica* Roth, Malakozoologische Blätter, 2 (1): 24, Tab. 1, Figs 3–5 [in fissuris rupium prope lacum Gihon agri Hierosolymitani et in valle Hinnom ad locum Hakeldama].

**Material examined:** M114 (5),Ajul, 18.3.2016.M177 (25),Mar Saba, 14.12.2015.M207 (1),Wadi Qana, 1.2.2014.M338 (1),Um Al Tout, 4.3.2016.M347 (1),Dayr Qurntul, 1.2.2016.M481(3),Sakka, 14.3.2016.M346 (2), Sabastia, 16.2.2014.M348 (1), Jinen, 2.2.2012.M349 (2), Wadi Al Quff, 21.2.2014.M1288 (1),Brukeen, 4.3.2016.M1290 (1), Dayr Al Ghousoon, 4.3.2016.M1291 (1),Ain Yabroud, 19.3.2016.M1311 (2),Brukeen,

4.3.2016.M1340 (8), Ain Nonqor, 18.5.2016.M1346 (1), Jenin, 2.2.2016.M1350 (1), Wadi Sareda, 19.9.2016.M1359 (4), Bait Illo, 1.8.2016.M1389 (5), Kufr Nea'mah, 26.5.2016.M1395 (6), Ain Yabroud, 12.4.2016.M1412 (7), Ain Yabroud, 1.4.2016.M1436 (4), Nahaleen, 25.5.2016.M1437 (1), Al Doha, 30.3.2016.M1445 (4), Ain Yabroud, 18.3.2016.M1503 (3), Zababdeh, March 2016.M1611 (1),Ethna, 1.11.2014.M1619 (3), Battir, 11.5.2016.M1623 (1), Al Rawabi, 3.8.2016.M1631 (2), Wadi Al Makhrour, 26.11.2016. M1632 (1), Wadi Al Makhrour, 15.1.2017.M1640 (7), Battir, 11.9.2016.M1654 (7), Wadi Al Makhrour, 16.1.2016.M1696 (3), Dayr Nizam, 21.1.2017.M1707 (8), Abood, 21.1.2017.M1731 (1), Ain Yabroud, 21.1.2017.M1736 (4), Wadi Al Makhrour, 15.1.2017.M2016 (3), Battir, 8.2.2017.M2026 (1), Dayr Ballout, 2.2.2017.M2033 (1), Ain Yabroud, 10.2016.M2042 (21), kufr Al Deek, 10.2.2017.M2132 (18), Ain Yabroud, 3.3.2017.M2137 (9), Battir, 2.2.2017.M2139 (1), Nahaleen, 8.3.2017.M2142 (4), Kufr Al Deek, 10.2.2017.M2154 (2), Wadi Bhour/Yatta, 8.4.2017.M1552 (2), Ajul, 28.2.2017.

**Remarks**: This species a common species in the West Bank, with a light brown transparent color to milky white transparent (Neubert et al., 2015 ; Heller, 2009). Our subspecies in Palestine is *E. p. jebusitica* which is different from the nominal species by crisscross of the spiral and radial grooves (Heller, 2009).

**Habitat:** This is a widely distributed species in the West Bank in the Mediterranean and Sudanian zones. It is found under rocks and boulders both by us and by Heller (2009). This species recorded from dry areas in Lebanon were we found it most of the times in Mediterranean areas (Bößneck, 2011).

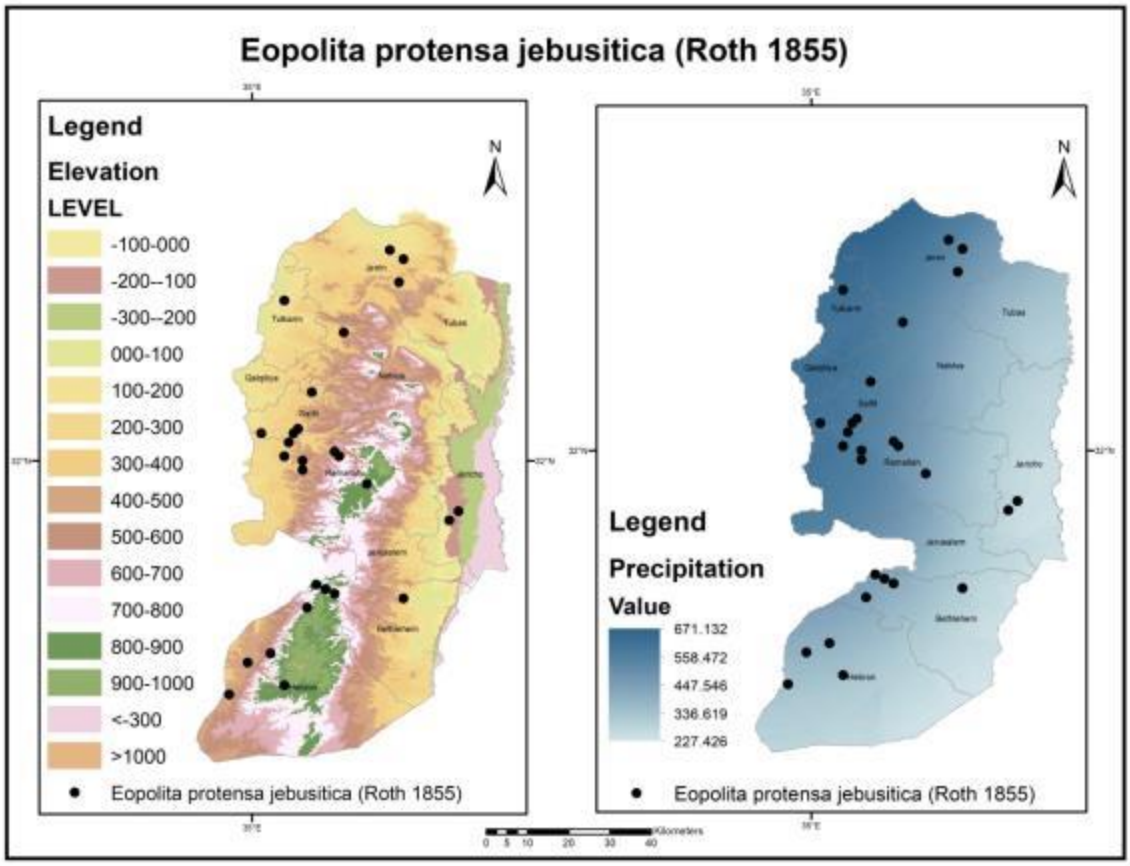


Figure 49. Distribution map for *E. p. jebustica* in the West Bank.

Figure 50. *Eopolita protensa jebusitica*, Scale Bar = 5mm.

**Family Sphincterochilidae**

***Sphincterochila fimbriata* (Fig. 51 & 52)**

1852*Helix fimbriata* Bourguignat, Testacea novissima: 11 [Palaestinam, in montibus, ac, locis sole calefactis circa mare Mortuum].

1861 *Helix candidissima* var. *hierochuntina* Mousson, Vierteljahresschrift der Naturforschenden Gesellschaft Zürich 6: 24 ["...Damas..., Marsaba...., environs de Jerusalem, ex Boissier].

1861 *Helix candidissima* var. *minuta* Mousson, Vierteljahresschrift der Naturforschenden Gesellschaft Zürich 6: 23 ["...Jaffa..., Marsaba...., environs de Jerusalem, ex Boissier].

**Material examined:** M183 (4), Mar Saba, 14.12.2015.M186 (7), Ne'mah, 21.3.2016.M205 (5), Ne'mah, 21.3.2016.M216 (9), Marah Rabah, 15.3.2014.M344 (6), Al Jiftlik, 21.3.2016.M356 (15), Wadi Al Qelt, 23.2.2015.M484 (2), Jabal Al Fredees,

4.13.2015.M485 (3), Yatta (al Boybe), 14.3.2016.M486 (19), Wadi Said (Al Dhahreyeh), 14.3.2016.M487 (5), Wadi Al Quff, 21.3.2014.M488 (12), Sair, 11.4.2015.M489 (3), Bait Sahor, 20.5.2013.M490, Wadi Al Quff, 21.3.2014.M491 (3), Artas, 12.1.2014.M493 (30), Nabi Musoa, 2.2.2014.M500 (2), Wadi Al Qelt, 20.6.2013.M501 (6), Sa'ir, 1.4.2013.M502 (3), Artas, 12.1.2014.M504 (11), Mar Saba, 13.1.2014.M505 (6), Wadi Mikhmas, 27.4.2013.M509 (2), Mar Saba, 13.1.2014.M511 (4), Bardala, 18.4.2014.M516 (1), Bethlehem, 11.1.2014.M517 (2), Nahaleen, 2.5.2013.M519 (1), Mar Saba, 22.6.2013.M520 (3), Wadi Mikhmas, 23.5.2013.M521 (1), Yatta, 29.1.2013.M523 (1), Wadi Mikhmas, 2.5.2013.M524 (3), Ain Yabroud, 6.3.2014.M525 (11), Nahaleen, 3.3.2015.M526 (1), Battir, 24.11.2013.M529 (2), Mar Saba, 13.1.2014.M530 (6), Wadi Al Qelt, 4.11.2013.M531 (1), Al Auja, 4.11.2013.M533 (6), Al Za'iem, 13.5.2013.M534 (2), Wadi Mikhmas, 27.4.2013.M532 (8), Nabi Saleh, 2.5.2013.M539 (1), Al Auja, no date.M541 (5), Wadi Mikhmas, 20.3.2014.M543 (1), Wadi Al Quff, 28.11.2015.M545 (1), Ubeidiya, 13.5.2013.M547(4), Bani Naim, 7.4.2013.M719 3(), Al Fasayel, 21.3.2016.M739 (7), Wadi Al Quff, 21.3.2014.M743 (1), Wadi Al Quff, 8.3.2014.M804 (1), Wadi Mikhmas, 27.4.2013.M807 (1), Sa'ir, 1.4.2013.M827 (1), Wadi Al Qelt, 15.11.2013.M829 (1), Mar Saba, 22.6.2013.M853 (4), Mar Saba, 13.1.2014.M862 (1), Al Za'iem, 13.5.2013.M870 (1), Wadi Al Quff, 30.8.2013.M898 (1), Nabi Saleh, 3.5.2013.M963, Battir, 24.11.2013. M966 (2), Nabi Mousa, 2.2.2014.M967 (2), Wadi Al Qelt, 15.11.2013.M969 (2), Bait Sahur, 20.5.2013.M981 (3), Al Auja, 11.4.2013.M972 (3), Wadi Mikhmas, 23.5.2013.M973, Wadi Al Qelt, 4.11.2013.M975 (3), Mar Saba, 13.1.2014.M976 (1), Wadi Mikhmas, 23.5.2013.M979, Al Auja, 27.3. 2013. M982 (6), Wadi Al Alayek, 21.1.2015.M983 (9), Bathlehem, Jaunary 2014. M1111 (1), Wadi Al Qelt, 14.11.2013.M1505 (4), Mar Saba, 30.5.2016. M1525 (8), Jericho-Dead Sea intersection, 12.1.2015.M1529 (11), Bardala, 10.10.2016.M1532 (28), Marj Na'jah, 10.10.2016.M1569 (7), Mar Saba, 14.12.2016.M1577 (2), Wadi Al Makhrour, 26.11.2016.M1589 (7), Wadi Mikhmas, 7.11.2016.M1677 (10), Modrajat Jericho, February, 2016.M1681(1), Wadi Abu Al Alayek, 21.1.2015.M1682(2), Nea'mah, 21.3.2016.M1711(3), Al Twan, 22.1.2017.M1734(1), Wadi Al Qelt, 6.1.2016.M1749(1), Jericho-Ramallah intersection, 12.1.2015.M1757(11), Al Jitha, 12.12.2016.M1769(4), Al Rashaydah-1, 25.1.2017.M2189 (4), Msafer Yatta/ Khalet Bayoud, 31.3.2017.M2190 (4), Khelat el Daba'/ Yatta, 25.3.2017.M2191 (5), Tamoun, 7.4.2017.

**Remarks**: this is a widlly distributied species found in the mid and south of the West Bank of Palestine. A medium-sized shell with elevated spire, white color with hard and thick shell, this species have varaity in shapes and could described subspecies from it population after fearther studies (Heller, 2009; Neurbert et al., 2015). A study used carbon and oxygen isotpes on arid and semi arid land snails and look to the kind of vegetation (C3 and C4 plants) could use as indicator for desertification (Goodfriend and Magaritz, 1987).

**Habitat:** This species was found in all the biogeographical zones in the West Bank but highest population was noted in the arid and semi arid areas and was less abundant in the mesic areas Mediterranian zone.

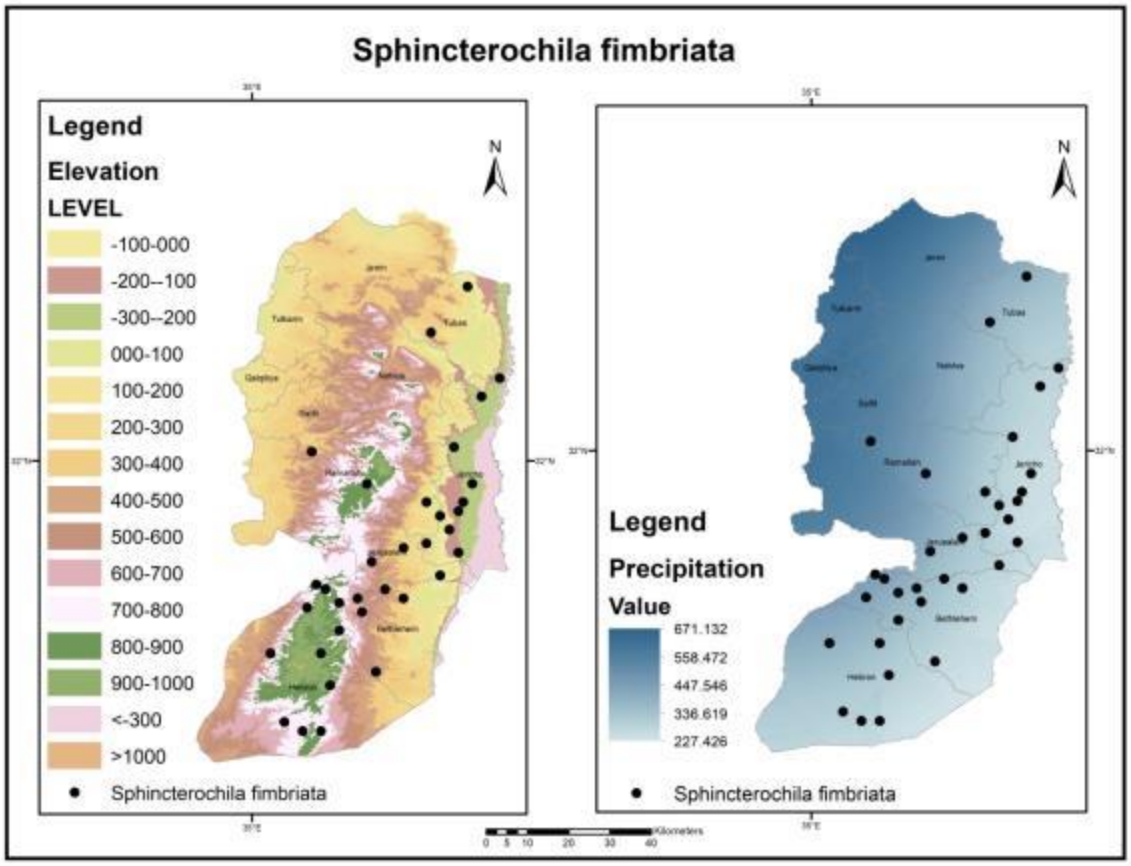


Figure 51. Distribution map for *S. fimbriata* in the West Bank.


Figure 52. *Sphincterochila fimbriata*, Scale Bar = 5mm.

***Sphincterochila prophetarum* (Bourguignat 1852) (Fig. 53)**

1852 *Helix prophetarum* Bourguignat, Testacea novissima quae Cl. De Saulcy in itinere per Orientem annis 1850 et 1851 collegit: 12 [Palaestinam, in locis aridis circa Hierosolymam urbem, etc.....].

**Material examined:** M209 (11), Qumran, 16.3.2016.M493 (30), Nabi Mousa, 2.2.2014.M518 (7), Nabi Mousa, 24.1.2014.M528 (1), Nabi Mousa, no date.M736 (2), Nabi Mousa, 21.1.2014.M902 (2), Nabi Mousa, 2.2.2014.M960, Nabi Musa, 21.1.2014.M1373 (1), Wadi Al Darja, 9.5.2016.

**Remarks**: This is a desert species with medium scize of shell, white in color with thick hard to breack shell (Neubert et al., 2015). This is a weel adapt species to the desert climate and habitat (Mienis1978; Petney & Huset 1992). Shows a grat ability to control

the organic storage food which it consume 0.2% per day in summer dry season (Steinberger et al., 1982).

**Habitat:** This is a desert species found in the arid and the semiarid areas in the West Bank in the Saharo Arabia and Sudanian zones. All our own collection comes from areas near the Dead Sea.

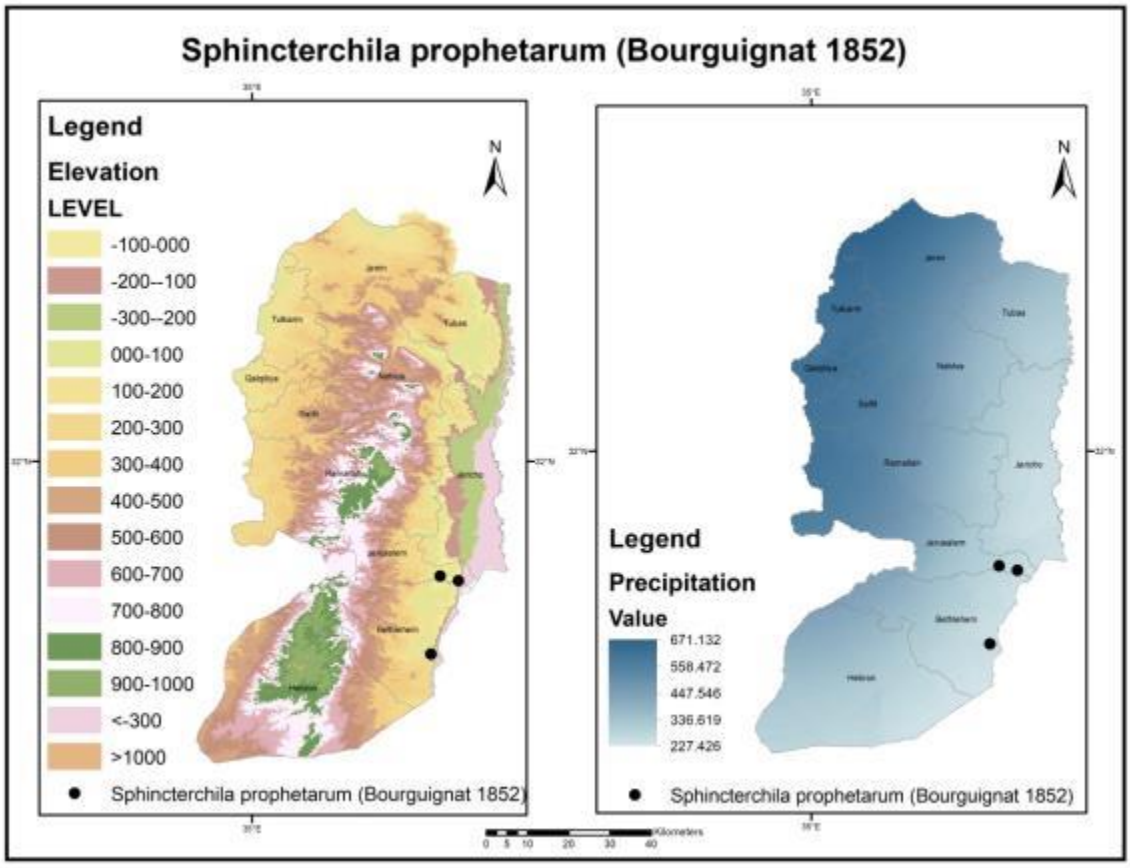


Figure 53. Distribution map for *S. prophetarum* in the West Bank.

***Sphincterochila zonata zonata* (Bourguignat 1853) (Fig. 54 & 55)**

**Material examined:** M1344 (21), Wadi Al Daraja, 5.9.2016.M225(14), Bani Naim, 7.4.2013.M202 (2), Zarb Khryan, 26.12.2014.M1244 (21), Jericho-Dead Sea intersection, 16.3.2016.M190 (4), Wadi Al Taa'mrah, 3.6.2015.M506 (1), Auja, 11.4.2013.M1344 (26), Wadi Al Daraja, 5.9.2016.M1765 (17), Wadi Al Daraja, 25.1.2017.M1770 (7), Wadi Al Daraja-1, 25.1.2017.M1774 (6), Hasasah-2, 25.1.2017.M1775 (13), Hasasah-1, 25.1.2017.M1778 (24), Al Rashaydah, 25.1.2017.M1779 (5), Hasasah-3, 25.1.2017.M1785 (14), Maksar Qa'adan, 25.1.2017.M1791 (3), Hasasah-4, 25.1.2017.M1799 (7), Zarb Khryan, 25.1.2017.M1806 (1), Hasasah-5, 25.1.2017.M2193 (10), Msafer Yatta, 15.4.2017.

**Remarks**: This is a large species of land sanils with heavy, white and thick shell (Neubert et al., 2015).

**Habitat:** This species was noted in the Saharo Arabia and Sudanian zones and was common along the mountains overseeing the Dead Sea region (rainfall less than 150 mm/year). The snails are highly adapted to arid climate and were reported by Heller (2009) to be active about 20 days per year (reproductive and feeding cycle).

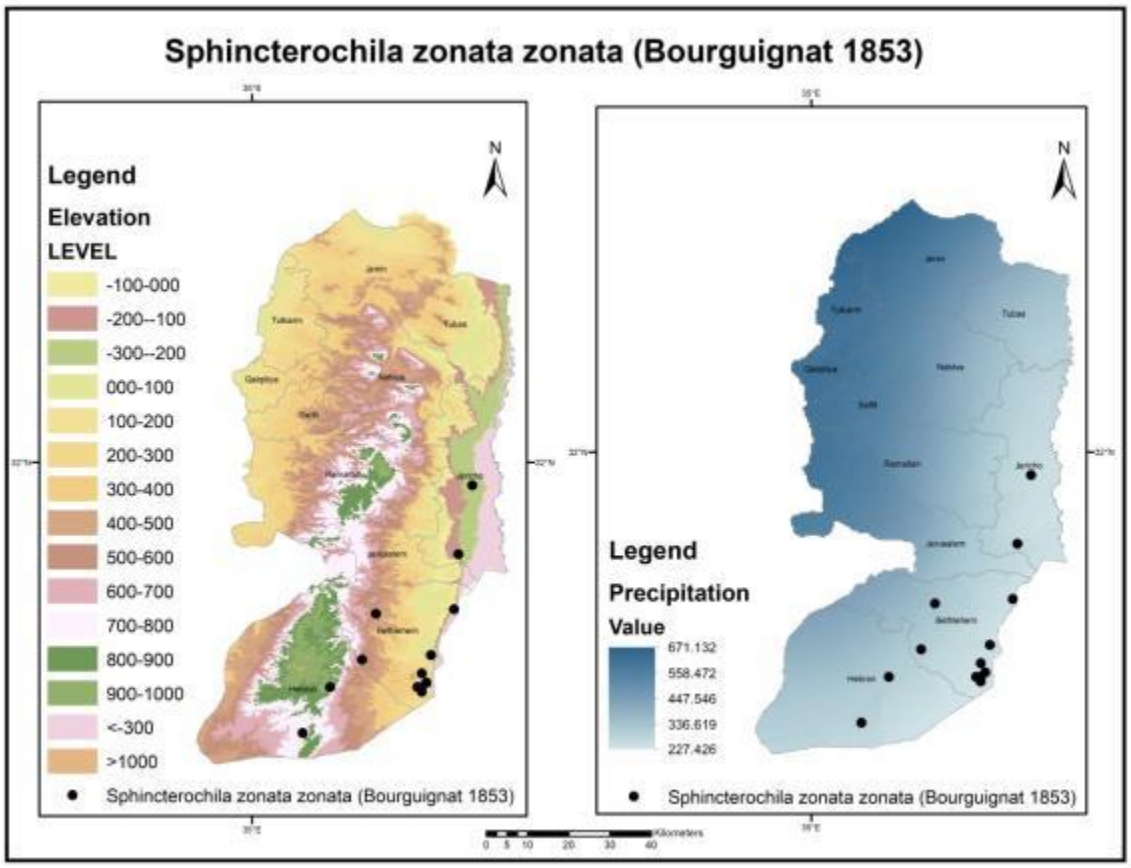


Figure 54. Distribution map for *S. z. zonata* in the West Bank.

Figure 55. *Sphincterochila zonata zonata*, Scale Bar = 5mm.

***Sphincterochila cariosa* (Olivier 1804) (Fig. 56 & 57)**
1804 *Helix cariosa* Olivier, Voy. Othoman, II, p. 221, pl. 31, fig. 4a, b [Barut = Beirut].
**Material examined:** M124 (6), Dayr Ballout, 10.8.2015.M132, Wadi Qana, 26.1.2015.M178 (18), Nabi Saleh, 4.5.2013.M181 (7), Wadi Fukeen, 9.8.2014.M184 (4),Sabastia, 1.2.2014.M185 (2), Bethlehem, 11.1.2014.M187, Wadi Al Quff, 22.3.2014.M192 (3), Battir, 16.2.2014.M193 (7), Dayr Ballout, 10.8.2015.M200 (4), Ain Yabroud, 6.3.2014.M201 (5), Wadi Al Quff, 8.3.2014.M203 (16), Artas, 12.1.2014.M204 (3), Salfeet, 3.5.2012.M206 (2), Ain Kenya, 15.8.2014.M208(6), Bait Wazan, 19.3.2016.M209 (16), Al Tairah, 3.8.2015.M247 (2), Dayr Ballout, 10.8.2015.M270, Brukeen, 30.11.2015.M286 (5), Bir Zait, 2.9.2015.M290 (16),Al Tairah, 3.8.2015.M303 (2),Al Walaja, 8.8.2014.M333 (4), Brukeen, 10.11.2015.M544, Wadi Al Quff, 24.1.2015.M555 (1),Khursa, 2.5.2013.M556 (12), Kufr Raa'i-Illar, 4.3.2016.M557 (4),

Wadi Fukeen, 7.3.2014.M 558 (1),Wadi Fukeen, 9.8.2014.M559 (2), Wadi Al Qarn Reserve, 4.3.2016.M560 (2), Dayr Al Ghousoon, 4.3.2016.M562 (11), Wadi Fukeen, 18.1.2014. M563 (3), Ajool, 19.3.2016.M564 (8), Wadi Al Hrameyeh, 13.3.2016.M565, Wadi Al Quff, 30.8.2013.M567 (4),Nabi Saleh, 3.5.2013.M985, Bethlehem, 22.6.2013.M996, Wadi Al Quff, 30.8.2013.M1004 (2),Nabi Saleh, 4.5.2013.M1361 (19), Bait Illo, 1.8.2016.M1378(9),Al Jaba'ah, 27.5.2016.M1379, Gaba'ah, 25.5.2016. M1393 (4), Kufr Nemaah, 26.5.2016.M1471 (10), Nahaleen (ain Faris), 25.5.2016.M1478 (2), Zababdeh, 1.3.2016.M1479, Zababdeh, March 2016.M1480 (44), Abood, 31.10.2016.M1522 (5), Bait Lid, 1.2.2014.M1606 (5), Wadi Sareda, 19.9.2016.M1625 (5), Al Rawabi, 3.8.2016.M1695 (7), Dayr Nizam, 21.1.2017.M1716 (5), Abood, 21.1.2017.M1986 (12), Wadi Al Matwy, 2.2.2017.M1995 (1), Nahaleen, 8.2.2017.M2013 (2), Wadi Qana, 2.2.2017.M2024 (9),Dayr Ballout, 2.2.2017.M2045 (26), kuffr Al Deek, 10.2.2017.

**Remarks**: This is a medium sized snail with white color and rought dorsal shell (Heller, 2009), This species has variation in shell shape (Neubert et al., 2015). This regionally endemic species is found in Palestine and Lebanon and some remains were noted in Jordan (Bößneck, 2011; Neubert et al., 2015).

**Habitat:** This is a species of land snails found on Mediterranean hills with only one record for it from the Sudanian penetration area. This species recorder to be a prey for the spine mouse in Palestine (Broza and Nevo, 1994).

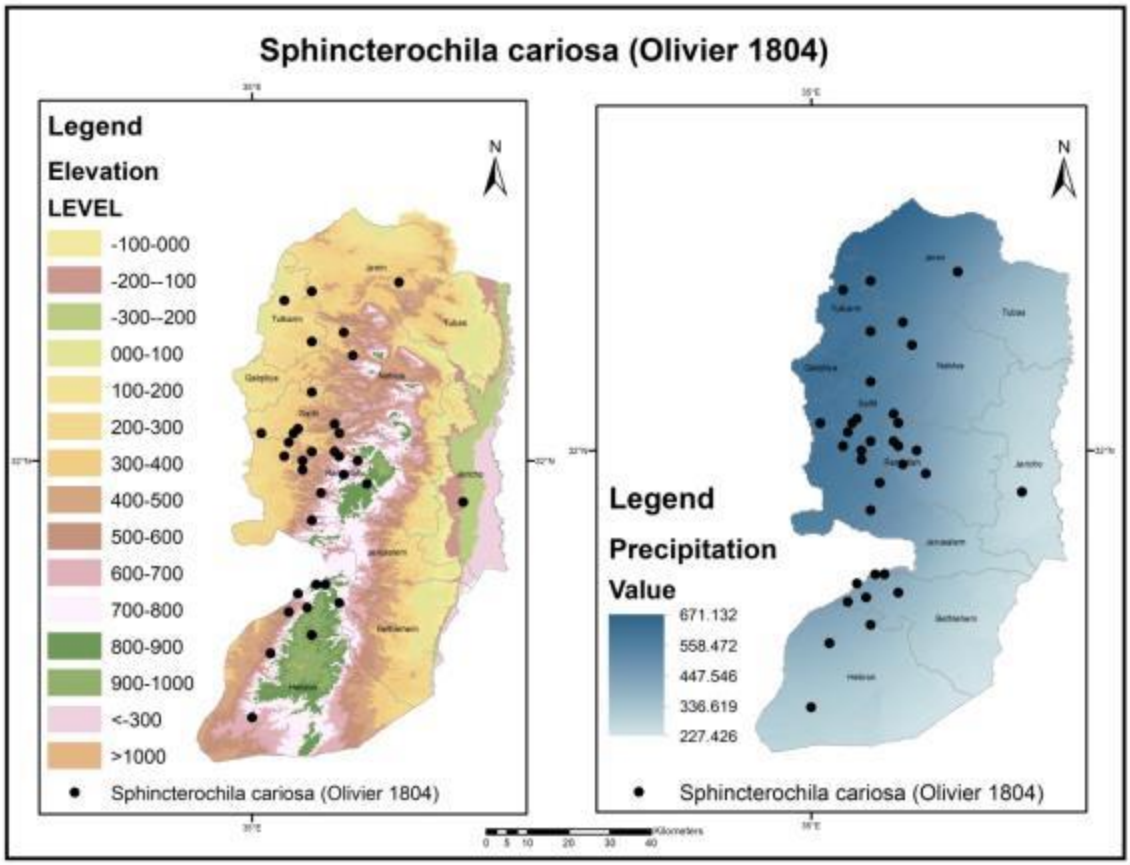


Figure 56. Distribution map for *S. cariosa* in the West Bank.


Figure 57. *Sphincterochila cariosa*, Scale Bar = 5mm.

**Family Cochlicellidae**

***Cochlicella acuta* (O. F. Müller 1774) (Fig. 58 & 59)**
1774 *Helix acuta* O. F. Müller, Vermium terrestrium et fluviatilium, 2: 100 [In Italia].
**Material examined:** M1247(11), Kishda, 16.12.2015.M1649(20), Al Aroub Nursery, 7.12.2016.

**Remarks**: This is and introduced species in Palestine (Roll et al., 2009). With a conical shape and dark strips on the shell this species found in the Ministry of Agriculture green houses and gardens. It may come with the imports plants. More studies and observation on this species to understand if it will reach a population (Neubert et al., 2015).
**Habitat:** This species found in the Mediterranean and Irano Turanian zones.

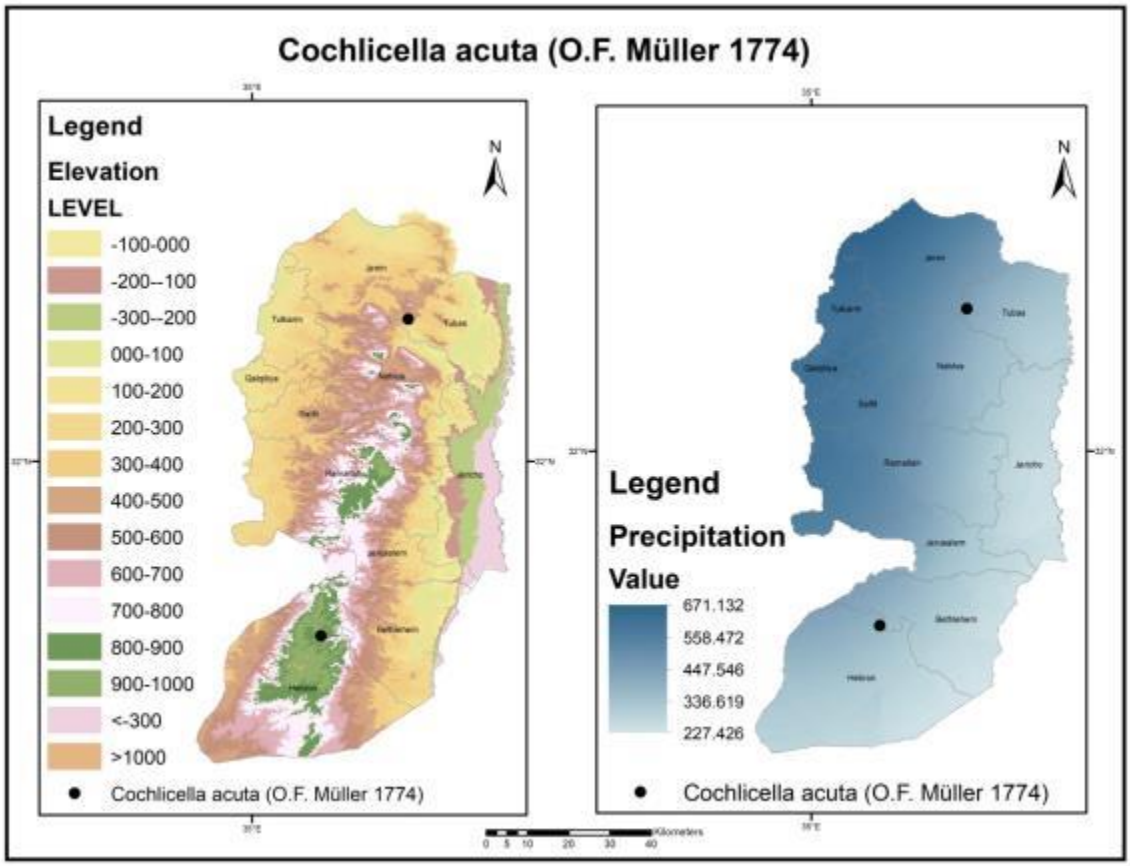


Figure 58. Distribution map for *C. acuta* in the West Bank.

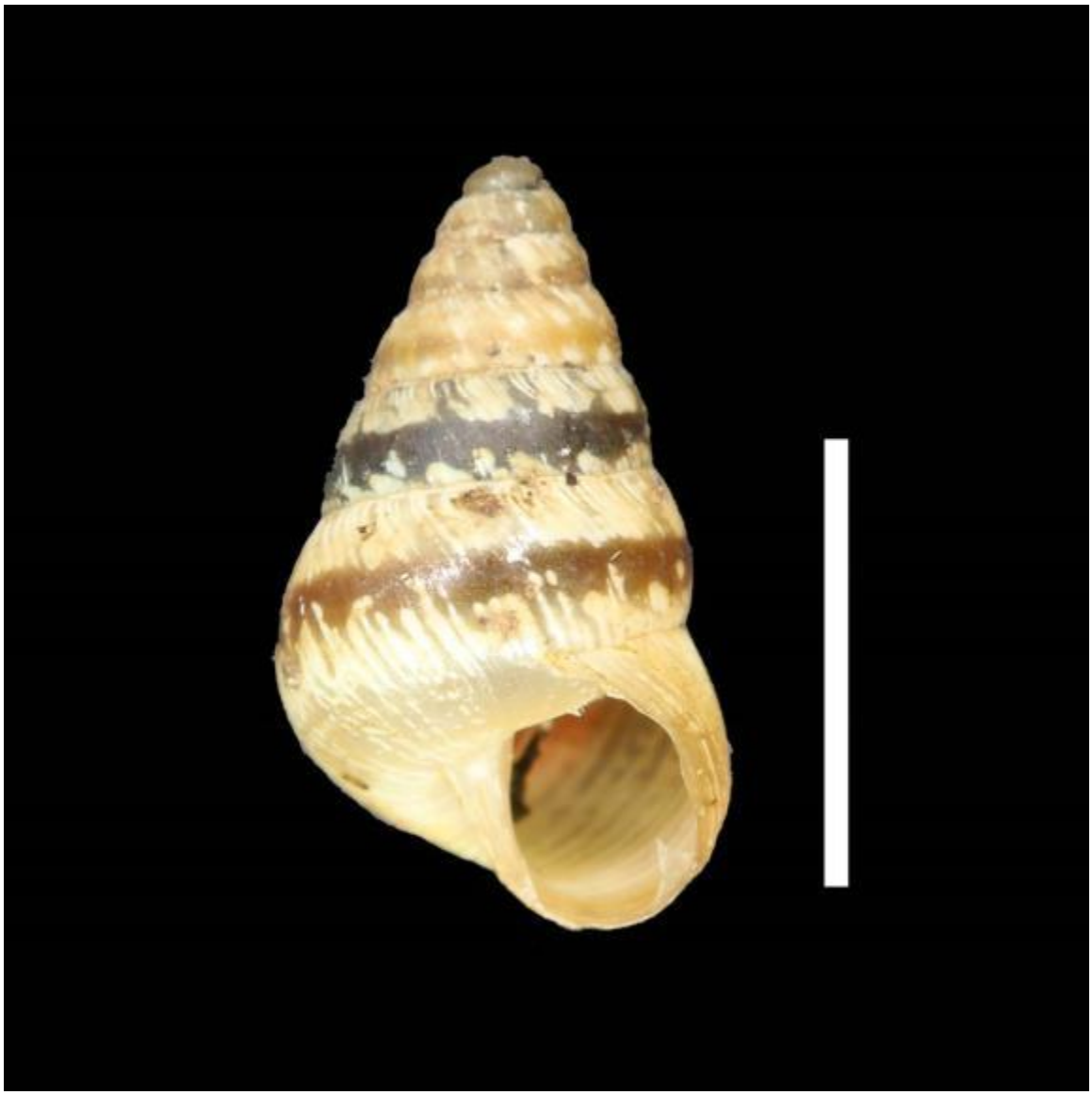

Figure 59. *Cochlicella acuta,* Scale Bar = 5mm.

**Family Hygromiidae**

***Monacha obstructa* (L. Pfeiffer 1842) (Fig. 60 & 61)**
1842*Helix obstructa* L. Pfeiffer, Symbolae ad Historiam Heliceorum, II: 35 [Tripoli].

**Material examined:** M217 (25), Wadi Al Makhrour, no date.M222 (2), Matahen Al Sokar, 11.1.2016.M384 (9), Dayr Qurntul, 1.2.2016.M456 (7), Dayr Qorontol, 29.2.2016.M464 (2), Jin Safut, No date.M468, Battir, 16.2.2014.M469 (4), Bardalh, 18.4.2014.M472(2), Al Walaja, 24.11.2013.M473 (2), Wadi **Fukeen**, 18.1.2014.M475, Sikhnin, 18.2.2014.M476, Mraha Rabah, 15.3.2014. M478 (7), Wadi Al Bathan, 17.9.2015. M479 (11), Jin Safut, 9.7.2013.M1673 (2), Aroub, 7.12.2016.M1991 (6),

Nahaleen, 8.2.2017.M1993 (1), Wadi Al Matwy, 2.2.2017.M2184 (1), Al Qarn Reserve, 26.2.2017.

**Remarks**: M. obstructa known in some countries as a pest feed on plants and need to be controlled, which they could reach an insecticide that could kill the eggs of this species (Shoaib et al., 2010). This is a medium size species dark to light brown (Heller, 2009). It's distribution reach from Egypt to southern Turkey to Pakistan (Neubert et al., 2015).
**Habitat:** This species found in the Mediterranean and Irano Turanian zones, found always on plants and dead shells found some times under rocks.

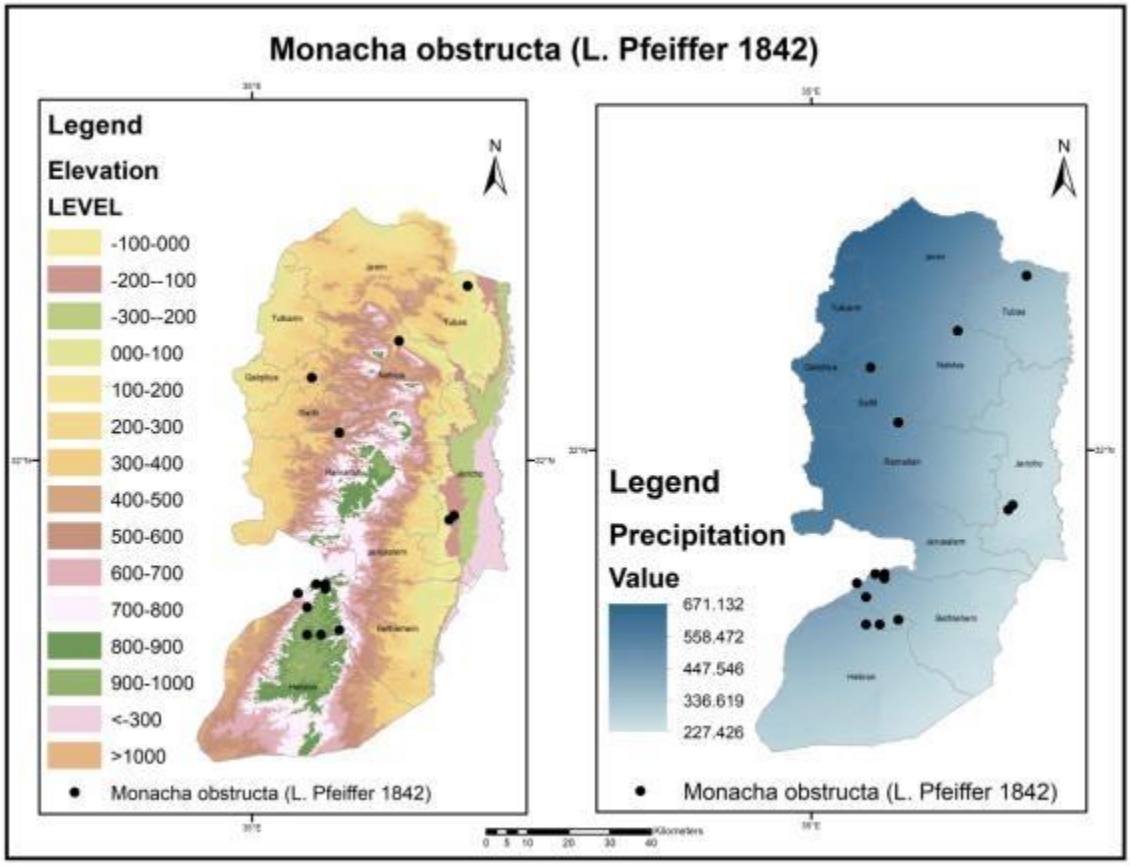


Figure 60. Distribution map for *M. obstructa* in the West Bank.

Figure 61. *Monacha obstructa*, Scale Bar = 5mm.

***Monacha syriaca* (Fig. 62 & 63)**

**Material examined:** M212 (28), Bethlehem, 8.11.2014.M367 (3), Zababdeh, March, 2016. M378 (2), Bait Sera, 3.8.2010.M379 (2), Zababdeh, 2.6.2014.M380 (12), Wadi Al Makhrour, 16.1.2016.M381 (4), Wadi Qana, 2.6.2014.M383 (4), Al Taerah, 3.8.2015.M385, Bait Sahour, 12.5.2013. M387, Wadi Fukeen, 2.3.2013.M390, Z'iem, 13.5.2013.M391 (1), Nahaleen, 2.2.2013.M393, Battir, 24.11.2013. M394, Husan, 17.6.2013.M395, Wadi Qana, 18.5.2013.M396 (2), Wadi Fukeen, 29.7.2015.M397, Wadi Fukeen, 27.5.2015.M400, Wadi Al Quelt, 20.6.2013.M401 (3), Al Walaja,24.11.2013. M402 (2), Wadi Fukeen, 2.3.2013.M403, Wadi Al Quff, 15.3.2014.M404, Wadi Al Makhrour, 2.1.2014.M405 (4), Wadi Al Makhrour, 12.1.2015.M406, Sikhnin, 18.2.2014.M407 (21), Wadi Qana, 1.2.2014.M409 (12), Al Walaja, 24.11.2013.M410 (6), Battir, 16.2.2014.M413 (1), Al Auja, 14.6.2013.M414 (6), Kufr Zibad, 17.5.2013.

M415 (4), Um Al Tout, 14.6.2013.M416 (2), Wadi Al Qelt, 20.6.2013.M417, Wadi Al Quff, 8.3.2014.M418 (1), Al Walaja, 24.11.2013.M419 (2), Al Walaja,24.11.2013.M420 (2), Bait Lid, 1.2.2014.M421 (17), Wadi Qana, 1.2.2014.M423, Bait Lid, 1.2.2014.M424 (12), Artas, 12.1.2014.M425 (4), Nablus, 16.9.2015.M426, Wadi Al Quff, 8.3.2014.M428, Al Walaja, 24.11.2013.M429 (8), Bait Sahor, 18.5.2013.M430 (7), Nablus, 30.5.2012.M431, Bethlehem, Jaunuary 2014.M432 (2), Ain Kenya, 15.8.2015.M433, Bait Lid, 1.2.2014.M434 (2), Ethna, 11.1.2014.M435 (4), Bal'a, 2.2.2014.M436 (14), Sikhnin, 18.2.2014.M437 (6), Artas, 2.2.2014.M438, Al Walaja,24.11.2013.M439, Battir, 24.11.2013.M442, Bait Fajar-Delba, 6.1.2014.M443 (6), Nabi Musa, 21.1.2014.M444, Al Walaja,24.11.2013.M446 (29), Jinen, 2.2.2014.M447 (4), Ain Yabroud, 6.3.2014. M452 (7), Nahaleen, 3.3.2015.M453 (4), Al Walajah, 24.11.2013.M454 (2), Dayr Al Ghousoon, 4.3.2016.M455 (3), Ain Yabroud, 19.3.2016.M457 (6), Kufr Rai-Allar, 4.3.2016.M458 (4), Wadi Fukeen, 7.3.2016.M460 (6), Um Al Tout, 4.3.2016.M461, Bait Wazan, 19.3.2016.M462 (6), Jin Safut, 18.3.2015.M463 (30), Kufr Kud, 2.2.2014.M465 (3), Wadi Al Harameyah, 18.4.2017.M467, Dayr Al Ghousoon, 4.3.2016.M477 (5), Kufr Zibad, 17.5.2013.M480 (8), Seris, 16.12.2015.M515 (3), Um Al Tout, 14.6.2013.M678 (3), Nablus, 2010.M710 (10), Jabal Qifeen, 7.4.2016.M727 (3), Ain Adas (Salfeet), no date.M731 (1), Ethna, 11.1.2014.M751 (1), Artas, 13.8.2014.M753 (1), Wadi Al Quff, 30.8.2013.M790 (1), Maksar Ka'dan, 25.1.2017.M846, Wadi Fukeen, 29.7.2015.M987 (1), Artas, 12.1.2014.M991 (1), Bait Lid, 1.2.2014.M992 (1), Wadi Qana, 2010.M997, Al Walaja,24.11.2013.M1015 (5), Nablus, 2010.M1028 (13), Wadi Al Makhrour, 23.11.2015.M1341 (3), Ain Qanqour, 18.5.2016. M1365, Bait Illo, 1.8.2016.M1377 (5), Al Jaba'ah, 25.5.2016.M1384 (2), Bir Zait, 3.4.2016.M1402 (2), Bir Zait, 2.4.2016.M1440 (9), Al Doha, 30.3.2016.M1452 (3), Nahaleen, 25.5.2016.M1457 (3), Nahaleen, 24.3.2015.M1462 (11), Al Doha, 30.3.2016.M1492 (17), Abood, 31.10.2016.M1499 (6), Al Zawyeh, 10.8.2015.M1504 (6), Zababdeh, March 2016.M1518(1), Battir, 8.1.2017.M1536(3), Nabi Saleh, 11.10.2016.M1548(5), Ajul, no date.M1552(2), Wadi Sareda, 19.9.2016.M1554 (20), Mar Saba, 14.12.2015.M1562 (26), Wadi Al Makhrour, 26.11.2016.M1593 (4), Artas, 13.11.2016.M1594 (3), Bir Zait, 17.1.2017.M1597 (8), Wadi Mikhmas, 7.11.2016.M1612 (1), Nabi Saleh, 3.5.2013.M1628 (1), Wadi Al Makhrour, 15.1.2017.M1648 (6), Al Aroub, 7.12.2016.M1651 (1), Wadi Al Quff, 8.3.2014.M1652 (3), Al Auja, 4.11.2013.M1659 (2), Wadi Al Quff, 24.1.2015.M1663 (4), Ain Yabroud, 12.4.2016.M1698 (1), Dayr Nizam, 21.1.2017. M1706 (9), Abood, 21.1.2017.M1762 (4), Al Qarn Reserve, 2.1.2017.M1982 (2), Bir Zait, 24.3.2016.M1984 (8), Wadi Al Matwy, 2.2.2017.M1996 (3), Nahaleen, 8.2.2017.M2003 (4), Wadi Qufeen, 7.4.2014.M2014 (10), Dayr Ballout, 2.2.2017.M2015 (1), Battir, 8.2.2017.M2017 (1), Wadi Qana, 2.2.2017. M2038 (9), Kufr Al Deek, 10.2.2017.M2131 (4), Husan, 8.2.2017.M2145 (2), Nahaleen, 8.3.2017.M2152 (1), Battir, 2.2.2017.M2162 (1), Wadi Bhour/Yatta, 8.4.2017.M2194 (4), Ain Yabroud, 3.3.2017.

**Remarks**: This is a species similar to *M. obstructa* and distinguished by not having a hole in the ventral side of the shell (Hellel, 2009). This wide distributed species in Palestine found to be a host to developed on some nematodes parasites that affect human

and it shows the existence of *Aelurostrongylus abstrusus*, *Troglostrongylus brevior and Anafilaroides* (Gerichter, 1949).

**Habitat:** This species found between stone walls holes and on plants or under rocks, and it is found in all the biogeographical zones and it is concentrate in the Mediterranean areas.

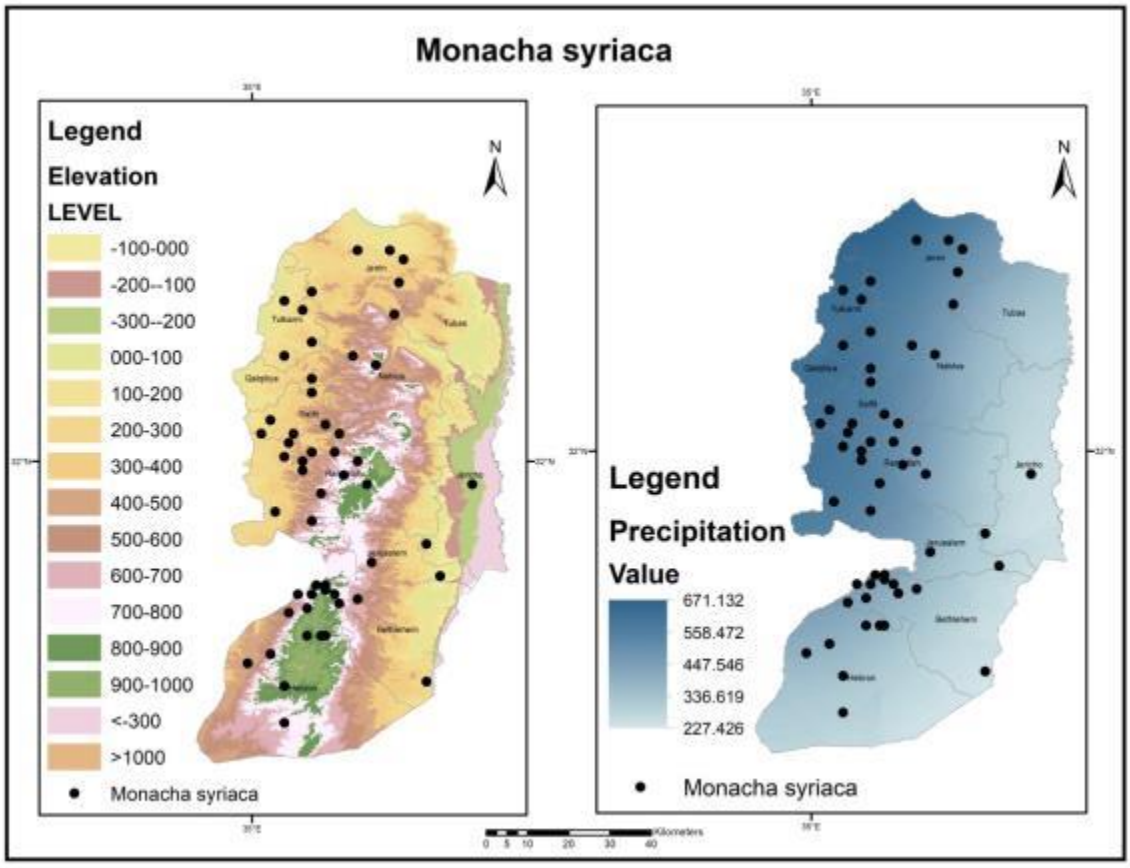


Figure 62. Distribution map for *M. syriaca* in the West Bank.

Figure 63. *Monacha syiaca*, Scale Bar = 5mm.

***Monacha crispulata* (Mousson1861) (Fig. 64 & 65)**

**Material Examined**: M102 (1), Seris, No date. M1449, Ain Yabroud, 12.4.2016. M2128 (18), Ain Yabroud, 3.3.2017. M2210 (1), Wadi Al Hour/Yatta, 8.4.2017.M2228(1), Wadi Al Quff, 2.5.2016. M2229 (1), Battir, 6.5.2016. M2230 (1), Wadi Qana, 1.6.2016.

**Remarks**: This is a unique species of land snails which has a shell covered with spines (hairs like) (Heller, 2009; Neubert et al., 2015). *M* crispulata has a small-range (endemic) found from central Lebanon to the middle of Palestine and northwestern Jordan (Forcart 1976; Heller 2009).
**Habitat:** This is a Mediterranean species found in oak forests in leaf letter. This species could be an indicator for the maquis Mediterranean oak trees in the West Bank Palestine.

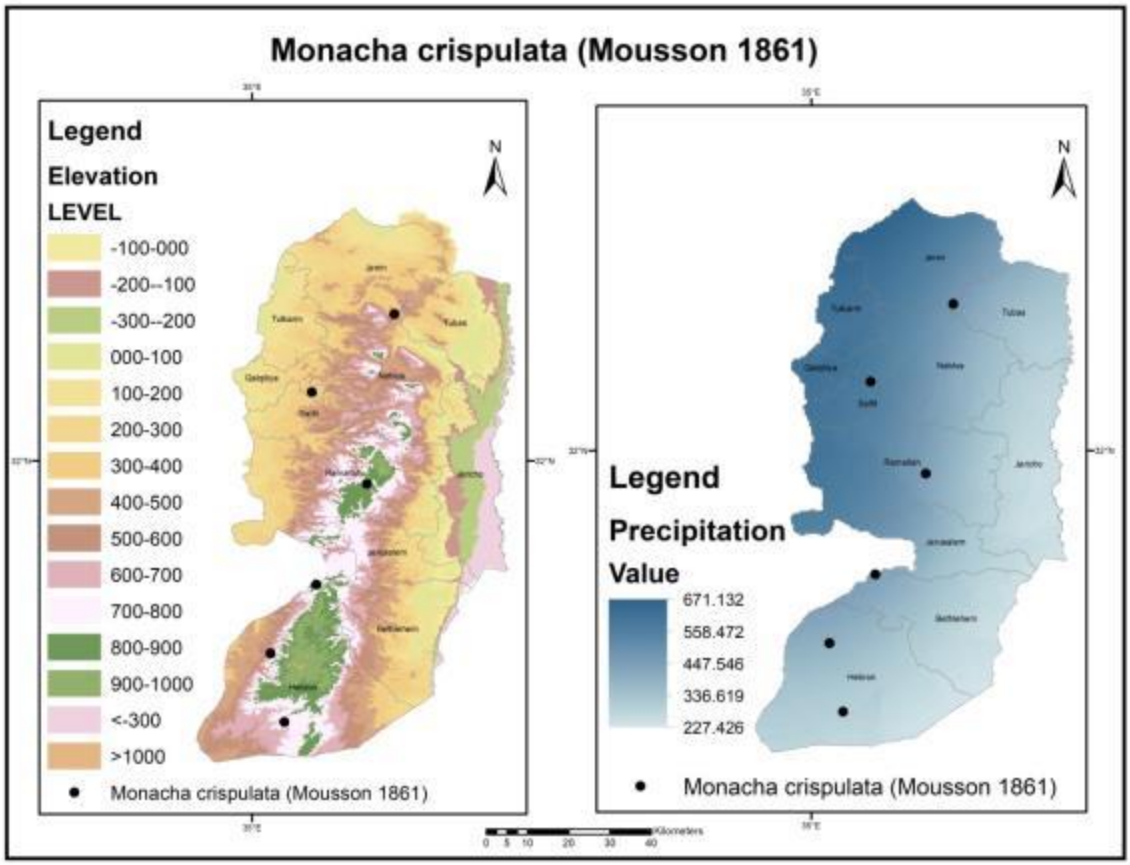


Figure 64. Distribution map for *M. crispulata* in the West Bank.

Figure 65. *Monacha crispulata*, Scale Bar = 5mm.

***Metafruticicola fourousi* (L. Pfeiffer 1841). (Fig. 66 & 67)**

**Material Examined**: M213 (1), Ajul, 1, 9.3.2016.M733 (1), Wadi Qana, 26.1.2015 M974 (2), Roabe, 3.8.2016.M993, Wadi Qana, 26.1.2015. M1487 (10), Abood, 31.10.2016.M1410 (1), Ain Yabroud, 1.4.2016.M1637 (1), Wadi Al Makhrour, 15.1.2017.M1701 (4), Dayr Nizam, 21.1.2017.M1709 (1), Abood, 21.1.2017.M2034 (1), koffr Al Deek, 10.2.2017.M2195 (30), Ain Yabroud, 3.3.2017.

**Remarks**: Bank et al. (2013) revised species of the genus *Metafruticicola* in the Mediterranean basin. They considered *Metafruticicola fourousi* used earlier by local authors like Heller as a junion synonym of *Metafruticicola berytensis.* This species has a wide range of distribution across Turkey, eastern tip of Cyprus, Syria and Lebanon reaching as far as central Palestine but ours are the first documented records from the

West Bank (see Bank et al., 2013). Two other species of genus are known in the area, *Metafruticicola hermonensis* Forcart 1981 and *Metafruticicola genezarethana* (Mousson 1861) both found only from Mount Hermon.

**Habitat:** This species is noted in the Mediterranean zones but seems limited to areas in the semi costal zones in the West Bank.

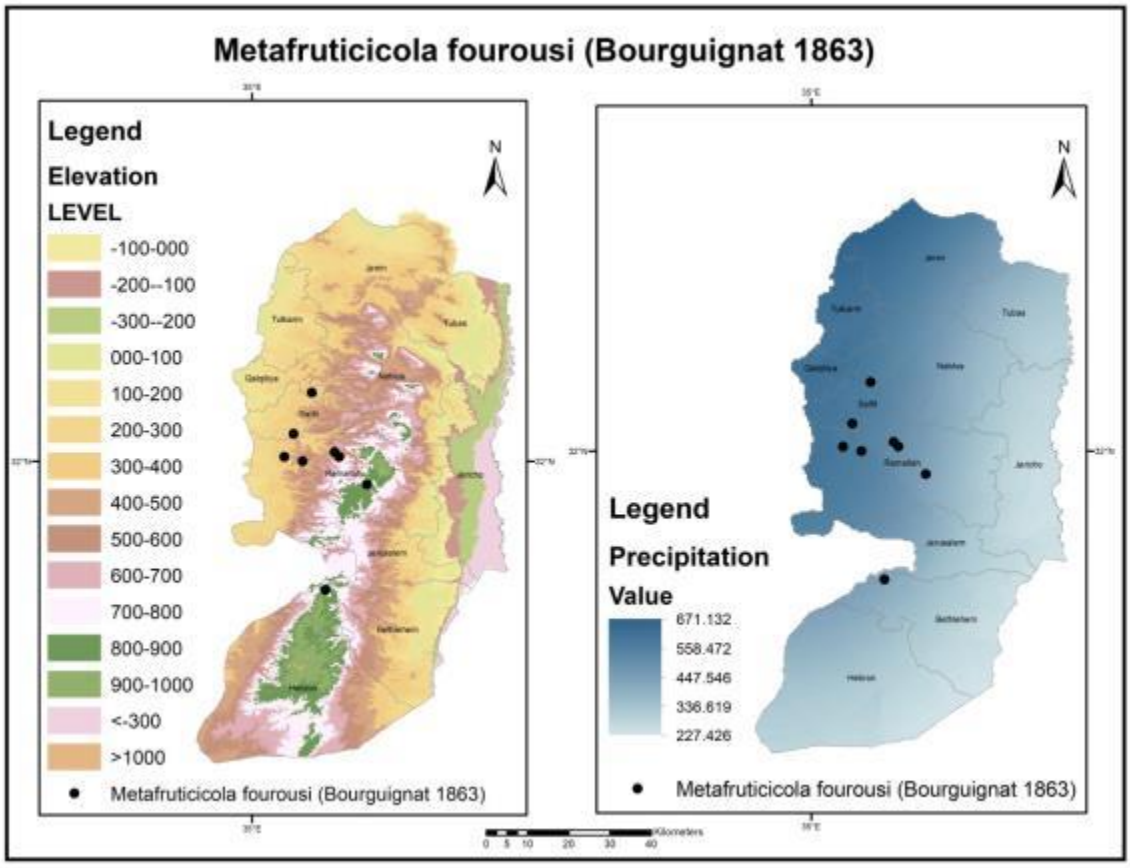


Figure 66. Distribution map for *M. fourousi* in the West Bank.

Figure 67. *Metafruticicola fourousi*, Scale Bar = 5mm.

***Xerocrassa seetzenii* (L. Pfeiffer 1847) (Fig. 68 & 69)**

**Material Examined:** M134 (3), Wadi Qelt, 23.2.2015. M811 (2), Nabi Mousa, 21.1.2014. M1534 (1), Bardala, 10.10.2016. M1555 (5), Mar Saba, 14.12.2015.

**Remarks**: This species is medium size, white in color and some species with dark brown line in the dorsal shell (Heller, 2009; Neubert et al., 2015). Its distribution is still not well-known but it was reported in Palestine, Jordan, Syria and northwest Arabia and may occur in Iraq (Neubert, 1998).

**Habitat:** This species is noted in the Irano-Turanian zones in elevations less than 400 m above sea level.

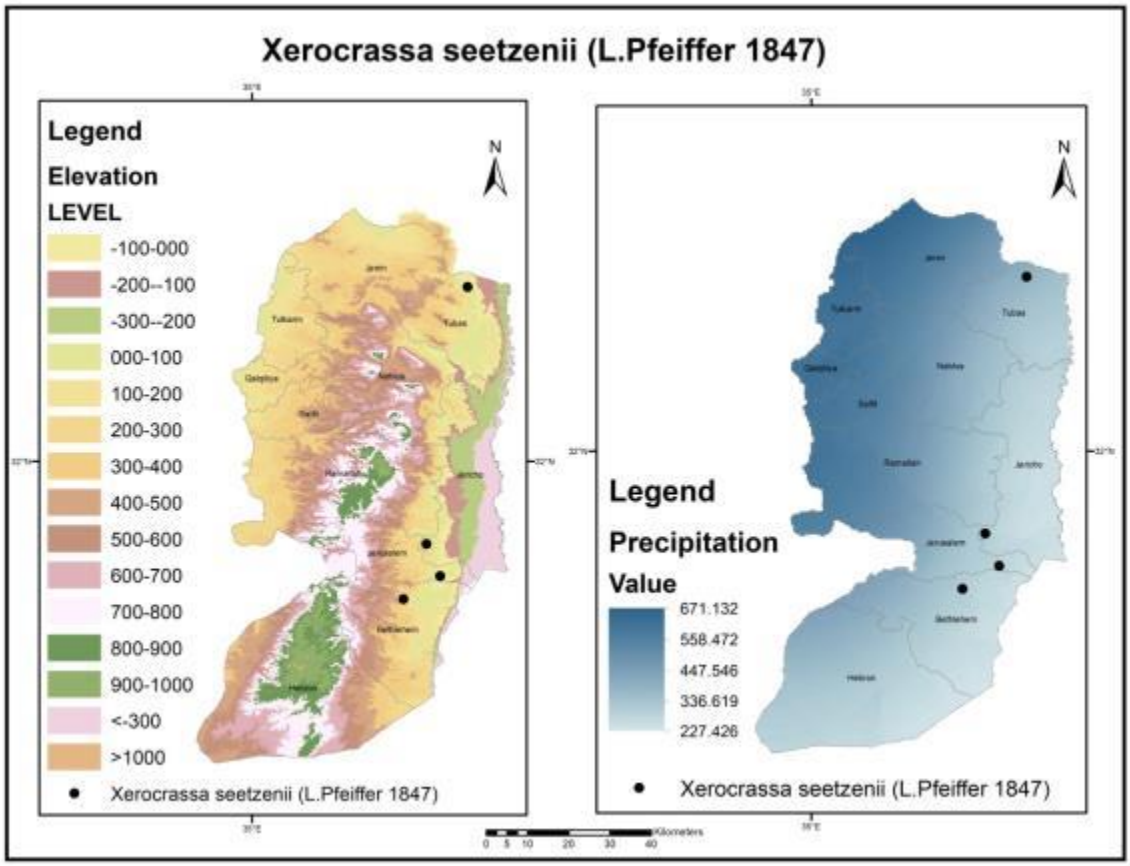


Figure 68. Distribution map for *X. seetzenii* in the West Bank.

Figure 69. *Xerocrassa seetzenii*, Scale Bar = 5mm.

***Xerocrassa tuberculosa* (Conrad 1852) (Fig. 70 & 71)**

**Materials examined:** M210 (1), Mar Saba, 19.12.2015.M311, Mar Saba, 14.12.2015.M1513 (1), Mar Saba, no date.M1372 (7), Wadi Daraja, 9.5.2016.M1807 (2), Al Rashaydah-2, 25.1.2017.M1808 (6), Maksar Qa'adan, 25.1.2017. M1816 (1), Hasasah-4, 25.1.2017.M1826 (1), Zarb Khryan, 25.1.2017.M1895 (1), Hasasah-1, 25.1.2017.

**Remarks**: This is a desert species easely distingwished by it conical pointed shell and the dentals on the edge of the shell (Heller, 2009). This species distributed from Sini to Iran (Biggs1937).

**Habitat:** This species found in the Irano Turanian and Saharo Arabia zones, it is collected from Mar Saba and other sited along with the Dead Sea area. It is always found

between rocks all specimens collected are dead. Heller (2009) mentioned that it is found in large populations in the Nagav where it digs under the soil to hide.

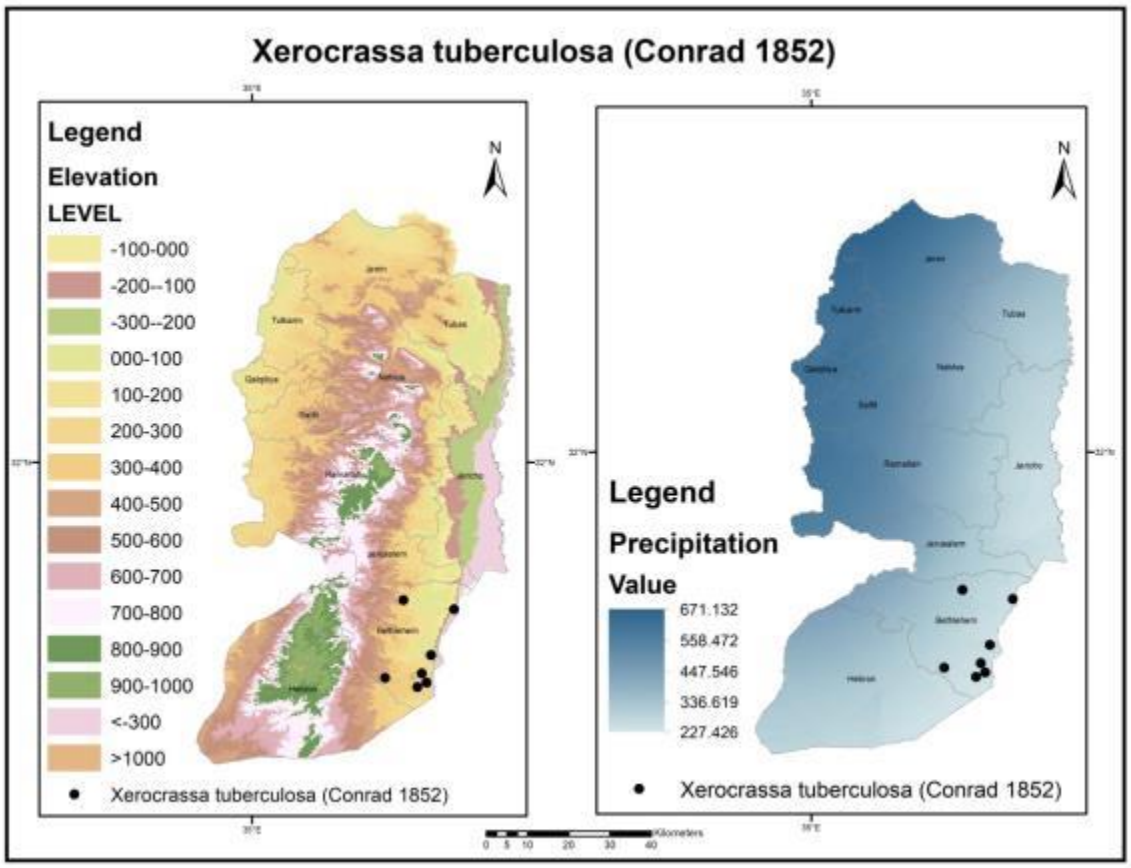


Figure 70. Distribution map for *X. tuberculosa* in the West Bank.

Figure 71. *Xerocrassa tuberculosa*, Scale Bar = 5mm.

***Xerocrassa langloisiana* (Bourguignat 1853) (Fig. 72)**

**Materials examined:** M88 (33), Wadi Abu Al Alayek, 21.12.2015.M106 (2), Jabal Al Fredees, 10.3.2016.M179 (21), Matahen Al Sokkar, 11.1.2016.M221 (9), Mar Saba, 14.12.2015.M336 (1), Um Al Tout, 4.3.2016.M459 (16), Wadi Al Quff, 21.3.2014.M513 (1), Marah Rabah, 15.3.2014.M535 (1), Battir, 24.11.2013.M546 (1), Dayr Qurntul, 29.2.2016.M755 (5), Jabal Al Fredees, 4.12.2015.M823 (7), Sa'ir, 1.4.2013. M844 (1), Al Auja, 4.11.2013.M860 (2), Wadi Al Quff, 30.8.2013.M873 (1), Nahaleen, 2.2.2013. M877 (1), Wadi Al Qelt, 20.6.2013.M1052 (1), Wadi Fukeen, 27.5.2015.M1053 (15), Al Auja, 4.11.2013.M1121 (11), Wadi Al Quff, 21.3.2014.M1408 (3), Bir Zait,

24.3.2016.M1438 (14), Al Doha, 30.3.2016. M1454 (3), Nahaleen, 22.8.2016.M1530 (22), Marj Na'jah, 10.10.2016.M1655 (1), Nabi Saleh, 2.5.2013.M1658 (1), Wadi Al Quff, 15.3.2014.M1660 (11), Bethlehem, 11.1.2014.M1661 (8), Tall Abu Al Alayek, 21.12.2015.M1662 (4), Khursa, 2.5.2013.M1664 (1), Ain Yabroud, 12.4.2016.M1668 (4), Al Aroub, 7.12.2016.M1683 (6), Nea'mah, 21.3.2016.M1729 (20), Al Twan, 22.1.2017.M1735 (2), Wadi Al Qelt, 6.1.2016.M1748 (3), Dayr Hijla, 9.2.2014.M1758 (5), Al Jitha, 12.12.2016.M1792 (7), Hasasah-4, 25.1.2017.M1815 (6), Al Rashaydah-2, 25.1.2017.M1824 (1), Wadi Al Daraja-3, 25.1.2017.M1827 (4), Maksar Qa'adan-1, 25.1.2017.M1828 (3), Hasasah-1, 25.1.2017.M1830 (6), Hasasah-2, 25.1.2017.M1893 (1), Hasasah-3, 25.1.2017.M1983 (1), Wadi Fukeen, 7.3.2016.M1987 (3), Ain Yabroud, 10.2016.M2041 (5), Kkufr Al Deekm 10.2.2017.

**Remarks**: This is a species with a shell small, depressed, sculpture of coarse axial ribs, last whorl bluntly keeled, and umbilicus widely open (Heller, 2009; Neubret et al., 2015). This is a common species found in the West Bank. Many researches subdivides this species into three subspecies, (*X. l. langloisiana, X. l. improbata, and X. l. hierocontina*), which mainly differ in their morphology by the relative diameter of the umbilicus, the patern of the ribbing mode of the shell, and the relative length of the flagellum (Forcart 1976; Heller 2009). However in our case we saw plenty of variations and we do not agree with subspecies designations.

**Habitat:** This is a wide distributed species that found in the four biogeographical zones (Mediterranean, Irano-Turanian, Saharo Arabian, Sudanian) in the West Bank.

Figure 72. *Xerocrassa langloisiana*, Scale Bar = 5mm.

***Xerocrassa simulate* (Fig. 73 & 74)**

**Material examined:** M104 (3), Nahaleen, 3.3.2015.M107 (3), Wadi Al Taa'mrah, 3.6.2015.M130 (2), Wadi Al Qelt, 26.3.2016.M230 (13), Nea'mah, 21.3.2016.M540 (1), Wadi Fukeen, 9.8.2014.M713 (7), Al Boyeeb, 14.3.2016.M716 (14), Jericho-Dead Sea intersection, 16.3.2016.M734 (7), Qumran, 16.3.2016.M757 (16), Wadi Abu Al Alayek, 21.1.2015.M803 (20), Nabi Mousa, 21.2.2014.M984 (3), Bethlehem, January 2013.M1343 (4), Wadi Al Daraja, 5.9.2015.M1507, Mar Saba, 30.5.2016.M831 (1),Al Walaja, 24.4.2013. M835 (3),Bani Na'im, 7.4.2013. M863 (2),Mar Saba,4.5.2013. M864 (1),Wadi Al Quff, 8.3.2014. M875 (1),Artas, 12.1.2014.M885 (8),Nabi Mousa, 21.1.2014. M897 (56), Dayr Hijla, 19.2.2014. M901 (8), Bani Na'im, 7.4.2013.M1217 (5), Zarb Khryan, 2.6.2014.M1224 (17), Jericho-Dead Sea intersection, 12.1.2015.M1425 (3), Al Auja, 21.3.2016.M1552 (1), Mar Saba, 14.12.2015.M1726 (16), Al Twan, 22.1.2017.M1756 (10), Al Jitha, 12.12.2016.M1760 (9), East Jericho, 12.12.2016.

**Remarks**: *X. simulate* is known from throughout the Levant except Lebanon (Pallary 1939; Heller 2009). This species found in areas with rain fall less than 400 mm. Neubert et al. (2015) shows that this species could be confused in identification with *X. seetzeni*.
**Habitat:** This distributed in the south of the West Bank, this species was found in all four biogeographical zones (Mediterranean, Irano-Turanian, Saharo Arabian, Sudanian).

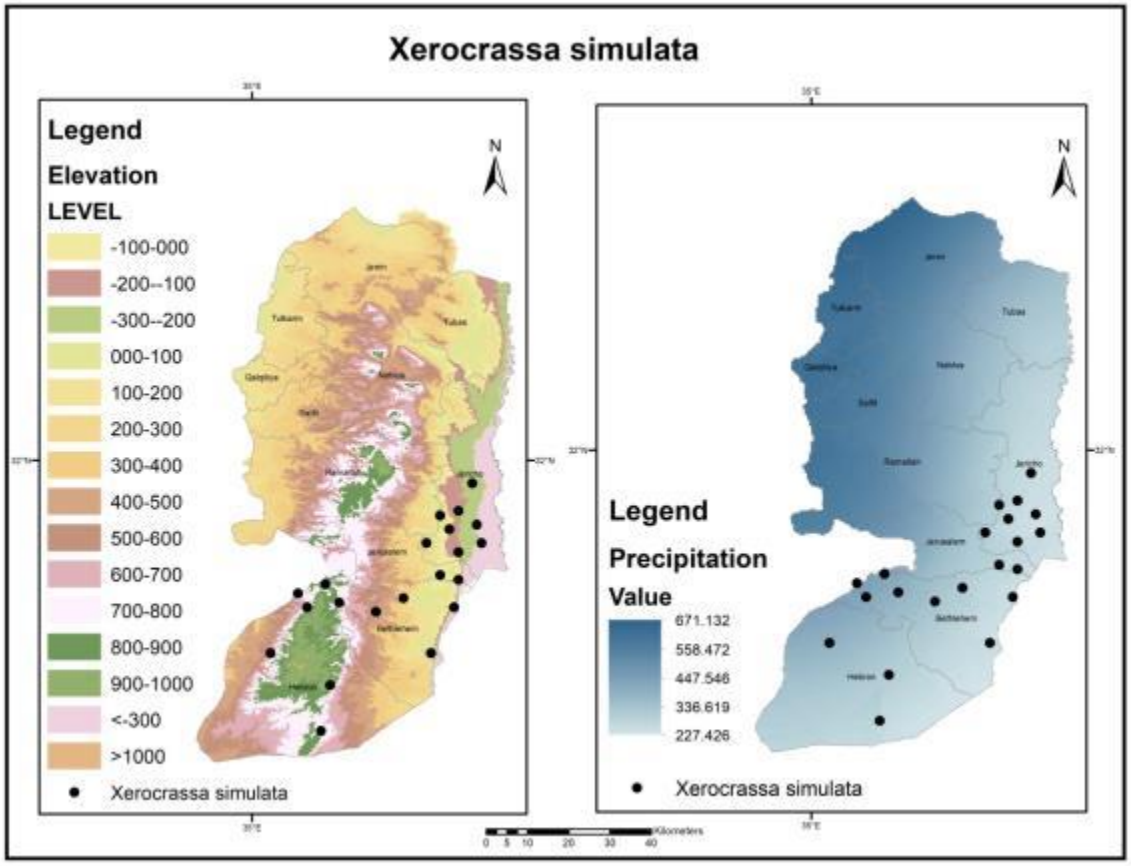


Figure 73. Distribution map for *X. simulata* in the West Bank.

Figure 74. *Xerocrassa simulate*, Scale Bar = 5mm.

***Xeropicta krynickii* (Fig. 46) (Fig. 75 & 76)**

**Material examined**: M92 (1), Wadi Fukeen, 27.5.2015. M93(1), Wadi Mikhmas, 1.2.2014. M110(17), Nahaleen, 3.3.2015.M111 (1), Ethna, 11.1.2014. M112(1), Artas, 12.1.2014. M133(11), Al Tairah, 3.8.2015. M135(4), Wadi Al Quff, 24.1.2015. M335(1), Bir Zait, 11.4.2013. M337 (8), Um Al tout, 4.3.2016.M371(11), Al Zawya, 10.8.2015.M374(10), Zababdeh, March, 2016.M466(1), Burkeen, 30.11.2015. M483(10), Sakka, 14.3.2016. M512(1), Bait Wazan, 19.3.2016. M542(3), Wadi Al Harameyeh, No data. M561(2), Jabal Al Fredees, 4.12.2015. M569(11), Wadi Sa'id, 14.3.2016. M588(1), Artas, 13.8.2014. M762(14), Wadi Al Quff, 15.3.2014. M767(13), Ethna11.1.2014. M769(2), Bir Zait, 2.9.201. M771(26), Wadi Al Makhrour, 23.11.2015. M775 (5), Nea'leen, 8.6.2015. M779 (2), Battir, 27.5.2015. M782 (32), Mar Saba, 13.1.2014. M783 (5), Wadi Al Makhrour, 2.1.2014. M791 (1), Ain Al Auja, 29.3.2013. M799 (1), Nabi Mousa, 21.1.2014. M821 (5), Artas, 12.1.2014. M826 (1), Nablus, 30.5.2012. M838 (11),

Bethlehem, 11.1.2014. M841 (2), Mar Saba, 13.1.2014. M874 (2), Al Za'iem, 13.5.2013. M1027 (1), Wadi Al Harameyeh, 15.5.2014. M1030 (1), Zababdeh, 6.2.2014. M1031 (1), Wadi Al Quff, 3.8.2014. M1033 (6), Khursa, 8.5.2013. M1036 (2), Wadi Qana, 1.2.2014. M1037 (3), Wadi Mikhmas, 27.4.2013. M1038 (1), Nablus, 2010.M1064 (3), Husan, 29.5.2013. M1065 (1), Bait Sera, 3.8.2010. M1072 (3), Al Auja, 14.6.2013. M1077 (2), Salfit, 30.5.2012. M1097 (9), Jabal Al Masateeh, No data.M1109 (1), Wadi Al Quff, 7.3.2014. M1110 (19), Wadi Mikhmas, 20.3.2014.M1113 (13), Wadi Mikhmas, 1.2.2014. M1118 (5), Zababdeh, 6.2.2014. M1128 (1), Battir, 24.11.2013. M1130 (1), Wadi Al Quff, 8.3.2014. M1131 (14), Bait Sahur, 20.5.2013. M1134 (1), Bani Na'im, 7.4.2013. M1137 (2), Nahaleen, 2.5.2013.M1151 (1), Wadi Al Qelt, 20.6.2013. M1153 (2), Wadi Mikhmas, 23.5.2013. M1155 (7), Nabi Saleh, 4.5.2013. M1158 (2), Bait Sahur, 12.5.2013. M1164 (3), Al Za'iem, 13.5.2012. M1165 (1), Bir Zait, 9.5.2013. M1168 (1), Wadi Al Qelt, 23.2.2015. M1170 (9), Wadi Al Quff, 8.3.2014. M1171 (7), Marah Rabah, 15.3.2014. M1172 (8), Bir Zait, 11.4.2013. M1174 (1), Wadi Fukeen, 27.5.2015.M1175 (2), Bardala, 18.4.2014. M1177 (7), Bait Lid, 1.2.2014. M1179(11), Artas, 13.8.2014. M1180(2), Wadi Fukeen, 29.7.2015. M1184(10), Wadi Qana, 1.2.214. M1186(1), Bait Sahur, 2.12.2013.M1190(3), Husan, 17.6.2013. M1193(2), Bait Fajar, 1.6.2014. M1196(5), Ethna, 1.11.2014. M1198(3), Al Sarj, 1.2.2014. M1199(2), Wadi Al Makhrour, 1.2.2014. M1200(7), Bait Lid, 2.1.2014. M1204(7), Al Walaja, 24.11.2013.M1205(7), Wadi Al Quff, 8.3.2014.M1209 (2), Salfit, 22.8.2014.M1210 (3), Wadi Mikhmas, 30.3.2014.M1211 (2), Ain Al Fawar, 16.8.2014.M1212 (6), Jenin, 2.2.2014.M1213 (2), Ain Yabroud, 6.3.2014.M1215 (13), Battir, 16.2.2014.M1216 (15), Bala’a, 2.2.2015.M1218 (4), Sabastia, 1.2.2014.M1219 (3), Illar, 2.2.2014. M1221 (15),Burkeen, 30.11.2015. M1292 (5),Dayr Al Ghousoon, 4.3.2016. M1336(6),Ain Nonqor, 18.5.2016. M1354 (9), Wadi Al Makhrour, 18.5.2016. M1362 (2), Bait Illo, 1.8.2016. M1388 (1), Kufr Nea’mah, 26.5.2016. M1399 (9), Ain Yabroud, 12.4.2016. M1401 (5), Yabroud, 27.7.2016. M1409 (9),Ain Yabroud, 1.5.2016. M1422 (13),Tall Al Asour, 27.7.2016.M1426 (7), Al Auja, 21.3.2016. M1441 (5), Al Doha, 3.3.2016. M1454 (3), Nahaleen, 22.5.2014. M1474 (35), Bir Zait, 2.4.2016. M1514 (1), Battir, 8.1.2017. M1515 (15), Bardala, 10.10.2016. M1517 (6), Wadi Mikhmas, 7.11.2016. M1538 (5), Nabi Saleh, 11.10.2016. M1543 (8), Halhul, 14.3.2016. M1545 (4), Ajul, 19.3.2016. M1553 (17), Mar Saba, 14.12.2015. M1579 (5), Nahaleen, 2.5.2013. M1585 (45), Bir Zait, 17.1.2017. M1588 (44), Artas, 13.11.2016. M1590 (1), Wadi Mikhmas, 7.11.2016. M1598 (9), Al Fasayel, 21.3.2016. M1599 (5), Al Mazra'h Al Sharqeyeh, 10.3.2016. M1610 (1), Wadi Sareda, 19.9.2016. M1621 (3), Al Rawabi, 3.8.2016. M1629 (5), Wadi Al Makhrour, 26.11.2016.M1634 (15),Wadi Al Makhrour, 15.1.2017. M 1647 (5),Battir, 11.5.2016. M 1650 (3),Al Aroub, 7.12.2016. M1653 (2),Al Auja, 4.11.2013. M1657 (1),Sa'ir, 1.4.2015. M1669 (1),Bethlehem, 28.7.2016. M1675 (16),Mdrjat Jarico, 2.2016. M1694 (2), Abood, 21.1.2016. M1705 (1), Al Mazra'h Al Sharqeyeh, 10.8.2016. M1732 (7), Ain Yabroud, 21.1.2017. M1763 (4), Al Qarn Reserve, 2.1.2017. M1794 (2), Hasasa, 25.1.2017. M1825 (1), Al Rshayda, 3, 25.1.2017. M1914 (4), Tall Al Asour, 27.7.2016. M1990 (4), Ain Yabroud, 10.2016. M1998 (1), Nahaleen, 8.2.2017. M1999 (3), Wadi Al Matwy, 2.2.2017. M2008 (1), Husan, 8.2.2017. M2019 (1), Battir, 8.2.2017. M2022 (7), Dayr Ballout, 2.2.2017. M2036 (12), Kufr Al Deek, 10.2.2017.

**Remarks**: Neubert et al. (2015) described this species as one with medium sized shell, depressed, glossy, and white or with brown spiral bands, teleoconch covered with fine axial ribs, and open umbilicus. This species distributed from eastern the Mediterranean region and Central of the Middle East (Petney & Huset 1992), it distribution start to increase and reach the Western part of the Mediterranean region and it is recorded from North Italy as an introduced species (De Mattia, 2007). In other countries in the Mediterranean region they consider it as pest species and many research on how to stop it are going on (Amiri-Besheli, 2009).

**Habitat:** This is a widespread species found in all areas of the West Bank in the Mediterranean, Irano Turanian and Saharo Arabia zones.

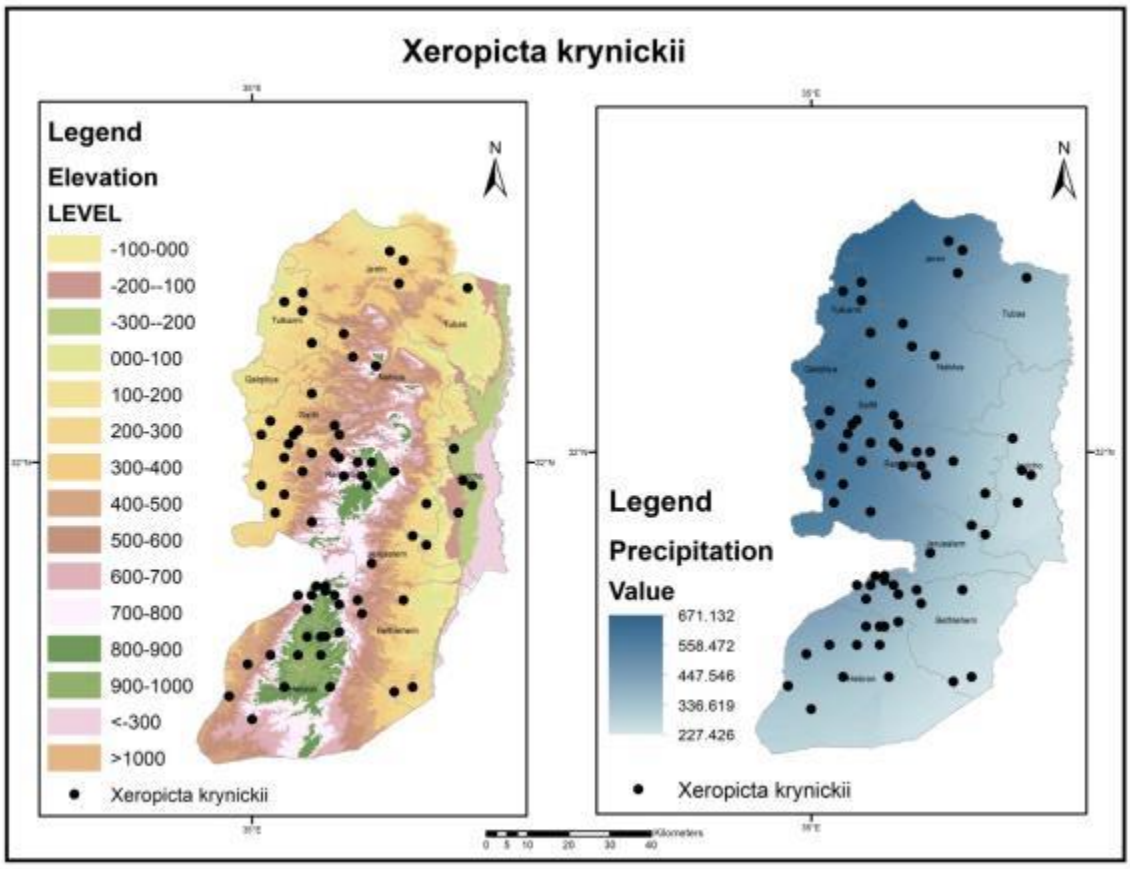


Figure 75. Distribution map for *X. krynickii* in the West Bank.

Figure 76. *Xeropicta krynickii*, Scale Bar = 5mm.

**Family Helicidae**

***Levantina caesareana* (Mousson1854) (Fig. 77 & 78)**

**Material examined**: M238 (11), Wadi Al Alayek, 21.1.2015.M243 (1), Bait lid, 1.2.2014. M268 (1), Al Sarj, 1.2.2014.M269 (3), Wadi Al Qelt, 4.11.2013.M271 (1), Bethlehem, 27.7.2015. M272 (1), Ain **Samya**, 26.8.2015.M279 (3), Bir Zait, 11.4.2013.M283 (1), Kufr Qad, 2.2.2014. M285(1), Bruqkeen, 31.11.2015.M287 (16), Brukeen, 30.11.2015.M293 (6), Salfit, 22.8.2014.M295 (1), Wadi Mikhmas, 23.5.2013.M295 (1), Wadi Mikhmas, 23.5.2013.M296 (4), Tarqumia, 4.4.2013.M342 (3), Ne'mah, 21.3.2016.M345 (6), Al Jiftlik, 21.3.2016.M365 (1), Ezz Al Din Forest, March, 2016.M366 (4), Ain Yabroud, no date. M368 (3), Zababdeh, no date.M369 (6), Zababdeh, March, 2016. M375 (1), Wadi Al Quff, 30.8.2013.M448 (2), Dura, 22.7.2016.M595 (2), Um Al Tout, 14.6.2013.M599 (3), Wadi Fukeen, 2.3.2013.M616

(8), Jericho-Dead Sea intersection, 16.3.2016.M623 (2), Battir, 15.2.2013.M639 (1), Wadi Qana, 1.2.2014. M640 (3), Sarj, 1.2.2014.M641 (1), Ain Kenia, 15.8.2014. M642 (1), Mikhmas, 1.2.2014. M644 (5), Bir Zait, 1.9.2015.M645 (6), Salfit, 22.8.2014. M646 (2), Wadi Mikhmas, 27.4.2013.M647 (5), Wadi Al Harameyeh, no date.M648 (3), Illar, 2.2.2014.M649 (3), Bir Zait, 11.4.2013. M651 (4), Wadi Al Quff, 21.4.204 M652 (1), Salfit, 3.8.2010.M653 (2), Sabastia, 1.2.2014. M654 (2), Artas, 26.1.2013.M655 (2), Al Auja, no date. M657 (4), Nablus, 2010. M658 (1), Wadi Mikhmas, 27.4.2013.M659 (6), Between Kufr Rai and Illar, 4.3.2016.M660 (1), Brukeen, 4.3.2016.M662 (1), Wadi Qana, 2.6.2014.M663 (1), Battir, 16.2.2014.M664 (1), Al Zaia'm, 13.5.2013.M665 (8), Dayr Al Ghousoon, 4.3.2016.M666 (1), Yatta, 29.1.2013.M669 (1), Bardala, 18.4.2014. M676 (2), Bait Wazan, 19.3.2016.M671 (1), Wadi Mikhmas, 1.2.2014. M672 (1), Nabi Saleh, 2.5.2013.M673 (4), Nablus, 30.5.2012. M675 (3), Wadi Al Quff, 30.8.2015. M676 (2), Bait Wazan, 19.3.2016.M679 (1), Dayr Ballout, 10.8.2015. M680 (2), Zababdeh, 2.6.2014. M682 (7), Ain Yabroud, 6.3.2014. M683 (3), Um Al Tout, 4.3.2016.M685 (1), Wadi Fukeen, 9.8.2014.M686 (1), Wadi Fukeen, 9.8.2014.M687 (6), Wadi Al Makhrour, 2.1.2014. M688 (2), Wadi Al Quff, 24.1.2015.M690 (5), Wadi Al Makhrour, 2.1.2014. M691 (5), Kufr Zibad, 17.5.2013.M692 (4), Artas, 26.1.2013.M694 (14), Dayr Baloot, 10.8.2015.M695 (8), Ain Kenya, 15.8.2014.M696 (1), Farkha, 20.11.2015.M697 (1), Jenin, 2.6.2014. M698 (1), Wadi Qana, 18.5.2013.M699 (1), Wadi Al Quff, 30.8.2013. M700 (1), Bethlehem, 6.8.2015. M701 (3), Nablus, 16.9.2015.M702 (1), Zababdeh, 6.2.2014.M703 (2), Bal'a, 2.2.2014.M706 (3), Ain Al Fowar, 16.8.2014. M707 (1), Um Al Tout, 14.6.2013.M1342 (3), Nea'mah, 21.3.2016.M1364 (3), Bait Illo, 1.8.2016.M1387, Kufr Nea'mah, 26.5.2016.M1391, Bair Zait, 2.4.2016.M1403 (4), Bair Zait, 24.3.2016. M1479 (5), Abood, 31.10.2016.M1509 (2), Surda, 18.8.2016.M1510 (3), Al Rawbee, no date.M1527 (7), Bardala, 10.10.2016.M1531 (9), Marj Na'jah, 10.10.2016.M1537 (2), Nabi Saleh, 11.10.2016.M1540 (2),Al Fasayel, 21.3.2016.M1546 (4), Ajul, 19.3.2016.M1567 (4),Bardala, 10.10.2016.M1578 (3),Al Mazra'h Al Sharqeyeh, 10.8.2016.M1601 (1),Ain Yabroud, 19.3.2016.M1607 (1),Wadi Sareda, 19.9.2016.M1639 (1),Wadi Al Makhrour, 15.1.2017.M1699 (1),Dayr Nizam, 21.1.2017.M1719 (2),Abood, 21.1.2017.M1753 (3),Al Jitha, 12.12.2016.M1920 (5),Tall Al Asour, 27.7.2016.M2035 (11),Kufr Al Deek, 10.2.2017.M2124 (2),Brukeen, 2.2.2017.M2138 (1),Tamoun, 7.4.2017.M2144 (2),Tyasser, 10.2.2017.M2150 (1), Msafer Yatta15.4.2017.

**Remarks**: This is a large species of land snails found near rocks and on stone walls in Palestine (Neurbet et al., 2015). The shell has a keel in two whorls near the protoconch (Heller, 2009).

**Habitat:** This is a widely-distributed species found mostly in the mid and north part of the Palestinian territories. This species found in all the biogeographical zones in our area (Mediterranean, Irano-Turanian, Saharo Arabian, Sudanian). It is considered as food source for humans (Bar, 1977). *Levantina* species used as bioindicators for the environment and measuring the heavy metal (Magaritz and Heller 1980; Swaileh et al. 2001 ; Swaileh and Ezzughayyar 2000 ; Swaileh and Ezzughayyar 2001).

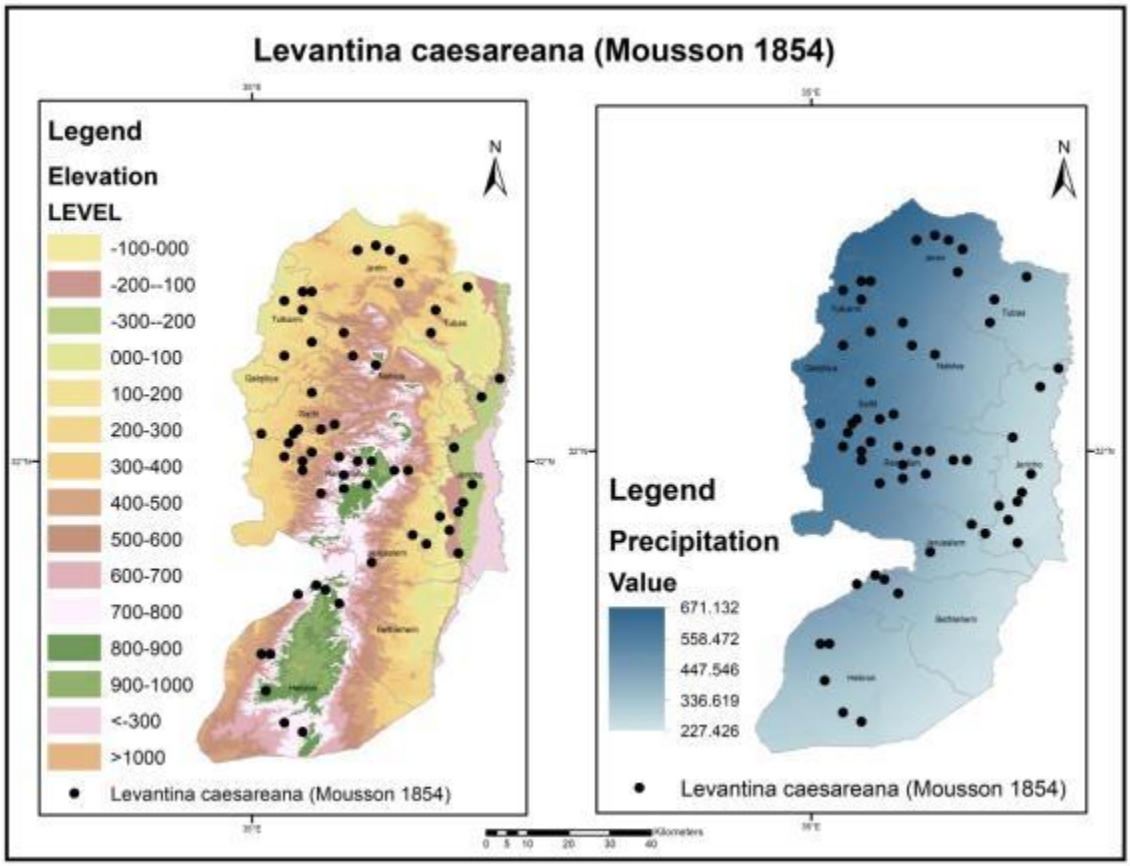


Figure 77. Distribution map for *L. caesareana* in the West Bank.


Figure 78. *Levantina caesareana*, Scale Bar = 5mm.

***Levantina lithophaga* (Conrad 1852) (Fig. 79 & 80)**

**Material examined:** M63 (5), Nahaleen, 8.1.2015.M231 (7), Ain Yabroud, 6.3.2014.M236 (4), Halhul, 14.3.2016.M240 (2), Wadi Al Quff, 24.5.2014.M242 (6), Wadi **Fukeen**, 9.8.2014.M244 (9), Al Walaja, 9.8.2014.M245 (9), Wadi Al Quff, 8.3.2014. M251 (15), Wadi Al Quff, 21.3.2014.M308 (16), Wadi Al Makhrour, 23.11.2015.M366 (4), Ain Yabroud, no date.M592 (4), Sa'ir, 1.4.2013.M594 (5), Bait Fajar, 6.1.2014.M595 (1), Um Al Tout, 14.6.2013.M596 (5), Wadi Al Quelt, 20.6.2013.M598, Wadi Al Quff, 30.8.2013.M599 (3),Wadi **Fukeen**, 2.3.2013.M600 (5), Delab-Bait Fajar, 6.1.2014.M601 (8), Battir, 16.2.2013.M602 (11), Wadi Fukeen, 29.7.2015.M603, Al Walaja, 21.10.2012.M604, Kharsa, 8.5.2013.M605 (5), Jabal Al Masateeh, no date.M606, Wadi Al Quelt, 15.11.2013.M607 (3), Al Walaja, 24.11.2013.M608 (29),Wadi Al Makhrour, 2.1.2014.M609 (2), Battir, 24.11.2013.M610, Wadi Al Quff, 28.11.2015.M611, Artas, 26.1.2013.M612 (7), Wadi Al Quff,

15.3.2014.M613 (9), Wadi Al Makhrour, 31.8.2015.M614 (12), Marah Rabah, 15.3.2014.M615 (10), Al Auja, 4.11.2013.M617, Wadi Al Quff, 30.8.2013.M618 (7),Al Walaja, 24.11.2013.M619 (15), Al Auja, 4.11.2013.M620 (5), Battir, 24.11.2013.M621 (18), Al Auja, 4.11.2013.M624, Wadi Al Quelt, 4.11.2013.M625 (2), Wadi Said (Al Dhahreyeh), 14.3.2016.M627 (4), Jabal Al Furdees, no date.M628 (9), Wadi **Fukeen**, 29.8.2014.M629 (4), Saka, 14.3.2016.M631 (3), Halhul, 2.1.2014.M634 (5), Nea'leen, 8.1.2015.M635 (4), Halhoul, no date.M636 (3), Ain Yabroud, 19.3.2016.M637 (3), Qumran, 16.3.2016.M667 (1), Bethlehem, 22.6.2013.M668 (5), Sair, 1.4.2013.M670 (2), Husan, 29.5.2013.M677, Artas, 29.5.2012.M1337 (2), Ain Qanqour, 18.5.2016.M1347 (5), Wadi Yahuda, 5.9.2016.M1349, Wadi Al Makhrour, 18.5.2016.M1386 (6), Ain Yabroud, 1.4.2016.M1398 (3), Ain Yabroud, 12.4.2016.M1405, Ain Yabroud, 27.7.2016.M1406 (2), Nahaleen, 22.5.2016.M1439 (11), Al Doha, 30.3.2016.M1455 (3), Nahaleen, 25.5.2016.M1520 (1), Battir, 8.1.2017.M1558 (9), Wadi Al Makhrour, 15.1.2017.M1564 (4), Wadi Al Makhrour, 26.11.2016.M1571 (7), Bait Bassa, 25.2.2015.M1574 (3), Wadi Mikhmas, 7.11.2016.M1575 (9), Nahaleen, 2.5.2013.M1582 (1), Wadi Al Makhrour, 20.1.2016.M1583 (11), Artas, 13.11.2016.M1644 (2), Battir, 11.5.2016.M1722 (17), Al Twan, 22.1.2017.M1761 (1), Al Qarn Reserve, 2.1.2017.M1771 (2), Hasasah-5, 25.1.2017.M1777 (4), Hasasah-3, 25.1.2017.M1780 (3), Maksar Qa'adan, 25.1.2017.M1782 (2), Al Rashaydah-1, 25.1.2017.M1783 (2), Al Rashaydah-2, 25.1.2017.M1789 (2), Wadi Al Daraja-3, 25.1.2017.M1793 (4), Wadi Al Daraja-2, 25.1.2017.M1796 (3), Hasasah-4, 25.1.2017.M1801 (5), Al Rashaydah-2, 25.1.2017.M1803 (3), Maksar Qa'adan, 25.1.2017.M1810 (1), Hasasah-2, 25.1.2017.M2023 (7), Dayr Ballout, 2.2.2017.M2120 (1), Ain Yabroud, 3.3.2017.M2125 (1), Al Qarn Reserve, 9.2.2017.M2140 (2), Msafer Yatta/ Khalet Bayoud, 31.3.2017.M2147 (2), Msafer Yatta, 15.4.2017.M2157 (6), Wadi Bhour/Yatta, 8.4.2017.M2158 (1), Al Berka/ Yatta, 25.3.2017.M2172 (1), Al Qarn Reserve, 26.2.2017.M2173 (2), Khelat el Daba'/ Yatta, 25.3.2017.

**Remarks**: This species used to known as *Levantina hierosolym* (Heller, 2009) but Neurbet et al. (2015) compared specimens from different museums and collection and shows that this *hierosolym* is a junior synonym of *Helix lithophaga*. This is a species a food source in Palestine.

**Habitat:** This species is widely range of distribution in the mid and south the West Bank of Palstine, and it is found in Mediterranean, Irano-Turanian, Sudanian penetration zones, always found near rocks.

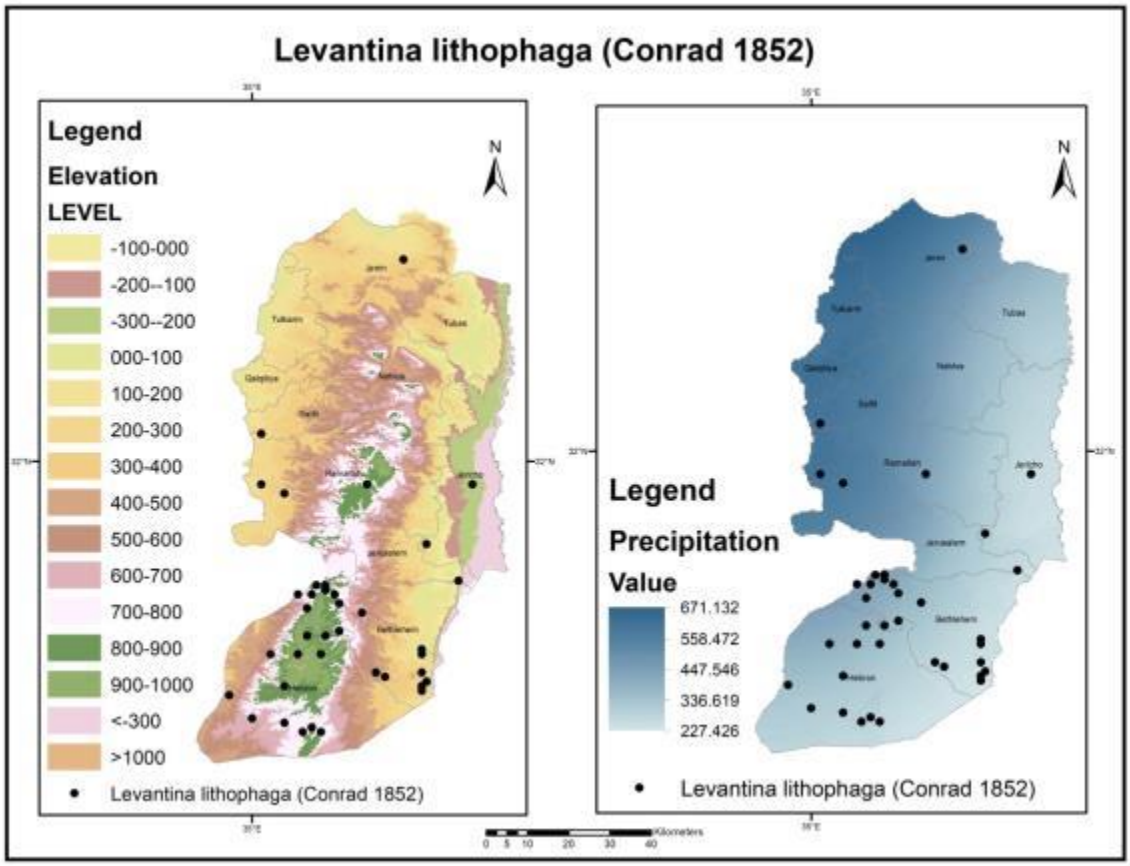


Figure 79. Distribution map for *L. lithophaga* in the West Bank.

Figure 80. *Levantina lithophaga*, Scale Bar = 5mm.

***Helix* (*Pelasga*) *engaddensis* Bourguignat 1852 (Fig. 81 & 82)**

**Materials examined:** M011 (3) Artas 12.1.2014. M015 (3) Jenin 2.2.2014. M054 (3), Kufr Raia-Illar, 4.3.2016. M067 (1), Illar, 2.2.2014. M087 (1), Zarb Khryan, 26.12.2015. M094 (1), Bala'a, 2.2.2014. M095 (2), Battir, 16.2.2014. M096 (2), Nabi Saleh, 2.5.2013. M097 (7), Nahaleen, 8.6.2015. M098 (2), Nablus, 10.9.2015. M099 (9), Ethna, 11.1.2014. M100 (3), Bardalah, 18.4.2014. M101 (6), Wadi Al Quff, 20.6.2013. M103 (7), Wadi Mikhmas, 20.3.2014. M105 (4), Wadi Al Quelt, 20.6.2013. M115 (1), Marah Rabah, 15.3.2014. M116 (2), Jenin, 2.2.2012. M117 (2), Al Zoiayem, 18.5.2013. M118 (2), Ain Kenya, 15.8.2014. M119 (3),Artas, 12.1.2014. M120 (4),Bethlehem, 8.11.2014. M121 (3), Furdees, 4.12.2015. M122 (1), Wadi Abu Al Alayek, 21.1.2015. M123 (2), Jabal Al Masateeh, no date. M143 (5), Zababdeh, 6.2.2014. M144 (3), Yatta, 29.1.2013. M145 (3), Bait Sahour, 30.5.2013. M146 (1), Nabi Musa, 2.2.2014. M147(8) Bait Lid, 1.2.2014. M148 (6), Jin Safut, 18.3.2015. M149 (2), Bani Nuaim, 7.4.2015. M150

(3),Jenin, 2.2.2014. M151 (3), Sabastia, 1.2.2014. M167 (1),Illar, 2.2.2014.M168 (6),Kufr Zibad, 17.5.2013. M169 (1), Mar Saba, 13.1.2014. M170 (3), Nahaleen, 2.5.2013. M172 (1), Sair, 1.4.2013. M173 (4), Salfeet, 22.8.2014. M175 (6), Wadi Al Quff, 15.3.2014. M176 (1), Wadi Fukeen, 27.5.2015. M191 (5), Neaa'ah (near Al Auja), 21.3.2016. M196 (), Jericho-Ramallah Crossing, 12.1.2015. M204 (1),Wadi Qufeen, 7.4.2014.M226 (2), Dayr Al Ghousoon, 4.3.2016. M234 (1), Wadi Al Quff, 28.11.2015. M239 (1), Battir, 16.2.2014. M246 (1), Wadi Al Quff, 8.3.2014. M249 (1), Mar Saba, 8.3.2013. M254 (2), Bait Fajar, 6.1.2014. M256 (5), Ain Samya, 26.8.2015. M258 (6), Wadi Al Makhrour, 2.1.2014. M259 (1), Wadi Al Quff, 8.3.2014. M265 (1), Wadi Al Quelt, 20. 6.2013. M273 (2),Abood, 21.1.2017.M289 (1), Bir Zait, 11.4.2013. M298 (1), Kufr Bura'm, 18.1.2014. M299 (2), Wadi Al Quelt, 22.2.2015. M300 (2), Wadi Al Makhrour, 23.11.2015. M330 (1),Bir Zait, 19.2.2013. M334 (4), Wadi Qana, no date. M343 (4), Al Jiftlik, 21.3.2016. M351 (1), Salfit, 30.5.2012. M548 (5), Saka, 14.3.2016. M549 (3),Kufr Raa'i-Illar, 4.3.2016. M550 (3), Wadi Said (al Dhahreyeh), 14.3.2016. M551 (1), Bait Wazan, 19.3.2016. M552 (2), Wadi Al Harameyeh, 13.3.2016. M553 (1), Wadi Fukeen, 9.8.2014. M554 (5), Dayr Al Ghousoon, 4.3.2016. M729 (1), Ain Yabroud, 6.3.2014. M923 (1),Wadi Mikhmas, 30.3.2014. M926 (7), Ethna, 11.1.2014. M929 (1),Wadi Al Qelt, 4.11.2013. M930 (1),Bait Fajar, 6.1.2014. M935 (1), Yatta, 29.1.2013. M937 (1),Auja, 11.4.2013. M940 (1), Wadi Mikhmas, 27.4.2013. M945 (1), Jabal Al Masateeh. No date. M952 (1),Wadi Mikhmas, 23.5.2013. M953 (1), Artas, 4.4.2013. M955 (2),Mar Saba, 14.12.2015. M956 (11), Al Auja, 11.4.2013. M957 (1), Brukeen, 4.3.2016. M995 (2), Mar Saba, 14.12.2015. M1029 (1), 2Km E. of Ubeidiya, 13.5.2013. M1067 (1), Bait Sahour, 30.5.2013. M1124 (1), Nabi Saleh, 4.5.2013. M1348 (2), Wadi Al Daraja, 5.9.2016. M1360 (1), Bait Illo, 1.8.2016. M1383 (1), Bair Zait, 24.3.2016. M1390 (1), Nahaleen, 22.5.2016. M1416 (1), Abu Al'layeq, 21.1.2015. M1434 (4), Al Doha, 30.3.2016. M1463 (2), Ain Al Helwa, 21.9.2016. M1489 (5), Abood, 31.10.2016. M1508 (1), Mar Saba, 30.5.2016. M1519 (4), Al Rawabee, no date. M1521 (1), Wadi Mikhmas, 7.11.2016. M1524 (2), Dayr Qurntul, 29.2.2016. M1526 (5), Marj Na'jah, 10.10.2016. M1535 (8), Bardala, 10.10.2016. M1541 (4), Al Fasaye, 21.3.2016. M1542 (1), Halhul, 14.3.2016. M1556 (5), Mar Saba, 14.12.2015. M1559 (2),Wadi Al Makhrour, 26.11.2016. M1561 (4),Wadi Al Makhrour, 15.1.2017. M1568 (1),Bait Sahur, 28.7.2016. M1572 (1),Bait Bassa, 25.2.2015. M1592 (1),Ain Al Fawar, 16.8.2012. M1602 (1),Al Walaja, 24.11.2013. M1642 (2), Battir, 11.5.2016. M1697 (2), Dayr Nizam, 21.1.2017. M1727 (4), Al Twan, 22.1.2017. M1728 (1), Ain Yabroud, 21.1.2017. M1750 (1), Zababdeh, no date. M1755 (2), Al Jitha, 12.12.2016. M1766 (2), Maksar Qa'adan-1, 25.1.2017. M1772 (3), Hasasah-5, 25.1.2017. M1776(1), Hasasah-4, 25.1.2017. M1784 (1), Zarb Khryan, 25.1.2017. M1786 (1), Hasasah-1, 25.1.2017. M1798 (1), Wadi Al Daraja-3, 25.1.2017. M1911 (1), Rashayda 1, 25.1.2017. M1919(3), Tall Al Asour, 27.7.2016. M2010(1), Battir, 8.2.2017. M2037(5), Kufr Al Deek, 10.2.2017. M2123(1), Dayr Ballout, 2.2.2017. M2141(2), Tamoun, 7.4.2017. M2143 (4),Msafer Yatta/ Khalet Bayoud, 31.3.2017. M2159 (3),Wadi Bhour/Yatta, 8.4.2017. M2160 (1),Msafer Yatta, 15.4.2017. M2161 (1),Al Berka/ Yatta, 25.3.2017. M2171 (1),Khelat el Daba'/ Yatta, 25.3.2017. M2180 (3),Al Qardia/ Yatta, 8.4.2017.

**Remarks**: It is medium sized species elongated with large aperture (Heller, 2009). We noted high variation in color patterns from dark brown to light brown to yellowish.

**Habitat:** This is the most common species that we found in the Palestinian territories, and it is widely spread in the Historic Palestine, Southern Syria and Jordan as endemic to this region (Neurbet et al., 2015). This species could have been introduced in Libya (Germain, 1936). H. *engaddensis* is found in all area in the West Bank and it is shows up in the four biogeographical zones (Mediterranean, Irano-Turanian, Saharo Arabian, Sudanian).

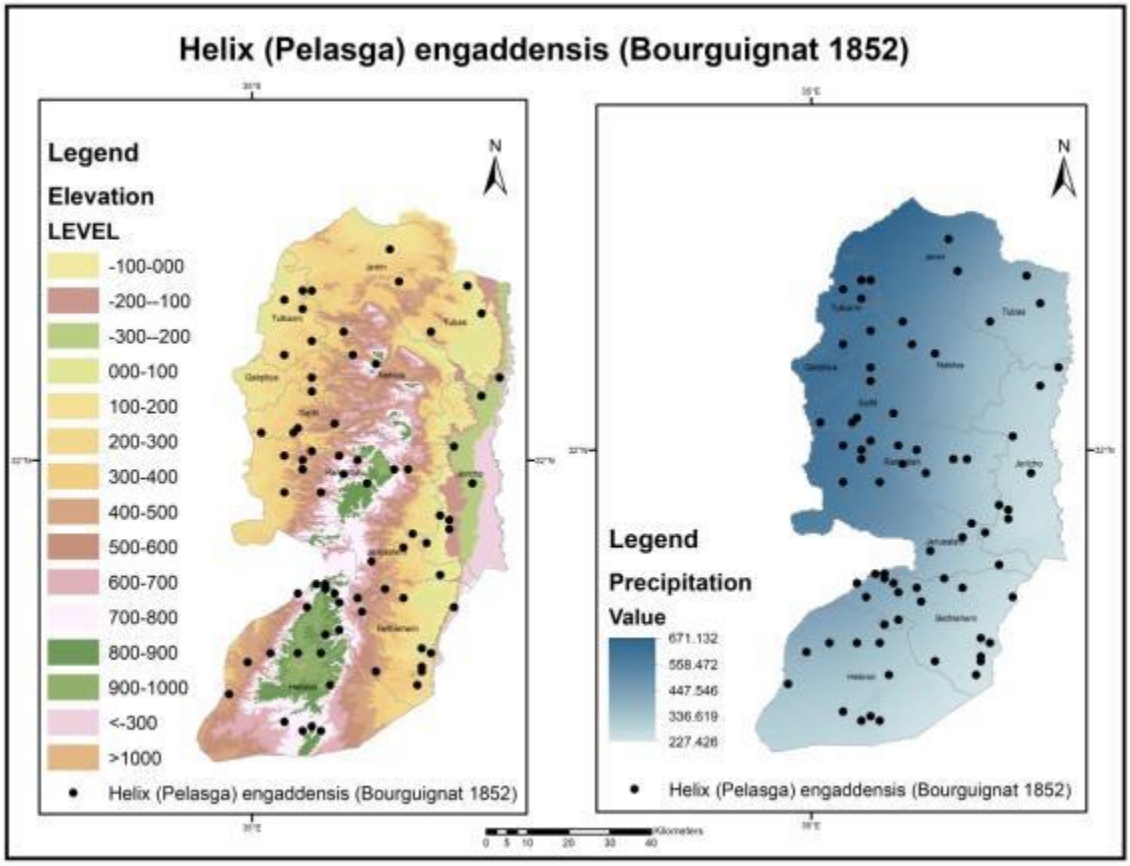


Figure 81. Distribution map for *H. engaddensis* in the West Bank.


Figure 82. *Helix engaddensis*, Scale Bar = 5mm.

***Cornu aspersum* (Fig. 51) (Fig. 83 & 84)**
**Material examined**: M154 (1) Al Walaja 2015.

***Remarks:*** This is an invasive species of land snails and is now the largest species found in the Palestinian territories. Roll et al., (2009) suggested that two subspecies occur in Historic Palestine (*megalostomum* and *aspersum*) having been introduced as a source of food (see Figure 85) from Italy. Most records come from house gardens.
**Habitat:** This species found in The Mediterranian area. We noted it in the gardens of Talitha Qumi School in Beit Jalla which is the southern most record having been previously noted from house gardens in Tal Aviv, Haifa and Jerusalem (Heller 2009).

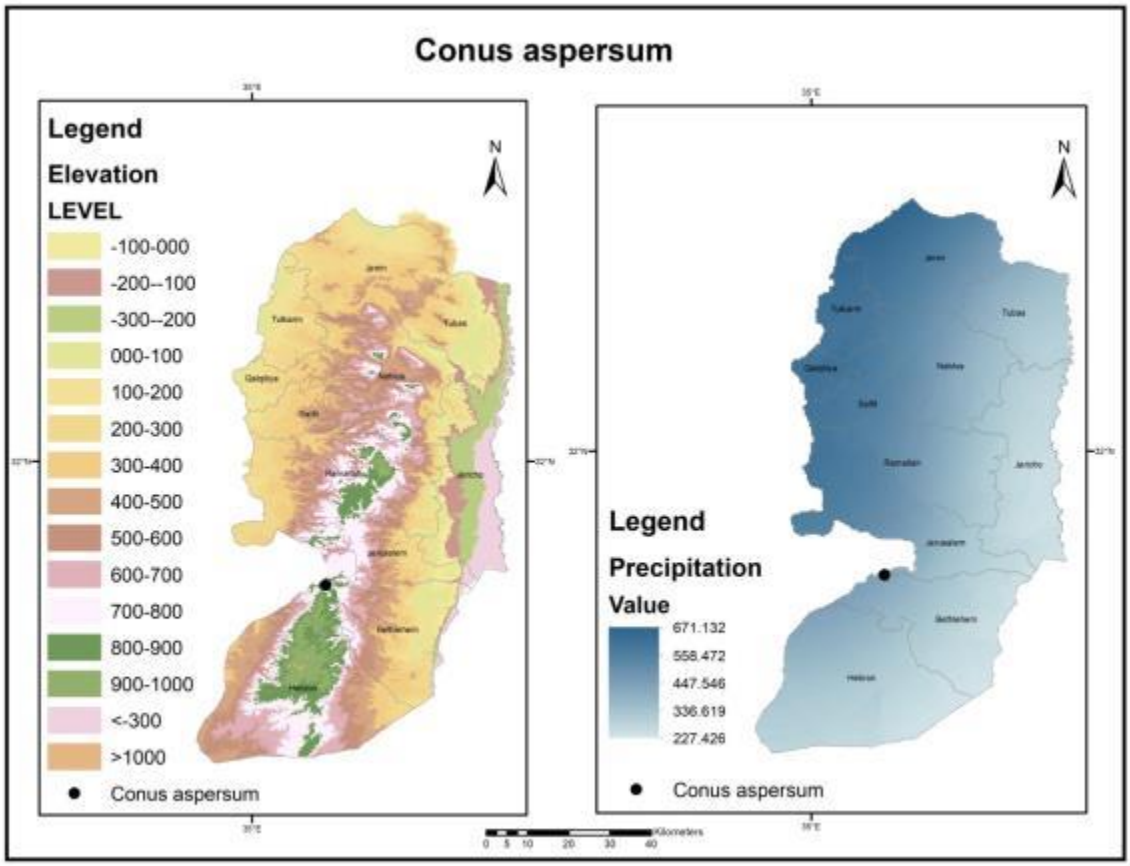


Figure 83. Distribution map for *C. aspersum* in the West Bank.

Figure 84. *Cornu aspersum*, Scale Bar = 5mm.

Figure 85. Dish of *C. aspersum* from a restaurant in Beit Jalla.

## 5. Discussion

41 species of land snails are hereby reported in the Palestinian Territory of the West Bank despite its small area (5,655 km²). Land snails in the WB with 41 species belong to 13 families. Families Enidae and Hygromiidae are the most dominant families (see Figure 86). Land snails have high diversity comparable and perhaps exceeding similar sized regions nearby like Jordan, Lebanon and the Arabian Peninsula (Neubert, 1998; Neubert et al., 2015; Neubert and Bariche, 2013). It would be worthwhile to study the unstudied malacological fauna of Egypt and Syria. Many factors enter into determining local diversity of snail species and it seems islands and mountain ranges undisturbed for a long time have the highest diversity (Solem 1984).

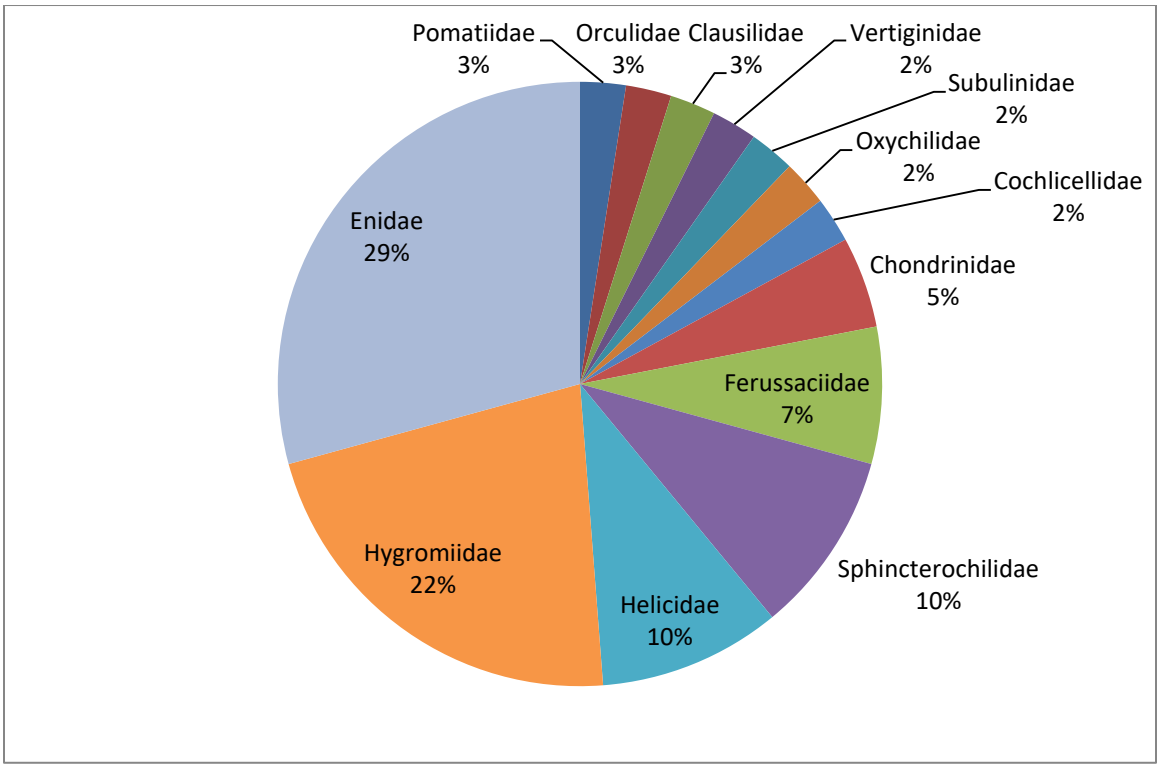


Figure 86. Percentage of species in each family found.

Table 3. shows species three of our land snails species are endemic to Palestine, *C. haasi* which a Mediterranean species found near the coastal area and it is found in the west of OPT. *G. glabratus* is a species is found in the arid area and it is found in Yatta and Judin desert which found near big rocks. *E. pseudovularis* is a species collected only from one location near Yatta desert area. 17 species are regionally endemics, eight species occurs in the Levant, three species found in the Circum-Mediterranean, three species distributed in the Western Palearctic and finally 10 species with wide range distribution (found in America, Australia, Africa, Europe and Asia).

Table 3. The relation of the land snails to our area.

| Endemic | Regionally endemics | Levantine | Circum-Mediterranean | Western Palearctic | Wider range |
|---|---|---|---|---|---|
| *C. haasi*<br>*B. glabratus*<br>*E. pseudovularis* | *B. diminutus*<br>*B. marsabansis*<br>*C. genezarethensis*<br>*E. saulcyi*<br>*E. chondriformis*<br>*H. engaddensis*<br>*L. lithophaga*<br>*M. crispulata*<br>*P. episomus*<br>*P. raymondi*<br>*S. cariosa*<br>*S. zonata*<br>*T. haasi*<br>*T. benjamitica*<br>*X. langloisiana*<br>*X. simulata*<br>*X. tuberculosa* | *B. labrosus*<br>*C. hierosolymarum*<br>*E. protensa*<br>*E. septemdentatus*<br>*L. caesareana*<br>*M. fourousi*<br>*P. bulimoides*<br>*S. fimbriata* | *P. glaucum*<br>*R. rhodia* | *C. acicula*<br>*G. granum* | *B. therinus*<br>*C. acuta*<br>*M. obstructa*<br>*M. syriaca*<br>*R. decollate*<br>*S. prophetarum*<br>*X. krynickii*<br>*X. seetzenii*<br>*C. aspersum* |
| 3 | 17 | 8 | 2 | 2 | 9 |

An earlier study on the ecology of land snails by our group was done (Amr et al., 2018) revealing information related to distribution in different biogeographical zones and species assemblages. In this expanded study, more detailed data show patterns of distribution of land snails relating to different variables (rain fall, elevation, and phytogeographical zones). Table 4 shows the distribution of land snails in the West Bank by phytogeographic zones. 41 species of land snails in 13 different families and 24 genera shows significant biodiversity in a small area. 83% of the species were found in the Mediterranean zone, five of them (*Granopupa granum, Sphinctreochila fimbriata, Xerocrassa langloisiana, Xerocrassa simulate* and *Helix engaddensis*) were found in all four phytogeographic zones. 46% if the species were noted in theIrano-Turanian zone *Bulimunus diminutus* was only found in this zone. 34% of the species were noted in the Saharo Arabian zone and 39 % of the species in the Sudanian zone.

Table 4: Distribution of 41 species of land snails (43 by including the two subspecies of *B. labrosus*) by phytogeographic zones (M=Mediterranean, IT=Irano-Turanian, SA=Saharo Arabian, S=Sudanian).

| Family | Land Snail Species | M | IT | SA | S |
|---|---|---|---|---|---|
| Pomatiidae | *Pomatis glaucum* | **X** | | | |
| Orculidae | *Pilorcula raymindi* | **X** | | | |
| Chondrinidae | *Granopupa granum* | **X** | **X** | **X** | **X** |
| | *Rupestrella rhodia* | **X** | | | |
| Vertiginidae | *Truncatellina haasi* | **X** | | | |
| Enidae | *Buliminus diminutus* | | **X** | | |
| | *Buliminus labrosus labrosus* | **X** | | **X** | **X** |
| | *Buliminus labrosus jiftliki* | **X** | | | |
| | *Buliminus labrosus sporectinus* | **X** | | | |
| | *Buliminus marsabensis* | | **X** | **X** | |
| | *Buliminus glabratus* | | | **X** | **X** |
| | *Buliminus therinus* | | **X** | **X** | **X** |
| | *Paramastus episomus* | **X** | | | |
| | *Pene bulimoides* | **X** | | | |
| | *Euchondrus septemdentatus* | **X** | **X** | | |
| | *Euchondrus chondriformis* | **X** | **X** | | |
| | *Euchndrus pseudovularis* | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | *Euchondrus saulcyi* | **X** | | | |
| | *Turanena benjamitica* | **X** | | | |
| Clausilidae | *Cristataria haasi* | **X** | | | |
| Ferussaciidae | *Calaxis hierosolymatum* | **X** | **X** | | **X** |
| | *Cecilioides acicula* | **X** | **X** | | **X** |
| | *Cecilioides genezarethensis* | **X** | | | **X** |
| Subulinidae | *Rumina decollate* | **X** | | | |
| Oxychilidae | *Eopolita protensa jebustica* | **X** | | | **X** |
| Sphincterochilidae | *Sphinctreochila fimbriata* | **X** | **X** | **X** | **X** |
| | *Sphinctreochila prophetarum* | | | **X** | **X** |
| | *Sphincterochila zonata zonata* | | **X** | **X** | **X** |
| | *Sphincterochila cariosa* | **X** | | | |
| Cochlicellidae | *Cochicella acuta* | **X** | | | |
| Hygromiidae | *Monacha obstructa* | **X** | **X** | | |
| | *Monacha syriaca* | **X** | | | |
| | *Monacha crispulata* | **X** | | | |
| | *Metafruticicola fourousi* | **X** | | | |
| | *Xerocrassa seetzenii* | | **X** | | |
| | *Xerocrassa tuberculosa* | | **X** | **X** | |
| | *Xerocrassa langloisiana* | **X** | **X** | **X** | **X** |
| | *Xerocrassa simulate* | **X** | **X** | **X** | **X** |
| | *Xeropicta krynickii* | **X** | **X** | **X** | |
| Helicidae | *Levantina caesareana* | **X** | **X** | **X** | **X** |
| | *Levantina lithophaga* | **X** | **X** | | **X** |
| | *Helix engaddensis* | **X** | **X** | **X** | **X** |
| | *Conus aspersum* | **X** | | | |

A total of 105 species of land snails are reported in the Historic Palestine and the Golan Heights of Syria (Heller, 2009). Our sampling produced the expected species based on geography and habitats. There may still be a few other species to be identified in the West Bank especially with more intensive sampling in the Jordan Valley.

**Malacogeographical zones versus phytogeographical zones**

Plants are a good bioindicator for different habitat where each species of them need specific conditions like soil ph, moisture, temperature, and food plants (Bond et al., 2005; Dahl, 1998). Animals like mammals thus live in specific environmental conditions and

there are limitation for their distribution with their food source and climate (Qumsiyeh, 1985).

Phytogeographical zone borders were first estimated in Palestine using plant and trees distribution by Zohary (1947). Since then most biologists studying fauna and flora have copied these areas without much discussion or revaluation of Zohary's work. This is especially notable in examining the series of volumes titled "Fauna Palestina" and "Flora Palestina" published by the Israel Academy of Sciences. Our initial work on the land snails (Amr et al., 2018) also attempted to relate species to the four biogeographical zones as identified by Zohary (1947). The current detailed study as shown in the results (especially the maps shown) forced us to rethink the issue of biogeographical zones at least in relation to the snail distributions. To discuss these it is worthwhile summarizing variables that could impact snail distributions:

1) Rain fall: Snails are significantly dependent on moisture and in dry seasons aestivate inside their shells. In some of our arid regions, they maybe active, reproduce and eat for as short a period as 20 days of the whole year. Thus, it is expected that rainfall plays a significant part in their distribution. Snails protect themselves with a hard shell that is even of use in reconstructing paleoenvironmental conditions including rainfall (Goodfriend and Magaritz 1987; Goodfriend 1992).
2) Closeness to Mediterranean Sea: There are some studies that show that distance from seashore affects arthropod distributions (Wasserstrom and Steinberger 2016; Liu et al., 2018). We could not locate similar studies on land snails but it is logical to assume that the same effects (like moisture drift, fog etc) would also hold sway.

Our data does show patterns consistent with this. For example the species *Pomatis glaucum* shows distribution only in the North West of the West Bank in areas with high rain fall range from 500-700mm (see Fig. 7). Some species are depending on moisture in the early morning that comes from fog but not like the species that exist in southern the West Bank which limited the distribution area of this species.

3) Vegetation: Most (& all Palestinian) land snails are herbivorous dependent on distribution of certain vegetation. For example, Labaune and Magnin (2001) used caonical analysis to demonstrate dependence of both abundance and distribution of land snails on grassland communities.
4) Altitude: Altitude is related to vegetation but also to rainfall and wind forces and this can effect land snail distributions (Welter-Schultes 2000).
5) Soil types: The snail communities are normally impacted by soil conditions such as moisture and ph (Astor et al. 2017). Soil could affect the distribution of snails and control it, from our observation the desert snails controlled by soil like in *X. tuberculosa* (Fig. 70), *X. seetxenii* (Fig. 68), *S. zonata* (Fig. 54) and *S. prophetarum* (Fig. 53) correlated with the soil type of desert stony land, brown desert skeletal soil (Fig. 87, 88).

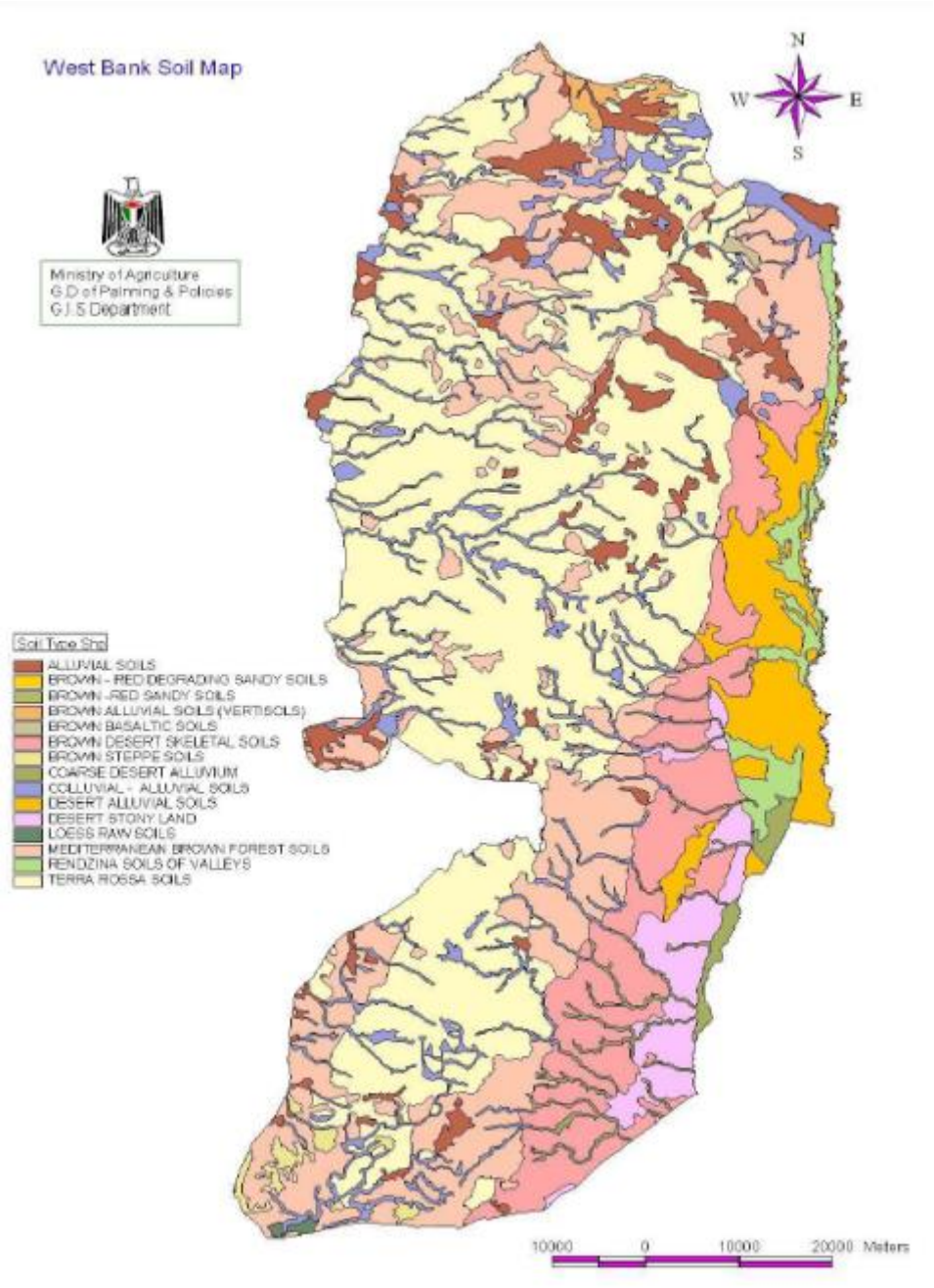


Figure 87. Map of the soil type in the West Bank Palestine.

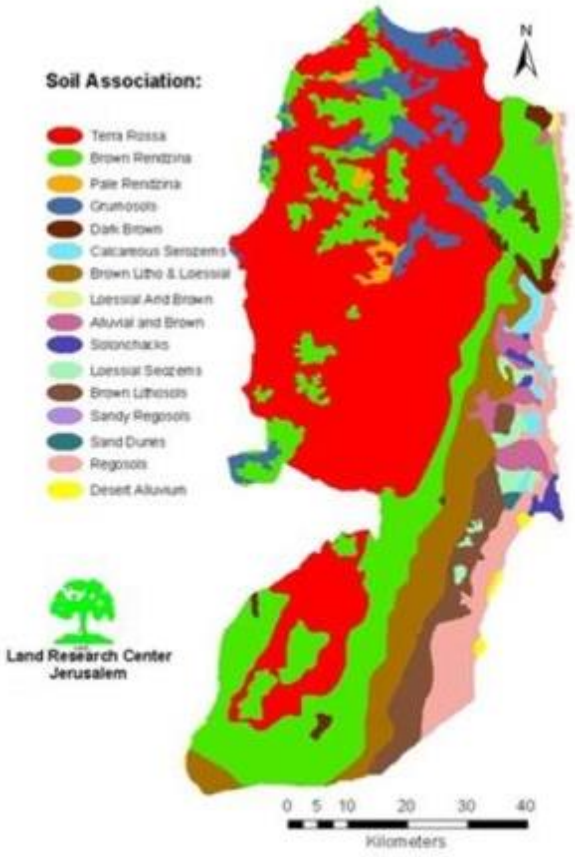


Figure 88. Map of the Soil Association of the West Bank.

6) Radiation/sun exposure: Nevo work facing areas with more radiation likely have fewer snails, which we can see in the specie *M. crspulata* (Fig. 64).

7) Anthropogenic factors: Bar (1977) discuss how people feed on land snails and showes that rule need to be role to prevent extension of some species. Invasive specie of land snail are commonly found in the historic Palestine, there are 72 invasive species of gastropoda recorded from the Historic Palestine, 52 species of them survive and reach to have population, 33 of them are terrestrial snails and 19 freshwatr snails (Roll et al., 2009). In this research only three species of invasive land snail were found in the West Bank belonging to three different families

(Subulinidae: *Rumina decollata*, Cochlicellidae: *Cochlicella acuta* and Helicidae: *Cornu aspersum*). *Rumina decollate* was found in Bethlehem at Bethlehem University near rose plants and never found in other places. *Cochlicella acuta* is a species we found in plant nurseries of the Ministry of Agriculture (MOA). It could be found distributed more in other similar artificial habitats in the West Bank. Finally, *Cornu aspersum* is an invasive species to Palestine introduced as a food source from Italy (Roll et al., 2009). For further issues on the anthropogenic factors, see discussion of threats below.

**Threats**

**Urbanization**: Increase in population lead to decline of the biodiversity by taking land and destroying the environment which change the species habitat which shows in Palestine (Adawi et al., 2017; Amr et al., 2016; Qumsiyeh et al., 2014). Lososová et al., (2011) shows the effect of urbanization on the habitat especially in cities and it results decrease of biodiversity focusing on land snails.

**Over Grazing**: Land snails that exist in Palestine are herbivourus, from our observation on some species of land snails (*Monacha syriaca* and *Xeropicta krynichii*) alive specimens always found on plants that sheep feed on which impact the habitat of land snails.

**Fire**: Fire like other threats is leading to reduce richness of land snails species. A study done in USA shows that 30% of the fire leads to decrease land snails richness by 50-90% (Nekola, 2002).

**Insecticides and pesticides**: Insecticide and pesticide are one of the biggest threats that could kill and reduce the diversity of land snails and other invertebrate (El-Gendy et al., 2009; Heiba et al., 2002). In Palestine and back to the fact that most of the land are prepared for farming and growing plants, farmers used both Insecticide and pesticide for insects and it affect land snails.

**Over collecting**: Palestinian and other use land snails as a food source and eat it (Bar, 1977). From our observation the genus *Levantina* and *Helix* are the one's that consumed. Some people bring specific species of land snails and reproduce it to sale it in the market, like what happened when they introduce a *Conus aspersum* from Italy (Roll et al., 2009).

**Waste water**: A big threat in Palestine is sewage water and lake for the right infrastructure to collect them, this could lead to accumulate heavy metals in their bodies which could affect the chain food of other land snail predator (Swaileh and Ezzughayyar, 2001; Swaileh et al., 2001).

**Climate Change**: Increasing in temperature on each as a result of climate change could affect gastropods in general and land snails in specific. Increasing in thermal radiaction from the sun could lead to an extension of some species of land snails (Baur and Baur, 1993). In the other hand it could lead for a huge selection between species of land snails, which could give the advantages for the species that live in the arid and semi-arid to survive (Arnold, 1969). In our case in Palestine – the West Bank it could be start happened the dominant of desert species like *Sphincterochila fimbriata* (see figure 33), and be threat on the Mediterranean species in our case most of our species exist in the Mediterranean zone.

Future studies on land snail could be improved. Taxonomic studies can be expanded to include genetics (cytogenetics and DNA phylogenic studies) and morphometics and use of soft anatomical parts like the sex organs. Additional studies can be done on ecology especially habitat preferences and changes in distribution temporally and spacially. This may also help us understand impacts of climate change and desertification.

## 6. Conclusion

A total of 41 species of land snail belongs to 13 families and 24 genera were found in the West Bank. Data were gathered for habitat relation and other ecological observation for each species with distribution map showing the relation of each species with elevation and rainfall precipitation. The distribution of land snails was addressed both locally and in relation to phytogeographical zones. 83% of the species were found in the Mediterranean zone, five of them (*Granopupa granum, Sphinctreochila fimbriata, Xerocrassa langloisiana, Xerocrassa simulate* and *Helix engaddensis*) were found in all four phytogeographic zones. 46% if the species were noted in theIrano-Turanian zone *Bulimunus diminutus* was only found in this zone. 34% of the species were noted in the Saharo Arabian zone and 39 % of the species in the Sudanian zone. The factors that impact distribution included soil type, humidity, altitude/elevation, radiation, vegetation, rainfall, closeness to Mediterranean Sea, and anthropogenic factors. The report also highlights threats that could affect the land snails population including urbanization, overgrazing, fire, insecticides and pesticides, over collecting, waste water and climate change. The richest locality noted was Wadi Zarqa Al-Ulwi protected area with 19 species of land snails including endemic forms.

Studies on land snail in our region is still in its infancy. Taxonomic studies can be improved to include genetics (cytogenetics and DNA phylogenic studies) and morphometics and use of soft anatomical parts like the sex organs. Additional studies can be done on ecology especially habitat preferences and changes in distribution temporally and spacially. This may also help us understand impacts of climate change and desertification

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