Collecting work done during the project

The main part of the project was carried out by a field technician, Michael Ben Zeev (Wolfson), who collected specimens in a series of field expeditions, mostly between January and May 2011/2012. Additional collection was carried out by the PI, and several specimens were received from amateurs and field biologists working on other groups. The collection of Dr. Stefan Negrea, collected in 1990 and 1995, and housed in Bucharest since then, has been retrieved and added to the collections in Jerusalem.

The catalogue of centipede specimens before the beginning of the project included approximately 300 specimens. To this, we have added some 160 newly collected specimens, and 120 specimens from the Negrea collection. We have also catalogued an additional 160 records, which are mentioned in publications, but the originals are lost. This brings the total volume of catalogued centipede data to over 700 records, some including multiple individuals. The geographical distribution of these specimens appears in Figure 1. At the time of this writing, about 75% of the specimens are identified to species level, and all of the specimens are identified to ordinal level. All of the recently collected specimens of the order Scolopendromorpha were sent to Dr. Stylianos Simaiakis in Crete for identification (these have already been returned). Dr. Simaiakis also visited the collection in Jerusalem, and joined a field collection trip. While here he gave the PI and associated students/technicians some important tips on field and lab identification of scolopendromorphs. Newly collected specimens of the order Geophilomorpha were sent to Dr. Lucio Bonato in Padova (all identified, but not yet returned). Specimens of the orders Lithobiomorpha and Scutigeromorpha have not been sent yet, but will be sent over the coming months.
Analyses and preliminary results

At the time of this writing there are 32 documented species of Israeli centipedes in our database; 16 species of geophilomorphs, 6 (or more) species of lithobiomorphs, 8 species of scolopendromorphs and 2 species of scutigeromorphs. There is some
controversy over the identity of a few of the species, and additional species may be identified in the samples we still have, so these numbers are not final. Note that Chilobase, the online world centipede database, lists only 17 species for Israel.

A project student, Neta Arazy, focused on the Geophilomorpha. She initially divided all of the specimens into 17 “morphotypes” based on obvious morphological traits; number of segments, length and width of the antennae, length and shape of the rear leg, size and shape of the head shield and overall color pattern. For each of these morphotypes we scored the sex and the number of leg bearing segments, and mapped them on GIS maps in order to identify geographical or climatic trends in segment number. Unfortunately, the sample size for any one morphotype was too small to draw any clear conclusions. Furthermore, these results must be seen as indefinite, until we have species identifications. The segment number distribution of the two morphotypes with the largest number of specimens appears in figures 2-3. In neither case is there a clear and identifiable trend.

We also looked at the connection between segment number and rainfall data. These results are also inconclusive. Some morphotypes show a positive correlation with rainfall amounts, whereas others show a negative correlation. In all cases the $R^2$ values are very low. A few examples are given in figure 4. Following identification of the geophilomorphs by Dr. Bonato, it turns out that the identification to morphotypes was insufficient. We are now repeating the analysis using correct identifications.

An interesting question we wanted to address is the diversity of color patterns in Israeli Scolopendromorpha. We have documented a very wide range of color patterns within the genus *Scolopendra* including red, orange, yellow, black, blue and charcoal pigmentation, and patterns in which the head and or the posterior segment are a different color from the body, the legs are a different color, dark segmental stripes on a light background and medial longitudinal stripes of a darker color than the background. We have not yet completed the geographical analysis of these patterns,
Figure 3: Geographical distribution of segment numbers in *Bothriogaster signata*. 

Bothiogaster signata in Israel
Collection Sites, Trunk Segment Number and Sex
Pachymerium ferrugineum in Israel
Collection Sites, Trunk Segment Number and Sex

Figure 2: geographical distribution of segment numbers in *Pachymerium ferrugineum*
but our preliminary impression is that all colors can be found in all Mediterranean regions, and there are no patterns that are specific to one region. We are currently following a number of clutches of juvenile *Scolopendra*, in order to see whether the color change with age. The identifications sent by Dr. Simaiakis have added further to the confusion, as he has identified several individuals to different species than what we had initially assumed based on their color patterns. According to Dr. Simaiakis there are 3 distinct species of *Scolopendra* in Israel, but they cannot be distinguished based on their color patterns.

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![Graphs showing the relationship between annual rainfall (in mm on the x-axis) and number of segments (on the y-axis) for a sample of geophilomorph morphotypes.]

**Type 1**

\[ y = -0.0071x + 113.29 \]

\[ R^2 = 0.1744 \]

**Type 2**

\[ y = -0.0009x + 99.409 \]

\[ R^2 = 0.0096 \]

**Type 3**

\[ y = 0.008x + 99.002 \]

\[ R^2 = 0.0778 \]

**Type 8**

\[ y = -0.0002x + 82.08 \]

\[ R^2 = 0.0008 \]

**Type 9**

\[ y = -0.0057x + 92.935 \]

\[ R^2 = 0.8014 \]

**Type 14**

\[ y = 0.0007x + 76.113 \]

\[ R^2 = 0.0049 \]

**Type 15**

\[ y = -0.0201x + 77.604 \]

\[ R^2 = 0.554 \]

**Type 16**

\[ y = 0.0038x + 63.234 \]

\[ R^2 = 0.0472 \]

**Type 17**

\[ y = -0.006x + 55.114 \]

\[ R^2 = 0.1854 \]

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Figure 4: the relationship between annual rainfall (in mm on the x-axis) and number of segments (on the y axis) for a sample of geophilomorph morphotypes.
Future prospects

We now have collection data from two field seasons, and are well into analysis of distribution patterns and regional variation. We have yet to begin a detailed analysis of the lithobiomorphs and scutigeromorphs (though these orders are less diverse, and we expect no surprises there).

We are in the process of plotting all of the collection data on GIS maps, with the aim of predicting the distribution range of each species. Partial results are presented here. For the geophilomorphs, we will plot segment number variability, for the 3 species where we have a large enough sample, against various geographic and climatic factors using GIS.

Once the distribution data is complete, we will use this as a basis for publishing a series of short papers, starting with the Geophilomorpha. We hope to ultimately publish a monograph (in collaboration with Dr. Negrea of Bucharest) on the centipede fauna of Israel. In addition we will publish a less technical version with a field identification guide for use by conservationists, field biologists and interested members of the public.