Acta Zoologica Academiae Scientiarum Hungaricae 51 (2), pp. 75–96, 2005

EARTHWORMS FROM ISRAEL. II. REMARKS ON THE GENUS PERELIA EASTON, 1983 WITH DESCRIPTIONS OF A NEW GENUS AND TWO NEW SPECIES

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The diagnosis of the genus *Perelia* EASTON, 1983 is revised and two species, *Perelia shamsi* sp. n. and *Perelia galileana* sp. n. are described from Israel. The taxonomic status of *Helodrilus (Allolobophora) aharonii* STEPHENSON, 1922 is clarified. To accommodate the species *Allolobophora handlirschi diplotetratheca* PEREL, 1967 removed from *Perelia* a new genus *Rhiphaeodrilus* gen. n. is erected. In addition, new data about species richness and distribution of the genera *Aporrectodea* ÖRLEY, 1885, *Allolobophora* EISEN, 1874, *Helodrilus* HOFFMEISTER, 1845, *Eisenia* MALM, 1877, *Eiseniella* MICHAELSEN, 1900 and *Criodrilus* HOFFMEISTER, 1845 in Israel are presented.

Key words: earthworms, Oligochaeta, Lumbricidae, *Perelia*, new species and genus, *Rhiphaeodrilus*, *Aporrectodea*, *Eisenia*, *Eiseniella*, *Helodrilus*, *Criodrilus*, The Levant, Israel

INTRODUCTION

Earthworms are thought to be one of the most important soil-inhabitant animal groups. They strongly affect both the structure and the chemical properties of the soil (DARWIN 1881, ZICSI 1975, LEE 1985). In the Palaearctic region, earthworm activity is particularly important in the places lying south of the quaternary ice sheet border and outside of the desert regions, e.g., in Central and Southern Europe as well as in the Mediterranean, where earthworms constitute one of the main components of the soil fauna (MICHAELSEN 1903, ZICSI 1983).

In the Mediterranean region, earthworms are poorly known despite their importance in pedogenesis, and, among others, in spite of their potential to contribute to the understanding of regional phylogeography, palaeography (e.g., COBOLLI SBORDONI *et al.* 1992), and as an important tool in ecology (e.g., DECAËNS *et al.* 2003), evolutionary biology (e.g., PAVLÍČEK *et al.* 2000), and ecotoxicology (SPURGEON *et al.* 2003). The same poor knowledge is true for the earthworm fauna of Israel as well although more than a dozen papers (ČERNOSVITOV 1940, 1942, MICHAELSEN 1901 1910, 1926, OMODEO 1956*a*, ROSA 1893, STEPHENSON 1913, 1922, ZICSI 1985, CSUZDI & PAVLÍČEK 1999, 2002, CSUZDI *et al.* 1999) and several reviews (BODENHEIMER 1935, 1937, ČERNOSVITOV 1938, PAVLÍČEK *et al.*

2003) have already been published. The reasons for this situation are the insufficient number of earthworm specialists working on the Mediterranean earthworm fauna, and the fact that most of the available specimens were collected mainly as a by-product of other investigations (e.g., ZICSI 1985). Almost no systematic earthworm survey had hitherto been conducted in Israel or in the adjacent countries until present when authors launched a country-wide investigation of the Israeli earthworm fauna.

Parts of the results of these investigations (genera *Dendrobaena* EISEN, 1874 and *Bimastos* MOORE, 1893) have already been published (CSUZDI & PAVLÍČEK 1999, 2002, CSUZDI *et al.* 1999). In the present paper we summarize the distributional data obtained on the species of the genera *Perelia* EASTON, 1983, *Aporrectodea* ÖRLEY, 1885, *Allolobophora* EISEN, 1874, *Helodrilus* HOFFMEISTER, 1845, *Eisenia* MALM, 1877, *Eiseniella* MICHAELSEN, 1900 and *Criodrilus* HOFFMEISTER, 1845. Also included in the paper are descriptions of two species and one genus new to science.

MATERIAL AND METHODS

Earthworms were collected by the diluted formalin method (RAW 1959) and digging. A combination of both methods provides a more complete sampling of species because the formalin method alone is not very efficient in collecting species living in the mineral soil layers or in a horizontal system of burrows like most of the *Perelia* species. Gathered specimens were immediately killed in 75% ethanol, fixed in 4% formalin, and transferred to 75% ethanol after several days. The collecting sites comprised natural and semi-natural (i.e., pastures), semiarid and arid biotopes of Israel.

The taxonomic status of *Helodrilus (Allolobophora) aharonii* STEPHENSON, 1922 was clarified by investigating the type specimen housed in the Natural History Museum, London, under registration number BMNH 1921.6.6.1.

For histological study, several postclitellar segments were embedded in paraffin, and 10 μm wide microscopic cross-sections sliced by using a Microm rotary-microtome, and stained with hematoxylin and eosin (KRUTSAY 1980). Measurements taken (in mm): total body length for number of segments; diameter measured just posterior to the clitellum.

The specimens are deposited in the Soil Zoology Collection of the Hungarian Natural History Museum, Budapest.

SYSTEMATICS

Family Lumbricidae RAFINESQUE-SCHMALTZ, 1815

Perelia EASTON, 1983
(Fig. 1)

Allolobophora (Svetlovia) PEREL, 1976: 833, PEREL 1979: 182.
Perelia EASTON, 1983: 484. [nom. nov. pro *Svetlovia* PEREL 1976 non *Svetlovia* CHEKANOVSKAYA, 1975 (Tubificidae)], MRŠIČ 1991: 653, PEREL 1997: 58. QIU & BOUCHÉ 1998: 191.
Alpodinaridella (Alpodinaridella) MRŠIČ, 1987: 63; MRŠIČ & ŠAPKAREV 1988: 17; MRŠIČ 1991: 231. **syn. n.**
Alpodinaridella (Dinaridella) MRŠIČ, 1987: 63; MRŠIČ & ŠAPKAREV 1988: 17; MRŠIČ 1991: 240. **syn. n.**

Type species – *Eophila arnoldiana* PEREL, 1971 by original designation.

Diagnosis. External characteristics: Setae closely paired, pigmentation lacking, sometimes with brownish colour on dorsum, prostomium epilobous, dorsal pore variable. Male pore on segment 15 fairly visible, usually with glandular crescent intruding into the neighbouring segments. Spermathecae open in setal line cd, nephropores irregularly alternate between *b* and above *cd*. Internal characteristics:

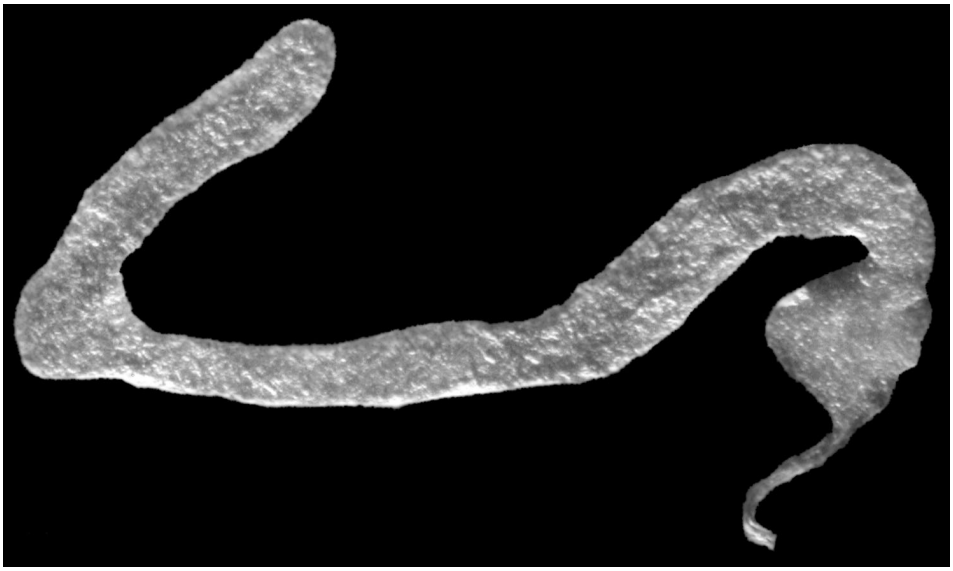


Fig. 1. Nephridial bladder of *P. arnoldiana* (PEREL, 1971)

Two pairs of testes in 10, 11, and two or four pairs of seminal vesicles in 11, 12 or 9–12. Receptacula seminis two to five pairs (sometimes lacking?). Calciferous glands with lateral diverticula in 10. Excretory system holonephridial, nephridial bladders "S" shaped with cephalad bent ental part and ectal looping (Fig. 1) that might be fused forming an ectal vesicle (sigmoid-type) (Fig. 2). The cross section of longitudinal muscle layer is fasciculate with well-developed radial walls.

Remarks. The genus *Allolobophora* was characterized by the U- or J-shaped nephridial bladders possessing cephalad bent ental part and simple ectal duct running directly into the nephridiopore (GATES 1975). PEREL (1976) demonstrated that a group of Central Asian species have more complicated nephridial bladders with ectal looping before entering into the nephridial pore and forming so an inverse "S". These species have been classified to the newly erected subgenus *Svetlovia* PEREL, 1976. Later EASTON (1983) pointed out that *Svetlovia* PEREL, 1976 is preoccupied by *Svetlovia* CHEKANOVSKAYA, 1975 (Tubificidae) and proposed a new name *Perelia* EASTON, 1983 for this group of species. Several years later, MRŠIČ (1987) described a new genus *Alpodinaridella* divided into two subgenera (*Alpodinaridella*, and *Dinaridella)* from the Balkan similar to *Perelia*. The only differences stated is that the nephridial bladders open not through a loop but a bag-like distension. Unfortunately, MRŠIČ had no *Perelia* material at hand when he prepared his monograph on the earthworms of the Balkan (MRSIČ 1991), so he had to rely on the somewhat scanty descriptions of PEREL (1976, 1979).

We had the opportunity to examine several *Perelia* species (including the type species *P. arnoldiana* (PEREL, 1971)) housed in the Hungarian Natural History Museum, Budapest, and recognized that several *Perelia* species (due to the fusing of the loop) also possess a bag-like distension that eliminates the difference between the two above-mentioned genera. Therefore *Alpodinaridella* MRŠIČ, 1987 represents a junior synonym of *Perelia* EASTON, 1983.

However, the above diagnosis of genus *Perelia* excludes *Allolobophora handlirschi diplotetratheca* PEREL, 1967 from *Perelia*. This species is distributed in the Ural region and characterized by an intensive red-violet pigmentation, directly opening calciferous glands in 11, 12, pinnate musculature and inverse "S" shaped nephridial bladders and it deserves a genus of its own that is described subsequently.

Perelia aharonii (STEPHENSON, 1922)

Helodrilus (Allolobophora) aharonii STEPHENSON, 1922: 136.
Allolobophora (s. l.) *aharonii*: PAVLÍČEK *et al*. 2003: 456.

Material examined. BMNH 1921.6.6.1. Syntype: Palestina, Rehoboth. Leg. T. Aharoni.

Diagnosis. Length –100 mm; diameter –4 mm; setae closely paired. Clitellum not fully developed, perhaps on 30–38. Tubercles as distinct bands on 33–37. Male pore small (due to the preadult stage of the specimen?) on 15. Dissepiments 5/6–9/10 thickened. Four pairs of vesicles in 9–12, spermathecae two pairs in 9/10, 10/11 open in setal line *cd*. Calciferous glands with small lateral diverticula in 10. Nephridial bladders "S" shaped, with cephalad bent ental part and an ectal vesiculum.

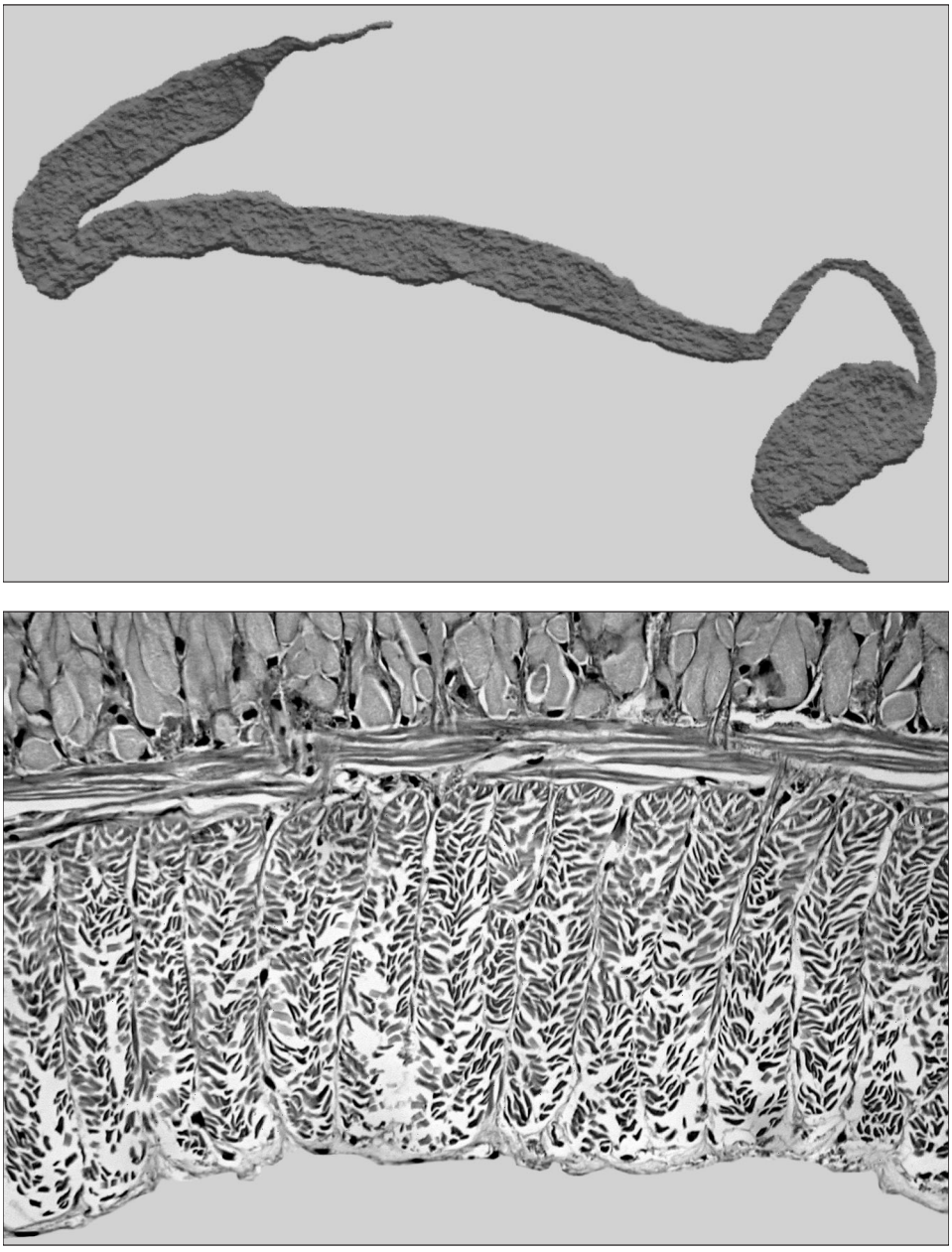
Remarks. Unfortunately, this species has not been collected recently and the only specimen known to us is deposited in the Natural History Museum, London. The original description was based on three preadult, softened specimens (STEPHENSON 1922). However, according to the registration number the specimen available in the Natural History Museum, London, is the only one that had been deposited there. We do not know anything about the two remaining Stephenson's specimens.

Perelia kaznakovi (MICHAELSEN, 1910)
(Figs 2–3)

Helodrilus (Eophila) kaznakovi MICHAELSEN, 1910: 65.
Eophila asiatica MALEVIC, 1949: 398.
Allolobophora (Svetlovia) kaznakovi: Perel 1976: 833.
Perelia kaznakovi: EASTON 1983: 484.

Material examined: No. 11504 4 ex., Chatkalsky hrebet, Tian-Shan Mts., Uzbekistan, CS. CSUZDI, 1983.05.28. No. 11523 8 ex., Asak-Ata, Uzbekistan, K. MÁRIALIGETI, 1989.05.29.

Diagnosis. Length 55–70 mm; diameter 5–6 mm; setae closely paired. First dorsal pore in 5/6; pigmentation lacking. Clitellum on 27–35. Tubercles as thin bands on 32–34. Male pore great on 15. Well-developed genital papillae around setae *ab* on 10, 11 and 27, 28. Dissepiments 5/6–11/12 strongly thickened. Two pairs of vesicles in 11, 12; spermathecae two pairs in 9/10, 10/11 open in setal line *cd*. Calciferous glands with well-developed lateral diverticula in 10. Nephridial bladders "S" shaped, with cephalad bent ental part and ectal vesiculum (Fig. 2). Longitudinal musculature fasciculate with strong radial walls (Fig. 3).



Figs 2–3. *P. kaznakovi* (MICHAELSEN, 1910): 2 = nephridial bladder (top), 3 = musculature (bottom)

Perelia galileana sp. n.
(Figs 4–7)

Allolobophora sp. PAVLÍČEK *et al.* 1996: 450.

Holotype: No. 14876 Qiryat Tivon, Israel, T. PAVLÍČEK, 1996.03.20.

Paratypes: No. 12228 3 ex., Mt. Carmel, Nahal Oren, Israel, T. PAVLÍČEK 1995.03.03. No. 12412 1+2 ex., Qiryat Tivon, Israel, T. PAVLÍČEK, 1996.03.20. No. 12957 2 ex., Latrun, Israel, T. PAVLÍČEK, 1998.03.22. No. 14040 1+2 ex., Allone Abba, Israel, T. PAVLÍČEK & Cs. Csuzdi, 2001.03.21. No. 14136 1+3 ex., southwestern slope of Golan Heights near Kinneret, Israel, T. PAVLÍČEK, 2001.02.09. No. 14724 1+2 ex., Allone Abba, Israel, T. PAVLÍČEK, 2004.03.27.

Additional material examined: No. 12442 0+1 ex., Israel, Allone Abba, T. PAVLÍČEK 1996. 03.20. No. 14715 0+2 ex., Nahal Tabor in Jordan Valley, Israel, T. PAVLÍČEK, 2004.02.21 (Fig. 4).

Etymology: The name of this species refers to the place of its distribution.

Diagnosis. Length: 40–68 mm, diameter: 3–5 mm, setae closely paired. Clitellum on 23, 24–34. Tubercles on 31–34. Male pore on 15 great. Dissepiments 6/7–8/9 thickened. Two pairs of vesicles in 11, 12; two pairs of spermathecae in 9/10, 10/11 open in setal line *cd*. Calciferous glands with lateral diverticula in 10. Nephridial bladders "S" shaped, with cephalad bent ental part and an ectal vesiculum.

Description. Holotype: length 71 mm, diameter just after the clitellum 5 mm. Number of segments 151. Paratypes: 40–68 mm long and 3–4.5 mm wide. Number of segments 133–146. Colour pale, pigmentation lacking. Prostomium epilobous ½ open. First dorsal pore at the intersegmental furrow 4/5. Setae strictly paired. Setal formula at segment *xl*: aa:ab:bc:cd:dd = 14.5:1.5:12:1:30. Two pairs of spermathecal pores present in furrows 9/10 and 10/11 in the setal line *cd*. Male pores ventral, just above setae *b*, on the segment *xv* intruding also to the neighbouring segments. Nephridial pores irregularly alternated between setal line *b-d*. Clitellum on segments *xxiv–xxxiv* sometimes slightly intruding into the neighbouring segments. Tubercula pubertatis on segments *(xxx) xxxi–xxxiv*. Genital papillae variable usually in the region *ix–xiii ab* and *xxx ab*. Genital setae of *xi* 0.580–0.650 mm long, spear-shaped with 0.240–0.300 mm long longitudinal grooves (Fig. 5).

Internal characteristics. Septa 6/7–8/9 thickened. Free testes and funnels paired in segments *x–xi*. Seminal vesicles present in segments *xi* and *xii*. Spermathecae in segments *ix*, *x* with external openings in the setal line *cd*. Calciferous diverticula present in segments *x* with lamellae extending into *xi.* Paired lateral hearts appear in segments *vi–xi*, with a pair of small extraoesophageal vessels in *xii*. Nephridial bladders "S" shaped with cephalad bent ental limb and an ectal vesicle (Fig. 6). Crop in segments *xv–xvi*, and gizzard in segments *xvii–xviii*. Typhosolis large, tri-lobed. Longitudinal muscle layers fasciculate with strong radial walls (Fig. 7).

Remark. The new species seems to be close to *P. shamsi* sp. n. and to the widely distributed *P. kaznakovi* (MICHAELSEN, 1910), but differs from both in the position of the clitellum and tubercles (Table 1).

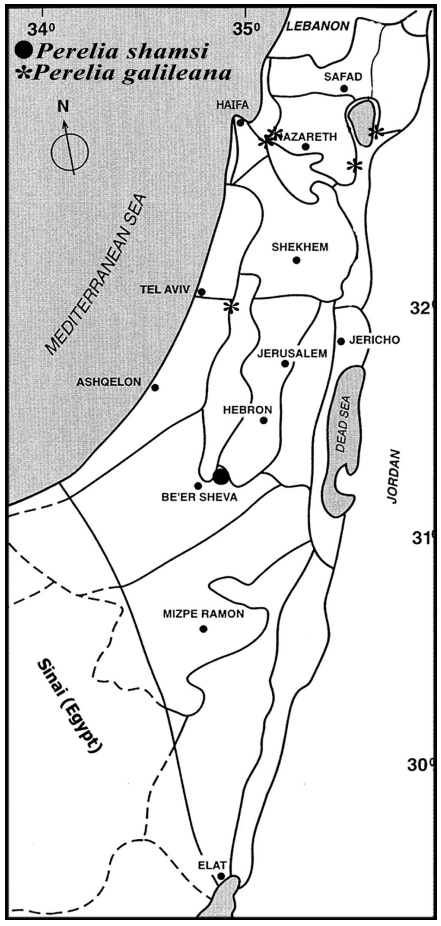
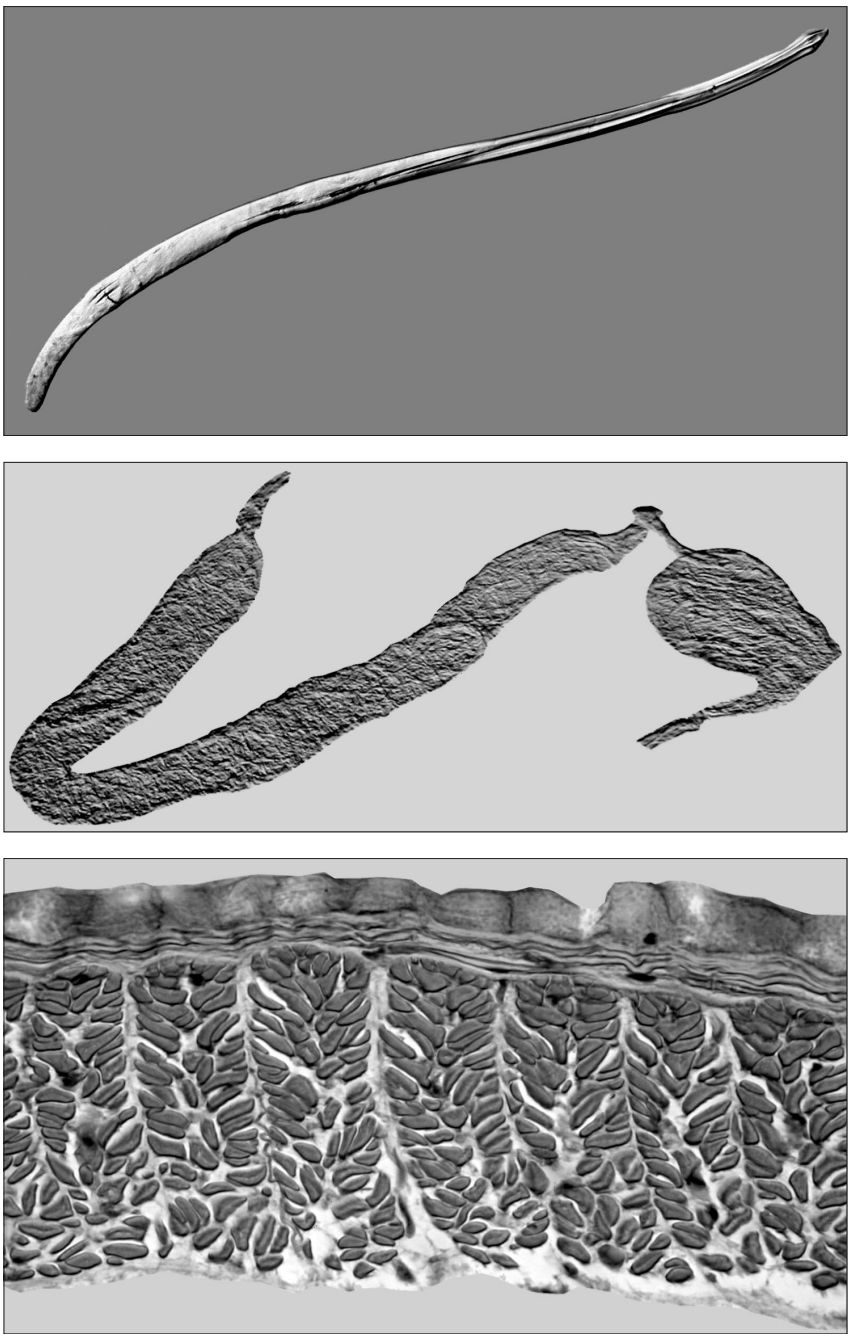


Fig. 4. Distribution of *P. galileana* sp. n. and *P. shamsi* sp. n.

Table 1. Distinguishing characters of the *Perelia* species possessing two pairs of receptacles in 9/10, 10/11

Species	Clitellum	Tubercle	Vesicles	Dorsal pore	Pigmentation	Distribution
P. media (PEREL, 1977)	24, 25–35	31–33	11, 12	4/5	brownish	Kazakhstan
P. galileana sp. n.	23, 24–34	31–34	11, 12	4/5	lacking	Israel
P. shamsi sp. n.	21–36	29–1/n35	11, 12	4/5	lacking	Israel
P. kaznakovi (MICHAELSEN, 1910)	27–35	32–1/n35	11, 12	4/5	lacking	Central Asia
P. aharonii (STEPHENSON, 1922)	30–38	33–37	9–12	?	lacking?	Israel
P. bouchei (PEREL, 1977)	26–40	37–39	11–12	10/11	lacking	Kazakhstan
P. graciosa (PEREL, 1977)	29–42	38–40	11–12	10/11	lacking	Kirgizstan
P. albicauda (PEREL, 1977)	25–43	39–41	11–12	11/12	brownish	Kirgizstan
P. stenosoma (PEREL, 1977)	30–46	40–44	11, 12	11/12	greenish-brown	Uzbekistan
P. longoclitellata (PEREL, 1977)	28–47	41–43	11, 12	11/12	brownish	USSR



Figs 5–7. *P. galileana* sp. n.: 5 = penial seta (top), 6 = nephridial bladder (middle), 7 = musculature (bottom)

Perelia shamsi sp. n.
(Figs 4, 8–10)

Holotype: No. 14875 Lahav, Israel, T. PAVLÍČEK, 1997.03.29.

Paratypes: No. 12476 6 ex., Lahav, Israel, T. PAVLÍČEK, 1997.03.29. No. 12477 3+1 ex., Lahav, Israel, T. PAVLÍČEK, 1997.03.29.

Additional material examined: No. 12468 0+6 ex., Lahav Israel, T. PAVLÍČEK 1997.02.03. No. 14252 0+4 ex., Lahav, Israel, T. PAVLÍČEK, 2000.03.29. No. 12463 0+6 ex., Lahav, Israel, T. PAVLÍČEK 1997.02.03 (Fig. 4).

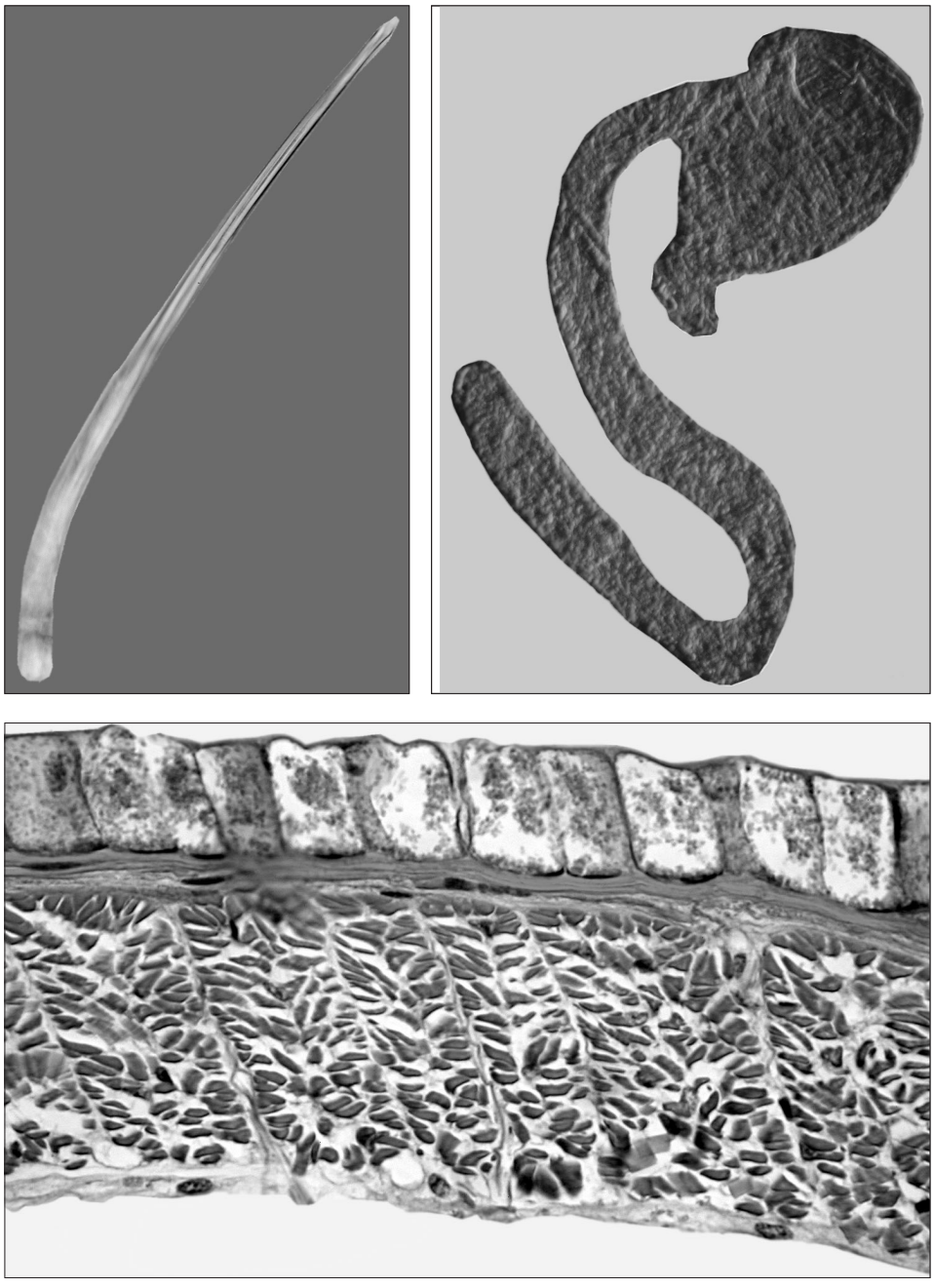
Etymology: The species is named in honour of IMAD SHAMS (Majdal Shams, Israel) for his valuable help during our collection trips.

Diagnosis. Length 60–80 mm diameter 3.5–4 mm, setae closely paired. Clitellum on 21, 22–35, 36. Tubercles on 29–34. Large male pore on 15. Dissepiments 6/7–9/10 thickened. Two pairs of vesicles in 11, 12; two pairs of spermathecae in 9/10, 10/11 open in setal line cd. Calciferous glands with lateral diverticula in 10. Nephridial bladders "S" shaped, with cephalad bent ental part and an ectal vesiculum.

Description. Holotype: length 70 mm, diameter just after the clitellum 4 mm. Number of segments 133. Paratypes: 60–85 mm long and 3.5–4 mm wide. Number of segments 124–150. Colour pale, pigmentation lacking. Prostomium epilobous ½ closed. First dorsal pore at the intersegmental furrow 4/5. Setae strictly paired. Setal formula at segment *xl*: aa:ab:bc:cd:dd = 12.5:1.25:9:1:17.5. Two pairs of spermathecal pores present in furrows 9/10 and 10/11 in the setal line *cd*. Male pores ventral just above setae *b*, on the segment *xv* intruding also to the neighbouring segments. Nephridial pores irregularly alternated between setal line *b–d*. Clitellum when fully developed on segments *xxi–xxxvi*, in lesser adult specimens *xxii–xxxv*. Tubercula pubertatis on segments *xxix–xxxiv*, *1/n xxxv*. Genital papillae on *ab x–xi* or *xi–xiii* and *ab xxviii–xxx*. Genital setae of *xi* 0.600–0.650 mm long, spear-shaped with 0.250–0.300 mm long longitudinal grooves (Fig. 8). Flat spermatophores present on the ventral surface of segment *xxv*.

Internal characteristics. Septa 6/7–9/10 thickened, 10/11–13/14 slightly strengthened. Free testes and funnels paired in segments *x–xi*. Seminal vesicles present in segments *xi* and *xii*. Spermathecae in segments *ix*, *x* with external openings in the setal line *cd*. Calciferous diverticula present in segments *x* with lamellae extending into *xi.* Paired lateral hearts appear in segments *vi–xi*, with a pair of small extraoesophageal vessels in *xii*. Nephridial bladders sigmoid with cephalad bent ental limb and an ectal vesicle (Fig. 9). Crop in segments *xv–xvi*, and gizzard in segments *xvii–xviii*. Typhosolis large, bi-lobed. Longitudinal muscle layers fasciculate with strong radial walls (Fig. 10).

Remarks. The new species is close to *P. galileana* sp. n. and to the widely distributed *P. kaznakovi* (MICHAELSEN, 1910), but differs from both in the position of the clitellum and the tubercles (Table 1).



Figs 8–10. *P. shamsi* sp. n.: 8 = penial seta (top left), 9 = nephridial bladder (top right), 10 = musculature (bottom)

Rhiphaeodrilus gen. nov.

Diagnosis. External characteristics: Setae closely paired, red-violet pigmentation present. Prostomium epilobous, dorsal pore around 5/6. Male pore on segment 15 fairly visible, usually with glandular crescent intruding into the neighbouring segments. Spermathecae open in setal line *cd*, nephropores irregularly alternate between *b* and above *cd*. Internal characteristics: two pairs of testes in 10, 11, and three pairs of seminal vesicles in 9, 11, 12. Four pairs of receptacula seminis 7/8, 8/9, 9/10, 10/11. Calciferous glands open directly in 11, 12. Excretory system holonephridial, nephridial bladders "S" shaped with cephalad bent ental part and ectal looping. The cross section of longitudinal muscle layer is of pinnate type.

Type species: *Allolobophora handlirschi diplotetratheca* PEREL, 1967.

Other species: Not known.

Etymology: From the Latin Montes Rhiphaeus = Ural Mts.

Remarks. *Rhiphaeodrilus diplotetrathecus* (PEREL, 1967) has long been placed into *Perelia*, but it differs from the *Perelia* species in three main characteristics. It has three pairs of vesicles, red-violet colour and pinnate musculature. According to the pigmentation and strictly paired setae, it shows affinity to the *Eisenia* MALM, 1877 and *Eisenoides* GATES, 1959 genera, but differs from both in the structure of nephridial bladders.

Rhiphaeodrilus diplotetrathecus (PEREL, 1967) **comb. n.**
(Figs 11–12)

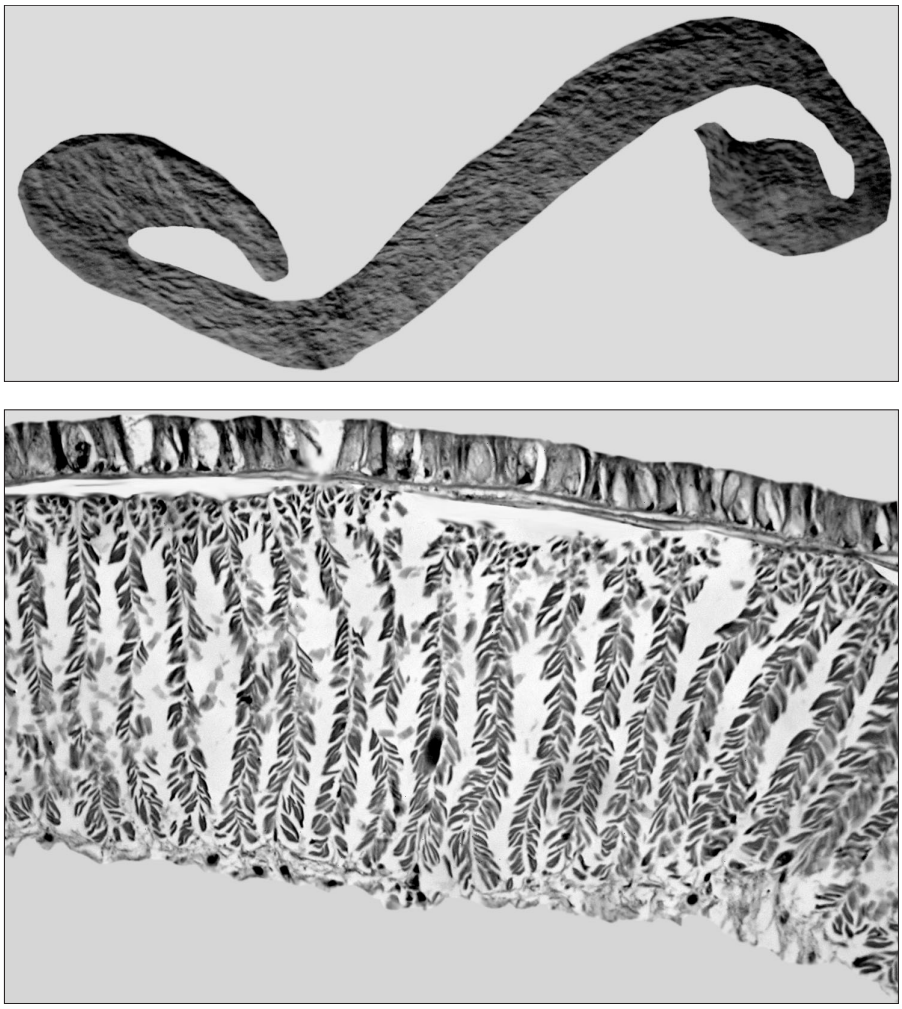
Allolobophora handlirschi diplotetratheca PEREL, 1967: 1321.
Allolobophora (Svetlovia) diplotetratheca: PEREL, 1976: 833.
Perelia diplotetratheca: EASTON 1983: 484.

Material examined: No. 12641 3 ex., Permskaya oblast, Det. Perel. No. 12642 2 ex., Ural, Ilmensi zapovednik, 1958. [transliterated from Russian]

Diagnosis. Length 45–70 mm diameter; 3–4 mm; setae closely paired. First dorsal pore in 5/6, red-violet pigments present. Clitellum on 1/n 26, 26–32. Tubercles as thin bands on 27–31, 1/n 32. Moderately large male pore on 15; well-developed genital papillae around setae *ab* on 16, 26–28, 31, 32. Nephridial pores irregularly alternate between setal line *b* and above *d*. Septa 6/7–7/8, 12/13–14/15

slightly strengthened, 8/9–11/12 moderately thickened. Three pairs of seminal vesicles in 9, 11, 12 segment; four pairs of spermathecae in 7/8, 8/9, 9/10, 10/11 open in setal line *cd*. Calciferous glands well developed, open directly in 11, 12. Nephridial bladders "S"' shaped, with cephalad bent ental part and ectal looping (Fig. 11). Longitudinal musculature pinnate (Fig. 12).

Remark. All the specimens were donated by T. S. PEREL and those that are registered under No. 12642 belong to the paratype series.



Figs 11–12. *Rhiphaeodrilus diplotetrathecus* (PEREL, 1967): 11 = nephridial bladder (top), 12 = musculature (bottom)

Allolobophora EISEN, 1874

Allolobophora EISEN, 1874: 46, CSUZDI & ZICSI 2003: 48 (for complete synonymy).

Allolobophora chlorotica chlorotica (SAVIGNY, 1826)

Enterion chloroticum SAVIGNY, 1826: 182.
Allolobophora (Allolobophora) chlorotica: ROSA 1893: 8.
Helodrilus chloroticus: BODENHEIMER, 1937: 259.
Allolobophora chlorotica: OMODEO, 1956a: 333, PAVLÍČEK *et al.* 2003: 456.
Allolobophora chlorotica chlorotica: CSUZDI & ZICSI 2003: 50 (for complete synonymy).

Material examined: No. 12889, 32 ex., Nahal Keziv, under *Platanus* tree, Israel, T. PAVLÍČEK, 1998.01.09.

Remark. Peregrine species.

Aporrectodea ÖRLEY, 1885

Aporrectodea ÖRLEY, 1885: 22, GATES 1975: 4, CSUZDI & ZICSI 2003: 73 (for complete synonymy).

Aporrectodea caliginosa (SAVIGNY, 1826)

Enterion caliginosum SAVIGNY, 1826: 180.
Allolobophora (Allolobophora) caliginosa: ROSA 1893: 7.
Allolobophora caliginosa: BODENHEIMER 1935: 393.
Helodrilus caliginosus: BODENHEIMER 1937: 259.
Allolobophora caliginosa var. *trapezoides*: ČERNOSVITOV 1940: 446.
Allolobophora caliginosa f. *trapezoides*: OMODEO 1956*a*: 335.
Aporrectodea caliginosa caliginosa: PAVLÍČEK *et al.* 2003: 456.
Aporrectodea caliginosa trapezoides: ZICSI 1985: 330; PAVLÍČEK *et al.* 2003: 456.
Aporrectodea caliginosa: CSUZDI & ZICSI 2003: 75 (for complete synonymy).

Material examined: No. 12428, 1 ex., Bet She'an, T. PAVLÍČEK, 1996.02.27. No. 12460, 1 ex., Yarkon River (Tel Aviv), T. PAVLÍČEK, 1996.11.17. No. 12480, 1 ex., Wadi Kelt, T. PAVLÍČEK, 1997.03.01. No. 12598, 6 ex., Eli-Al, Golan Heights, T. PAVLÍČEK, 1997.04.05. No. 12606, 1 ex., Mt. Carmel, T. PAVLÍČEK, 1997.05.08. No. 12610, 1 ex., Mas'ada, Golan Heights, T. PAVLÍČEK, 1997. 05.03. No. 12613, 1 ex, Dalton, Upper Galilee, rendzina, T. PAVLÍČEK, 1997.05.03. No. 12901, 5 ex., Afeq, near spring, T. PAVLÍČEK, 1998.01.17. No. 12902, 2 ex., Nahal Oren, under trunk of *Ceratonia siliqua*, T. PAVLÍČEK, 1997.12.15. No. 12909, 4 ex., Yeriho spring, T. PAVLÍČEK, 1998.01.31. No. 12924, 2 ex., Bet She'an – Haifa crossroad (5 km north of Bet-She'an), T. PAVLÍČEK, 1998.02.28. No. 14022, 3 ex., Tel Keshet, T. PAVLÍČEK, & CS. CSUZDI, 2001.03.16. No. 14051, 5 ex., Jubat el Kabira,

Golan Heights, T. PAVLÍČEK, & CS. CSUZDI, 2001.03.23. No. 14070, Majdal Shams, Golan Heights, T. PAVLÍČEK, & CS. CSUZDI, 2001.03.24. No. 14105, 2 ex., near Ramla, T. PAVLÍČEK, 2000.12.23. No. 14142, 2 ex., western slopes of Golan Heights near Lake Kinneret, T. PAVLÍČEK, 2001.02.03. No. 14173, 1 ex., 3 km east of Sede Uzziahu, T. PAVLÍČEK, 1999.01.27. No. 14175, 2 km east of Sede Uzziahu, T. Pavlíček, 1999.01.27. No. 14262, 2 ex., Mas'ada, Golan Heights, T. PAVLÍČEK, 2000.04.03. No. 14302, 1 ex., Ein Edem, Mt. Carmel, T. PAVLÍČEK, 2001.11.10. No. 14303, 1 ex., Ein Edem, Mt. Carmel, T. PAVLÍČEK, 2001.11.10. Z/14395, 1 ex., eastern bank of Lake Kinneret, T. PAVLÍČEK, 2002.02.05. No. 14401, 2 ex., eastern bank of Lake Kinneret, T. PAVLÍČEK, 2002.02.05. No. 14422, 1 ex., Rabana, Golan Heights, T. PAVLÍČEK, 2002.02.15. No. 14438, 1 ex., Ein Kedem, Mt. Carmel, T. PAVLÍČEK, 2002.02.05.

Remarks. Peregrine species.

Aporrectodea jassyensis MICHAELSEN, 1891

Allolobophora jassyensis MICHAELSEN, 1891: 15.
Allolobophora (Allolobophora) jassyensis: ROSA 1893: 8.
Helodrilus jassyensis orientalis: BODENHEIMER 1935: 393; BODENHEIMER 1937: 259.
Allolobophora jassyensis f. *orientalis*: OMODEO 1956a: 333.
Aporrectodea jassyensis: PAVLÍČEK *et al.* 2003: 456; CSUZDI & ZICSI 2003: 87 (for complete synonymy).

Material examined: No. 12439, 1 ex., Nahal Sharakh, T. PAVLÍČEK, 1996.01.31. No. 12459, 1 ex., Yarkon River (Tel Aviv), T. PAVLÍČEK, 1996.11.17. No. 12465, 3 ex., Megiddo, T. PAVLÍČEK, 1997.02.01. No. 12479, 2 ex., Wadi Kelt, T. PAVLÍČEK, 1997.03.01. No. 12892, 2 ex., Nahal Keziv, under oak trees, T. PAVLÍČEK, 1998.01.09. No. 12897, 2 ex., Nahal Keziv, under stones, T. PAVLÍČEK, 1998.01.09. No. 12898, 5 ex., Nahal Keziv, abandoned field, T. PAVLÍČEK, 1998.01.09. No. 14057, 3 ex., Ha Emir Junction, Golan Heights, T. PAVLÍČEK, & CS. CSUZDI, 2001.03.23. No. 14067, 4 ex., Majdal Shams, Golan Heights, T. PAVLÍČEK, & CS. CSUZDI, 2001.03.24. No. 14158, 3 ex., Latrun, T. PAVLÍČEK, 1999.03.06. No.14440, 1 ex., Rehanyia, T. PAVLÍČEK, 2002.02.21. No. 14718 2 ex., Rehanyia, T. PAVLÍČEK, 2002.03.29. No. 14720 1 ex., Mi'ilya, T. PAVLÍČEK, 2002.03.29.

Remark. This species has an extensive trans-Aegean type of distribution (CSUZDI & ZICSI 2003).

Aporrectodea rosea (SAVIGNY, 1826)

Enterion roseum SAVIGNY, 1826: 182.
Allolobophora (Notogama) rosea: ROSA 1893: 2.
Eisenia rosea: BODENHEIMER 1935: 393; BODENHEIMER 1937: 259.
Eisenia rosea ? var.: ČERNOSVITOV 1940: 441.
Allolobophora rosea: OMODEO 1956*a*: 334; ZICSI 1985: 331.
Aporrectodea rosea: PAVLÍČEK *et al*. 2003: 456; CSUZDI & ZICSI 2003: 92 (for complete synonymy).

Material examined: No. 12280, 1 ex, Ein Avdat, Negev, T. PAVLÍČEK, 1995.05.04. No. 12415, 3 ex., Netva, T. PAVLÍČEK, 1996.01.31. No. 12429, 4 ex., Bet She'an, T. PAVLÍČEK, 1996.02.27. No. 12432, 9 ex., near Kibbutz Lahav, Negev, T. PAVLÍČEK, 1995.11.27. No. 12438, 1 ex., Chursat Tall, T. PAVLÍČEK, 1996.01.31. No. 12440, 2 ex., Nahal Sharakh, T. PAVLÍČEK, 1996.01.31. No. 12466, 3 ex., Megiddo, T. PAVLÍČEK, 1997.02.01. No. 12471, 1 ex., Lahav, northern Negev, T. PAVLÍČEK, 1997. 02.03. No. 12475, 1 ex., Churvat Anim near Yattir forest, T. PAVLÍČEK, 1997.03.29. No. 12481, 19 ex., Yatir Mts., T. PAVLÍČEK, 1997.03.29. No. 12597, 4 ex., Eli-Al, Golan Heights, T. PAVLÍČEK, 1997.04.05. No. 12611, 3 ex., Mas'ada, Golan Heights, T. PAVLÍČEK, 1997.05.03. No. 12614, 1 ex., Dalton, Upper Galilee, rendzina, T. PAVLÍČEK, 1997.05.03. *No*. 2617, 6 ex., Nahal Dishon, Upper Galilee, T. PAVLÍČEK, 1997.05.03. No. 12896, 2 ex., Nahal Keziv, T. PAVLÍČEK, 1998.01.09. No. 12903, 10 ex., Avedat, T. PAVLÍČEK, 1998.01.21. No. 12904, 6 ex., Avedat, T. PAVLÍČEK, 1998.01.21. No. 12905, 1 ex., Avedat, T. Pavlíček, 1998.01.21. No. 12912, 7 ex., Gan Ha-Shelosha, T. PAVLÍČEK, 1998.02.28. No. 12922, 4 ex., bank of the Jordan River near Menahemiya, T. PAVLÍČEK, 1998.02.14. No. 12925, 3 ex., Bet She'an – Haifa crossroad (5 km north of Bet-She'an), T. PAVLÍČEK, 1998.02.28. No. 12935, 3 ex., Nahal Tavor near Taburiya, T. PAVLÍČEK, 1998.02.14. No. 12936, 4 ex., Nahal Tavor near Taburiya, T. PAVLÍČEK, 1998.02.14. Z/14018, 2 ex., Nakshon Junction, T. PAVLÍČEK & CS. CSUZDI, 2001.03.16. No. 14021, 6 ex., Tel Keshet, T. PAVLÍČEK & CS. CSUZDI, 2001.03.16. No. 14026, 1 ex., Arad, T. PAVLÍČEK & CS. CSUZDI, 2001.03.18. Z/14027, 5 ex., 1 km from Hura, T. PAVLÍČEK & CS. CSUZDI, 2001.03.18. No. 14028, 1 ex., Eshkolot, T. PAVLÍČEK & CS. CSUZDI, 2001.03.18. No. 14031, 3 ex., Churvat Anim (Yattir forest), T. PAVLÍČEK & CS. CSUZDI, 2001.03.18. No. 14033, 7 ex., Nahal Pura near Belya Bridge, T. PAVLÍČEK & CS. CSUZDI, 2001.03.18. No. 14044, 2 ex., Mt. Arbel, Nahal Savyona, T. PAVLÍČEK & CS. CSUZDI, 2001.03.23. No. 14050, 3 ex., Jubat el Kabira, Golan Heights, T. PAVLÍČEK & CS. CSUZDI, 2001.03.23. No. 14063, 15 ex., Mas'ada oak forest, Golan Heights, T. PAVLÍČEK & CS. CSUZDI, 2001.03.24. No. 14075, 1 ex., Banias, Golan Heights, T. PAVLÍČEK & CS. CSUZDI, 2001.03.25. No. 14078, 1ex., Nahal Dishon, T. PAVLÍČEK & CS. CSUZDI, 2001.03.25. No. 14081, 2 ex., Nahal Dishon, Tsiv'on, T. PAVLÍČEK & CS. CSUZDI, 2001.03.25. No. 14106, 1 ex., near Ramla, T. PAVLÍČEK, 2000.12.23. No. 14121, 1 ex., south of Kafr Menakhem, T. PAVLÍČEK, 2001.01.13. No. 14124, 1 ex., Hamat Gader, T. PAVLÍČEK, 2000.02.19. No. 14126, 1 ex., Nahal Hadera near Hadera railway station, T. PAVLÍČEK, 2000.02.22. No. 14153, 2 ex., Nahal Kidron near Mar Saba, T. PAVLÍČEK, 1999.03.20. No. 14160, 1 ex., Nahal Beit Khorol near Beit Sira, T. PAVLÍČEK, 1999.03.06. Z/14177, 1 ex., Banias, Golan Heights, T. PAVLÍČEK, 1998.05.25. No. 14179, 1 ex., Nahal Yitan (Samaria), T. PAVLÍČEK, 1999.03.06. No. 14249, 3 ex., Nahal Taninim, T. PAVLÍČEK, 2000.03.25. No. 14257, 3 ex., Nahal Oren, Mt. Carmel, T. PAVLÍČEK, 2000.03.23. No. 14261, 1 ex., Mas'ada, Golan Heights, T. PAVLÍČEK, 2000.04.03. No. 14396, 2 ex., eastern bank of the Lake Kinneret, T. PAVLÍČEK, 2002.02.05. No. 14413, 1 ex., Nahal Neshef, Golan Heights, T. PAVLÍČEK, 2002.02.16. No. 14417, 2 ex., Rabana, Golan Heights, T. PAVLÍČEK, 2002.02.15. No. 14426, 1 ex., Rabana, Golan Heights, T. PAVLÍČEK, 2002.02.15. No. 14443, 1 ex., Nahal Keziv, T. PAVLÍČEK, 2002.02.18.

Remark. Peregrine species.

Eisenia MALM, 1877

Eisenia MALM, 1877: 45, CSUZDI & ZICSI 2003: 73 (for complete synonymy).

Eisenia fetida (SAVIGNY, 1826)

Enterion fetidum SAVIGNY, 1826: 182.
Eisenia foetida: OMODEO 1956*a*: 329.
Eisenia fetida: PAVLÍČEK *et al*. 2003: 456; CSUZDI & ZICSI 2003: 143 (for complete synonymy).

Material examined: No. 14157, 2 ex., Nahal Kidron near Mar Saba, T. PAVLÍČEK, 1999.02.10. No. 14178, 5 ex., Nahal Og, Samaria, T. PAVLÍČEK, 1999.03.06.

Remark. Peregrine species.

Eiseniella MICHAELSEN, 1900

Eiseniella MICHAELSEN, 1900: 471, CSUZDI & ZICSI 2003: 152 (for complete synonymy).

Eiseniella tetraedra (SAVIGNY, 1826)

Enterion tetraedrum SAVIGNY, 1826: 184.
Allurus tetraedrus: ROSA 1893: 10.
Eiseniella tetraedra tetraedra: PAVLÍČEK *et al.* 2003: 457.
Eiseniella tetraedra: BODENHEIMER 1935: 393; BODENHEIMER 1937: 259; CSUZDI & ZICSI 2003: 153 (for complete synonymy).

Material examined: No. 12422, 2 ex., Mt. Meron, spring, T. PAVLÍČEK, 1996.01.31. No. 12458, 6 ex., Nahal Betzet, Upper Galilee, T. PAVLÍČEK, 1996.11.17. No. 12603, Mas'ada, Golan Heights, T. PAVLÍČEK, 1997.05.06. No. 14025, 1 ex., Nahal Arugot, T. PAVLÍČEK, & CS. CSUZDI, 2001.03.17. No. 14245, 11 ex., Mt. Meron, T. PAVLÍČEK, 2000.04.03.

Remark. Peregrine species.

Eiseniella neapolitana ÖRLEY, 1885

Allurus neapolitanus ÖRLEY, 1885: 12.
Allurus ninnii (ROSA, 1886): ROSA 1893: 11.
Allolobophora (Eiseniella) tetraedra var. *sewelli* STEPHENSON, 1924: 363.
Eiseniella tetraedra ninii: BODENHEIMER 1937: 259; ČERNOSVITOV 1938: 549.
Eiseniella tetraedra forma ?: ČERNOSVITOV 1940: 440.
Eiseniella tetraedra neapolitana: PAVLÍČEK *et al.* 2003: 456.

Material examined: No. 14877, 3 ex., Golan Heights, Nahal Neshef. T. PAVLÍČEK, 2002.05.25. No. 14710 2 ex. Golan Heights, Nahal Parash, T. PAVLÍČEK, 2002.05.25.

Remark. Our specimens show the characteristics of *A. (Eis.) t. sewelli* STEPHENSON, 1924 described from Wadi Ain Zirka, Palestine (today Israel) as the clitellum on *xxi–xvi* and tubercles on *xxii–xxv* that are somewhat different from that of the original description of ÖRLEY (1885).

Helodrilus HOFFMEISTER, 1845

Helodrilus HOFFMEISTER, 1845: 38. CSUZDI & ZICSI 2003: 169 (for complete synonymy).

Helodrilus patriarchalis (ROSA, 1893)

Allolobophora patriarchalis ROSA, 1893: 9; BODENHEIMER 1935: 393.
Helodrilus patriarchalis: BODENHEIMER 1937: 259; PAVLÍČEK *et al.* 2003: 457.

Material examined: : No. 10604, 4 ex., Mas'ada, Golan Heights, T. PAVLÍČEK, 1997.06.05. No. 12423, 6 ex., Nahal David, T. PAVLÍČEK, 1996.02.18. No. 12456, 5 ex., Nahal Betzet, Upper Galilee, T. PAVLÍČEK, 1996.11.17. No. 12887, 21 ex., Afeq, under *Tamariscus* bush, T. PAVLÍČEK, 1998.01.17. No. 12900, 3 ex., Afeq, bank of stream, T. PAVLÍČEK, 1998.01.17. No. 14056, 1 ex., Ha Emir Junction, Golan Junction, T. PAVLÍČEK & CS. CSUZDI, 2001.03.23. No. 14130, 1 ex., Jordan River near the Kinneret, T. PAVLÍČEK, 2000.12.30. No. 12601, juv. 3 ex., Golan Heights, T. PAVLÍČEK, 1997.04.05. No. 14023, 4 ex., Nahal Arugot, T. PAVLÍČEK & CS. CSUZDI, 2001.03.17. No. 14617 4 ex., Atlit, stream bank, T. PAVLÍČEK, 2002.03.12. No. 14707 1 ex., Zarka, Má'in Jordan, T. PAVLÍČEK, 2004.01.16.

Remark. This amphibious species is recorded from Greece (ZICSI & MICHALIS 1981), Transcaucasus (KVAVADZE 1985), and the East Mediterranean.

Octodrilus OMODEO, 1956

Octolasium (Octodrilus) OMODEO, 1956b: 175.
Octodrilus: BOUCHÉ 1972: 311, CSUZDI & ZICSI 2003: 206 (for complete synonymy).

Octodrilus complanatus (DUGÈS, 1828)

Lumbricus complanatus DUGÈS, 1828: 289.
Allolobophora (Octolasia) complanata: ROSA 1893: 9.
Octolasium complanatum: BODENHEIMER 1937: 259.
Octodrilus complanatus: PAVLÍČEK *et al.* 2003: 457.

Material examined: No. 12608, 1 ex., Mas'ada, Golan Heights, T. PAVLÍČEK, 1997.05.03. No. 14064, 10 ex., Mas'ada, Golan Heights, oak forest, T. PAVLÍČEK & CS. CSUZDI, 2001.03.24.

Remark. This species has a typical holo-Mediterranean distribution.

Family Criodrilidae VEJDOVSKY, 1884

Criodrilus lacuum HOFFMEISTER, 1845

Criodrilus lacuum HOFFMEISTER, 1845: 41; STEPHENSON 1913: 53; ČERNOSVITOV 1938: 549; ČERNOSVITOV 1940: 440; PAVLÍČEK *et al.* 2003: 457.

Material examined: No. 12441, 2 ex., Nahal Tanur, T. PAVLÍČEK, 1995.11.19.

DISCUSSION

Thirty-three species of earthworms (representing families Lumbricidae, Criodrilidae and Megascolecidae) were recorded in Israel so far, including the two new species described here. In the Levant, only two additional earthworm species: *Metaphire californica* (KINBERG, 1867) and *Octodrilus transpadanus* (ROSA, 1884) were recorded from Lebanon (OMODEO 1956*a*) and Jordan (PAVLÍČEK *et al.* 2003, CSUZDI & PAVLÍČEK 2005). Out of all Israeli species, 14–15 (42.4–45.5%) species are introduced and 18–19 (54.5–57.6%) species are autochthonous. However, systematic surveys are still yet to be done in the greenhouses, flower gardens, compost heaps, etc., where additional earthworm species might be present. The process of new earthworm colonization in Israel is taking place and is indicated by the tropical species, *Dichogaster bolaui* (MICHAELSEN, 1891), which seems to be presently colonizing the canalization systems in Europe and Israel (CSUZDI *et al.* 2004). The presence of many still undescribed species in the Levant, including Israel, is, according to our opinion, expected.

Currently, seven earthworm species are endemic (36.8–38.9% of autochthonous species) to Israel (*Bimastos jordanis* CSUZDI et PAVLÍČEK, 1999, *Dendrobaena nevoi* CSUZDI et PAVLÍČEK, 1999, *D. negevis* CSUZDI et PAVLÍČEK, 1999, *D. rothschildae* CSUZDI et PAVLÍČEK, 1999, *Perelia aharonii* (STEPHENSON, 1922), *P. shamsi* sp. n., and *P. galileana* sp. n.). However, it should be borne in mind that there is no real evidence of the absence of the mentioned species in wider areas of the Levant since the earthworm fauna of Israel is better known than those of the adjacent countries (see PAVLÍČEK *et al.* 2003 for more details). The description of the *P. shamsi* sp. n. from Lahav represents additional evidence that the areas bordering

the Saharo-Syrian desert belt, receiving on the average about 200 mm of precipitation per year, harbours interesting autochthonous fauna. So far, we cannot decide whether these species are a product of active speciation near the desert border or the surviving remnants of an earlier fauna.

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Acknowledgements – We thank ROBIN PERMUT for comments on the manuscript. This work was supported by the Israeli Bank Chair of Evolutionary Biology and the Ancell-Teicher Research Foundation for Genetics and Molecular Evolution, furthermore by the Hungarian Scientific Research Fund (OTKA No. T42745).

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Revised version received May 23, 2005, accepted June 1, 2005, published June 30, 2005