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Notes on the earthworms *(Oligochaeta, Lumbricidae)* from central west Macedonia

[With 3 text — figs.]

Dżdżownice *(Oligochaeta, Lumbricidae)* środkowozachodniej Macedonii

Abstract: The earthworms of the mountainous mass of the N. W. region of Pella province and the Eastern region of Kozani and Florina provinces have been studied. The presence of *Allolobophora minuscola* is interesting, as our previous work has shown that this species is rare in the North Greek oligochaetofauna. In addition, the subspecies *Helodrilus antipai tuberculatus* is widespread although the typical form is rare in this region.

Soil pH ranged from 4.9 to 6.9, and the number of individuals decreased significantly with increasing pH. Increased sand content of the soil was significantly related to increased number of species. Other relationships, including number of individuals and species with soil organic matter, were not significant.

I. INTRODUCTION

This paper is part of a study which, since 1982, has investigated the ecology and distribution of earthworms of the mountainous mass which extends from the province of Emathia, through Pella, Kozani and Florina, and into Grevena and Kastoria. MICHALIS et al. (1985) covered the South-West of Pella and the North-West of Emathia, and this paper covers North-West Pella and eastern Kozani and Florina. Eventually it is hoped that the whole of Western Macedonia will be covered.

A preliminary report of our work was given at 4th scientific congress of the Greek Association of Biological Sciences, Thessaloniki, September 1982.

II. METHODS

Material was collected in two seasons, autumn 1984 and spring 1985 and 1986. 35 biotopes were visited, from 21 of which soil samples were taken. The earthworm faunas of these 21 sites were investigated in detail.

Samples were collected with two methods, digging and with formalin. Most samples were collected with the former method which although more difficult, is more effective, as formalin has disadvantages, such as its shallow penetra-


YUGOSLAVIA
Prov. PELLA
Prov. KILKIS
8 km
Prov. FLORINA
Prov. THESSALONIKI
Prov. KOZANI
Prov. IMATHIA
ARIDAEA
HYDRAEA
POLYKARPI
CSIPHIANI
13 APSALOS
11 NEA ZOI
12
AGRAS
EDESSA
18
19
21
17
RIZARI
14
10 MAVROVOUNI
15
LOGOS
20
16
SEVASTIANA
6 7
2 PLATANI
FLAMOURIA
5
1
8
4
AGIA FOETINI
3
VEVI
KELI
AETOS
ANTIGONOS
PHILOTAS
LIMNOCHORI

tion in agriliceous soils. Digging after fomalin use showed that the latter method was only about 3% efficient in terms of the size and variety of samples.

Classification followed POP (1941) and ZICSI (1959), with additional information from OMODEO (1956), GATES (1957 a, b), BOUCHÈ (1972, 1975) and PEREL (1976, 1979).

Soil pH was measured with a potentiometer using 1N KCl solution (ALEXIADIS, 1977). Soil carbon content (%C) was determined by moist burning. Total soil organic matter was calculated as 1.724 × %C (ALEXIADIS, 1977). The proportion of siltclay and sand in the soil were measured by sedimentary analysis with sieves. Soil composition percentage values were arcsine transformed for statistical analysis (SOKAL, ROHLF, 1969).

III. SYNOPTICAL TABLE OF *LUMBRICIDAE* SPECIES FOUND IN THE REGIONS STUDIED

Genera *Allolobophora* EISEN, 1874
- *Allolobophora caliginosa* (SAVIGNY, 1826)
- *Allolobophora handlirschi* ROSA, 1897
- *Allolobophora chlorotica* (SAVIGNY, 1826)
- *Allolobophora minuscola* ROSA, 1905
- *Allolobophora georgii* MICHAELSEN, 1890
- *Allolobophora jassyensis* MICHAELSEN, 1891

Genera *Helodrilus* HOFFMEISTER, 1845
- *Helodrilus antipai antipai* MICHAELSEN, 1891
- *Helodrilus antipai tuberculatus* (CERNOSVITOV, 1935)

Genera *Dendrobaena* EISEN 1874
- *Dendrobaena byblica* (ROSA, 1893)
- *Dendrobaena rubida rubida* (SAVIGNY, 1826)
- *Dendrobaena rubida subrubicunda* (EISEN, 1874)

Genera *Eiseniella* MICHAELSEN, 1900
- *Eiseniella tetraedra tetraedra* (SAVIGNY, 1826)
- *Eiseniella tetraedra hercynia* (MICHAELSEN, 1891)

Genera *Bimastus* MOORE, 1893
- *Bimastus antiquus michalisi* (KARAMAN, 1972)

Genera *Eisenia* MALM, 1877
- *Eisenia foetida* (SAVIGNY, 1826)

Genera *Lumbricus* LINNAEUS 1758
- *Lumbricus rubellus* HOFFMEISTER, 1843

Genera *Octodrilus* OMEDEO, 1956
- *Octodrilus complanatus* (ANT. DUGÉS, 1828)

Genera *Octolasium* ORLEY, 1885
- *Octolasium lacteum* (ORLEY, 1881)

←

Fig. 1. A map of Central-West Macedonia, the numbered sites have been studied ecologically

IV. DISTRIBUTION OF THE SPECIES IN THE VARIOUS BIOTOPES OF THE REGION STUDIED

The letter T before every number, refers to the collection of the Department of Zoology of the University of Thessaloniki. The number refers to the serial number of the biotope.

Proastio (topsi) Edessa 23-IV-1982. T/852 *Allolobophora rosea* 9 sam. T/953 *Allolobophora jessyensis* 7 sam. T/854 *Lumbricus rubellus* 2 sam. T/855 *Eisenia foetida* 1 sam. T/856 *Octolasium lacteum* 1 sam.

Platani Edessa 23-VI-1982. T/862 *Allolobophora rosea* 6 sam.

Bridge Flamouria 23-VI-1982. T/846 *Lumbricus rubellus* 15 sam.

River Flamouria 23-VI-1982. T/846 *Lumbricus rubellus* 9 sam. T/847 *Octolasium lacteum* 1 sam. T/848 *Allolobophora rosea* 3 sam. T/849 *Eiseniella tetraedra tetraedra* 1 sam. T/850 *Dendrobaena byblica* 1 sam. T/851 *Allolobophora caliginosa* 1 sam.

Bridge Agia Foteini 23-VI-1982. T/832 *Dendrobaena subrubicunda* 1 sam. T/833 *Allolobophora caliginosa* 4 sam. T/834 *Allolobophora chlorotica* 2 sam. T/835 *Lumbricus rubellus* 30 sam. T/836 *Allolobophora rosea* 5 sam. T/837 *Eiseniella tetraedra tetraedra* 10 sam. T/838 *Eiseniella tetraedra hercynia* 1 sam.

Agia Foteini eastern side 23-VI-1982. T/828 *Lumbricus rubellus* 26 sam. T/829 *Allolobophora rosea* 10 sam. T/830 *Allolobophora chlorotica* 1 sam. T/831 *Octolasium lacteum* 3 sam.

Cherry trees Agia Foteini and South region 23-VI-1982. T/875 *Allolobophora chlorotica* 6 sam. T/841 *Allolobophora caliginosa* 8 sam. T/844 *Allolobophora jassyensis* 1 sam. T/859 *Allolobophora rosea* 11 sam. T/858 *Lumbricus rubellus* 32 sam. T/845 *Eiseniella tetraedra tetraedra* 2 sam.

Sevastiana 23-VI-1982 T/839 *Allolobophora jassyensis* 2 sam.

Csiphiani Aridea 9-XI-1984. T/962 *Allolobophora minuscola* (The occurrence of this species is very interesting. Our previous data have proved that that is very rare species for the Oligochaetofauna of N. Greece) 2 sam. T/963 *Allolobophora chlorotica* 2 sam. T/964 *Lumbricus rubellus* 2 sam. T/965 *Eiseniella tetraedra tetraedra* 18 sam. T/966 *Allolobophora rosea* 1 sam. T/967 *Allolobophora caliginosa* 7 sam.

Mavrovouni 9-XI-1984, Bridge 8 kilometres from the village. T/984 *Allolobophora caliginosa* 11 sam. T/985 *Dendrobaena byblica* 18 sam. T/986 *Dendrobaena rubida* 4 sam. T/987 *Lumbricus rubellus* 1 sam. T/988 *Eiseniella tetraedra hercynia* 3 sam. T/989 *Eiseniella tetraedra tetraedra* 3 sam. T/990 *Allolobophora chlorotica* 1 sam. T/999 *Allolobophora rosea* 1 sam.

Bridge Nea Zoi Aridea 1-XI-1984 T/954 *Allolobophora caliginosa* 11 sam. T/955 *Allolobophora chlorotica* 4 sam T/956 *Allolobophora rosea* 7 sam. T/957 *Dendrobaena rubida* 2 sam. T/958 *Dendrobaena byblica* 3 sam. T/959 *Lumbricus rubellus* 5 sam. T/960 *Octolasium lacteum* 7 sam. T/961 *Eiseniella tetraedra tetraedra* 2 sam.

Nea Zoi Aridea 9-XI-1984. T/946 *Lumbricus rubellus* 18 sam. T/947 *Allolobophora handlirschi* 1 sam. T/948 *Allolobophora caliginosa* 11 sam. T/949 *Octodrilus complanatus* 1 sam. T/950 *Allolobophora chlorotica* 3 sam. T/951 *Dendrobaena rubida* 2 sam. T/952 *Dendrobaena byblica* 2 sam. T/953 *Eiseniella tetraedra tetraedra* 3 sam.

Apsalos Aridea 9-XI-1984. T/968 *Allolobophora caliginosa* 25 sam. T/969 *Allolobophora chlorotica* 5 sam. T/970 *Lumbricus rubellus* 1 sam.

Aridea 9-11-1984. T/971 *Allolobophora caliginosa* 19 sam. T/972 *Allolobophora chlorotica* 1 sam. T/973 *Eiseniella tetraedra tetraedra* 1 sam.

Polycarpi 9-XI-1984. T/975 *Allolobophora caliginosa* 12 sam. T/976 *Lumbricus rubellus* 10 sam. T/977 *Eiseniella tetraedra tetraedra* 17 sam. T/979 *Allolobophora chlorotica* 1 sam. T/980 *Eiseniella tetraedra hercynia* 1 sam.

Hydraea Almopia 9-XI-1984. T/981 *Allolobophora georgii* 1 sam. T/982 *Allolobophora caliginosa* 12 sam. T/983 *Allolobophora rosea* 1 sam.

Mavrovouni Edessa 29-III-1985. T/1005 *Lumbricus rubellus* 5 sam. T/1006 *Allolobophora caliginosa* 8 sam. T/1007 *Allolobophora rosea* 7 sam. T/1008 *Allolobophora chlorotica* 9 sam.

Mavrovouni, West area 29-III-1985. T/1025 *Allobophora caliginosa* 8 sam. T/1026 *Lumbricus rubellus* 12 sam. T/1027 *Allolobophora chlorotica* 9 sam. T/1028 *Allolobophora rosea* 9 sam. T/1029 *Helodrilus antipai tuberculatus* 4 sam. T/1030 *Eiseniella tetraedra tetraedra* 2 sam. T/1031 *Allolobophora handlirschi* 1 sam. T/1032 *Octolasium lacteum* 1 sam. T/1033 *Allolobophora jassyensis* 1 sam.

2 Kilometres from Sevastiana towards Thessaloniki 29-III-1985. T/1019 *Lumbricus rubellus* 5sam. T/1020 *Octolasium lacteum* 2 sam.T/1021 *Allolobophora chlorotica* 8 sam. T/1022 *Helodrilus antipai tuberculatus* 1 sam. T/1023 *Allolobophora handlirschi* 10 sam. T/1024 *Allolobophora caliginosa* 4 sam.

Outskirts of the village of Rizari from Thessaloniki side 29-III-1985. T/1034 *Octodrilus complanatus* 3 sam. T/1035 *Lumbricus rubellus* 7 sam. T/1036 *Allolobophora caliginosa* 2 sam. T/1037 *Allolobophora handlirschi* 2 sam. T/1038 *Allolobophora rosea* 3 sam. T/1037 *Helodrilus antipai tuberculatus* 1 sam. T/1040 *Allolobophora jassyensis* 1 sam.

Agras Edessa 31-V-1986. T/1041 *Allolobophora caliginosa* 8 sam. T/1042 *Allolobophora chlorotica* 5 sam. T/1043 *Allolobophora rosea* 10 sam. T/1044 *Lumbricus rubellus* 1 sam. 2 Kilometres from the village of Philotas 31 V-1986. T/1045 *Allolobophora chlorotica* 2 sam.

Vevi 31-V-1986. T/1046 *Helodrilus antipai antipai* 1 sam. (This subspecies is interesting: while the local species appears as a very rare one in the whole area studied, the subspecies *Helodrilus antipai tuberculatus*, on the contrary, exhibits a wide distribution, it has been found at 7 biotopes and in a satisfying number of individuals but typical form was found only at one biotope and only one individual. We could say here that it is a result of the influence of the environment, which tends to erase the typical form and consolidate the subspecies). T/1047 *Allolobophora caliginosa* 7 sam.

Limnochori Florina 31-V-1986. T/1048 *Allolobophora caliginosa* 10 sam. T/1049 *Allolobophora rosea* 3 sam. T/1050 *Allolobophora chlorotica* 1 sam. T/1051 *Octolasium lacteum* 6 sam.

Edessa area 29-III-1985. T/993 *Allolobophora handlirschi* 9 sam. T/994 *Lumbricus rubellus* 9 sam. T/995 *Helodrilus antipai tuberculatus* 3 sam. T/996 *Allolobophora chlorotica* 6 sam. T/997 *Octolasium lacteum* 1 sam.

Monastery of St. Trias Edessa 29-III-1985. T/1013 *Lumbricus rubellus* 4 sam. T/1014 *Allolobophora handlirschi* 3 sam. T/1015 *Allolobophora georgii* 6 sam. T/1016 *Helodrilus antipai tuberculatus* 1 sam. T/1017 *Eiseniella tetraedra tetraedra* 5 sam. T/1018 *Eiseniella tetraedra hercynia* 1 sam.

Logos 29-III-1985. T/1009 *Lumbricus rubellus* 7 sam. T/1010 *Allolobophora caliginosa* 10 sam. T/1011 *Allolobophora chlorotica* 22 sam. T/1012 *Helodrilus antipai tuberculatus* 3 sam.

Logos area 29-III-1985. T/1033 *Octolasium lacteum* 1 sam. T/998 *Eiseniella tetraedra tetraedra* 29 sam. T/1004 *Lumbricus rubellus* 2 sam. T/999 *Eiseniella tetraedra hercynia* 3 sam. T/1000 *Allolobophora chlorotica* 3 sam. T/1001 *Helodrilus antipai tuberculatus* 1 sam. T/1002 *Eiseniella tetraedra bernesis* 1 sam.

V. ECOLOGICAL NOTES

Table I shows the number of individuals of each taxon at each biotope, together with the total number of individuals for each taxon. *Lumbricus rubellus* was the most widespread taxon found at 19 of 21 biotopes; it is followed by *Allolobophora chlorotica*, *A. caliginosa*, *A. rosea* and *Eiseniella tetraedra tetra-*

Table I

The number of individuals of each taxon found at each biotope

	Biotopes / Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total individuals per species	Number of sites per species
1	Lumbricus rubellus	2		15	9	30	26	32		9	1	5	18	1	5	12	5	7	9	4	7	2	192	19
2	Allolobophora chlorotica					2	1	6		2	1	4	3	5	9	9	8		6		23	2	81	14
3	Allolobophora caliginosa				1	4		8		7	11	11	11	25	8	8	4	2			10		110	13
4	Allolobophora rosea	9	6		3	6	10	11		1	1	7			7	9	3						72	12
5	Allolobophora handlirschi												1			1	10	2	9	3			26	6
6	Allolobophora jassyensis	7						1	2							1		1					12	5
7	Allolobophora georgii																			6			6	1
8	Allolobophora minuscola									2													2	1
9	Eiseniella tetraedra tetraedra				1	10		2		18	3	2	3			2				5		29	75	10
10	Eiseniella tetraedra hercynia					1					3									1		2	8	4
11	Eiseniella tetraedra bernensis																					1	1	1
12	Octolasium lacteum	1			1		3					7				1	2		1			1	17	8
13	Helodrilus antipai tuberculatus															4	1	1	3	1	3	1	14	7
14	Dendrobaena byblica				1						18	3	2										24	4
15	Dendrobaena rubida										4	2	2										8	3
16	Dendrobaena subrubicunda					1																	1	1
17	Octodrilus complanatus																			6			6	1
18	Eisania foetida	1																					1	1
	Number of species per site	5	1	1	6	7	4	6	1	6	8	8	8	3	4	9	6	7	5	6	4	7		
	Number of individuals per site	20	6	15	16	53	40	60	2	32	42	41	41	31	29	47	30	19	28	20	42	40		

Table II

Soil pH and composition in each biotope

Biotope	pH	C%	Organic matter %	Silt-Clay %	Sand %
1	6.59	1.85	3.19	59.74	39.05
2	6.69	0.92	1.59	73.72	24.07
3	6.71	2.37	4.08	59.65	34.55
4	6.81	2.08	3.58	34.97	58.82
5	6.76	2.00	3.45	43.00	53.37
6	6.58	2.89	4.98	60.89	31.23
7	4.96	4.48	7.72	43.80	47.32
8	6.82	0.87	1.16	63.40	33.38
9	6.86	2.31	3.98	24.90	74.04
10	6.43	0.78	1.34	16.15	81.65
11	6.38	0.83	1.43	8.57	90.10
12	6.56	1.37	2.36	16.80	81.18
13	6.74	2.09	3.60	22.76	75.94
14	6.24	1.89	3.26	19.80	79.19
15	5.94	1.90	3.27	4.13	93.67
16	6.54	2.40	4.14	17.12	80.77
17	6.73	2.15	3.71	18.59	80.53
18	5.82	1.15	1.98	15.08	83.91
19	6.90	3.25	5.60	17.92	80.06
20	6.84	2.85	4.91	12.99	85.97
21	6.80	1.11	1.91	15.75	83.23

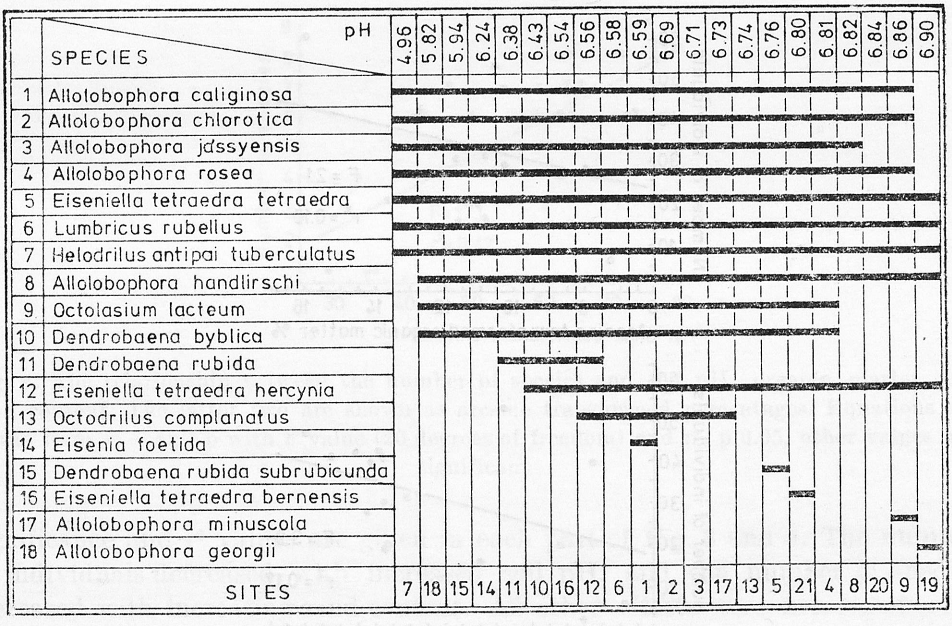

Fig. 2. Soil pH range over which each taxon was found

edra. Five taxa were found at a single site only, three of these being represented by a single individual. There was strong correlation ($r^2 = 0{,}864$) between the abundance of a taxon in our sample (total number of individuals) and how widespread it was (number of biotopes with that taxon).

Table II shows the soil composition and pH for each biotope. Fig. 2 shows the pH range over which each taxon was found, from the data in tables I and II, so that those taxa occurring over a wide range of pH can be identified (EDWARDS and LOFTY, 1977). Wide-range pH taxa in our study were *Allolobophora caliginosa*, *A. chlorotica*, *A. jassyensis*, *A. rosea*, *Eiseniella tetraedra tetraedra* and *Lumbricus rubellus*, although firm conclusions cannot be drawn without more low pH biotope samples.

Fig. 3 and 4 shows the relationships between the number of individuals of species per biotope and the soil pH, organic matter and sand content. F test

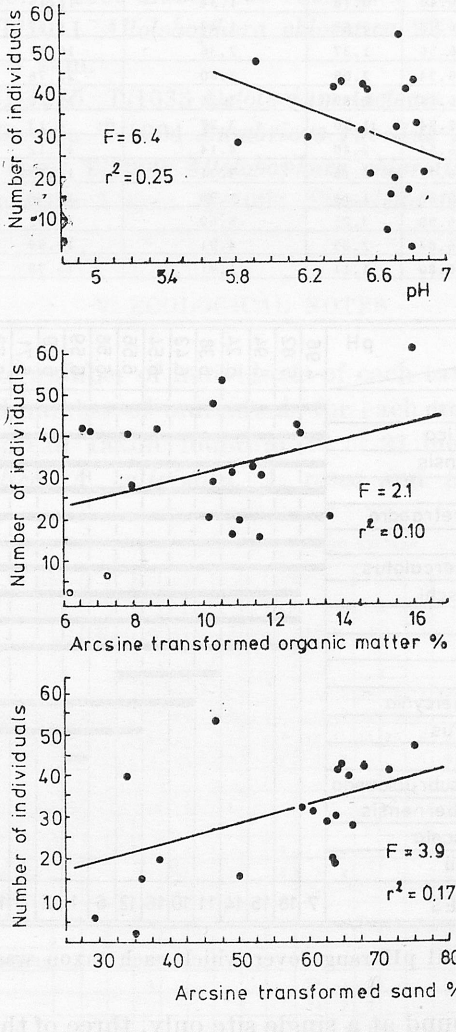

Fig. 3. The relationship between the number of individuals and soil pH, organic matter, and sand content. The latter two are shown as arcsine transformed percentages. Equations are in the form y = ax+b with F value (20 degrees of freedom) and r^2, p 0.05, other F values not significant

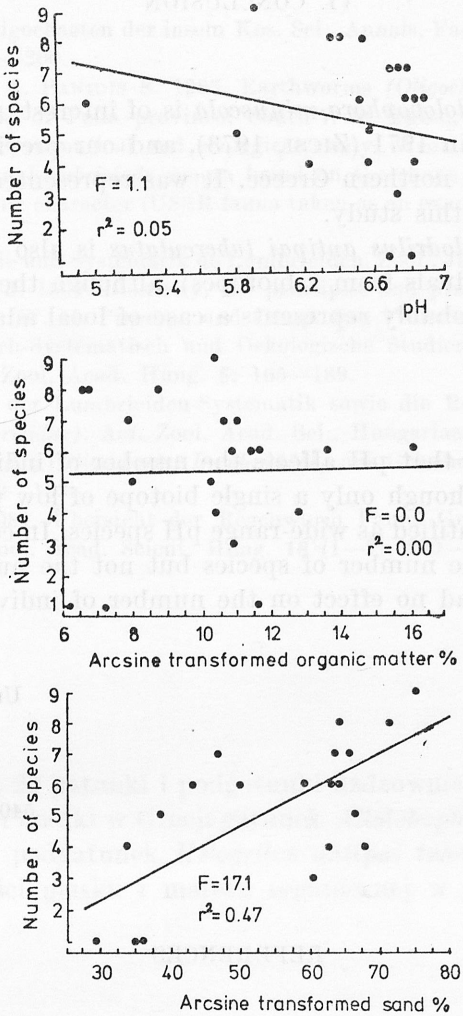

Fig. 4. The relationship between the number of species and soil pH, organic matter, and sand content. The latter two are shown as arcsine transformed percentages. Equations are in the form $y = ax+b$ with F value (20 degrees of freedom) and r^2, p 0.05, other values not significant

significance and r^2 values are given in each part of Fig. 3 and 4. The number of individuals decreased with increased soil pH, and the number of species increased with increasing sand content. All other effects were non-significant.

Similar conclusions can be drawn from multiple regression analysis of the number of individuals or species against all three independent wariables. The regression for the number of individuals was significant ($F = 4.6$; p 0.025), and partial F values show that pH and sand content had large effects, but in different directions (Table III). For the number of species, $F = 5.8$; p 0.01, and sand content had the greatest effect.

VI. CONCLUSION

Faunistic

The presence of *Allolobophora minuscola* is of interest, since this species was first found in Greece in 1971 (Zicsi, 1973), and our previous work has shown that it is very rare in northern Greece. It was represented by two individuals from a single site in this study.

The subspecies *Helodrilus antipai tuberculatus* is also of interest as it was widespread (14 individuals from 7 biotopes), although the typical form is rare in this region. This probably represents a case of local adaptation to the environment.

Ecological

It has been shown that pH affects the number of individuals, but not the number of species, although only a single biotope of low pH could be located. Some species were identified as wide-range pH species. In contrast, sand content of the soil affected the number of species but not the number of individuals. Soil organic matter had no effect on the number of individuals or species.

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STRESZCZENIE

Autorzy wykazują 22 gatunki i podgatunki dżdżownic ze środkowozachodniej Macedonii (w tym rzadki w Grecji gatunek *Allolobophora minuscola* i znany z nielicznych okazów podgatunek *Helogrilus antipai tuberculatus*) oraz podają dane o pH, zawartości piasku i materii organicznej w przebadanych stanowiskach.

Redaktor pracy: mgr J. K. Młynarski

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STRESZCZENIE

Autorzy wykazują 22 gatunki i podgatunki dżdżownic ze środkowowschodniej Macedonii (w tym rzadki w Grecji gatunek Allolobophora minuscola i znany z nielicznych okazów podgatunek Helodrilus antipai tuberculatus) oraz podają dane o pH, zawartości piasku i materii organicznej w przebadanych stanowiskach.

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