



Three generations in Earthworm Systematics: Homage to the work of the Pop family in the systematics of earthworms (Crassiclitellata: Lumbricidae)

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The 9th International Oligochaeta Taxonomy Meeting (11th to 15th December, 2023 San Lorenzo del Escorial, Spain) was dedicated, among others, to the memory of Dr. Victor V. Pop who passed away on the 04th December, 2022 at the age of 86.

Victor V. Pop cannot be authentically commemorated without remembering the role the Pop family has played in earthworm taxonomy and systematics since the early 20th century (Fig. 1).

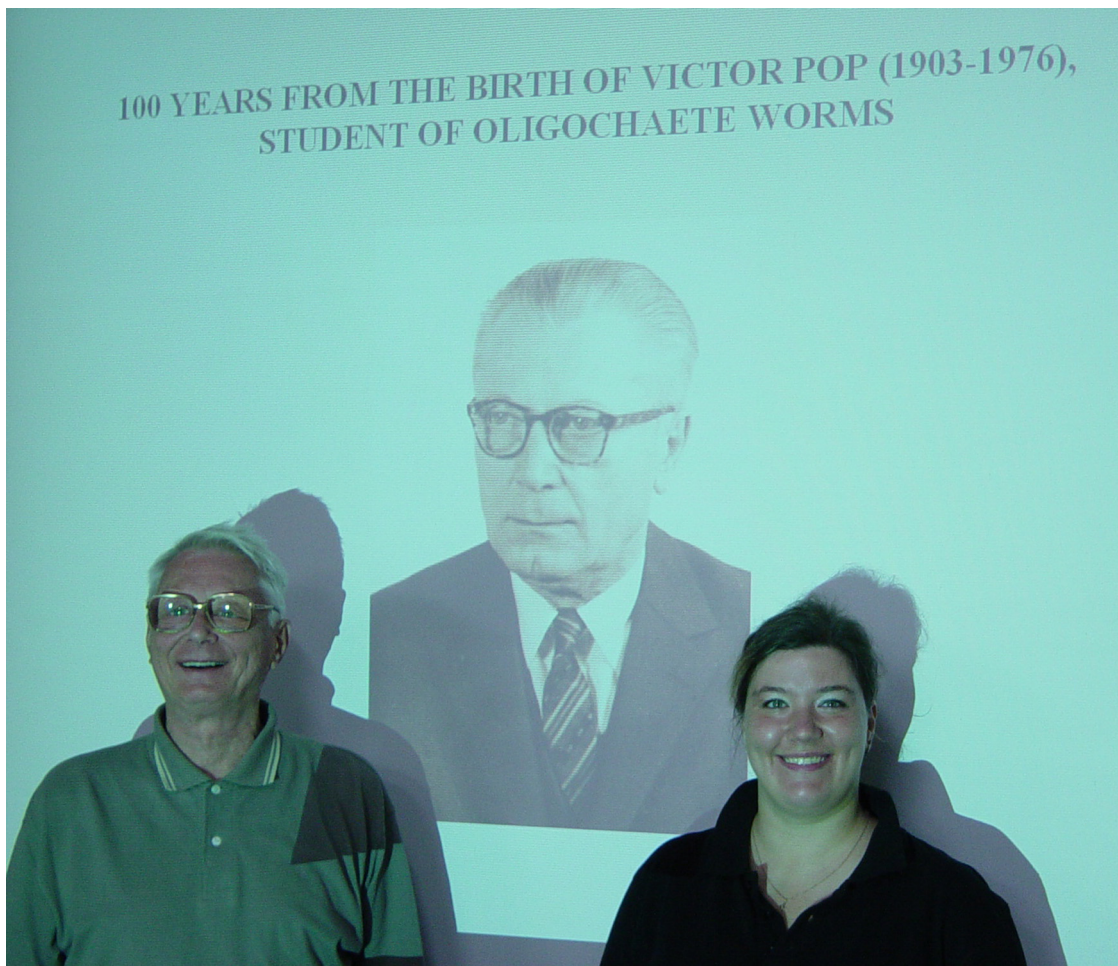


FIGURE 1. Antonia and Victor celebrate the 100th birthday of V. Pop Sr. (Photo from V.V. Pop's collection).

Victor was the first son of senior Victor Pop (1903–1976) a professor of zoology at the Babes-Bolyai University, Cluj (Romania) and world renowned lumbricid systematist. Senior Victor Pop's role was instrumental in furthering Central European earthworm research with continuing the work started by László Örley (1857–1887) and Andor Szüts (1884–??) despite the many difficulties he faced during his career.

He graduated from the “King Ferdinand” University, Cluj in 1929 with an MSc thesis in botany. For a short time he was an assistant at the Institute of Zoology in Cluj but then spent almost two decades (between 1931–1949) in secondary education in various cities in Transylvania (V.V. Pop 2004; Munteanu & V.V. Pop 2013). Even as a high school teacher, he started working with earthworms and began publishing (V. Pop 1938) and obtained his PhD in 1945 at the University of Cluj-Napoca. In 1946 he returned to the Department of Zoology at the University of Cluj, first as a part-time lecturer, then as an assistant professor (1949) and from 1971 as full professor. After his retirement in 1973 he was a Professor Emeritus until his death in 1976.

Sr. Victor Pop published relatively few scientific papers but most of them have received wide international recognition (Munteanu & V.V. Pop 2013). Of his work on earthworms, we must highlight two synthesizing works that have had the greatest international impact in laying the foundations for modern lumbricid taxonomy. One was published in 1941 (when he was still a high school teacher) entitled „Zur Phylogenie und Systematik der Lumbriciden” where he put forward the ‘Pop’s earthworm classification’ (Pop 1941), which later became widely accepted. The second was his monograph on the Romanian earthworm fauna (Pop 1949). The ‘Pop’s classification’ gradually replaced the Rosa-Michaelsen system, which gave too much taxonomic importance to the structure of the reproductive apparatus, which led to the lumping together of obviously unrelated species. Reassessment of the variability of morphological, anatomical and histological characters in species from different parts of Europe, led Sr. Victor Pop to develop a new hierarchical approach. Thus, Pop distinguished three characters with diagnostic value at genus level (body pigmentation, setal distances and structure of the musculature) and several other characters with diagnostic value at species and subspecies level (e.g. position of the clitellar organs, type of prostomium, calciferous glands, and others). On the basis of these characters, Pop managed to distinguish evolutionary lineages and placed all lumbricid species in 7 genera (Fig. 2). This system was widely used until the mid-1970s.

However, Prof. Pop was aware that his system is an oversimplification and sometimes resulted in polyphyletic genera. He wrote to Otto Graff in a letter just before his sudden death in 1976:

„I included the species of Eophila (Helodrilus) and Bimastus genera into Allolobophora, Dendrobaena and Eisenia genera because I wanted to put together, temporarily, in a genus the species presumed to derive either one from another or closely related, whichever the number of seminal vesicles pairs they maintained during their evolution, or how the number of the pairs of spermathecae and the pores’ position have evolved as compared to the setal lines. I always considered the above-mentioned genera, emended by me, as collective genera (Sammelgattungen) and I affirmed repeatedly that they have to be divided in the same number of small homogenous genera as that of the evolution lines, which exists or could be detected among them.,,

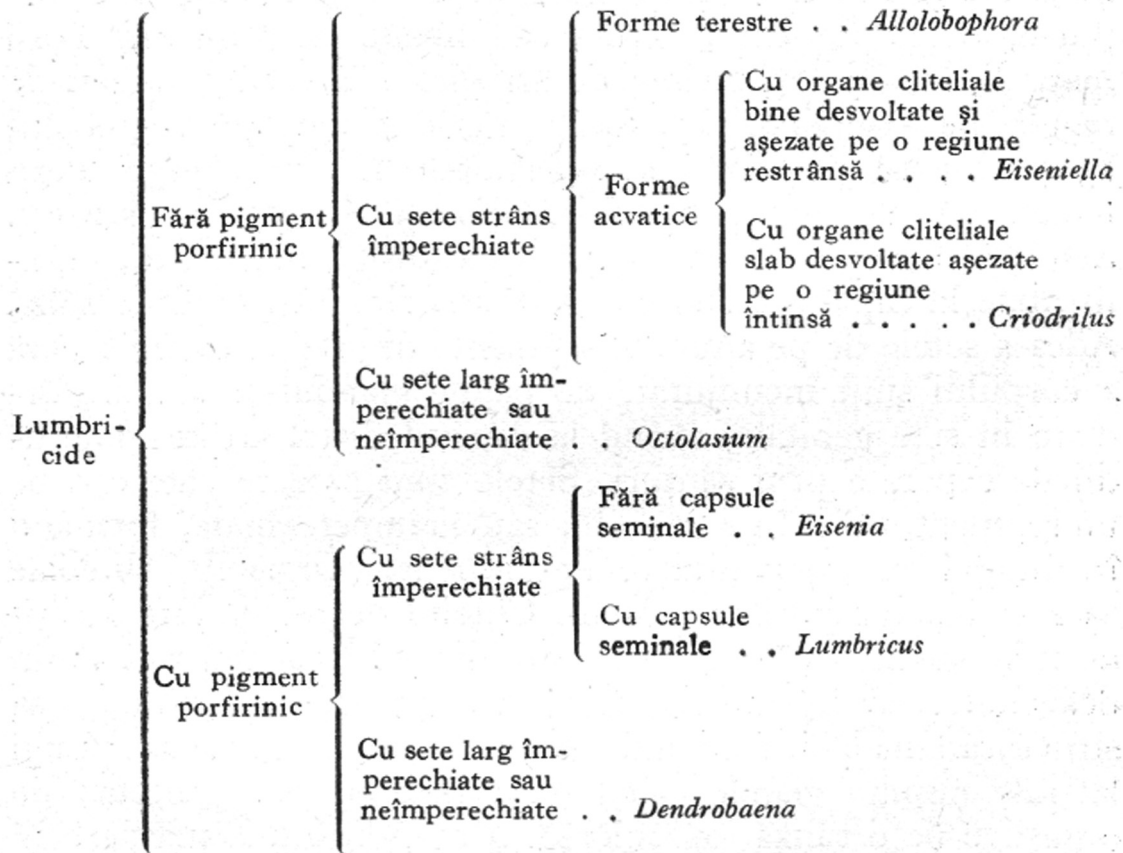
But, because of its simplicity, his system has been used for decades. As Stop Bøvitz (1969) wrote:

“The system of Pop permits us to give much more clear generic diagnoses, without the many exceptions and reservations which Michaelsen little by little had to introduce. Even if some of the genera are still obviously polyphyletic (Allolobophora, Eisenia, Dendrobaena), the system of Pop enables us to see some evolutionary features which were formerly difficult to detect.,,

However, Sr. Victor Pop's influence on earthworm research was not limited to the system he developed. He also helped to launch a new generation of researchers such as Danuta Plisko from Poland and András Zicsi from Hungary. They both learned the basics from Sr. Victor Pop and utilized his detailed ID tables (Figs. 3, 4).

It therefore seemed obvious that his son Victor V. Pop would continue his work. However, Jr. Victor V. Pop (Fig. 5) after graduating from the Babes-Bolyai University, Cluj in 1959, first worked as a soil scientist at the Department of Pedology of the Cluj Branch of the Romanian Academy of Sciences from 1959 to 1969. In 1965, together with his colleagues he won the Academy Prize of the Romanian Academy of Sciences for preparing the detailed soil map of the Transylvanian Plain. Victor published some 15 papers on pedology between 1962–1972 mainly in Romanian as it was the requirement in those times (Appendix 1).

Tabloul ce urmează arată gradul de diferențiere între genurile familiei.



Porphyritic pigment absent	Setae closely paired	Terricolous	<i>Allolobophora</i> Eisen, 1874, emend. Pop, 1941	
		Aquatic	Clitellar organs well developed on a short part of body	<i>Eiseniella</i> Michaelsen, 1900, emend. Michaelsen 1932
			Clitellar organs poorly developed on an broad part of body	<i>Criodrilus</i> Hoffmeister, 1845
Setae widely-paired or unpaired			<i>Octolasion</i> Örley, 1885	
Porphyritic pigment present	Setae closely paired	Testis sac absent, prostomium epilobic	<i>Eisenia</i> Malm, 1977 emend Pop, 1941	
		Testis sac present, prostomium tanilobic	<i>Lumbricus</i> L., 1758 emend. Eisen, 1874	
	Setae widely-paired or unpaired			<i>Dendrobaena</i> Eisen, 1874, emend. Pop, 1941

FIGURE 2. Identification table of earthworm genera from the book on Romanian Earthworms (V. Pop 1949).



FIGURE 3. Danuta Plisko (on the left) visiting V. Pop in Cluj in 1961 (photo from Danuta Plisko's collection).

		Chiffres sur les segments:	Crêtes ou tubercules sur les segments:	Coloration ou pigmentation de la face dorsale	Longueur en mm	Forme de la tête	Reproduction	Notes
Hygrophila (Cognetti) 1904	s	20 - 22 (12-13-14-15-16-17-18-19-20)	22, 23 - 26	grisâtre-jaune	85-90	aplatie	5/6	...
Hanae (Michaelson) 1925	s	20 - 23, 25 (17-18-19)	22 - 26	...	120-130	aplatie	5/6	...
Leleuxi (Rosa) 1892	s	20, 21, 22 - 23 (17-18-19)	29, 28 - 28, 32	sans pigment	75-85	aplatie	5/6	...
oculata (Hoffmeister) 1866 f. typica	s	21, 22 - 33	29 - 30	sans pigment	65-70	aplatie	4/5	...
oculata var. caucasiatica (Agostini) 1866	s	21, 22 - 33	1/2 29 - 1/2 32	...	60-65	aplatie	4/5	...
oculata var. sudica Pop 1945	s	22, 23 - 32 (17-18-19)	29-32	sans pigment	50-55	aplatie	4/5	...
oculata var. caucasiatica (Agostini) 1866	s	21, 22 - 33 (17-18-19)	29-32	...	50-55	aplatie	4/5	...
parvicauda (Rosa) 1893	s	22, 1/2 22 - 33 (17-18-19)	29-32	grisâtre-jaune	60-65	aplatie	4/5	...
intima (Michaelson) 1911	s	23 - 1/2 30, 30 (17-18)	24, 25 - 29, 30	grisâtre-jaune	125-130	aplatie	5/6	...
antiqua (Cernuschi) 1938	c	23 - 30, 31 (6-8)	---	grisâtre-jaune	65-70	aplatie	4/5	...
Olivieri (Rosa) 1894	c	24 - 30 (7)	1/2 24 - 1/2 30	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894	c	24 - 30 (7)	26 - 29	grisâtre-jaune	85-90	aplatie	4/5	...
indica (Michaelson) 1907	s	25 - 32 (7-8)	26 - 30	grisâtre-jaune	75-80	aplatie	4/5	...
Rebeli (Rosa) 1897	c	25 - 32 (7-8)	1/2 25 - 31, 32	grisâtre-jaune	65-70	aplatie	4/5	...
cupulifera Tilly 1897	s	26 - 32 (7-8)	26 - 30	grisâtre-jaune	65-70	aplatie	4/5	...
minuscula Rosa 1905	s	26 - 32 (7-8)	26 - 30	grisâtre-jaune	65-70	aplatie	4/5	...
Cuginii Rosa 1905	s	27 - 32 (7-8)	30 - 31	grisâtre-jaune	65-70	aplatie	4/5	...
mediana (Michaelson) 1908	s	27 - 32	31 - 1/2 33	grisâtre-jaune	65-70	aplatie	4/5	...
Kralochvile (Cernuschi) 1937	s	28, 1/2 28 - 35 (15-16)	30 - 31	grisâtre-jaune	65-70	aplatie	4/5	...
Szentkuthi (Michaelson) 1912	s	28, 1/2 34 (10-14)	31 - 33 (10-14)	grisâtre-jaune	65-70	aplatie	4/5	...
saeva (Savigny) 1826 f. typica	c	24, 25, 26 - 31, 32, 33 (6-8)	1/2 27, 28, 29, 30 - 1/2 31, 32	grisâtre-jaune	125-130	aplatie	5/6	...
saeva var. sudensis Szécs 1909	c	26, 27 - 31, 32, 33 (6-8)	28, 1/2 28, 29 - 1/2 31, 1/2 32	grisâtre-jaune	115-120	aplatie	5/6	...
saeva var. athenica (Cernuschi) 1938	c	25 - 33 (7-8)	26 - 32	grisâtre-jaune	85-90	aplatie	4/5	...
saeva var. bomastri (Cognetti) 1911	c	24, 25, 26, 27, 28 - 32, 33 (6-8)	29 - 30, 31	grisâtre-jaune	85-90	aplatie	4/5	...
Hanslichski (Rosa) 1897	c	22, 24, 25, 26, 27, 28, 29, 30	1/2 29, 28, 29, 30 - 1/2 32, 32	grisâtre-jaune	85-90	aplatie	4/5	...
Hixonii (Cognetti) 1904	s	24 - 33 (7-8)	1/2 28 - 32	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894	s	22, 24, 25 - 32, 33, 34 (10-14)	29, 1/2 29, 30, 31 - 32, 1/2 33, 33, 34	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...
gavarnica (Cognetti) 1894 f. typica	c	24, 26 - 33 (7-8)	29, 30, 31 (7-8)	grisâtre-jaune	85-90	aplatie	4/5	...

FIGURE 4. Handwritten identification table of earthworm species by Sr. Victor Pop.



FIGURE 5. Victor V. Pop holding a bough of *Cernosvitovia robusta* in Baile Herculane, Romania in 2004 (Photo Cs. Csuzdi).

After this little detour in soil science, Victor V. Pop followed in his father's footsteps and published his first paper on the earthworm fauna of the Retezat National Park (V.V. Pop 1972). However, despite working on soil for the preceding years, he had never forgotten earthworms and from the middle of the 1960s he had been combining his soil research with earthworm studies. This was especially the case when studying the Apuseni and Retezat Mts. This work resulted in some really influential ecology papers like V.V. Pop & Vasu (1995) written on the „vermic character” of mountain soils or V.V. Pop (1997) on the earthworm —vegetation — soil relationships in the Romanian Carpathians.

Unfortunately his PhD thesis (1979, Babes-Bolyai University, Cluj) entitled „Lumbricidele din Muntii Apuseni. Studiu faunistic, sistematic și ecologic” (The earthworm fauna of the Apuseni Mts. A faunistic, systematic and ecological study) was not published in English, but this is one of the most thorough studies of earthworm communities

in relation to vegetation and soil. Between 1965 and 1976 V.V. Pop collected samples at 147 sites in the Apuseni Mountains, where he also collected soil and vegetation data. From these he carried out detailed community analyses (Figs. 6–7).

His first taxonomic work with the description of *Allolobophora zarandensis* a new earthworm species from the Apuseni Mts. was published in 1978 and Jr. V. Pop has since spent decades exploring the earthworm fauna of the Western Carpathians. This work has resulted in a detailed numerical taxonomic analysis of the endemic *Octodrilus* species of the Apuseni Mountains and the description of several large-bodied *Octodrilus* spp. such as *Oc. aporus* Pop, 1989 or *Oc. permagnus* V. Pop, 1989. In total, Victor has described 24 new earthworm species and subspecies from Romania (Table 1), making a significant contribution to the exploration of the country's earthworm fauna.

TABLE 1. List of earthworm species described by V.V. Pop.

<i>Allolobophora zarandensis</i> Pop, 1978
<i>Allolobophora mehadiensis oreophila</i> Pop, 1978
<i>Octodrilus transylvanicus</i> Zicsi & Pop, 1984
<i>Octodrilus compromissus</i> Zicsi & Pop, 1984
<i>Octodrilus aporus</i> Pop, 1989
<i>Octodrilus bihariensis bihariensis</i> Pop, 1989
<i>Octodrilus bihariensis rendzinicola</i> Pop, 1989
<i>Octodrilus compromissus minimus</i> Pop, 1989
<i>Octodrilus exacystis meziadensis</i> Pop, 1989
<i>Octodrilus exacystis oresbius</i> Pop, 1989
<i>Octodrilus ophiomorphus</i> Pop, 1989
<i>Octodrilus permagnus</i> Pop, 1989
<i>Cernosvitovia munteniana</i> Zicsi & Pop, 1991
<i>Allolobophora prosellodacica</i> Csuzdi & Pop, 2008
<i>Dendrobaena vladeasa</i> Csuzdi, Pop & Pop, 2011
<i>Octodriloides izanus</i> Csuzdi, Pop & Pop, 2011
<i>Octodrilus parvivesiculatus</i> Csuzdi, Pop & Pop, 2011
<i>Dendrobaena virgata</i> Szederjesi, Pop & Csuzdi, 2014
<i>Allolobophora zicsica</i> Szederjesi, Pop & Csuzdi, 2016
<i>Allolobophora sturanyi biharica</i> Szederjesi, Pop & Csuzdi, 2016
<i>Dendrobaena herculis</i> Szederjesi, Pop & Csuzdi, 2017
<i>Dendrobaena transylvanica</i> Szederjesi, Pop & Csuzdi, 2017
<i>Dendrobaena cinerea</i> Szederjesi, Pop & Csuzdi, 2019
<i>Octodrilus banaticus</i> Szederjesi, Pop & Csuzdi, 2019

Victor had a strong presence in the vermiculturist community. He was among the participants at the first conference on earthworms in Nitra (Slovakia; then Czechoslovakia) in 1969 (Fig. 8), and also on the first IOTM in Madrid, Spain (2003). He co-organised the second IOTM with his daughter Antonia in Cluj-Napoca, Romania (2005), and participated in Platres, Cyprus (2007), Diyarbakir, Turkey (2009) and Beatenberg, Switzerland (2011) as well.

Victor V. Pop was among the first earthworm scientists who recognized the importance of molecular methods and from the early 2000's his interest turned to molecular systematics. Together with Antonia and her supervisor Prof. Michael Wink (Heidelberg) he was among the first to emphasize the importance of molecular genetic studies in the systematics of Lumbricidae (A.A. Pop *et al.* 2003). This field was taken up by his daughter Antonia Adriana Pop, who wrote her PhD thesis on this topic entitled "Molecular Taxonomy of the earthworm family Lumbricidae" at the University of Heidelberg in 2004. And later, Antonia, together with her father and other co-authors, published a number of pioneering molecular studies to explore the relationships of the Lumbricidae family (A.A. Pop *et al.* 2005, 2007, 2008).

Schema structurii asociațiilor de lumbricide

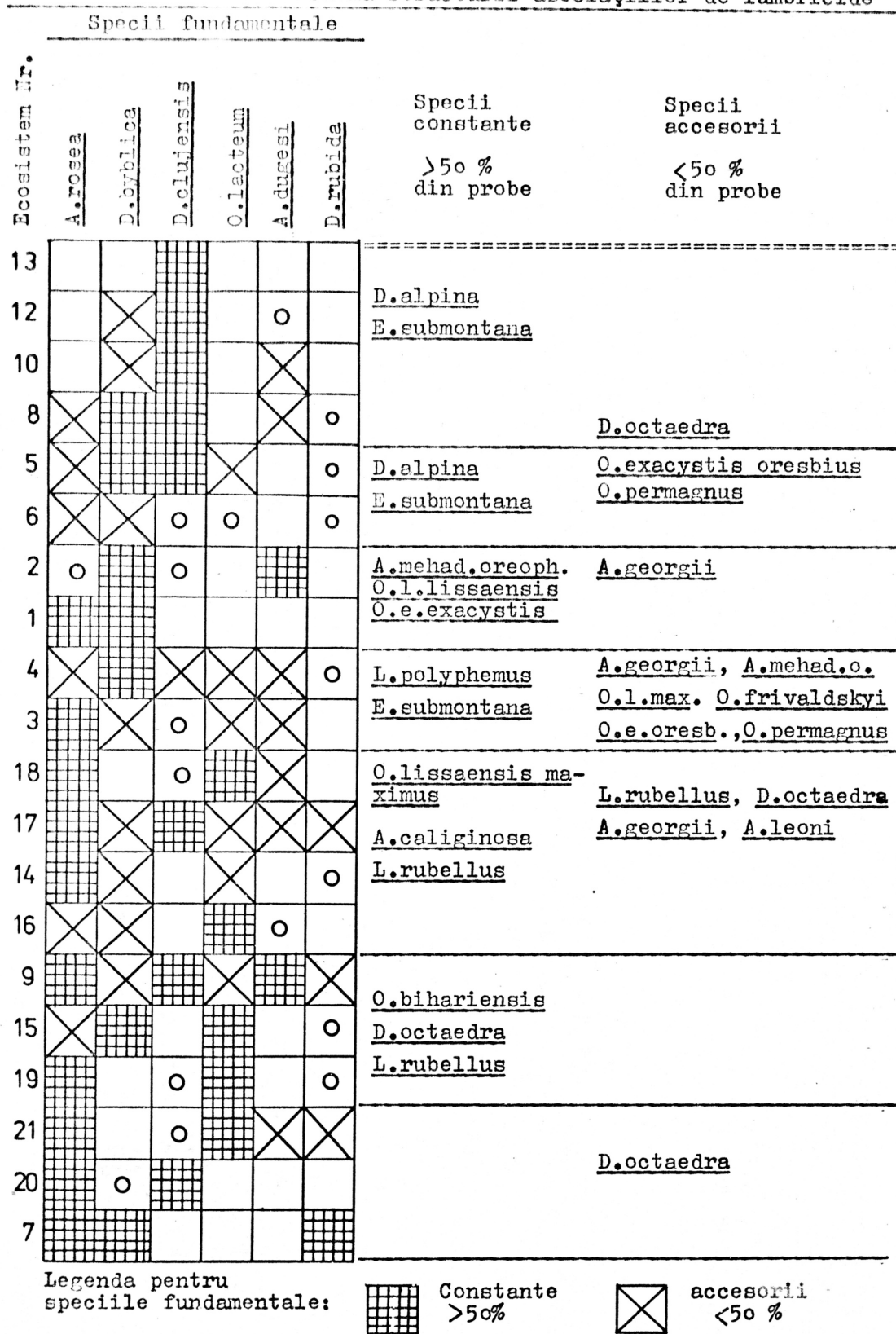


FIGURE 6. Earthworm community structure in different ecosystems in the Apuseni Mts. from V.V. Pop's PhD dissertation (1979).

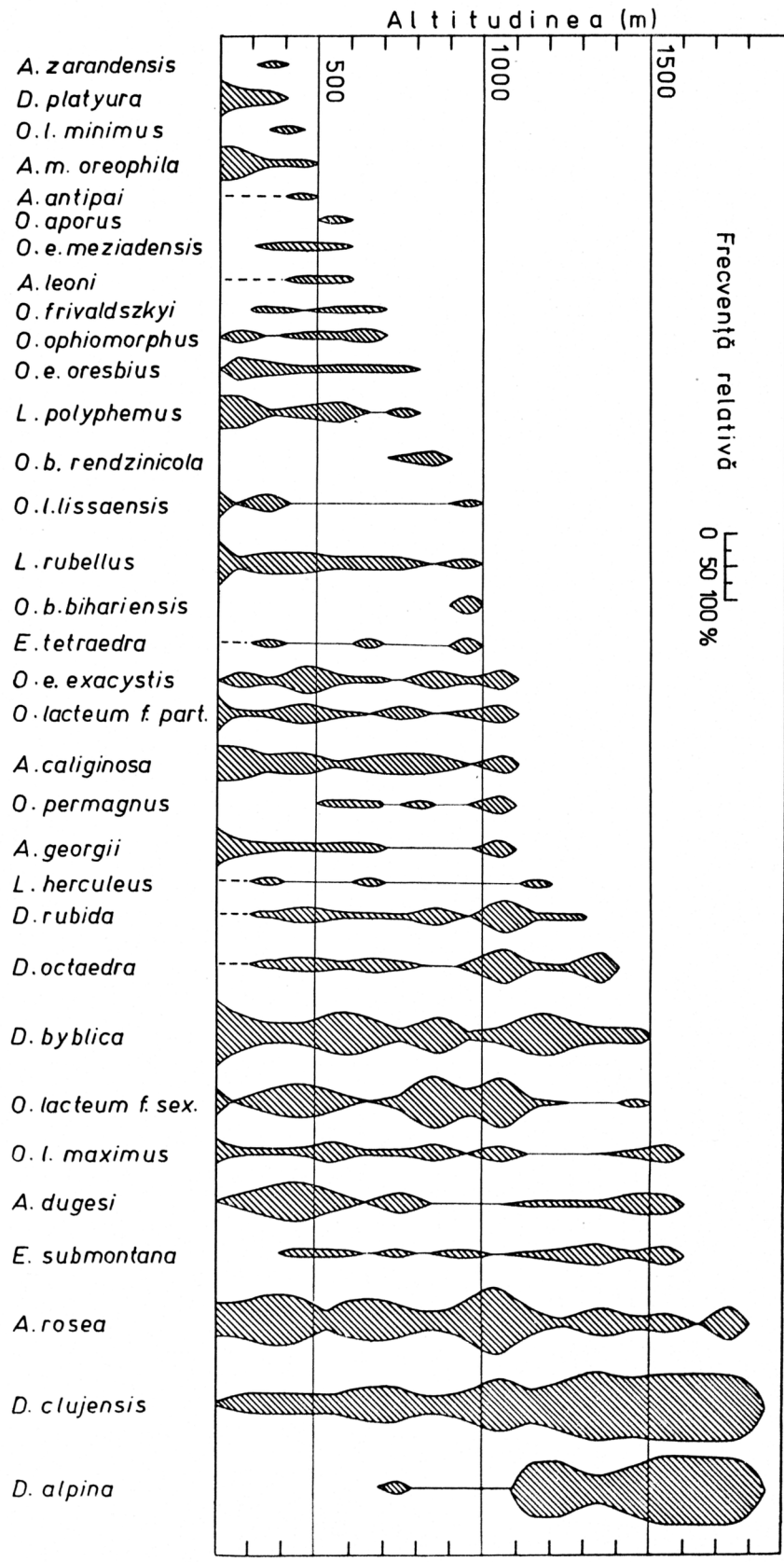


FIGURE 7. Vertical distribution of earthworm species in the Apuseni Mts. from V.V. Pop's PhD dissertation (1979).



FIGURE 8. Signed badge of the first Colloquium on Earthworms Nitra (Slovakia).

So this is a special case where three successive generations of the same family have studied an animal group with world-renowned results. Unfortunately, Antonia was not able to continue her studies in earthworm molecular systematics; she is now working for the Swiss pharmaceutical company Roche. However, Jr. Victor Pop's confidence in molecular studies has since been fully confirmed.

Victor spent his last years working hard on the book of Romanian earthworms, but unfortunately COVID intervened. He celebrated his 85th birthday in good health, but then his condition deteriorated rapidly and he passed away on 4 December 2022. His enormous knowledge on lumbricid taxonomy and ecology, his jovial attitude and characteristic smile will be missed by us all.

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Appendix 1. List of publications of Victor V. Pop

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