COLLEMBOLA OF THE KARSTIC SYSTEM FROM MOVILE

MAGDALENA GRUIA

By way of comparison with other groups of invertebrates that can be found in the cave from Movile, the collembolla fauna is less spectacular. None of the identified species(with one possible exception) are troglobitic forms and none exhibit apomorphic characteristics related to cavernicol life. Only two species are characteristic for this cave: *Onychiurus movilae* Gruia 1989 and *Oncopodura vioreli* Gruia 1989.The collembola fauna can be divided into 2 groups [3]:

- To the first group belong the species which populate the cave proper. These are: *Onychiurus movilae, Heteromurus nitidus* (Templeton), *Oncopodera vioreli, Neelus murinus* (Folson) and *Arrhopalites pygmaeus* (Wankel). These species populate not only the superior, dry level (they can be found on vegetal debris in the cave's galleries and halls) but also the inferior level, flooded by the mezothermal sulphurous water (they populate the gelatinous mass on the surface of the lake water and in the bells). Some species form numerous populations – an estimate of the populations of *H. nitidus* on the surface of the lake and of bell I indicates aprox. 1500 individuals/m^2, while for the populations of *O. movilae*, the number is of aprox. 1900 individuals/m^2 in bell II. This fact can be accounted for on the basis of the enormous quantity of food, consisting of the bacterial and fiungic wave which develops on the surface of the water and which attracts species that have been able to adapt to the specific biotic conditions that the cave evinces (high temperature –21°C, H_2S–32 mg/ l, CH_4–2% and O_2–7%).

These conditions account for the reduced number of Collembolean species in the cave. *Onychiurus movilae* and *Oncopodura vioreli* are characteristic forms for this cave; their main source of food being represented by the chimioautotrophic sulphurous bacteria which are at the basisi of the trophic pyramid. The other 3 species, common troglophilic forms, exhibit a broad ecological valence which has enabled their adapting to the rough conditions of the cave. They are commonly found in the caves from Dobrogea, and they do depend on the presence of guano. The majority of guanobiontic forms, which represent the main segment of the Collembola populations from the neighbouring caves, are absent from the cave at Movile. Instead we find species that feed on sulphurous bacteria.

The only species that can be considered to be a possible troglobitic form is *Onychiurus movilae*. As we have already shown, the species can be found in great number on the gelatinous mass on the surface of the water, but also in the dry areas of the cave, where the cracks have indicated a prevalence of the mature individuals.

Trav. Inst. Spéol. «Émile Racovitza», t. XXXVII–XXXVIII, p. 167–174, Bucarest, 1998–1999

The second characteristic species is *Oncopodura vioreli,* which has been found in dozens of individuals in the vicinity of sulphurous springs at Obanu Mare. It is probably a tiophilic, troglophilic species.

– The second group is made up of species that can be found in: a – the access shaft (depth 18 m) and, b – the fissures in the calcareous massif (drillings up to –24m).

a – proof sticks set at different levels in the wall of the shaft have rendered manifest the fauna material. We have found all the 5 species mentioned for the cave, and also *Pseudosinella sexoculata* Schott. This last species is a hemiedaphic, troglophilic form, frequently found in Southern Dobrogea, not only in caves, but also at the exterior, in the soil. In the Limanu cave, situated at only 2 km from the karstic system of Movile, *P. sexoculata* penetrates as far as to the deep areas of the cave. The question one feels bound to ask is: which is the element which impedes the access of the species in the cave from Movile. Among all the restrictive conditions of this cave, the main restristive factor should be the presence of H_2S. But it has been ascertained that P. sexoculata is frequently found in the soil at Obanele, in the vicinity of sulphurous springs, so H_2S cannot be held responsible for it, but some other factors (such as the quantity of CO_2). The data made available by the samples in the drills account for the shifting of this species, on the vertical, through the fissures of the entire calcareous massif.

b – With the help of drills, performed between 1995–2000 (Dr. Vasile Decu, the Bucharest Institute of Speology, was in charge of this project. We would also like to thank V. Gheorghiu, who periodically collected the traps set in drills), 22 species have been identified in the deep fissures of the calcareous massif. (Table 1) In the vicinity of the cave's mouth, in 1994, 2 drills were performed, with depths of 22m and respectively 24m. One of the drill, at the depth of 15,5m, crosses a subterranean void (height 0,5m) (this shall be given the denomination "**cave drill**" and the other "**doline drill**"). It was found that the 19 Collembola species, depending on the depth at which they were found, had migrated either from the endogene or from the cave [4]. The number of individuals from one species is relatively small, seldom surpassing a number of 20 individuals.

The species that are thought to have descended from the endogene are in their great majority strong, leaping forms; so, it is then possible that they might have fallen in the drills at depths higher than their customary ones. Thus, *Heteromurus sexoculatus* Brown and *Cyphoderus asimilis* Borner frequently go down to –8.5, –12m, while *Cryptopygus ponticus* (Stach) or *Lepidocyrtus lignorum* Fabricius are usually found in traps set at high depths, 15 or 18m.

The frequency and the exuberance of species at various depths depend on the season and on the year. Thus:

– *Cryptopygus ponticus* is most frequently found in the samples in the "**cave drills**". It is a species with medium frequency, but exuberant especially from 9m

Table 1

Collembola of the carstic system from Movile

Species	endogeus	deep fissures	cave	only in Dobr.
Hypogastrura denticulata (Bagnall,1941)	+	+		
Xenylla welchi Folsom,1935	+			
Willemia anophthalma Borner,1901	+			
Axenyllodes bayeri Kseneman,1935	+			
Anurida maritima (Guérin 1836)	+			+
Oligophorura sp.	+	+		+
Protaphorura cancellatus Gisin,1956	+			
Protaphorura fimatus Gisin 1952	+			
Hymenaphorura sibiricus (Tullberg,1876)	+			
Onychiurus ghidini Denis,1938	+	+		+
Onychiurus movilae Gruia,1989		+	+	+
Metaphorura affinis Borner,1912	+	+		
Stenaphorura quadrispina (Borner,1901)	+			
Folsomides parvulus Stach,1922	+	+		
Proisotoma minuta (Tullb.,1871)		+		
Folsomia spinosa Kseneman,1936		+		+
Folsomia candida Willem,1902	+			
Cryptopigus termophylus (Axelson)	+			+
Cryptopigus ponticus (Stach,1947)	+	+		+
Isotomiella minor (Schaffer, 1896)	+			
Isotoma notabilis Schaffer,1896	+	+		
Sinella(C) tenebricosa Folsom 1902	+			
Entomobrya marginata (Tullberg, 1871)	+			
Pseudosinella octopunctata Borner,1901	+	+		
Pseudosinella sexoculata Schott,1902	+	+		
Pseudosinella imparipunctata Gisin,1953	+			+
Pseudosinella obane Gruia,1998	+			+
Pseudosinella crenelata Gruia,1998	+	+		
Heteromurus major (Moniez,1889)	+	+		
Heteromurus sexoculatus Brown,1926	+	+		+
Heteromurus nitidus (Templeton,1835)			+	+
Heteromurus nitidus callaticola Gruia,1965	+			+
Lepidocyrtus lignorum Fabricius,1775	+	+		
Lepidocyrtus fimetarius Gisin, 1964	+			
Lepidocyrtus paradoxus Uzel,1890	+	+		
Cyphoderus bidenticulatus (Parona,1888)		+		
Cyphoderus asimilis Borner,1906	+	+		+
Oncopodura vioreli Gruia,1989		+	+	+
Tomocerus vulgaris (Tullberg,1871)	+			
Neelus murinus Folsom,1896				+
Arrhopalites pygmaeus (Wankel,1869)		+	+	
Bourletiella novemlineata (Tullberg,1871)	+			

down. (ex. in 1996–50 ex., 13 ex. in the March sample, at 15m). In the "doline drill", at depths under 6m, the species only appears in 1996, in a great number of individuals (for example, 18 individuals, in the September sample, at 18m). Apicurs usually appear in autumn.

– *Lepidocyrtus sp* and *Pseudosinella sexoculata* are the 2 species most commonly found in the samples in the "**cave drill**" (Fig. 1). In the case of both species, years 1997 and 1998 proved to be the most favorable, the samples from these years being very abundant. Thus:

– In 1997, we found 41 individuals of *Lepidocyrtus.sp* in July, at 9 m or 20 individuals in October, at 15 m; in 1998 we found 23 individuals of the same species, in April, at 3 m.

– In 1997, we found 30 individuals of *P. sexoculata* in October, at 6 m and 10 individuals at 9 m; in July 1998, we found 20 individuals of the same species, at 6 m and 8 individuals at 9 m.

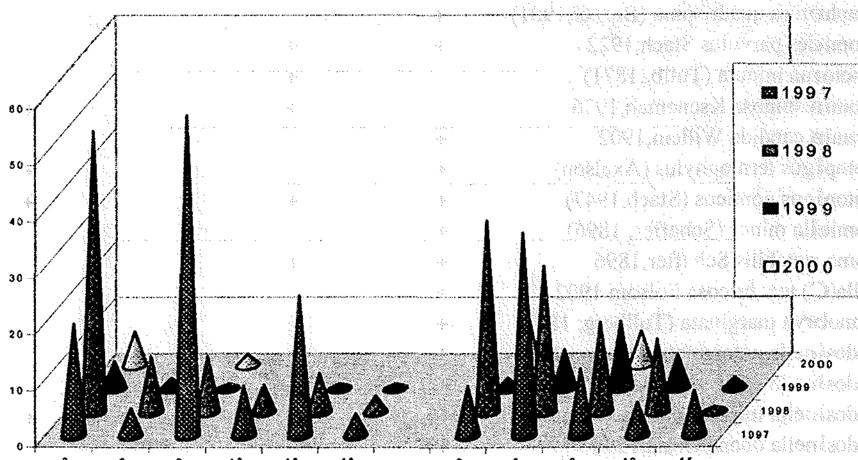

Fig. 1 – Depth repartition of *Lepidocyrtus* cf. *lignorum* (left) and *Pseudosinella sexoculata* (right) from the "cave drill" between 1997–2000.

In the case of these 2 species, the apics (sometimes spectacular, like in 1997), appear in autumn, at all *depths, even at 15 m* (Fig. 2).

–*Heteromurus sexoculatus* and *H. nitidus quadriocelatus* are the most frequent and exuberant species in the samples in the "**doline drill**". They appear each year, at almost each level, from 3 m to 19 m (in some samples they are the only species found, for example – *H. sexoculatus* in the 2000 samples at depths varying between 6 m and 19 m). In the samples "cave drill" the species are present every year, especially at a depth of 3m; the deeper we go, the less frequent they are. It is also worth noticing that the individuals of *H. sexoculatus* found during the autumn months are white at winter time, only with their 3 eyes intensely pigmented in black.

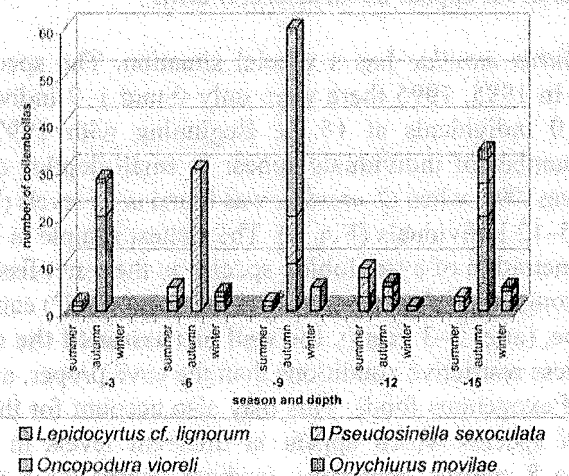

Fig. 2 – Depth distribution of four Collembolean species, during summer, autumn and winter of 1997.

The species which populate the cave and which climb up and down the fissures in the calcareous massif evince a much clearer situation. Thus:

– *Oncopodura vioreli* exhibits a somehow reduced mobility, it can climb up to 6 m (it most frequently appears in **"cave drills"** – "for example in 1997, 40 individuals were found at 9 m). Being a tiophilic form, it does not show much interest in the bait; with a few exceptions, the samples do not contain more than 1–5 individuals (Fig. 3).

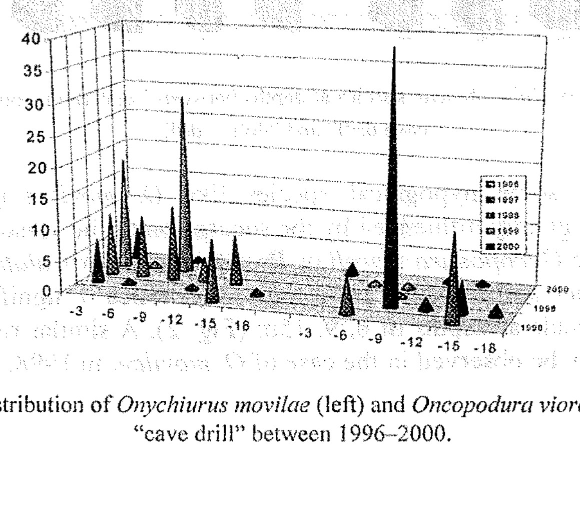

Fig. 3 – Depth distribution of *Onychiurus movilae* (left) and *Oncopodura vioreli* (right) from the "cave drill" between 1996–2000.

Similarly, *Arrhopalites pygmaeus* climbs up to 3 m (a species which is frequent and exuberant only in the 1995 and 1997 samples, for example – in October1995, at 5 m, we found 37 individuals, in October 1997, at 12 m, we found 42 individuals). These 2 species never appear in surface, soil drills.

– *Onychiurus movilae* has a special situation. The species only appears in "**cave drills**". In 1995, 1996 there were only found 1–2 individuals, at 8,5 m and respectively 10 individuals at 15 m. Beginning with 1997, things change: a considerable number of individuals appear at small depths, of 6, 3 m. The most edifying year was1998, when *O. movilae* was found at all levels (between 15 and 3 m), in number of 5–12 individuals (Fig. 3). The richest sample is in september 1999 – 20 ex. This penetration of a troglobitic species in the microfissures around the drill which goes through the subterranean void (the "cave drill") can be explained by the fact that in time, (after 2–3 years), **the well has assumed the conditions of a cave gallery** (with less restrictive conditions than the cave proper, and with a substantial contribution of exogenous food). This may also account for the great difference in the number of species which appear at different levels in the "cave drills" – constantly 5 to 8 species, preferring medium depths, of 6 m to 12 m, and the number of species in the "doline drill" – 1 to 5 species, depending on depth and year (Fig. 4) The only exception is the year 1999, when 9 species were found at 19 m.

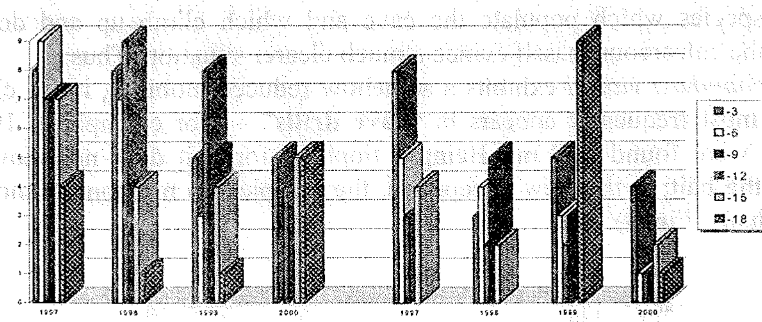

Fig. 4 – The number of Collembolean species at depths between 3 and 18 m, comparatively between "cave drill" and "doline drill".

Expectedly, some hypogeical species like *O. movilae* (Fig. 2) and *A. pygmaeus* are not greatly influenced by the succession of the seasons. In the case of other species, like *Oncopodura vioreli* or *Pseudosinella sexoculata*, during autumn months, September and October 1997, one may notice a significant rise in the number of indivduals at depths of 6, 9, 15m (Fig. 2). A similar rise in the number of individuals may be observed in the case of *O. movilae*, in 1998, at 9m.

The years 1997, 1998 and partially 1999 (depending on the climatic conditions at the exterior) were the richest in fauna and interesting species. We found in the "**cave drill**" a mixture of endogenuous and cavernicol fauna; *A. pygmaeus, O.vioreli, P. sexoculata,* and especially *O. movilae*, togheter with *Hypogastrura denticulata, Folsomia spinosa, Cryptopygus ponticus, Lepyclocyrtus sp.* and *Heteromurus sexoculatus*, at all levels, between 3m and 19m.

The only species that seems to populate the entire calcareous massif, from 1.5 to 8.5 m, as well as the interior of the cave, is *H.nitidus paucidentatus*, a form with a broad ecological valence. It is a frequent and exuberant species in these environments, commonly found in both **cave** and **doline drills**. It is worth noticing that in the drills we found white individuals, with a slight pink pigment near the ocular stain and which, in their great majority, have 6 macrochetae at the base of the antennae. There are some cases (March 1998 and December 1999 at 8 m) in which the individuals have 5 macrochetae at the base of the antennae, just like the individuals in the dry galleries of the cave [4].

Of the 22 species which populate the deep fissures of the calcareous massif, none is characteristic to this environment, they are either endogenuous species going down or hypogeicolous forms going up in the system of fissures up to the levels which surpass the area of karstic calcareous systems.

The collembola of the karstic system from Movile raise an important question:

– The population of *Onychiurus movilae* and *Heteromurus nitidus* at the inferior level, and especially from bells II and III are of a smaller size than the individuals found in the superior dry level, or in the fissures of the calcareous massif.

– Thus, the samples of *O. movilae* from bell III include individuals of a very small size (0,9–1 mm), exhibiting subadult male secondary sexual characteristics. The individuals found in the dry galleries of the cave are of a bigger size (1.8–2.1 mm) and exhibit the secondary sexual characteristics of an adult which has already shed hair. In an attempt to explain this phenomenon, we have put forth 2 hypotheses:

a – we can assume the existence of 2 populations: P_1, of a smaller size, which develops on the bacterial and phungic wave at the surface of water in bells II and III. The growth in size of the individuals of the population may be stopped because of the rough ecological conditions, as shown above. The presence of H_2S may play an important part, blocking the circulation of the oxygen, phenomenon noticed in the cases of some species from the vents. The second population P_2, which can reach 2mm at adulthood, might develop in the fissures of the calcareous massif, in the immediate vicinity of the cave.

b – the second hypothesis presupposes the existence of only 1 population, whose development is especially connected to the gelatinous mass in the bells (which constitutes their main source of food), the individuals then migrating back to the cave or in the fissures. The circulation of the fauna to the cave is connected either to the fissures in the calcareous massif, or, when the level of water decreases, it is performed by free circulation on the walls, between the bells and the cave proper. This may account for the presence of adult individuals in the cave's galleries [3].

Some things should be mentioned, regarding the Collembola fauna from the soil at Obane (Table 1). Of the 42 species identified in the karstic system of Movile, 34 species have been so far found in the endogene. Of these, 1/3 are species, *Cryptopygus ponticus, Pseudosinella obane, Heteromurus nitidus callaticola, H. sexoculatus* and *Cyphoderus asimilis* are species that we have only found in Southern Dobrogea. As suggested by its name, *Pseudosinella obane* is an endemic species for this area.

REFERENCES

1. GRUIA, M., *Nouvelles espèces troglobiontes des Collemboles de Roumanie.*, Misc. Speol. Rom., Bucharest, 1, 103–111, 1989.
2. GRUIA, M., *Les Oncopodura (Collembola, Oncopoduridae) des grottes de Roumanie.* Mém. Biospéol., **22**, 67–74, 1994.
3. GRUIA, M., *Quelques considérations sur la faune de Collemboles de grotte de Movile, Roumanie.* Mém. Biospéol. **23**, 105–109, 1996.
4. GRUIA, M. Sur la faune des collemboles de l'écosystème exokarstique et karstique de Movile(Dobrogea de Sud, Mangalia, Roumanie). Mém. Biospéol., **25**, 45–52, 1998.

Speological Institut "Emil Racovitza"
Bucharest