On Cave-Dwelling Sphaeroceridae from Hungary and Germany (Diptera)

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Abstract — Locality data of nearly 600 Sphaerocerid specimens from vertical karst pits and caves in Hungary and the Federal Republic of Germany complete with ecological data, mainly in tables are compiled. Data from Hungary are compared with those from Germany; furthermore, a comparison is made between the cave-dwelling Sphaerocerid fauna and the fauna of small mammal burrows. Validity of the classification of the cave fauna elaborated by E. DUDICH is proved for Sphaerocerids. No troglobiont species was found, the bulk of the species belongs to the hemitroglophilous group. Morphological and physiological characteristics of the troglophilous Sphaerocerids are summarized. With 2 figures, 3 tables and 1 diagram.

Heretofore numerous data have been gathered on the cave-dwelling *Sphaeroceridae* (BEZZI 1907, 1911, 1914; SCHMITZ 1909, 1914; VON ROEDER 1891; LERUTH 1931; WOLF 1934–38 etc.; valuable critical summary of all the data is in DUDA's, 1938, book). Thus, it was well-known that the family of Sphaeroceridae (together with the Helomyzids) is the most important one among the low-numbered Acalyptratae families dwelling in caves. But earlier data are not entirely reliable owing to difficulties in the determination of species, and, the data are rather scattered, too.

Thus, it was a pleasure to receive a material of 191 Sphaerocerid specimens, which were collected by DR. I. LOKSA in caves of Mt. Bükk and by D. BAJOMI in vertical karst pits at Alsóhegy (NE Hungary). The collectors much enhanced the value of these materials by the numerous valuable ecological data, which supplement the locality data. It is our agreable duty to express sincere thanks to DR. I. LOKSA and to D. BAJOMI for their valuable data and for presenting these and other fly materials to the Hungarian Natural History Museum, Budapest.

H. PLACHTER carried out extensive zoological researches in the caves of "Frankenalb" in the Federal Republic of Germany (= FRG), A part comprises 403 Sphaerocerid specimens collected in 21 caves. Many ecological data were also obtained, and independently of collectings the average numbers of Sphaerocerids in every meter from the entrance of all the 21 caves were registered with naked eye in summer and in winter, furthermore, the average number of the Sphaerocerid specimens per cave was also established in the four biggest caves in each month over a period of one year.

L. PAPP identified all the specimens in the above materials and made the evaluation of the data with especial regard to the life-habit of the Sphaerocerid species.

The results are summarized in Tables 1–3.

R e m a r k s — 1: on pieces of rotten wood and under small stones; 2: aphotic part of the cave, under stones (between stones very small pieces of rotten wood); 3: under stones, on lower side of pieces of wood, rather wet floor; 4: under wood, under stones; 5: under stones; 6: under a piece of wood, rather wet place; 7: on a dead mouse put into the cave 2 months before; 8: same as 7, in the carcass very small *Brachycera* larvae, rather wet place; 9: on lower side of a stone; 10: on a mouse carcass; 11: on the 30 th of October 1974 dead mice were put into tho cave, on the 3rd of January they were taken out. The Brachyceran larvae were transferred into a small box and were cultured at 90–100% of relative humidity and at 7.5 ± 1.0 °C on cave 100 m. The larvae were fed with parts of dead mice and with powder of *Urtica*. The Brachyceran larvae preferred the meat (for detailed information see below); 12: on the wall, near the ground, on the ground much wood, scraps of paper, etc.; 13: at the bottom of a pit, ground covered with stones, with branches of wood; 14. twilight zone, at the wall; 15: twilight zone; 16: under a small stone, aphotic part of the cave, rather much wood and other remnants of organic material (leaves, etc.); 17: on lower side of a stone, little pieces of wood scattered between the logs; 18: on branches of wood, rather wet place; 19: at excrement of aminals together with Collembola.

MR. H. PLACHTER collected Sphaerocerids in 15 other caves in the FRG. Data are as follows: Diebslochhöhle bei Utzmannsbach (D 19), 11. VIII. 73, 3 m from entrance: *C. (Crumomyia) glabrifrons* 1 ♀; 8 m: *C. (Crumomyia) glacialis* 1 ♂; 20 m: *C. glacialis* 1 ♂; 28. III. 75, 1–16 m: *C. (Fungobia) nitida* 2 ♂, 4 ♀, *Limosina bequaerti* 1 ♀, *L. crassimana*

Table 1. Sphaerocerids in Hungarian caves

Locality	Date	Temperature (°C)	Rel. humidity (%)	Collecting method	*Limosina claviventris* STROBL	*Limosina rakovitzai* BEZZI	*Leptocera caenosa* ROND.
Mt. Bükk, leg. DR. I. LOKSA Kőlyuk I.,	9. IV. 64	9.2 (X: 9.4, VI: 10.0)	96	soil trap singled	1 ♀ —	— 5♂, 4♀	— —
Kőlyuk II.	9. IV. 64 8. X. 63	9.2 (X: 9.4, VI: 9.4)	96	3 soil traps 2 soil traps	— —	3♂, 4♀ 3♂, 3♀	— —
Kecskelyuk	10. IV. 64	9.8	84	soil traps	1 ♀	—	—
Felsőforrástöbri cave	16. IV. 64	4.8 (XI: 13.6, VI: 19.4)	93	soil trap in the "dilatation"	1 ♀	—	—
Csókásforrás cave Ist place Csókásforrás cave 2nd place	24. III. 64 8. X. 63 24.III. 64 8. X. 63	4.8 (X: 7.8, VI: 7.2) 7.2 (X: 8.6, VI: 8.6)	94 96	soil traps (1—5) soil traps (6—14)	— — — —	9♂, 2♀ 3♂ 5♂, 2♀ 1♂	— — — —
Alsóhegy (NE Hungary) Baradla, Rókalyuk	11. XI. 64	10.0		singled (leg. Loksa)	—	4♀	—
Baradla, Bio-lab cr.	19. XI. 64	10 ± 1	98—100	singled (Bajomi)	—	14♂, 20♀	—
Vár cave (Budapest)	6. XI. 64	—	—	singled (Bajomi)	—	1♂, 2♀	8♂, 3♀

* light: 4 lux

2 ♂, 1 ♀, *L. silvatica* 2 ♀. — Klufthöhle beim Schwingbogen bei Streitberg (C 323), 14. VIII. 75, 1–5 m: *C. (Fungobia) nitida* 1 ♂, 5–8 m: *C. (Fungobia) nitida* 1 ♂, 3 ♀, *Limosina silvatica* 1 ♀, *L. talparum* 3 ♂, 2 ♀. — Untere Kesselleitenhöhle bei Möchs (D 61b), 3. VIII. 75: *C. (Crumomyia) glabrifrons* 1 ♀, *C. (Fungobia) nitida* 1 ♂, 2 ♀, *Limosina silvatica* 9 ♂, 7 ♀. — Buchnerhöhle bei Kröttenhof (D 128), 3. VIII. 75, 1–13 m: *Limosina silvatica* 1 ♂, 4 ♀. — Brunnsteinhöhle bei Streitberg (C 10), 14. VIII. 75: *Limosina penetralis* 1 ♀, *L. (Leptocera) fontinalis* 4 ♀. — Nördl. Farbmühlhöhle bei Steinamwasser (A 82a), 14. VIII. 75: *C. (Fungobia) nitida* 1 ♂, 1 ♀, *Limosina penetralis* 1 ♀, *L. silvatica* 2 ♂, 1 ♀. — Schwarmbergloch bei Bärnhof (A 74), 14. VIII. 75: *C. (Fungobia) nitida* 1 ♂, 1 ♀, *Limosina silvatica* 1 ♂, 1 ♀. — Lichtengrabenhöhle bei Rinnenbrunn (A 24), 14. VIII. 75, 1–20 m: *C. (Fungobia) nitida* 9 ♂, 4 ♀, *Limosina crassimana* 4 ♂, 19 ♀, *L. silvatica* 5 ♂, 2 ♀, *Leptocera (Opacifrons) coxata* 1 ♂, 1 ♀. — Höhle südl. Silberloch (H74), 20. VIII. 75: *Limosina flaviceps* 1 ♀. — Moorloch bei Oberau (H 22), 20. VIII. 75, 1–23 m: *C. (Crumomyia) glabrifrons* 1 ♂, 1 ♀, *C. glacialis* 1 ♀, *C. (Fungobia) nitida* 4 ♂, 3 ♀, *Limosina schmitzi* 1 ♂, 1 ♀, *L. silvatica* 4 ♂, 1 ♀. — Untere Höhle im Höhlenknock bei Draisendorf (C 57), 23. VIII. 75: *Limosina silvatica* 1 ♂, 2 ♀; 11–30 m: *L. silvatica* 3 ♂, 1 ♀. — Obere Höhle im Höhlenknock bei Draisendorf (C 56), 23. VIII, 75: *Limosina silvatica* 1 ♂; (side-cave): *L. silvatica* 2 ♂. — Grosse Weidmannsgeseeser Höhle (B 11), 23. VIII. 75, 1–20 m: *C. (Fungobia) nitida* 1 ♂, *Limosina claviventris* 1 ♂, 2 ♀, *L. penetralis* 1 ♂, 1 ♀. — Fleischhöhle bei Plech (D 37), 23. VIII. 75: *C. (Fungobia) nitida* 4 ♂, 1 ♀, *Limosina crassimana* 19 ♂, 14 ♀, *L. silvatica* 5 ♂, 2 ♀. — Fuchsloch bei Plech (D 161), 23. VIII. 75: *C. (Fungobia) nitida* 2 ♀, *Limosina silvatica* 1 ♂, *L. talparum* 1 ♀.

In consideration of the extreme difficulties in collecting flies in caves and vertical karst pits these materials are rather remarkable regarding the number of exemplars (total 594 specimens). The 19 species obtained from the collections represent about two-thirds of the cave-dwelling Sphaerocerid fauna of the Palaearctic region, which have been known until now (cf. WOLF 1934–38). Only three species were found in the Hungarian caves. This small number is understandable if we consider that these caves are generally deeper than the German ones, and the collections have been made in the interior of the caves only. However, the lack of the species *Limosina bequaerti* (VILLENEUVE, 1917) is rather striking (the only Hungarian record of this species is: 1 ♂, Com. Borsod, Kecske barl., 29. VII. 1925, leg. BOKOR). The species *Limosina rakovitzai* BEZZI, 1911, was found to be a dominant species. Anyway, except for the species from vertical karst pits in this paper, the specimens of the following other Sphaerocerid species are in the collection of the Hungarian Natural History Museum from Hungarian caves (cf. PAPP 1973): *Copromyza (Fungobia) fimetaria* (MEIGEN, 1830), *C. (Fungobia) roseri* (RONDANI, 1880), *Limosina appendiculata* (VILLENEUVE, 1918), *Limosina fungicola* HALIDAY, 1836, *Limosina manicata* RICHARDS, 1927, *Limosina parapusio* DAHL, 1909 and *Limosina penetralis* COLLIN, 1925 (for the species *Leptocera ciliata* ROND. and *L. oldenbergi* DUDA see DUDA 1918).

In the vertical karst pits (gouffres) of the Alsóhegy (NE Hungary) twelve Sphaerocerid species were detected. All these species are — except for the two, probably trogloxene species of *Sphaerocera (curvipes* LATREILLE, 1802, predominantly coprophagous, *monilis* HALIDAY, 1836, terricolous in forests) — dwelling also in caves. This fact also supports the opinion that we must consider the vertical karst pits as vertical caves; the light conditions in them are remarkably different from those of the horizontal caves and they offer more varied habitats for living organisms, and the number of trogloxene species is higher in them than in the true caves, but their microclimate is wholly identical with the horizontal caves nearby.

In the caves from Germany 15 Sphaerocerid species have been found, among them eight are identical with the species in the Hungarian materials. The finding

Table 2. Sphaerocerids in vertical karst pits (gouffres) near Alsóhegy (NE Hungary)

Locality	Max. depth (m)	Date	Collecting method and nearest location	*Sphae-* *curvi-pes*
Iskola zs.**	15.5	29. IV. 67— 15. VIII. 67	3 soil traps at lowest point	—
		29. IV. 67	singled	—
Fenyves zs.	19.6	IV. 67— 12. VIII. 67	Soil trap at 10 m, within funnel	—
		12. VIII. 67	Funnel extraction from soil at lowest point	—
Töltényes zs.	7.2 big hollow	IV. 67 (4 °C) 15. VIII. 67	soil traps near entrance	—
		15. VIII. 67	soil traps, 2 m from entrance	—
		15. VIII. 67	soil traps, 3 m from entrance	—
		15. VIII. 67	soil traps, 4—5 m from entrance innermost part of small cave	—
		15. VIII. 67	funnel extraction from soil, 3 m from entrance	—
Róka zs.	27.0 (0.5 m^2)	IX. 69— 4. IV. 70	soil traps at the beginning of "storey"	—
		4. IV. 70	soil traps at 24 m	—
		4. IV. 70	soil traps at 27 m	—
Banán zs.	45.3	5. IV. 67— 15. VIII. 67	soil traps near lowest point	1 ♀
Cickány zs.	18.0	IX. 69— IV. 70	soil trap at lowest point	—
Kifli zs.*	25.0	9. VIII. 65	3 soil traps at lowest point	—
Kilátó zs.	12.0	19.IX. 70— 20.VIII. 71	soil traps at a depth of 10 m	—
		19. IX. 70— 22.IX. 71	soil trap near entrance, 3 m	—
Favágó zs.	17.4	19. IX. 70— 23. VIII. 71	soil trap at a depth of 8—9 m	—
		23. VIII. 71	soil trap at a depth of 17 m	—
		19. IX. 70	singled near entrance	—
		19. IX. 70	singled at a depth of 8—9 m	—
Éves zs.	5.0	18. X. 70	singled	—

* For detailed descriptin see BAJOMI (1968)
* zs. = zsomboly, vertical karst pit (or gouffre)

(leg. D. Bajomi)

rocera	*Copromyza*			*Limosina*						*Leptocera coxata*
	(Crumomyia)		*(Fungobia) nitida*							
monilis	*glabrifrons*	*glacialis*		*claviventris*	*crassimana*	*czizeki*	*palmata*	*rakovitzai*	*silvatica*	
—	—	1♂	—	2♂	—	—	—	—	—	—
—	—	—	—	—	—	—	1♀	—	—	—
—	—	—	1♀	—	—	—	—	—	—	—
1♀	—	—	1♂	—	—	—	—	—	—	—
—	—	1♂	—	—	1♂	1♂ +	L. sp.	3♀	1♀	1♂
—	—	—	—	1♂	—	—	—	—	—	—
1♂										
	—	—	—	—	—	—	—	1♀	—	—
—	—	1♂, 1♀	—	—	—	—	—	1♂	—	—
—	—	—	—	—	1♀	—	—	—	—	—
—	—	—	—	—	3♂, 6♀	—	—	—	—	—
—	—	—	—	—	1♀	—	—	—	—	—
—	—	—	—	—	9♂, 4♀		—	1♂	—	—
—	—	—	—	—	—	1♂	—	—	—	—
—	—	—	—	—	—	—	1♀	—	—	—
—	—	—	—	1♀	—	—	—	—	—	—
—	—	—	—	6♂, 10♀	—	—	—	—	—	—
—	—	—	—	1♀	—	—	—	—	—	—
—	—	—	—	—	3♀	—	—	—	—	—
—	—	1♀	—	—	2♀	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1♀	—
—	—	2♂	—	—	2♀	—	—	—	4♂, 6♀	—
—	1♀	—	—	—	—	—	—	—	—	—

Table 3. Sphaerocerids from German caves.

3/1: Höhle in Steinamwasser — 50 km NE of Nürnberg; number in the Franconian cave register: A 56; total length of 550 m, passages nearly completely horizontal, no larger pits; rather wet, in spring sometimes a large pond in the entrance region; temparature in the interior: 8.3 °C.

Date	Distance from entrance (m)	*Copromyza*			*Limosina*						
		glabrifrons	*glacialis*	*(F.) nitida*	*beguaerti*	*claviventris*	*penetralis*	*rakovitzai*	*silvatica*	*Lep. fontinalis*	*Remarks*
30. X. 74	2—5	2	—	—	—	—	—	—	—	—	
	3—7	—	—	—	—	—	3	—	—	—	1
	8	—	—	—	—	—	—	3	—	—	2
	9—14	—	—	—	3	—	—	—	—	—	3
3. I. 75	2—8	—	—	—	—	1	1	—	—	—	4
	8—20	—	—	—	2	1	4	—	—	—	5
	30	—	—	—	—	—	—	1	—	—	6
	40	—	—	—	1	—	—	—	—	—	7
	50	—	—	—	—	—	—	1	—	—	8
2. III. 75	10	—	—	—	1	—	—	—	—	—	9
20. VI. 75		—	—	—	1	—	—	—	—	—	10
14. VIII. 75	1—10	1	2	3	2	—	5	4	1	1	.
	14—19	—	—	—	19	—	2	4	—	—	
3. I. 75	c	—	—	—	—	—	—	10	—	—	11
	u										
3. I. 74—	l										
9. IV. 75	t	—	—	—	3	—	—	2	—	—	
14. VI. 75	u	—	—	—	2	—	—	5	—	—	
	r										
10. VIII. 75	e										
	d	—	—	—	—	—	—	7	—	—	

3/2: Schönsteinhöhle bei Streitberg — 40 km N of Nürnberg; C 9; about 600 m long, system with many side-passages; no so wet as former; 7.0 °C; entrance in a forest of *Fagus silvatica*

Date	Distance from entrance (m)	*Copromyza*		*Limosina*		Remarks
		galbrifrons	*glacialis*	*beguaerti*	*silvatica*	
1. XII. 74	18	–	–	1	–	12
21. V. 75		1	—	1	—	
14. VIII. 75	13—22	1	—	—	9	

3/3: Bauernhöhle bei Draisendorf — 50 km NNE of Nürnberg; C 55; about 50 m long, containing a small pit of 7 m depth; moisture as in C 9.

Date	Distance from entrance (m)	*Copromyza*			*Limosina*			Remarks
		glabrifrons	*glacialis*	(*F.*) *nitida*	*bequaerti*	*crassimana*	*silvatica*	
29. XII. 74	11	—	—	—	3	—	—	13
23. VIII. 1975	1—5	2	—	1	—	3	4	
	6—20	1	3	—	1	—	5	

3/4 Hohberghöhle bei Sorg — 35 km NE of Nürnberg; D 195; 330 m long, narrow, horizontal system; partially very dry; 6.8 °C; in a forest of *Fagus silvatica* and *Acer* sp.

Date	Distance from entrance (m)	*Copromyza*				*Limosina*		Remarks
		glabrifrons	*glacialis*	*nigra*	(*F.*) *nitida*	*crassimana*	*silvatica*	
16. XI. 74	1—7	1	—	—	—	—	—	
	8—10	1	—	—	—	—	—	
	10	—	—	—	—	—	1	14
21. V. 75	1—11	—	6	1	—	—	—	
3. VIII. 1975	1—13	1	—	—	1	4	8	
	14—40	1	1	—	—	—	7	

3/5: Silberloch bei Neu-Essing; — 100 km SE of Nürnberg H 2; 250 m long, with big passages and deep pits; partially very wet, with much clay; 6.6 °C; in a forest of *Fagus silvatica* and *Acer* sp.

Date	Distance from entrance (m)	*Copromyza*			*Limosina*				Remarks
		glabriforns	*galcialis*	(*F.*) *nitida*	*bequaerti*	*crassimana*	*silyatica*	*talparum*	
10. XI. 74	11	—	—	—	1	—	—	—	15
	14—16	1	—	1	—	—	—	—	
	15	—	—	—	1	—	—	—	
	23	—	—	—	1	—	—	—	16
	30—35	—	—	—	1	—	—	—	17
22. I. 75	11	—	—	—	5	—	—	—	
	25	—	—	—	1	—	—	—	18
16. III. 1975	1—20	—	6	—	—	—	—	—	
20. VIII. 1975	1—20	—	2	1	6	1	7	1	
	18—23	—	—	—	2	—	1	—	

3/6: Christianengrotte bei Oberau — 110 km SE of Nürnberg; H 24; total length of 25 m, continuations possible; rather warm; entrance to S.

Date	Distance from entrance (m)	*Limosina*			Re-marks
		bequ-aerti	*flavi-ceps*	*silva-tica*	
6. III. 75	17	1	—	—	19
20. VIII. 75	10	—	1	1	

of the extremely rare species of *Limosina flaviceps* ZETTERSTEDT, 1847 is very interesting and the dominant role of *Limosina bequaerti* in the interior of the caves should be stressed. The caves of the "Frankenalb" are rather small. In winter the Sphaerocerids were found only in the five biggest caves (with one exception, see Table 3/1–6), and there were only five species in the collected material *(Limosina bequaerti, L. claviventris, L. penetralis, L. rakovitzai* and *L. silvatica)*. In summer the species of the family were collected in 15 additional caves, and what is more, all the 15 species. But the two true troglophilous species *(L. bequaerti* and *L. rakovitzai)* live only in seven caves (in the biggest caves). Anyway, over the collected material, several thousand Sphaerocerid specimens were observed in the German caves. PLACHTER's observations are depicted in Figs. 1 and 2. Since it is impossible to determine the Sphaerocerid specimens to species by the naked eye, only two groups were separated. The smaller specimens belong to the genus *Limosina* with very few exceptions (Fig. 1A), while all the bigger specimens are *Copromyza* species (Fig. 1B). With the aid of the collected material (Table 3/1–6) the peaks in the figures can be interpreted. In summer (August) many of the *Limosina* species can be found near the entrance of the caves (Fig. 1A, cf. Diagram 1). In the intermediate

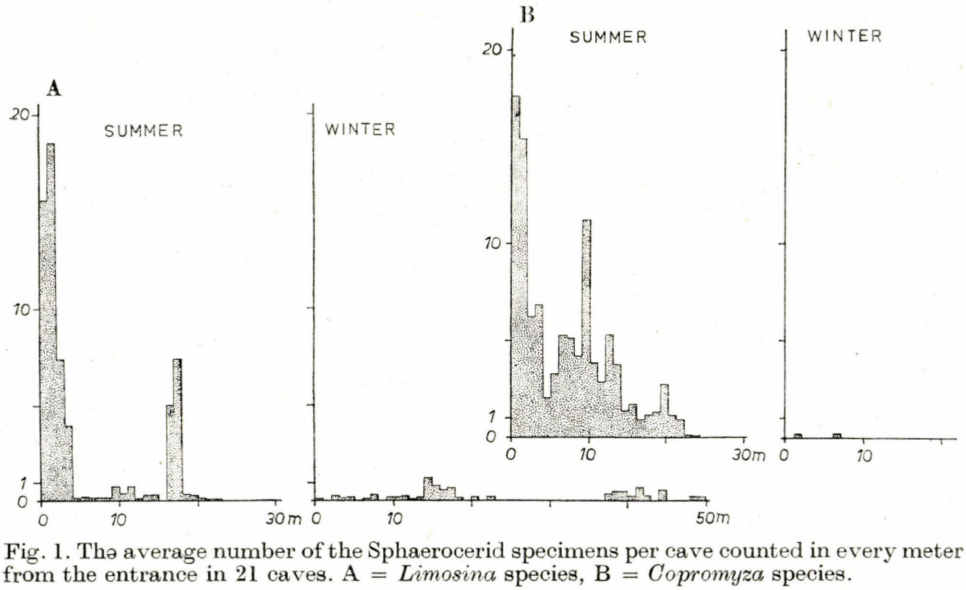


Fig. 1. The average number of the Sphaerocerid specimens per cave counted in every meter from the entrance in 21 caves. A = *Limosina* species, B = *Copromyza* species.

zone (about 10 m from the entrance) there are specimens of *L. silvatica, L. penetralis* and *L. claviventris* and possibly some of the specimens of the two troglophilous species, which live in the aphotic inner parts (max. at 18 m). In summer many specimens of *C. (Fungobia) nitida* and some specimens of the three *C. (Crumomyia)* species live near the entrance. The second peak (about 10 m) indicates the specimens of *C. glabrifrons* and *C. glacialis*, with the latter giving the last peak (20 m) (Fig. 1B). In winter (Dec.—Febr.) there are almost no *Copromyza* specimens in the caves. Only those hemitroglophilous species of the genus *Limosina*, which tend to be troglophilous *(L. silvatica, L. penetralis, L. claviventris)* can be found in the caves at 10–20 m from the entrance in winter. In that season the true troglophilous species live and breed from 40–50 m from the entrance (Fig. 1A). Thus, the real distribution of the species is entirely different from the one, which we may except by the superficial glance: the Sphaerocerid species generally do not take cover in the frost-free caves in winter, but contrarily, the species in the forests, which are psychropilous, scotophilous and which like high humidity, live in the caves temporarily in summer. These species are found near the entrance, where they can find free space and favourable ecological conditions sometimes even for the breeding of their larvae (cf. Fig. 2). So the Sphaerocerids may be so frequent near the entrance in summer that we can find some thousand specimens in one place (300–800 spec./m^2). They are living at 1–20 m from entrance under stones, among and under tree-leaves, which the wind whirls into the caves. In the interior of the caves the Sphaerocerids live during the whole year, but they are only the true troglophilous species. These latter can be found mainly isolated, but in some places their abundance may reach the value of 20–50 specim./m^2. In every place where they were collected some kinds of dead organic material were found (mainly rotten wood, sometimes cadavers of dead animals). 51 dead mice were placed into the caves as decoys, and Brachyceran fly larvae were detected in most of them some two months later.

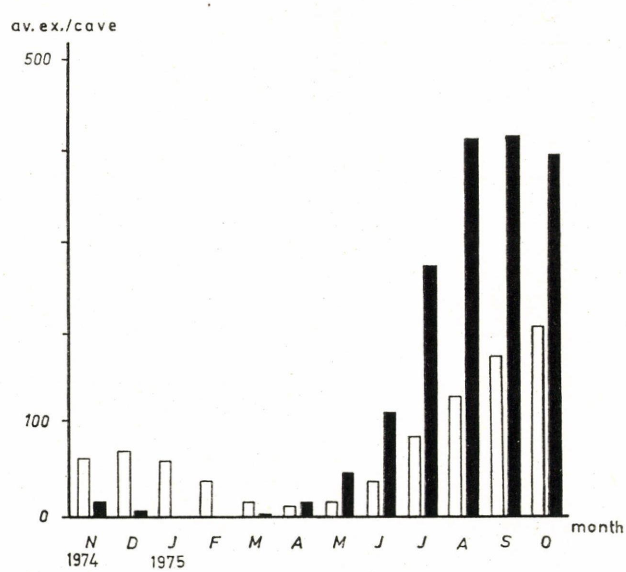


Fig. 2. Average number of the Sphaerocerid specimens in the four biggest caves (C 9, A 56. D 195, H 2) during one year (Nov. 1974 — Oct. 1975, Germany); white columns = = *Limosina* species, black columns = *Copromyza* species.

Among them there were also Helomyzid larvae, thus it was impossible to count the exact number of the Sphaerocerid larvae, probably it was several hundred specimens per decoy mouse. Some of the Sphaerocerid larvae were taken from the decoys into small plastic boxes and they were cultured (see Table 3/1). The data of the ontogenesis of the troglophilous *Limosina* species can be summarized as follows: The copulation of the imagos is very short. The couples were never found in prae-copula. The eggs were placed in groups of 3–10 but with some distance between each egg. The egg number per female is 50–60. The hatching of the larvae takes 2–3 weeks at 7.5 ± 1.0 °C. The larvae are found within the tissues, where they concentrate at the lower side and between the muscle particles and the loam floor. The larvae start to wander in the culture boxes about a week before pupation. The pupae are found at the surface of the loam and in the loam fissures. The duration of the whole ontogenesis from egg to imago is 70–90 days (but probably the larvae were not cultured in the optimum conditions).

It is obvious that the troglophilous or troglobiont species are not too specialized as regards the substrate of breeding. The larvae of the same Sphaerocerid species consume dead animals, wholly rotten wood and the mycelia of fungi (cf. rearing data of HACKMAN 1963, referring to *Limosina* species living also in caves).

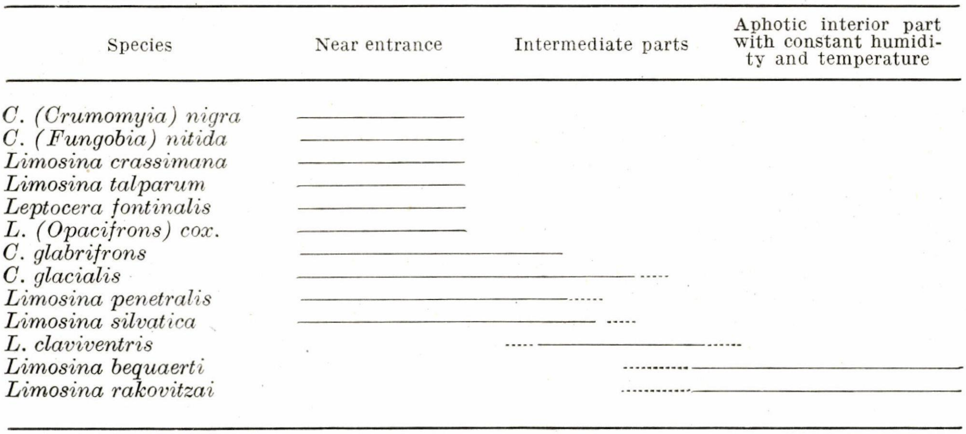
The life length of the imagos of the true troglophilous species was also determined (at 7.5 ± 1.0 °C, 90–100% rel. humidity), yielding an average of 38 days. The maximum length of life of *L. rakovitzai* is 62 days. The true troglophilous *Limosina* species are rarely seen deeper than 50 m from entrance but since the mice-decoys were placed at such a depth and were filled with larvae, it is obvious that they live also there, although they are rare in the innermost parts. While collecting Sphaerocerid imagos it was found that the species in the caves never fly (like many of the coprophagous species). Though they try to escape by running away or by jumps of 5–10 cm. This way of changing place is very similar to that of the Phorid species.

In the entrance region of the caves the Sphaerocerids live together with a great number of other animals. The spiders (21 species were found in 23 caves) are possible predators of Sphaerocerids. In summer dead Sphaerocerids were often found in the nets of spider *Meta menardi* LATR. (twice in nets of *Nesticus cellulanus* CLERCK and once on nets of *Meta merianae* SCOP.). The other predators may be: *Tegenaria silvestris* L. KOCH and Linyphiid species. In the interior of the caves only the Linyphiid species are regarded to be possible predators (the commonest being *Lepthyphantes pallidus* BLACKW.). The eggs and young larvae are attacked by the Parasitidae acari and by some Staphylinid species. Still we do not consider the predators in the caves to be important limiting factors of the propagation of Sphaeroceridae. The assumption does not seem impossible, although it was made on the basis of only insufficient data, that the abundance of the true troglophilous species in the interior parts of the caves depends almost exclusively on the quantity of the available dead organic matter (transported by cave water, sometimes also by wind). Thus, the periodicity of the incoming organic matters can strongly — although secondarily — influence the aperiodicity in the propagation of these species.

As a general evaluation of the data, it seems very instructive and thought-provoking to compare the data obtained from the above materials with the Sphaerocerid fauna of small mammal burrows and nests, the ecological conditions of which are quite similar to those of the caves and vertical karst pits. The Sphaerocerid fauna of the caves are poorer (cf. FALCOZ 1915, HESELHAUS 1913, HACKMAN 1963, 1967, etc.), and in the caves the species, which do not live in small mammal burrows, are scarcely found (the possible exceptions are the extremely rare and thus rather mysterious species of *Speomyia absoloni* BEZZI, 1914 and *Paraspeomyia hungarica* DUDA, 1938); the species of *Limosina czizeki* and *L. penetralis*, which were found in the above materials, probably also live there judging by the basis of their life-habit, although they have not been collected in small mammal burrows until now. The fauna of the small mammal runs and nests is richer, which is easy to understand because the small mammal burrows have also special characteristic species, besides some elements of the terricolous fauna can be found there, too (see HACKMAN 1963, 1967). It is sure that the study of the cave-dwelling Sphaerocerids will be fundamentally helped by the increasing knowledge of the life-habit of Sphaerocerids of small mammal burrows and vice versa.

Among the numerous diverse classifications of the cavernicolous fauna, the classification given by DUDICH (1932) seems the best and it is valid even today. The study of the materials in the present paper supported the quadripartite classification proposed by DUDICH enterily. It is established that there are no troglobiont species in our materials (there are no such species even in the whole Palaearctic region with the possible exception of the two species of *Speomyia* and *Paraspeomyia*). Only two troglophilous species have been found *(L. bequaerti, L. rakovitzai.)* These latter species have some of the characteristics of the troglobiont species (see below), they partially accomodate to the ecological conditions of the caves, they regularly breed in them, but both of them live also in small mammal burrows. There are rather few trogloxenic species in the materials, too (two species of *Sphaerocera*, and perhaps *C. nigra*, which was considered to be a predominantly coprophagous species, may be regarded as trogloxenic one). The bulk of the species belongs to the hemitroglophilous group. These species did not accomodate to the ecological conditions of the caves, they live in the caves near or closely near the entrance owing to the causes examined above. As the distribution of the separate species in the caves (distance from entrance) is a good index of the accomodation to the ecological conditions of the caves, data of the collected specimens concerning these relations were summarized in Diagram 1. The diagram illustrates the statements above, but it is to be remarked that the species *L. claviventris* STROBL, 1909, which is rather common in small mammal burrows, and which is found also in the lower layers of wet forest litter, probably because it is a

Diagram 1. Distribution of Sphaerocerid species in caves



psychrophilous and hygrophilous species, occurs in the parts of the caves near the entrance very rarely, and, although it is not regarded here as a true troglophilous species, it represents some intermediate position between the groups of troglophilous and hemitroglophilous species.

As we can find macrocavernicolous, microcavernicolous and terricolous species alike in the family Sphaeroceridae — even in the same species groups — the further study of the lifehabits of the species will support also the development of a model: how the fly species can become true troglobiont species.

Finally, it seems useful to summarize the main characteristics of the troglophilous Sphaerocerid species for the further study of the cave-dwelling flies. These are: a) extremely heterogenous breeding substrates of the larvae (recuperants); b) reduction in eyes owing to the accomodation to aphotic caves; c) they never fly, that is why the wing moving muscles are reduced and thus the volume of their thorax became smaller, this can result in the reduction of the wing during the phylogenesis of the species (a strongly reduced winged specimen of *Limosina bequaerti* was found in the present material for first time for this species); d) they are psychrophilous thus their ontogenesis is rather long; e) in the conditions of the caves they have no periodicity in their propagation; f) they are stenohygrous but they are not necessarily stenothermous; g) they have almost so strong negative phototaxy as the troglobiont organisms (contrarily to the *Copromyza* species in the present materials).

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