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ON AN INVASION OF THE FLESH-FLY *LIOSARCOPHAGA AEGYPTICA* (SALEM, 1935) INTO CENTRAL EUROPE WITH THE DISCOVERY OF *HELICOPHAGELLA VERSTRAETENI* (LEHRER, 1975) IN EAST SLOVAKIA (DIPTERA, SARCOPHAGIDAE)

D. Povolný, V. Hula

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Abstract

POVOLNÝ, D., HULA, V.: *On an invasion of the flesh-fly Liosarcophaga aegyptica (Salem, 1935) into Central Europe with the discovery of Helicophagella verstraeteni (Lehrer, 1975) in East Slovakia (Diptera, Sarcophagidae).* Acta univ. agric. et silvic. Mendel. Brun., 2004, LII, No. 4, pp. 91-102

The invasion of the subtropical flesh-fly *Liosarcophaga aegyptica* (Salem, 1935) into South Moravia was observed during late summer 2003. This African insect was known to occur in the maritime habitats of the Black Sea and after World War II sporadically also in eastern Hungary, southern Slovakia and Lower Austria. Its population density increased in the Danube Basin and the first flies were also captured in South Moravia during late summer 2003. Elementary analyses revealed that this flesh-fly prefers habitats with high species diversity and important species similarity and that it might become sedentary in this territory. The flesh-fly *Helicophagella verstraeteni* (Lehrer, 1975) accompanying very dry and warm habitats of Romania, Hungary and France was discovered in a similar habitat of eastern Slovakia and is new to the fauna of Central Europe. Results of single linkage analyses in communities with *Liosarcophaga aegyptica* are presented together with the figures of the male genitalia of the two species of flesh-flies treated.

flesh-flies, Sarcophagidae, Ponticomediterranean element, ecology

The invasions of Central Europe by (thermophilous) insect species from southeastern Europe are becoming an interesting attribute of the repeated warm years that have been occurring mainly in the second half of the 20th century. Let us briefly mention only some of interesting and/or particularly striking invasions (immigrations) within which we may discern several groups, e.g.

a) immigrated and establishing species: *Colias erate* (Esper, 1805) (Stiova, 1991; Švestka, 1995), *Euscrobipalpa ocellatella* (Beyd, 1858) (Weismann & Povolný, 1960), *Cucullia fraudatrix* Everesmann, 1837 (Kudla, 1965), *Diachrysia zosimi* (Hübner, 1822) (Moucha & Šmelhaus, 1954);
b) periodically immigrating species: *Argynnis pandora* (Dennis & Schiffermüller, 1775) (Moucha, 1951), *Catocala puerpera* (Giorna, 1791) (Laštůvka et al., 1993);
c) presently immigrating: *Brenthis daphne* (Dennis & Schiffermüller,1775) (Potocký & Němý, 1996);
d) immigrant taxa later disappeared: *Eupithecia*

gueneata Millière, 1862 (Wichra, 1965), *Hyssia cavernosa* (Everesmann, 1842) (Schwarz, 1947), *Aetheria cappa* (Hübner, 1809) (Wichra, 1965);

e) sudden outbursts of species from natural or semi-natural habitats into secondary habitats: *Lycaena dispar* (Haworth, 1803) or *Mantis religiosa* (Linnaeus, 1767) etc.

In contrast to the above insect species that invaded Central Europe, there are two invasive species of clearly tropical origin among calliphorid and sarcophagid flies, both more or less scavenging or carcass reducing species. The first of them is the greenbottle, *Chrysomya albiceps* (Wiedemann, 1819) of the family Calliphoridae, which has repeatedly invaded Central Europe during the past 40 years (Gregor & Povolný, 1960; Povolný, 2002). The second one, *Liosarcophaga aegyptica* (Salem, 1935), a tropical flesh-fly of the family Sarcophagidae, has invaded Central Europe quite recently. It was first observed in southern Moravia during the first days of August and repeatedly captured there until October 2003. The invasion of the latter species appears to show similar traits as that of *Chrysomya albiceps*.

METHODS

For the evaluation of the flesh-fly taxocenoses similarity of the individual habitats the single linkage (or cluster analysis) was applied. This approach is successfully used in this kind of studies to vizualize the numerical tables. Of other methods, especially the model PCA (Principial Correspondence Analysis) or its modification DCA (Detrended Correspondence Analysis – see e.g. Gauch, 1982; Povolný & Znojil, 1994) was considered, but not applied due to a considerable heterogeneity of the material of flesh-flies resulting from the impossibility to achieve the synchronicity of the samples. This fact results from the geographic distance of the individual habitats (Black Sea shore – Lower Austria and South Moravia), from the limited financial possibilities of the authors and from other similar factors. The material enabled us to check such indices as dominance, equitability, diversity, total number of species and individuals.

HABITATS AND THEIR FLESH-FLY TAXOCENOSES

Zaječí (South Moravia)

This is a loess hill near the village of Zaječí in South Moravia arising from the surrounding lowland with artificial lakes (about 12 km eastward from the dominating Pavlovské vrchy Hills), at 550 m a.s.l., a Jurassic limestone cliff in one of the warmest and driest areas of the Czech Republic. The hilltop itself is an artificial sand embankment of material excavated from the bottom of one of the artificial lakes (formerly a riverbank) and transported on the top of the vineyard terraces. The hilltop is a prominent mound exposed to air streams from all directions of the compass and protected from cold northern winds by a stand of *Pinus nigra* (see Fig. 1). Exposed for thirty years to settle down, this mound now harbors

1: *Photograph showing the typical habitat of Liosarcophaga aegyptica in South Moravia where the first males were captured on August 5th and 9th 2003. The limestone Hills Pálava in the background and the artificial dams (originally the riverbed of Thaya/Dyje). The hilltop in the foreground is typical tertiary loess formation above vineyards with late summer steppe vegetation and with a secondary Pinus nigra stand on its northern slope. Foto I. Valová*

a succession of thermophilous plant communities (largerly a *Stipetum*, with *Dorycnium pentaphyllum*, *Eryngium campestre*, *Dictamnus albus*, *Teucrium chamaedrys*, *Iris pumila*, *Thymus* etc.) and is fully integrated into its surroundings. Its flesh-fly community is dominated as usual by three earthworm parasiting flesh-flies of the genus *Sarcophaga* (*S. variegata*, *S. subvicina*, *S. carnaria*) and *Myorhina nigriventris*. The next common species are the parasitoids of snails – *Discachaeta arcipes*, *Heteronychia filia* and *H. haemorrhoa*. The thermophilic element is represented by such taxa as *Helicophagella hirticrus*, *Liosarcophaga emdeni*, *L. portshinskyi* and *Ravinia pernix*. The high summer element consists of such thermophilous synanthropes as individual *Liopygia argyrostoma*, *L. crassipalpis*, of other synanthropes especially *Parasarcophaga albiceps*, *Helicophagella melanura* are common. During such years as 2001–2003 the subtropical blowfly *Chrysomya albiceps* was common on animal carcasses.

Kurdějov (South Moravia)

This habitat consists of Oligocene limestone clay and flysh conglomerate banks with a loess cover at 360 m a.s.l. These layers show a southern to eastern exposition like an amphitheatre with strong impact of submediterranean vegetation (*Quercion pubescenti-petraeae*) and insects association. Its flesh-fly association is generally similar to the situation of Zaječí, but somewhat poorer being not so open to the wide plains of South Moravia.

Braunsberg (Hainburger Berge, Austria)

This is a prominent limestone hill on the Austrian overhang of the Malé Karpaty with its Danube break (Porta Hungarica). Its deep core form the layers of the so-called Central Alpine Zone, the next are solid silica sands and conglomerates (like in the Carpathians) covered by the edaphically most important jurassic limestone and limestone slates specially characteristic of this hill (at 346 m a.s.l.). The growth is mostly a dry grassland with *Stipa* spp., *Iris pumila*, *Onosma arenarium*, of thin shrubs especially *Cerasus fruticosa*, *Cornus mas*, *Viburnum lantana*, *Juniperus communis*. The flesh-fly association reflects the more thermophilous character of this habitat: the general similarity with the association of Zaječí is graduated by such mediterranean species as *Discachaeta cucullans*, by constant presence of *Liopygia crassipalpis* in late summer, by such Carpathian endemismi as *Sarcophaga zumptiana* etc. and by increased densities of *Chrysomya albiceps* especially on dead animals during its invasions.

Hegyfárok (Modrý Kopec – South Slovakia)

This is a bank with the Sarmatian phase of Miocene sediments at 250 m a.s.l. with dust sand covered by layers of loess. The vegetation cover is determined by *Quercus pubescens*, *Cornus sanguinea*, *Amygdalus nana*, *Cerasus fruticosa* etc. Its flesh-fly association is characterized by more or less rare but permanent presence of such taxa as *Heteronychia haemorrhoides*, *Discachaeta cucullans*, *Sarcophaga moldavica*, *Liopygia crassipalpis* and also with very rare individuals of *Liosarcophaga aegyptica* and *Wohlfahrtia vigil*. *Chrysomya albiceps* remains rare even during the years of its general absence in the Danube Basin.

Pobiti Kamni (Near Varna, Bulgaria)

This is a Late Miocene seaside of several square kilometres and some 18 km westward from Varna at 18 m a.s.l. famous especially by several metres high collumns (gradually destroyed by people during the Turkish wars and recently by tourism assault etc.). These collumns originated by erosion of minerals from marine cavities filled up with clay, sand and limestone. Originally *Quercetum pubescentis-Carpinetum orientale* suffers from tourism assault and economic activities. The flesh fly association is extremely rich, because the „maritime“ flesh-fly communities (see e.g. Cape Kaliakra) are completed by dry land snail parasitoids (*Heteronychia mutila*, *H. consanguinea*, *H. filia*, *H. setinervis*, *Discachaeta cucullans*), by more continental scavangers (*Liosarcophaga portshinskyi*, *Liopygia argyrostoma* and *L. crassipalpis*) and especially by the desert species *Helicophagella maculata*. Moreover, the tourism assault, parking places etc. concentrate such synanthropic taxa as *Helicophagella melanura*, *Ravinia pernix*, *Parasarcophaga albiceps* and mainly *Bercaea africa*. This causes that the species diversity of this habitat is extremely high.

Sozopol (Bulgarian Black Sea Coast)

This is an ancient little fisher harbour (founded 610 B.C.) south from Varna with steep rocky blocks above the sea north and south from the harbour. The adjacent plateau was originally a dry mixed deciduous forest with *Quercus cerris*, *Q. frainetto* and *Carpinus orientalis*. The seastrand shows psammophytic vegetation with *Eryngium maritimum*, *Elymus sabulosus* and *Ammophila arenaria*. The flesh-fly associations of the rocky seashore are essentially similar to those of Cape Kaliakra: practical absence of taxa parasitizing on earthworms (*Sarcophaga* spp.) and presence of destructors of decaying meat of dead, animal, mainly fish bodies.

Cape Kaliakra (near Balchikh – Bulgaria)

This is a two-kilometer long promotory with sheer cliffs that drop 70 m sea below. It is a part of the geological deformation called Bay of Kaliakra, coastal rocks including mainly calcareous sediments of

Neogene age. The rock itself is a massif of sarmatian limestone terraces. The plateau above the rock was originally a dry forest – *Quercetum pubescentis-Carpinetum orientale*. The seastrand consists of shallow lagunes with halophilous vegetation mainly Chenopodiaceae and Asteraceae. The flesh-fly community is mainly remarkable due to the total absence of the earthworm parasitoids (*Sarcophaga* s. str.) and by the presence of such taxa as *Liosarcophaga dux* (very common), *Liopygia argyrostoma*, *L. crassipalpis*, *Liosarcophaga aegyptica*, *L. jacobsoni*, *L. tibialis*, *Helicophagella maculata* and *Bercaea africa*. Whereas the species of the genus *Liosarcophaga* are mostly autochthoneous consumming dead decaying dolphins, fish, crayfis, sea crustaceans, the high density of *Bercaea africa* is probably a result of intensive, partly wild unlimited tourist assaults with all their negative consequences in hygiene etc. (see also Povolný & Znojil, 1994). It seems that habitats like this are primary sources of *Liosarcophaga aegyptica* in the Black Sea maritime ecosystems.

TAXONOMY AND NOMENCLATURE

Liosarcophaga aegyptica (Salem, 1935) was first described as *Sarcophaga dux* var. *aegyptica* from Alexandria, Egypt. It is also known from several other localities in Egypt (Pape, 1996). It was Rohdendorf (1937) who, two years later, described the same species as *Parasarcophaga* (*Liosarcophaga*) *parkeri* from the southern shore of Crimea. He also characterized its considerable distribution over the territory of the former USSR (see below). The synonymy of *Liosarcophaga parkeri* (Rohdendorf, 1937) and *Liosarcophaga aegyptica* (Salem, 1935) was first recognized by Gregor & Povolný (1960). Another synonym is *Liosarcophaga salemiana* Lehrer, 1995. The present status of the synonymy is as follows:

Liosarcophaga aegyptica (Salem, 1935) – *Sarcophaga dux* var. *aegyptica*; Publ. Egypt. Univ., Fac. Medic. 5: 56

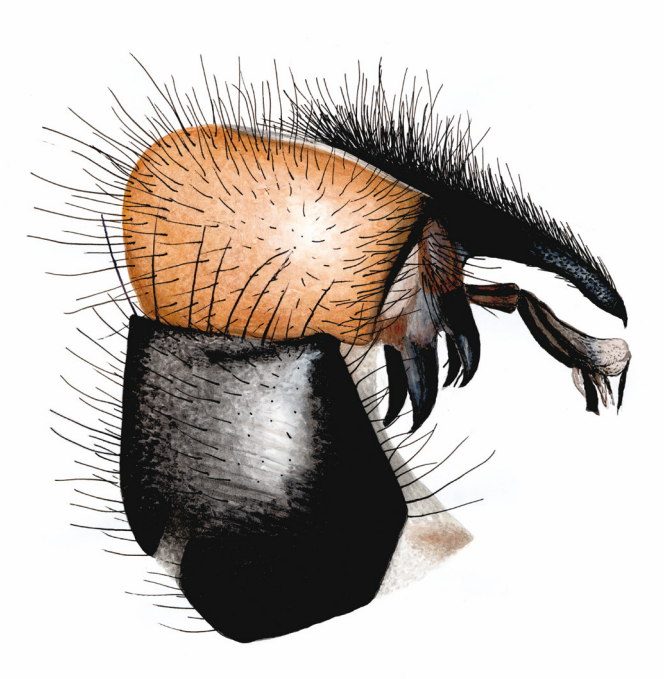
Synonyms:

Parasarcophaga (*Liosarcophaga*) *parkeri* Rohdendorf, 1937 – Fauna SSSR 19: 217

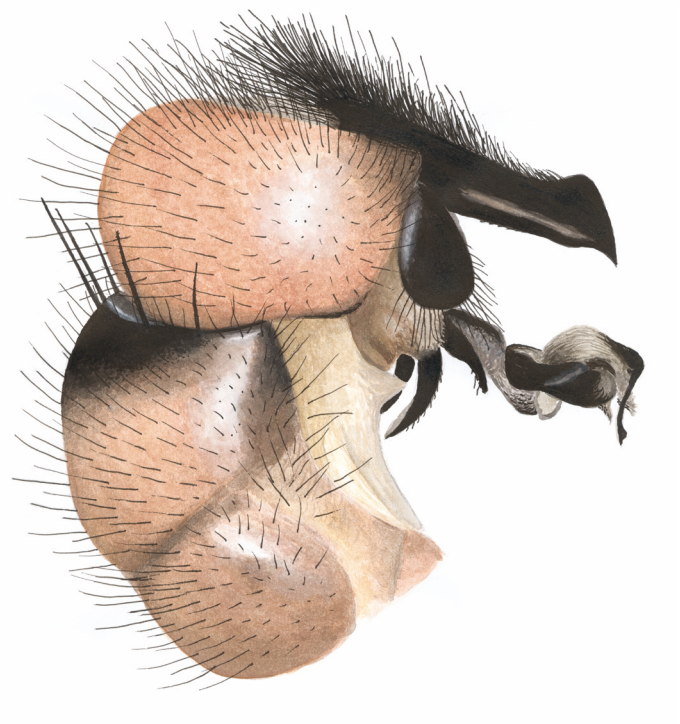
Liosarcophaga salemiana Lehrer, 1995 - Rev. Roum. Biol., Biol. Anim. 40: 14

The species is characterized, above all, by its male genitalia (Figs. 2, 3):

- The apical plate runs out to form a short subtriangular process, different from the short spine found in the related species of *Liosarcophaga*.



2: *Liosarcophaga aegyptica – lateral view of 8th abdominal tergite (black) and anal (genital) segment (reddish). The specific characters are: Comparatively splender elongate cercus with acute tip; slender elongate paraphallus with several acute paired or unpaired distal and ventral processes and two paired broadly rounded spines of deeply black gonites. (A. Laštůvka pinxit)*



3: *Liopygia crassipalpis – lateral view of 8th abdominal tergite (black) and anal (genital) segment (reddish). The specific characters are: Rather parallel-sided cercus with apical dilatation; paraphallus short and semiglobate with a (paired) slender and elongate ledge with moderately bifurcate tip; gonites not so stout as in L. aegyptica and finely haired. (A. Laštůvka pinxit)*

- The harpe is comparatively slender with an acute, moderately curved tip.
- The membranal plate is longer than the harpe, somewhat broader and with acute apical edge provided with two or more short spines.
- The progonite is comparatively short, stout and broad, with short acute tip.
- The postgonite is a short robust spine.

Liosarcophaga aegyptica belongs to the group of species of the genus *Liosarcophaga* Enderlein, 1928, with reddish abdominal (anal) tergite and usually black or blackish 8th abdominal tergite, which frequently visit animal (especially vertebrate) carcasses: e.g. *L. dux* (Thomson, 1869), *L. tibialis* (Macquart, 1851), *L. jacobsoni* Rohdendorf, 1937 (revised by Povolný, 1987) and show synanthropic and partly cosmopolitan trends. These flesh-flies are frequently confused with some of the so-called „red-tailed" flesh-flies, a group also comprising other cosmopolitan flesh-flies which visit carcasses, faeces, etc., such as *Bercaea africa* (Wiedemann, 1824) and two species of the genus *Liopygia* Enderlein, 1928, see, *L. crassipalpis* (Macquart, 1839) and *L. argyrostoma* (Robineau-Desvoidy, 1830), to mention only the most important taxa of this group. Usually, these flesh-flies show reddish 9th and 8th abdominal tergites (cf. Figs. 2, 3). In particular, *Liopygia crassipalpis*, originally a Palaeo- Tropical to Subtropical species secondarily known also from North and South America (and possibly secondary in Europe – Balkan countries, Danube Basin, Lower Austria, Burgenland, Wiener Becken, and southern Moravia) reaches there the northernmost limit of its range, and it might be confused with *Liosarcophaga aegyptica*. This fact should be emphasized not only because of the (habitual) similarity of the two taxa but also because of their common occurrence, which apparently reflects their similar ecological requirements, and because of its possible forensic importance (as in all "red-tailed" species of *Liosarcophaga*).

DISTRIBUTION AND ECOLOGY

Rodendorf (1937), Verves (1986) and Povolný & Verves (1997) completed the data on the distribution of *L. aegyptica* as follows: Moldavia, Russia, Georgia, Armenia, Azerbaijan, Kazakhstan, Turkmenistan, Uzbekistan, Tajikistan, Near and Middle East, Iran, NW China, and Ethiopia. Pape (1996) also mentioned South Africa. Povolný & Verves (1990) added their

faunistic data from the whole of the Black Sea coast (Balchikh – Cape Kaliakra, Pobiti Kamni, Sozopol) as well as from Veliko Tarnovo in continental Bulgaria. Gregor & Povolný (1960) mentioned for the first time the rather overall distribution of *L. aegyptica* over the Hungarian Basin of the Danube (Gemenc, Debrecén, Hortobágy), and also in the southernmost parts of Slovakia (Čenkov, Hegyfárok, Kolárovo, Kráľovský Chlmec, Lupka; individual or rare flies – see also Slamečková /1959/). In their recent paper, Povolný et al. (2003) mention additional localities in southern Slovakia: Ardovo (very rare), Hegyfárok (individual specimens), Kováčov (very rare), and also Budapest, Hungary (one specimen). Apparently, *Liosarcophaga aegyptica* has been present in the Danube Basin for at least fifty years, and it is difficult to decide whether this is due to its gradual dispersal over this territory or to an insufficient level of knowledge in the past.

No precise observations on the life history of *L. aegyptica* are available, but numerous data suggest that the maggots of this species might develop in carcasses. In his review of the data on the distribution of this species available at that time, Štakeľberg (1956) mentions moribund locusts, decaying carcasses, and faeces. Mihályi (1979) characterizes *L. aegyptica* as a „synanthropic fly whose maggots develop in decaying meat." Gregor & Povolný (1960) baited the flies with small rodent and snake carcasses. During late summer 2004 the males were succesfully baited on dead hares, decaying meat, eggs and fish.

RECENT OBSERVATIONS

This paper was originally inspired by the first capture of a male of *Liosarcophaga aegyptica* near Zaječí (South Moravia, Czech Republic) on August 5th and the next one in the same habitat on August 9th 2003. The third male was captured in Kurdějov on 17th August 2003, in a habitat situated some 15 km to the northwest in the foothills of the Moravian Carpathians.

It was therefore decided to undertake immediately at least tentative investigations and search for the possible distributional ways of this flesh-fly concentrated not only on the terraces of Zaječí (where *Liosarcophaga aegyptica* was first captured) but to collect also in the southern edge of the Slovakian part of the Danube basin near Štúrovo (Hegyfárok, Mužla up to Číčov). We captured there approximately seventy of males – a number convincing us that the species invades to the northwest. As is seen from table I, the highest numbers of *L. aegyptica* males are dated in the mid of sixties from near Varna (11), but the species was individually captured in coastal Bulgaria Pobiti Kamni, Sozopol, Cape Kaliakra) during high summer months of the years 1965, 1970, 1971 and 1987 evidencing its presence in the Bulgarian maritime habitats without indication of its spread. The same is true of its distribution in Hungary and in southern Slovakia (see table I) which corresponds to the contemporary of its past distributional pattern: it was a rare taxon representing the subtropical element in the Ponticomediterranean part of Central Europe, mainly in Bal-

I: *Review of specimens of Liosarcophaga aegyptica captured by authors*

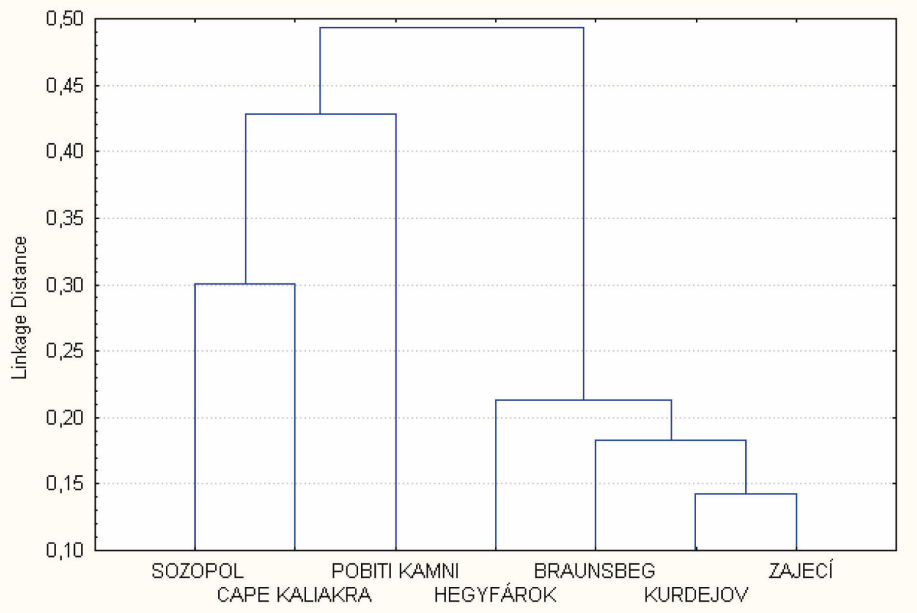
Localities	1957	1958	1963	1965	1970	1971	1976	1981	1983	1985	1987	1989	1990	2003
Zaječí (Mor.)														4
Kurdějov (Mor.)														1
Hegyfárok (Slov.)	2						2	3	3	2		2	3	75
Žemberovce (Slov.)	2													
Čenkov (Slov.)	2													
Kolárovo (Slov.)		4												
Královský Chlmec (Slov.)			3											
Cigeľka (Slov.)			3											
Balatonhenese (Hung.)	1													
Balatanederics (Hung.)	1													
Szt. György (Hung.)	2													
Velence (Hung.)	3													
Hortobagy (Hung.)	5													
Gemnec, Hortobágy (Hung.)	1													
Pobiti Kamni (Bulg.)				11	6	5								
Cape Kaliakra (Bulg.)						2					6			
Sozopol (Bulg.)						3								

kan countries and in the warmest parts of the Basin of the Danube. This contrasts with the above situation of the high and late summer of 2003 with the sudden increase in flies in the core of the Danube Basin and their invasion to the northwest especially in its left side tributaries.

The attempt was undertaken to evaluate the species composition and the routine synecological tests (dominance, frequency, constancy, diversity, equitability and similarity) to define the flesh-fly associations into which *L. aegyptica* penetrated to forecast its possible future spread.

DISSCUSION

Several methods were used for mathematic-statistic and graphic evaluation of our results (see above). Of these, the cluster analysis (Fig. 4) appeared to be most useful. The other approaches, especially PCA, revealed no significant pattern of the habitat similarity due to the impossibility of repeated collecting in the Bulgarian (Black Sea) habitats so that the visiting frequency of these habitats was lower compared with those in the Basin of Danube. It results from the Single Lincage Graph that the Bulgarian (mostly maritime) habitats differ distinctly from those of the



4: *This graph resulting from Tab. I shows the similarity distances between all study habitats*

Danube Basin. The lower homogeneity of the Bulgarian habitats has the same methodical reason – the inevitably lower frequency of collecting visits. The low similarity of Pobiti Kamni (Dakiti Taš) with the other (Bulgarian) habitats has several reasons.

This is, in the first place, the presence of *Helicophagella maculata* (Meigen, 1835). Rohdendorf (1937) characterizes it as a „desert species“ accompanying sandy habitats (sand dunes, litoral sands with increasing densities in desert habitats of Central Asia starting with Armenia, Uzbekistan, Kazakhstan, Mongolia, China). Blackith et al. (1997) express serious doubts on informations and material of this species from North Africa and from many other countries (Israel, Lebanon, Poland, Syria and former Yougoslavia.). Senior author collected this species, still individually, in the hottest habitats of Bulgarian Macedonia (Valley of Struma) and on sandy habitats on the Bulgarian Black Sea shore. Some of these individuals were identified by late Prof. B. B. Rohdendorf. Regardless of the long-term collections of the flesh-flies in the Mediterranean, senior author never collected this species in this teritory, the Bulgarian ones representing the only authenticated individuals of *H. maculata*. This situation and the personal connections with Prof. Rohdendorf attribute a high credit to Rohdendorf´s data and knowledge, and it seems that *H. maculata* reaches its western distributional limit in the hot and

sandy habitats of Eastern Balkan countries especially of Bulgaria representing the subtropical habitats of eremial parts of Palaearctic Asia. The next „eastern" and probably very representative pontomediterranean taxon is *Heteronychia mutila* (Villeneuve, 1912) reaching its western limits in Hungary and in Slovakia (Pape, 1996). The third obviously pontomediterranean species *Heteronychia setinervis* (Rondani, 1860) is a rarity in Pobiti Kamni and in all maritime habitats under study, as it accompanies limestone rocky habitats being locally common (e.g. in Greece). All these three species are also found in other (Bulgarian) habitats, but their simultaneous presence in Pobiti Kamni is unique.

The holomediterranean element in Pobiti Kamni is represented by such taxa as *Heteronychia haemorrhoides* (Böttcher, 1913), a very local and rare species accompanying well preserved thermophytic habitats both on dry sites (loess) and in litoral growths along rivers. The next species of holomediterranean distribution is *Heteronychia consanguinea* (Rondani, 1860), but contrary to *H. haemorrhoides*, which reaches Iran, *H. consanguinea* accompanies habitats in the vicinity of seashores mainly of the eastern Mediterranean (including Italy and France) and of the Black Sea countries (described as *H. portschinskyana* Rohdendorf, 1937). The third representative of the holomediterranean element is *Discachaeta cucullans* (Pandellé, 1896), along with the above two taxa a snail parasitoid. *D. cucullans* enters also the Danubian thermophyticum (up to Lower Austria).

The next complex of very thermophilic flesh-flies comprises taxa showing notorious synanthropic trends and occasionally common along tropical and subtropical seasides, e.g. panpalaeotropic *Liosarcophaga dux* (Thomson, 1869) (reaching Black Sea Shores), Palaearctic *Liosarcophaga jacobsoni* Rohdendorf, 1937, Palaearctic-Australian-Oceanian *Liosarcophaga tibialis* (Macquart, 1851), panpalaeotropic-subtropic *Liopygia crassipalpis* (Macquart, 1839), cosmopolitan *Liopygia argyrostoma* (Robineau-Desvoidy, 1830). These last four species penetrate occasionally the Basin of Danube along its stream and may locally establish colonies (*L. crassipalpis*, *L. argyrostoma* in Austria, *L. tibialis*, *L. jacobsoni* in Hungary). All these last taxa accompany such litoral habitats as Sozopol and/or Cape Kaliakra so that their presence in Pobiti Kamni is occasional (especially *L. dux* and *L. jacobsoni*). *Liosarcophaga aegyptica* also belonged to the above ecological group of taxa before it started to invade to the north and/or north-west.

The individual and obviously occasional presence of *Heteronychia minima* (Rondani, 1862) is characteristic, but it comes from the neighbouring more or less maritime habitats. The two thermophilous helicophagous taxa, see *Discachaeta arcipes* (Pandellé, 1896) and partly *Heteronychia filia* (Rondani, 1860) are snail parasites accompanying thermophilic habitats in numerous European habitats. Anyhow, the habitat Pobiti Kamni occupies a special position correspondingly to its history, edaphic conditions and vegetation cover.

The flesh-fly associations of the Danube Basin habitats (including South Moravia and Lower Austria) are considerably similar (Zaječí-Kurdějov at 87%, Braunsberg-Zaječí, Kurdějov at 82%, the latter three habitats and Hegyfárok at 76%, but all these habitats and the Bulgarian Pobiti Kami only at 57% – see Fig. 4). A special position of Hegyfárok compared with the other Danube Basin habitats results from its high species diversity and its special edaphic conditions (layers of loess) (see also Povolný et al., 2003). An important connecting factor between the Bulgarian (mostly maritime) flesh-fly associations and the Danube Basin is consequently the presence of some species representing the mediterranean element and reaching their distributional limits in the north and northwest of the Danube Basin and showing low abundance. This their rare presence shows no essential statistic influence on the species diversity of the flesh-fly association similarly as the periodical invasions by *Chrysomya albiceps* (Wiedemann, 1819).

CONCLUSIONS

After almost all of the Danube river Basin had been repeatedly invaded by the Afro-tropical greenbottle species *Chrysomya albiceps* (Wiedemann, 1819) (Povolný, 2002), this calliphorid species seems to be followed by the essentially Palaeotropical flesh-fly species *Liosarcophaga aegyptica* (Salem, 1935). While the question of the year during which *Chrysomya albiceps* invaded this region for the first time (most likely during the series of hot summers after 1947) remains open, there is no doubt that the first individuals of *Liosarcophaga aegyptica* reached the Porta Hungarica (the region between Bratislava, Slovakia and Hainburg, Austria) and southern Moravia during the summer of 2003, since this species had never been discovered there in spite of many years of intense faunistic investigations implemented in those regions (Povolný et al., 2003). It is uncertain whether or not these two species can share the same ecological niche, since *Chrysomya albiceps* vanished from, or became very rare in, the study area during 2003. *Liosarcophaga aegyptica* is another „red-tailed" flesh-fly species that destroys carrion, and it should be included in forensic literature because it may possibly develop in unburried human corpses.

The single linkage approach shows that, with the exception of the Bulgarian Pobiti Kamni, all flesh-fly associations in which *Liosarcophaga aegyptica* was

observed show important and comparatively high similarity indices at high taxa diversity. It might be expected that this unexpected immigrant species from the European south-east might gradually establish its colonies in similar habitats of the Danube Basin, possibly limited by the mean yearly isotherme of 9 °C.

The most representative conclusions result from the above single linkage analysis are reflected in table II. The total of 55 427 individual flies, members of flesh-fly associations studied, belonging to 63 species were the basis for the above statistic analyses.

II: *Diversity table values of flesh-fly associations in seven study habitats. It is obvious that only minor differences exist between most of them. More detailed interpretation including Graph 1. in text.*

Localities	Zaječí	Braunsberg	Pobiti Kamni	Hegyfárok	Kurdějov	Cape Kaliakra	Sozopol
Zaječí	**1.00000**	0.80000	0.46429	0.69880	0.85714	0.23256	0.24390
Braunsberg	0.80000	**1.00000**	0.49123	0.78571	0.81690	0.27273	0.19048
Pobiti Kamni	0.46429	0.49123	**1.00000**	0.50667	0.48387	0.57143	0.48485
Hegyfárok	0.69880	0.78571	0.50667	**1.00000**	0.78652	0.25806	0.23333
Kurdějov	0.85714	0.81690	0.48387	0.78652	**1.00000**	0.24490	0.21277
Cape Kaliakra	0.23256	0.27273	0.57143	0.25806	0.24490	**1.00000**	0.70000
Sozopol	0.24390	0.19048	0.48485	0.23333	0.21277	0.70000	**1.00000**

Helicophagella verstraeteni (Lehrer, 1975) – NEW TO SLOVAKIA

Lehrer, 1975, Bull. Ann. Soc. Roy. Ent. Belg. (Bruxelles), 111: 281

Material studied: 5 ♂♂, Ladmovce (near Somotor), eastern Slovakia, 15th July 2003

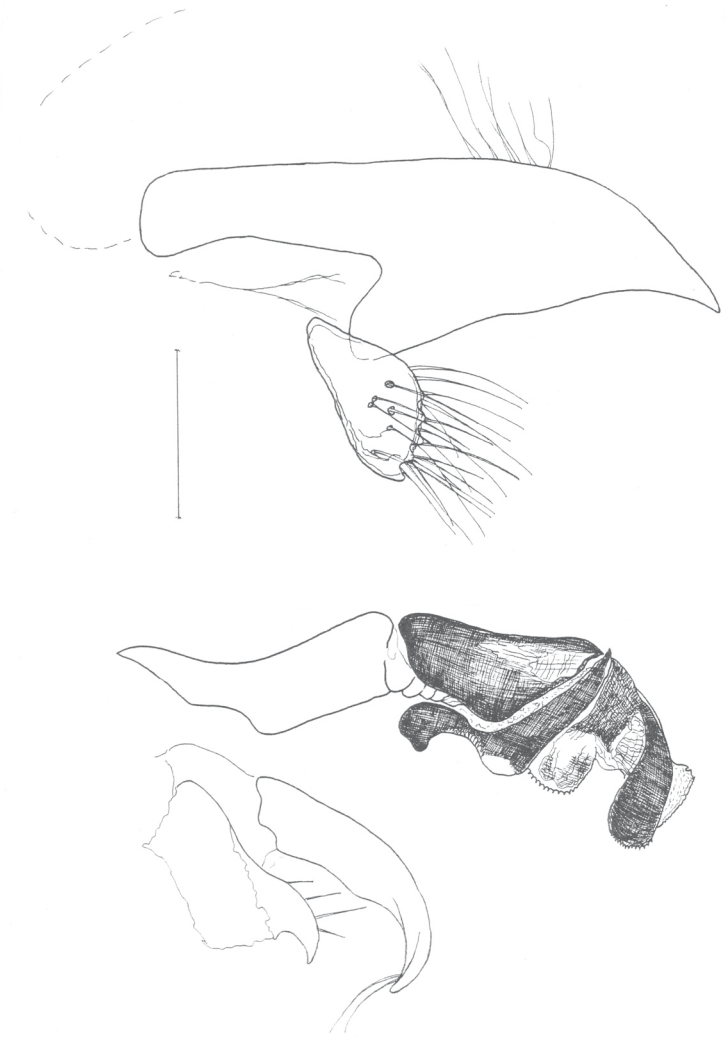
COMENTS TO DISTRIBUTION, ECOLOGY AND TAXONOMY

The species has been definitely cleared by Blackith et al. (1997) in their exact taxonomical paper on all hitherto described species of the genus (in their sense, a subgenus). The authors have also indirectly shown that *Helicophagella rosellei* (Böttcher, 1912) and *Helicophagella verstraeteni* (Lehrer, 1975) do not share an identical niche, as they would seem to do. It has become clear, with advancing knowledge of the ecology of these taxa, that *Helicophagella rosellei* is actually a Trans-Palaearctic taxon accompanying warm and sunlit sites in the Palaearctic forest belt, however avoiding „Mediterranean" and similar eremic habitats. The distributional pattern of *Helicophagella verstraeteni* is far from being satisfactorily cleared but it appears that its distribution is rather scattered (Corsica, Hungary, Romania, Switzerland). This interesting species was collected in one of the driest and hottest habitats of the steppe-like formations in eastern Slovakia, which is the northernmost part of the Hungarian puszta. The flies were captured on a hilltop among low hawthorn shrubs (*Crataegus* spp.) during a period in which the midday temperatures approached 35 °C, similarly as they did during the preceding spell of hot weather.

As regards the „breeding records" of this species (Blackith et al., 1997) as well as other species of *Helicophagella* (and many species of Sarcophagini in general), it should be pointed out that the literary and other data, sceptically confronted by the above authors, are not contradictory. Flesh-flies (s. str., tribe Sarcophagini) are generally predatory, showing inclination towards parasitism (e.g., the species of *Sarcophaga* on earthworms, *Heteronychia* on snails, *Liosarcophaga* on insect larvae, above all, caterpillars), but their feeding strategies are far from being „monophagous", etc., as reflected by the fact that most of them would visit (human) faeces as well as decaying animal carrion of all kinds, thus forming the so-called „second wave" of carrion flies. The results of rearing flesh-flies from small corpses, as published by Blackith et al. (1997), should not be understood as suggesting that only *Rosellea aratrix* (Pandellé, 1896), *Liosarcophaga teretirostris* (Pandellé, 1896) and *Myorhina nigriventris* (Meigen, 1826) but none of the specimens of *Helicophagella crassimargo* (Pandellé, 1896) are „specific" parasitoids of *Helix aspersa*. In

other situations a completely different spectrum of flesh-flies could be reared from the same host. Also, it is generally known that during gradations of such insect pests as *Lymantria dispar*, different flesh-fly species may attack moribund septicaemic larvae of such pests, and that these flesh-fly species can occasionally be reared from quite different „hosts“. One may state that most flesh-fly species are trophic opportunists preferring a narrow or wide range of hosts but not avoiding other hosts or decaying carrion (or faeces) if available. Therefore, varying literary data on flesh-fly hosts may not necessarily be misidentifications, errors etc. But, rather, they reflect the wide trophic selection of the flesh-flies. This is particularly markedly seen in the wide range of trophic selections of such cosmopolitan or synanthropic species as *Liosarcophaga* (e.g. the *dux*-group), *Liopygia* (e.g., *crassipalpis* or *argyrostoma*), *Parasarcophaga hirtipes*, or *Helicophagella melanura*. Russian (and other) dipterists have used the term „schizophagy“ to denote this trophic strategy (see also Povolný & Verves, 1997).

As regards the most decisive taxonomic characters of *H. verstraeteni*, above all, the male genitalia (Fig. 5), their similarity with those of *H. rosellei* is far from being „minor“: in lateral view, the distiphallus and vesica are more elongate, the upper edge of distiphallus is less vaulted, and the iuxta is elongate nose-formed; the postgonite of the two gonopods is short, robust and spine-shaped, whereas in *H. rosellei* it is elongate, rather straight and slender (terminology according to Blackith et al., 1997 and Povolný & Verves, 1997).



5: *Helicophagella verstraeteni – lateral view of male genitalia; cercus and coxite (above), phallus and gonites (bottom). Ladmovce, eastern Slovakia, 15th July 2003. The bar corresponds to 0,25 mm.*

COMMENTS

Helicophagella verstraeteni has been discovered for the first time in eastern Slovakia on top of a hot and dry limestone hill, about 110 metres above the sea-level in vegetation tier 1. The locality lies in the Ladmovce Nature Reserve, north of Kráľovský Chlmec. Most of the area is formed by Lower Cretaceous layers covered, during the Carpathian flysh development, with marl and clay. This habitat resembles those in Romania and Hungary.

In both morphological and ecological respect, *H. verstraeteni* is mot closely related to *H. rosellei*, the latter accompanying Trans-Palaearctic forests. *Helicophagella verstraeteni* is probably most closely related taxonomically to *H. reicostae* Povolný, 1999 from Sardinia. This taxon shows a strongly curved pregonite with an obtuse tip, and a detached, very slender iuxta. Since *H. reicostae* shows insular distribution and is probably endemic, examining additional material appears to be necessary in order to decide whether or not *H. reicostae* is strictly conspecific or consubspecific with *H. verstraeteni*.

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SOUHRN

O invazi masařky *Liosarcophaga aegyptica* (Salem, 1935) do střední Evropy a objevu masařky *Heliophagella verstraeteni* (Lehrer, 1975) na východním Slovensku (Diptera, Sarcophagidae)

Na přelomu padesátých a šedesátých let minulého století a posléze druhého a třetího tisíciletí pronikla Podunajím až na jižní Moravu tropická masařka *Chrysomya albiceps* – objevila se vždy v pozdním létě. Na přelomu srpna a září 2003 ji následovala další tropická moucha – tentokrát masařka *Liosarcophaga aegyptica* (Salem, 1935) popsaná ze severního Egypta v roce 1935 a záhy objevená a popsaná v roce 1937 jako *Liosarcophaga parkeri* Rohdendorf, 1937 z tehdejšího sovětského Černomoří. Po roce 1945 byla sbírána jednotlivě kolem bulharského pobřeží od Sozopolu až do blízkosti Balčiku (Mys Kaliakra). Koncem padesátých let byla jako vzácnost pozorovaná také v maďarské Hortobagy i na některých jihoslovenských lokalitách kolem Dunaje a jeho přítoků (Hegyfárok u Štúrova, Kráľovský Chlmec apod.). Po nálezu ojedinělých samečků na jižní Moravě (u Zaječí) se ukázalo, že jde zřejmě o invazi, protože na zmíněných jihoslovenských lokalitách a zejména na obnažených příbřežních písčinách Dunaje (v nichž začali zahnívat uhynulí mlži a ryby) se tato masařka začala vyskytovat velmi hojně. Statistická analýza všech vzorků masařek, v nichž se *Sarcophaga aegyptica* vyskytovala (od černomořského pobřeží až po jižní Moravu), ukázala, že žije na nivních extrémně suchobytných a teplobytných stanovištích pontomediterránní povahy s poměrně vysokou a stálou druhovou diverzitou společenstva masařek, kde zřejmě našla volnou niku. Takto začaly také zmíněné invaze bzučivky *Chrysomya albiceps*. Během těchto šetření byla na východoslovenské lokalitě Ladmovce u Somotoru objevena mediterránní masařka *Helicophagella verstraeteni* (Lehrer, 1975), což je první nález tohoto vysoce xerotermofilního druhu na Slovensku.

masařky, Sargophagidae, pontikomediterrání element, ekologie

REFERENCES

BLACKITH, R., BLACKITH, R. and PAPE, T.: Taxonomy and systematics of Helicophagella Enderlein, 1928 (Diptera, Sarcophagidae) with the description of a new species and a revised catalogue. Stud. dipt., 1997, 4: 383-434.

GAUCH, H. G. (jr): Nose reduction by eigenvector ordinations. Ecology, 1982, 63: 1643-1649.

GREGOR, F., POVOLNÝ, D.: Beitrag zur Kenntnis der synanthropen Fliegen Ungarns. Acta. Soc. Ent. Bohemoslov., 1960, 57: 158-177.

KUDLA, M.: Weiteres zum Vordringen der Cuculia fraudatrix nach Mitteleuropa. Ent. Ztschr. (Stuttgart), 1965, 75: 199-201.

LAŠTŮVKA, Z. et al.: Katalog motýlů Moravskoslezského regionu. AF VŠZ, Brno, 1993, 130 pp.

MIHÁLYI, F.: Fémeslegyek-Húslegyek Calliphoridae-Sarcophagidae. In: Fauna Hungariae 16 (Diptera II), Akadémiai Kiadó, Budapest, 1979, 152 pp.

MOUCHA, J.: *The distribution of Pandoriana maja* Cr. in Central Europe (Lepidoptera, Nymphalidae). Acta Ent. Mus. Nat. Pragae, 1951, 27: 69-87.

MOUCHA, J., ŠMELHAUS, J.: Über weitere Funde von Phytometra (Plusia) zosimi Hbn. in Mitteleuropa. Ent. Nachr. Bl. (Wien), 1954, 1: 65-67

PAPE, T.: Catalogue of the Sarcophagidae of the World (Insecta, Diptera). Assoc. Publ. Gainesville, Florida, 1996, 556 pp.

POTOCKÝ, P., NĚMÝ, J.: Faunistic records from the Czech Republic. Klapalekiana, 1996, 32: 277.

POVOLNÝ, D.: Male genitalia of the *Parasarcophaga dux* (Thomson)-group of the subgenus *Liosarcophaga* Enderlein, 1928 (Diptera, Sarcophagidae). Acta Ent. Mus. Nat. Pragae, 1987, 42: 149-187.

POVOLNÝ, D.: *Chrysomya albiceps* (Wiedemann, 1819): The first forensic case in Central Europe involving this blowfly (Diptera Calliphoridae), Acta Univ. Agric. et Silvic. Brun. (Brno), 2002, 50: 105-112.

POVOLNÝ, D., HULA, V., ŠŤASTNÁ, P.: Zum Verbreitungsbild und Gefälle der Fleischfliegengemeinschaften (Diptera, Sarcophagidae) im westlichen Donaubecken. Linzer biol. Beitr., 2003, 35: 289-311.

POVOLNÝ, D., VERVES, A.: A preliminary list of Bulgarian Sarcophaginae (Diptera). Acta Ent. Mus. Nat. Pragae, 1990, 43: 283-328.

POVOLNÝ, D., VERVES, J.: The flesh-flies of Central Europe, Spixiana (München), 1997, Suppl. 24, 260 pp.

POVOLNÝ, D., ZNOJIL, V.: Versuch eines Vergleichs zwischen Sarcophaginae – Taxozönosen der dalmatinischen Adria-Küste, der bulgarischen Schwarzmeerküste und jeweils anschliessender Binnenlandgebiete. Ent. Gener., 1994, 18: 115-130.

POVOLNÝ, D., ZNOJIL, V.: Vergleich zwischen Fleischfliegen-Taxozönosen der dalmatinischen Adria-Küste, der bulgerischen Schwarzmeerküste, der griechischen ägäischen und ionischen Küste und jeweils anschliessender Binnenland-Gebiete (Diptera, Sarcophagidae). Ent. Gener., 1998, 22: 277-294.

RODENDORF, B. B.: Semejstvo Sarcophagidae. In: Fauna SSSR 19, Izdat. Akad. Nauk SSSR. Moskva - Leningrad, 1937, 500 pp.

SEGUY, E.: Mouches Parasites, Tome. II, Calliphorides – Calliphorines (suite), Sarcophagines et Rhinophorines de l'Europe occidentale et meridionale. In: Encyclopédie Entomologique, Paul Lechevalier, Paris, 1941, 436 pp.

SCHWARZ, R.: Přízpěvek k Lepidopterologii Československa, Čas. Čsl. Spol. ent., 1947, 44, 67-70.

SLAMEČKOVÁ, M.: Mäsiarky (Diptera, Sarcophagidae) z okolí Štůrova. Prír. Sbor, Slov. Múz., 1959, 5: 64-73.

SLAMEČKOVÁ, M.: Rozšírenie a ecológia múch tribu Sarcophagini (Diptera) na Slovensku. Diploma Thesis, 1967, 147 pp.

STIOVA, L.: Příspěvek k výskytu žluťáska *Colias erate* Esp. (Lepidoptera, Pieridae) na území ČSFR. Čas. Slez. Mus. Opava (A), 1991, 40: 45-51.

ŠTAKEĹBERG, A. A.: Synentropnyje dvukrylyje fauny SSSR. Izdat. Akad. Nauk SSSR, Moskva-Leningrad, 1956, 164 pp.

ŠVESTKA, M.: Expanse *Colias erate* Esp. a výskyt *Colias crocea* Fourc. na Moravě. Acta Sci. Natn. Mus. Mor. Occ. Třebíč, 1995, 20: 111-195.

VERVES, J.: Family Sarcophagidae. In: Cat. Pal. Dipt. 12: 58-263, Akad. Kiadó, Budapest, 1986

WEISMANN, L., POVOLNÝ, D.: Moľ repný (Scrobipalpa ocellatella /Boyd/). VSAV Bratislava, 1960, 180 pp.

WICHRA, J.: Další nálezy vzácných Lepidopter v Československu. Zprávy Čsl. spol.ent. při ČSAV, 1965, 1: 5-11.

Address

Prof. Dr. Ing. Dalibor Povolný, DrSc., Ing. Vladimír Hula, Ústav zoologie a včelařství, Mendelova zemědělská a lesnická univerzita v Brně, Zemědělská 1, 613 00 Brno, Česká republika