An assessment of the sanitary importance of sixteen blowfly species (Diptera: Calliphoridae)

Hodnocení zdravotního významu šestnácti druhů bzučivkovitých (Diptera: Calliphoridae)

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Abstract: A total 3857 imagos of blowflies (Diptera: Calliphoridae) originating from 30 localities in South Moravia (Czech Republic) were captured from 1999 to 2006 to be classified by the awarding of points in terms of their potential for the transmission of causative agents of infectious diseases of man and animals (degree of danger). Sixteen species of Calliphoridae obtained points for visiting of municipal waste, carcasses or meat baits, faeces of animals or human stool and rooms or stables. *Calliphora loewi* Enderlein, 1903, *Cynomya mortuorum* (Linnaeus, 1761) and *Lucilia pilosiventris* Kramer, 1910 were assessed as non-dangerous, because they did not win any points. *C. uralensis* Villeneuve, 1922, *Chrysomya albiceps* Wiedemann, 1819, *L. ampullacea* Villeneuve, 1922, *L. regalis* (Meigen, 1826) and *L. richardsi* Collin, 1926 were assessed as potentially dangerous (1–5 points). *Calliphora vomitoria* (Linnaeus, 1758), *Phormia regina* (Meigen, 1826) and *Protophormia terraenovae* (Robineau-Desvoidy, 1830) were assessed as dangerous (6–9 points). *C. vicina* (Robineau-Desvoidy, 1830), *L. caesar* (Linnaeus, 1758), *L. illustris* (Meigen, 1826), *L. sericata* (Meigen, 1826) and *L. silvarum* (Meigen, 1826) were assessed as very dangerous (10–20 points). The most dangerous blowfly, *C. vicina*, received 20 points, because it occurred at 21 (70 %) of the 30 localities under study.

Key words: insect vectors, synanthropy of flies, Moravia, Czech Republic.

INTRODUCTION

Flies are important transmitters of causative agents of infectious and parasitic diseases of man and animals. Although their sanitary importance has been known for a long time (Graham-Smith 1929), the significance of many fly species remained unknown. The flies are able to transmit causative agents of infectious and parasitic diseases from carcasses, faeces, and communal waste, and by them contaminate humans or animals and their foodstuffs or fodder (Greenberg 1964, 1973, Sasaki et al. 2000). Flies are able to fly up to 15 km under natural conditions (Shura-Bura et al. 1958). Transmission of a disease depends on the type of infectious agent, its ability to survive on the body surface or in the gastrointestinal tract of the fly (Kobayashi et al. 1999, Fischer et al. 2004), but mostly on the behaviour of fly and its ability to transmit the agent from source of contamination (i.e. municipal waste, carcasses, faeces, pus, vomit, contaminated food, egg shells, infected wound, milk gland affected by mastitis, inflamed conjunctiva or mucous membrane, aborted foetus, crushed nerve tissue, etc.) to man or an animal and thereby contaminate either directly or indirectly the body surface, food or fodder, conjunctiva, mucous membranes, gaping wound, etc. of the host (Rosický et al. 1989). Causative disease agents, such as *Mycobacterium avium* subspecies *paratuberculosis* causing paratuberculosis of ruminants (Fischer et al. 2004) or orthomyxovirus influenzae (type A, subtype H5N1) causing avian influenza (Sawabe et al. 2006), were isolated from blowflies which were in contact with infected animals. The first assessment of the danger posed by particular fly species was made by Gregor et Povolný (1958), who divided the flies according to their relationship to man into the following three groups: asynanthropic, synanthropic, and hemisynanthropic. Most flies are asynanthropic, in that they avoid any contact with man. Some flies are synanthropic, living in close contact with man. Hemisynanthropic flies are facultatively synanthropic, but they also live without any contact with man. Each of the last two groups was subdivided into two subgroups: communicative flies visiting the human body and food, and non-communicative flies which occur in close proximity to man, but touch neither humans nor their food. Nuorteva (1963) proposed an index of synanthropy. Also, a danger-index for classifying the ability of flies to transmit pathogens was proposed by Mihályi (1967) and modified by Maldonado et Centeno (2003).

The classification of sixteen species of the family Calliphoridae by the awarding of points is described in this paper.

MATERIAL AND METHODS

Area under study

The blowflies were obtained from 30 localities in South Moravia (Czech Republic) from 1999 to 2006 in quadrates of the national monitoring of fauna program, with codes 6465, 6765, 6863, 6864, 6865, 6866, 6969, 7065 (Pruner et Míka 1996) (tab. 1). The whole area under study was situated between 49°32‘–48°56‘ N and 16°15‘–17°12‘ E. Average elevations of the localities were 177–461 m above sea level (tab. 1).

Tab. 1: List of investigated localities.
Tab. 1: Seznam sledovaných lokalit.

Number	Name	Elevation (m above sea level)	Faunistic code
1	Letovice	330	6465
2	Vísky	415	6465

Number	Name	Elevation (m above sea level)	Faunistic code
3	Kuřim	286	6765
4	Brno-Útěchov	461	6765
5	Brno-Mokrá Hora	249	6765
6	Brno-Soběšice	373	6765
7	Brno-Jehnice	308	6765
8	Brno-Královo Pole	235	6765
9	Brno-Obřany	220	6765
10	Brno-Řečkovice	305	6765
11	Brno-Jundrov	215	6765
12	Brno-Žabovřesky	270	6765
13	Brno-Staré Brno	310	6765
14	Brno-Bystrc	215	6765
15	Brno-Žebětín	315	6765
16	Brno-Židenice	215	6765
17	Brno-Líšeň	350	6765
18	Ketkovice	433	6863
19	Ivančice	210	6864
20	Brno-Stránice	250	6865
21	Brno-Štýřice	220	6865
22	Brno-Dolní Heršpice	195	6865
23	Brno-Černovice	210	6865
24	Brno-Kohoutovice	340	6865
25	Brno-Bohunice	230	6865
26	Ostopovice	245	6865
27	Šlapanice	230	6866
28	Ponětovice	220	6866
29	Vřesovice	281	6969
30	Pouzdřany	177	7065

Data of blowfly species

Blowfly imagos were caught with a black sweep net of 30 cm in diameter and 60 cm in depth. They were swept either from containers with municipal waste, carcasses of animals and/or meat baits (Fischer 2000, 2005), faeces of animals or human stool, and ripe fruits or they were captured in rooms or stables. Captured blowflies were prepared and determined using determination keys (Gregor 1961, Schumann 1965, 1971, Tumrasvin et al. 1979, Rognes 1991, Wells and Kurahashi 1996). The blowflies from each source of contamination, as well as rooms and/or stables, flowers, leaves of plants covered with honeydew, mushrooms, walls or captured in flight, were counted (tab. 2). Data of every blowfly imago (family, species, gender, locality, day and visiting of a substrate or a building) were recorded into a database.

Relative abundance (R) was calculated as percentage using the following formula:

R = number of localities with occurrence of a species × 100 / total number of localities under study.

Assessment of dangerousness

The blowflies were divided according to the substrates visited into the following eight groups (tab. 3):

1. Blowflies visiting flowers in blossom (BL);
2. Blowflies swept from vegetation other than flowers in blossom, leaves covered with honeydew, walls, or captured in flight (SW);
3. Blowflies visiting stinkhorn mushroom (*Phallus impundicus*) (MR);
4. Blowflies visiting municipal waste (MW);
5. Blowflies visiting carcasses and/or meat baits (CM);
6. Blowflies visiting faeces and/or human stool (FAE);

Tab. 2: Blowfly species included in the study.
Tab. 2: Studované druhy bzučivek.

Species	Number of imagos (females/males)	Months	Localities	R (%)
Calliphora loewi Enderlein, 1903	51 (20/ 31)	VIII	2	3
C. uralensis Villeneuve, 1922	5 (3/ 2)	VIII	2, 29	7
C. vicina Robineau-Desvoidy, 1830	800 (442/358)	I-XII	2-9, 11-18, 20, 24, 25, 27, 29	70
C. vomitoria (Linnaeus, 1758)	403 (129/274)	V-X	2, 6-8, 14, 15, 17, 20, 25	30
Cynomya mortuorum (Linnaeus, 1761)	25 (15/ 10)	V-X	2	3
Phormia regina (Meigen, 1826)	19 (6/ 13)	III-IX	3, 6, 8, 13, 14, 19	20
Chrysomya albiceps Wiedemann, 1819	10 (2/ 8)	VIII-IX	2, 13, 25	10
Protophormia terraenovae (Robineau-Desvoidy, 1830)	78 (30/ 48)	IV-IX	2, 8-10, 12-14, 22, 25	30
Lucilia ampullacea Villeneuve, 1922	30 (11/ 19)	V-X	1-3, 7, 8, 13, 15	23
L. caesar (Linnaeus, 1758)	1116 (553/463)	IV-X	2-9, 13, 14, 17, 22, 23, 25, 26, 28-30	60
L. illustris (Meigen, 1826)	190 (176/ 14)	V-X	2, 3, 5, 9, 11, 12, 15-17, 22, 24-26, 28, 30	50
L. pilosiventris Kramer, 1910	1 (0/ 1)	VIII	26	3
L. regalis (Meigen, 1826)	4 (2/ 2)	VII-IX	8, 13	7
L. richardsi Collin, 1926	4 (1/ 3)	VI-VIII	8, 22, 26	10
L. sericata (Meigen, 1826)	979 (654/325)	IV-X	2-6, 8-17, 19, 21-23, 25-28	76.6
L. silvarum (Meigen, 1826)	242 (108/134)	V-X	1, 2, 5, 8, 11, 17, 19, 22, 25, 26, 28	36.7
Total	3857 (2152/1705)			

Tab. 3: Blowfly species, points awarded and classification of dangerousness of the blowflies based on the number of points. BL – flowers in bloom, SW – swept, MR – mushrooms, MW – municipal waste, CM – carcasses or meat baits, FAE – faeces, FRU – fruit, RS – rooms or stables, DS – dangerousness.

Tab. 3: Druhy bzučivek, bodování a hodnocení nebezpečnosti bzučivek podle počtu bodů. BL – květy, SW – smyk, MR – houby, MW – komunální odpad, CM – mrtvá těla zvířat nebo masné návnady, FAE – trus nebo stolice, FRU – ovoce, RS – místnosti nebo stáje, DS – nebezpečnost.

Species	Number of imagos (females/males) visiting								Awarding points for visiting of					Number of points	
	BL	SW	MR	MW	CM	FAE	FRU	RS	MW	CM	FAE	FRU	RS		DS
Calliphora loewi	0	1/1	19/30	0	0	0	0	0	0	0	0	0	0	0	0
C. uralensis	0	0	1/0	0	0	0	2/2	0	0	0	0	4	0	4	I
C. vicina	8/21	124/127	11/7	5/5	210/61	4/3	71/120	9/4	4	4	4	4	4	20	III
C. vomitoria	0/1	4/5	74/243	0	51/18	0/2	0/5	0	0	4	1	1	0	6	II
Cynomya mortuorum	3/3	12/7	0	0	0	0	0	0	0	0	0	0	0	0	0
Phormia regina	0	0/5	0	1/0	5/2	0	0/6	0	3	4	0	1	0	8	II
Chrysomya albiceps	0	0	0	2/7	0/1	0	0	0	4	1	0	0	0	5	I
Protophormia terraenovae	0	0	0	17/4	13/8	0	0	0	4	4	0	0	0	8	II
Lucilia ampullacea	0	3/2	2/12	0	6/2	0	0/3	0	0	4	0	1	0	5	I
L. caesar	19/33	109/198	82/53	6/0	302/113	6/9	28/57	1/0	3	4	4	4	3	18	III
L. illustris	7/3	30/3	2/0	0	128/8	4/0	5/0	0	0	4	3	3	0	10	III
L. pilosiventris	0/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L. regalis	0	0/1	0	0	2/1	0	0	0	0	4	0	0	0	4	I
L. richardsi	0/1	0/1	0	0	1/1	0	0	0	0	4	0	0	0	4	I
L. sericata	23/30	28/20	0	101/40	473/145	8/5	21/85	0	4	4	4	4	0	16	III
L. silvarum	19/36	49/70	0	0	38/28	1/0	1/0	0	0	4	3	3	0	10	III
Total	79/129	360/440	191/355	132/92	1229/388	23/19	128/278	10/4							
	(208)	(800)	(546)	(224)	(1617)	(42)	(406)	(14)							

7. Blowflies visiting ripe fruits (FRU);
8. Blowflies visiting buildings (rooms and/or stables) (RS).

The blowflies from groups 1–3 (BL, SW, MR) were counted, but their degree of danger was not assessed by the awarding of points. Groups 4–8 (MW, CM, FAE, FRU, RS) were awarded points in the following way:

no points (0) – absence of a blowfly species;
1 point – presence of males;
3 points – presence of females;
4 points – presence of both males and females (= 1 point + 3 points).
The highest obtainable score was 20 points.

Blowflies with no points were assessed as non-dangerous. The blowflies with 1–5 points, 6–9 points, 10–20 points were assessed as potentially dangerous (I), dangerous (II) and very dangerous (III), respectively (tab. 3).

RESULTS

A total 3857 imagos (i.e. 2152 females and 1705 males) of the Calliphoridae were captured (tab. 2).

Lucilia sericata (Meigen, 1826) had the highest relative abundance (76.6 %), occurring in 23 of the 30 study localities. This was followed by *Calliphora vicina* Robineau-Desvoidy, 1830 and *Lucilia caesar* (Linnaeus, 1758), which had relative abundances of 70 % and 60 %, respectively. Relative abundances of the other thirteen blowfly species did not exceed 50 % (tab. 2).

Three species of Calliphoridae, i.e. *Calliphora loewi* Enderlein, 1903, *Cynomya mortuorum* (Linnaeus, 1761) and *Lucilia pilosiventris* Kramer, 1910 received no points and thus were assessed as non-dangerous (0) (tab. 3).

Five species, i.e. *Calliphora uralensis* Villeneuve, 1922, *Chrysomya albiceps* Wiedemann, 1819, *Lucilia ampullacea* Villeneuve, 1922, *L. regalis* (Meigen, 1826) and *L. richardsi* Collin, 1926, received 3–5 points and were assessed as potentially dangerous (I) (tab. 3).

Three species, i.e. *Calliphora vomitoria* (Linnaeus, 1758), *Phormia regina* (Meigen, 1826) and *Protophormia terraenovae* (Robineau-Desvoidy, 1830), which received 6–8 points, were assessed as dangerous (II) (tab. 3).

Five species, i.e. *Calliphora vicina*, *Lucilia caesar*, *L. illustris* (Meigen, 1826), *L. sericata* and *L. silvarum* (Meigen, 1826), which received 10–20 points, were assessed as very dangerous (III) (tab. 3).

DISCUSSION

The flies were captured at 30 various localities with different elevation, environmental and climatic conditions, because some fly species (*C. vicina*, *L. sericata*) have both rural and urban populations (Gregor et Povolný 1961, Povolný et Rozsypal 1968). The urban population of *L. sericata* in the city of Brno differs from its rural one by the ability to utilize municipal waste containing plant remnants for development of larvae (Povolný et Rozsypal 1968).

Females of flies were more active than males and therefore their presence was marked with 3 and 1 points, respectively.

The synanthropy of flies, which was calculated using the modified Mihályi´s dander index by Maldonado et Centeno (2003), is also very variable. It is necessary to take into account the climate of the studied area, because hemisynanthropic species became synanthropic under extreme climatic conditions (Nuorteva et al. 1964, Nuorteva 1966). For instance, *C. uralensis*, which is an asynanthropic, but communicative, species in the Czech Republic (Fischer 2000), had a high index of synanthropy in Finland (Nuorteva 1963).

Mihályi´s danger index was based on body size of fly species (Mihályi 1967). However, body size of blowflies is very variable and depends on the conditions for larval development and nutrition of larvae (Saunders et al. 1999).

C. uralensis and *C. loewi* are asynthropic blowflies living in forests (Fischer 2000). Both of these blowflies are often attracted by the stinkhorn mushroom (*Phallus impudicus*) (Fischer et Vícha 2003).

C. mortuorum is a necrophagous blowfly (Stærkeby 2001), but it is asynanthropic and non-communicative and therefore not dangerous.

P. terraenovae was often found in slaughterhouses by Zuska et Laštovka (1969).

Facultative myiases of amphibians are caused by *L. silvarum* (Bolek et Janovy 2004). *L. pilosiventris*, *L. regalis* and *L. richardsi* are rare asynanthropic blowflies reported from Southern Moravia by Gregor (1991) and Rozkošný et Vaňhara (1992, 1993).

Even synanthropic blowflies visit rooms and stables for a short time if only to lay their eggs (Fischer 1999). A calamitous occurrence of blowflies in a hospital as result of the non-disposal of rodent carcasses after pest control was reported by Beckendorf et al. (2002). More serious is contamination of fruit, especially raspberries and blackberries, with faeces and regurgitated fluid of the blowflies. The fruit, as well as nectar (Dirlbek, 1988) and honeydew (Rosický et al. 1989) are utilized by blowflies as a source of saccharides.

Roads and railways are dangerous places, where many animals die every day (Čech et Jankovský 2001, Fischer 2005, Pokorny 2006). Although animal carcasses are collected by the veterinary sanitary service to be safely disposed in rendering plants in the Czech Republic (Dvořák 1995), it is quite impossible to find all carcasses of small animals. Blowflies may come into close contact with the contents of the gastrointestinal tract, crushed tissues of victims of accidents, such as muscles, blood, neural tissues etc. and, thus, be contaminated by infectious agents. The blowflies represent the first wave of necrophagous insects on carcasses, followed by the second wave which includes Fanniidae, Muscidae and Sarcophagidae (Grassberger et Frank 2004, Fischer 2005).

The sanitary importance of the tropical blowfly species *C. albiceps* was assessed for the first time in the Czech Republic. *C. albiceps* increased its area of occurrence from the equator to territories with a mild climate in both hemispheres (Fischer 2007). The most northern occurrence of *C. albiceps* in Europe (in Ukraine) was reported by Verves (2004). This blowfly visits carcasses (Povolný 2002, Grassberger et al. 2003, Grassberger et Frank 2004) and municipal waste (Fischer 2005), but it is not a significant transmitter of causative agents of infection diseases (Maldonado et Centeno 2003) and its occurrence in the Czech Republic is rare (Fischer 2005).

C. vicina is the most dangerous blowfly in regards to possible transmission of pathogens (Mihályi 1967, Maldonado et Centeno 2003) and causing of myiases (Knotek et al. 2005). It is active during the whole year (Schroeder et al. 2003). *C. vicina* was observed to not only fly but also copulate on January 8th, 2005 in Brno-Bystrc (referred to as locality No. 14 in this paper, Fischer 2005). *C. vicina* is able to lay its eggs in darkness (Daněk et al. 1987) and develop at temperatures below 10 °C (Faucherre et al. 1999). The first ova develop in the uteri of *C. vicina* females, as well as *C. vomitoria* and *L. sericata*, prior to laying as freshly hatched larvae (Wells and King 2001).

Occurrence of blowflies is a problem for farm animals (Axtell et Arends 1990, Gregor 1982, Fischer et al. 2000, 2001, Sawabe et al. 2006), slaughterhouses (Fischer et al. 2004, Holešovská et al. 2004) and foodstuffs processing plants (Zuska et Laštovka 1969), veterinary dissection rooms and preparation rooms (Kühlhorn 1979), rendering plants (Dvořák 1995), open-air markets (Aradi et Mihályi 1971) and densely populated areas producing a great amount of municipal waste (Dirlbek 1986, Havlík et Čeledová 1962, Fischer 2000, 2005). The sanitary importance of blowflies increases in areas with poor hygiene (Kovařík et al. 2003) and as a result of extraordinary events, such as floods, earthquakes, tsunami and war (Cirillo 2006).

Other blowflies species, such as *Pollenia rudis* Fabricius, 1794, which is generally considered to be a harmless parasitoid of earthworms (Větříček 1991), can obtain significant epidemiologic significance (Faulde et al. 2001), and not only the above-mentioned blowflies under study. Therefore, it is necessary to continue to study the behaviour of blowflies to better know their real significance for public health.

SOUHRN

V letech 1999–2006 bylo chyceno celkem 3857 imag much z čeledi bzučivkovitých (Diptera: Calliphoridae) pocházejících ze 30 lokalit jižní Moravy, aby byla bodováním zhodnocena jejich schopnost přenášet původce onemocnění lidí a zvířat (nebezpečnost). Šestnáct druhů bzučivkovitých získalo body za navštěvování komunálního odpadu, kadáverů nebo masných návnad, trusu zvířat nebo lidské stolice, ovoce a místností nebo stájí. *Calliphora loewi* Enderlein, 1903, *Cynomya mortuorum* (Linnaeus, 1761) a *Lucilia pilosiventris* Kramer, 1910 byly hodnoceny jako neškodné, neboť nedostaly ani jeden bod. *C. uralensis* Villeneuve, 1922, *Chrysomya albiceps* Wiedemann, 1819, *L. ampullacea* Villeneuve, 1922, *L. regalis* (Meigen, 1826) a *L. richardsi* Collin, 1926 byly hodnoceny jako potenciálně nebezpečné (1–5 bodů). (Fabricius, 1794), *Calliphora vomitoria* (Linnaeus, 1758), *Phormia regina* (Meigen, 1826) a *Protophormia terraenovae* (Robineau-Desvoidy, 1830) byly hodnoceny jako nebezpečné (6–9 bodů). *C. vicina* (Robineau-Desvoidy, 1830), *L. caesar* (Linnaeus, 1758), *L. illustris* (Meigen, 1826), *L. sericata* (Meigen, 1826) a *L. silvarum* (Meigen, 1826) byly hodnoceny jako velmi nebezpečné (10–20 bodů). Nejnebezpečnější bzučivka, *C. vicina*, která se vyskytla na 21 (70 %) ze 30 sledovaných lokalit, získala 20 bodů.

Klíčová slova: hmyzí vektory, synantropie much, Morava, Česká republika.

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