

SHORT COMMUNICATION

Quantifying the Potential Pathogens Transmission of the Blowflies (Diptera: Calliphoridae)

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To quantify the potential capability of transporting and passing infective pathogens of some blowflies (Diptera: Calliphoridae), Mihályi's danger-index was calculated for seven species. The original equation was modified to include synanthropic information to discriminate between asynanthropic, hemisynanthropic, and eusynanthropic status. Three groups were recognized, of which *Phaenicia cluvia* and *Musca domestica* proved the flies with lowest index value ($D = 2.93$ and 3.00 respectively); *Cochliomyia macellaria*, *Chrysomya albiceps* and *Sarconesia chlorogaster* presented a significantly higher index value ($p < 0.10$; $D = 4.28, 4.44$ and 5.66 respectively) and *C. megacephala*, *C. vicina* and *P. sericata* appear to represent the heaviest potential sanitary risk with the highest index value ($p < 0.10$; $D = 15.54, 16.88$ and 12.49 respectively).

Key words: sanitary entomology - disease transmission - Argentina

Many flies, particularly those linked to the human settlements, are important disease vectors (Brown 1997, Chavasse et al. 1999, Graczyk et al. 1999, 2000, Fischer et al. 2001). The blowflies (Diptera: Calliphoridae) are important vectors in the transmission of many pathogens of human and domestic animals (Greenberg 1971).

Passive transport was demonstrated for eggs of *Taenia* sp., *Entamoeba coli*, *Giardia lamblia* (Mariluis et al. 1989), *Mycobacterium paratuberculosis* and so on (Fischer et al. 2001). Also the participation of the Calliphoridae flies in myiasis (Guimarães et al. 1983, Leclercq 1990, Guimarães & Papavero 1999, Kumarasinghe et al. 2000, Costamagna et al. 2002) is of interest to sanitary entomologists.

Around the middle of the last century, some researchers proposed to quantify and discriminate the communicability of mature flies. Gregor and Povolny (1958) made a sharp distinction in the communication and non-communication in synanthropic flies, and Nuorteva (1963) proposed to express numerically the synanthropy degree by means of the synanthropic index (SI).

The SI ranges between +100 and -100, the former representing the highest degree of synanthropy. Negative values indicate avoidance of man.

Mihályi (1967) did not consider the SI sufficiently informative, in a sanitary sense, and for this reason he makes up a "danger-index" keeping in mind three aspects of the behavioural and morphological characteristics of the insect vectors: the undergoing infection, the passing infection and body size of the vector.

The idea of a direct relationship between body size and the capability of contamination and transmission of pathogens seem to be supported by several researches around the world (Mariluis et al. 1989, Brown 1997, Graczyk et al. 1999, 2000, Fischer et al. 2001).

The aim of this work is to quantify the potential infection and transmission of pathogens of some blowflies species from Buenos Aires province (Argentina) using the Mihályi's index. In addition, a modification to the original equation of the Danger-Index is proposed in order to insert into the index information on the synanthropy of the species.

The taxocoenoses of Calliphoridae in Hudson (34°45'S, 58°25'W), province of Buenos Aires, Argentina, was studied from 1993 to 1995 (Centeno 2002). From these captures, a total of 177 specimens including 7 species of Calliphoridae and 1 of Muscidae (*Musca domestica* L.) were separated for measuring. The number of specimens taken from each species is summarized in the Table.

To calculate the body size (volume) of each fly, the measurements of their three dimensions were made using a miniscale (precision 0.1 mm, Bioquip®).

The danger-index (D) was calculated using the following equation (Mihályi 1967):

$$(1) D = (a + b + c + d) \times (e + f + g) \times m$$

with a, b, c, d, e, f and g taking value 1 for positive cases and 0 in negative cases. The parameters are defined as a : visiting human faeces for egg-laying, hunting ground, etc., the fly thus liable to infection of surface of body, feet, bristles, etc.; b : female flies feeding on faeces; c : males also feeding on faeces; d : flies feeding on other infectious secretions, e.g.; *M. domestica* L. feeding on sputum, pus, urine, sweat, etc.; e : the synanthropic status, *sensu* Mihályi (1967): "domestication, inferring the visitation of human homes, courtyards, streets, settlements"; f : visiting meat, milk and other food of animal origin;

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g: visiting of fruit. This is a special situation, from the viewpoint of a potential pathogen transmission, since fruit is usually consumed uncooked and frequently unwashed; *m*: volume_{fly}/volume_{*M. domestica*} is the relative body size (volume) of the species compared to *M. domestica*.

In the original index (1) a modification has been introduced: the parameter *e* takes values 0 for asynanthropic, 0.5 for hemisynanthropic or 1 for eusynanthropic. The synanthropic indexes for the species were previously calculated (Centeno 2002), where the cut-off values used to discriminate them are +100 to +20 for eusynanthropic, +20 to -20 for hemisynanthropic and -20 to -100 for asynanthropic status (Povolny 1971). The rest of the parameters (*a*, *b*, *c*, *d*, *f* and *g*) were obtained from the bibliography (Mihályi 1967, Mendes & Linhares 1993, d'Almeida et al. 1997).

For every species, normality of data was analyzed with a Shapiro-Wilk test (SXW 1998) with a significance level of 0.10. Also the mean, standard deviation and the confidence interval (CI) of D with significance 0.10 were calculated (Croxtton 1959, SXW 1998).

The species of Calliphoridae under study were: *Calliphora vicina* Robineau-Desvoidy; *Phaenicia sericata* (Meigen); *P. cluvia* (Walker); *Chrysomya albiceps* (Wiedemann); *C. megacephala* (F.); *Cochliomyia macellaria* (F.) and *Sarconesia chlorogaster* (Wiedemann).

The Table summarizes all the parameters and statistics used to calculate D.

The Figure shows the 90% confidence intervals of D (boxes) for each species; *C. vicina*, *C. megacephala* and *P. sericata* were the species with the highest danger-index value and no significant differences between them ($p > 0.10$). These three species differed significantly ($p < 0.10$) from a second group of blowflies, including *S. chlorogaster*, *C. albiceps*, *P. cluvia*, *C. macellaria* and *M. domestica*. Within this group, *P. cluvia* and *M. domestica* do not differ significantly between them ($p > 0.10$) but they differ from *C. macellaria* and *C. albiceps* ($p < 0.10$).

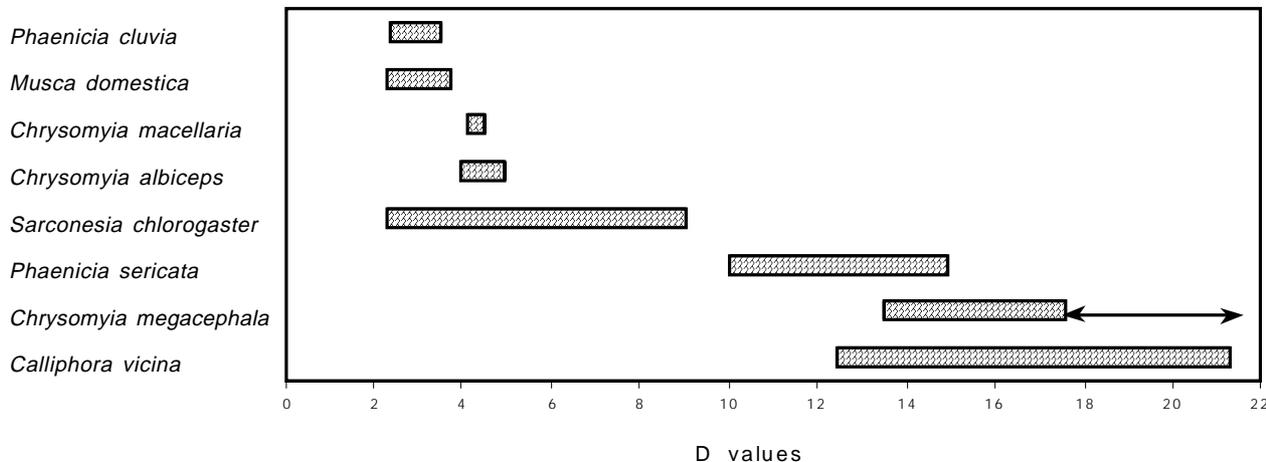
Three groups of potential pathogen communication are found, of which the one that includes the greenbottle *P. sericata*, the oriental latrine fly *C. megacephala* and the bluebottle *C. vicina* showed the highest potential pathogen transmission. These three groups are made apparent when the qualitative information of synanthropy of the population is incorporated.

If the equation is used in its original form, assuming $e = 0$ (asynanthropic-hemisynanthropic) or $e = 1$ (eusynanthropic), only two groups are generated, although the three species mentioned above as the main potential risk still retain that condition (results not shown). The incorporation of this new information (hemisynanthropic) might help sanitary and health officials to reconsider the

TABLE
Parameters used to calculate the danger-index (D)

Species	N	a	b	c	d	e	f	g	m	SI	Vol _{flies}	D ± STD
<i>Calliphora vicina</i>	7	1	1	1	0	0.5	1	1	2.25	5.70	124.10	16.88 ± 6.04
<i>Chrysomya megacephala</i>	5	1	1	1	0	0	1	1	2.59	-20.89	142.82	15.54 ± 2.15
<i>Phaenicia sericata</i>	16	0	1	1	1	1	1	1	1.39	36.83	76.52	12.49 ± 5.56
<i>Sarconesia chlorogaster</i>	6	0	1	1	0	0.5	1	0	1.89	-13.47	104.00	5.66 ± 4.07
<i>Chrysomya albiceps</i>	25	0	1	1	0	0.5	1	0	1.48	-18.76	81.70	4.44 ± 1.42
<i>Chrysomya macellaria</i>	97	0	1	1	0	0.5	1	0	1.43	15.37	78.76	4.28 ± 1.22
<i>Musca domestica</i>	9	0	0	0	1	1	1	1	1.00	-	55.14	3.00 ± 1.19
<i>Phaenicia cluvia</i>	12	1	1	1	0	0	1	0	0.98	-38.98	53.79	2.93 ± 1.07

N: number of specimen measured from each species



The danger-index (D) of the studied flies. Boxes represent the 90% confidence interval of D and the arrowed line showing the changes for *Chrysomya megacephala* as considered as an hemisynanthropic (D 19.43)

potential sanitary importance of some species or populations, now considered of low communication.

The bluebottle *C. vicina* showed the highest index value, although this species was hemisynanthropic (Centeno 2002). This apparent inconsistency shows that the major weight in the index value is supported by the mean body size of the flies and the quality of the feeding/breeding sources that they visit, rather than the synanthropic status for this species.

The weight of body size in the D value is very evident for *S. chlorogaster* too. The analyzed sample of this species showed an asymmetrical curve of frequencies with a peak in 57.61 mm³ and a tail (outliers) toward the largest sizes, more than 220 mm³.

This important variability in body size causes the wide range in the confidence interval of D. This should be kept in mind when choosing the sampling method in order to evaluate correctly the potential pathogen transmission of the species using this index.

Although it is not the purpose of this research, an observation should be made on some population and intraspecific characters not included into D, but which might prove important to health officials, e.g. relative abundance, in particular its seasonal changes.

The secondary screwworm *C. macellaria* gave a low value of D (compares to *P. sericata*), but former investigations reported a remarkable seasonality. At the end of spring and the beginning of summer, this species dominates in the taxocoenoses, and its relative abundance increases by several orders of magnitude (Centeno 2002).

This characteristic of the fly population should be kept in mind because the impact of the control of fly abundance on disease transmission like childhood diarrhoea was well demonstrated (Chavasse et al. 1999).

Another important character is the dispersion potential of the species. The exotic *C. albiceps*, an invading species from Africa, has extended its distribution range toward the Center and South of Argentina (Schnack & Mariluis 1995, Centeno 1998). This could become a sanitary problem into those areas.

An interesting situation emerges when the index is analyzed for the oriental latrine fly *C. megacephala*. This species showed the second highest value of D (15.54 ± 2.15) right after the bluebottle *C. vicina*. Once again body size (142.82 mm³ ± 15.61 mm³) influences greatly the value of the index.

This species could be dismissed as a potential disease transmitter in urban systems, because its SI defines it as an asynanthropic fly. However, the health authorities should stay alert, because although its SI is low for temperate climates (Centeno 2002) it increases, along with its relative abundance, in tropical or sub-tropical climates (Peris 1987, Mariluis et al. 1990).

The Figure shows how much "dangerousness" (D value) increased, with the single change of considering the species as hemisynanthropic.

Finally, we consider that more researches are necessary to evaluate properly the whole of circumstances that could increase the potential pathogen transmission of these Calliphoridae, e.g. a better knowledge about their identity and probability of infection and of transporting pathogens to the human environment.

However the index D, in particular with the introduced modification, would offer a useful measure of the potential disease transmission of the blowflies. This information could be used to focus the effort toward the control of proper species.

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