BULLETIN DE L'INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE, ENTOMOLOGIE, **57**: 173-186, 1987
BULLETIN VAN HET KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN, ENTOMOLOGIE, **57**: 173-186, 1987

Ecological data on *Dolichopodidae (Diptera)* from a woodland ecosystem: I. Colour preference, detailed distribution and comparison of different sampling techniques*

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Summary

During the period March-December 1986, Dolichopodids were sampled with a Malaise trap, water traps and pitfall traps in a humid woodland habitat at "Wijnendalebos" (Torhout, Western Flanders, Belgium). Water traps of different colours (white, blue, red) and position (on soil surface level, at 60 cm height) were used to obtain information about colour preference and vertical distribution. A total number of 16,143 Dolichopodids were collected, belonging to 60 species. Among these, *Campsicnemus scambus, C. curvipes, Dolichopus ungulatus* and *Hercostomus cupreus* appeared to be dominant.
Clustering of the different traps on the basis of the Renkonen similarity index revealed a clear separation between the three colours, whereas the Malaise trap was pooled together with the white traps. Most species were highly attracted by the white colour, while soil-dwelling and arboreal species were most numerously found in the red and the blue traps respectively. In regard to the vertical distribution, *Campsicnemus curvipes, C. scambus, Syntormon denticulatus* and *Dolichopus nubilus* were almost exclusively soil surface active. In the remaining species a great variation of vertical occurrence was apparent. The remarkably low numbers of males in *Sciapus platypterus, Argyra diaphana* and *Rhaphium crassipes,* caught by means of the water traps correspond with a highly pronounced flying activity of this sex. Furthermore, in most species a preference for the lightest and most humid parts of the investigated site was noticed, whereas only few species proved to be dark-preferent. Moreover, several species were seemingly favoured by the highly developed herbage, demonstrating a leaf-dwelling behaviour. When comparing the different sampling methods, the Malaise trap as well as the white water traps were most efficient for collecting Dolichopodidae.

Résumé

Des récoltes ont été effectuées dans un bois humide, Wijnendalebos à Torhout (Flandre Occidentale, Belgique), pendant la période de mars à décembre 1986. Des Dolichopodides ont été pris avec des pièges Malaise, des pièges Barber et des assiettes colorées de différentes couleurs (blanc, bleu, rouge) et mises soit au ras du sol soit à 60 cm d'hauteur.
Un total de 16.143 Dolichopodides ont été pris, appartenant à 60 espèces. *Campsicnemus scambus, C. curvipes, Dolichopus ungulatus* et *Hercostomus cupreus* étaient les espèces dominantes.
L'index de similarité de Renkonen montrait une séparation distincte entre les différentes couleurs tandis que les résultats du piège Malaise et des assiettes blanches étaient comparables. Les deux derniers étaient aussi les plus effectifs pour capturer des Dolichopodides.
La plupart des espèces sont attirées par le blanc tandis que les espèces terricoles et arboricoles sont plus abondantes respectivement dans les assiettes rouges et bleues. Les espèces presqu'exclusivement terricoles sont *Campsicnemus curvipes, C. scambus, Syntormon denticulatus* et *Dolichopus nubilus.* La distribution verticale des autres espèces est plus variable.
En plus, la plupart des espèces montrait une préférence pour les endroits clairs et humides, peu d'espèces ont une préférence pour les endroits obscures.

* Deposited for publication on 23.VI.1987.

Introduction

The Dolichopodidae are a rather uniform family of small to moderate sized flies usually showing metallic green or yellow colours. Although some species (e.g. *Medetera* spp., *Sciapus* spp.) are known to occur mainly on tree-trunks, most species can be found often in large numbers on low herbage or on the soil surface. The larger part is hygrophilous, as they are mainly observed in moderately to very wet places.
In the literature, most authors record species lists as a result of a very short visit to a particular area or captures of "rare„ or interesting species (BEQUAERT, 1955; COLLART, 1935, 1937; GOETGHEBUER, 1928, 1930, 1931, 1934, 1940, 1942, 1943; MEUNIER, 1898, 1903, 1905, 1908, 1911). However, ecological notes are added in very few cases only. Furthermore, data on the ecology and detailed distribution of adult Dolichopodidae are very scarce in the literature. In this regard, VAN DER VELDE *et al.* (1985) dealt with the dolichopodid fauna of nymphaeid stands, whereas KABOS (1950, 1954) investigated the flies of the islands Texel and Schiermonnikoog. EMEIS (1964) gives an overview of the dolichopodid species collected during a twenty year period in Schleswig-Holstein and records the preferred habitat for each species. Besides their ecological demands, also the life cycle of many species is unknown or not fully understood.
In order to investigate the detailed distribution of dolichopodid flies of a woodland area, POLLET *et al.* (1986) started investigations in six different woodland sites of "Wijnendalebos" (Western Flanders, Bel-

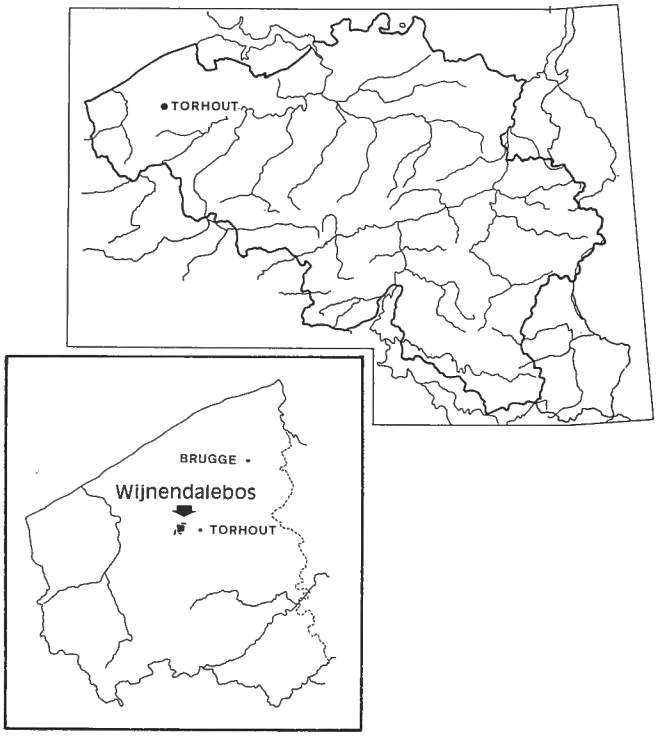


Fig. 1. *The localisation of the investigated woodland "Wijnendalebos" in Belgium.*

gium), using pitfall traps. Since the most humid site yielded the largest number of species and individuals, we focused a further study on this particular site. Besides pitfall traps, other sampling techniques were applicated during these investigations. In this paper, we deal with the colour preference and the detailed distribution of the most abundant species. Finally, we also compare the results for all sampling methods used.

I. The study site

"Wijnendalebos" is one of the larger woodland areas (70 ha) in the central region of Western Flanders (Belgium), called "het Houtland" (Fig. 1). The soil is mainly a sandy loam to a loamy sand. A great diversity of different woodland types is present in this area (cfr. POLLET *et al.*, 1986).

The particular habitat studied here is a water-meadow forest at the border of a temporary pond. The site is partly divided in ridges by ditches, which dry up in summer. The tree layer consists of poplar trees (*Populus* × *canadensis* MOENCH) only and there is a large amount of dead wood present. Only in the drier parts of the site, a shrub layer is apparent, comprising maple (*Acer pseudoplatanus* L.), elder (*Scambus nigra* L.), elm (*Ulmus minor* MILL.) and alder (*Alnus incana* (L.) MOENCH). Furthermore, *Lamium galeobdolon* (L.) L., *Rubus* sp., *Urtica dioica* L., *Oxalis acetosella* L., *Dryopteris dilatata* (HOFFM.) A. GRAY and *Stellaria uliginosa* MURRAY are the dominant herb species in the drier part, whereas near the temporary pond mainly *Solanum dulcamara* L., *Lycopus europaeus* L., *Cirsium palustre* (L.) SCOP. and *Ranunculus ficaria* L. are present. Finally, in general the litter layer is very poorly developed.

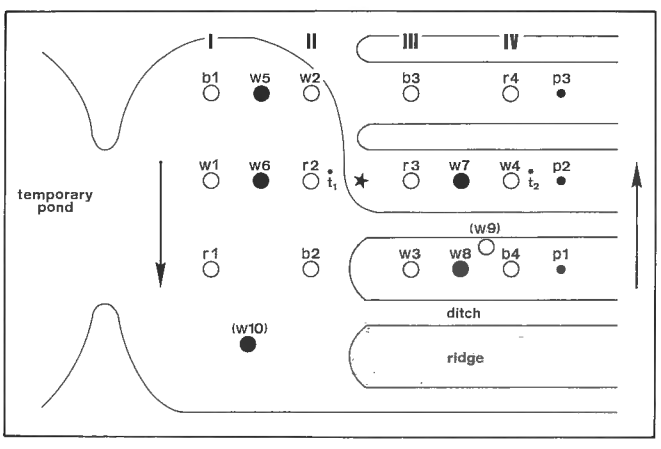
II. Material and methods

Dolichopodidae and other dipteran families were collected by means of the following sampling techniques:

(i) a Malaise trap, based on the type described by TOWNES (1972): it consists of a black vertical nylon net (width 2 m, height 2 m at the highest point), bordered on the upper side with a small nylon roof. The trap was installed in the middle of the investigated site, at the end of a narrow ridge (Fig. 2). The collecting jar was filled for 1/2 with 70% alcohol and emptied at approximately weekly intervals during the period 15.III.-13.XII.1986;

(ii) water traps, consisting of coloured plastic recipients (inner diameter ± 20 cm, depth ± 7 cm): 12 of these sampling devices were set up in four zones (cfr. Fig. 2), each zone comprising a white, blue and red trap at the same time. They were placed on a wooden support (painted completely black) with the rim at approximately 60 cm above the soil. Another 4 white water traps were dug into the soil to their rim between zone I-II and III-IV. They were all filled with 2.5% formalin solution, to which 3% detergent was

Fig. 2. *Diagram of the investigated site with the exact position of the different traps on 16.III.1986.*
Explanation: ★: Malaise trap; ○: water trap on a wooden support at 60 cm height; ●: water trap dug into the soil; ●: pitfall trap; t_1,t_2: minimum-maximum thermometers; I, II, III, IV: different zones; w: white, b: blue, r: red; arrows indicate the direction of the weekly switching of the water traps in the zones I-II and III-IV. For more information, see text.



added in order to decrease the surface tension. Apart from the water traps mentioned above, two other white, plastic traps (w9, on the soil; w10, in the soil) were installed as indicated in Fig. 2 on 1.VI.1986 and 8.VI.1986 resp. Data on Dolichopodidae, collected with these two traps were only used in reconstructing the seasonal activity distribution of the different species. All water traps were emptied on the same dates as the Malaise trap during the period 16.III.1986-13.XII.1986. In order to eliminate possible effects of microclimatological differences within the zones, during the weekly collection of the flies, the elevated traps in zones I-II and III-IV were switched according to the direction indicated by arrows in Fig. 2;
(iii) pitfall traps, consisting of three glas jam jars (inner diameter 9.5 cm, depth 8.5 cm); they were installed on the same spot as the preceding year (Fig. 2). They were filled for a third with 2.5% formalin solution (+3% detergent) and emptied at approximately weekly intervals during the period 16.III.1986-31.XII.1986.

The following biotic and abiotic factors were recorded (the spots with water traps w9 and w10 were not included):

(i) biotic factors: for each water trap, the development of the surrounding herb layer was determined by 10 measurements on 10.VIII.1986;
(ii) abiotic factors:
— soil humidity: on 20.VII.1986 and 11.X.1986 per water trap one and two soil samples (depth 9 cm) were taken respectively and dried at room temperature (in the following soil humidity will be expressed as the mean percentage of water content of the soil samples);
— light intensity: for each water trap, 8 light intensity measurements were taken on 25.V.1986 and 10.VII.1986 (this factor will be expressed as mean lux ± 95% c.l.);
— development of the litter layer: on 20.VII.1986 the thickness of the litter layer was determined by 10 measurements per water trap;
— temperature was continuously recorded by means of two minimum-maximum thermometers (for the exact position, cfr. Fig. 2) and noted during the weekly collection of the flies.

Results of these measurements, except for the temperature, are summarized in Table 1.

Table 1.
Summary of the biotic and abiotic factors, recorded in the investigated woodland site (mean values ± 95% c.l.). For more information, see text.

	Zone I	Zone II	Zone III	Zone IV	w (5-6)	w (7-8)
Soil humidity (%)						
20.VII.1986	38.7	39.0	35.4	33.7	—	—
	± 18.4	± 17.6	± 12.9	± 28.3		
11.X.1986	33.1	35.8	23.3	28.0	32.2	33.0
	± 7.7	± 2.9	± 10.5	± 12.3	± 5.4	± 6.3
Light intensity (lux)						
25.V.1986	7827.3	6768.2	3761.6	1990.6	—	—
	± 5095.0	± 3954.6	± 2458.1	± 1341.2		
20.VII.1986	3768.3	3471.2	2408.0	1889.3	2920.3	2841.2
	± 580.0	± 521.8	± 395.7	± 512.5	± 561.5	± 1013.2
Development of the litter layer (cm)						
20.VII.1986	1.0	1.7	2.2	1.5	0	1.9
	± 0.3	± 0.8	± 0.5	± 0.3		± 0.5
Development of the herb layer (cm)						
10.VIII.1986	20.9	51.6	25.5	14.3	47.4	14.7
	± 9.6	± 8.8	± 7.4	± 7.2	± 17.1	± 5.0

The Dolichopodidae were identified (nomenclature according to MEUFFELS & GROOTAERT, 1987) by means of D'ASSIS FONSECA (1978), PARENT (1938) and NEGROBOV (1974a, b) as well as some unpublished keys by H.J.G. MEUFFELS. Furthermore, the sex of the flies and the freshly emerged specimens were noted. All flies are conserved in a 70% alcohol solution in the collection of the "Koninklijk Instituut voor Natuurwetenschappen" at Brussel.
In order to compare the dolichopodid community according to the species composition and the abundance of the species present, the qualitative similarity

index of Renkonen (RENKONEN, 1938) was calculated. This is obtained by summation of the minimal percentage occurrence values for all species common for both samples. For the comparison of the different traps, per dolichopodid species, numbers were calculated to percentages on the total number caught. All similarity values were converted to percentages. The different sampling devices, except for the pitfalls and water traps w9 and w10, were classified into a dendrogram (average linkage, SOUTHWOOD, 1978). The most numerously caught flies (n > 17) were also clustered according to their occurrence in the different traps (pitfall traps and water traps w9 and w10 not included) in order to distinguish species associations.

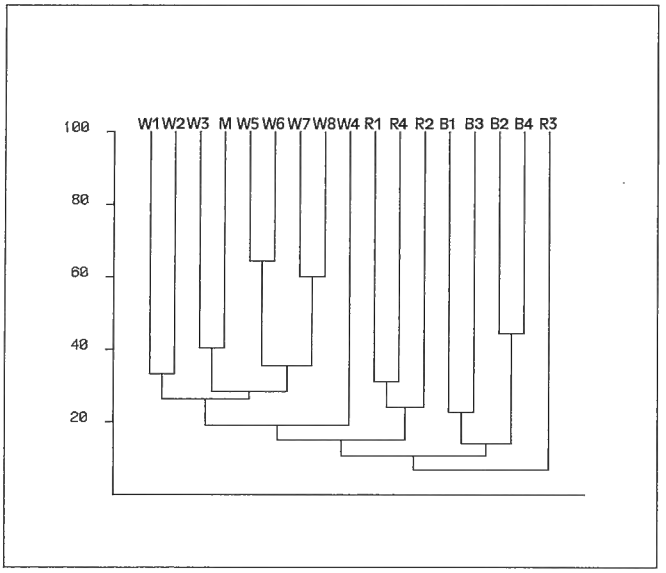


Fig. 3. *Dendrogram based on similarities between the different sampling techniques by means of the % Renkonen similarity index.*
Explanation: M: Malaise trap; W: white; B: blue and R: red water traps. For more information, see text and Fig. 2.

III. Results

1. SPECIES INVENTORY

Table 2 summarizes the data on the dolichopodid species, collected in the woodland site investigated. The species are ranged, according to MEUFFELS & GROOTAERT (1987). A total number of 16,143 flies were collected, belonging to 60 species. Thusfar, females of some *Medetera* spp. as well as the females of *Campsicnemus curvipes/scambus* were not identified yet. From a previous study (POLLET *et al.*, 1986) and additional sweeping in "Wijnendalebos", the following species can be added to this list: *Sciapus contristans* (WIEDEMANN, 1817), *Neurigona quadrifasciata* (FABRICIUS, 1781), *Medetera dendrobaena* KOWARZ, 1877, *Medetera truncorum* MEIGEN, 1824, *Thrypticus tarsalis* PARENT, 1932, *Campsicnemus loripes* HALIDAY, 1862), *Chrysotimus flaviventris* (VON ROSER, 1840), *Chrysotimus molliculus* (FALLEN, 1823), *Xanthochlorus ornatus* (HALIDAY, 1832), *Hercostomus angustifrons* (STAEGER, 1842) and *Hercostomus nigripennis* (FALLEN, 1823). As a result, thusfar 71 dolichopodid species are known for this area. Among the species collected, some are of special faunistic interest, whereas *Medetera brevitarsa* and *M. jugalis* are new for the Belgian fauna (POLLET *et al.*, in press). On the whole, *Campsicnemus scambus, C. curvipes, Dolichopus ungulatus* and *Hercostomus cupreus* appeared to be the most abundant species, followed by *Argyra diaphana, Rhaphium crassipes, Hercostomus metallicus, Sciapus platypterus, Dolichopus claviger, D. latilimbatus* and *D. pennatus*. In 26 species, less than 10 specimens were caught.

2. SIMILARITY BETWEEN THE COLLECTING DEVICES AND THE MOST ABUNDANT DOLICHOPODID SPECIES

Figures 3 and 4 present the dendrograms of the different sampling techniques and the most abundant dolichopodid species respectively. The white traps are obviously pooled together with the Malaise trap, whereas on the other hand the red (except for r3) and the blue traps form distinct groups. Trap r3 is separated due to its very low catches. Furthermore, within the first group mentioned, the traps at soil surface level are clustered apart from the elevated ones.
The abundant species are clustered in two large groups, a smaller one and two single species (on a similarity level of ± 43%).
The first group is characterized by a high flying activity, since these species were found in largest numbers in the Malaise trap. Four subgroups can be distinguished: (i) the females of *Medetera* spp., highly attracted by the blue coloured traps, (ii) a group, in which the species were found in equal numbers in all white traps, (iii) a group with a pronounced soil surface activity in both the light and dark zones, and (iv) two soil-dwelling species with a preference for the darkest parts of the woodland site.
A second large group contains species with a pronounced preference for the white water traps. Here also a distinction can be made between two minor groups of species which were either mostly caught in the elevated water traps or found in equal numbers in all white traps.
The smaller third group consists exclusively of mainly ground-dwelling species and finally, the two *Sciapus* species differ from most other species by their remarkable preference for the blue water traps. In contrast to *S. wiedemanni, S. platypterus* appeared to be frequently caught in the Malaise trap too.

Table 2.
Data on Dolichopodidae (males/females), collected by means of white (w), red (r) and blue (b) coloured water traps, pitfall traps (p) and a Malaise trap (M) in a humid woodland site at "Wijnendalebos" (Western Flanders, Belgium) during the period III - XII.1986. For more information, see text and Fig. 2.

Dolichopodidae / Sampling techniques	w1	w2	w3	w4	w5	w6	w7	w8	r1	r2	r3	r4	b1	b2	b3	b4	w9	w10	p1	p2	p3	M	Total
Sciapus platypterus (FABRICIUS, 1805)	1/1	/2	1/14	8/29	-	/2	4/7	1/8	2/1	2/1	6/7	4/13	/3	18/5	35/13	33/36	4/20	-	/3	/2	1/	89/31	209/198
Sciapus wiedemanni (FALLEN, 1823)	6/5	-	-	1/3	-	-	/3	-	12/1	1/2	1/1	3/2	17/6	1/3	1/2	2/7	/1	-	-	-	-	1/4	46/40
Medetera abstrusa THUNEBERG, 1955	-	-	2/	-	-	-	-	-	-	-	-	-	-	1/	-	1/	-	-	-	-	-	3/	7/
Medetera brevitarsa PARENT,	-	-	-	-	-	-	-	-	-	-	-	-	2/	-	-	-	-	-	-	-	-	-	2/
Medetera impigra COLLIN, 1941	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/	-	-	-	-	-	-	1/
Medetera jugalis COLLIN, 1941	-	1/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3/	4/
Medetera parenti STACKELBERG, 1925	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/	1/
Medetera saxatilis COLLIN, 1941	-	-	-	-	-	-	-	-	1/	/1	-	/1	-	-	-	-	-	-	-	-	-	-	1/2
Medetera spp. (females)	/3	/2	/1	-	-	-	-	-	/1	/6	/1	/2	/7	/10	/10	/4	/1	-	-	-	-	/60	/108
Systenus pallipes (VON ROSER, 1840)	-	-	-	-	-	-	-	-	-	-	-	-	-	/1	-	1/	-	-	-	-	-	-	1/1
Chrysotus angulicornis KOWARZ, 1874	1/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/
Chrysotus cilipes MEIGEN, 1824	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	/1	-	-	-	-	/1
Chrysotus gramineus (FALLEN, 1823)	/13	/16	/3	/4	/1	/1	1/	/2	/2	-	-	1/1	1/5	1/	-	-	/4	/3	-	-	-	/9	4/64
Chrysotus neglectus (WIEDEMANN, 1817)	/2	1/	/1	-	-	/1	-	-	-	-	-	-	/1	-	1/	-	1/1	-	-	-	-	-	3/6
Chrysotus varians KOWARZ, 1874	-	1/	-	-	-	-	-	-	-	1/	-	-	-	-	-	-	-	-	-	-	-	-	2/
Diaphorus oculatus (FALLEN, 1823)	-	1/2	-	/2	-	-	/7	/4	-	-	-	-	-	-	-	-	/3	/2	/2	/3	/2	/9	1/36
Argyra diaphana (FABRICIUS, 1775)	6/4	4/8	2/5	-	4/6	3/5	3/4	7/29	2/	3/5	/1	-	-	/1	-	-	1/5	1/3	/1	-	/2	510/234	546/313
Argyra leucocephala (MEIGEN, 1824)	-	-	-	-	1/	/1	1/	1/1	-	-	-	-	-	-	-	-	-	1/2	-	-	-	/4	4/8
Argyra perplexa BECKER, 1918	-	-	-	-	-	-	-	/1	1/	-	-	-	-	-	-	-	-	-	-	-	-	-	1/1
Rhaphium appendiculatum ZETTERSTEDT, 1849	-	1/	1/1	-	-	-	1/	-	-	1/	-	-	-	-	-	-	-	-	-	-	-	15/5	19/6
Rhaphium caliginosum MEIGEN, 1824	1/6	1/2	/1	/2	3/	20/2	2/1	2/	1/	1/1	-	-	-	/1	-	/1	-	2/	-	-	/1	5/21	38/39
Rhaphium crassipes (MEIGEN, 1824)	/59	5/62	3/51	2/33	6/7	4/2	9/9	4/35	/2	-	-	/1	/1	/1	-	-	3/23	-	/2	-	/3	192/337	228/628
Rhaphium elegantulum (MEIGEN, 1824)	-	-	-	-	1/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/
Rhaphium fascipes (MEIGEN, 1824)	-	-	-	-	-	/1	/1	-	-	/1	-	-	-	/1	-	-	-	-	-	-	-	/2	/6
Anepsiomyia flaviventris (MEIGEN, 1824)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/	1/
Campsicnemus armatus (ZETTERSTEDT, 1849)	-	-	-	-	/1	1/	-	-	-	-	-	-	-	-	-	-	-	1/	-	-	-	-	2/1
Campsicnemus curvipes (FALLEN, 1823)	2/	1/	2/	1/	422/	292/	387/	232/	3/	14/	5/	2/	4/	8/	-	2/	10/	241/	60/	29/	80/	8/	1805/
Campsicnemus lumbatus LOEW, 1857	-	-	-	-	/1	-	-	-	-	-	-	-	-	-	-	-	-	3/3	-	-	-	/1	3/5
Campsicnemus picticornis (ZETTERSTEDT, 1843)	/1	-	/1	-	6/1	2/3	-	1/	/1	/1	-	-	-	-	-	-	-	119/48	-	-	-	/1	128/57
Campsicnemus scambus (FALLEN, 1823)	4/	2/	1/	-	1272/	683/	234/	163/	4/	20/	9/	1/	5/	6/	5/	7/	10/	356/	21/	22/	32/	9/	2871/
Campsicnemus curvipes/scambus (females)	/7	/7	/10	/3	/535	/369	/192	/239	/9	/36	/14	/16	/9	/18	/10	/5	/30	/232	/49	/25	/69	/24	/1907
Sympycnus pulicarius (FALLEN, 1823)	1/1	2/1	/1	-	6/3	4/3	/1	1/	-	-	-	-	-	-	-	-	-	/4	-	-	-	3/37	17/51
Syntormon denticulatus (ZETTERSTEDT, 1843)	3/4	2/2	/1	-	36/4	54/5	-	-	/4	/1	1/	1/	1/	1/	-	-	1/	4/1	-	-	-	2/1	106/23
Syntormon pallipes (FABRICIUS, 1794)	-	-	-	-	1/	1/	-	-	-	1/	-	-	-	-	-	-	/1	-	-	-	-	-	3/1
Syntormon pumilus (MEIGEN, 1824)	/2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15/2	-	-	-	-	15/4
Teuchophorus spinigerellus (ZETTERSTEDT, 1843)	-	-	-	-	-	-	-	-	-	-	-	/1	-	-	-	-	-	/1	-	-	-	-	/2
Xanthochlorus tenellus (WIEDEMANN, 1817)	/1	-	-	-	-	-	-	-	-	-	1/	-	-	-	-	-	-	-	-	-	-	/1	1/2
Dolichopus atratus MEIGEN, 1824	-	-	-	-	-	-	-	-	-	-	/1	-	-	-	-	-	-	-	-	-	-	-	/1
Dolichopus brevipennis MEIGEN, 1824	8/19	5/3	/1	-	2/3	-	1/1	-	/2	1/1	-	-	/1	-	-	-	/1	16/2	-	-	-	3/4	36/38
Dolichopus claviger STANNIUS, 1831	2/1	13/10	7/7	/6	15/3	14/2	45/4	14/1	/1	/2	/2	-	-	-	-	/1	67/6	1/	-	1/	/1	84/47	263/94
Dolichopus discifer STANNIUS, 1831	1/	/1	/1	-	/1	/1	/2	3/	-	-	-	-	-	-	-	-	12/	/1	-	-	-	15/32	31/39
Dolichopus latilimbatus MACQUART, 1827	18/44	7/22	/1	-	28/7	23/12	-	-	3/6	-	-	-	-	/1	-	/1	-	127/29	-	-	-	4/5	210/128
Dolichopus longicornis STANNIUS, 1831	/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/	1/1
Dolichopus nubilus MEIGEN, 1824	10/6	1/2	-	/1	16/2	58/18	-	-	-	/1	-	-	-	-	-	-	-	84/9	-	-	-	3/1	172/40
Dolichopus pennatus MEIGEN, 1824	4/12	1/10	3/27	3/23	58/15	44/21	4/	2/8	/1	2/1	/1	-	-	-	/1	-	5/5	21/14	-	-	-	20/39	167/1[illegible]
Dolichopus plantitarsis FALLEN, 1823	-	1/	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/
Dolichopus plumipes (SCOPOLI, 1763)	3/9	/5	1/2	/1	19/5	18/2	1/1	2/	1/3	1/1	-	-	/1	/1	-	/1	1/	17/4	-	-	-	27/41	91/77
Dolichopus popularis WIEDEMANN, 1817	3/5	7/1	5/6	/3	1/9	4/3	8/2	1/4	/1	/1	-	/3	-	/1	-	-	2/5	3/4	-	/1	2/1	91/92	127/142
Dolichopus signatus MEIGEN, 1824	/2	3/4	6/3	/9	-	/1	4/2	5/2	-	-	/1	/1	-	-	-	-	61/15	-	-	-	-	65/10	144/50
Dolichopus trivialis HALIDAY, 1832	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	/1	-	-	-	-	-	/1
Dolichopus ungulatus (LINNAEUS, 1758)	85/55	131/31	16/10	6/6	174/105	49/32	20/17	80/94	4/8	18/13	3/10	-	/1	5/2	/1	-	152/40	229/140	/8	1/2	/7	55/70	1028/652
Dolichopus wahlbergi ZETTERSTEDT, 1843	-	1/	1/	-	-	-	1/	/2	-	-	-	-	-	1/	-	-	-	/1	-	-	1/	1/1	6/4
Hercostomus aerosus (FALLEN, 1823)	14/8	5/1	/2	1/	12/2	5/5	2/3	7/6	2/2	11/7	/3	/1	/3	/1	-	-	1/6	22/13	/2	/3	-	18/47	100/115
Hercostomus assimilis (STAEGER, 1842)	2/3	-	-	-	-	1/1	-	-	-	-	-	-	-	-	-	-	-	5/	/1	-	-	1/	9/5
Hercostomus celer (MEIGEN, 1824)	8/6	1/1	2/2	1/	3/2	9/4	5/3	6/6	/1	1/3	-	-	-	-	-	-	/2	12/4	2/1	-	/1	2/12	52/48
Hercostomus chrysozygos (WIEDEMANN, 1817)	30/15	4/7	-	/1	7/9	3/2	1/4	/4	-	-	/1	-	-	-	-	-	/1	27/59	-	-	-	1/	73/103
Hercostomus cupreus (FALLEN, 1823)	180/210	94/65	28/18	20/20	148/17	268/47	25/24	26/16	5/16	/5	1/	1/	18/25	4/8	1/3	/1	6/9	115/52	5/3	/3	/1	16/78	961/621
Hercostomus metallicus (STANNIUS, 1831)	28/50	19/26	6/7	5/6	35/14	197/28	13/8	13/10	2/7	1/4	/1	1/2	1/5	/1	3/	1/1	4/2	58/25	/8	/2	-	15/64	402/271
Hercostomus pilifer (LOEW, 1859)	/1	2/1	-	-	6/2	2/	3/3	8/2	-	-	-	-	-	-	/1	-	3/1	-	-	-	-	10/2	34/13
Hypophyllus obscurellus (FALLEN, 1823)	-	-	-	-	3/3	-	/1	2/	-	1/2	-	-	-	-	-	-	-	-	/2	/1	1/1	/1	7/11
Poecilobothrus nobilitatus (LINNAEUS, 1767)	1/1	-	-	-	-	-	-	/1	-	1/	-	-	-	-	-	-	-	7/1	-	-	-	/1	9/4
Hydrophorus bipunctatus (LEHMANN, 1822)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/	-	-	-	-	1/
no. of species	36	34	29	20	31	32	30	29	25	28	18	16	17	22	11	15	28	34	14	12	15	44	60
no. of individuals	979	616	264	200	3043	2333	1075	1056	112	177	71	58	117	102	87	106	526	2148	170	95	206	2602	16143

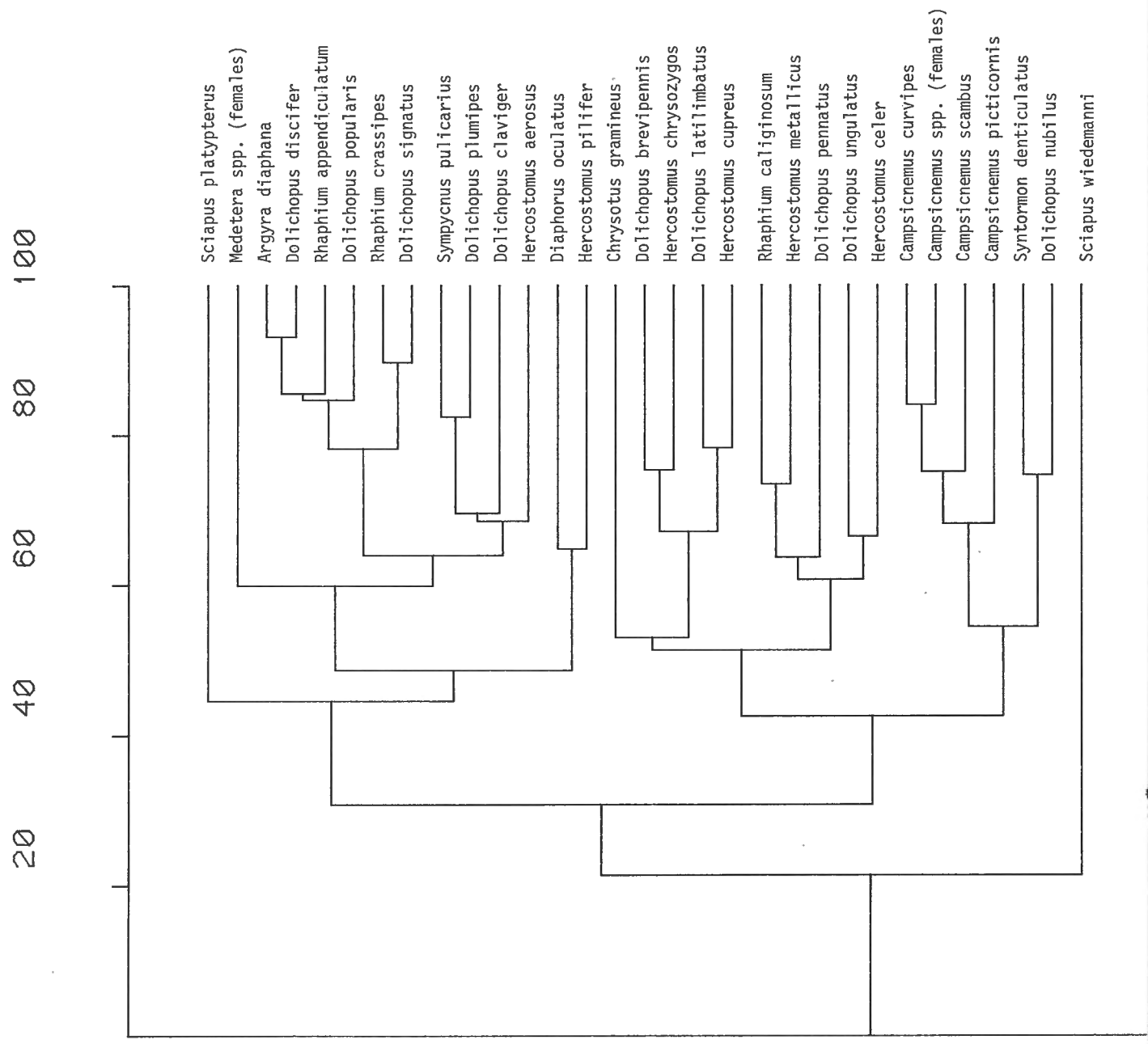


Fig. 4. *Dendrogram between the most abundant species according to their occurrence in the traps (Renkonen similarity index).*

3. COLOUR PREFERENCE

Although coloured water traps are widely used in studies on flying insects (DE BRUYN, 1986; HILL & HOOPER, 1984; KIRK, 1984; OWENS & PROKOPY, 1986), colour attractiveness in dolichopodid species has never been studied intensively before. Only KIRK (1984) reports that *Medetera saxatilis* and *M. truncorum* are most attracted to white traps, whereas blue, green, yellow, red and black coloured traps showed much lower yields.

In Figure 5 and the next figures, confidence limits were calculated on proportions (WONNACOTT & WONNACOTT, 1977).

In our study, three distinct groups of dolichopodid species can be noticed, concerning their colour preference (Fig. 5) (for this comparison, only the elevated water traps were considered):

(i) a large group of species, preferring the white coloured traps; it comprises all *Dolichopus* spp., *Hercostomus* spp., *Chrysotus gramineus, Argyra diaphana* and *Rhaphium crassipes*. In *A. diaphana* and *H. aerosus,* obviously more flies were caught in the red traps, as compared to the blue ones;

(ii) two species, *Campsicnemus curvipes* and *C. scambus,* are most attracted by the red coloured traps. Although the females of these species, when stored in alcohol, are hard to distinguish, they do demonstrate the same behaviour as the males. The smallest

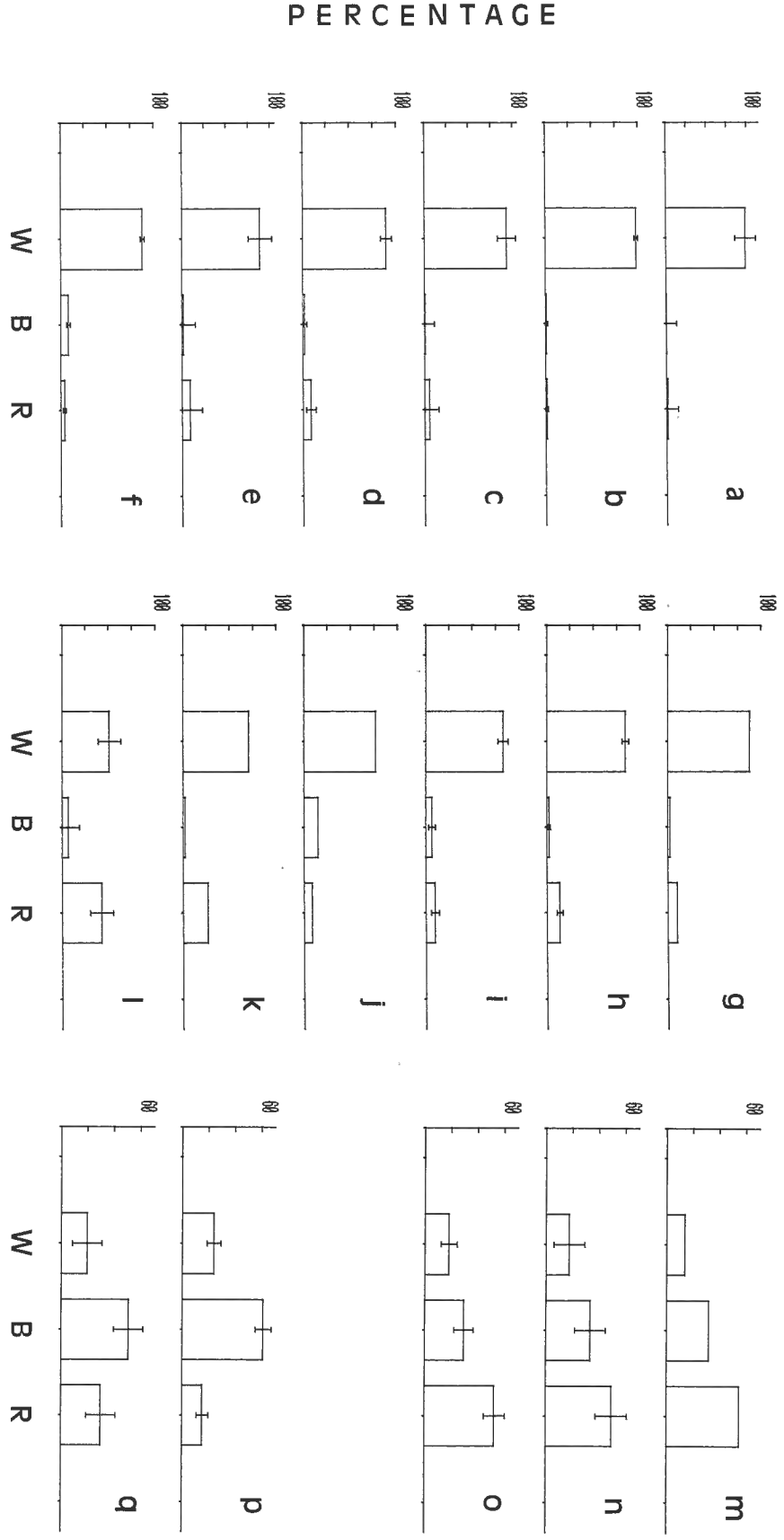


Fig. 5. *Occurrence of Dolichopodidae in the supported white (W), blue (B) and red (R) water traps (Percentage ± 95% c.l.). Explanation: a:* Hercostomus chrysozygos *(n = 58); b:* Rhaphium crassipes *(n = 220); c:* Dolichopus pennatus *(n = 89); d:* Dolichopus latilimbatus *(n = 103); e:* Dolichopus claviger *(n = 52); f:* Hercostomus cupreus *(n = 723); g:* Dolichopus brevipennis *(n = 41); h:* Dolichopus ungulatus *(n = 405); i:* Hercostomus metallicus *(n = 177); j:* Chrysotus gramineus *(n = 47); l:* Argyra diaphana *(n = 41); l:* Hercostomus aerosus *(n = 61); m:* Campsicnemus curvipes *(n = 44); n:* Campsicnemus scambus *(n = 69); o:* Campsicnemus curvipes/scambus *(females) (n = 143); p:* Sciapus platypterus *(n = 237); q:* Sciapus wiedemanni *(n = 77).*

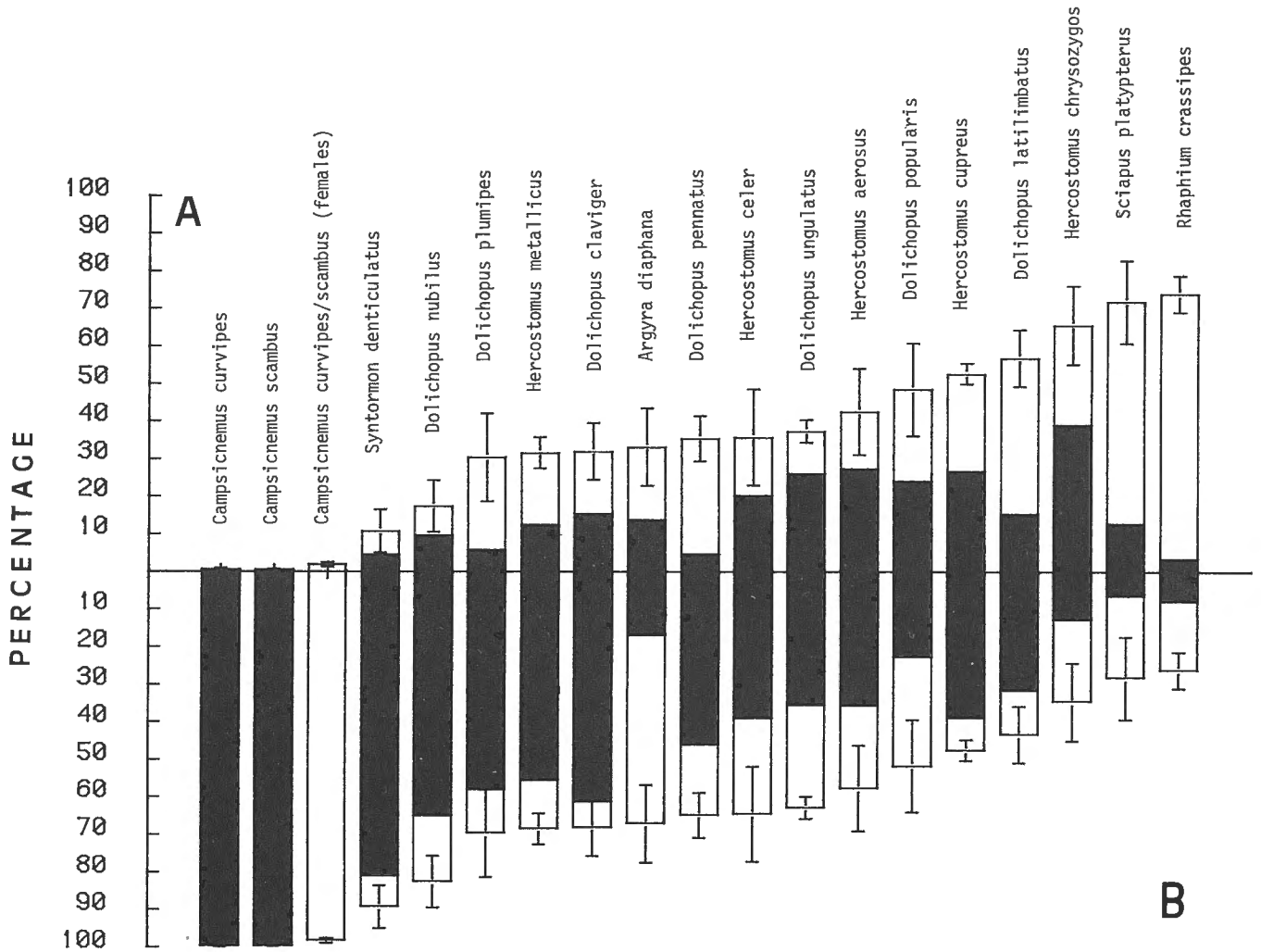
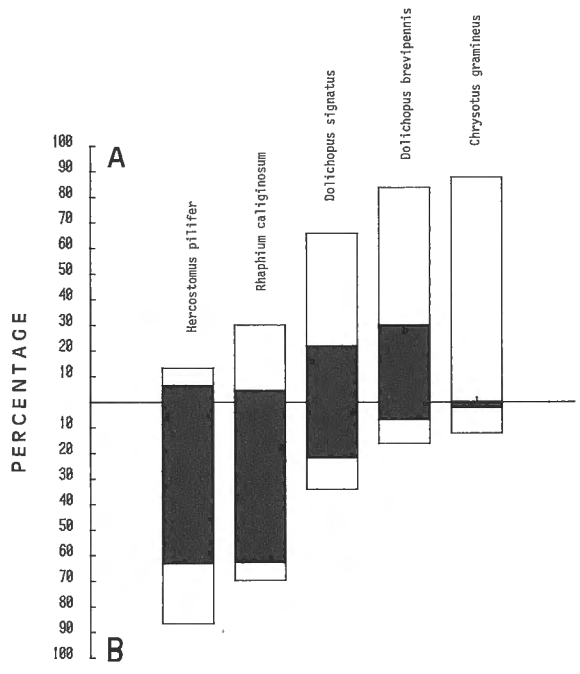


Fig. 6 and 7. *Occurrence of Dolichopodidae in white water traps, on a wooden support at a height of 60 cm (A) or dug into the soil (B) (percentage ± 95% c.l.).*
Explanation: black columns: males; white columns: females.



numbers of *C. curvipes* and *C. scambus* were found in the white traps;
(iii) as mentioned before, *Sciapus platypterus* and *S. wiedemanni* show a different behaviour by being caught mainly in the blue traps.

4. VERTICAL DISTRIBUTION

To investigate the vertical occurrence of the abundant dolichopodid species, numbers caught in the white traps at 60 cm height were compared to those, collected in the white traps at soil surface level. Figures 6 and 7 present the results of this comparison for the more or less abundant species respectively.
A great variation in vertical stratification is apparent: males and females of *Campsicnemus curvipes* and *C. scambus* are almost exclusively soil-dwelling. The same holds true for the other species of this genus, although they were caught in much lower numbers.

Syntormon denticulatus and *Dolichopus nubilus* also exhibit a distinct epigeic activity. These species both appear in very early spring (POLLET & GROOTAERT, in prep.).
In 13 species, more males were collected, as compared to females. Contrary to these, in *Sciapus platypterus, Argyra diaphana* and *Rhaphium crassipes* remarkably few males were caught in the water traps. Considering the Malaise trap catches (cfr. Table 2), however, males of the former species made up to 74.1%, 68.5% and 36.3% resp. of the total number of flies caught. Furthermore, in six species (*Dolichopus claviger, D. pennatus, D. plumipes, Hercostomus metallicus, Rhaphium caliginosum* and *Syntormon denticulatus*) males were more abundant on the soil surface, whereas females were more numerously found in the elevated traps. In *Hercostomus chrysozygos,* the opposite phenomenon was noticed.

5. DETAILED DISTRIBUTION

From Table 1 can be concluded that the four zones are situated on a light intensity gradient only, zone I and zone IV being the lightest and the darkest resp. Zones I-II show a higher soil humidity, although no distinct difference is apparent within the zones I-II and III-IV. Moreover, during winter and spring (until the end of June), zones I and II are almost entirely but discontinuously inundated and remain very muddy until midsummer. Furthermore, zone III shows the thickest litter layer, whereas zone II is characterized by the highest herbage.

Figure 8 gives data on the occurrence of the most abundant dolichopodid species over the four zones. A large number of species (n = 13) are clearly light-preferent and hygrophilous as they were found in largest numbers in zone I, their numbers gradually declining towards the darker zones: *Hercostomus chrysozygos, Dolichopus latilimbatus, H. cupreus, H. metallicus, H. aerosus* and some less abundant species. *Sciapus wiedemanni* proved to occur mainly in the lightest (I) and darkest (IV) zones.
In the following six species, most individuals were collected in zone II: *Dolichopus ungulatus, Rhaphium*

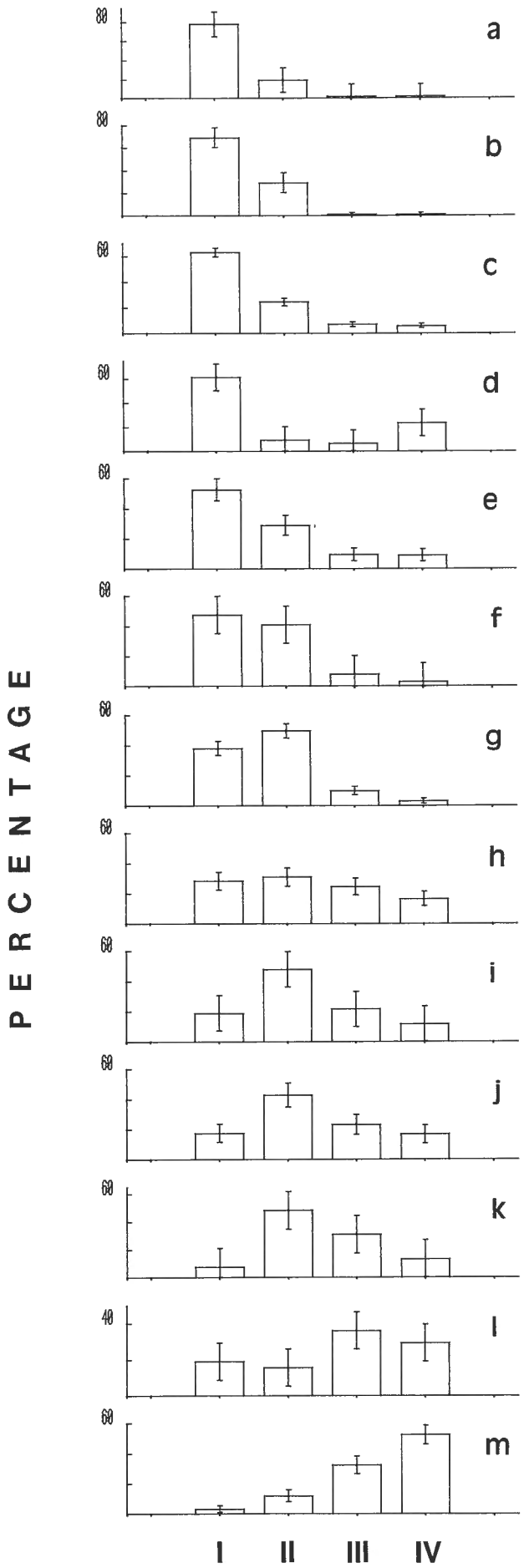


Fig. 8. *Occurrence of Dolichopodidae in zones I, II, III and IV, collected by means of white, red and blue water traps on a wooden support at a height of 60 cm (percentage ± 95% c.l.).*
Explanation: a: Hercostomus chrysozygos*; b:* Dolichopus latilimbatus*; c:* Hercostomus cupreus*; d:* Sciapus wiedemanni*; e:* Hercostomus metallicus*; f:* Hercostomus aerosus*; g:* Dolichopus ungulatus*; h:* Rhaphium crassipes*; i:* Campsicnemus scambus*; j:* Campsicnemus curvipes/scambus *(females); k:* Dolichopus claviger*; l:* Dolichopus pennatus*; k:* Sciapus platypterus. *For more information, see legend Fig. 5.*

crassipes, Campsicnemus curvipes, C. scambus, D. claviger and *Argyra diaphana.* Since zone II shows the most developed herb layer, this might suggest that those species are light-preferent with a distinct leaf-dwelling behaviour. Indeed, on many occasions this was observed in the field.
Furthermore, *Dolichopus pennatus, D. popularis, D. signatus* and *Sciapus platypterus* demonstrated a preference for the darker part of the investigated site.
When comparing the occurrence on 60 cm height and on the soil surface, similar patterns were found for most species: on soil surface, they thus also proved to be more abundant in the lighter zones (w5-6). Being light-preferent, however, *Sciapus wiedemanni, Dolichopus claviger, Rhaphium crassipes* and *Argyra diaphana* were caught more numerously in traps w7-8, as compared to traps w5-6. In *Dolichopus pennatus,* which demonstrated a dark-preference, more flies were collected in the water traps at soil surface level in the lighter zone.

6. COMPARISON OF THE DIFFERENT SAMPLING TECHNIQUES

Since Malaise traps, water traps and pitfall traps catch Dolichopodidae in a totally different way, when comparing the numbers of species and individuals caught, observed differences must be interpreted with great caution. Table 3 summarizes the number of species and individuals per different type of trap.

Table 3.
Comparison of the number of species and individuals of Dolichopodidae, collected by means of the different trap types (mean + standard error).

		w (1-4)	w (5-8)	r (1-4)	b (1-4)	p (1-3)	M
No. of species	mean	29.8	30.5	21.8	16.3	13.7	44
	(s.e.)	(3.6)	(0.6)	(2.8)	(2.3)	(0.9)	—
No. of indivuals	mean	514.8	1876.8	104.5	103	157	2602
	(s.e.)	(180.0)	(490.3)	(26.8)	(6.2)	(32.7)	—

The highest number of species and individuals was obtained by the Malaise trap. The white traps also proved to be very efficient in collecting dolichopodid species, whereas the blue water traps and the pitfall traps were the least successful. Furthermore, great differences were observed between traps of the same type, most probably due to differences in microclimatology or vegetation. In general, more species and specimens were caught in the lightest and wettest part of the investigated site. Moreover, Dolichopodidae appeared to be more abundant at soil surface level, as compared to the catches at 60 cm height.

IV. Discussion

1. HABITAT PREFERENCE

As mentioned before, only few ecological data are available in the literature, concerning the habitat preference and the detailed distribution of particular species. Only LUNDBECK (1912) and EMEIS (1964) report information about the preferred habitats of species, occurring in Denmark and Schleswig-Holstein (W.-Germany) respectively. Nevertheless, comment given by LUNDBECK (1912) is specific in very few cases only, since almost all species are said to occur "on low herbage and bushes, in humid places and near water".

In general, the following species appear to be found mainly in moist woodland habitats: *Sciapus platypterus, Argyra diaphana, Campsicnemus curvipes, C. scambus, Diaphorus oculatus, Dolichopus claviger, D. discifer, D. pennatus, D. popularis, D. wahlbergi, Hercostomus aerosus, H. celer, H. chrysozygos, H. cupreus, H. metallicus, Rhaphium caliginosum* and *R. crassipes* (EMEIS, 1964; GOETGHEBUER, 1930, 1934; JONASSEN, 1985; LUNDBECK, 1912). Eurytopic species such as *Chrysotus gramineus, Dolichopus plumipes, D. ungulatus* and *Sympycnus pulicarius* occur both in woodlands and more open places, however, generally near water. In our study, also true woodland species demonstrated a preference for the clear and muddy part of the woodland study site: *Hercostomus chrysozygos, H. cupreus, H. metallicus, H. aerosus, H. celer* and *Rhaphium caliginosum.* On the other hand, species such as *Dolichopus pennatus, D. signatus, D. popularis* and *Sciapus platypterus* were most abundant in the darkest places.
Furthermore, for some species, very contradictory data were found in the literature:
(i) EMEIS (1964) calls *Dolichopus nubilus* halophilous and mentions records for this species from salt marshes and dune grassland only. LUNDBECK (1912) found it almost exclusively on the shore. The very related *D. latilimbatus* is termed rare everywhere (EMEIS, 1964; LUNDBECK, 1912) and was only very recently recorded as new for the Netherlands (MEUFFELS, 1974,

1978) and Ireland (SPEIGHT, 1983). According to EMEIS (1964), this is a coast species. Contrary to the former authors, both species are also known from floating leaves of water plants (VAN DER VELDE *et al.*, 1985) and ponds, ditches and marshland (GOETGHEBUER, 1930). They apparently have a much broader distribution area than previously thought and, as proved our investigations, are rather abundant in very humid and light places in woodland too. Furthermore, it is striking that *D. nubilus* and *D. latilimbatus* are often found together;

(ii) GOETGHEBUER (1934) claims that *Hercostomus pilifer* is not strictly halophilous but because of the favourable climatological conditions for its larval development, it is restricted to the littoral zone. In sharp contrast, POLLET *et al.* (1986) showed that this species demonstrates a preference for the darkest woodland sites of "Wijnendalebos" and has been found in several similar habitat types ever since. *Dolichopus wahlbergi,* also a dark-preferent woodland inhabiting dolichopodid species (JONASSEN, 1985; POLLET *et al.*, 1986) is recorded from both woodland and salt marshes (EMEIS, 1964).

Until now, nothing or very little was known about the habitat selection of *Dolichopus signatus* and *Campsicnemus picticornis.* The first species appeared to be most abundant in the darker and drier parts of the study site, whereas a pronounced flying activity is observed. *C. picticornis* was caught in large numbers on a very humid spot, covered by a very thin grass vegetation in the lightest zone of this woodland habitat, which is in agreement with the findings of VAN DER VELDE *et al.* (1985).

2. SPECIES COMMUNITIES

According to the occurrence of the dolichopodid species on the soil surface and at 60 cm height, different species combinations are apparent (Table 4). A number of species can be found on the soil in equal numbers in the zones I-II and III-IV, whereas catches for the same species in the traps at 60 cm height suggest that they demonstrate a preference for either a high or low light intensity. Furthermore, *Argyra diaphana, Rhaphium crassipes* and *Dolichopus claviger* are found in the largest numbers in the elevated traps in the clearest zones, but their epigeic activity seems to be restricted to the darker area.

However, when taking also the colour preferences and the Malaise trap catches into account, we get a more reliable idea of the ecological niche of the different dolichopodid species. On this basis, different species groups can be distinguished (cfr. Fig. 4):

(i) a group of mainly soil-dwelling species, but exhibiting also a leaf-dwelling behaviour, however, much less frequently. Some of these species (*Campsicnemus curvipes* and *C. scambus*) show a colour preference for red. Insects preferring red, black or dark grey colours are thought to respond to dark shades and the contrast with the background (KIRK, 1984). Since the former species were caught in the red water traps mainly during September-October, when temperature declines, they are most probably favoured by the relatively higher temperatures due to the high absorption of warmth by the red traps, as compared to the white and blue ones. Furthermore, other species of the genus *Campsicnemus, Syntormon denticulatus* and *Dolichopus nubilus* belong to this group, however, preferring a white colour. Together with *C. scambus,* they appear to be light-preferent, whereas on soil surface level *C. curvipes* occurs to the same extent both in the clear and dark parts.

(ii) *Sciapus platypterus* and *S. wiedemanni* are somewhat separated from the other species, due to their pronounced preference for the blue water traps. Here, the explanation of KIRK (1984) apparently holds true, since both species are tree-trunk-dwellers and in this way most probably orientate to silhouettes. Nevertheless, *Sciapus platypterus* and *S. wiedemanni* react differently on light intensity, being dark-preferent and mainly light-preferent respectively, which is in agreement with the findings of EMEIS (1964). Moreover, in contrast to the latter species, high numbers of *Sciapus platypterus* were collected by the Malaise trap, suggesting either a high flying activity or a well developed behaviour of climbing up vertical walls in this species. Besides the *Sciapus* spp., representatives of the genus *Medetera* are regularly flying (especially the females) and blue-preferent too.

(iii) the following species are frequent flyers, most attracted by a white colour and found in approximately the same numbers in the water traps on soil surface level and at 60 cm height: *Argyra diaphana, Rhaphium crassipes, Dolichopus discifer, Rhaphium appendiculatum, D. popularis* and *D. signatus.* Nevertheless, minor differences are apparent between the species: *A. diaphana* and *R. crassipes* females are leaf dwellers in the light and sunny area, but on the ground mainly found in the densely covered zones. Males of both species are very scarce in the water traps, but exhibit high flying activity. In *D. discifer* and *R. appendiculatum,* very few specimens were collected by the water traps. *D. popularis* and *D. signatus* prefer obviously the darker (and drier) zones.

(iv) the next group of species differ from the preceding one only by the fact that they are pronounced soil surface active: *Sympycnus pulicarius, Dolichopus plumipes, Hercostomus aerosus, D. claviger, Diaphorus oculatus* and *Hercostomus pilifer.* The first three species proved to be light-preferent, while *D. claviger* is apparently favoured by the microclimatological conditions in the darkest places, both on the soil surface and at 60 cm height. *D. oculatus* and *H. pilifer* are almost exclusively epigeic in the darker zones.

(v) the group comprising *Chrysotus gramineus, Dolichopus brevipennis, Hercostomus chrysozygos, D. latilimbatus* and *H. cupreus* is characterized by a very uniform behaviour: the species do not fly regularly

Table 4.
Classification of the most abundant dolichopodid species, according to their occurrence in the different parts of the investigated site.
Explanation: A: species which were most abundant in the lighter and more humid zones (I-II); B: species which occurred in approximately equal numbers over the four zones; C: species which were most abundant in the darker and drier zones (III-IV); species are ranged, according to decreasing abundance.

At soil surface level (w5-8)

A	B	C
Campsicnemus scambus	Campsicnemus curvipes	Dolichopus claviger
Dolichopus ungulatus	Hercostomus aerosus	Rhaphium crassipes
Hercostomus cupreus	Hercostomus celer	Argyra diaphana
Hercostomus metallicus	Dolichopus popularis	Hercostomus pilifer
Dolichopus pennatus		Sciapus platypterus
Syntormon denticulatus		Dolichopus signatus
Dolichopus nubilus		Diaphorus oculatus
Dolichopus latilimbatus		
Dolichopus plumipes		
Hercostomus chrysozygos		
Rhaphium caliginosum		
Sympycnus pulicarius		

At 60 cm height (w1-4)

A	B	C
Hercostomus cupreus	Rhaphium crassipes	Dolichopus pennatus
Dolichopus ungulatus	Dolichopus claviger	Sciapus platypterus
Hercostomus metallicus	Dolichopus popularis	Dolichopus signatus
Dolichopus latilimbatus		
Hercostomus chrysozygos		
Dolichopus brevipennis		
Hercostomus aerosus		
Argyra diaphana		
Chrysotus gramineus		
Dolichopus plumipes		
Hercostomus celer		
Dolichopus nubilis		
Sciapus wiedemanni		
Rhaphium caliginosum		
Syntormon denticulatus		
Campsicnemus scambus		
Campsicnemus curvipes		

but are very strongly attracted by the supported white water traps. They are light-preferent, highly hygrophilous and occur on soil surface level mainly in the clear area or in equal numbers over the four zones. The very closely related species, *Dolichopus nubilus* and *D. latilimbatus,* inhabit a different ecological niche. However, both are highly light-preferent, hygrophilous and white-attracted. Nevertheless, in contrast to the mainly soil-dwelling *D. nubilus, D. latilimbatus* is most active at 60 cm height.
(vi) the last cluster of species differs from the former by the fact that the dolichopodid species demonstrate a higher flying activity and are more epigeic: *Rhaphium caliginosum, Hercostomus metallicus, Dolichopus pennatus, D. ungulatus* and *H. celer.* In contrast to the other species, at 60 cm height *D. pennatus* is found in the largest numbers in the clear and wet site, whereas it is most abundant in the dark and relatively drier zones at soil surface level.

3. COMPARISON OF THE SAMPLING TECHNIQUES

Dolichopodidae and other invertebrates are caught by the sampling techniques used in very different ways. The Malaise trap is an interceptive trap, collecting mainly flying insects. However, arboreal species, occurring on tree-trunks, might show a pronounced climbing up behaviour and in this way be favoured by

the vertical baffles of the trap. Subsequently, these species might be collected in relatively larger numbers, as compared to other species.
Water traps attract flying insects either by their colour or the presence of a liquid. To eliminate the possible attractive effect of the fixative, only 2.5% formalin solution and a colourless and odourless detergent were used. As a result, differences between traps are due to different colours only. In contrast to most species, which are attracted to white traps, *Rhaphium appendiculatum* appeared to be not attracted by any colour used.
Pitfall traps are widely used in pedobiological studies (THIELE, 1977) and proved to be very efficient in collecting epigeic arthropods. The traps thus yield most soil-dwelling dolichopodid species, eventually in search for open water (especially during the dry summer period).
As mentioned before, when using different collecting methods, more species will be obtained, as compared to the application of one sampling technique only. The Malaise trap and the white water traps proved to be most efficient, whereas in blue water traps and pitfall traps, a much smaller number of dolichopodid species was gathered. Nevertheless, three species (*Medetera impigra, M. brevitarsa* and *Systenus pallipes*), of which the two latter are of special faunistic interest, were found in the blue traps only. Moreover, the arboreal *Sciapus* spp. and *Medetera* spp. even show a pronounced preference for this colour.
Besides the colour of the trap, also the placing seemed to be of fundamental importance: in our study, several species (*Campsicnemus* spp., *Syntormon denticulatus*) appeared to be almost exclusively soil-dwelling, whereas other dolichopodids were found in approximately the same numbers in both traps, dug into the soil and supported at a height of 60 cm. Few species (*Chrysotus gramineus, Dolichopus brevipennis*) were reported from the elevated traps only. Also the setting up of the traps in zones with a different light intensity and soil humidity revealed different results.
However, replicates were used in our investigations only in the water traps on soil surface level and when considering colour preferences. For some species, considerable differences in numbers were noticed between these replicates, due to several environmental factors. Nevertheless, the effect of microclimatological differences within the zones were eliminated by switching the traps during the weekly collection of the flies. Furthermore, other restrictions were made in this study: only white water traps were used at soil surface level, whereas the vertical stratification was investigated by means of catches from two levels only. In future, this will be elaborated in further detail.

Acknowledgements

The authors thank Mr. Ir. J. De Schuyter and Mr. H. Van Den Bosch, who allowed us to study the woodland area "Wijnendalebos". Many thanks are also due to Dr. K. Desender and Mr. A. De Kimpe for computing several programs and Drs. M. Alderweireldt for his assistance in producing the dendrograms. We are also very grateful to Mr. K. Pollet and Mrs. G. Christiaens for their valuable help with field work. Mrs. L. Demarest recorded the plant species. Finally, we are much indebted to Drs. H.J.G. Meuffels for his critical reading of the manuscript. This work was in part financially supported by the Institute for the Encouragement of Scientific Research in Industry and Agriculture.

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