

# Seasonal occurrence and voltinism of Pipunculidae (Diptera) in Belgium

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## Abstract

The annual modality of 37 Pipunculidae (Diptera) species occurring in Belgium is discussed. The results are based on data from 28 site-year cycles of Malaise traps (occasionally emergence and water traps) and material collected by handsweepings.

Voltinism is detected and a seasonal sequence pattern is composed for the species discussed, showing a temporal distribution between univoltine and bivoltine species during the Summer. The results are compared with those from some other West and Central European countries.

Intraspecific variability, probably caused by geographical as well as climatological differences, is discussed for some common species. Interspecific variability among closely related species is discussed as well as sex-ratios of the captures in the Malaise traps.

**Key-words:** phenology, voltinism, Pipunculidae, Belgium.

## Résumé

Dans cet article, nous étudions la phénologie de 37 espèces de pipunculides (Diptera) présentes en Belgique. Nos résultats sont principalement basés sur 28 séries de données annuelles obtenues au moyen de pièges Malaise. Le voltinisme est déterminé et la succession d'espèces univoltines et bivoltines est observée au cours des saisons. Enfin, l'existence d'une variation intra- et interspécifique est discutée.

**Mots-clés:** phénologie, Pipunculidae, Belgique.

## Introduction

Pipunculidae are known as parasitoids of Auchenorrhyncha (Hemiptera) and about 70 species have been reported from Belgium (De Meyer & De Bruyn, 1985). In their monograph, Waloff and Jervis (1987) give a summary of the known voltinism of European Pipunculidae. A preliminary phenological study of some of the more abundant species in Belgium has been made previously (De Meyer & De Bruyn, 1984). At this moment we have more extended data and results which comprise about half of the entire Belgian pipunculid fauna.

## Material and methods

Material from 28 site-year cycles has been sorted out and all Pipunculidae specimens have been identified. This material has been collected during the last 7 years in the

scope of an intensive sampling program of Diptera, coordinated by the Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels (K.B.I.N.). The sites are summarised in table 1 with reference to the year that the trap was active; the UTM quadrate, the type of trap(s) used (MT=Malaise traps, ET=emergence traps, WT=water traps), and the collector. In general, the traps were emptied weekly and were active for a full cycle (i.e. from April till November).

This material is conserved in alcohol and deposited in the collections of the K.B.I.N., and will hereafter be referred to as the Malaise trap data. In addition dry material that has been collected over several decennia (mainly by handsweeping with insect nets) at different localities and by different collectors has been identified. This material is deposited in the collections of the K.B.I.N. or other institutes or private collections. Most of the specimens are listed in De Meyer & De Bruyn (1985) and will hereafter be referred to as the dry collection data. Taxonomy and identification is mainly based on Bańkowska (1973), Coe (1966), Kozánek (1981) and Sack (1935). The data were ordered in graphs as follows:

— For the dry collection data and small figures in Malaise trap data: A hypothetical year was plotted with week 1: Jan. 1-7; week 2: Jan. 8-14; etc. The dry collection records were considered as species-day-collector records (Scott & Epstein, 1987) and ordered in the hypothetical weeks according to the collecting dates. If more than two specimens were collected by the same collector on one day, they were considered as two species-day-collector records. The weekly data of the Malaise trap were placed in the most coinciding hypothetical week. Here actual numbers were used. The records were manipulated with the method of running averages before being plotted (Pollard, 1977). Three weeks running averages were used.

— For the Malaise trap data with high numbers: the same hypothetical year was used as above. The data were ordered in the hypothetical weeks most resembling the actual weeks of collecting. Actual numbers were plotted as histograms.

— For species with the total number of data less than 20, and for the seasonal sequence overview (Fig. 26): range, median, and interquartile range were calculated for

Table 1.

List of annual cycles studied (type of traps: WT=watertraps; MT=Malaise traps; ET=emergence traps)

SITE	U.T.M.	YEAR	TYPE	LEG.
Châtillon	FR.90	1981	WT	Jacob, J.P.
Ethe-Buzenol	FR.80	1981	MT	Grootaert, P.
Ottignies	FS.01	1981	MT	Dessart, P.
St Martens Latem	ES.45	1981	MT	Grootaert, P.
Ottignies	FS.01	1982	MT	Dessart, P.
Turnhout	FS.38	1982	MT/ET	De Bruyn & De Meyer
Schoten	FS.08	1983	MT	De Bruyn, L.
Ferrières	FR.88	1983	MT	Grootaert, P., R. Detry
Koksijde	DS.76	1983	MT	Muylaert, A.
Mont Rigi	KA.99	1983	MT	Magis, N.
Ottignies	FS.01	1983	MT	Dessart, P.
Schoten	FS.08	1984	MT	De Bruyn, L.
Kortenbergh	FS.03	1984	MT	Verlinden, L.
Antwerpen	ES.97	1984	WT	De Bruyn & De Meyer
Treignes	FR.25	1984	MT/WT	Hofmans, De Meyer & De Bruyn
Les Epioux	FR.60	1984	MT	Gaspar & Verstraeten
Liernu	FS.20	1984	MT	Gaspar & Verstraeten
Gembloux	FS.10	1984	MT	Fassotte, C.
Bleret	FS.61	1984	MT	Fassotte, C.
Erpent	FR.39	1984	MT	Fassotte, C.
Mont Rigi	KA.99	1984	MT	Magis, N.
Balen	FS.57	1985	MT	Backeljau, T.
Turnhout	FS.38	1985	MT/WT	De Bruyn & De Meyer
Raversijde	DS.87	1986	MT	Haghebaert, G.
Virelles	ER.94	1986	MT	Magis, N.
Logne	FR.88	1986	MT	Detry, R.
Oostende	DS.97	1987	MT	Haghebaert, G.
Raversijde	DS.87	1987	MT	Haghebaert, G.

each species (all measured in weeks) (Scott & Epstein, 1987). For multivoltine species the segregation of the generations was done by visual inspection of the plots and the statistics were calculated separately for each generation.

When comparing periods of occurrence statistically, the Mann-Whitney U test, and Kruskal-Wallis variance analysis with Dun's a posteriori test were used (Siegel, 1956; Hollander & Wolfe, 1973; Sokal & Rohlf, 1981).

## Results

Results will be discussed per genus. *Chalarus* spp. are not included because of the present difficulties in identifying species of this genus (cfr. Jervis, 1980a). *Nephrocerus* spp., will only be discussed briefly. For more detailed information on the phenology of this genus we refer to Grootaert & De Meyer (1986).

Fig. 1-8. Seasonal activity cycles of adult Pipunculidae in Belgium.

Fig. 1a. *Verrallia aucta*, collection data reordered according to three weeks running averages (N=41).

Fig. 1b. *V. aucta*, Malaise traps data, actual numbers (N=47).

Fig. 2. *V. pilosa*, collection data reordered according to three weeks running averages (N=24).

Fig. 3. *V. setosa*, collection data and Malaise trap data combined, reordered according to three weeks running averages (N=46).

Fig. 4. *V. villosa*, collection data reordered according to three weeks running averages (N=22).

Fig. 5. *Tomosvaryella kuthyi*, collection data reordered according to three weeks running averages (N=22).

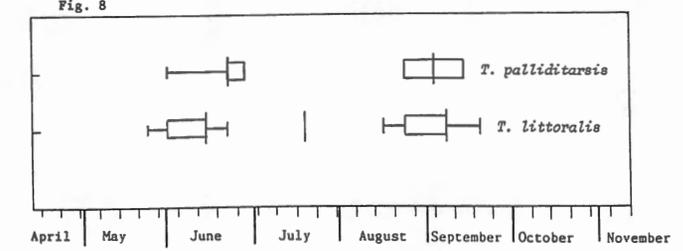
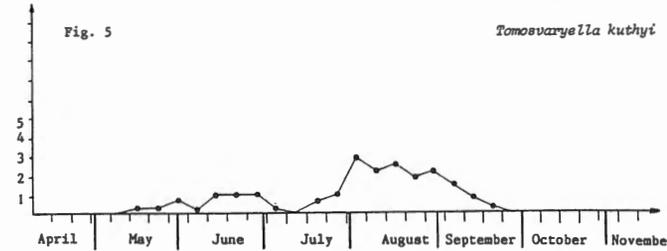
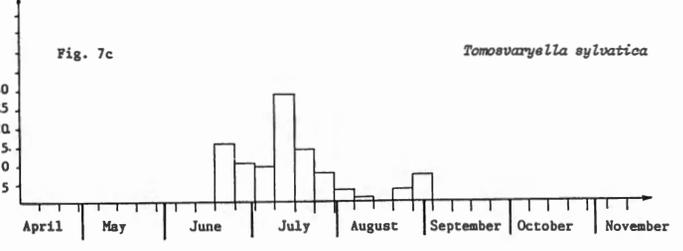
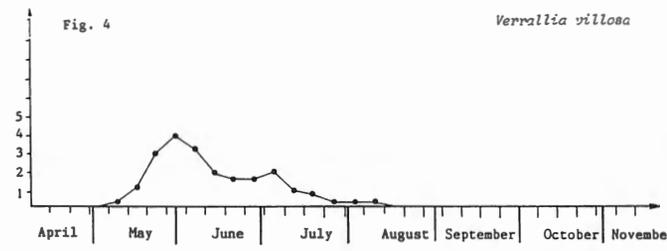
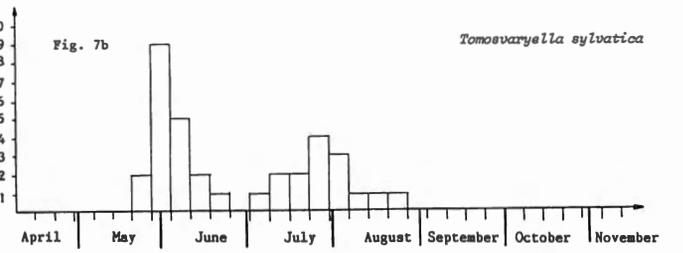
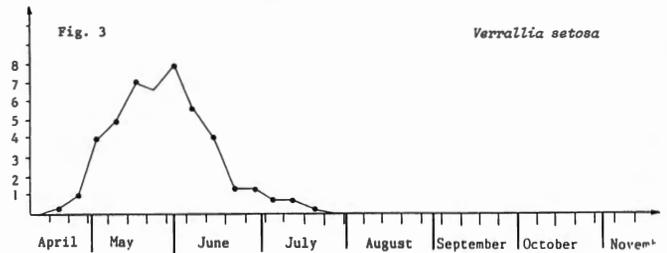
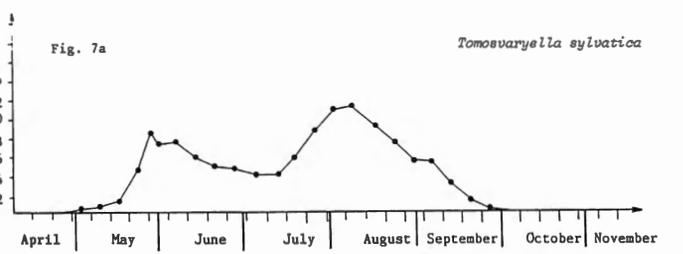
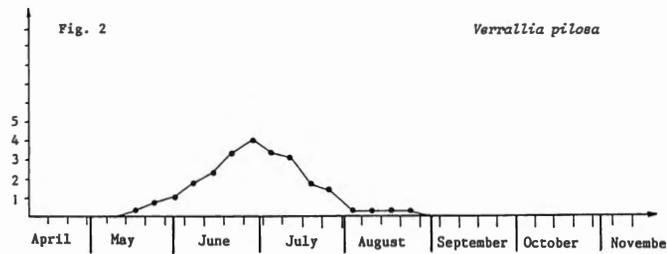
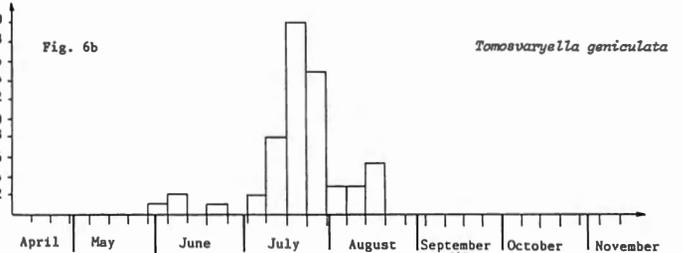
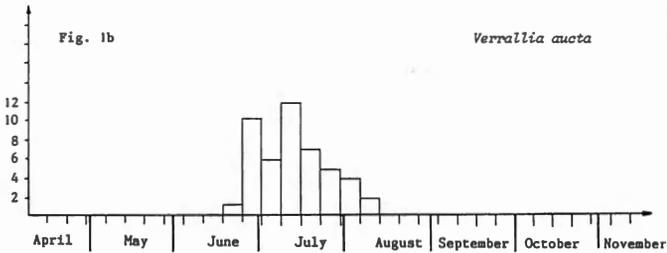
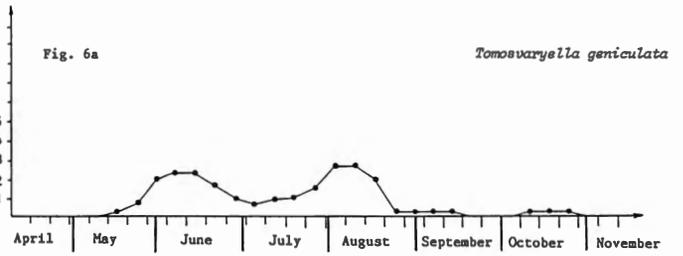
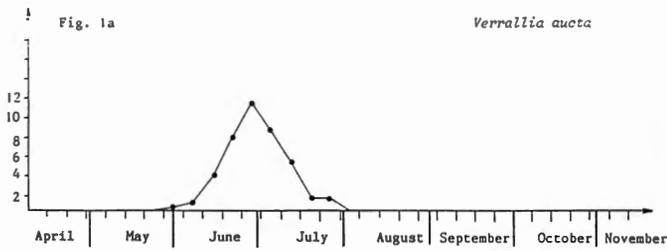
Fig. 6a. *T. geniculata*, collection data and Malaise traps data (except for Koksijde 1983) combined, reordered according to three weeks running averages (N=24).

Fig. 6b. *T. geniculata*, Malaise trap data of Koksijde 1983, actual numbers (N=60).

Fig. 7a. *T. sylvatica*, collection data reordered according to three weeks running averages (N=114).

Fig. 7b. *T. sylvatica*, Malaise trap and emergence trap data of Turnhout 1982 combined, actual numbers (N=34).

Fig. 8. *T. palliditarsis* (N=7) and *T. littoralis* (N=41), collection data and Malaise trap data combined, horizontal lines are ranges, boxes are interquartile ranges with vertical line indicating median.



The genus *Verrallia* MIK, 1899

Four species of this genus are known from Belgium and they all seem to show one peak period. *V. aucta* (FALLEN) occurs from June till the beginning of August, with a peak around the end of June, beginning of July (Fig. 1a,b). *V. pilosa* (ZETTERSTEDT) occurs mainly between the end of May till the end of July, with a peak around end of June, beginning of July (Fig. 2). *V. setosa* VERRALL seems to occur earlier, from the end of April till the beginning of July with a peak around the end of May (Fig. 3). *V. villosa* (VON ROSER) is found over a long period from mid May till July, with a peak around the beginning of June (Fig. 4). These results coincide with previous results (De Meyer & De Bruyn, 1984) and with those found in Czechoslovakia (Lauterer, 1981) and Great Britain (Whittaker, 1969; Waloff, 1975) except for *villosa* in Czechoslovakia where it occurs earlier. Both *pilosa* and *setosa* parasitise the same host (Waloff & Jervis, 1987): *Oncopsis subangulata* (SAHLBERG) but there is significant difference in temporal distribution (Mann-Whitney U test,  $U=97.000$ ;  $N_1: 24$ ,  $N_2: 46$ ;  $Z=-5.659$ ;  $P < 0.001$ ). In those sites where we found both species during the same year there is also a tendency towards temporal distribution but the numbers captured were too few to draw any definite conclusions. Maybe a mechanism of resource partitioning is an underlying reason of the temporal distribution (Brown & Wilson, 1956; Schoener, 1974). The host of *villosa* is unknown.

The genus *Nephrocerus* ZETTERSTEDT, 1838

All three species occurring in Belgium seem to have one peak (Grootaert & De Meyer, 1986), occurring in late Spring or early Summer. *N. scutellatus* (MACQUART, 1834) and *N. lapponicus* ZETTERSTEDT, 1838 are found between the beginning of May till the end of June (with a few records from July). *N. flavicornis* ZETTERSTEDT, 1844 occurs later than the other two (second half of June till mid July).

The genus *Tomosvaryella* ACZEL, 1939

Although several species of this genus occur in Belgium,

the data are usually too limited, except for a few abundant species. *T. kuthyi* ACZEL is a bimodal species (Fig. 5) with a first period from the end of May till the end of June and second period from end July till mid September. The known host, *Psammotettix confinis* (DAHLBOM) is bivoltine (Waloff, 1975). *T. geniculata* (MEIGEN) (Fig. 6a) is probably also bimodal with approximately the same peak occurrence as *T. kuthyi*. In a Malaise trap at Koksijde during 1983 where the species was captured in relatively high numbers, the first peak periode was hardly distinguishable (Fig. 6b). The host is unknown. *T. sylvatica* (MEIGEN) is one of the more common species in Belgium. It occurs from May till the end of September. Two distinct peak periods (Fig. 7a,b), can be detected: one around beginning of June and a second at beginning of August. However at Mt Rigi, 1983 the first period occurred later while the second was hardly distinguishable (Fig. 7c). We have to remark that Mt Rigi is situated in a special ecological biotope for Belgium. It belongs to the "Hautes Fagnes", a moorlike area on high altitude and with a different climatic pattern from the rest of the country: lower temperatures and more severe winters. We have also noticed that the peak periods of some other species are also different at Mt Rigi (De Meyer, 1985). The results for these three species confirm earlier findings in Great Britain, Germany (Waloff & Jervis, 1987), Czechoslovakia (Lauterer, 1981) and Belgium (De Meyer & De Bruyn, 1984). The data for *T. palliditarsis* (COLLIN) and *T. littoralis* (BECKER) seem to indicate that both are bimodal (the latter may be trimodal) (Fig. 8).

The genus *Dorylomorpha* ACZEL, 1939

According to the results from the dry collections as well as the Malaise traps (Fig. 9), *D. albitarsis* (ZETTERSTEDT) is clearly an unimodal species occurring from mid June till mid July with a peak around the end of June. *D. confusa* (VERRALL) is collected from mid May till July with a peak period in June (Fig. 10). *D. infirmata* (COLLIN) (Fig. 11) is probably a bimodal species occurring from May till beginning of June and again at the end of July till beginning of August. *D. imparata* (COLLIN) and *D. rufipes* (MEIGEN) are both univoltine species (Fig. 11) occurring from beginning of May till mid June, while *D.*

Fig. 9-15e. Seasonal activity of adult Pipunculidae in Belgium.

Fig. 9. *Dorylomorpha albitarsis*, Malaise trap data of Mt Rigi 1983 and 1984 combined, actual numbers ( $N=50$ ).

Fig. 10. *D. confusa*, collection data and Malaise trap data combined, reordered according to three weeks running averages ( $N=23$ ).

Fig. 11. *D. infirmata* ( $N=18$ ), *D. imparata* ( $N=13$ ), *D. rufipes* ( $N=12$ ) and *D. xanthocera* ( $N=12$ ), collection data and Malaise trap combined, horizontal lines are ranges, boxes are interquartile ranges with vertical line indicating median.

Fig. 12a. *D. xanthopus*, collection data reordered according to three weeks running averages ( $N=22$ ).

Fig. 12b. *D. xanthopus*, Malaise trap data of Mt Rigi 1983 and 1984 combined, actual numbers ( $N=91$ ).

Fig. 13. *Pipunculus thomsoni*, Malaise trap data combined, actual numbers ( $N=567$ ).

Fig. 14. *P. varipes* ( $N=16$ ) and *P. calceatus* ( $N=18$ ), Malaise trap data and collection data combined; symbols as in Fig. 11.

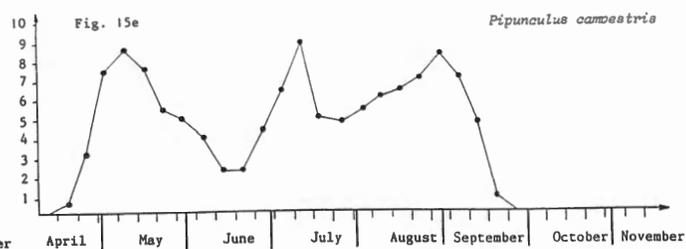
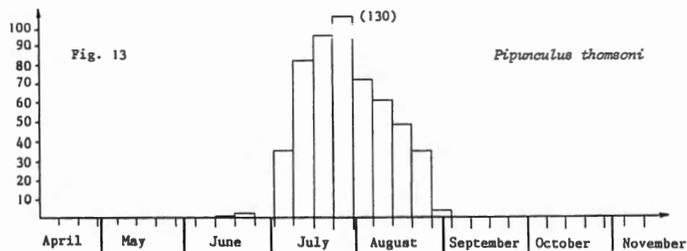
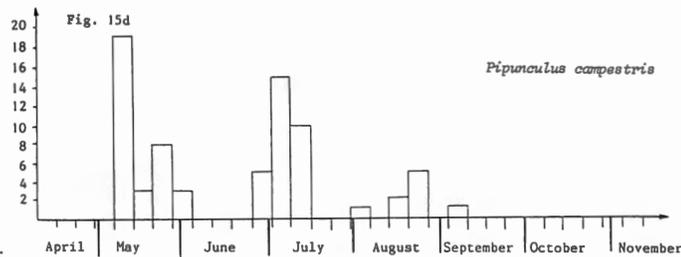
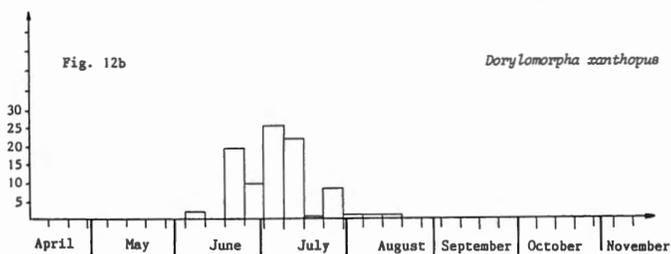
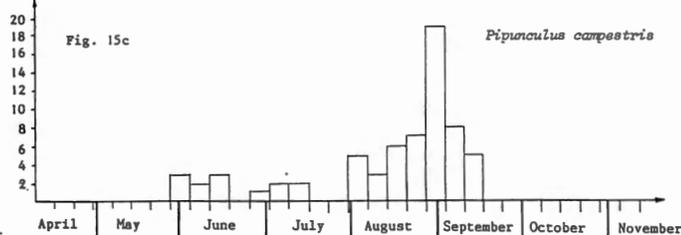
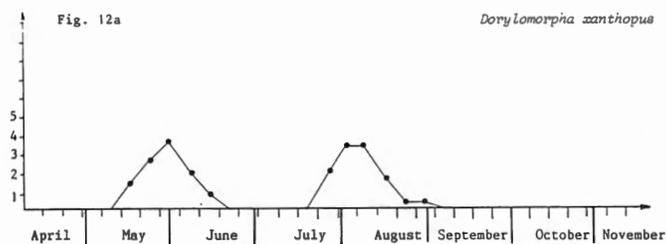
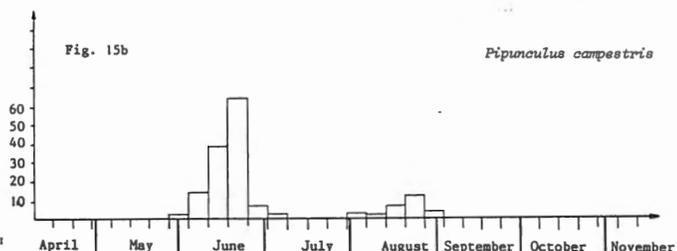
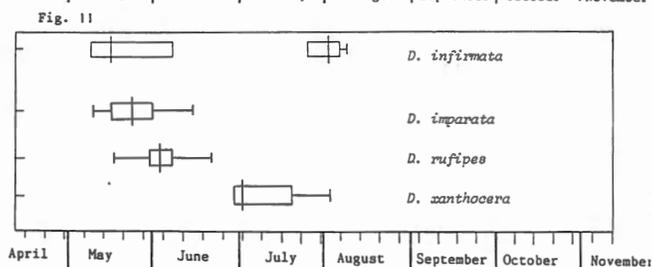
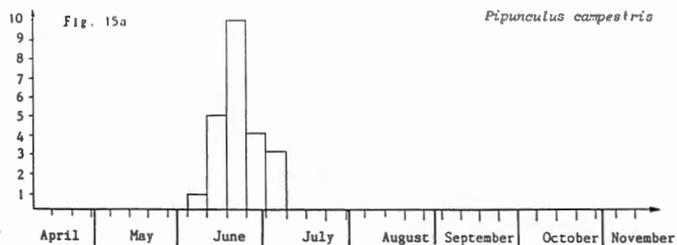
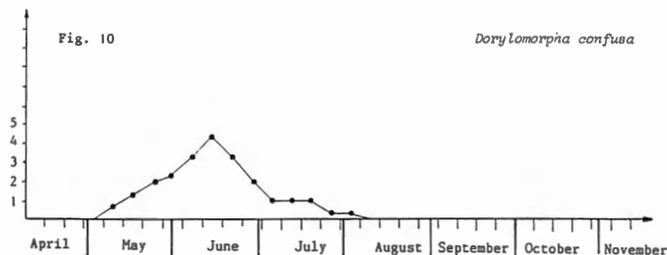
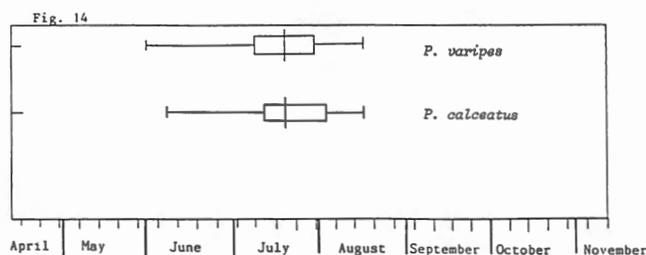
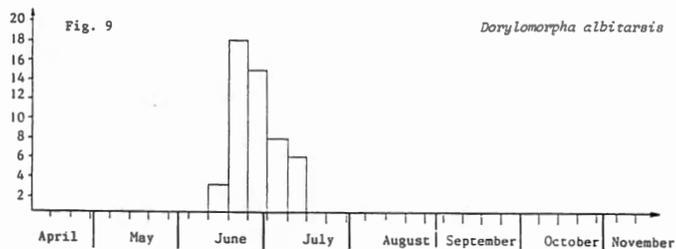
Fig. 15a. *P. campestris*, Malaise trap data of Mt Rigi 1984, actual numbers ( $N=23$ ).

Fig. 15b. *P. campestris*, Malaise trap data of Mt Rigi 1983, actual numbers ( $N=149$ ).

Fig. 15c. *P. campestris*, Malaise trap data of Treignes 1984, actual numbers ( $N=66$ ).

Fig. 15d. *P. campestris*, Malaise trap data and emergence trap data of Turnhout 1982 combined, actual numbers ( $N=72$ ).

Fig. 15e. *P. campestris*, collection data reordered according to three weeks running averages ( $N=119$ ).



*xanthocera* (KOWARZ) is also unimodal but occurs somewhat later (Fig. 11). These results coincide with the finding of Lauterer (1981) in Czechoslovakia except that *D. albitarsis* occurs somewhat later in Belgium. *D. xanthopus* (THOMSON) shows two periods of occurrence in the dry collection data (Fig. 12a). In Malaise traps the species was only present in relatively high numbers at Mt Rigi during 1983 and 1984 (Fig. 12b). Here we notice that the species occurs later in the season and for a shorter time; two peak periods could not be distinguished. Lauterer (1981) found the species in Czechoslovakia occurring from the beginning of May till the end of July with a peak at the end of May and the first half of June. For *D. maculata* (WALKER) a tendency could be noticed to occur distinctly later than other *Dorylomorpha* species (from end of August till beginning of October). In Czechoslovakia, *D. hungarica* has a bimodal occurrence, coinciding with the occurrence of the larvae of its hosts (*Cicadula* spp.). In Belgium it seems to have a similar pattern.

#### The genus *Pipunculus* LATREILLE, 1802

*P. thomsoni* BECKER is clearly an unimodal species occurring from the end of June till the end of August, with a distinct peak period around the end of July (Fig. 13). *P. varipes* MEIGEN and *P. calceatus* VON ROSER (Fig. 14) seem to have a similar periodicity as *P. thomsoni* (Fig. 14). Both occur mainly during July and August, except for a few data from early June. *P. campestris* LATREILLE is a common species occurring over a long period from the end of April till the beginning of November. Despite its abundance in dry collection material as well as Malaise trap material, it is not very easy to draw conclusions regarding modality. Data from Mt Rigi 1984 show one peak period in June (Fig. 15a); data from Mt Rigi 1983 and Treignes 1984 show two peak periods, the first one similar to Mt Rigi 1983, the second one at end of August (Fig.

15b,c). The data from the trap in Turnhout 1982 distinctly show a first occurrence in May. Later in the season there is a discontinuous appearance with maybe a peak around mid July and a third one at the end of August (Fig. 15d). Geographical as well as climatological differences may explain these different patterns. The peculiar geographical situation of Mt Rigi has been mentioned earlier. In 1981 and 1982 we had fairly good weather with a warm spring and summer. 1983 and 1984 on the other hand were marked by a cold and rainy spring, followed by a moderately warm summer. The dry collection data (Fig. 15e) are showing a mixed representation of the two above mentioned tendencies, with inclination towards trimodality. The species has been found bivoltine in Germany and bi- or trivoltine in Great Britain (Waloff & Jervis, 1987).

#### The genus *Cephalops* FALLEN, 1810

*C. semifumosus* (KOWARZ) is a common species occurring over a long period from end of May till beginning of October and showing two peaks (Fig. 16a,b). A first one around end of June, beginning of July; a second one at the end of August, beginning of September. *C. subultimus* COLLIN and *C. ultimus* (BECKER) seem to coincide more or less with the previous species (Figs. 17, 18). These three species are taxonomically closely related and also the host range known so far shows some similarity (Waloff & Jervis, 1987). However with the data available from Belgium we have found some significant differences in peak occurrence. A Kruskal-Wallis variance analysis with a Dun's a posteriori test shows that the first peak of *C. ultimus* occurs earlier than the one of the two other species ( $H=18.285$ ;  $df=2$ ;  $P<0.001$ ) (Dun's a posteriori test significant with  $\alpha=0.5$ ). For the second peak *C. semifumosus* and *C. subultimus* have a different temporal distribution with *C. ultimus* being intermediate and not significant different from the other two. This was also tested with the tests mentioned above ( $H=12.510$ ;  $df=2$ ;

Fig. 16a-25. Seasonal activity of adult *Pipunculidae* in Belgium.

Fig. 16a. *Cephalops semifumosus*, collection data and Malaise trap data (except for Turnhout 1982) combined, reordered according to three weeks running averages ( $N=92$ ).

Fig. 16b. *C. semifumosus*, Malaise trap data and emergence trap data combined of Turnhout 1982, actual numbers ( $N=99$ ).

Fig. 17. *C. subultimus*, collection data and Malaise trap data combined, reordered according to three weeks running averages ( $N=40$ ).

Fig. 18. *C. ultimus*, collection data and Malaise trap data combined, reordered according to three weeks running averages ( $N=45$ ).

Fig. 19. *C. aeneus*, collection data and Malaise trap data combined, reordered according to three weeks running averages ( $N=25$ ).

Fig. 20. *C. germanicus* ( $N=10$ ), *C. obtusinervis* ( $N=13$ ), *C. carinatus* ( $N=12$ ) and *C. vestitus* ( $N=9$ ), collection data and Malaise trap data combined, horizontal lines are ranges, boxes are interquartile ranges with vertical line indicating median.

Fig. 21a. *Eudorylus subterminalis*, collection data reordered according to three weeks running averages ( $N=35$ ).

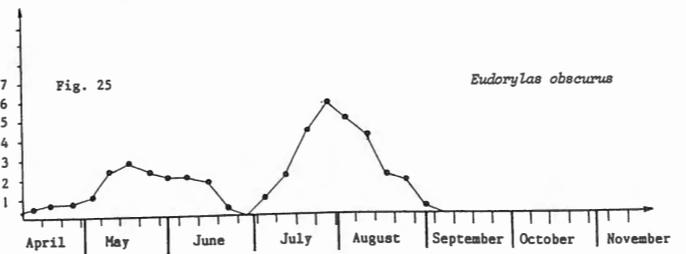
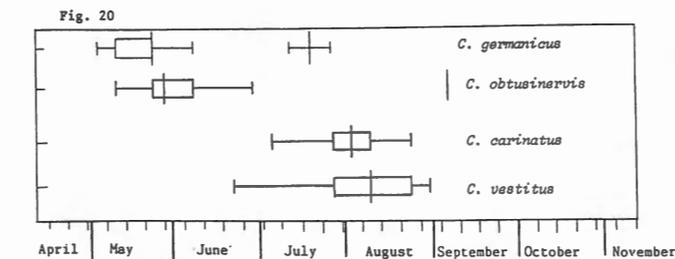
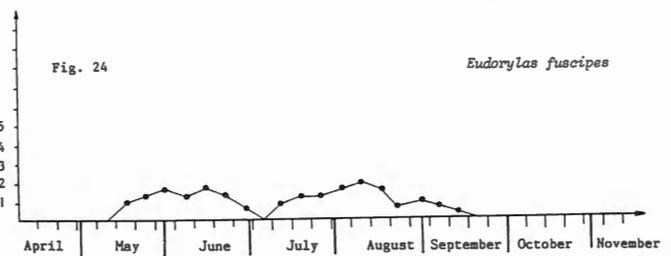
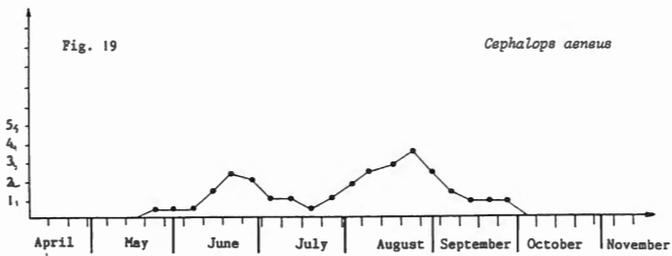
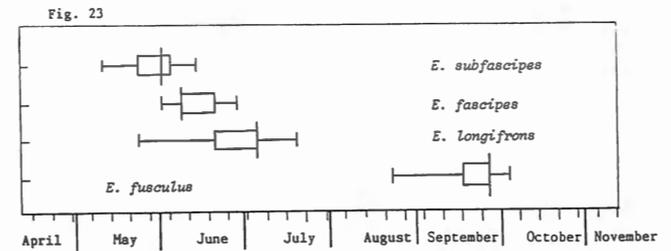
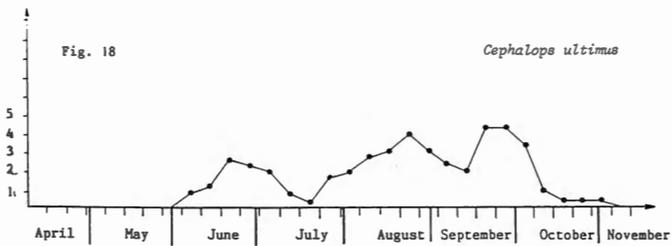
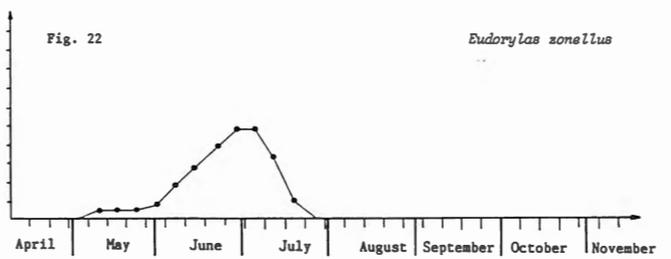
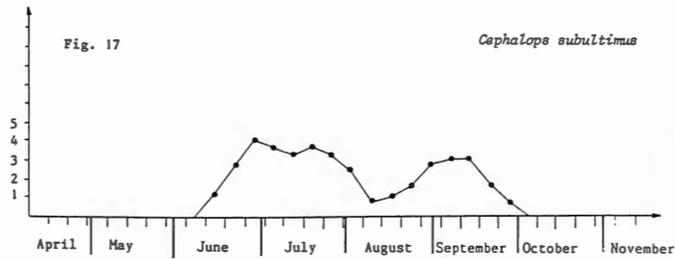
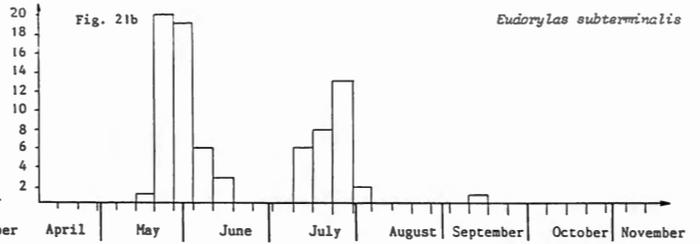
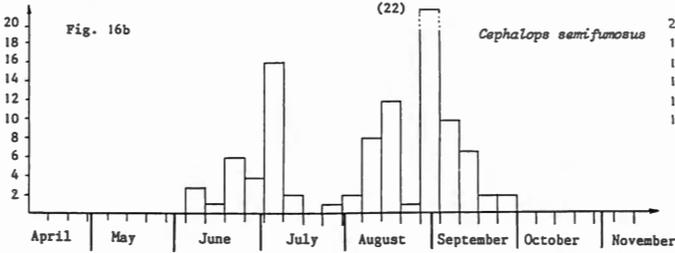
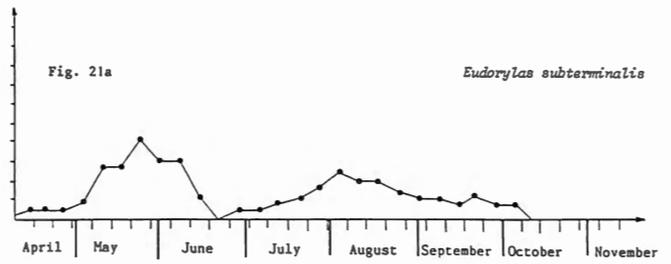
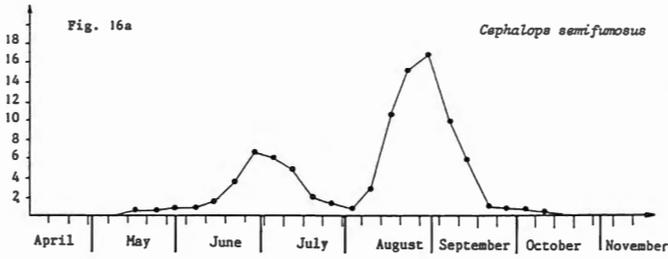
Fig. 21b. *E. subterminalis*, Malaise trap data emergence trap data of Turnhout 1982 combined, actual numbers ( $N=80$ ).

Fig. 22. *E. zonellus*, collection data reordered according to three weeks running averages ( $N=23$ ).

Fig. 23. *E. subfascipes* ( $N=10$ ), *E. fascipes* ( $N=5$ ), *E. longifrons* ( $N=11$ ) and *E. fuscus* ( $N=19$ ), collection data and Malaise trap data combined, symbols as Fig. 20.

Fig. 24. *E. fuscipes*, collection data reordered according to three weeks running averages ( $N=20$ ).

Fig. 25. *E. obscurus*, collection data and Malaise trap data combined, reordered according to three weeks running averages ( $N=43$ ).



$P < 0.01$ ). On several occasions two or all three species of this group have been captured in Malaise traps at one particular site. *C. semifumosus* is usually predominant (except for Treignes 1984 where it was co-dominant with *C. ultimus*). Again resource partitioning may play a role in their distribution pattern. Rothschild (1964) reports *C. semifumosus* from Great Britain as a bivoltine species with a first peak around mid July and a second in late July, early August. *C. aeneus* also shows a bimodal occurrence. One period in June and a second around August (Fig. 19). For the other species were the data too scarce but certain tendencies could be distinguished (Fig. 20). *C. obtusinervis* (ZETTERSTEDT) is unimodal occurring early in the year, except for one specimen from September. *C. carinatus* (VERRALL) is found mainly during July and August; so is *C. vestitus* (BECKER) except for one specimen of June. *C. germanicus* (ACZEL) is an early species with two periods of occurrence. *C. vittipes* (ZETTERSTEDT) seem to occur only in May and June (high numbers only in one Malaise trap: Logne 1986).

#### The genus *Eudorylas* ACZEL, 1940

Although several species of this genus occur in Belgium, the data are usually too sporadic except for some common species. *E. subterminalis* COLLIN is clearly bimodal with one peak at the end of May, beginning of June; while the second period of occurrence is at the end of July. There are a few records from the end of September, which might indicate a third period of occurrence (Fig. 21a,b). *E. zonellus* COLLIN is unimodal (Fig. 22) and found mainly in June and beginning of July. Peak is around the end of June. *E. fuscus* (ZETTERSTEDT) is probably a late occurring species (end of August till the beginning of October) (Fig. 23) but was only found in high numbers at Mt Rigi, 1983. For other species the following tendencies could be distinguished (Fig. 23): *E. subfascipes* COLLIN, *fascipes* (ZETTERSTEDT) (Fig. 24) and *obscurus* COE (Fig. 25) seem to be bimodal. The results are similar to those from Great Britain where Waloff has stated *E. fascipes*, *E. fuscipes*, *E. zonellus* as univoltine and *E. obscurus*, *E. obliquus* as bivoltine species. *E. subterminalis* is reported as bivoltine, occasionally trivoltine. However, *E. subfascipes* seems to be bivoltine there.

## Discussion

### ★ VOLTINISM

Studies of lifecycles of certain European bivoltine species (Rothschild 1964; Jervis 1980a, 1980b; Huq 1986) have shown that the usual time between the two successive annual generations is more or less two months. May (1979) states for *C. curtifrons* that the duration of the pupal stage varies with the temperature. Records for the duration of pupation of non-diapausing pupae varies from 13 to 30 days. The life span of the adults varies between 3 and 11

days (May, 1979; Jervis 1980; Huq 1986). Since the period of occurrence for a species is usually longer, the density of the population changes daily by the death of old individuals and the emergence of newly matured individuals.

The modality mentioned in the results seems to reflect the voltinism of each species. The following species are univoltine and thus show one annual generation: *V. aucta*, *V. pilosa*, *V. setosa*, *N. flavicornis*, *N. lapponicus*, *N. scutellatus*, *D. albitarsis*, *D. confusa*, *E. zonellus* and *P. thomsoni*; and probably also *V. villosa*, *D. imparata*, *D. rufipes*, *D. xanthocera*, *P. calceatus*, *P. varipes*, *C. vittipes*, *C. carinatus*, *C. obtusinervis*, *E. longifrons* and *E. fuscus*. Following species are bivoltine: *T. sylvatica*, *T. kuthyi*, *T. nigrifrons*, *C. aeneus*, *E. subterminalis*, *C. semifumosus*, *C. ultimus* and *C. subultimus*; or are showing a tendency towards bivoltinism: *C. germanicus*, *D. infirmata*, *E. fuscipes*, *D. hungarica*, *T. palliditarsis* and *T. littoralis*. *P. campestris* is bivoltine or trivoltine, with one exception (Mt Rigi, 1984) where only one peak period could be detected. *D. xanthopus* seems to be univoltine or bivoltine.

### ★ INTRASPECIFIC VARIATION

Intraspecific variation regarding periodicity and voltinism has been recorded for some of the more abundant species: *Pipunculus campestris*, *D. xanthopus*, *T. sylvatica*. Two reasons for these differences could be suggested. First of all the geographical variation in the sites where the flies were collected, and consequently the different climatic conditions of these sites. Belgium shows a considerable heterogeneity in geographical patterns, some places being of a "boreo-montane" type while others of a "submediterranean" type. This is also reflected in the diversity of species occurring in this country (cfr. De Meyer & De Bruyn, 1985). A second reason may be the meteorological differences between the successive years that the traps were placed which might influence the periodicity, as has been noticed clearly in the material collected in 1984 at Treignes and Mt Rigi (De Meyer, 1984, 1985).

### ★ SEASONAL VARIETY

A seasonal variety and resulting sequence of occurrence could be distinguished for the pipunculid fauna in Belgium. The results are represented in Fig. 26. Early species occur at beginning of May (occasionally already in April). These are several univoltine species but also some bivoltine species like *C. germanicus* and *D. hungarica*. The first generation of *P. campestris* in trivoltine cycles and *D. xanthopus* in bivoltine cycles occurs around this period as well. Most species occur at the end of May till the beginning of August. First we notice a number of bivoltine species who have their first adult generation. Later (mid June till mid July) we find a number of univoltine species and the second generation of *P. campestris* in trivoltine cycles. Also the first genera-

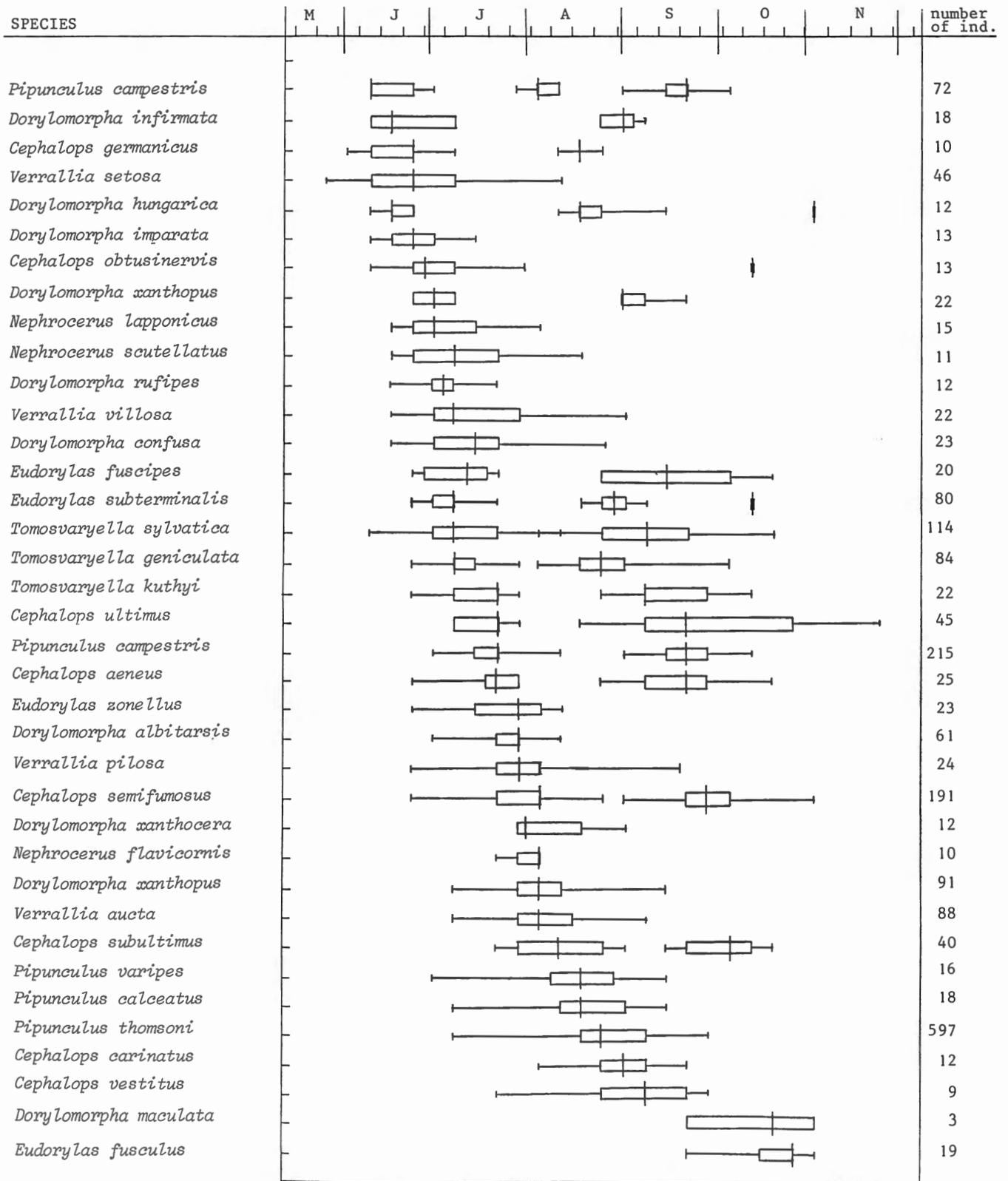


Fig. 26. Seasonal sequence of adult Pipunculidae in Belgium (horizontal lines are ranges, boxes are interquartile ranges with vertical line indicating median).

tion of the bivoltine *C. semifumosus* group occurs at this time. From mid July onwards starts the second generation of a number of bivoltine species. Later in August the second generation of the *C. semifumosus* group appears as well as the third generation of *P. campestris* in trivoltine cycles. Finally, in August and September, some late occurring, univoltine species are found. This seasonal cycle comprises only half of the Belgian pipunculid fauna, hence is incomplete and might have to be altered when more data are available.

#### ★ SEX-RATIOS

Malaise traps are interception traps, hence depend on the activity pattern of the insects. This has been clearly shown in Syrphidae where the abundant species *Myathropa florea* is hardly found in Malaise trap material because the individuals are capable of avoiding the trap in flight (Verlinden, loc. cit.). Also in Pipunculidae some species seem to be found only or mainly in Malaise trap material while others are mostly caught by handsweeping and are lacking in Malaise traps. The following sex-ratios are based on data from Malaise traps but are most likely not a reflection of their real presence in nature but also susceptible to the differences in activity patterns between sexes. Sex-ratios in Malaise traps show interspecific and intraspecific variation. The results are summarised in table 2 (only species with abundant numbers are included).

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Table 2.  
*Sex-ratios of Pipunculidae species in Malaise traps.*

SPECIES	SEX-RATIO (variation) fem./male	TOTAL
<i>Pipunculus campestris</i>	0.93 (0.35-2.30)	210
<i>Pipunculus thomsoni</i>	1.83 (1.59-1.91)	461
<i>Cephalops semifumosus</i>	4.98 (1.84-11.37)	263
<i>Tomosvaryella sylvatica</i>	0.40 (0.35-0.78)	299
<i>Tomosvaryella geniculata</i>	0.58 —	60
<i>Dorylomorpha xanthopus</i>	0.21 —	55
<i>Dorylomorpha albitarsis</i>	0.19 —	38
<i>Verrallia aucta</i>	19.50 —	88
<i>Eudorylas subterminalis</i>	2.00 —	48

Female/male ratio varies interspecifically from 19.5 in *V. aucta* to 0.19 in *D. albitarsis*. Intraspecifically we found the greatest variety in *P. campestris* (0.35-2.3) and *C. semifumosus* (1.84-11.37) while *P. thomsoni* shows the least variety (1.59-1.91). These results show a considerable variability. In their study of Japanese Pipunculidae in paddy fields, Yano et al. (1984) found average sex-ratios varying between 0.6-1.19. The results presented here, were based on data from Malaise traps and handsweepings. However, the total number of date was much higher (N: 1071-1581). According to breeding experiments of May (1979) male individuals emerge earlier from pupal stadium than female individuals, but this proterandry could not be detected in data of Malaise traps.

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