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Annotated list of the entomophagous complex associated with pear psylla, *Psylla pyri* (L.) (*Hom.* : *Psyllidae*) in France

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SUMMARY

Among the 56 beneficial insects collected and observed associated with pear psylla in France, 16 were abundant ; these arthropods included 2 parasitoids, *Prionomitus mitratus* (Dalman) and *Trechmites psyllae* (Ruschka) (*Encyrtidae*), and 14 predators, *Anthocoris nemoralis* (F.), *A. nemorum* (L.), *Orius horvathi* (Reuter), *O. vicinus* (Ribaut) (*Het.* : *Anthocoridae*) ; *Heterotoma meriopterum* (Scopoli), *Campyloneura virgula* (Herrich-Schäffer), *Orthotylus nassatus* (F.) (*Het.* : *Miridae*) ; *Stethorus punctillum* (Weise), *Scymnus rubromaculatus* (Goeze), *S. subvillosus* (Goeze), *Coccinella septempunctata* L. (*Col.* : *Coccinellidae*) ; *Chrysoperla carnea* (Stephens) (*Neur.* : *Chrysopidae*) ; *Coniopteryx borealis* Tjeder (*Neur.* : *Coniopterygidae*) and the mite *Allothrombium fuliginosum* Hermann. All these species are polyphagous but only the first three are tied to pear psylla. It was shown that the environment of the orchards, comprising hawthorn and nettle, is a reservoir for the main pear psylla enemies. Other prey or hosts and host plants of these beneficial arthropods are cited from recent literature.

Additional key words : Pear trees, parasitoids, predators, worldwide literature review on the hosts and prey of the *P. pyri* natural enemies.

RÉSUMÉ

Inventaire commenté des espèces du complexe biologique du psylle du poirier, Psylla pyri (L.) (*Hom.* : *Psyllidae*) en France.

Parmi les 56 auxiliaires inventoriés dans le complexe biologique du psylle du poirier en France, 16 sont relativement abondants ; ce sont 2 parasites, *Prionomitus mitratus* (Dalman) et *Trechmites psyllae* (Ruschka) (*Encyrtidae*), et 14 prédateurs, *Anthocoris nemoralis* (F.), *A. nemorum* (L.), *Orius horvathi* (Reuter), *O. vicinus* (Ribaut) (*Het.* : *Anthocoridae*) ; *Heterotoma meriopterum* (Scopoli), *Campyloneura virgula* (Herrich-Schäffer), *Orthotylus nassatus* (F.) (*Het.* : *Miridae*) ; *Stethorus punctillum* (Weise), *Scymnus rubromaculatus* (Goeze), *S. subvillosus* (Goeze), *Coccinella septempunctata* L. (*Col.* : *Coccinellidae*) ; *Chrysoperla carnea* (Stephens) (*Neur.* : *Chrysopidae*) ; *Coniopteryx borealis* Tjeder (*Neur.* : *Coniopterygidae*) et l'acarien *Allothrombium fuliginosum* Hermann. Toutes ces espèces sont polyphages ; seules les 3 premières citées sont étroitement liées au psylle du poirier. L'environnement immédiat des vergers, contenant aubépines et orties, s'est révélé être un réservoir des principaux ennemis du psylle du poirier. D'autres proies, hôtes et plante-hôtes de ces auxiliaires sont signalés d'après la littérature.

Mots clés additionnels : Poiriers, parasites, prédateurs, revue bibliographique mondiale sur les hôtes et les proies des ennemis naturels de *P. pyri*.

I. INTRODUCTION

Psylla pyri (L.) (*Hom.* : *Psyllidae*) has long been known as the main pest of pear trees in France (BONNEMAISON & MISSONNIER, 1956 ; GEOFFRION, 1981). Two other pear psyllids, *Psylla pyrisuga* Foerster and *Psylla pyricola* Foerster, are sporadically distributed in France and their damage is not significant (BONNEMAISON & MISSONNIER, 1956 ; ATGER, 1978 ; GEOFFRION, 1981).

ATGER (1977) emphasized that the general upsurge of *P. pyri* populations was closely related to the increase in number of chemical applications made to control it. These treatments both induced increased resistance in the pest and also contributed to reduction of antagonistic fauna (ATGER, 1977, 1978, 1979a, 1979b ; ATGER *et al.*, 1979). Failure of chemical control of *P. pyri* forced growers to reconsider their methods. Better knowledge of biology of the pest and of climatic, agricultural, ecological

and human factors for regulation of its populations, led to use of an integrated control strategy. In France, it is mainly based on use of soft pesticides applied during low activity of predators and in such a manner as to protect the orchard's environment, which is an excellent reservoir for beneficial insects (ATGER *et al.*, 1979).

Possibility of control of pear psylla by its natural enemies was noted in early studies on this pest in Europe (WILLE, 1950; BONNEMAISON & MISSONNIER, 1956; OVERMEER, 1961). The major natural enemies of pear psylla recorded in the literature in Europe are listed in table 1, which completes and updates the inventory of PHILOGENE & CHANG (1978).

In France, most authorities agree that only 3 species, *Anthocoris nemoralis* (F.) (*Het.* : *Anthocoridae*), *Prionomitus mitratus* (Dalman) and *Trechmites psyllae* (Ruschka) (*Hym.* : *Encyrtidae*) are closely tied to pear psylla and locally very effective in reducing it (FAUVEL & ATGER, 1981; NGUYEN *et al.*, 1981). However, when natural control of the psylla occurs, it cannot be done without the aid of many other species (BOUYJOU *et al.*, 1984; NGUYEN & DELVARE, 1984) and we do not precisely know their relationship and impact on *P. pyri* (FAUVEL & ATGER, 1981).

Our objective was to inventory parasitoids and predators of pear psylla in 3 orchards in France. By recording abundance of each species, we attempted to determine the most appropriate species for use in biological control.

II. MATERIALS AND METHODS

A. The orchards

We collected insects in a 7-hectare commercial orchard near Toulouse (Haute-Garonne) Southwestern France, in a 2-hectare abandoned plot in an orchard near Avignon (Vaucluse) Southeastern France, and in three 5 000 m² plots at Chanteloup-les-Vignes (Yvelines), Paris region.

At Avignon, the climate was mediterranean, moderated by the Rhone valley. The climate was more humid at Toulouse and much more humid at Chanteloup-les-Vignes. In the orchards visited, pear varieties were "Yellow Williams" at Avignon, and "Red Williams", "Beurré-Hardy" and "Dr. Guyot" at Toulouse and at Chanteloup-les-Vignes. The environment of the orchards was especially rich in the 3 regions. At Avignon, the orchard was surrounded by rows of poplar and hedges of various shrubs, with hawthorn dominating. At Toulouse, the orchard was also surrounded by hawthorn hedges and was close to several groves of deciduous trees (*Quercus*, *Carpinus*, *Ulmus*). At Chanteloup-les-Vignes, the pear plots were situated in a polyculture truck farming plain, the irrigation canals of which are hedged with nettle, *Urtica dioica* L. In southern France, hawthorn was mainly attacked by 2 psyllids, *Psylla melanoneura* Foerster and *Psylla crataegi* (Schrank); in northern France, it was also attacked by a third species *Psylla peregrina* Foerster. Nettle mainly was attacked by a psyllid, *Trioza urticae* L., by an aphid *Microlophium evansi* (Theobald) and by cicadellids, the most

frequent of which were *Eupteryx urticae* (F.) and *Eupteryx aurata* (L.). We regularly explored the spontaneous vegetation surrounding the orchards to determine if it harbored alternate hosts and prey for pear psylla enemies.

B. Methods

Adult psyllids and larvae and adults of predators were collected by beating branches over a 0.5 m² tray. Pear psylla nymphs and mummies were collected by cutting twigs bearing them. In the laboratory, mummies were isolated until parasites emerged. Living larvae were transferred to fresh ligneous pear twigs bearing tender leaves. The twigs, standing in aerated water, were placed in an incubator with 16-hour photoperiod and rather low constant temperature (16 °C) to avoid wilting. Mummies which formed on these twigs were also isolated.

III. RESULTS : ANNOTATED LIST OF SPECIES

Species inventoried, their hosts or prey, host plants, abundance and localities of collections are listed in table 2.

A. Parasitoids

The polyphagous encyrtid, *P. mitratus* was one of the most frequent primary parasitoids found in our pear psylla and hawthorn psylla samples (table 2). This confirmed the high attraction of the latter plant as a reservoir for beneficial insects for natural control of pear psylla. *P. mitratus* hibernated as an adult (LAL, 1934) and attacked 4th and 5th instar psylla nymphs (NGUYEN *et al.*, 1981). It occurred early in the year on the most precocious psyllae, *P. melanoneura* on hawthorn and *P. pyrisuga* on pear.

In Europe *P. mitratus* has often been noted on pear psylla (table 1), as sometimes being very efficacious against various psyllids (LAL, 1934; CARL & ZWÖLFER, 1965; TALITSKII, 1966), and especially against *P. pyri* (NGUYEN *et al.*, 1981; DELVARE *et al.*, 1981). *P. mitratus* was recently redescribed by DELVARE *et al.* (1981) and its development and ethology studied in detail by DELVARE (1977). It is holarctic in distribution (KROMBEIN *et al.*, 1979) and has been noted from Canada (PHILOGENE & CHANG, 1978), and in several states in the USA (JENSEN, 1957) on many species of psyllids.

According to FERRIERE (1961), *Prionomitus tiliaris* (Dalman) has rarely been noted in Europe; HELLEN (1949) collected it in Finland from an unknown host. FERRIERE (1961) noted its strong affinity to *P. peregrina*. However, ARZONE (1979) and GIUNCHI (1980) mentioned *P. tiliaris* as a very efficacious parasitoid of *P. pyri* at Pimerolo, Italy. We personally found it abundant on *P. peregrina* in the Paris region but also at Avignon on other hawthorn psyllids (table 2).

In abundance *T. psyllae* was the second primary parasitoid in our samples (table 2). It has been noted several times in Europe on pear psylla (table 1) as being responsible for a high rate of parasitism

TABLE 1

Biocomplex of pear psylla in Europe (Literature review).
Complexe biologique des psylles du poirier en Europe (Revue bibliographique).

| Order & Family | Species or Genus | Location | References |
|------------------------|---|--|---|
| PARASITIDS | | | |
| HYMENOPTERA | | | |
| Encyrtidae | <i>Prionomitus mitratus</i> (Dalman) | Scotland Switzerland France | LAL (1934). WILLE (1950). BONNEMAISON & MISSONNIER (1956), ATGER (1979b), ATGER <i>et al.</i> (1979), NGUYEN <i>et al.</i> (1981), DELVARE (1977), DELVARE <i>et al.</i> (1981), FERRIERE (1926, 1961). |
| | | Poland | WOJNAROWSKA (1962). |
| | | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Prionomitus tiliaris</i> (Dalman) | Italy | ARZONE (1979), GIUNCHI (1980). |
| | <i>Trechnites psyllae</i> (Ruschka) | Germany France | RUSCHKA (1923). BONNEMAISON & MISSONNIER (1956), NGUYEN <i>et al.</i> (1981). |
| | | England | GEORGALA (1957). |
| | | Russia | TALITSKII (1966). |
| | | Italy | ARZONE (1979), GIUNCHI (1980). |
| | <i>Psyllaephagus</i> sp. | Italy England | GOLFARI (1937), GRANDI (1951). GEORGALA (1957). |
| DIPTERA | | | |
| Cecidomyiidae | <i>Endopsylla agilis</i> de Meijere | England Scotland Holland Switzerland Austria Germany France Italy | BAGNALL & HARRISON (1924). BARNES (1930), LAL (1934). BARNES (1930). CARL (1969). CARL (1969). CARL (1969). CARL (1969). CARL (1969). |
| | <i>Endopsylla</i> sp. | Scotland | LAL (1934). |
| HYPERPARASITIDS | | | |
| HYMENOPTERA | | | |
| Encyrtidae | <i>Aphidencyrtus cantabricus</i> (Mercet) | Italy | ARZONE (1979), GIUNCHI (1980). |
| | <i>Aphidencyrtus mamitus</i> (Walker) | France | NGUYEN <i>et al.</i> (1981). |
| | <i>Aphidencyrtus taeniatus</i> (Foerster) | Russia | TALITSKII (1966). |
| | <i>Aphidencyrtus</i> sp. | France | BONNEMAISON & MISSONNIER (1956). |
| | <i>Marietta picta</i> (André) | Russia | TALITSKII (1966). |
| | <i>Encyrtus</i> sp. | Russia | YAKHONTOV (1929). |
| Pteromalidae | <i>Pachyneuron aphidis</i> Bouché | Russia France | TALITSKII (1966). NGUYEN <i>et al.</i> (1981). |
| | <i>Pachyneuron concolor</i> (Foerster) | Italy France | ARZONE (1979), GIUNCHI (1980). NGUYEN <i>et al.</i> (1981). |
| | <i>Pachyneuron solitarium</i> (Hartig) | Russia | TALITSKII (1966). |
| | <i>Pachyneuron</i> sp. | Scotland Italy France | LAL (1934). GOLFARI (1937), GRANDI (1951). BONNEMAISON & MISSONNIER (1956). |
| | <i>Asaphes vulgaris</i> Walker | Scotland | LAL (1934). |
| Ceraphronoidea | <i>Lygocerus semiramosus</i> Kieffer | Scotland | LAL (1934). |
| | <i>Lygocerus</i> sp. | England France | GEORGALA (1957). BONNEMAISON & MISSONNIER (1956). |
| PREDATORS | | | |
| HETEROPTERA | | | |
| Anthocoridae | <i>Anthocoris gallarum-ulmi</i> (DeGeer) | Yugoslavia | VRABL & MATIS (1977). |
| | <i>Anthocoris nemoralis</i> (F.) | England Europe Switzerland | BRONNIMANN (1964), CRANHAM (1980). CARL & ZWOLFER (1965), IOBC (1980). FIELDS & BEIRNE (1973), KEIMER (1983), BAGGIOLINI <i>et al.</i> (1979). |
| | | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), PEZZI (1982). |
| | | France | ATGER (1979b), ATGER <i>et al.</i> (1979), NGUYEN <i>et al.</i> (1981), FAUVEL & ATGER (1981), GEOFFRION (1981). |
| | <i>Anthocoris nemorum</i> (L.) | England Poland Europe France | GEORGALA (1957), BRONNIMANN (1964). WOJNAROWSKA <i>et al.</i> (1960). CARL & ZWOLFER (1965). BONNEMAISON & MISSONNIER (1956), NGUYEN <i>et al.</i> (1981). |
| | | Switzerland | SCHEURER <i>et al.</i> (1975). |

Table 1 (continued)

| Order & Family | Species or Genus | Location | References |
|-----------------------------|--|---|---|
| Miridae | <i>Orius minutus</i> (L.) | France | BONNEMAISON & MISSONNIER (1956), NGUYEN <i>et al.</i> (1981). |
| | | Yugoslavia | VRABL & MATIS (1977). |
| | | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Orius niger</i> (Wolff) | France | NGUYEN <i>et al.</i> (1981). |
| | <i>Orius vicinus</i> (Ribaut) | France | ATGER (1979 <i>b</i>), ATGER <i>et al.</i> (1979), FAUVEL & ATGER (1981), NGUYEN <i>et al.</i> (1981), GEOFFRION (1981). |
| | Anthocoridae spp. | Holland | OVERMEER (1961). |
| | <i>Campylomma verbasci</i> Meyer-Duer | France | FAUVEL & ATGER (1981). |
| | <i>Deraeocoris lutescens</i> (Schilling) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | | France | ATGER <i>et al.</i> (1979), FAUVEL & ATGER (1981). |
| | <i>Deraeocoris ruber</i> (L.) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| Nabidae | <i>Deraeocoris serenus</i> Douglas & Scott | France | FAUVEL & ATGER (1981). |
| | <i>Deraeocoris</i> sp. | France | ATGER (1979 <i>b</i>), NGUYEN <i>et al.</i> (1981). |
| | <i>Heterotoma meriopterum</i> (Scopoli) | France | FAUVEL & ATGER (1981). |
| | <i>Orthotylus nassatus</i> (F.) | France | FAUVEL & ATGER (1981). |
| | <i>Phytocoris</i> spp. | France | FAUVEL & ATGER (1981). |
| | | Denmark | THYGESSEN <i>et al.</i> (1973). |
| | <i>Pilophorus perplexus</i> (Doug. & Sc.) | France | FAUVEL & ATGER (1981). |
| | <i>Aptus myrmecoides</i> (O.C.) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Himacerus apterus</i> (F.) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| COLEOPTERA Coccinellidae | <i>Adalia bipunctata</i> (L.) | Poland | WOJNAROWSKA <i>et al.</i> (1960), WOJNAROWSKA (1962). |
| | | U.S.S.R. | SHALAMBERIDZE (1980). |
| | | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Calvia 14-guttata</i> (L.) | Italy | ARZONE (1979), GIUNCHI (1980). |
| | <i>Coccinella 7-punctata</i> L. | Poland | WOJNAROWSKA <i>et al.</i> (1960), WOJNAROWSKA (1962). |
| | | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Scymnus</i> sp. | France | ATGER (1979 <i>b</i>). |
| | <i>Stethorus punctillum</i> Weise | France | ATGER <i>et al.</i> (1979), FAUVEL & ATGER (1981). |
| | <i>Stethorus</i> sp. | France | ATGER (1979 <i>b</i>). |
| | Coccinellidae spp. | France | BONNEMAISON & MISSONNIER (1956), ATGER (1979 <i>b</i>), NGUYEN <i>et al.</i> (1981), FAUVEL & ATGER (1981). |
| NEUROPTERA Chrysopidae | | Holland | OVERMEER (1961). |
| | | Belgium | KNAPEN & VANWETSWINKEL (1977). |
| | | Yugoslavia | VRABL & MATIS (1977). |
| | <i>Chrysopa carnea</i> Stephens | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | | France | NGUYEN <i>et al.</i> (1981). |
| | | U.S.S.R. | SHALAMBERIDZE (1980). |
| | <i>Chrysopa flavifrons</i> Brauer | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Chrysopa perla</i> (L.) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Chrysopa 7-punctata</i> Wesmael | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Chrysopa</i> sp. | Poland | WOJNAROWSKA <i>et al.</i> (1960), WOJNAROWSKA (1962). |
| Chrysopidae spp. | France | BONNEMAISON & MISSONNIER (1956), BASSINO <i>et al.</i> (1975), ATGER <i>et al.</i> (1979), ATGER (1979 <i>b</i>), FAUVEL & ATGER (1981). | |
| Hemerobiidae | | Yugoslavia | VRABL & MATIS (1977). |
| | <i>Drepanopteryx phalaenoides</i> (L.) | Italy | ARZONE (1979), GIUNCHI (1980). |
| | <i>Hemerobius lutescens</i> F. | Italy | ARZONE (1979), GIUNCHI (1980). |
| | <i>Hemerobius micans</i> Olivier | Italy | ARZONE (1979), GIUNCHI (1980). |
| | Hemerobiidae spp. | France | BONNEMAISON & MISSONNIER (1956), ATGER <i>et al.</i> (1979), NGUYEN <i>et al.</i> (1981). |
| Coniopterygidae | Coniopterygidae spp. | France | ATGER <i>et al.</i> (1979). |
| DIPTERA Syrphidae | <i>Episyrphus balteatus</i> (DeGeer) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Lasiophthicus pyrastris</i> (L.) | Italy | ARZONE (1979), GIUNCHI (1980). |
| | <i>Platycheirus albimanus</i> (F.) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | <i>Platycheirus sticticus</i> (Meigen) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |

Table 1 (continued)

| Order & Family | Species or Genus | Location | References |
|-------------------|--------------------------------------|-----------------|---|
| | <i>Sphaerophoria scripta</i> (L.) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| | Syrphidae spp. | France | BONNEMAISON & MISSONNIER (1956), BASSINO <i>et al.</i> (1975), ATGER <i>et al.</i> (1979), ATGER (1979 <i>b</i>), NGUYEN <i>et al.</i> (1981). |
| | | Yugoslavia | VRABL & MATIS (1977). |
| ORTHOPTERA | | | |
| Tettigoniidae | <i>Meconema thalassinum</i> (DeGeer) | Italy | ARZONE (1979), GIUNCHI (1980). |
| Gryllidae | <i>Oecanthus pellucens</i> (Scopoli) | Italy | VIDANO <i>et al.</i> (1977-1978), ARZONE (1979), GIUNCHI (1980). |
| HYMENOPTERA | | | |
| Formicidae | Formicidae spp. | France | NGUYEN <i>et al.</i> (1981). |
| ARACHNIDA | | | |
| Araneidae | Araneidae spp. | France | FAUVEL & ATGER (1981). |
| PATHOGEN | | | |
| Entomophthoraceae | <i>Entomophthora</i> sp. | France Italy | BONNEMAISON & MISSONNIER (1956). VIDANO <i>et al.</i> (1977-1978), PICCO (1978), ARZONE (1979), GIUNCHI (1980). |

TABLE 2

Biocomplex of Psylla spp. on pear trees, hawthorn and nettle in France, by F. HERARD
Complexe biologique des psylles du poirier, aubépine et ortie en France, par F. HERARD

| Species | Host or Prey PP = Pear psylla | Host Plant PT = Pear tree H = Hawthorn N = Nettle | Locality A = Avignon T = Toulouse C = Chanteloup- les-vignes S = Sèvres | Abundance | |
|--|--|--|--|---|-------------------|
| | | | | 0 = rare + = not very abundant ++ = rather abundant +++ = abundant | |
| PARASITOIDS | | | | | |
| HYMENOPTERA | | | | | |
| Encyrtidae | | | | | |
| <i>Prionomitus mitratus</i> (Dalman) | <i>Psylla pyri</i> (L.) | PT | A, T | ++ | |
| | <i>Psylla pyrisuga</i> Foerster | PT | A, T | 0 | |
| | <i>Psylla melanoneura</i> Foerster | H | A | + | |
| | <i>Psylla peregrina</i> Foerster | H | S | ++ | |
| | <i>Psylla crataegi</i> (Schrank) | H | A | +++ | |
| | <i>Prionomitus tiliaris</i> (Dalman) | <i>P. melanoneura</i> <i>P. peregrina</i> <i>P. crataegi</i> | H H H | A S A | + +++ + |
| <i>Trechnites psyllae</i> (Ruschka) | <i>P. pyri</i> | PT | A, T, C | ++ | |
| | <i>P. pyrisuga</i> | PT | A, T | 0 | |
| | <i>P. crataegi</i> | H | A | + | |
| <i>Coccophagus ? obscurus</i> Westwood | <i>P. peregrina</i> | H | S | 0 | |
| HYPERPARASITOIDS | | | | | |
| HYMENOPTERA | | | | | |
| Encyrtidae | | | | | |
| <i>Aphidencyrus mamitus</i> (Walker) | <i>P. mitratus</i> in <i>P. pyri</i> | PT | A, T | + | |
| | in <i>P. pyrisuga</i> | PT | A, T | + | |
| | in <i>P. peregrina</i> | H | S | + | |
| | in <i>P. crataegi</i> | H | A | + | |
| | <i>P. tiliaris</i> in <i>P. peregrina</i> | H | S | +++ | |
| | <i>T. psyllae</i> in <i>P. pyri</i> | PT | A, T, C | + | |
| | in <i>P. pyrisuga</i> | PT | A, T | + | |
| | <i>Aphidencyrus ? taeniatus</i> (Foerster) | <i>P. mitratus</i> in <i>P. pyri</i> | PT | A | 0 |
| | <i>Aphidencyrus ? aphidivorus</i> (Mayr) | <i>P. tiliaris</i> in <i>P. peregrina</i> | H | S | 0 |

Table 2 (continued)

| Species | Host or Prey PP = Pear psylla | Host Plant PT = Pear tree H = Hawthorn N = Nettle | Locality A = Avignon T = Toulouse C = Chanteloup- les-vignes S = Sèvres | Abundance 0 = rare + = not very abundant ++ = rather abundant +++ = abundant |
|--|--|--|--|--|
| Pteromalidae | | | | |
| <i>Pachyneuron concolor</i> (Foerster) (= <i>muscarum</i> (L.)) | <i>P. mitratus</i> in <i>P. peregrina</i> in <i>P. crataegi</i> in <i>P. pyri</i> | H H PT | S A A, T, C | 0 0 + |
| <i>Hyperimerus pusillus</i> (Walker)* | <i>P. tiliaris</i> in <i>P. peregrina</i> | H | S | 0 |
| <i>Coruna clavata</i> Walker | <i>P. tiliaris</i> in <i>P. peregrina</i> | H | S | 0 |
| Cynipoidea | | | | |
| Alloxystidae | | | | |
| <i>Dilyta subclavata</i> Foerster | <i>P. mitratus</i> in <i>P. pyri</i> | PT | A, T | 0 |
| Ceraphronoidea | | | | |
| Megaspilidae | | | | |
| <i>Dendrocercus psyllarum</i> Dessart** | <i>P. tiliaris</i> in <i>P. peregrina</i> | H | S | 0 |
| PREDATORS | | | | |
| HETEROPTERA | | | | |
| Anthocoridae | | | | |
| <i>Anthocoris nemoralis</i> (F.) | PP | PT | A, T, C | +++ |
| | <i>P. peregrina</i> | H | S | ++ |
| | <i>P. crataegi</i> | H | A | + |
| <i>Anthocoris nemorum</i> (L.) | PP | PT | C | ++ |
| | <i>Trioxa urticae</i> L. | N | C, S | + |
| <i>Anthocoris confusus</i> Reuter | PP | PT | C | 0 |
| <i>Orius horvathi</i> (Reuter) | PP | PT | A, T, C | +++ |
| <i>Orius vicinus</i> (Ribaut) | PP | PT | A, T, C | ++ |
| | <i>P. peregrina</i> | H | S | + |
| <i>Orius minutus</i> (L.) | PP | PT | A, T, C | + |
| | <i>P. peregrina</i> | H | S | + |
| <i>Orius niger</i> (Wolff) | PP | PT | T, C | + |
| | <i>T. urticae</i> | N | T, C | + |
| <i>Orius laevigatus</i> (Fieber) | PP | PT | A, T, C | 0 |
| <i>Orius majusculus</i> (Reuter) | PP | PT | A, C | 0 |
| <i>Temnostethus pusillus</i> (Herrich-Schäffer) | PP | PT | T | 0 |
| <i>Cardiastethus fasciventris</i> (Garb.) | Psocidae, <i>Psylla</i> ? | PT | A, T | 0 |
| | | H | S | 0 |
| Miridae | | | | |
| <i>Heterotoma meriopterum</i> (Scopoli) | PP | PT | A, T, C | +++ |
| | <i>P. crataegi</i> | H | A | ++ |
| | <i>P. peregrina</i> | H | S | + |
| | <i>T. urticae</i> | N | S | ++ |
| <i>Campyloneura virgula</i> (Herrich-Schäffer) | PP | PT | A, T, C | +++ |
| | <i>P. peregrina</i> | H | S | + |
| | <i>P. crataegi</i> | H | A | + |
| <i>Orthotylus nassatus</i> (F.) | PP | PT | A, T | +++ |
| | <i>P. crataegi</i> | H | A | + |
| <i>Deraeocoris lutescens</i> (Schilling) | PP | PT | A, T | + |
| | <i>P. crataegi</i> | H | A | 0 |
| <i>Deraeocoris ruber</i> (L.) | PP | PT | C | 0 |
| <i>Pilophorus perplexus</i> (Douglas & Scott) | PP | PT | A, T | + |
| <i>Pilophorus gallicus</i> Remane | PP | PT | A | 0 |
| <i>Pilophorus clavatus</i> (L.) | PP | PT | T | + |
| <i>Mimocoris rugicollis</i> (Costa) | PP | PT | A | 0 |
| <i>Psallus ambiguus</i> (Fallen) | PP | PT | T | 0 |
| | <i>P. peregrina</i> | H | S | 0 |
| <i>Phytocoris longipennis</i> Flor | PP | PT | T, C | 0 |
| <i>Phytocoris ulmi</i> (L.) | PP | PT | T | 0 |
| Nabidae | | | | |
| <i>Himacerus apterus</i> (L.) | PP | PT | T, C | 0 |
| <i>Nabis ferus</i> (L.) | PP | PT | T | 0 |
| <i>Nabis punctatus</i> Costa | PP | PT | T | 0 |

* First host record ; ** New species ; ? Species = means that the identification is not certain, because the specimen is aberrant, usually too small, with unevident characters.

Table 2 (continued)

| Species | Host or Prey PP = Pear psylla | Host Plant PT = Pear tree H = Hawthorn N = Nettle | Locality A = Avignon T = Toulouse C = Chanteloup- les-vignes S = Sèvres | Abundance 0 = rare + = not very abundant ++ = rather abundant +++ = abundant |
|---|----------------------------------|--|--|--|
| COLEOPTERA | | | | |
| Coccinellidae | | | | |
| <i>Stethorus punctillum</i> (Weise) | Mites, <i>Psylla</i> ? | PT | A | +++ |
| <i>Scymnus rubromaculatus</i> (Goeze) | PP | PT | A, T | +++ |
| | <i>P. crataegi</i> | H | A | + |
| <i>Scymnus subvillosus</i> (Goeze) | PP | PT | A | +++ |
| <i>Scymnus interruptus</i> (Goeze) | PP | PT | A | 0 |
| <i>Rhyzobius chrysomeloides</i> (Herbst) | PP | PT | A | 0 |
| | <i>P. peregrina</i> | H | S | 0 |
| <i>Clitostethus arcuatus</i> (Rossi) | White flies | H | S | + |
| | <i>P. peregrina</i> | H | S | 0 |
| <i>Adalia bipunctata</i> (L.) | PP | PT | A, T, C | + |
| <i>Synharmonia conglobata</i> (L.) | PP | PT | A, T | 0 |
| <i>Synharmonia lyncea</i> Olivier | PP | PT | T | 0 |
| <i>Propylea quatuordecimpunctata</i> (L.) | PP | PT | A, T | 0 |
| <i>Coccinella septempunctata</i> L. | PP | PT | A, T | ++ |
| <i>Chilocorus renipustulatus</i> (Scriba) | PP | PT | T | 0 |
| <i>Coccinula quatuordecimpustulata</i> (L.) | PP | PT | T | 0 |
| <i>Thea vigintiduopunctata</i> (L.) | PP | PT | A | + |
| Carabidae | | | | |
| <i>Demetrias atricapillus</i> (L.) | PP | PT | A, T | + |
| NEUROPTERA | | | | |
| Chrysopidae | | | | |
| <i>Chrysoperla carnea</i> (Stephens) | PP | PT | A, T, C | +++ |
| <i>Anisochrysa prasina</i> (Burmeister) | PP | PT | A | 0 |
| <i>Anisochrysa picteti</i> (McLachlan) | PP | PT | A | 0 |
| Hemerobiidae | | | | |
| <i>Hemerobius humulinus</i> L. | PP | PT | A, T | + |
| | <i>P. crataegi</i> | H | A | + |
| <i>Wesmaelius subnebulosa</i> (Stephens) | PP | PT | A | 0 |
| <i>Symphorobius pygmaeus</i> (Rambur) | PP | PT | A | 0 |
| Coniopterygidae | | | | |
| <i>Coniopteryx borealis</i> Tjeder | PP | PT | A, T | ++ |
| | <i>P. peregrina</i> | H | S | + |
| | <i>P. crataegi</i> | H | A | + |
| DIPTERA | | | | |
| Syrphidae | | | | |
| <i>Meliscaeva auricollis</i> (Meigen) | PP | PT | T | + |
| <i>Syrphus vitripennis</i> (Meigen) | PP | PT | T | + |
| <i>Episyrphus balteatus</i> (De Geer) | PP | PT | T | + |
| ACARI | | | | |
| <i>Anystis</i> sp. | PP | PT | A, T | + |
| <i>Allothrombium fuliginosum</i> Hermann | PP | PT | A, T | ++ |
| PATHOGEN | | | | |
| <i>Entomophthora</i> sp. | <i>P. peregrina</i> | H | S | 0 |

(TALITSKII, 1966). We also obtained it from *P. crataegi* nymphs at Avignon in 1981. In contrast to *P. mitratus*, *T. psyllae* generally were abundant in late summer and in autumn. It hibernated in the larval stage inside its mummified host. In early winter, we observed that *P. pyri* nymphs parasitized by *T. psyllae* moved downward on pear trees, 2 to 3 meters from the crown. There they stopped in crevices of the bark and mummified. We trapped them in large numbers using undulated cardboard traps placed at the base of the tree. This implies that the parasitoid can influence the behavior of its host in autumn thus affording it a favorable hibernating site at the moment of host mummification. In contrast, we found that in autumn unparasitized 5th instar

nymphs abandoned leaves which were going to fall and come to rest on twigs 10 to 30 cm from their original feeding site. There they moult to become adults and to overwinter. Interestingly, in summer, the parasitized nymphs of pear psylla did not mummify further than 30 cm from their feeding site.

T. psyllae was introduced several times in California between 1965 and 1968 (CLAUSEN, 1978) to contribute to the control of *P. pyricola*. This encyrtid has also been found in Ontario, Canada, where its introduction probably was fortuitous.

Specimens of *Coccophagus* (?) *obscurus* Westwood which we obtained from *P. peregrina* were considered by Dr. BOUCEK (pers. com.), who identified them, most probably as primary parasitoids of this psyllid.

This encyrtid has been recorded as a primary parasitoid of the coccid, *Euphillippia olivina* Berl. & Silv., on olive in Italy (SCALTRITI, 1982).

B. Hyperparasitoids

In our samples of pear and hawthorn psyllid mummies, the encyrtids, *P. mitratus*, *P. tiliaris* and *T. psyllae*, were sometimes parasitized by *Aphidencyrthus mamitus* (Walker) (table 2). According to NGUYEN *et al.* (1981), this encyrtid can attack 2nd and 5th instar larvae and prepupae of *P. mitratus* and *T. psyllae* inside *P. pyri*. STARY (1970) obtained *A. mamitus* from the sycamore aphid *Drepanosiphum platanoides* (Schrank) in Czechoslovakia.

We obtained *Aphidencyrthus* (?) *taeniatus* (Foerster) from *P. pyri* nymphs parasitized by *P. mitratus*. In the USSR, TALITSKII (1966) noted *A. taeniatus* as a primary and occasionally a secondary parasitoid of *P. pyri*.

We reared *Aphidencyrthus* (?) *aphidivorus* (Mayr) from *P. peregrina* parasitized by *P. tiliaris*. From references recorded in table 3, *A. aphidivorus* is holarctic in distribution and generally collected from aphids, sometimes as a primary parasitoid but most often as a hyperparasitoid.

Among the pteromalid hyperparasitoids found in our pear and hawthorn psyllid samples, *Pachyneuron concolor* (Foerster) (= *muscarum* (L.)) was the commonest (table 2). It was recorded in 1939 from *P. peregrina* (GRAHAM, 1969), very probably as a hyperparasitoid of this psyllid. NGUYEN *et al.* (1981) observed it as an ectoparasitoid of 5th instar larvae, prepupae and pupae of *P. mitratus* and *T. psyllae* inside *P. pyri* mummies. *P. concolor* is polyphagous and was sometimes mentioned as a primary parasitoid (table 4). More often it has been a hyperparasitoid and sometimes as a tertiary parasitoid on members of its own species, as well as on various other chalcidoids that have developed as secondary parasitoids in an encyrtid host (ROSEN & KFIR, 1983).

We obtained *Hyperimerus pusillus* (Walker) from *P. peregrina* nymphs parasitized by *P. tiliaris*. According to Dr. BOUCEK (pers. com.) who identified this Pteromalid, it is a first host record. Biology of *H. pusillus* is unknown (GRAHAM, 1969), but it was collected in Britain, Sweden, Czechoslovakia, Yugoslavia, and now in France. A related nearctic species, *Hyperimerus corvus* Girault, was mentioned as a parasitoid of *Chrysopa* sp., *Hemerobius* sp. and *Sympherobius* sp., closely associated with *Pseudococcus* in its native environment (KROMBEIN *et al.*, 1979).

TABLE 3

Host of Aphidencyrthus aphidivorus (Mayr) noted in recent literature.
Hôtes d'A. aphidivorus signalés récemment dans la littérature.

| Primary host | Secondary host | Host plant | Location | References |
|--|--|---------------------|-------------------|--|
| Aphids | | | | |
| <i>Aphis gossypii</i> Glover | ..... | cotton | Bulgaria India | RADEV (1968). PALANISWAMI & PILLAI (1980). |
| <i>Aphis fabae</i> Scopoli | ..... | broad bean | Iraq | SELIM (1977). |
| <i>Aphis pomi</i> De Geer | ..... | apple | India | HAYAT (1981). |
| <i>Aphis craccivora</i> Koch | ..... | leguminous crops | Pakistan | HAMID <i>et al.</i> (1977). |
| <i>Uroleucon compositae</i> (Theobald) | ..... | safflower | India | THONTADARYA <i>et al.</i> (1976). |
| <i>Rhopalosiphum maidis</i> (Fitch) | ..... | sorghum | India | RADKE & BARWAD (1978). |
| Hymenoptera | | | | |
| | Aphids | | | |
| ? | <i>Toxoptera aurantii</i> | | | |
| | Boyer de Fonscolombe | citrus | Greece | SANTAS (1979). |
| ? | <i>Diuraphis noxia</i> (Mordvilko) | barley, wheat | U.S.S.R. | BEREST (1980a). |
| ? | <i>Schizaphis graminum</i> (Rondani) | barley, wheat | U.S.S.R. | BEREST (1980a). |
| ? | <i>A. gossypii</i> | cotton | China | SHI (1982). |
| <i>Aphelinus flavus</i> Thomson | <i>Drepanosiphum platanoides</i> (Schrank) | sycamore | Scotland | HAMILTON (1973). |
| <i>Aphelinus abdominalis</i> (Dalman) | <i>Metopolophium dirhodum</i> (Walker) | <i>Phalaris</i> sp. | Argentina | BOTTO (1981). |
| <i>Aphelinus nigritus</i> Howard | <i>R. maidis</i> | sorghum | U.S.A. | SUMMY <i>et al.</i> (1979), ARCHER <i>et al.</i> (1974), JACKSON <i>et al.</i> (1970). |
| <i>Aphelinus varipes</i> (Foerster) | <i>R. maidis</i> | sorghum | U.S.A. | ARCHER <i>et al.</i> (1974), JACKSON <i>et al.</i> (1970). |
| <i>Aphidius colemani</i> Viereck | <i>S. graminum</i> | sorghum | Brazil | GRAVENA (1982). |
| <i>Aphidius smithi</i> | | | | |
| Sharma & Subba Rao | <i>Acyrtosiphon pisum</i> (Harris) | lucerne, red clover | U.S.A. | PASS & PARR (1971). |
| <i>Diaeretiella rapae</i> (Mc Intosh) | <i>S. graminum</i> | sorghum | Brazil U.S.A. | GRAVENA (1979). WALKER <i>et al.</i> (1973). |
| <i>Lysiphlebus testaceipes</i> (Cresson) | <i>S. graminum</i> | sorghum | U.S.A. | JACKSON <i>et al.</i> (1970), WALKER <i>et al.</i> (1973), ARCHER <i>et al.</i> (1974), SUMMY <i>et al.</i> (1979). |

TABLE 4

Hosts of Pachyneuron concolor (Foerster) noted in recent literature.
Hôtes de P. concolor signalés récemment dans la littérature.

| Primary host | Secondary host | Host plant | Location | References |
|---|---|-----------------------|----------|------------------------------|
| <i>Sphaerolecanium prunastri</i> (Fonsc.) | ..... | fruit trees | Serbia | MITIC-MUZINA (1967). |
| <i>Dendrolimus pini</i> (L.) eggs | ..... | pinus | Hungary | BENEDEK (1969). |
| <i>Oscinella frit</i> (L.) | ..... | cereals | Israel | ROSEN & KFIR (1983). |
| <i>Leucopis</i> sp. | ..... | various plants | Israel | ROSEN & KFIR (1983). |
| ? | soft scales | various plants | U.S.S.R. | SUGONYAEV & BABAEV (1978). |
| ? | <i>Psylla peregrina</i> Foerster | hawthorn | Scotland | GRAHAM (1969). |
| <i>Prionomitus mitratus</i> (Dalman) | <i>Psylla pyri</i> (L.) | pear | France | NGUYEN <i>et al.</i> (1981). |
| <i>Trechmites psyllae</i> (Ruschka) | <i>P. pyri</i> | pear | France | NGUYEN <i>et al.</i> (1981). |
| <i>Microterys flavus</i> (Howard) | <i>Coccus hesperidum</i> L. | citrus | Israel | KFIR & ROSEN (1981). |
| <i>Microterys hortulanus</i> Erdős | <i>S. prunastri</i> | sloe | Poland | PODSIADLO (1981). |
| <i>Coccophagus lycimnia</i> (Walker) | <i>S. prunastri</i> | peach, cherry, almond | Greece | ARGYRIOU & PALOUKIS (1976). |
| <i>Discoides coccophagus</i> (Ratzeburg) | <i>S. prunastri</i> | sloe | Poland | PODSIADLO (1981). |
| <i>Metaphycus silvestrii</i> Sugonyaev | <i>S. prunastri</i> | sloe | Poland | PODSIADLO (1981). |
| <i>Metaphycus lounsburyi</i> (Howard) | <i>Saissetia oleae</i> (Olivier) | olive | Italy | MONACO (1976). |
| Encyrtids | coccids, mealybugs, coccinellids | various plants | Israel | ROSEN & KFIR (1983). |
| <i>Trichogramma embryophagum</i> (Hartig) | <i>Acantholyda pinivora</i> Enslin eggs | pinus | Poland | KOEHLER (1967). |

We found *Coruna clavata* Walker as a hyperparasite of *P. peregrina* (parasitized by *P. tiliaris*) in the Paris region. According to GRAHAM (1969), this Pteromalid is widely distributed in Europe, USSR and North America. It generally has been noted as a hyperparasite of aphids through various species of *Aphidiidae* (SHANDS *et al.*, 1965; GRAHAM, 1969; DEAN, 1974; HAMILTON, 1973; JONES, 1979; KROMBEIN *et al.*, 1979).

We found *Dilyta subclavata* Foerster as a hyperparasite of *P. pyri* through *P. mitratus* in Southern France. Nothing is known on this species. Other species belonging to the same family *Alloxystidae* parasitize braconid or chalcidoid primary parasites of aphids or other *Homoptera* (KROMBEIN *et al.*, 1979).

From some of the *P. peregrina* nymphs (parasitized by *P. tiliaris*) collected in the Paris region, a new species of *Ceraphronoidea* (*Megaspilidae*) emerged which DESSART described and named *Dendrocerus psyllarum* (DESSART, 1983). Specimens previously obtained from *P. pyri* mummies at Versailles by BONNEMAISON & MISSONNIER in 1956, were also used by DESSART for describing the species. Other *Dendrocerus* were already mentioned as hyperparasitoids of psyllids; in Britain, *Lygocerus* (= *Dendrocerus*) *semiramosus* Kieffer (LAL, 1934), a hyperparasitoid of *P. peregrina* through *P. mitratus* and *Lygocerus* sp. was obtained from 5th instar nymphs of *P. pyricola* (GEORGALA, 1957). In France, BONNEMAISON & MISSONNIER (1956) recorded *Lygocerus* sp. from *P. pyri* mummies.

C. Predators

1. Heteroptera

a) Anthocoridae

The anthocorid *A. nemoralis* was the most abundant predator in all the orchards infested with

P. pyri which we examined and the most efficacious enemy of this pest. A literature review (table 1) showed that *A. nemoralis* is a permanent component of the biocomplex of pear psylla in Europe. It is a very polyphagous predator, but its most common prey are psyllids (ANDERSON, 1962a). It preferably frequents the tree and shrub stratum and a few conifers, but over all, it prefers deciduous species, mainly fruit trees (PERICART, 1972). Its distribution includes Europe and the mediterranean countries (PERICART, 1972). Its main prey other than pear psylla, based on recent literature, are listed in table 5. *A. nemoralis* was introduced in 1963 in North America in a pear orchard infested with *P. pyricola* near Summerland, British Columbia, where its establishment was successful (McMULLEN & JONG, 1967b; FIELDS & BEIRNE, 1973; CLAUSEN, 1978). Release in other locations resulted in establishment as well, i.e. Ontario (KELTON, 1978; HAGLEY & SIMPSON, 1983). *A. nemoralis* has dispersed and replaced the native predators, *Anthocoris antevolens* White and *Anthocoris melanocerus* Reuter as the most common anthocorid predator in some orchards (FIELDS & BEIRNE, 1973).

We did not observed *Anthocoris nemorum* (L.) in pear orchards in southern France, but it was abundant in the Paris region, especially in autumn. Otherwise, we found it abundantly in spring and summer in the herbaceous stratum, especially on nettle close to orchards. That led us to study some components of its ecology and ethology to evaluate its relationship to pear psylla and its potential as a biological control agent against this pest. These results were presented in another paper (HERARD & CHEN, 1985) and complete information already furnished by HILL (1957), ANDERSON (1962a, b, c), COLLYER (1967), RUSSEL (1970, 1972), PARKER (1975), EVANS (1976a), CAMPBELL (1977), LAUENSTEIN (1976, 1977, 1980) on this predator.

TABLE 5

Prey of Anthocoris nemoralis (F.), other than pear psylla, noted in recent literature.
Proies d'A. nemoralis (sauf les psylles du poirier), signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|---|-------------------------|-------------------------------|--|
| Aphids | | | |
| <i>Phorodon humuli</i> (Schrank) | hops | England | AVELING (1981a, 1981b), CAMPBELL (1977, 1978). |
| <i>Eriosoma ulmi</i> (L.) | elm | Poland | JANISZEWSKA-CIHOCKA (1971). |
| <i>Brevicoryne brassicae</i> (L.) | cabbage | Bulgaria | TSACHEV (1972). |
| Cecidomyiids | | | |
| <i>Dasineura mali</i> (Kieffer) | apple | Germany | CARL (1980). |
| <i>Macrolabis</i> sp. | apple | Germany | CARL (1980). |
| Aleurodids | | | |
| <i>Siphoninus phillyreae</i> (Haliday) | pear hawthorn | Bulgaria Bulgaria | PELOV & TRENCH (1973). PELOV & TRENCH (1973). |
| Lepidoptera | | | |
| <i>Leucoptera scitella</i> (Zeller) | apple | Bulgaria | IVANOV (1978). |
| <i>Phyllonorycter blancardella</i> (F.) | apple | Bulgaria | IVANOV (1978). |
| <i>Phyllonorycter corylifoliella</i> (Herbst) | apple | Bulgaria | IVANOV (1978). |
| <i>Stigmella malella</i> (Sainton) | apple | Bulgaria | IVANOV (1978). |
| <i>Cydia pomonella</i> (L.) | apple | England Bulgaria | GLEN (1975). KARADZHOV (1973a). |
| Mites | | | |
| <i>Panonychus ulmi</i> (Koch) | apple | England Bulgaria Poland | SOLOMON (1982). KARADZHOV (1973b). KORCZ (1971). |
| <i>Bryobia rubrioculus</i> (Scheuten) | apple | Poland | KORCZ (1971). |
| <i>Tetranychus urticae</i> Koch | apple | Poland | KORCZ (1971). |
| <i>Tetranychus viennensis</i> Zacher | apple | Poland | KORCZ (1971). |
| Tetranychids | various plants | Bulgaria | BALEVSKI (1977). |
| Various prey | | | |
| aphids, psyllids, thrips, noctuid larvae, mites | apple various plants | Sweden Turkey | NORLANDER (1977). ONDER (1982). |

A. nemorum is distributed throughout Europe, Russia, Siberia (except the steppes regions), and China. However, it is rare in the mediterranean region (PERICART, 1972). It is an ubiquitous species and very eclectic in the choice of its prey (PERICART, 1972). Although it accepts many prey, there are great differences among them in nutritive value for the predator (HERARD & CHEN, 1985). *A. nemorum* has sometimes been noted on pear (table 1), and a long list of its prey was prepared by COLLYER (1967). Table 6 presents a list of prey besides pear psylla, as noted in the literature since 1965. Unsuccessful attempts to introduce *A. nemorum* into North America for control of *P. pyricola* were made in 1962 (CLAUSEN, 1978). New attempts were made in 1982 and 1983 in the state of Washington (USA), using predators reared and supplied by us. Results of these U.S. releases to control the pest are yet unknown, but our observations on this predator lead us to believe that it cannot be an efficient species against pear psylla (HERARD & CHEN, 1985).

We collected very small numbers of the predator *Anthocoris confusus* Reuter on pear trees in the Paris region (table 2). This anthocorid has been noted from Europe, Siberia and Japan, but in France, it is most common in the northern half of the country, occurring on deciduous and fruit trees (PERICART, 1972). It was observed mainly as a predator of aphids, notably of *D. platanoides* on sycamore in Scotland (RUSSEL, 1970 ; DIXON & RUSSEL, 1972 ; HAMILTON,

1973) ; in England, as a predator of *Acyrtosiphon pisum* (Harris) (ELLIOTT, 1970) and of *Aulacorthum circumflexum* (Buckton) (EVANS, 1976b, c, d, e) on broad bean, and of *Phorodon humuli* (Schrank) on hops (AVELING, 1981b). In France, it has been listed as a predator of various prey on apple (FAUVEL, 1974a).

Among the 6 species of *Orius* inventoried in pear orchards, 3 were abundant, *Orius horvathi* (Reuter), *Orius vicinus* (Ribaut), *Orius minutus* (L.), and 3 were rare, *Orius niger* (Wolff), *Orius laevigatus* (Fieber) and *Orius majusculus* (Reuter).

We observed *O. horvathi* in high numbers in the pear psylla infested orchards we examined (table 2). According to FAUVEL (1974a), this anthocorid seems more tied to phytophagous mites than to psyllids and aphids in orchards. However, it has been noted as a predator of *Aphis pomi* De Geer (STRAWINSKI, in PERICART, 1972), and of aphids, psyllids, thrips, noctuid larvae, and mites in Turkey (ONDER, 1982). Distribution of *O. horvathi* is throughout the western and eastern palearctic regions (PERICART, 1972) to China (ZHENG, 1982).

We found *O. vicinus* associated with *P. pyri* in all orchards examined and with *P. peregrina* in the Paris region, as well (table 2). This anthocorid was previously mentioned as being associated with pear psylla (table 1), but it accepts many other prey, from many plants (PERICART, 1972). *O. vicinus* and *A. nemoralis* are the most common predator of

TABLE 6

Prey of Anthocoris nemorum (L.) other than pear psylla, noted in the literature since 1965.

Proies d'A. nemorum (sauf les psylles du poirier), signalées dans la littérature depuis 1965.

| Prey | Host plants | Location | References |
|--|-----------------------|--------------|--|
| Aphids | | | |
| <i>Drepanosiphum platanoides</i> (Schrank) | sycamore | Scotland | RUSSEL (1970), DIXON & RUSSEL (1972), HAMILTON (1973). |
| <i>Phorodon humuli</i> (Schrank) | hops | England | CAMPBELL (1977, 1978) AVELING (1981b), PARKER (1981). |
| <i>Aphis pomi</i> DeGeer | apple | Germany | ASCARI (1966). |
| Aphids spp. | apple | France | FAUVEL (1974a). |
| | fruit trees | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Acyrtosiphon pisum</i> (Harris) | broad bean | England | ELLIOTT (1970). |
| | pea | England | EVANS (1976a). |
| Aphids spp. | Brussels sprouts | England | SMITH (1976). |
| | cabbage, beet, potato | France | BONNEMAISON (1971). |
| Psyllids | | | |
| <i>Psyllopsis fraxini</i> (L.) | ash | England | HODKINSON & FLINT (1971). |
| Aleurodids | | | |
| <i>Trialeurodes vaporariorum</i> (Westwood) | tomato, cucumber | Sweden | EKBOM (1981). |
| Diptera | | | |
| <i>Thomasiniana theobaldi</i> Barnes | raspberry | U.S.S.R. | BOLDYREV (1968b). |
| <i>Dasineura tetensi</i> (Rübsaamen) | black currant | U.S.S.R. | GONCHAROVA (1968), GONCHAROVA & SAMOSUDOV (1979). |
| <i>Dasineura mali</i> (Kieffer) | apple | Germany | CARL (1980). |
| <i>Macrolabis</i> sp. | apple | Germany | CARL (1980). |
| <i>Oscinella frit</i> (L.) | cats | England | JONES (1969). |
| Coleoptera | | | |
| <i>Coccinella septempunctata</i> L. | hibernating site | U.S.S.R. | LIPA & SEM'YANOV (1967). |
| | various plants | U.S.S.R. | SEM'YANOV (1981). |
| <i>Coccinella quinquepunctata</i> L. | hibernating site | U.S.S.R. | LIPA & SEM'YANOV (1967). |
| <i>Adalia bipunctata</i> (L.) | hibernating site | U.S.S.R. | LIPA & SEM'YANOV (1967). |
| Coccinellids | various plants | Bulgaria | GRIGOROV (1983). |
| <i>Byturus tomentosus</i> (DeGeer) | raspberry | U.S.S.R. | BATASHEVA (1979). |
| <i>Gastrophysa viridula</i> (DeGeer) | <i>Rumex</i> | England | SMITH & WHITTAKER (1980). |
| Lepidoptera | | | |
| <i>Orthotaenia undulana</i> (Denis & Schiff.) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Choristoneura diversana</i> (Hübner) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Archips rosanus</i> (L.) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Archips xylosteanus</i> (L.) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Archips podanus</i> (Scopoli) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Ptycholoma lecheanum</i> (L.) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Pandemis cerasana</i> (Hübner) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Hedya nubiferana</i> (Haworth) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Syndemis musculana</i> (Hübner) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Eulia ministrans</i> (L.) | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Cnephasia</i> sp. | raspberry | U.S.S.R. | BATASHEVA (1981). |
| <i>Cydia funebrana</i> (Treitschke) | plum | U.S.S.R. | GOLUBENKO (1969). |
| <i>Cydia pomonella</i> (L.) | apple | England | GLEN (1975). |
| <i>Phyllonorycter pyrifoliella</i> (Gerasimov) | apple | U.S.S.R. | BOLDHYREV (1968a, 1975). |
| <i>Sitotroga cerealella</i> (Olivier) | laboratory | Poland | NIEMCZYK (1970). |
| Mites | | | |
| <i>Panonychus ulmi</i> (Koch) | apple | U.S.S.R. | SIDLJAREVICH (1965). |
| | | Poland | KORCZ (1971). |
| | | Bulgaria | KARADZHOV (1973a, 1973b). |
| | | France | FAUVEL (1974a). |
| | | England | SOLOMON (1982). |
| | | U.S.S.R. | SIDLJAREVICH (1968). |
| <i>Bryobia rubrioculus</i> (Scheuten) | orchards | Poland | KORCZ (1971). |
| <i>Tetranychus urticae</i> Koch | apple | Poland | KORCZ (1971). |
| <i>Tetranychus viennensis</i> Zacher | apple | Poland | KORCZ (1971). |
| Tetranychids spp. | various plants | Bulgaria | BALEVSKI (1977). |
| Various prey | | | |
| | apple | East Germany | ZELETZKI & RINNHOFER (1966). |
| | | Poland | KORCZ (1967), NIEMCZYK (1969, 1978b). |
| | | Sweden | NORDLANDER (1977). |
| | | Norway | AUSTRENG & SOMME (1980), SKANLAND (1981). |
| | various plants | Yugoslavia | GOLLNER-SCEIDING (1978). |
| | | Germany | LAUENSTEIN (1977, 1980). |

P. pyri in southeastern France (ATGER, 1979b). It generally shows a degree of specificity for a prey in a particular habitat, for example in apple orchards, for *Panonychus ulmi* (Koch) (FAUVEL, 1974a), *Thrips major* Uzel, and *Thrips flavus* Schrank (FAUVEL *et al.*, 1980) and in pear orchards, for *P. ulmi* (FAUVEL & ATGER, 1981). It prefers the phytophagous mite, *Aceria fraxinivora* (Nal.), and the predacious cecidomyiid, *Arthrocnodax fraxinella* (Meade), in ash spangle galls (FAUVEL *et al.*, 1978), *Coryihucha ciliata* (Say) on plane trees (D'AGUILAR *et al.*, 1977), *Aphis gossypii* Glover, *Thrips tabaci* Lindemann, and spider mites on cucurbitaceous crops and egg plant (AKRAMOVSKAYA, 1978). In some cases, *O. vicinus* was noted as a pollen feeder (FAUVEL, 1974b). The distribution of *O. vicinus* is not completely known ; it seems widely distributed in Europe south of the 60th

parallel, and we have very little information on its distribution in Asia (PERICART, 1972). It has been noted recently from China (ZHENG, 1982).

We observed *O. minutus* associated with pear and hawthorn psyllids in the south of France and in the Paris region (table 2). *O. minutus* has already been reported several times as a predator of eggs and larvae of pear psylla (table 1). Apparently it is a very polyphagous predator, encountered on many species of plants in Europe, Siberia, Turkestan and China ; it seems rare in the mediterranean region, but it has been noted from North Africa (PERICART, 1972). Its prey, besides pear psylla, as listed in recent literature are listed in table 7.

We collected *O. niger* on pear trees, where it attacks eggs and larvae of *P. pyri*, but overall it was most common on nettle infested with *T. urticae*

TABLE 7

Prey of Orius minutus (L.) (other than pear psylla) noted in recent literature.
Proies d'O. minutus (sauf les psylles du poirier) signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|---|-----------------------------|-------------------------------|---|
| Mites | | | |
| <i>Panonychus ulmi</i> (Koch) | apple | Yugoslavia Poland China | ARCANIN & BALARIN (1973). NIEMCZYK (1978c). ZHANG <i>et al.</i> (1982). |
| <i>Tetranychus urticae</i> Koch | laboratory apple | Poland Poland | NIEMCZYK (1978b). NIEMCZYK (1978a). |
| <i>Tetranychus viennensis</i> Zacher | laboratory apple | Poland China | NIEMCZYK (1978b). ZHANG <i>et al.</i> (1982). |
| Tetranychids | various crops | Bulgaria | BALEVSKI (1977). |
| Thrips | | | |
| <i>Haplothrips niger</i> (Osb.) | berry-fruit crops | U.S.S.R. | DYADECHKO (1967). |
| <i>Megalurothrips distalis</i> (Karny) | <i>Gliricidia sepium</i> L. | India | VISWANATHAN & ANANTHAKRISHNAN (1974). |
| <i>Frankliniella schultzei</i> (Tryb.) | <i>G. sepium</i> | India | VISWANATHAN & ANANTHAKRISHNAN (1974). |
| <i>Haplothrips ganglbaueri</i> Schmutz | <i>G. sepium</i> | India | VISWANATHAN & ANANTHAKRISHNAN (1974). |
| <i>Thrips tabaci</i> Lindemann | cucumber, sweet pepper | Netherlands | RAMAKERS (1978). |
| Diptera | | | |
| <i>Dasineura mali</i> (Kieffer) | apple | Germany | CARL (1980). |
| <i>Macrolabis</i> sp. | apple | Germany | CARL (1980). |
| <i>Jaapiella cirsiicola</i> Rübsaamen | rose sowthistle | U.S.S.R. | SHUROVENKOV (1981). |
| Lepidoptera | | | |
| <i>Cydia pomonella</i> (L.) | apple | England | GLEN (1975). |
| <i>Heliothis armigera</i> (Hubner) | cotton | China | WU <i>et al.</i> (1981). |
| <i>Sitotroga cerealella</i> (Olivier) | laboratory | Poland | NIEMCZYK (1978b). |
| <i>Ephestia kuehniella</i> Zeller | laboratory | Poland | NIEMCZYK (1978b). |
| Coleoptera | | | |
| <i>Leptinotarsa decemlineata</i> (Say) | potato | Poland | KANIA <i>et al.</i> (1976). |
| Coccids | | | |
| <i>Planococcus citri</i> (Risso) | citrus | Turkey | SOYLU & UREL (1977). |
| Aleurodids | | | |
| <i>Dialeurodes citri</i> (Ashmead) | citrus | Turkey | SOYLU (1980). |
| Aphids | | | |
| <i>Aphis pomi</i> DeGeer | laboratory | Poland | NIEMCZYK (1978b). |
| Various prey | | | |
| Various prey | apple | Sweden | NORLANDER (1977). |
| Various prey | apple | Poland | KORCZ (1967). |
| aphids, psyllids, thrips, noctuid larvae, mites | various plants | Turkey | ONDER (1982). |

surrounding the orchards (table 2). It had been noted once previously, associated with *P. pyri* (NGUYEN *et al.*, 1981). It is distributed over most of the western palearctic region (PERICART, 1972), and it has been also noted from China (ZHENG, 1982). Its prey, besides *P. pyri*, noted in recent literature, are listed in table 8.

We found *O. laevigatus* in small numbers in pear orchards of southern France and in the Paris region, as well (table 2). According to PERICART (1972), this *Orius* is characteristic of the western palearctic region under seaboard influence ; it is common in the mediterranean basin. It was observed on many host plants, mostly shrubs and herbaceous plants (PERICART, 1972). It has been collected several times in Egypt, where it is abundant and widespread (TAWFIK & ATA, 1974). It was observed there, as a predator of various insect species in fields of clover and cotton (HAFEZ *et al.*, 1975), mainly as a predator of *A. gossypii* and *T. tabaci* (AFIFI *et al.*, 1980). It also belongs to fauna of apple trees in Egypt, essentially as a predator of *Tetranychus turkestanii* (Ugar. & Nik.) (ABDELSALAM, 1967).

We rarely encountered *O. majusculus* in orchards attacked by *P. pyri* in Avignon and in the Paris region, although this species is mentioned by PERICART (1972) as common and ubiquitous in France. *O. majusculus* is known to feed on many species of trees and herbaceous plants, mainly consuming aphids and mites (PERICART, 1972). It was recently noted as

a predator of the aphids, *Diuraphis noxia* (Mordvilko) and *Schizaphis graminum* (Rondani), in barley and wheat in the USSR (BEREST, 1980a). It was already known as a predator of *Trialeurodes vaporariorum* (Westwood) on greenhouse crops in Italy (ARZONE, 1976) and as a predator of various prey in apple orchards in Poland (KORCZ, 1967) and of *P. ulmi* and *Tetranychus* sp. in apple orchards in France (FAUVEL, 1974a).

Although these species of *Orius* showed some food preferences in particular habitats, they were essentially polyphagous. They were from the same geographical region, but we observed some differences in their distribution, namely in *O. minutus*, which was more northerly than *O. vicinus*.

Temnostethus pusillus (Herrich-Schaeffer) was very rare in our samples of pear tree fauna (table 2). Although it is known to feed on aphids, psyllids and coccids, its occurrence in fruit trees seems to be related to the presence of lichens ; it is known all over Europe and in western USSR (PERICART, 1972).

The presence of *Cardiastethus fasciventris* (Garbignietti) in our samples probably was not exclusively related to the presence of *P. pyri*. In fact, this predator seems mainly to live at the expense of psocids (PERICART, 1972). Psocids feeding on fumagine were numerous on pear trees examined. The known distribution of *C. fasciventris* is throughout western Europe and North Africa ; it has also been observed in Egypt (PERICART, 1972).

TABLE 8

Prey of Orius niger (Wolff) (other than pear psylla), noted in recent literature.
Proies d'O. niger (sauf les psylles du poirier), signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|---|---------------------|------------|---|
| Aphids | | | |
| <i>Aphis gossypii</i> Glover | cotton | U.S.S.R. | AKRAMOVSKAYA (1978), SUKHORUCHENKO <i>et al.</i> (1981). |
| <i>Schizaphis graminum</i> (Rondani) | wheat | U.S.S.R. | BEREST (1980b). |
| | rice | U.S.S.R. | MYRZIN & LUK'YANCHIKOV (1981). |
| <i>Diuraphis noxia</i> (Mordvilko) | wheat | U.S.S.R. | BEREST (1980b). |
| <i>Sitobion avenae</i> (F.) | wheat | U.S.S.R. | BEREST (1980b). |
| <i>Acyrtosiphon gossypii</i> Mordvilko | cotton | U.S.S.R. | SUKHORUCHENKO <i>et al.</i> (1981). |
| Thrips | | | |
| <i>Thrips tabaci</i> Lindemann | cucurbits, eggplant | U.S.S.R. | AKRAMOVSKAYA (1978). |
| <i>T. tabaci</i> | tobacco | Bulgaria | DIMITROV (1975). |
| <i>Thrips</i> spp. | berry-fruit crops | U.S.S.R. | DYADECHKO (1967). |
| Aleurodids | | | |
| <i>Trialeurodes vaporariorum</i> (Westwood) | greenhouse crops | Italy | ARZONE (1976). |
| Diptera | | | |
| <i>Jaapiella cirsiicola</i> Rübssaamen | rose sowthistle | U.S.S.R. | SHUROVENKOV (1981). |
| Lepidoptera | | | |
| <i>Heliothis armigera</i> (Hübner) | cotton | U.S.S.R. | SUKHORUCHENKO <i>et al.</i> (1981). |
| Mites | | | |
| <i>Panonychus ulmi</i> (Koch) | apple | Yugoslavia | ARCANIN & BALARIN (1973). |
| <i>Tetranychus urticae</i> Koch | cotton | U.S.S.R. | SUKHORUCHENKO <i>et al.</i> (1981). |
| mites | cucurbits, eggplant | U.S.S.R. | AKRAMOVSKAYA (1978). |
| Various prey | | | |
| aphids, psyllids, thrips, noctuid larvae, mites | various plants | Turkey | ONDER (1982). |

b) *Miridae*

Heterotoma meriopterum (Scopoli) was not only one of the most common mirids in the pear orchards we visited but also on hawthorn and nettle, where it feeds mainly on psyllids and aphids. It has one generation per year, the egg overwintering (FAUVEL, 1974a). On pear trees, eggs are laid in young twigs. We cut these twigs in autumn, obtained many individuals and placed them in a refrigerator. Normal and unavoidable pruning of pear trees in winter intensely depressed predator populations in the orchard. Consequently, plants such as hawthorn were very useful for survival of this pear psylla enemy and to retain them near the orchards. Its abundance in orchards is not constant since FAUVEL & ATGER (1981) found it in low numbers. It has also been noted as a predator of aphids and of the mite, *Bryobia rubrioculus* (Scheuten), on apple (FAUVEL, 1974a). It sometimes feeds on plant sap (WAGNER & WEBER, 1964; FAUVEL & GRIVAUT, 1976). It is widely distributed in Europe and North Africa (WAGNER & WEBER, 1964).

Campyloneura virgula (Herrich-Schaeffer) was the second most common mirid found in our samples from pear orchards, being as abundant in southern France as in the Paris region, where it also occurred on hawthorn (table 2). This polyphagous predator, already observed on various deciduous trees, *Fraxinus*, *Tilia*, *Alnus*, *Fagus* (WAGNER & WEBER, 1964), has not been reported in orchards before. It is a poorly known species. We verified that it is exclusively represented by females; its reproduction very probably is parthenogenetic (WAGNER & WEBER, 1964). It is distributed throughout Europe, North Africa and the Near East (WAGNER & WEBER, 1964).

Orthotylus nassatus (F.) was the third most abundant mirid collected in pear orchards in southern France (table 2). It is a polyphagous predator encountered notably on *Quercus*, *Tilia*, *Fraxinus* and *Salix* and known throughout Europe (WAGNER & WEBER, 1964). It has already been noted on pear (FAUVEL & ATGER, 1981) but seems more tied to locuses of infestation of the mite *P. ulmi* than of pear psylla. *O. nassatus* was fortuitously, and successfully, introduced in North America, probably in nursery stock. It has been found in Pennsylvania on pear (HENRY, 1977) and on maple (HENRY & WHEELER, 1979). It has been found in Canada on maple, walnut, and lime infested with aphids and on pear infested with *P. pyricola* (KELTON, 1982).

All other mirids cited below were rare in pear orchards examined.

Deraeocoris lutescens (Schilling) has already been reported as a predator associated with pear psylla (table 2), mainly as a predator of its eggs (FAUVEL & ATGER, 1981), of aphids on lime and oak (WAGNER & WEBER, 1964), and above all as a predator of *P. ulmi* in apple orchards (ARCANIN & BALARIN, 1973) and in pear orchards (FAUVEL & ATGER, 1981). *D. lutescens* is a mediterranean species also found in central Europe (WAGNER & WEBER, 1964) and in Poland (NIEMCZYK *et al.*, 1972).

Deraeocoris ruber (L.) has been known as an occasional predator of *P. pyri* in Italy (table 1), of aphids, young caterpillars, mites, and various small

insects on apple (FAUVEL, 1974a), on *Rubus* and *Urtica* (WAGNER & WEBER, 1964) and on *Corylus* (VIGGIANI, 1971). The most commonly observed aphids, which served as prey on hazel in Italy, were *Myzocallis coryli* (Goeze) and *Corylobium avellanae* (Schränk) (VIGGIANI, 1971). It is distributed everywhere in Europe, but is more common in the south. It was recorded for the first time in the US on egg plant at Newark, New Jersey, in 1979 (USDA, 1980).

Pilophorus perplexus (Douglas & Scott) has already been noted as a predator of *P. pyri* in France (FAUVEL & ATGER, 1981), though not very abundant in orchards. In apple orchards it has been also known as a predator of *A. pomi* and *B. rubrioculus* in France (FAUVEL, 1974a) and of *P. ulmi* in Russia (SIDLYAREVICH, 1968) and in Canada (LORD, 1968, 1971). *P. perplexus* has been found on various other deciduous trees, *Fraxinus*, *Alnus*, *Tilia*, *Acer*, *Quercus*, and *Salix* (WAGNER & WEBER, 1964).

Pilophorus gallicus Remane was very rare in our samples of predators collected on pear trees near Avignon. Formerly, it was only known on *Populus* and *Salix* in southern France (WAGNER & WEBER, 1964).

Pilophorus clavatus (L.) was rare on pear trees near Toulouse. It has been recorded from *Salix*, *Tilia*, *Quercus* and *Populus* in Europe and North America (WAGNER & WEBER, 1964).

Mimocoris rugicollis (Costa) was also very rare on pear trees in Avignon. This mediterranean species has already been observed on *Quercus ilex* (WAGNER & WEBER, 1964).

We observed *Psallus ambiguus* (Fallen) in low numbers on pear and hawthorn (table 2). According to WAGNER & WEBER (1964), this polyphagous predator, which is occasionally phytophagous, is known throughout Europe. It has been observed on *Pirus*, *Alnus* and *Salix* and especially on apple in France (FAUVEL, 1974a), in England (MORRIS, 1968), in Yugoslavia (ARCANIN & BALARIN, 1973), in Poland (KORCZ, 1967; NIEMCZYK, 1967, 1968) and in Norway (AUSTRENG & SOMME, 1980; SKANLAND, 1981). Its most common prey are *P. ulmi*, *Bryobia* spp., *Psylla mali* Schmidberger, *A. pomi*, and *Brachycaudus helichrysi* (Kaltenbach) (NIEMCZYK, 1968).

We encountered some specimens of *Phytocoris longipennis* Flor in pear orchards at Toulouse and in the Paris region (table 2). This predator has already been recorded feeding on small insects in apple orchards (FAUVEL, 1974a) and on *Acer*, *Corylus*, *Quercus* and *Fagus* (WAGNER & WEBER, 1964). According to these authors, it is distributed throughout Europe but is more common in northern and central Europe. It was noted recently in Turkey (ERKIN, 1983).

Phytocoris ulmi (L.) was found in very low numbers in the pear orchard visited at Toulouse. It had previously been noted in France on apple (FAUVEL, 1974a) and as a possible vector of fireblight on the shoots of pear in Denmark (THYGESEN *et al.*, 1973). Moreover, it is known on *Ulmus*, *Acer*, *Prunus*, *Fagus*, *Corylus*, *Salix* and *Cistus* (WAGNER & WEBER, 1964). These authors indicated that its

distribution is throughout Europe, North Africa, Asia Minor and Caucasia.

c) *Nabidae*

Nabid predators were very rare in the examined orchards and were represented by only 3 species (table 2). *Himacerus apterus* (L.) has previously been noted on apple in Poland (KORCZ, 1967) and in France (FAUVEL, 1974a), but has been encountered most frequently on herbaceous plants and bushes as a predator of aphids and young caterpillars. It occurs throughout Europe (FAUVEL, 1974a). It has also been noted as a predator of aphids in pine plantations grown for seed in Russia (SMETANIN, 1970).

Nabis ferus (L.) has been noted in apple orchards in France (FAUVEL, 1974a) and the USA (WHALON & PARKER, 1978), but it mainly occurs in grass and bushes. The list of its main prey is presented in table 9.

Nabis punctatus Costa was previously observed on apple in France (FAUVEL, 1974a) and in the USSR as a predator of aphids on various plants (PUCHKOV, 1980) and as one of the main predators of cereal aphids, *D. noxia*, *S. graminum* and *Sitobion avenae* (F.) (BEREST, 1980b).

2. *Coleoptera*

a) *Coccinellidae*

Small ladybird beetles of the *Scymnini* tribe were represented in our samples by 4 species, 3 of which, *Stethorus punctillum* (Weise), *Scymnus rubromaculatus* (Goeze) and *Scymnus subvillosus* (Goeze), were abundant on pear trees at Avignon (table 2). According to IPERTI (1974), GOURREAU (1974), FAUVEL & ATGER (1981), *S. punctillum* shows a degree of

specificity for fruit tree mites, notably for *P. ulmi* and *Tetranychus urticae* Koch. It probably is an occasional predator of pear psylla. Its main prey are listed in table 10.

The coccinellid, *S. rubromaculatus*, very common in France and in the major part of the palearctic region, has been known as a predator of aphids on oak, willow, hazel, peach, juniper, box and various cereals, mainly maize (GOURREAU, 1974). Since aphids did not proliferate in the orchard visited at Avignon, presence of this predator is most probably related only to pear psylla.

Previously, *S. subvillosus* had been often observed on various fruit trees, orange, peach, plum (GOURREAU, 1974) and apple (IPERTI, 1974), and on many other host plants, oak, juniper, hazel, laurel, tamarisk, pine, maize (GOURREAU, 1974). *S. subvillosus* has generally been noted as a predator of aphids, of *Brevicoryne brassicae* (L.) on cultivated crucifers in Rumania (CONSTANTINESCU, 1972), cereal aphids on wheat, oats and barley in the USSR (ABDULKHAIROVA, 1979), *Aphis craccivora* Koch on liquorice in the USSR (KESTEN, 1975), *Brachycaudus amygdalinus* (Schouteden) and *B. helichrysi* on almond, and of some coccids, *Planococcus citri* (Risso) on grape vine, citrus and pomegranate in the USSR, and *Saissetia oleae* (Olivier) on olive in Greece (ARGYRIOU & KATSOYANNOS, 1977).

Scymnus interruptus (Goeze) was very rare on pear trees attacked by *P. pyri* at Avignon, probably due to its high preference for aphids. In fact, TAWFIK *et al.* (1974a) found that its development and reproduction are possible only when aphids are available as prey.

S. interruptus is known in the major part of the palearctic region from many plants (GOURREAU, 1974), but it is especially efficacious against *A. gossypii* on cotton in Egypt (HASSANEIN *et al.*, 1968; REZK *et al.*, 1975; HABIB *et al.*, 1980). In Egypt, *S. interruptus* was also found preying on *Aphis nerii*

TABLE 9

Prey of Nabis ferus (L.), noted in recent literature.
Proies de N. ferus, signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|---|-----------------|----------|----------------------------|
| <i>Mirids</i> | | | |
| <i>Lygus lineolaris</i> (Palisot de Beauvois) | apple | U.S.A. | WHALON & PARKER (1978). |
| <i>Lygus rugulipennis</i> Poppius | strawberry | Sweden | GERTSSON (1980). |
| <i>Aphids</i> | | | |
| | various plants | U.S.S.R. | PUCHKOV (1980). |
| | pine | U.S.S.R. | SMETANIN (1970). |
| <i>Lepidoptera</i> | | | |
| <i>Pectinophora gossypiella</i> (Saunders) | cotton | Mexico | ESTRADA & CARRILLO (1971). |
| <i>Heliothis zea</i> (Boddie) | cotton | Mexico | ESTRADA & CARRILLO (1971). |
| <i>Coleoptera</i> | | | |
| <i>Leptinotarsa decemlineata</i> (Say) | potato | Poland | ZIARKIEWICZ (1976). |
| <i>Diptera</i> | | | |
| <i>Jaapiella cirsiicola</i> Rübssaamen | rose sowthistle | U.S.S.R. | SHUROVENKOV (1981). |
| <i>Thrips</i> | | | |
| <i>Thrips tabaci</i> Lindemann | tobacco | Bulgaria | DIMITROV (1975). |

TABLE 10

Prey of Stethorus punctillum (Weise) (other than pear psylla), noted in recent literature.
Proies de S. punctillum (sauf les psylles du poirier), signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|---|--|-----------------------|---|
| Mites | | | |
| <i>Panonychus ulmi</i> (Koch) | apple | France Italy | AUDEMARD (1973). PASQUALINI (1979), PAPAIOANNOU-SOULIOTI (1980), MORI & VIANELLO (1980), PASQUALINI <i>et al.</i> (1982). VERESHCHAGINA (1981). |
| <i>Panonychus citri</i> (McGeer) | strawberry | U.S.S.R. | VERESHCHAGINA (1981). |
| <i>Eotetranychus pruni</i> (Oudm.) | citrus | Italy | PAPAIOANNOU-SOULIOTI (1980). |
| | grapevine | Spain | GARCIA MARI & RIVERO (1982). |
| | various orchards | Bulgaria | BAYAN (1981). |
| <i>Eotetranychus carpini vitis</i> (Boisd.) | grapevine | U.S.S.R. | KARTASHEVA & LESTEVA (1979). |
| Tetranychid & Eriophyid mites | various plants | Italy | LAFFI (1982). |
| various mites | apple | Bulgaria | BALEVSKI (1977). |
| | various orchards | France | IPERTI (1974). |
| | | U.S.S.R. | LIVSHITS & MITROFANOV (1981b). |
| Aphids | | | |
| <i>Aphis craccivora</i> Koch | liquorice | U.S.S.R. | KESTEN (1975). |
| Coccids | | | |
| <i>Saissetia oleae</i> Olivier | olive | Greece | ARGYRIOU & KATSOYANNOS (1977). |
| Various prey mites, aphids | lime, citrus, apple, hazel, plum, peach, oak, pine, cypress, raspberry, ivy, maize, <i>Pittosporum</i> , tobacco, rose, moss. | Palaearctic region | GOURREAU (1974). |

Boyer on *Nerium oleander* L., on *Aphis verbasci* Schrank on *Buddleia asiatica* Lour., on *Aphis punicea* Passerini on *Duranta* sp. and on *Rhopalosiphum maidis* (Fitch) on maize (TAWFIK *et al.*, 1974b). It can feed on nectar and secretions from the leaves. CONSTANTINESCU (1972) observed *S. interruptus* as a predator of *B. brassicae* on cultivated crucifers in Rumania.

Rhyzobius chrysomeloides (Herbst) was also rare in our samples and we did not find it noted as a predator of any pest of economic importance in the literature.

Clitostethus arcuatus (Rossi) was collected on hawthorn, but its presence was probably tied more to the presence of aleurodids than to psyllids on this host plant. *C. arcuatus* has been noted as the main natural enemy of *Dialeurodes citri* (Ashmead) on citrus in Italy (PRIORE, 1969; LIOTTA & MANIGLIA, 1975; LOI, 1979; DELRIO *et al.*, 1981; LIOTTA, 1981), in Turkey (SOYLU, 1980), and in the USSR (AGEKYAN, 1977). It has also been observed as a predator of *Aleurothrixus floccosus* (Mask.) (*Aleurodidae*) on *Citrus* in Italy (LIOTTA, 1982) and in Portugal (MAGALHAES, 1980). On apple and pear, *C. arcuatus* has been noted as a predator of the aleurodid, *Siphoninus phillyreae* (Haliday), in Greece (MENTZELOS, 1967) and in Italy (TREMBLAY, 1969). *C. arcuatus* has been found preying on *T. vaporariorum* on tobacco in the USSR (AGEKYAN, 1977). However, it seemed to be capable of attacking prey other than aleurodids; it has been noted in wooded areas and occasionally was observed preying on aphids (AGEKYAN, 1977).

We observed *Adalia bipunctata* (L.) in low numbers in all pear orchards infested with pear psylla (table 2). This coccinellid was already noted as an enemy of *P. pyri* in Poland and in the USSR (table 1). However, its main prey are aphids of trees of the family of *Rosaceae* (IPERTI, 1978a, b). Its main prey from recent literature are listed in table 11. *A. bipunctata* has been reared and released in pear orchards for control of *P. pyricola* in central Washington (USA) without apparent establishment (FYE, 1981).

Synharmonia conglobata (L.) was very rare in pear orchards examined (table 2). This coccinellid has already been collected in Israel as a predator of *P. pyricola* (SWIRSKI, 1954). Its main prey were aphids (table 12). It has been reared and released against *P. pyricola* in central Washington (USA), without apparent establishment (FYE, 1981).

Synharmonia lyncea Olivier was found in very small numbers on pear trees at Toulouse (table 2). This coccinellid generally was rare in the field. It has been collected on oak and lime infested with aphids in East Germany (WITSACK, 1971). According to this author it accepts *Aphis fabae* Scopoli and *Myzus persicae* (Sulzer) as prey in the laboratory. Its known prey in the field are *Dysaphis sorbi* (Kaltenbach) and *Eucalopteris tiliae* (L.) (WITSACK, 1971).

Propylea quattuordecimpunctata (L.) was present in very small numbers in pear orchards at Avignon and Toulouse. It is essentially a predator of aphids (table 13). It has been reared and released in pear orchards in central Washington (USA) without apparent establishment (FYE, 1981).

TABLE 11

Prey of *Adalia bipunctata* (L.) (other than pear psylla), noted in recent literature.
 Proies d'*A. bipunctata* (sauf les psylles du poirier), signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|--|--|----------------|--|
| Aphids | | | |
| <i>Microlophium carnosum</i> (Buckton) | oats, wheat, barley, rye, maize | Argentina | SERANTES DE GONZALEZ & SIERRA DE NUNEZ (1976). |
| <i>Macrosiphoniella artemisiae</i> (Boyer) | <i>Urtica dioica</i> L. | Czechoslovakia | HONEK (1978). |
| <i>Myzus cerasi</i> (F.) | <i>Artemisia vulgaris</i> L. | Czechoslovakia | HONEK (1978). |
| <i>Aphis fabae</i> Scopoli | cherry | France | IPERTI (1978a). |
| | sugar beet | England | HEATHCOTE (1978). |
| | <i>Euonymus alatus</i> (Thunb.) | U.S.A. | WHEELER & STIMMEL (1979). |
| <i>Eucallipterus tiliiae</i> (L.) | lime | England | DIXON & BARLOW (1979), MILLS (1982). |
| <i>Brevicoryne brassicae</i> (L.) | cabbage | U.S.S.R. | YASTREBOV (1979). |
| <i>Metopolophium dirhodum</i> (Walker) | wheat, <i>Bromus unioloides</i> (Willd.) | Argentina | BOTTO <i>et al.</i> (1979). |
| <i>Lachnus roboris</i> (L.) | <i>Quercus robur</i> L. | U.S.S.R. | BLAZHIEVSKAYA (1980). |
| <i>Rhopalosiphum padi</i> (L.) | <i>Prunus padus</i> L. | West Germany | BODE (1980a). |
| aphids | apple | France | IPERTI (1974). |
| | cereals | U.S.S.R. | ABDULKHAIROVA (1979). |
| | wheat | England | DEAN (1982). |
| | pome & stone fruit trees | Turkey | ERKIN (1983). |
| Coleoptera | | | |
| <i>Chrysomela populi</i> L. | poplar | Romania | TEODORESCU (1980). |
| <i>Chrysomela saliceti</i> (Weise) | poplar | Romania | TEODORESCU (1980). |
| <i>Chrysomela tremula</i> F. | poplar | Romania | TEODORESCU (1980). |
| Lepidoptera | | | |
| <i>Colias lesbia</i> (F.) | lucerne | Argentina | BOTTO & CROUZEL (1981). |
| Coccids | | | |
| <i>Pseudaulacaspis pentagona</i> (Targioni-Tozzetti) | Kwanzan cherry | U.S.A. | STIMMEL (1982). |
| Various prey | | | |
| | apple | Sweden | NORLANDER (1977). |
| | orchards | Hungary | LOVEI (1981), RADWAN & LOVEI (1982). |
| | various trees | U.S.S.R. | LIVSHITZ & MITROFANOV (1981b). |
| | | England | MILLS (1979). |

Among the species of large coccinellids, *Coccinella septempunctata* L. was the most abundant on pear trees examined at Avignon and Toulouse (table 2). It has already been noted as a predator of *P. pyri* in Europe (table 1) and of *P. pyricola* in Israel (SWIRSKI, 1954). It has been reared and released against *P. pyricola* in central Washington (USA); it survived the mild winter there but without lasting establishment in pear orchards (FYE, 1981). *C. septempunctata* is a very polyphagous predator; its main prey are listed in table 14.

We collected some specimens of *Chilocorus renipustulatus* (Scriba) on pear trees at Toulouse (table 2). This coccinellid has been recognized as a predator of coccids, but it has also been noted as a predator of mites. *C. renipustulatus* is considered in the USSR to be one of the main predators of the coccid, *Quadraspidiotus perniciosus* (Comstock), on fruit trees (PANTYUKHOV, 1968; MURASHEVSKAYA, 1969; POPOVA, 1971, 1974). In Bulgaria, TSACHEV (1978) observed it on apple and willow as a predator of *Lepidosaphes ulmi* (L.). In France, BAYLAC (1980) observed it as a predator of *Cryptococcus fagi* (Baerensprung) on beech, and IPERTI (1974) as a predator of various coccids on apple. GOKSU & ATAK (1969) observed *C. renipustulatus* as a predator of the

mite *P. ulmi* on a wide variety of fruit trees and also vines and hazel in Turkey.

We found *Coccinula quatuordecimpustulata* (L.) in very low numbers on pear trees at Toulouse (table 2). This coccinellid has been recorded in the literature most often as a predator of aphids. In the USSR, it attacks *A. pisum* on leguminous crops (KANTERINA, 1974) and various aphids on cereal crops and alfalfa (FEDOSIMOV & TSEDEV, 1970). It was observed as a predator of aphids in Poland on alfalfa (PRUSZYNSKI & LIPA, 1971) and on potato (KACZMAREK, 1973), and in Bulgaria on herbaceous crops (GRIGOROV, 1977a).

Some specimens of *Thea vigintiduopunctata* (L.) were collected on pear trees at Avignon (table 2). This coccinellid has already been noted several times in orchards, as a predator of coccids in Turkey (ALTAY *et al.*, 1973) and in Iran on apple trees infested with *Lepidosaphes malicola* Borkhs. (MOSTAAN *et al.*, 1972). *T. vigintiduopunctata* also was noted as predator of the two-spotted spider mite *T. urticae* on bean (*Phaseolus*) in Turkey (ONGOREN *et al.*, 1975). It was noted in the USSR as a predator of cereal aphids on wheat, oats and barley (ABDULKHAIROVA, 1979), as a predator of *S. graminum* on rice (MYRZIN & LUK'YANCHIKOV, 1981) and of *A. pisum* on alfalfa

TABLE 12

Prey of Synharmonia conglobata (L.) (other than pear psylla), noted in recent literature.
Proies de S. conglobata (sauf les psylles du poirier), signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|--|---------------------------------------|----------|-----------------------------|
| Aphids | | | |
| <i>Aphis gossypii</i> Glover | cotton | U.S.S.R. | ALEKSEEV & NIYAZOV (1975). |
| | citrus | Greece | ARGYRIOU (1970). |
| <i>Aphis craccivora</i> Koch | liquorice | U.S.S.R. | KESTEN (1975). |
| <i>Brachycaudus amygdalinus</i> (Schouteden) | almond | Lebanon | TALHOUK (1977). |
| <i>Brachycaudus helichrysi</i> (Kaltenbach) | almond | Lebanon | TALHOUK (1977). |
| <i>Toxoptera aurantii</i> (Boyer) | citrus | Greece | ARGYRIOU (1970). |
| <i>Myzus persicae</i> (Sulzer) | citrus | Greece | ARGYRIOU (1970). |
| aphids | apple | France | IPERTI (1974). |
| | trees, shrubs | Bulgaria | GRIGOROV (1977a). |
| | wheat, oats, barley | U.S.S.R. | ABDULKHAIROVA (1979). |
| | pome & stone fruit trees | Turkey | ERKIN (1983). |
| Coccids | | | |
| <i>Quadraspidiotus perniciosus</i> (Comstock) | orchards | Turkey | ALTAY <i>et al.</i> (1973). |
| <i>Pseudaulacaspis pentagona</i> (Targioni-Tozzetti) | orchards | Turkey | ALTAY <i>et al.</i> (1973). |
| <i>Parlatoria</i> spp. | orchards | Turkey | ALTAY <i>et al.</i> (1973). |
| <i>Eulecanium prunastri</i> (Fonscolombe) | orchards | Turkey | ALTAY <i>et al.</i> (1973). |
| <i>Parthenolecanium corni</i> (L.) | orchards | Turkey | ALTAY <i>et al.</i> (1973). |
| <i>Ceroplastes sinensis</i> Del G. | orchards | Turkey | ALTAY <i>et al.</i> (1973). |
| <i>Lepidosaphes ulmi</i> (L.) | orchards | Turkey | ALTAY <i>et al.</i> (1973). |
| Coleoptera | | | |
| <i>Altica quercetorum</i> Foudr. | oak | U.S.S.R. | PLUGARU (1969). |
| <i>Altica</i> sp. | <i>Elaeagnus angustifolia</i> (Nakai) | China | CHEN (1982). |

TABLE 13

Prey of Propylea quattuordecimpunctata (L.), noted in recent literature.
Proies de P. quattuordecimpunctata, signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|---|--------------------------|----------------|--------------------------------|
| Aphids | | | |
| <i>Aphis fabae</i> Scopoli | sugar-beet | England | HEATHCOTE (1978). |
| | | U.S.S.R. | GUMOVSKAYA (1982). |
| <i>Aphis gossypii</i> Glover | cucumber | U.S.S.R. | YARKULOV (1978). |
| <i>Metopolophium dirhodum</i> (Walker) | wheat | England | CHAMBERS <i>et al.</i> (1982). |
| <i>Metopolophium festucae</i> (Theobald) | wheat | England | CHAMBERS <i>et al.</i> (1982). |
| <i>Sitobion avenae</i> (F.) | wheat | England | CHAMBERS <i>et al.</i> (1982). |
| <i>Rhopalosiphum maidis</i> (Fitch) | maize | France | IPERTI (1978a). |
| <i>Rhopalosiphum padi</i> (L.) | <i>Prunus padus</i> L. | West Germany | BODE (1980a). |
| <i>Brachycaudus helichrysi</i> (Kaltenbach) | sunflower | Yugoslavia | THALJI (1981). |
| aphids | cultivated bushes | France | IPERTI (1978b). |
| | wheat, oats, barley | U.S.S.R. | ABDULKHAIROVA (1979). |
| | lucerne, clover, cereals | Czechoslovakia | HONEK (1982). |
| Lepidoptera | | | |
| <i>Plutella xylostella</i> (L.) | cabbage | U.S.S.R. | SLABOSPITSKII (1980). |
| <i>Artogeia rapae</i> (L.) | cabbage | U.S.S.R. | SLABOSPITSKII (1980). |
| <i>Mamestra brassicae</i> (L.) | cabbage | U.S.S.R. | SLABOSPITSKII (1980). |
| Aleurodids | | | |
| <i>Trialeurodes vaporariorum</i> (Westwood) | cucurbits | U.S.S.R. | LYASHOVA (1981). |
| Various prey | | | |
| | pine | U.S.S.R. | MOLCHANOV (1981). |

(LAKHIDOV, 1970). *T. vigintiduopunctata* is not only a predator ; it feeds on the spores and mycelium of various injurious fungi, mainly on powdery mildew, *Erysiphe graminis f. tritici*, infesting wheat in Bulgaria (KUNOVSKI, 1969).

b) *Carabidae*

Only one Carabid predator was occasionally encountered on pear trees at Toulouse and Avignon, *Demetrius atricapillus* (L.). This species has been

TABLE 14

Prey of Coccinella septempunctata L. (other than pear psylla), noted in recent literature.
Proies de C. septempunctata (sauf les psylles du poirier), signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|--|-------------------------|----------------|--|
| Aphids | | | |
| <i>Aphis craccivora</i> Koch | groundnut | India | TALATI & BUTANI (1979), BAKHETIA & SIDHU (1977). |
| | liquorice | U.S.S.R. | KESTEN (1975). |
| | leguminous crops | Pakistan | HAMID <i>et al.</i> (1977). |
| | vetch | U.S.A. | TEDDERS & ANGALET (1981). |
| <i>Aphis gossypii</i> Glover | citrus | Italy | BARBAGALLO & PATTI (1983). |
| | cucumber | U.S.S.R. | YARKULOV (1978). |
| | cotton | China | WU <i>et al.</i> (1981). |
| <i>Aphis gossypii</i> complex | chilli | India | AGARWALA & RAYCHAUDHURI (1981). |
| <i>Aphis fabae</i> Scopoli | sugar-beet | England | HEATHCOTE (1978). |
| | | U.S.S.R. | GUMOVSKAYA (1982). |
| | broad bean | Spain | NOTARIO <i>et al.</i> (1978). |
| <i>Aphis pomi</i> DeGeer | apple | Hungary | MESZLENY & SZALAY-MARZSO (1979). |
| <i>Aphis citricola</i> v. d. Goot | citrus | Italy | BARBAGALLO & PATTI (1983). |
| <i>Aphis</i> sp. | potato | India | WADHI & PARSHAD (1980). |
| <i>Metopolophium dirhodum</i> (Walker) | wheat | England | CHAMBERS & SUNDERLAND (1983). |
| | | Spain | CASTANERA (1983). |
| | oats, wheat | West Germany | BASEDOW (1982). |
| <i>Metopolophium festucae</i> (Theobald) | wheat | England | CHAMBERS & SUNDERLAND (1983). |
| <i>Schizaphis graminum</i> (Rondani) | wheat | U.S.S.R. | NOVOKHATKA <i>et al.</i> (1980), BABENKO (1980). |
| | | Romania | VARVARA <i>et al.</i> (1982). |
| | rice | U.S.S.R. | MYRZIN & LUK'YANCHIKOV (1981). |
| <i>Rhopalosiphum padi</i> (L.) | <i>Prunus padus</i> L. | West Germany | BODE (1980a). |
| | wheat | Spain | CASTANERA (1983). |
| | oats, wheat | West Germany | BASEDOW (1982). |
| | oats | U.S.S.R. | PUKINSKAYA <i>et al.</i> (1981). |
| <i>Rhopalosiphum insertum</i> (Walker) | apple | Hungary | MESZLENY & SZALAY-MARZSO (1979). |
| <i>Acyrtosiphon pisum</i> (Harris) | broad bean | West Germany | GAUDCHAU (1979). |
| | vetch | U.S.A. | TEDDERS & ANGALET (1981). |
| | potato | U.S.A. | OBRYCKI <i>et al.</i> (1982). |
| <i>Sitobion avenae</i> (F.) | wheat | U.S.S.R. | BABENKO (1980). |
| | | England | CHAMBERS & SUNDERLAND (1983). |
| | | Spain | CASTANERA (1983). |
| | oats, wheat | West Germany | BASEDOW (1982). |
| <i>Myzus persicae</i> (Sulzer) | tobacco, pepper, potato | Bulgaria | GRIGOROV (1978). |
| | potato | U.S.A. | OBRYCKI <i>et al.</i> (1982). |
| <i>Brachycaudus amygdalinus</i> (Schouteden) | peach | Iraq | MAHMOUD <i>et al.</i> (1981). |
| <i>Brachycaudus helichrysi</i> (Kaltenbach) | sunflower | Yugoslavia | THALJI (1981). |
| <i>Hyalopterus pruni</i> Geoffroy | peach | Iraq | MAHMOUD <i>et al.</i> (1981). |
| | fruit trees | Romania | VARVARA <i>et al.</i> (1982). |
| <i>Dysaphis plantaginea</i> (Passerini) | apple | Hungary | MESZLENY & SZALAY-MARZSO (1979). |
| <i>Eriosoma lanigerum</i> Hausmann | apple | Hungary | MESZLENY & SZALAY-MARZSO (1979). |
| <i>Diuraphis noxia</i> (Mordvilko) | wheat | U.S.S.R. | BABENKO (1980). |
| <i>Uroleucon carthami</i> (H.R.L.) | safflower | India | UPADHYAY <i>et al.</i> (1981). |
| <i>Toxoptera aurantii</i> (Boyer) | citrus | Italy | BARBAGALLO & PATTI (1983). |
| <i>Brevicoryne brassicae</i> (L.) | cabbage | U.S.S.R. | YASTREBOV (1979). |
| <i>Lipaphis erysimi</i> (Kaltenbach) | mustard | India | SINHA <i>et al.</i> (1982). |
| <i>Macrosiphum euphorbiae</i> (Thomson) | potato | U.S.A. | OBRYCKI <i>et al.</i> (1982). |
| aphids | cereals | France | IPERTI (1978a). |
| | wheat, oats, barley | U.S.S.R. | ABDULKHAIROVA (1979). |
| | cotton | U.S.S.R. | ADASHKEVICH <i>et al.</i> (1981). |
| | lucerne, clover | Czechoslovakia | HONEK (1982). |
| | low-growing plants | France | IPERTI (1978b). |
| | | Czechoslovakia | ZELENY (1978). |
| Lepidoptera | | | |
| <i>Plutella xylostella</i> (L.) | cabbage | U.S.S.R. | SLABOSPITSKII (1980). |
| <i>Artogeia rapae</i> (L.) | cabbage | U.S.S.R. | SLABOSPITSKII (1980). |
| <i>Mamestra brassicae</i> (L.) | cabbage | U.S.S.R. | SLABOSPITSKII (1980). |
| <i>Heliothis armigera</i> (Hubner) | cotton | U.S.S.R. | RUSTAMOVA (1981). |
| leafrollers | raspberry | U.S.S.R. | BATASHEVA (1981). |
| Diptera | | | |
| <i>Contarinia sorghicola</i> (Coquillett) | sorghum | India | THONTADARYA <i>et al.</i> (1979). |
| Coleoptera | | | |
| <i>Sitona</i> spp. | beet | U.S.S.R. | RYBCHIN (1982). |
| Various prey | | | |
| | apple | Norway | SKANLAND (1981). |
| | | Hungary | RADWAN & LOVEI (1982). |
| | | Sweden | NORLANDER (1977). |
| | lucerne | Iraq | KHALIL <i>et al.</i> (1979). |

recorded as a general predator on small insects in orchards, (STEINER, 1974 ; LIVSHITS & MITROFANOV, 1981b). It was also recorded in England as a predator of cereal aphids (SUNDERLAND, 1975 ; SUNDERLAND & VICKERMAN, 1980) and of the chrysomelid *Gastrophysa polygoni* (L.) on knot grass (*Polygonum aviculare* L.) and black bindweed (*P. convolvulus* L.) in cereal fields (SOTHERTON, 1982). In Italy, it was noted as a predator of the curculionid *Ceuthorrhynchus rapae* Gyllenhal on hemp (*Cannabis sativa*) (TREMBLAY, 1968).

3. Neuroptera

a) Chrysopidae

Chrysoperla carnea (Stephens) was abundant in all pear orchards examined (table 2). Larvae of this chrysopid have already been noted as predator of pear psylla in Europe (table 1), in the U.S.A. and in Canada, and as predator on many other pests in many other countries as well (table 15).

Anisochrysa prasina (Burmeister) was captured in very small numbers on pear trees at Avignon. This chrysopid was already recorded from southeastern France as predator of olive pests (ALROUECHDI *et al.*, 1981b) and as predator of eggs of *Tortrix viridana* (L.) (*Lep. : Tortricidae*) on *Quercus ilex* L. and *Quercus pubescens* Willd. (DU MERLE, 1983).

Anisochrysa picteti (Mc Lachlan) was also very rare in orchards at Avignon. It is definitely a mediterranean species, exclusively xerophilous, limited to warm habitats of dense vegetation (CANARD, pers. com.).

b) Hemerobiidae

Hemerobius humulinus L. was present on pear and hawthorn surrounding the orchards at Avignon and Toulouse (table 2). This very polyphagous predator is widely distributed all over the world. In apple orchards, it attacks aphids and *P. ulmi* (PRINCIPI & CANARD, 1974 ; SZABO & SZENTKIRALYI, 1981 ; ZELENY, 1978), and in the U.S.A., it attacks *Cydia pomonella* (L.), and *Anuraphis plantaginea* (Passerini) (HOLDSWORTH, 1970a, b). It has also been noted in grape vineyards in the U.S.A. (JUBB & MASTELLER, 1977), in windbreaks in the U.S.S.R. (TSYBUL'SKAYA *et al.*, 1977) and in cotton fields in China (CHAO & CHANG, 1978).

Wesmaelius subnebulosa (Stephens) was very rare on pear trees at Avignon. This hemerobiid has previously been noted in apple orchards in Hungary (SZABO & SZENTKIRALYI, 1981).

Symphorobius pygmaeus (Rambur) was also very rare in pear orchards at Avignon. This hemerobiid was already known as a predator of the coccid, *Trabutina leonardii* Silvestri, infesting *Tamarix africana* Webb. in Italy (MONACO, 1977).

c) Coniopterygidae

Coniopteryx borealis Tjeder was the one coniopterygid found on pear trees at Avignon and Toulouse. It was also collected on hawthorn infested with psyllids (table 2). Coniopterygids are known as

predators of aleurodids, aphids, coccids and mites on many plants, especially on apple (PRINCIPI & CANARD, 1974).

4. Diptera

The syrphid *Meliscaeva auricollis* (Meigen) was found in small numbers on pear trees at Toulouse. This species has already been recorded as a predator of aphids on pome and stone fruit trees in Turkey (ERKIN, 1982) and of *A. pomi*, *Dysaphis plantaginea* (Passerini) and *Eriosoma lanigerum* Haussmann in apple orchards in Italy (SETTI, 1973).

Syrphus vitripennis (Meigen) was found in low numbers on pear trees at Toulouse. According to LYON & GOLDLIN DE TIEFENAU (1974), it is a very polyphagous predator, mostly aphidiphagous, as the list of its prey from the literature shows (table 16). PEK (1975) believed it to be a predator of general occurrence and not associated with a particular environment.

Some specimens of *Episyrphus balteatus* (DeGeer) were collected on pear trees infested with *P. pyri* at Toulouse. Rareness of the syrphid in these orchards was due to the fact that it is essentially a predator of aphids, as indicated by the list of its prey from the literature (table 17). However, it has already been noted several times in Italy as a predator of *P. pyri* (table 1).

5. Acari

A predacious mite of the genus *Anystis* was observed several times on pear trees at Avignon and Toulouse. Psyllids have previously been cited as prey of these mites, especially *Psyllopsis distinguenda* Edw. on ash trees and *Trioza chenopodii* Reut. on beet and spinach, as prey of *Anystis baccharum* (L.) in Czechoslovakia (LAUTERER, 1982). In orchards, *A. baccharum* was also noted as a predator of various pests in the U.S.S.R. (LIVSHITS & MITROFANOV, 1981a), of tortricids on apple trees in New Zealand (BAKER, 1983), and of the mite *Panonychus citri* (McG.) on *Citrus* in South Korea (KIM *et al.*, 1978). An unidentified species of *Anystis* was noted as predator of the phytophagous mites, *P. ulmi*, *B. rubrioculus* and *Tetranychus viennensis* Zacher on fruit trees in the U.S.S.R. (PAURIENE, 1970), and another species of *Anystis*, as predator of *Scirtothrips aurantii* Faure on citrus, in South Africa (MILNE, 1977). The genus *Anystis* contains very polyphagous species ; *A. baccharum* was also recorded as predator of *Oulema melanopus* L. on cereal crops in Sweden (BORG, 1983), and various *Anystis* as predators of aphids on non-crop plants in Canada (FRAZER & NELSON, 1981). *Anystis* species were also found on conifers in forests, as predators of *Adelges* spp. in India (RAO & GHANI, 1972), and of *Matsucoccus matsumurae* Kuw. on pine in China (CHENG & MING, 1979). In ornamental hedges of *Euonymus japonicus* Thunb. in England, *Unaspis euonymi* (Comstock) was observed to be preyed upon by *Anystis* sp. (DENNIS, 1969).

TABLE 15

Prey of Chrysoperla carnea (Stephens) (other than pear psylla in Europe) noted in recent literature.
Proies de C. carnea (sauf les psylles du poirier en Europe), signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|--|--|--|---|
| Psyllids | | | |
| <i>Psylla pyricola</i> (Foerster) | pear | U.S.A. Canada | NICKEL <i>et al.</i> (1965), WESTIGARD <i>et al.</i> (1968), BURTS (1970), WESTIGARD (1979). McMULLEN & JONG (1967a, 1967b), WILDE (1962). |
| Aphids | | | |
| <i>Rhopalosiphum padi</i> (L.) | <i>Prunus padus</i> L. maize oats wheat | West Germany France Finland West Germany Spain | BODE (1980a). MOREAU (1983). RAUTAPAA (1977). HELLPAP (1982). CASTANERA (1983). |
| <i>Schizaphis graminum</i> (Rondani) | cereals | U.S.S.R. | BEREST (1980b). |
| <i>Sitobion avenae</i> (F.) | rice cereals wheat | U.S.S.R. U.S.S.R. West Germany Spain | MYRZIN & LUK'YANCHIKOV (1981). BEREST (1980b). HELLPAP (1982). CASTANERA (1983). |
| <i>Metopolophium dirhodum</i> (Walker) | wheat | England West Germany Spain | DEAN (1982). HELLPAP (1982). CASTANERA (1983). |
| <i>Diuraphis noxia</i> (Mordvilko) | cereals | U.S.S.R. | BEREST (1980b). |
| <i>Aphis craccivora</i> Koch | liquorice | U.S.S.R. | KESTEN (1975). |
| <i>Aphis gossypii</i> Glover | cotton | Egypt Pakistan U.S.S.R. | HABIB <i>et al.</i> (1980). AFZAL & KHAN (1978). RADZIVILOVSKAYA (1980), ISHANKULIEVA (1979). |
| <i>Brevicoryne brassicae</i> (L.) | clover cabbage | Egypt England U.S.S.R. | AFIFI <i>et al.</i> (1980). AKINLOSOTU (1978). YASTREBOV (1979). |
| <i>Acyrtosiphon pisum</i> (Harris) | lucerne | U.S.A. | BAUMGAERTNER <i>et al.</i> (1981). |
| <i>Myzus persicae</i> (Sulzer) | potato | U.S.A. | MACK & SMILOWITZ (1979). |
| <i>Illinoia pepperi</i> (Mac Gillivray) | blueberry | U.S.A. | WHALON & ELSNER (1982). |
| <i>Hyalopterus pruni</i> (Geoffroy) | peach | Iraq | MAHMOUD <i>et al.</i> (1981). |
| <i>Brachycaudus amygdalinus</i> (Schouteden) | peach | Iraq | MAHMOUD <i>et al.</i> (1981). |
| Coccids | | | |
| <i>Saissetia oleae</i> (Olivier) | olive | France | ALROUECHDI <i>et al.</i> (1980). |
| <i>Aspidiotus nerii</i> Bouché | olive | Greece Chile Chile | ARGYRIOU & KOURMADAS (1980). MATTA (1979). MATTA (1979). |
| <i>Hemiberlesia lataniae</i> (Signoret) | olive | Chile | MATTA (1979). |
| <i>Planococcus citri</i> (Risso) | grapefruit | Israel | BERLINGER <i>et al.</i> (1979). |
| <i>Pulvinaria innumerabilis</i> (Rathvon) | urban shade trees | U.S.A. | ANONYMOUS (1982). |
| coccids spp. | citrus | France | PANIS (1980). |
| Aleurodids | | | |
| <i>Bemisia tabaci</i> (Gennadius) | cotton | Egypt | HAFEZ <i>et al.</i> (1983). |
| Lepidoptera | | | |
| <i>Prays oleae</i> (Bernard) | olive | France Syria | ALROUECHDI <i>et al.</i> (1981a). ALROUECHDI (1981). |
| <i>Heliothis armigera</i> (Hubner) | cotton | U.S.S.R. Israel Egypt | RUSTAMOVA (1981), SUKHORUCHENKO <i>et al.</i> (1981). BAR <i>et al.</i> (1979). ISMAIL & SWAILEM (1976). |
| <i>Heliothis zea</i> (Boddie) | cotton | U.S.A. Turkey | WILSON & GUTIERREZ (1980). KISMIR & SENGONCA (1981). |
| <i>Heliothis virescens</i> (F.) | cotton | Turkey | KISMIR & SENGONCA (1981). |
| <i>Heliothis</i> spp. | cotton | U.S.A. | SMITH <i>et al.</i> (1978). |
| <i>Pectinophora gossypiella</i> (Saunders) | cotton | Egypt | ABUL-NASR <i>et al.</i> (1978). |
| <i>Trichoplusia ni</i> (Hubner) | cotton | U.S.A. | WILSON & GUTIERREZ (1980). |
| <i>Spodoptera littoralis</i> (Boisduval) | cotton | Egypt | MAHER-ALI <i>et al.</i> (1983), HABIB <i>et al.</i> (1980). |
| <i>Spodoptera praefica</i> (Grote) | lucerne | U.S.A. | BISABRI-ERSHADI & EHLER (1981). |
| <i>Gymnoscelis rufifasciata</i> Haworth | artichoke | Egypt | SADDIK & EL-MINIAWI (1978). |
| <i>Tortrix viridana</i> (L.) | <i>Quercus ilex</i> L. | France | DU MERLE (1983). |
| Coleoptera | | | |
| <i>Leptinotarsa decemlineata</i> (Say) | potato, egg plant | U.S.S.R. | FILIPPOV (1982). |
| <i>Hypera brunneipennis</i> (Boheman) | tomato | Egypt | AFIFI <i>et al.</i> (1980). |
| Diptera | | | |
| <i>Pegomya hyoscyami</i> (Panzer) | sugar-beet | West Germany | GROH & TANKE (1980). |

Table 15 (continued)

| Prey | Host plants | Location | References |
|------------------------------------|------------------|----------------|--|
| Thrips | | | |
| <i>Thrips tabaci</i> Lindemann | cotton clover | Egypt Egypt | HABIB <i>et al.</i> (1980). AFIFI <i>et al.</i> (1980). |
| Acari | | | |
| <i>Tetranychus urticae</i> Koch | cotton | U.S.S.R. | ISHANKULIEVA (1979). |
| <i>Eotetranychus pruni</i> (Oudm.) | orchards | U.S.S.R. | KARTASHEVA & LESTEVA (1979). |

TABLE 16

Prey of Syrphus vitripennis (Meigen), noted in recent literature.

Proies de S. vitripennis, signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|---|--|----------------------|---|
| Aphids | | | |
| <i>Myzus persicae</i> (Sulzer) | cucumber green vegetables | U.S.S.R. Bulgaria | KARELIN (1980). NATSKOVA (1977). |
| <i>Myzus humuli</i> (Schrank) | plum | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Myzus cerasi</i> (F.) | cherry | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Myzus cerasi pruniavium</i> Börner | cherry | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Capitophorus ribis</i> (L.) | currants | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Brachycaudus cardui</i> (L.) | plum | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Brachycaudus helichrysi</i> (Kaltenbach) | plum | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Rhopalosiphum oxyacanthae</i> (Schrank) | apple | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Rhopalosiphum nymphaeae</i> (L.) | plum | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Rhopalosiphum padi</i> (L.) | <i>Prunus padus</i> L. | U.S.S.R. | CHERKASHINA (1973). |
| <i>Aphis pomi</i> DeGeer | apple | Italy Poland | SETTI (1973). WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Aphis schneideri</i> (Börner) | currants | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Aphis gossypii</i> Glover | cucumber green vegetables | U.S.S.R. Bulgaria | KARELIN (1980). NATSKOVA (1977). |
| <i>Aphis craccivora</i> Koch | green vegetables | Bulgaria | NATSKOVA (1977). |
| <i>Aphis fabae</i> Scopoli | green vegetables sugar-beet | Bulgaria France | NATSKOVA (1977). LYON (1971). |
| <i>Aphis sambuci</i> L. | ornamental shrubs | Poland | ZIARKIEWICZ & KOZLOWSKA (1973). |
| <i>Anoecia corni</i> (F.) | ornamental shrubs | Poland | ZIARKIEWICZ & KOZLOWSKA (1973). |
| <i>Macrosiphum rosae</i> (L.) | ornamental shrubs | Poland | ZIARKIEWICZ & KOZLOWSKA (1973). |
| <i>Macrosiphum euphorbiae</i> (Thomas) | cucumber green vegetables | U.S.S.R. Bulgaria | KARELIN (1980). NATSKOVA (1977). |
| <i>Acyrtosiphon pisum</i> (Harris) | green vegetables | Bulgaria | NATSKOVA (1977). |
| <i>Eriosoma lanigerum</i> (Hausmann) | apple | Italy | SETTI (1973). |
| <i>Eriosoma ulmi</i> (L.) | elm | Poland | JANISZEWSKA-CIHOCKA (1971). |
| <i>Disaphis plantaginea</i> (Passerini) | apple | Italy Poland | SETTI (1973). WNUK (1972), WIACKOWSKI & WIACKOWSKA (1968). |
| <i>Hyalopterus pruni</i> (Geoffroy) | peach plum | France Poland | REMAUDIERE & LECLANT (1971). SMOLARZ (1970). |
| <i>Brevicoryne brassicae</i> (L.) | green vegetables | Bulgaria | NATSKOVA (1977). |
| <i>Amphorophora lactucae</i> (L.) | cultivated crucifers | Rumania | CONSTANTINESCU (1972). |
| | fruit trees, ornamental shrubs | Poland | KOZLOWSKA (1978), WNUK (1972). |
| | currants | Poland | WIACKOWSKI & WIACKOWSKA (1968). |
| aphids spp. | cabbage | Czechoslovakia | DUSEK & LASKA (1974). |
| | pome & stone fruit trees | Turkey | ERKIN (1983). |
| Psyllids | | | |
| <i>Craspedolepta dorecinia</i> sp. n. | <i>Artemisia</i> spp. | U.S.S.R. | KONOVALOVA (1978). |
| <i>Craspedolepta chasanica</i> sp. n. | <i>Artemisia</i> spp. | U.S.S.R. | KONOVALOVA (1978). |
| <i>Calophya nigra</i> Kuway. | <i>Phellodendron sachalinense</i> F. Schmidt., <i>Phellodendron amurense</i> Rupr. | U.S.S.R. | KONOVALOVA (1978). |

TABLE 17

Prey of Episyrrhus balteatus (DeGeer) (other than pear psylla), noted in recent literature.
Proies d'E. balteatus (sauf les psylles du poirier), signalées récemment dans la littérature.

| Prey | Host plants | Location | References |
|--|--|---|---|
| Aphids | | | |
| <i>Acyrtosiphon pisum</i> (Harris) | lucerne green vegetables broad bean | Bulgaria Bulgaria West Germany | ABDULMADZHID (1973). NATSKOVA (1977). TANKE (1976). |
| <i>Anoecia corni</i> (F.) | ornamental shrubs | Poland | ZIARKIEWICZ & KOZLOWSKA (1973). |
| <i>Aphis craccivora</i> Koch | green vegetables | Bulgaria | NATSKOVA (1977). |
| <i>Aphis fabae</i> Scopoli | broad bean sugar-beet ornamental shrubs | England France Poland | CHANDLER (1968). LYON (1971). ZIARKIEWICZ & KOZLOWSKA (1973). |
| <i>Aphis gossypii</i> Glover | green vegetables green vegetables cucumber | Bulgaria Bulgaria U.S.S.R. | NATSKOVA (1977). NATSKOVA (1977). KARELIN (1980). |
| <i>Aphis pomi</i> DeGeer | apple | France | LYON & GOLDLIN DE TIEFENAU (1974), MARBOUTIE (1976). |
| | | Italy | SETTI (1973). |
| | | Poland | WNUK (1977). |
| <i>Aphis sambuci</i> L. | ornamental shrubs | Poland | ZIARKIEWICZ & KOZLOWSKA (1973). |
| <i>Aphis spiraeophaga</i> Müller | ornamental shrubs | Poland | ZIARKIEWICZ & KOZLOWSKA (1973). |
| <i>Brachycaudus amygdalinus</i> (Schouteden) | almond | Lebanon | ZIARKIEWICZ & KOZLOWSKA (1973). |
| <i>Brachycaudus helichrysi</i> (Kaltenbach) | almond | Lebanon | TALHOUK (1977). |
| <i>Brevicoryne brassicae</i> (L.) | cabbage | Czechoslovakia Bulgaria U.S.S.R. | TALHOUK (1977). LASKA (1967). TSACHEV (1972), STRAKA (1976). SHLYAKHOVOI & BOBONICH (1975), YAS- TREBOV (1979). |
| | brussels sprouts | England | POLLARD (1969). |
| | cultivated crucifers | Rumania | CONSTANTINESCU (1972). |
| | green vegetables | Bulgaria | NATSKOVA (1977). |
| | tobacco | Japan | TAKAOKA (1975). |
| <i>Cinara pilicornis</i> (Hartig) | spruce | Czechoslovakia | KULA (1982). |
| <i>Dysaphis plantaginea</i> (Passerini) | apple | France Italy | LYON & GOLDLIN DE TIEFENAU (1974). SETTI (1973). |
| <i>Eriosoma lanigerum</i> (Hausmann) | apple | France Italy | LYON & GOLDLIN DE TIEFENAU (1974). SETTI (1973). |
| <i>Eriosoma ulmi</i> (L.) | elm | Poland | JANISZEWSKA-CICHOCKA (1971). |
| <i>Hyalopterus pruni</i> (Geoffroy) | plum peach | Poland France | SMOLARZ (1970). REMAUDIERE & LECLANT (1971). |
| <i>Hysteroneura setariae</i> (Thomas) | peach | Taiwan | LEE & HSU (1979). |
| <i>Lachnus tropicalis</i> (v. d. Goot) | chestnut | Japan | TOGOSHI (1976). |
| <i>Lipaphis erysimi</i> Kaltenbach | cabbage | Pakistan India | KHAN & YUNUS (1970). ROY & BASU (1978), AGARWALA & RAY- CHAUDHURI (1981). |
| | <i>Eruca sativa</i> (Miller) | India | BAKHETIA & SHARMA (1979). |
| <i>Macrosiphum euphorbiae</i> (Thomas) | green vegetables cucumber | Bulgaria U.S.S.R. | NATSKOVA (1977). KARELIN (1980). |
| <i>Macrosiphum rosae</i> (L.) | roses | Bulgaria | NATSKOVA (1971). |
| <i>Metopolophium dirhodum</i> (Walker) | ornamental shrubs cereals wheat | Poland England Belgium West Germany | ZIARKIEWICZ & KOZLOWSKA (1973). DEAN (1974). LATTEUR (1973). BODE (1980b). |
| | | England | CHAMBERS <i>et al.</i> (1982). |
| <i>Metopolophium festucae</i> (Theobald) | wheat | Belgium England | LATTEUR (1973). CHAMBERS <i>et al.</i> (1982). |
| | | England | CHAMBERS <i>et al.</i> (1982). |
| <i>Myzus persicae</i> (Sulzer) | tobacco | Japan Bulgaria | TAKAOKA (1975). DIRIMANOV & DIMITROV (1975). |
| | green vegetables cucumber cabbage | Bulgaria U.S.S.R. India Japan | NATSKOVA (1977). KARELIN (1980). AGARWALA & RAYCHAUDHURI (1981). ITO & IWAO (1977). |
| | peach | France Bulgaria | RENAUDIERE & LECLANT (1971). GRIGOROV (1978). |
| | <i>E. sativa</i> | India | BAKHETIA & SHARMA (1979). |
| <i>Pemphigus fuscicornis</i> (Koch) | sugar-beet | Bulgaria | GRIGOROV (1977b). |
| <i>Rhopalosiphum insertum</i> (Walker) | apple | France | LYON & GOLDLIN DE TIEFENAU (1974). |
| <i>Rhopalosiphum padi</i> (L.) | wheat maize <i>Prunus padus</i> L. | Belgium Poland U.S.S.R. West Germany | LATTEUR (1973). JASIOLEK <i>et al.</i> (1974). CHERKASHINA (1973). BODE (1980b). |
| <i>Schizaphis graminum</i> (Rondani) | maize | Poland | JASIOLEK <i>et al.</i> (1974). |
| | rice | U.S.S.R. | MYRZIN & LUK'YANCHIKOV (1981). |
| <i>Schizaphis hypersiphonata</i> Basu | pangola grass | Australia | BROADLEY & ROGERS (1978). |

Table 17 (continued)

| Prey | Host plants | Location | References |
|--|---|-------------------------|---|
| <i>Sitobion avenae</i> (F.) | wheat | Belgium West Germany | LATTEUR (1973). BODE (1980b). |
| | maize | England Poland | CHAMBERS <i>et al.</i> (1982), DEAN (1982). JASIOLEK <i>et al.</i> (1974). |
| <i>Toxoptera aurantii</i> (Boyer) aphids spp. | cereals | England | DEAN (1974). |
| | citrus | Greece | ARGYRIOU (1970). |
| | fruit trees, bushes | Poland | WNUK (1983). |
| | pome & stone fruit trees | Turkey | ERKIN (1983). |
| | pepper | Bulgaria | NATSKOVA (1973). |
| | sorghum, maize, pulse, egg-plant, mustard, cole tea, fennel, <i>Malus</i> | India Azores | PATNAIK <i>et al.</i> (1977). GOMES (1980). |
| Various prey | cotton | U.S.S.R. | NARZIKULOV & UMAROV (1975). |

Another predacious mite *Allothrombium fuliginosum* Hermann was common in the orchards at Toulouse and Avignon and observed as a predator of *P. pyri*. *A. fuliginosum* has been noted in the literature as predator of a large variety of prey. In orchards in Italy, it was observed preying upon winter eggs of the aphid, *D. plantaginea*, on apple (BARONIO, 1971) and upon the coccid *Filippia follicularis* Targioni, on olive (SCALTRITI, 1982). It was also observed in the U.S.S.R. as a predator of eggs of *Leptinotarsa decemlineata* (Say) (KOVAL, 1968) and of *A. craccivora* on liquorice (KESTEN, 1975). Also, it was observed attacking *Pegomya betae* (Curtis) on sugar beet in France (MISSONNIER, 1971) and *B. brassicae* on cultivated crucifers in Rumania (CONSTANTINESCU, 1972).

D. Fungi

We did not encounter *P. pyri* larvae infected with fungi, although some cases of attack by *Entomophthora* sp. are already known in France and Italy (table 1). On the other hand, we did find a few *P. peregrina* larvae parasitized by *Entomophthora* sp. in the Paris region.

IV. DISCUSSION & CONCLUSION

Among the 66 species inventoried, 56 had a useful role, to varying degrees, in limiting populations of pear psylla. Only 16 species were fairly abundant and seem to be especially appropriate for biological control. Among these are the 3 species traditionally well tied to pear psylla, *P. mitratus*, *T. psyllae* and *A. nemoralis*, plus 13 predators as follows :

A. nemorum, *O. horvathi*, *O. vicinus*, *H. meriopterum*, *C. virgula*, *O. nassatus*, *S. punctillum*, *S. ru-*

bromaculatus, *S. subvillosus*, *C. septempunctata*, *C. carnea*, *C. borealis* and *A. fuliginosum*.

The main beneficial insects for biological control of pear psylla were also found on hawthorn where they also attack psyllids ; moreover, 2 predators common on pear trees, *A. nemorum* and *H. meriopterum*, abundantly frequented nettle attacked by *T. urticae* and aphids inside or surrounding the orchards. Not only hawthorn and nettle, but many other host plants serve as a reservoir for the beneficial insects occurring in pear orchards. The richness of the orchard's natural environment may have contributed to maintain and to increase the population of pear psylla natural enemies.

The main enemies mentioned above are not active during the total development of the 5 to 7 generations of *P. pyri* which occur in France. Some species occur early in the season and others later, in such a way that the limiting combined and complementary action of these enemies definitely covers almost the entire season (HERARD, 1985).

This literature review shows that the inventoried species are basically polyphagous. The parasites, *P. mitratus* and *T. psyllae*, attack various psyllids, and the main predators are either common in various kinds of orchards, or predaceous on insects of a particular taxonomic group, such as aphids, which have a wide spectrum of host plants.

This lack of specificity for the pear psylla among its enemies must be considered if using any of them in biological control. It remains to be seen whether any of these beneficial species could survive on a diet of largely pear psylla, would lead themselves to economical mass production in the laboratory, would disperse, too, rapidly considering their apparent need for diversity, to effect control of the pest and could be applied when and where needed in adequate quantity.

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