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SAWFLY SPECIES ASSEMBLAGE (*HYMENOPTERA: SYMPHYTA*) IN AN HETEROGENOUS ACIDOFILOUS FOREST IN ARTIKUTZA (NAVARRE, SPAIN)

RACCOLTA DI SINFITI (*HYMENOPTERA: SYMPHYTA*) IN UNA FORESTA ETEROGENEA ACIDOFILA IN ARTIKUTZA (NAVARRA, SPAGNA)

ABSTRACT

The sawfly species assemblage in an acidofilous heterogenous forest in Artikutza (Navarre, Spain) was used as an indicator group to assess the diversity of these semi-natural forests. In this paper we describe the data relative to taxonomic composition, relative abundance and temporal activity recorded from six Malaise traps over a two year period. Our data represent the first comprehensive forest sawfly community study in Spain and contribute to go deeply into the methodological approach for monitoring this group.

INTRODUCTION

The European strategy for biodiversity conservation was designed to encourage the restoration and conservation of natural forests for sustainable resource management (Delbaere, 1998). Restoration of natural decidous forests combining with development of recreation values and other sustainable uses are the main concerns in the basque natural park of Peñas de Aia-Aiako Harria (Gipuzkoa) (B.O.P.V., 1995; 2002) and the adjacent forest reserve of Artikutza (Navarre). The invertebrate catalogue of these reserves is one of the main tasks needed to approach management plans for biodiversity conservation. Recording of a sawfly species assemblage in Artikutza was framed in a wider study in which *Hymenoptera* were used as an indicator group to assess diversity of semi-natural acid forests in the region (Martínez De Murguía, 2002; Martínez De Murguía *et al.*, 2003).

Sawflies are grouped taxonomically in 5 superfamilies and 13 families (Hanson & Gauld, 1995) and form an uniform ecological group. Their larvae are found external and internally associated with trees, shrubs, ferns and herbs. In Europe they account with above 1.000 especies (Gauld *et al.*, 1990; Ulrich, 1999) and are involved in important economic processes; for instance, among the major forest insect pests in Europe eighteen species are sawflies (Day & Leather, 1997). On the other hand many species are threatened by loss of plant hosts by intensification of agriculture, due to their monophagy character towards their host, and the use of pesticides (Gauld *et al.*, 1990).

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The Malaise trap (MALAISE, 1937; TOWNES, 1972) is a common method used for the study of sawfly species assemblages in forests. As a standarized method Malaise traps have been used to monitor richness (MARCHAL, 1985; MAGIS, 1998; ROLLER, 1998), seasonality (SMITH & BARROWS, 1987) and species spatial distributions (PAPP & JÓZAN, 1995). Other methods include active searching (LISTON, 1984) and the use of photoeclectors (HILPERT, 1989; ULRICH, 1998).

The lack of information on forest sawfly composition in our region along with the significance of faunistic collections as a basic scientific resource in biodiversity assessment (WIGGINS *et al.*, 1991) were the main reasons to conduct this study. The aim of this paper is to analyze the sawfly species assemblage in a regenerating acidofilous heterogenous forest in relation to its taxonomic composition, richness, relative abundances, sex rates, seasonal activity and Malaise trap efficiency. For this purpose we study the data obtained during two consecutive years from six traps covering two successional vegetation series, mixed pine forest and beechwood in the forest reserve of Artikutza (Navarre).

MATERIALS AND METHODS

Study Area

The study took place in the forest reserve of Artikutza (Goizueta, Navarre) (43°09'28" - 43°14'52" North and 01°45'35" - 01°49'30" West), which is characterized by nutrient poor, acidic soils with a humus moder of granitic origin, that supports a vegetation dominated by oak, *Quercus robur* Linnaeus (*Tamo Quercetum-robori*), and beech, *Fagus sylvatica* Linnaeus (*Saxifrago hirsutae-Fagetum*) (CATALÁN, 1987). Following extensive deforestation up to 1925, plantations were established comprising a variety of deciduous species (*F. sylvatica* L., *Quercus* spp., *Castanea sativa* Mill.) and conifers (*Pinus sylvestris* Linnaeus, *Larix x eurolepis* A. Henry, *Chamaecyparis lawsoniana* ((A. Murray) Parl.) (CATALÁN *et al.*, 1989). The present-day landscape supports a heterogenous mosaic of remanent forest, pine plantations and derived secondary mixed forests.

Sampling was conducted in 5 Ha located in the northwest of the reserve (30TWN972868 U.T.M.) at an elevation of 575-652 m altitude and includes two adjacent successional series defined by a stream: mixed pine forest and beechwood. The mixed pine forest represents a secondary forest (70 years old) dominated by pine, oak and beech, and the beechwood is partially restocked with young plantings and surrounded by conifer plantations. Site characteristics as pine advanced age, clearings and restockings, are responsible in a great extent for the important amount of dead wood, that accumulates particularly in the stream banks.

Sampling design and data collection

TOWNES (1972) modified Malaise traps supplied by Marris House Nets (United Kingdom) were used in this study. They are bidirectional (203 cm front height, 112 cm back height, and 122 cm wide by 183 cm long) black with the roof white and fine mesh (0.3 mm). Trap collection jars were filled with 70% ethanol along with three drops of glycerine to soften specimens. A total of six Malaise traps were placed, three in each vegetation series: M-1, M-2 and M-3 in the mixed pine forest and H-1, H-2 and H-3 in the beechwood. Trap settlement characteristics are described in MARTÍNEZ DE

MURGUÍA *et al.* (2002). Sampling was conducted continuously during two seasonal cycles, from May 1995 to April 1997, and produced a total of 46 samples per trap in 733 days. Species identification was made available by taxonomist Dr. G. Llorente Vigil. The material was labelled and stored in the collections of the Sociedad de Ciencias Aranzadi in San Sebastiàn (Guipùzcoa) and the Facultad de Ciencias Biològicas de la Universidad Complutense (Madrid).

Analyses

Quantitative data recorded from Malaise traps refers to adult abundance, mobility or level of activity and selection by phototropic response of species, sex or caste (SOUTHWOOD, 1978; SOUTHWOOD & HENDERSON, 2000). Abundance distribution among species is studied by a frequency diagram. The number of traps needed to record all species in each cycle is obtained from the cumulative curve of number of species per trap (COLWELL & CODDINGTON, 1994). To know the estimated richness percentage obtained in our samples we compare observed data with non parametric richness estimators, Chao1, Chao2, Jacknife1, Jacknife2 and Boostrap discussed in COLWELL & CODDINGTON (1994) and ACE and ICE included in COLWELL (1997). Chao1 (CHAO, 1984) is based in the distribution of individuals among species, giving special importance to species that show one or two individuals; Chao2, that is calculated by species distibutions among samples, focus on the number of species that show in an unique or two samples; Jacknife1 y Jacknife2 reduce the underestimation of the real number of species, the former focus only in the number of species that show in one sample and the second on the number that show in one and two samples; Boostrap is based in the proportion of samples that contain each species; ACE and ICE are based in the sum of encounter probabilities for observed species taking into account the species present but not observed, the former is based in those species with 10 or less individuals in the sample and the second in those species that are found in 10 or less number of samples.

RESULTS

Taxonomic composition and relative abundances

The sawfly assemblage included 440 individuals representing 4 superfamilies, 4 families, 28 genera and 43 species (Tab. 1). The family *Tenthredinidae* predominated with more than 90% of total abundance and species richness; a greater number of species, 16, were recorded in *Nematinae* and 10 species in *Selandriinae*, 9 in *Blennocampinae* and 5 in *Tenthredininae*. According to relative abundances *Selandriinae* and *Tenthrediinae* dominated, with 183 (44.30%) and 160 (38.74%) individuals respectively, followed by *Nematinae* with 52 (2.59%) and *Blennocampinae* with 18 (4.35%).

Frequencies graph (Fig. 1) show the dominance of species represented by only one individual (48.83%) and up to 4 individuals (76.74%) and very few species with high abundances. Most abundant species were *Dolerus aeneus* Hartig (37%), *Tenthredopis nassata* Linnaeus (33%) and *Xyela julii* Brébisson (5%) followed by *Pachynematus obductus* Hartig (2.5%), *Tenthredo livida* Linnaeus (2.5%), *Ametastegia pallipes* Spinola (1.8%) and *P. vagus* Fabricius (1.8%).

The first cycle we obtained 67.44% of total species, 13 was the number of common species to both years, 16 were present only in the first cycle and 14 only in the

Tab. 1 - Sawfly species and abundances in each cycle and in total with host plant recorded in the bibliography.

Species	1995-96	1996-97	Total	Host plant
XYELOIDEA, Xyelidae				
Xyela julii Bréb.	2	23	25	*Pinus*
CEPHOIDEA, Cephidae				
Janus femoratus (Curt.)	1	0	1	*Quercus*
MEGALODONTOIDEA, Pamphilidae				
Acantholyda posticalis Mat.	0	1	1	*Pinus*
TENTHREDINOIDEA, Tenthredinidae				
Selandriinae				
Aneugmenus padi (L.)	0	2	2	*Pteridium*
Dolerus aeneus Hart.	109	53	162	Gramineae
Dolerus gonager (Fab.)	0	4	4	*Festuca*
Dolerus madidus Klug	1	1	2	*Juncus*
Dolerus niger (L.)	1	0	1	Gramineae
Dolerus puncticollis Thom.	2	2	4	Gramineae
Dolerus sanguinicollis (Klug)	2	0	2	Gramineae
Heptamelus ochroleucus (Steph.)	0	1	1	*Athyrium, Blechnum*
Strombocerina delicatula (Fallén)	2	0	2	*Athyrium, Pteridium, Polystichum*
Strongylogaster lineata (Christ)	0	3	3	*Pteridium, Polystichum, Dryopteris*
Blennocampinae				
Ametastegia carpini (Hart.)	2	0	2	*Geranium*
Ametastegia equiseti (Fallén)	1	0	1	*Polygonum, Rumex*
Ametastegia pallipes (Spin.)	5	3	8	*Viola*
Athalia circularis (Klug)	1	0	1	*Veronica, Plantago*
Athalia cornubiae (Ben.)	1	0	1	*Sedum*
Empria tridens (Konow)	1	0	1	*Rubus*
Periclista albida (Klug)	0	2	2	*Quercus*
Monophadnus monticola (Hart.)	0	1	1	*Ranunculus, Anemone*
Scolioneura betuleti (Klug)	0	1	1	*Betula*
Nematinae				
Amauronematus viduatus (Zett.)	1	0	1	*Salix*
Cladius pectinicornis Geof.	2	0	2	*Fragaria, Rosa*
Euura mucronata (Hart.)	0	1	1	*Salix*
Euura venusta (Zadd.)	1	0	1	*Salix*
Nematus fuscomaculatus Förs.	4	2	6	*Populus*
Nematus hypoxanthus Föers.	1	0	1	*Populus, Salix*
Pachynematus moerens (Föers.)	1	3	4	No record
Pachynematus obductus (Hart.)	5	6	11	*Poa, Festuca*
Pachynematus vagus (Fab.)	5	3	8	No record
Priophorus pallipes (Lep.)	0	1	1	*Crataegus, Fragaria, Pyrus, Malus, Sorbus, Ribes, Prunus, Rubus, Betula*
Pristiphora abbreviata (Hart.)	1	0	1	*Pyrus*
Pristiphora laricis (Hart.)	0	5	5	*Larix*
Pristiphora pallidiventris (Fallén)	1	5	6	*Fragaria, Rubus, Geum, Potentilla*
Pristiphora punctifrons (Thom.)	1	1	2	*Rosa, Prunus*

Pseudodineura fuscula (Klug)	0	1	1	*Ranunculus*
Trichiocampus ulmi (L.)	0	1	1	*Ulmus*
Tenthredininae				
Macrophya teutona (Panz.)	1	0	1	No record
Pachyprotasis antenata (Klug)	1	0	1	*Fraxinus, Filipendula*
Tenthredo livida L.	6	4	10	*Viburnum, Salix, Corylus, Sorbus, Rosa, Lonicera, Pteridium*
Tenthredopis litterata (Geoff.)	0	1	1	*Dactylis, Deschampsia*
Tenthredopis nassata L.	92	55	147	*Dactylis, Carex, Deschampsia*
Number of individuals	254	186	440	
Number of species	29	27	43	

second one. Abundance variability between cycles was due to variability of the three dominant species; without these, abundances in each of the two cycles are similar, with 51 and 55 individuals respectively.

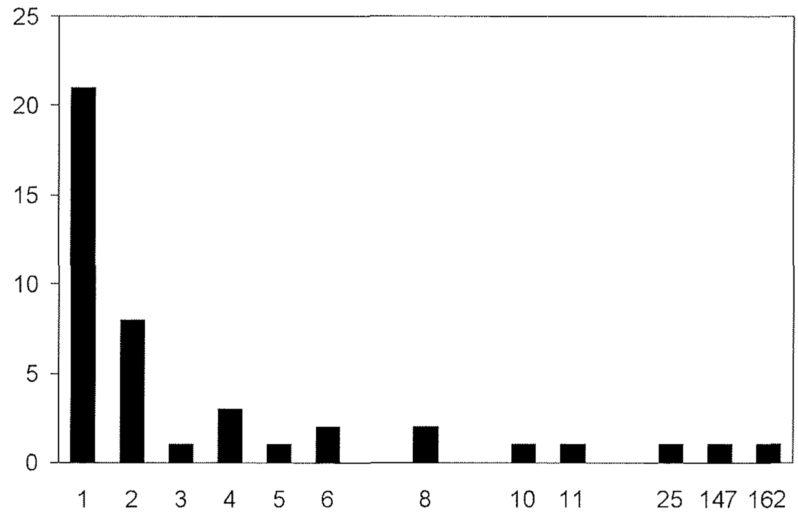

Fig. 1 - Frequency graph of the number of individuals recorded among species.

Sex rates

From all species recorded 23 were represented only by females, 9 only by males and 10 by both sexes (Tab. 2). Number of species represented with only females was greater both years and showed a great variation those with both sexes, abundant in the first and scarce in the second (Tab. 3). For species with both sexes a greater proportion of males in respect to females was recorded for *D. aeneus* Hartig (157:5), *T. nassata* Linnaeus (119:28) and *Nematus fuscomaculatus* Förster (5:1), more females than males for *P. obductus* (Hartig) (10:1), *T. livida* Linnaeus (8:2), *P. vagus* (Fabricius) (5:3) and with similar numbers *Strombocerina delicatula* (Fallén), *D. san-*

Tab. 2. Sex and number of individuals recorded for each species (G. Llorente det.).

SPECIES	SEX AND DATES
Acantholyda posticalis Matsumura ♀♀	1 ♀ 12.V-26.V.1996.
Amauronematus viduatus (Zetterstedt) ♀♀	1 ♀ 17.III-31.III.1996
Ametastegia carpini (Hartig) ♀♀	2 ♀♀ 10.VII-24.VII.1995.
Ametastegia equiseti (Fàllen) ♀♀	1 ♀ 24.VII-7.VIII.1995.
Ametastegia pallipes (Spinola) ♀♀	3 ♀♀ 26.VI-10.VII.1995: 2 ♀♀ 7.VIII-21.VIII.1995: 1 ♀ 12.V-26.V.1996: 1 ♀ 22.IX-6.X.1996: 1 ♀ 7.III-23.III.1997.
Aneugmenus padi (Linnaeus) ♀♀	1 ♀ 26.V-9.VI.1996: 1 ♀ 9.VI-23.VI.1996.
Athalia circularis (Klug) ♀♀	1 ♀ 26.VI-10.VII.1995.
Athalia cornubiae (Benson) ♀♀	1 ♀ 26.VI-10.VII.1995.
Cladius pectinicornis Geoffroy ♂♂ ♀♀	1 ♂ 24.VII-7.VIII.1995: 1 ♀ 10.VII-24.VII.1995.
Dolerus aeneus Hartig ♂♂ ♀♀	25 ♂♂ 1 ♀ 1.V-15.V.1995: 35 ♂♂ 2 ♀♀ 15.V-29.V.1995: 14 ♂♂ 29.V-12.VI.1995: 19 ♂♂ 12.VI-26.VI.1995: 8 ♂♂ 1 ♀ 26.VI-10.VII.1995: 2 ♂♂ 10.VII-24.VII.1995: 1 ♂ 31.III-14.IV.1996: 1 ♂ 28.IV-12.V.1996: 13 ♂♂ 12.V-29.V.1996: 10 ♂♂ 26.V-9.VI.1996: 5 ♂♂ 9.VI-23.VI.1996: 1 ♂ 23.VI-14.VII.1996: 1 ♂ 14.VII-11.VIII.1996: 1 ♂ 23.II-7.III.1997: 2 ♂♂ 7.III-23.III.1997: 1 ♂ 6.IV-20.IV.1997: 18 ♂♂ 20.IV-4.V.1997.
Dolerus gonager (Fabricius) ♂♂	4 ♂♂ 12.V-26.V.1996.
Dolerus madidus Klug ♂♂ ♀♀	1 ♂ 17.III-31.III.1996:1 ♀ 12.V-26.V.1996.
Dolerus niger (Linnaeus) ♀♀	1 ♀ 15.V-29.V.1995.
Dolerus puncticollis C.G.Thomson ♂♂	1 ♂ 1.V-15.V.1995: 1 ♂ 15.V-29.V.1995.
Dolerus sanguinicollis (Klug) ♂♂ ♀♀	1 ♀ 15.V-29.V.1995: 1 ♂ 29.V-12.VI.1995.
Empria tridens (Konow) ♂♂	1 ♂ 1.V-15.V.1995.
Euura mucronata (Hartig) ♂♂	1 ♂ 28.IV-12.V.1996.
Euura venusta (Zaddach) ♂♂	1 ♂ 1.V-15.V.1995.
Heptamelus ochroleucus (Stephens) ♀♀	1 ♀ 12.V-26.V.1996.
Janus femoratus (Curtis)	Indet. 1.V-15.V.1995.
Macrophya teutona (Panzer) ♀♀	1 ♀ 15.V-29.V.1995.
Monophadnus monticola (Hartig) ♀♀	1 ♀ 26.I-9.II.1997.
Nematus fuscomaculatus Förster ♂♂ ♀♀	1 ♂ 15.V-29.V.1995: 2 ♂♂ 26.VI-10.VII.1995: 1 ♀ 7.VIII-21.VIII.1995: 2 ♂♂ 7.III-23.III.1997.
Nematus hypoxanthus Förster ♀♀	1 ♀ 10.VII-24.VII.1995.
Pachynematus moerens (Förster) ♂♂	1 ♂ 31.III-14.IV.1996: 2 ♂♂ 7.III-23.III.1997: 1 ♂ 23.III-6.IV.1997.
Pachynematus obductus (Hartig) ♂♂ ♀♀	1 ♀ 15.V-29.V.1995: 1 ♂ 1 ♀ 26.VI-10.VII.1995: 1 ♀ 10.VII-24.VII.1995: 1 ♀ 4.IX-18.IX.1995: 1 ♀ 12.V-26.V.1996: 2 ♀♀ 25.VIII-22.IX.1996: 1 ♀ 7.III-23.III.1997: 2 ♀♀ 6.IV-20.IV.1997.
Pachynematus vagus (Fabricius) ♂♂ ♀♀	1 ♂ 29.V-12.VI.1995: 1♀ 26.VI-10.VII.1995: 1 ♂ 1 ♀ 10.VII-24.VII.1995: 1 ♀ 24.VII-7.VIII.1995: 1 ♀ 28.IV-12.V.1996: 1 ♂ 26.V-9.VI.1996: 1 ♀ 14.VII-11.VIII.1996.
Pachyprotasis antenata (Klug) ♀♀	1 ♀ 26.VI-10.VII.1995.
Periclista albida (Klug) ♀♀	2 ♀♀ 6.IV-20.IV.1997.
Priophorus pallipes (Lepeletier) ♂♂	1 ♂ 26.V-9.VI.1996.
Pristiphora abbreviata (Hartig) ♀♀	1♀ 17.III-31.III.1996.
Pristiphora laricis (Hartig) ♂♂	1 ♂ 28.IV-12.V.1996: 1 ♂ 12.V-26.V.1996: 2 ♂♂ 26.V-9.VI.1996: 1 ♂ 20.IV-4.V.1997.

Pristiphora pallidiventris (Fallén) ♀♀	1 ♀ 26.VI-10.VII.1995: 1 ♀ 12.V-26.V.1996: 2 ♀♀ 26.V-9.VI.1996: 1 ♀ 9.VI-23.VI.1996: 1 ♀ 14.VII-11.VIII.1996.
Pristiphora punctifrons (Thomson) ♀♀	1 ♀ 12.VI-26.VI.1995: 1 ♀ 26.V-9.VI.1996.
Pseudodineura fuscula (Klug) ♀♀	1 ♀ 7.III-23.III.1997.
Scolioneura betuleti (Klug) ♂♂	1 ♂ 22.IX-2.X.1996.
Strombocerina delicatula (Fallén) ♂♂ ♀♀	1 ♀ 15.V-29.V.1995: 1 ♂ 10.VII-24.VII.1995.
Strongylogaster lineata (Christ) ♀♀	1 ♀ 12.V-26.V.1996: 2 ♀ 26.V-9.VI.1996.
Tenthredo livida L. ♂♂ ♀♀	1 ♂ 2 ♀♀ 12.VI-26.VI.1995: 1 ♂ 1 ♀ 26.VI-10.VII.1995: 1 ♀ 24.VII-7.VIII.1995: 2 ♀♀ 26.V-9.VI.1996: 2 ♀♀ 9.VI-23.VI.1996.
Tenthredopis litterata (Geoffroy) ♀♀	1 ♀ 9.VI-23.VI.1996.
Tenthredopis nassata Linnaeus ♂♂ ♀♀	33 ♂♂ 3 ♀♀ 15.V-29.V.1995: 1 ♂ 29.V-12.VI.1995: 18 ♂♂ 2 ♀♀ 26.VI-10.VII.1995: 19 ♂♂ 9 ♀♀ 10.VII-24.VII.1995: 3 ♂♂ 4 ♀♀ 24.VII-7.VIII.1995: 21 ♂♂ 2 ♀♀ 12.V-26.V.1996: 4 ♂♂ 5 ♀♀ 26.V-9.VI.1996: 11 ♂♂ 23.VI-14.VII.1996: 9 ♂♂ 3 ♀♀ 14.VII-11.VIII.1996.
Trichiocampus ulmi (Linnaeus) ♀♀	1 ♀ 26.V-9.VI.1996.
Xyela julii Brébisson ♀♀	1 ♀ 1.V-15.V.1995: 1 ♀ 14.IV-28.IV.1996: 2 ♀♀ 28.IV-12.V.1996: 1 ♀ 12.V-26.V.1996: 13 ♀♀ 23.III-6.IV.1997: 7 ♀♀ 6.IV-20.IV.1997.

guinicollis (Klug), *D. madidus* (Klug) y *Cladius pecticornis* Geoffroy (1:1). Mean annual number of males, 156, greater to number of females, 63, resulted without two dominant species in 8 and 34 individuals respectively for each sex. Among the species with both sexes, only *T. nassatta* Linnaeus and *P. vagus* (Fabricius) showed them both cycles; females were lacking the second cycle for *D. aeneus* Hartig and *N. fuscomaculatus* Förster and males for *P. obductus* (Hartig), *T. livida* Linnaeus. Other species as *S. delicatula* (Fallén), *D. sanguinicollis* (Klug), *D. madidus* Klug and *C. pectinicornis* Geoffroy showed both sexes only in one cycle.

Tab. 3 - Number of species (S) and individuals (N) represented by different sexes in each cycle and in total.

Sex	1995-96		1996-97		1995-97	
	S	N	S	N	S	N
Both	9	227	2	58	10	352
Males	5	6	9	72	9	22
Females	14	20	16	56	23	65
No data	1	1	0	0	1	1
Total	29	254	27	186	43	440

Number of traps and species richness

The curve of the cumulative number of species per trap was similar in each of the two cycles (Fig. 2) and showed that the number of species recorded by an unique trap, 7 (24.15%) and 10 (33.36%), increased with a second trap in 7 species and for each new trap from 2 to 5 species in each cycle. Half of the species recorded, 22, was found exclusively in one of the six traps, 12 species were present in two traps and only 2 or 3 species were recorded at the same time by three, four, five or six traps. Observed richness and its different estimators in each cycle and in total are shown in Table 3. Total observed richness was between 42.02% and 61.36% in relation with the greater estimator and 80.55% and 84.37% in relation to the lowest respectively in each cycle.

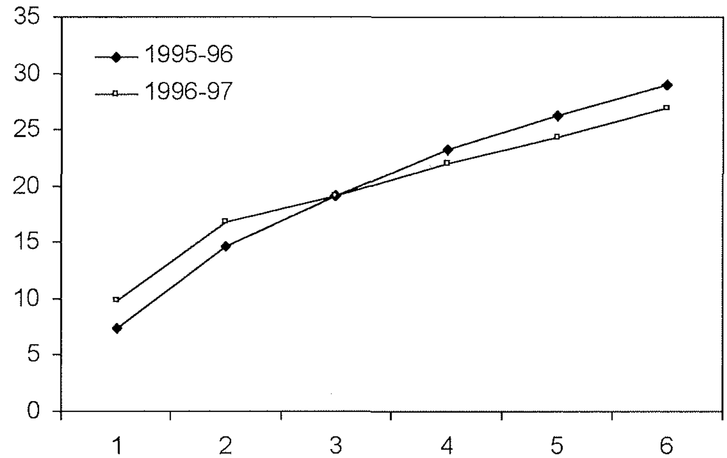

Fig. 2 - Species cumulative curves by number of traps in each cycle.

Tab. 3 - Number of species (S_{obs}) and individuals (N_{obs}) observed and values for different richness estimators for each cycle and total.

Cycle	Sobs	Nobs	ChaO1	ChaO2	Jacknife1	Jacknife2	ACE	ICE	Boostrap
1995-96	29	254	50.33	56.00	44.00	52.80	54.42	68.7	35.55
1996-97	27	187	37.00	37.56	37.83	42.23	34.82	44.12	32.07
1995-97	43	440	70.56	63.16	61.33	69.60	78.50	75.88	51.45

Host plants

The recorded species feed, following Benson (1951; 1952; 1958), Berland (1947) and Schedl (1987) (Tab. 1) on 18 families and at least 38 species of potential host plants recorded in these forests (Tab. 4). The number of sawflies related to trees and shrubs was 15, 10 especies were related to dicotyledoneous herbs and 9 to graminae and other monocotylenous, 4 to ferns, 2 were of ample spectrum and 3 had no data. The 80% of symphytan species related to trees were caught with only one individual. Among trees, *Salicaceae* had more species related than any other taxonomic plant group but with poor abundance, 10 individuals versus 31 individuals in *Pinaceae*. In relation to herbs, *Graminae* had more species related than *Rosaceae* and invidual abundances of these species was the greatest, with 185 versus 22 respectively. From the 21 species with only one individual, 12 were related to trees and shrubs, 2 to graminae, 1 to ferns, 5 to herbs and 1 has no record.

Tab. 4. Family and plant species recorded in inventories at the reserve of Artikutza (Na.) (CATALÁN, 1987) that have been recorded as host plants (Tab. 3) with the number of species (S) and individuals (N) of sawflies associated to different taxa.

TAXA	PLANT SPECIES RECORDED	S	N
PTERYDOPHYTA		5	18
Aspidiaceae	*Polystichum setiferum* (Forskal) Woynar, *Dryopteris affinis* (Lowe) Faser-Jenkins, *D. dilatata* (Hoffm.) A. Gray, *Blechnum spicant* (L.) Roth		
Hypolepidaceae	*Pteridium aquilinum* L. Kuhn		
Athyriaceae	*Athyrium filix-femina* (L.) Roth		
WOODED SPERMATOPHYTA		17	61
Pinaceae	*Pinus sylvestris* L., *Larix x eurolepis* A. Henry	3	31
Betulaceae	*Betula celtiberica* Rothm. ♀ Vasc.	2	2
Ulmaceae	*Ulmus glabra* Hudson	1	1
Fagaceae	*Quercus robur* L.	2	3
Salicaceae	*Populus tremula* L., *Salix atrocinerea* Brot	6	20
Oleaceae	*Fraxinus excelsior* L.	1	1
Rosaceae	*Pyrus cordata* Desv., *Malus sylvestris* Miller, *Crategus monogyna* Jacq., *Prunus spinosa* L. *Corylus avellana* L., *S.aria* (L.) Crantz, *S. aucuparia* (L.) Crantz,.	4	14
HERBS SPERMATOPHYTA			
DICOTILEDONEOUS		11	25
Geraniaceae	*Geranium robertianum* L.	1	2
Scrophulariaceae	*Veronica officinalis* L., *V.montana* L.	1	1
Violaceae	*Viola riviniana* Reichenb.	1	8
Rosaceae	*Rubus ulmifolius* Schott, *Fragaria vesca* L., *Potentilla erecta* (L.) Raüschel	4	10
Ranunculaceae	*Ranunculus nemorosus* Lapeyr., *Anemone nemorosa* L.	2	2
Chenopodiaceae y Polygonaceae	*Chenopodium*, *Polygonum*, *Rumex*	1	1
Crassulaceae	*Sedum*	1	1
MONOCOTILEDONEOUS		9	333
Gramineae	*Deschampsia flexuosa* (L.) Trin, *Brachypodium rupestre* (Host) R. et S., *Agrostis capillaris* L., *A. curtissi* Kerguélen, *Festuca rubra* L.	8	332
Juncaceae	*Luzula sylvatica* (Hudson) Gaudin, *L. multiflora* (Retz.)	1	1
Cyperaceae	*Carex pilulifera* L., C. *caryophyllea* Latourr	1	147
NO RECORD		2	13

Monthly activity rhytms and seasonal variations

Flight activity extends from early March until late September. Variations in the number of species and individuals at fourteen day intervals during part of the period of study are shown in Figure 3. In the first cycle a peak of maximum abundance was

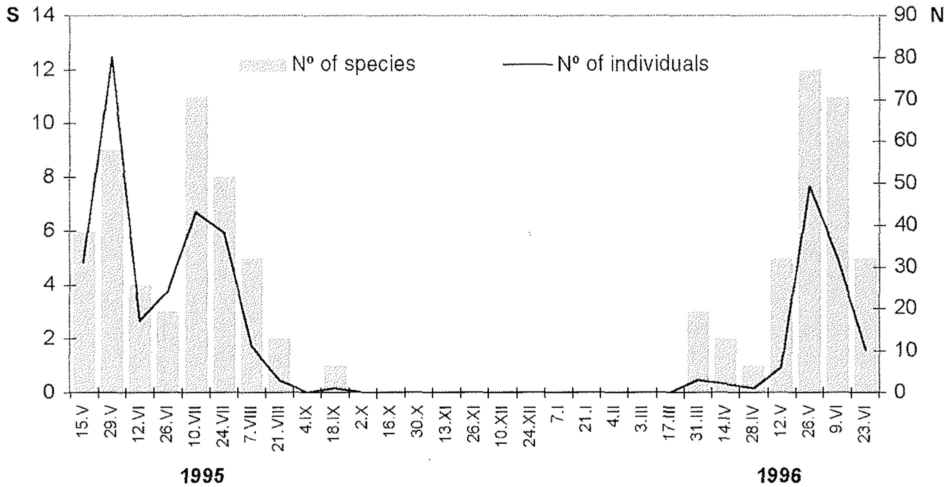

Fig. 3 - Number of species and individuals recorded with two weeks intervals from May 1995 to June 1996.

recorded in the second half of May (a similar peak is observed also the second cycle) followed by another peak in the first half of July; the same but inverted was observed in relation to species richness. For total data, thirteen species were recorded in each peak of greater species richness, May and July. Maximum abundances periods correspond with abundances of two dominant species, *D. aeneus* Hartig in May and *T. nassata* Linnaeus in May and July; without these, the first half of July was not only the greater period of species richness but also of greater abundances, with 14 individuals in contrast with 7 individuals recorded in the second half of May, in the first cycle. The greatest number of species were recorded in the spring, with 12 species from February to April, 23 in May, 13 in June, 15 in July, 8 in August and 3 in September.

Flight periods of each species are shown in Tab. 2. A relative high number of species, 35, were collected in only one concrete period; 27 species at late winter and in spring (from February to June), 7 in the summer and 1 in the autumn. Other eight species showed two or more flight periods; *S. delicatula* (Fallén), *T. nassata* Linnaeus, *P. pallidiventris* (Fallén) and *P. vagus* (Fabricius) from May until July, *T. livida* Linnaeus in June and July, *N. fuscomaculatus* Förster from March until August, and *P. obductus* (Hartig) and *A. pallipes* (Spinola) from March until September. Flight periods of most abundant species and its generations (Fig. 4) showed the different reproductive periods, and in part, explain the community seasonal succesion.

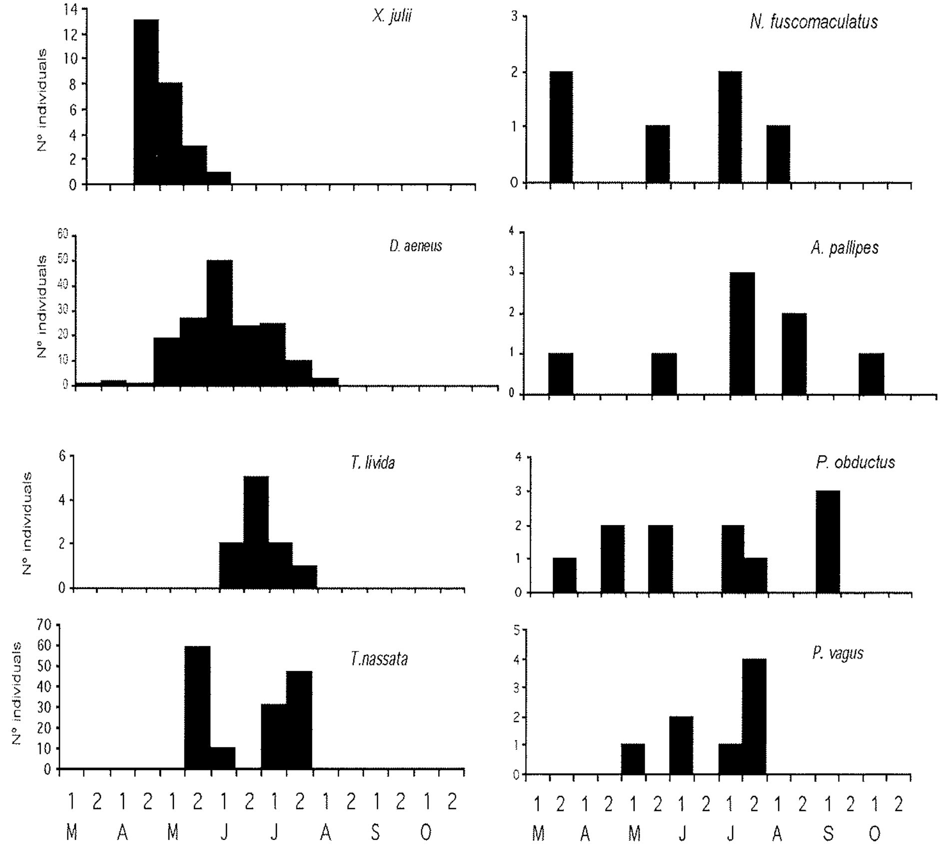

Fig. 4 - Flight periods of most abundant species form March (M) to October (O) represented at half months intervals. 1: first half; 2: second half.

DISCUSSION

Species composition showed a dominant proportion of holoartic and paleartic distributions following Benson (1951; 1952; 1958) and Berland (1947) and the predominance of *Tenthredinidae* is representative of the north and central europe temperate fauna (Gauld & Bolton, 1988). Some of these species as *Strongylogaster lineata* (Christ), *Aneugmenus padi* (Linnaeus), *Athalia circularis* (Klug), *A. cornubiae* Benson and *C. pectinicornis* Geoffroy have been shown to reach the mediterranean region (Schedl, 1987). The species list represents the first contribution in this group to the invertebrate catalogue of the forest fauna in the basque region and the first comprehensive forest sawfly community study in Spain.

Recording of as many species related to trees and shrubs as to herbs, and the high proportion of those associated to edge plants, reflect the heterogenous condition of the stand and the influence of glades in the composition of the species assemblage. Six traps were not enough to record all species in each cycle, at least two traps are needed to get half of total species recorded with six. The abundance distributions among species obtained by Malaise traps reflect their different activity at this forest layer. Species related to herbs showed relative higher populations than species related to trees which were mainly recorded by only one individual. Analyzed data concerning the distributions of these species among traps showed concordance with host plant distributions (MARTÍNEZ DE MURGUÍA *et al.*, 2002).

Other causes for recording of one or few individuals of a species can be its dispersed population or inmigration from other habitats (SMITH & BARROWS, 1987). These authors indicate that among species known to frequent other layers, and that can or cannot be collected by Malaise traps are included species in *Neodiprion* Rohwer and *Uroceros* Geoffroy. In this sense, it is significant the absence in our inventory of *Neodiprion sertifer* Geoffroy, widely recorded in the province as a comon pine defoliator (ROMANYK & CADAHIA, 1992).

One year inventory records only little more than half of total species. Annual community variation is mainly qualitative with as many common species between cycles as exclusive of one of the two cycles. Abundance variability between years in *X. julii* Brébisson reflects the known vital cycle behavior that shows a year of diapause and emergence in the following year (GAULD & BOLTON, 1988). Sex rates among species and cycles show the different types of parthenogenesis but could be influenced by trap location (MARCHAL, 1987).

The earliest species was *Monophadnus monticola* Hartig, recorded at the end of January, and the latest, *Scolioneura betuleti* (Klug), at the end of September. We observed two main flight periods, May and July, wih a greater activity of univoltine species in spring and of polivoltine in the summer, that agree with the results obtained in Europe (MARCHAL, 1985; GAULD & BOLTON, 1988). Among the species that show an unique short period, half of them are recorded as univoltines (BENSON, 1951-58), six *Dolerus* species, *M. monticola* (Hartig), *Periclista albida* (Klug), *Pachyprotasis antenata* (Klug), *Pseudodineura fuscula* (Klug), *Pristiphora abbreviata* (Hartig), *Amauronematus viduatus* Zetterstedt, *Euura venusta* (Zaddach) and *E. mucronata* (Hartig). Other species wih more generations in the bibliography are *Heptamelus ochroleucus* (Stephens), *Priophorus pallipes* (Lepeletier), *A. equiseti* (Fallén), *A. carpini* (Hartig), *S. betuleti* (Klug) and *Pristiphora laricis* (Hartig). Recording of an annual species succession and its different generations, with a small number of individuals, show the Malaise trap efficiency in reflecting seasonal dynamics of the community.

Sawfly taxonomic and ecological diversity should be taken into account for evaluating the conservation of biodiversity in managed forests. Spatial heterogenicity provided by clearings and bank rivers favours the availability of different plant resources that meet species ecological requirements. Encouragement of forest management strategies in favour of sawfly conservation will be contributing in a sound way to promote invertebrate biodiversity, one of the principles of sustainable forest management.

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SUMMARY

Sawfly composition and seasonal rhythms in an acidofilous mixed forest were studied in Artikutza (Navarra, Spain) by means of six Malaise traps operating continously during two seasonal cycles. The species assemblage consisted in 43 species of which more than half were represented only by females. Recording of as many species related to trees and shrubs as to herbs, particularly edge plants, reflect the influence of glades in the assemblage composition. One year of sampling was not enough to record all species, two to three traps are needed to record 50-75% of species respectively in each cycle. Late May and early July were the two periods of greater species richness and abundance with a great proportion of univoltine species in the former and polivoltine species in the second one.

RIASSUNTO

La composizione e i ritmi stagionali di imenotteri sinfiti, in una foresta acidofila mista in Artikutza (Navarra, Spagna), sono stati oggetto di uno studio basato su campionamenti per mezzo di sei trappole Malaise che hanno operato in maniera continua per due cicli stagionali. La raccolta di esemplari ha permesso di collezionare individui appartenenti a 43 specie, delle quali più della metà rappresentate solo da individui di sesso femminile. La raccolta di un elevato numero di specie legate ad alberi, arbusti e piante erbacee, in particolare a essenze presenti nelle siepi, riflette l'influsso delle radure nella composizione della raccolta. Un anno di campionamenti non è stato sufficiente per registrare tutte le specie, dato che due o tre trappole sono necessarie per raccogliere 50-75% delle specie, rispettivamente in ogni ciclo. La fine di Maggio e l'inizio di Luglio sono stati i due periodi di maggiore ricchezza ed abbondanza di specie, con una proporzione maggiore di specie univoltine nel primo periodo e di specie polivoltine nel secondo.

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