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THE MESOSTIGMATA MITE COMMUNITY OF TWO JAPANESE LARCH (*LARIX KAEMPFERI*) PLANTATIONS AND AN OAK (*QUERCUS PYRENAICA*) FOREST IN NAVARRA (NORTHERN SPAIN)

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Abstract: In recent decades, refforestation with non-native species has been a common practice in Europe. In the particular case of Spain, the effects of the plantation of exotic tree species such as larch or non-native pine in native oak and beech forests on the communities of oribatid mites, springtails, and nematodes have been studied, but little is known of their influence on Mesostigmata mites. In the current study we examine the mesostigmatid mite communities of two Japanese larch (*Larix kaempferi* (Lamb.) Carr.) plantations and an oak forest (*Quercus pyrenaica* Willd.) to compare the mite assemblages and to determine if the replacement of tree species affects the soil's Mesostigmata populations. A total of 2752 mites belonging to 56 species of 17 families were collected. There were differences in the diversity and species composition of the assemblages. A total of 13 species are first records for the Iberian Peninsula: *Gamasellodes bicolor*, *Geholaspis longispinosus*, *Geholaspis mandibularis*, *Pseudoparasitus dentatus*, *Pachyseius angustiventris*, *Holoparasitus obsoloni*, *Paragamasus disparinas*, *Paragamasus longisetosus*, *Amblyseius filixis*, *Veigaia bouvieri*, *Discourella baloghi*, *Trachytes eustructura* and *Urodiaspis tecta*.
Key words: Acari, Mesostigmata, community structure, diversity, *Larix kaempferi, Quercus pyrenaica*, Navarra, Spain.

La comunidad de ácaros Mesotigmata en dos plantaciones de alerce japonés (*Larix kaempferi*) y en un robledal (*Quercus pyrenaica*) de Navarra (norte de España)
Resumen: La plantación de especies no nativas ha sido una práctica común en Europa en las últimas décadas. En el caso concreto de España, se han estudiado los efectos de plantaciones con alerces y pinos no nativos sustituyendo a robledales y hayedos nativos sobre las comunidades de oribátidos, colémbolos y nemátodos, pero poco se conoce de sus efectos sobre los ácaros Mesostigmata. En el presente estudio, se examina la comunidad de Mesostigmata en dos repoblaciones con alerce japonés (*Larix kaempferi* (Lamb.) Carr.) y en un robledal (*Quercus pyrenaica* Willd.) con el fin de comparar sus grupos diagnósticos y determinar si la sustitución de la especie de árbol afecta a las poblaciones de los Mesostigmata en el suelo. Se recolectaron un total de 2752 ácaros pertenecientes a 56 especies de 17 familias. Se encontraron diferencias entre las diversidades y la composición de especies de los agrupamientos. Se citan por primera vez para la Península Ibérica 13 especies: *Gamasellodes bicolor*, *Geholaspis longispinosus*, *Geholaspis mandibularis*, *Pseudoparasitus dentatus*, *Pachyseius angustiventris*, *Holoparasitus obsoloni*, *Paragamasus disparinas*, *Paragamasus longisetosus*, *Amblyseius filixis*, *Veigaia bouvieri*, *Discourella baloghi*, *Trachytes eustructura* y *Urodiaspis tecta*.
Palabras clave: Acari, Mesostigmata, estructura de la comunidad, diversidad, *Larix kaempferi*, *Quercus pyrenaica,* Navarra, España.

Introduction

Reforestation with *Eucalyptus* L'Hér., *Pinus halepensis* Mill., *Pinus nigra* Arnold and *Larix kaempferi* (Lamb.) Carr. in the Mediterranean shrub, oak and beech forests of northern Spain has already been studied and its effects on their oribatid mite (Acari: Oribatida), springtail (Insecta: Collembola), and nematode soil communities tested (Iturrondobeiti & Saloña, 1985; Jordana *et al*., 1987, Arbea & Jordana, 1988, Ariño *et al*., 1992, Arroyo *et al*. 2005, 2006; Moraza 2006, 2007, 2009). Other studies have been conducted on oribatid and collembolan communities of different native (alder, beech, oak and black poplar) and non-native (*Acacia dealbata* Link) forests of the Iberian Peninsula and other European countries (Moraza *et al*., 1980; Pinto *et al.* 1997; Sousa *et al.* 1997; Gergócs *et al*. 2011; Erdmann *et al*, 2012; Eissfeller *et al.*, 2013), giving data about their characteristics, relationships with physicochemical soil factors and their responses to environmental changes (Iturrondobeitia & Saloña, 1992a, b). However, the effects on other soil microarthropods, especially predatory species of mites, have yet to be examined.

Mesostigmata, which are mostly free-living predatory mites, do not seem to live under permanent aggregates. They are able to exploit a good number of habitats, including restricted ones, due to their life strategies (Lindquist *et al.*, 2009). They are indirect participants in soil decomposition, regulating the population densities of their prey and, since they depend on other soil fauna and on various soil conditions (acidity, humidity, temperature, carbon content, total nitrogen, decomposed organic matter, heavy metal content, etc.) (Hasegawa, 2001; Cole *et al*., 2006; Barbercheck *et al*., 2009; Ruf & Bedano, 2010; Manu, 2011, Lindo *et al*., 2012; Santamaria *et al*., 2012; Klarner *et al*., 2013), they have proven to be useful indicators of soil management (Siepel, 1996; Maraun & Scheu, 2000; Huhta & Niemi; 2003; Migliorini *et al*., 2003; Minor & Norton, 2004; Huhta *et al*., 2005). However, only with previous knowledge of soil communities in a specific habitat, and especially its diagnostic species, can we assess any disruption resulting in the media and evaluate its effects on the fauna.

Preliminary studies on free living Mesostigmata mites in the Iberian Peninsula (Ariño *et al*., 1992; Moraza, 2006, 2007, 2009), northern Europe, and other regions (Usher, 1971; Buryn, 1992; Ageeva, 1995; Salmane, 2000; Arroyo & Bolger, 2007; Arroyo *et al.,* 2010, 2012, 2013; Bolger *et al*., 2014) have provided data on the composition and structure of their assemblages in beech (*Fagus sylvatica*), oak (*Quercus rotundifolia* and *Quercus coccifera*), pine (*Pinus nigra*) forests and in Mediterranean shrub, among others, and on their populations and distribution dynamics in soil. It is surprising

Table I. Physico-chemical parameters of the seasonal soil samples and seasonal and global diversity indices of Mesostigmata communities (pH s: in surface; pH p: in deep soil; Tª s: surface; Tº p: deep soil; Av: average; Gl.: Global sample). // **Tabla 1**. Parámetros físico-químicos de las muestras estacionales e índices de diversidad estacionales y globales de las comunidades de Mesostigmata (pH s: en superficie;; pH p: en profundidad; Tª s: en superficie; Tº p: en profundidad; Av: media; Gl.: muestra global).

	Beunza (oak forest)					Erize-Atez (larch plantation)					Quinto-Real (larch plantation)				
	Spring	Summer	Autum	Winter	Av	Spring	Summer	Autum	Winter	Av	Spring	Summer	Autum	Winter	Av
pH s	5	4,3	5,5	4,7	**4,9**	4,4	5,7	5,7	4,2	**5,0**	4,9	4,6	4,8	4,8	**4,8**
pH p	4,8	4,9	4,8	5	**4,9**	5,4	5,8	6	5,5	**5,7**	4,9	4,6	5,3	4,7	**4,9**
Tª s	9	16	6,2	6	**9,3**	9,8	19	5	5,7	**9,9**	15,2	15,3	5,7	3,7	**10,0**
Tª p	7,7	15	7,6	4,2	**8,6**	8,3	15	8,4	4,5	**9,1**	11,2	13,9	8,6	4,6	**9,6**
					Gl.					**Gl.**					**Gl.**
Abundance	208	773	155	106	**1242**	316	0	100	138	**554**	187	196	114	459	**956**
R	26	27	16	15	**33**	18	0	18	15	**23**	22	21	18	31	**41**
Shannon H´	2,68	2,46	2,33	2,38	**2,71**	2,15	0	2,22	2,07	**2,35**	2,27	2,34	2,24	2,35	**2,77**
J´ Shannon	0,82	0,75	0,84	0,88	**0,78**	0,74	0	0,77	0,76	**0,75**	0,73	0,77	0,77	0,69	**0,75**



Figure 1. Map of Navarra with Universal Transverse Mercator coordinate system (UTM). Black solid triangle refers to oak forest; black solid stars refer to larch plantations. // **Figura 1.** Mapa de Navarra con el sistema de coordenadas "Universal Transverse Mercator" (UTM). El triángulo indica el robledal; las estrellas negras indican las plantaciones de alerce.

that very diverse and abundant mesostigmatid communities can be found in early successional or ruderal sites, while it is widely known that these parameters of diversity and abundance are usually greatly reduced for Mesostigmata inhabiting agricultural ecosystems and degraded forests (Kochler, 1991, 1999; Salmane, 1999; Minor & Cianciolo, 2007).

Three species of larch are commonly used in reforestation: the European larch (*Larix decidua* Mill.), growing naturally in Central Europe; the Japanese larch (*Larix kaempferi*), from an area of the island of Honshu in Japan; and a more productive species *Larix xeurolepis* Henry (hybrid between Japanese and European larch). The first two species prefer soils with a pH of between 5 and 7 and require abundant light. In Navarra, *L. kaempferi* has often been used in plantations. Previous studies of this type of plantation have been restricted to plant species diversity in relationship with the age of the plantation (Nagaike *et al*., 2003, 2006).

The main objective of this work is to contribute to the knowledge of the Mesostigmata mites on the Península Iberica, estimate whether the mite community is forest-type dependent and, in a small way, to provide more study data on plantations and their impact on biotic diversity.

Material and methods

Study sites

The study was carried out in two larch plantations and in a native oak forest located in two climatic regions in Navarra, northern Spain, bordering Pyrenees mountains (Fig. 1).

Two forests were studied, both located in a wet region with an average annual rainfall of 1200 - 1600 mm:

(**1**) A native oak forest (*Quercus pyrenaica* Wild.) near the town of Beunza (UTM: 30TXN044584). The forest is in a regressive state as result of significant reforestation activity in this area and in which hybridization with *Quercus robur* L. and *Quercus pubescens* Wild. is not uncommon. This forest belongs to the vegetation series *Festuco - Quercetum pyrenaicae* and *Blechner - Quercetum roboris* (Bascones, 1982) and grows in Alfisol soil at an altitude of 600 m a.s.l.; pH of the humic layer range between 5.4 and 6.0.

(**2**) A 30-year-old, exotic larch (*Larix kaempferi* (Lamb.) Carr. replacing the oak forest previously described and located at the same UTM coordinates (although belonging to the municipality of Erice-Atez), with the same soil type and altitude; pH of the humic layer range between 4.2 and 5.7. In this larch, the litter layer was nearly 50 cm deep.
Located in the hyper-humid region (average annual rainfall ≥ 1600 mm of precipitation), at an altitude of 900 m a.s.l., growing in Haplic Cambisol soil, mor type humus. pH of the humic layer range is between 4.6 and 4.9, there is a 100-year-old larch plantation (*L. kaempfei)* located in the Quinto-Real Nature Reserve, in the Erreguerena mountains (UTM: 30TXN210625). It is surrounded by native beech forest with a deep layer of litter (*Fagus sylvatica*, vegetation series *Blechno-Fagetum ibericum*). The trees are widely distributed, allowing light into the understory and giving space for regeneration gaps inside the beech forest. The litter layer was nearly 15 cm deep. A similar beech forest was previously studied by our group (Ariño *et al*., 1992; Moraza, 2007).

Sampling and extraction

Sampling was conducted during the months of April, August, November, and January (04/20/1982, 07/27/1982, 12/01/1982 and 02/22/1983). The Sample surface was 25 cm^2. Samples were taken at different depths (subsamples) and extracted layer by layer: leaf litter (Ao), decomposition layer (edaphic horizon H) 3-7 cm depth, and mineral soil (B) 5-7 cm depth. In the larch, separating the decomposition layer (H) from the mineral layer (B) was impossible and thus only two layers were analyzed: Ao and H+B (8-15 cm depth). A total of 28

Table II. Checklist of Mesostigmata families and species; type of life strategy of the family (values of r and K); species and family abundance for global sample (AGl.)) and species and family abundance in each soil layer (Ao: litter; H: humus; B: mineral soil). Diversity indices *R*, *H´*, *J´*, and Maturity index of the community. Ib: Global sample, Irati, beech forest (Moraza, 2007). Species with an asterisk are new records for the Península Ibérica. // **Tabla II**. Lista de familias y especies de ácaros Mesostigmata; tipos de estrategia vital de la familia (valores de r y K); abundancia de especies y familias para la muestra global (AGl.) y para las especies y familias en cada horizonte del suelo (Ao: hojarasca; H: humus; B: suelo mineral); índices de diversidad *R*, *H´*, *J´* e índice de madurez de la comunidad. Ib, muestra global de hayedo de Irati (Moraza, 2007). Las especies con un asterisco son nuevas citas para la Península ibérica.

Life strategy values	Abundance (AGl.) Oak Bo	Larch El	Larch QRl	Beech Ib	Mesostigmata species	Beunza (Bo) OAK Ao	H	B	Erice (El) LARCH Ao	H+B	QR (QRL) LARCH Ao	H+B
1r	**2.9**	**0.2**	**1.2**	**1.0**	**F. Ascidae**	**4.1**	**2.1**	**2.9**	**0.2**	**0**	**2.7**	**0**
	-	-	0.2	2.4	*Arctoseius minutus (Ascidae)*	-	-	-	-	-	0.3	-
	-	-	0.5	0.6	*Arctoseius venustulus*	-	-	-	-	-	1.7	-
	-	0.2	0.2	-	*Arctoseius* sp.	-	-	-	0.2	-	0.3	-
	2.1	-	-	-	*Asca aphidioide*	3	1.2	2.9	-	-	-	-
	0.8	-	0.3	-	**Gamasellodes bicolor*	1.1	0.9	-	-	-	0.4	-
				0.2	*Zercoseius spathuliger* (Leonardi. 1899)							
1r	**0.8**	**0.4**	**1.2**	**-**	**F. Epicriidae**	**0.6**	**1.1**	**0**	**0.4**	**0**	**1.6**	**0.5**
	0.6	-	-	-	*Berlesiana beunzana*	0.3	0.9	-	-	-	-	-
	0.2	0.4	1.2	-	*Epicrius jonhstoni*	0.3	0.2	-	0.4	-	1.6	0.5
4r					**F.Eviphididae**							
	0.4	-	-	-	*Iphidiosoma sp.*	-	0.9	-	-	-	-	-
¿?					**F. Hirstyonissidae**							
-	0.1	-	-	-	*Hirstionyssus* sp.	0.2	-	-	-	-	-	-
¿?	**1.2**	**0.7**	**1.5**	**0.9**	**F. Macrochelidae**	**1.3**	**1.3**	**0**	**0.4**	**0**	**1.7**	**0.5**
-	0.1	-	0.4	-	**Geholaspis longispinosus*	-	0.4	-	-	-	0.5	-
-	0.1	-	0.2	-	**Geholaspis mandibularis*	0.2	-	-	-	-	0.3	-
-	1.0	0.7	0.7	0.5	*Macrocheles montanus*	1.1	0.9	-	0.4	-	0.6	0.5
-	-	-	0.2	0.2	*Macrolaspis* sp.	-	-	-	-	-	0.3	-
				0.2	*Poecilochirus necrophori* Vitzthum. 1930							
					F. Melicharidae							
	-	**-**	**-**	**0.9**	*Orthadenella lawrencei* (Evans. 1957)							
1r	**0.5**	**1.6**	**1.6**	**0.7**	**F. Laelapidae**	**0.2**	**0.9**	**0**	**1.8**	**3.4**	**1.7**	**0.5**
	-	-	0.1	-	*Hypoaspis (Euandrolaelaps) karawaewi*	-	-	-	-	-	0.1	-
	-	-	0.1	-	*Hypoaspis (Galeolaelaps) sp.*	-	-	-	0.2	1.7	0.1	-
	0.5	1.6	1.3	0.5	*Pseudolaelaps doderoi*	0.2	-	-	1.6	1.7	1.4	0.5
	-	-	0.1	-	**Pseudoparasitus dentatus*	-	0.9	-	-	-	0.1	-
				0.2	*Proctolaelaps robustus* Evans. 1958							
1K	**0.1**		**0.3**	**2.4**	**F. Pachylaelapidae**							
				0.3	*Pachylaelaps longisetis* Halbert. 1915							
	0.1	-	-	-	**Pachyseius angustiventris*	0.2	-	-	-	-	-	-
				0.9	*Pachyseius morenoi* Moraza							
	-	-	0.3	1.2	*Pseudoparasitus (Pseudopachys) parasitizans*	-	-	-	-	-	0.3	-
2K	**26.2**	**33.5**	**40.3**	**52.9**	**F. Parasitidae**	**18.6**	**35.4**	**44**	**35.6**	**25.1**	**47.4**	**9.7**
	0.8	1.6	0.5	0.3	*Holoparasitus calcaratus*	1.3	0.2	2.9	1.8	-	0.6	-
	-	-	0.6	-	**Holoparasitus obsoloni*	-	-	-	-	-	0.6	0.5
	-	-	1.2	2.3	*Holoparasitus stramenti* c.f.	-	-	-	-	-	1.4	-
	-	-	0.5	-	**Paragamasus disparinas*	-	-	-	-	-	0.6	-
	-	1.4	-	-	**Paragamasus longisetosus*	-	-	-	**1.2**	**3.3**	-	-
	7.7	6.0	5.4	6.3	*Paragamasus navarrensis*	8.5	7.3	2.9	6.3	1.7	6.1	2.4
	6.5	2.9	9.5	8.3	*Paragamasus ponantinus*	1.1	13.2	23.5	2.4	6.7	11.1	2.4
	4.1	2.7	7.1	6.0	*Paragamasus rothamstedensis*	1.4	7.3	11.8	4.8	-	7.8	3.9
	6.1	15.3	14.3	18.1	*Paragamasus* immature stages	5.3	7.1	2.9	15.5	11.7	17.6	0.5
				0.6	*Paragamasus* sp. 1							
				0.6	*Paragamasus* sp. 2							
				0.2	*Paragamasus* sp. 3							
				3.0	*Parasitus craepelini* Karg. 1971							
	-	-	0.2	1.5	*Parasitus sp. 1*	-	-	-	-	-	0.3	-
	-	-	0.4	-	*Parasitus sp. 2*	-	-	-	-	-	0.5	-
	1.0	**3.6**	**0.6**	**1.2**	***Pergamasus robustus***	**1**	**1.2**	**-**	**3.6**	**1.7**	**0.8**	**-**
				5.0	*Pergamasus crassipes* (L. 1758)							
				0.3	*Pergamasus* sp. 3							
2r					**F. Phytoseiidae**							
	-	-	0.1	**-**	**Amblyseius filixis*	-	-	-	-	-	0.1	-
	0.1	-	-	.	*Amblyseius sp.1*	0.2	-	-	-	-	-	-
				0.2	*Typhlodromus (Anthoseius) pirianykae* Wainstein. 1972							

Life strategy values	Abundance (AGl.) Oak Bo	Larch El	Larch QRl	Beech Ib	Mesostigmata species	Beunza (Bo) OAK Ao	H	B	Erice (El) LARCH Ao	H+B	QR (QRL) LARCH Ao	H+B
2K					**F. Rhodacaridae**							
	2.9	**-**	**16.8**	**5.7**	*Rhodacarus coronatus*	0.3	4.7	26.5	-	-	**1**	**74.6**
2K	**6.8**	**25.7**	**14.1**	**11.1**	**F. Vegaidae**	**6.06**	**7.1**	**0**	**27.6**	**8.3**	**16.7**	**2.9**
	2.4	21.7	4.6	-	**Veigaia bouvieri*	3	1.9	-	23.8	-	5.7	-
	4.3	0.5	9.5	7.5	*Vegaia nemorensis*	2.9	5.2	-	0.6	-	11	2.9
	0.1	3.1	-	3.2	*Veigaia planicola*	0.16	-	-	2.8	8.3	-	-
				0.2	*Veigaia sanamamedi* Athias-Henriot .1961							
	-	0.4	-	0.2	*Veigaia* sp.	-	-	-	0.4	-	-	-
3K	**9.6**	**22.0**	**2.2**	**7.8**	**F. Zerconiidae**	**7.1**	**10.5**	**14.7**	**17.5**	**56.7**	**2.1**	**3.4**
				3.3	*Prozercon davidii* Moraza 2006							
	-	-	0.8	**-**	*Prozercon lutulentus*	-	-	-	-	-	0.1	3.4
	1.6	21.8	-	-	*Prozercon tellecheai*	0.5	2.3	11.8	**17.3**	**56.7**	-	-
	-	-	0.2	0.3	*Zercon guadarramicus*	-	-	-	-	-	0.3	-
				3.0	*Zercon arcuatus* Trägärdh 1931							
	-	-	0.5	-	*Zercon keiseri*	-	-	-	-	-	0.6	-
	7.1	0.2	0.1	1.2	*Zercon parivus*	5.6	7.3	2.9	0.2	-	0.3	-
	0.1	-	-	-	*Zercon peltatus*	0.2	-	-	-	-	-	-
	0.8	-	0.6	-	*Zercon pustulescens*	0.8	0.9	-	-	-	0.8	-
	48.5	**15.9**	**20.3**	**14.4**	**UROPODINA**	**61.38**	**36.6**	**11.7**	**16.7**	**6.7**	**24.9**	**7.9**
¿?	**11.8**	**-**	**1.0**	**1.0**	**F. Dinychidae**							
-	11.4	-	1.0	0.5	*Dinychus hispanicus*	**16.2**	**6.4**	**5.9**	-	-	1.3	-
-	0.4	-	-	-	**Urodiaspis tecta*	0.2	0.7	-	-	-	-	-
				0.5	Uropodonina sp. 1							
¿?					**F. Discourellidae**							
-	-	-	0.3	-	**Discourella baloghi*	-	-	-	-	-	0.4	0.5
3K	**8.0**	**10.7**	**10.3**	**5.2**	**F. Uropodidae**							
	8.0	9.6	10.3	3.7	*Cilliba cassidea*	11.5	4.5	2.9	10.5	-	12.4	2.4
	-	0.9	-	-	*Cilliba sellnicki*	-	-	-	1	-	-	-
				1.5	*Uropoda misella* (Belerse. 1916)							
	-	0.2	-	-	*Uropoda minima*	-	-	-	0.2	-	-	-
3K	**28. 7**	**5.2**	**8. 6**	**8. 2**	**F.Trachytidae**							
-	0.4	-	2.8	3.8	*Polyaspinus cylindricus*	0.5	-	-	-	-	4.3	2
-	2.7	2.0	2.0	0.2	*Trachytes aegrota*	4.5	1	-	2.2	1.7	2.5	-
-	22.5	-	3.1	-	**Trachytes eustructura*	**24**	**22.3**	**2.9**	-	-	3.5	1.5
-	3.1	3.2	0.7	4.2	*Trachytes welbourni*	4.48	1.7	-	2.8	5	0.5	1.5
	1242	**554**	**956**	**2752**	**Total studied specimens**	**654**	**553**	**35**	**501**	**60**	**744**	**205**
	33	**23**	**41**	**41**	***R***	**30**	**25**	**11**	**22**	**10**	**40**	**15**
	2.71	**2.35**	**2.77**	**3.10**	***H´log10***	**2.55**	**2.7**	**2.08**	**2.36**	**1.57**	**2.81**	**1.19**
	0.78	**0.75**	**0.75**	**0.83**	***J´***	**0.74**	**0.82**	**0.81**	**0.75**	**0.65**	**0.76**	**0.43**
	0.89	**0.89**	**0.86**	**0.91**	***Maturity Index***							

subsamples were processed for extraction of microarthropods: eight from the young larch (four Aoo+ four H+B), eight from the old larch (four Aoo+ four H+B), and 12 from the oak forest (four Aoo+four H+four B) (see table I).

When samples were collected, temperature and pH in distilled water were measured at every site, at the soil surface (horizon H) and deep (horizon B or H+B) in the soil. Soil humidity was calculated from the difference between fresh and dry sample weight (after drying at 20 ºC and 40% r.h.) (%) (Table I).

Soil mites were extracted using Berlese-Tullgren funnels and were identified to the species level (Ghilarov & Bregetova, 1977; Karg, 1993). after clearing in Nesbitt's solution and mounted in Hoyer's medium. Adult and immature mites (larval and nymphal instars) from each sample were counted (Table I and II, Annex 1). The specimens are on deposit in the Ohio State University Acarology Laboratory (OSAL) Collection (Columbus, Ohio, USA).

Data analysis

A global sampling unit resulting from the addition of four seasonal samples was used to estimate the mesostigmatid mite community. All immature specimens of the family Parasitidae were considered as one taxon.

Diversity indices were calculated for each seasonal sample, for each soil layer and for the global sample (Gl.): *relative abundance* (A), *diversity* (H´ log 10) (Shannon-Wiener, 1963), *richness* (R), *equitability* (J´). Biological parameters and statistical analysis were calculated using the software package "PAST" (Hammer et al., 2001).

The maturity index of Ruf (1998) was also calculated. This index, with a range of values between 0 and 1, has been used as an indicator of environmental impact on forest soils and to discriminate between sites. Its value is calculated based on different life strategies "*r*" and "*K*" of Mesostigmata families. The index is calculated as the proportion of *K*-values to the sum of the *r* and *K*-values of all species of a sampled community.

Results

A total number of 2752 mesostigmatid mites were collected from the sites, representing 17 families and 56 species: 33 species in the oak forest (1242 specimens studied), 22 in the young larch in Erice (554 specimens), and 41 in the older larch in Quinto Real (956 specimens) (Tables 1, 2; Annex 1).

In the oak forest (Beunza), where the three soil layers are clearly distinguished, the highest richness (R) was found in the litter (29 species) and the lowest in the mineral layer (10 species) (Table II). Uropodina were the most abundant (48.5%) and diverse mites (four families and seven species). The family Parasitidae represented 26.2% of the community with five species and was found in the three layers, mainly H and B. The Family Zerconidae was represented by four species, 9.6% of the community, and was present in all three layers. The most significant species of this assemblage were *Trachytes eustructure* (22.5%), *Dinychus hispanicus* (11.4%) and the exclusive, although non-abundant species *Berlesiana beunzana*, *Iphidosoma* sp., *Hirstionyssus* sp. and *Pachyseius angustiventris*.

In the larch plantation of Erice-Atez*,* most of the community inhabits the litter layer. *Prozercon tellecheai* and *Veigaia bouveri* were the dominant species (abundance 21.8% and 21.7% respectively). Both species were present in the oak site but in low abundances (1.6 and 2.4% respectively); *Paragamasus longisetosus* and *Veigaia* sp. are the two taxa unique to this forest. The family Parasitidae (seven species) represented 33.5% of the community, and Uropodina mites (five species, the 15.9%). Zerconiidae, with only two species (global abundance 22%), is clearly the dominant group in the deepest layer due to *P. tellecheai* (global abundance 56.7%). The summer sample lacked mesostigmatid mites.

Sixteen of the species (48.5%) present in the oak forest were not found in the larch, and six species (26.1%) present in the larch forest were not collected in the oak. Diagnostic species in the oak forest (*T. estructura* and *Dynichus hispanicus*) were not found in the larch and others such as *P. tellecheai* and *V. bouvieri* have become more abundant following plantation with larch.

In the larch plantation of Quinto Real, *Rhodacarus coronatus* (16.8%), *Veigaia nemorensis* (9.5%) and *Cilliba cassidea* (10.3%) are the dominant species. As in the previous larch forest, more than 75% of the community was found in the litter layer. The family Parasitidae, represented by 10 species, constitutes 40.3% of the community. Uropodina mites were represented by seven species, 20.3% of the community, and the family Zerconiidae with six species was not abundant (2.2%).

If the community data obtained for this larch forest is compared with the community of a similar previously studied beech forest in Irati (Moraza 2007), of similar vegetation series and climatic characteristics, differences in the species composition are distinctive, although they share approximately 50% of the species (22 species) (Table II). The species assemblage that characterized the beech forest in Irati (*P. ponantinus, P. navarrensis, Paragamasus rothamstedensis, R. coronatus* and *V. nemorensis*) is similar in the larch forest, although their abundances differ slightly (Table II).

The composition of the community between larch forests is quite different judging by their diagnostic species and R values (23 in the young forest and 41 in the old (Table II). The two larch plantations share 16 species, nearly 70% of the species found in the young larch, and 13 of which have been found in other forests and different habitats in this region (Moraza, 2006, 2007). However, both larch plantations have the same value of equitability (0.75) and similar values of *H´* (2.35 for the young larch and 2.77 for the old).

Uropodina mites (16 - 48%), Zerconiidae (2 - 22%), Parasitidae (26 - 40%) and Veigaiidae (7 – 26%) are the most abundant families, and Ascidae (0.2- 3%) and Laelapidae (0.5 - 2%) are poorly represented (Table II).

The maturity index for the oak and for the 30-year-old larch forest in Erice-Atez was 0.89; for the native beech forest 0.91, while the larch forest in Quinto Real scored slightly lower (0.83). Regarding generation cycles, in the forests studied the vast majority of species were *K* strategists, following Ruf *et al*, (1999, 2003) (Table II).

Discussion

In Quinto Real, the characteristics of the plantation program (small regeneration larch gaps in the beech forest) and the time elapsed from plantation (100 years) may have facilitated the establishment of a new community which retains the characteristic species of the beech community (Ariño *et al*., 1992; Moraza, 2007), enhancing the presence of some of these and, as a result, the extinction of others and their subsequent replacement by newly arrived species (Table II). Plantations surrounded by native forest give rise to "regeneration gaps" which may be a better way to conserve the specific richness and diversity of the habitat. Diagnostic species for the beech forest could adapt to the larch by giving way to new populations at the expense of other, less adaptable species. Nagaike and co-authors (2006) indicated that *Larix kaempferi* plantation age affects plant community composition, although it does not affect plant diversity in the plantation understory. In this larch, regeneration gaps mean higher plant diversity, which may give rise to a greater number of niches to be occupied by the Mesostigmata and their prey.

In the larch forest in Erice, a deep layer of larch litter covers the soil and the values of richness and density of the Mesostigmata community is lower than in the Quinto Real (with a finer litter layer). The thickness of the litter layer affects the oribatid mite densities in broadleaf deciduous forests, since these two factors are strongly correlated (Osler *et al*., 2006; Erdmann *et al*., 2012). However, our results suggest that thickness of larch litter could be affecting Mesostigmata mites in a different way - being caused by different physical and chemical conditions of the larch litter and other new environmental parameters introduced to the habitat by the tree characteristics as result of reforestation.

Differences in community composition between larch forests could be due to the different ages of the larch plantations, as some mite species present in both sites show distinct values of relative abundance (e.g. *Paragamasus ponantinus*, *Paragamasus rothamstedensis, Veigaia bouvieri, Vegaia nemorensis,* among others). The older plantation (about 100 years old), which has larger-sized trees and greater understory plant diversity, has the highest Mesostigmata species diversity and richness and includes many species not found in the younger plantation. Comparing *Larix kaempferi* forests of various ages (Nagaike *et al*. 2003, 2006), greater plant diversity was found in young plantations, although the higher diversity was due to weed species present, which are not the best habitat for most Mesostigmata mites.

Dafet (1979) mentioned that values of equitability greater than 0.8 indicate an optimum population balance. The data obtained, although from a concrete and punctual study such as it is, suggests no larch plantation shows an optimum balance, either in the overall or in seasonal samples (Tables 1 and 2). However, the obtained values are relatively high (0.69 to 0.77 for the seasonal samples; 0.75 for the global). Only the native beech forest in Irati showed an optimum population balance (J´ = 0.83).

Uropodina mites appear to be the most sensitive to this type of plantation; their abundances decreased from 48.5% in the oak forest to 20.3% in the larch plantation (Erice-Atez). Uropodines, characteristic of ephemeral litter habitats in temperate regions, feed on small invertebrates, fungi, and decaying organic matter (Karg 1989). Other families such as Vegaiidae, Zerconidae and Parasitidae, increased their abundances (Table II) in the young larch, and Zerconidae decreased in the older plantation. Our results suggest that mesostigmatid populations in the oak and larch plantations are well structured. Uropodina (especially Trachytidae), Zerconiidae, Parasitidae and Veigaiidae, all families known to be associated with forests (Moraza, 2007; Arroyo *et al*., 2012, 2013), are well represented in the present study, while two poorly represented families, the Ascidae and Laelapidae, are associated mainly with disturbed agricultural environments (Minor & Cianciolo, 2007).

Mesostigmatid mites have life cycles ranging from 1.5 to two weeks in Ascidae and Laelapidae (r- selected traits) (Binns, 1974; Enkegaard *et al.*, 1997); from three to four weeks in large Parasitidae (e.g. *Pergamasus*) (2K selected strategy) (Hartenstein, 1962); and 11 months in *Trachytes* (Athias-Binche, 1989) (probably 3K selected strategy as other Uropodina mites). The vast majority of species collected in this study were K strategists, with slow development and a low dispersal range, usually associated with forest sites (Minor & Cianciolo, 2007). About 16% of the species could not be assigned r or K-values because Ruf *et al*. (1999, 2003) did not classify them, and we assigned 3K values to *Trachytes* species. This fact could significantly affect the validity of the given index because if unassigned species were all either treated as 3K or 4r the forests would be ranked in a different order (Cŏja & Bruckner 2006). We obtained the maturity index not only to provide other information about these forests, but in the hope of finding some other clues about the effect the replacement of native plants might have on it. Maturity index values obtained for the four forests are near the high end of the total range of the index and values expected for undisturbed habitats (Ruf & Römbke, 1999; Ruf *et al.*, 1999, 2003; Cŏja & Bruckner, 2006). This may suggest that planted larch forests are very stable, as may be expected of a growth forest with no human intervention for an extended period of time. Cŏja & Bruckner (2006) indicated that if the index value is near 1, the maturity of gamasine communities is seemingly more influenced by parameters other than humus type. So the different thickness and perhaps chemical composition of the humus layer in the larch may not negatively impact the mesostigmatid mite community structure.

Enhanced biodiversity outcomes are to be expected in plantations using native species of trees, while there are differences in results when non-native species are used. Our results suggest that reforestation with larch trees may adversely affect mesostigmatid mite diversity in the soil. However a customized reforestation program and simply the natural aging of the plantation could minimize the loss of diversity and even increase it if sufficient time is allowed for a new mite population to become established.

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Annex 1. List of families and species and number of studied specimens and development instar (D: deutonymph: P: protonymph; L: larva). Species with an asterisk are new records for the Península Ibérica. // **Anexo 1**. Listado de familias y especies y número de los ejemplares estudiados de cada sexo y estadio de desarrollo (D: deutoninfa: P: protoninfa; L: larva). Las especies con un asterisco son nuevas citas para la Península ibérica. SPR: Spring; SUM: Summer; AUT: Autum; WIN: Winter.

MESOSTIGMATA (♀♂ = adults, D = Deutonymphs, P = Protonymphs, L= Larvae)	Beunza (Bo) OAK				Erize-Atez (EI) LARCH				Quinto Real (QRI) LARCH			
	SPR	SUM	AUT	WIN	SPR	SUM	AUT	WIN	SPR	SUM	AUT	WIN
F. Ascidae												
Arctoseius minutus (Halbert, 1915)	-	-	-	-	-	-	-	-	-	1♀	1♀	-
Arctoseius venustulus (Berlese, 1907)	-	-	-	-	-	-	-	-	1♀	-	1♀, 1♂	7♀, 1♂, 2D
Arctoseius sp.	-	-	-	-	1♀	-	-	-	-	1♀	-	1D
Asca aphidioide (Linneaus, 1758)	-	7♀, 5D, 5P	4♀, 2P	3♀	-	-	-	-	-	-	-	-
**Gamasellodes bicolor* (Berlese, 1918)	3♀	6♀	1♀	-	-	-	-	-	-	2♀	-	1♀
F. Epicriidae												
Berlesiana beunzana Moraza, 2006	-	3♀, 4♂	-	-	-	-	-	-	-	-	-	-
Epicrius jonhstoni Moraza, 2005	2♂	1♂	-	-	-	-	2♀	-	1♀	2♀, 4♂, 2P	1	3
F. Eviphididae												
Ophidiosoma sp.	-	5D	-	-	-	-	-	-	-	-	-	-
F. Hirstyonissidae												
Hirstionyssus sp.	1♀	-	-	-	-	-	-	-	-	-	-	-
F. Macrochelidae												
**Geholaspis longispinosus* (Kramer, 18976)	-	1♀	-	-	-	-	-	-	-	-	-	3♀, 1P
**Geholaspis mandibularis* (Berlese, 1904)	-	1♀	-	-	-	-	-	-	2♀	-	-	-
Macrocheles montanus (Willmann, 1951)	4♀, 1♂	2♀, 4D	-	1♀	1♂, 1D	-	1♀, 1D	-	-	1♂	2♀, 1♂, 1D	D
Macrolaspis sp.	-	-	-	-	-	-	-	-	-	1♀, 1♂	-	-
F. Laelapidae												
Hypoaspis (Euandrolaelaps) karawaewi (Berlese, 1903)	-	-	-	-	-	-	-	-	-	-	-	1♀
Hypoaspis (Geolaelaps) sp.	-	-	-	-	-	-	-	-	-	-	-	1♀
Pseudolaelaps doderoi Solari, 1954	1♀	5♀	-	-	5♀, 3♂	-	1♀	-	10♀, 1♂	-	1♀	-
**Pseudoparasitus dentatus* (Halbert, 1920)	-	-	-	-	-	-	-	-	-	-	-	1♀
F. Pachylaelapidae												
**Pachyseius angustiventris* Willmann, 1935	1♀	-	-	-	-	-	-	-	-	-	-	-
Pseudoparasitus (Pseudopachys) parasitizans Berlese, 1916	-	-	-	-	-	-	-	-	-	-	1♀	1♂, 1D
F. Parasitidae												
Holoparasitus calcaratus (C. L. Koch, 1839)	3♀	1♂	-	-	-	-	1♂	6♀, 2♂	2♀	-	-	3♀
**Holoparasitus obsoloni* (Willmann, 1940)	-	-	-	-	-	-	-	-	4♀	-	-	2♂
Holoparasitus stramenti c.f. Karg, 1971	-	-	-	-	-	-	-	-	-	1♀, 1♂, 1D	1♀	4♀, 3♂
Parasitus sp. 1	-	-	-	-	-	-	-	-	-	-	-	1♀, 1P
Parasitus sp. 2	-	-	-	-	-	-	-	-	-	-	-	1♀, 3♂
**Paragamasus disparinas* Athias-Henriot, 1967	-	-	-	-	-	-	-	-	4♂, 1p	-	-	-
**Paragamasus longisetosus* (Bhattacharyya, 1963)	-	-	-	-	1♀, 1♂	-	3♀, 1♂	1♀, 1♂	-	-	-	-
Paragamasus navarrensis Athias-Henriot, 1967	7♀, 11♂, 7P	28♀, 25♂	4♀, 2♂, 1D	4♀, 2♂, 4D, 1P	9♀, 6♂, 3D	-	3♀, 1D, 2P	6♀, 2♂, 1D	4♀, 10♂	1♀	7♀, 6♂, 2D	7♀, 8♂, 1D
Paragamasus ponantinus Athias-Henriot, 1967	2♀, 4P	28♀, 1♂	15♀, 26♂	3♀, 2♂	-	-	12♀, 12♂	3♀, 1♂	9♀, 6♂, 1D, 1L	8♀, 6♂	15♀, 20♂, 2D	7♀, 16♂
Paragamasus rothamstedensis Bhattacharyya 1963	2♀	42♀, 1♂	1♀, 1♂	2♀, 2♂	11♀, 1♂	-	2♀	1♀	2♀	15♀	13♀, 1♂, 2D	31♀, 4♂
Pergamasus robustus (Oudemans, 1902)	1♀, 3D	7♀, 2♂	-	-	9♀, 1♂, 1D	-	1♂, 2D	3♀, 1♂, 1D	1♀	2♀	1♀, 1♂, 1D	-
Paragamasus immature stages	2D. 5P	1D, 60P	1D, 4P, 3L	-	75D	-	7P	3P	75D	62D	-	-
F. Phytoseiidae												
**Amblyseius filixis* Karg, 1970	-	-	-	-	-	-	-	-	-	-	1♀	-
Amblyseius sp.1	1♀	-	-	-	-	-	-	-	-	-	-	-
F. Rhodacaridae												
Rhodacarus coronatus Berlese, 1921	1♀, 2♂, 1L	5♀, 3♂	22P	1♀, 1♂	-	-	-	-	1♂	1♂	-	5♀, 2♂, 152P

MESOSTIGMATA (♀♂ = adults, D = Deutonymphs, P = Protonymphs, L= Larvae)	Beunza (Bo) OAK				Erize-Atez (EI) LARCH				Quinto Real (QRI) LARCH			
	SPR	SUM	AUT	WIN	SPR	SUM	AUT	WIN	SPR	SUM	AUT	WIN
F. Vegaidae												
**Veigaia bouvieri* (Berlese, 1916)	1♀, 2♂, 3P	3♀, 5♂, 8D, 2P	-	4♀, 1♂, 1D	17♀, 6♂, 66D	-	4♀, 3D	7♀, 6♂, 11D	1♀, 2♂	4♀. 1♂, 2D, 2P, 1L	2♀, 2D, 1P	9♀, 3♂, 4D, 8P
Vegaia nemorensis (C. L. Koch, 1839)	2♀, 4D, 3P	12♀, 3♂, 2D, 1P, 1L	13♀, 1♂, 5D	♀	3♀	-	-	-	12♀, 1D, 1P	10♀, 2D, 8P, 1L	2♀	28♀. 23D, 3P
Veigaia planicola (Berlese, 1892)	1D	-	-	-	3♀, 1D	-	1♀, 1D	11♀	-	-	-	-
Veigaia sp.	-	-	-	-	1♂	-	-	1♂	-	-	-	-
F. Zerconiidae												
Prozercon lutulentus Halasková, 1963	-	-	-	-	-	-	-	-	1♂, 1P, 2L	-	-	2♀, 2♂
Prozercon tellecheai Moraza, 1990	-	5♀, 8♂	4♀, 2P	1♂	35♀	-	17♀,6♂,13P, 3L	14♀, 10♂, 16D, 7P, 2L	-	-	-	-
Zercon guadarramicus Mihelcic, 1960	-	-	-	-	-	-	-	-	1♀	1♂	-	-
Zercon keiseri Schweizer 1949	-	-	-	-	-	-	-	-	3♂, 1D	-	-	1♂
Zercon parivus Moraza, 1991	2♀, 10P, 2L	17♀, 12L	1♀, 10P	4♀, 4D, 3P	-	-	1D	-	1♀	-	-	-
Zercon peltatus C.L Koch, 1836	1♀	-	-	-	-	-	-	-	-	-	-	-
Zercon pustulescens Athias-Henriot, 1961	3♀, 2♂, 2D	3♀	-	-	-	-	-	-	-	-	1♂, 2D	1♂, 1D, 1L
UROPODINA												
F. Uropodidae												
Cilliba cassidea (Hermann, 1804)	2♀,3♂,17D	25♀,8♂,23D,9P	2♀, 1D	2♀,4♂,2D, 1P	5♀,4♂,14D,5P ,1L	-	4♀,2D	4♀,1♂,4D ,4P,5L	2♀,2♂,1D,1L	3♀,2♂,10D, 1P,6L	2♀,1D,1P,7L	11♀, 8♂, 11D, 21P,7L
Cilliba sellnicki Hirschmann & Zirngiebl-Nicol, 1969	-	-	-	-	1♀, 1D	-	2♀	1♀	-	-	-	-
Uropoda minima Kramer, 1882	-	-	-	-	-	-	-	-	-	-	-	-
F. Dnychidae												
Dinychus hispanicus (Gilyarov & Bregetova, 1977)	3♀,3♂,5D, 32P	17♀,26♂,7D,11P	1♀,3♂,4D,2P	3♀,7♂,9D ,3P	-	-	-	-	-	1♀, 1♂, 1D, 1P	-	4♂, 2P
F. Discourellidae												
**Discourella baloghi* Hirschmann & Zirngiebl-Nicol 1969	-	-	-	-	-	-	-	-	-	-	-	1♀,6♂,1D,3P
F.Trachytidae												
Polyaspinus cylindricus Berlese, 1916	2♀	1♀	-	-	-	-	-	-	3♀, 2♂, 5D, 2P	3♀, 1P	-	4♀, 3♂, 1D, 3P
Trachytes aegrota (C. L. Koch, 1841)	3♀, 2P	11♀, 3D, 3P, 1L	1♀	9♀, 1P	9	-	1	1	-	2♀, 2D, 3P	2♀. 2D	2♀, 3D, 3P
**Trachytes eustructura* Hirschmann & Zirngiebl-N.1969	-	70♀, 96♂, 91D, 1P	6♀, 2♂, 3D, 2P	3♀, 6♂	-	-	-	-	-	4♀, 8♂, 4D	2♀, 2D	2♀, 3D, 3P
Trachytes welbourni Moraza, 1989	3♀, 2♂, 16P	4♀, 3♂	1♀, 1♂	6♀, 2♂	7♀, 6♂, 1P	-	1♀, 1D	1♀	2♀, 1♂, 2P	-	-	2♂
F. Dinychidae												
**Urodiaspis tecta* (Kramer, 1876)	1♀, 1D	-	2D, 1P	-	-	-	-	-	-	-	-	-
Number of studied specimens	**208**	**773**	**155**	**106**	**316**	**0**	**100**	**138**	**187**	**196**	**114**	**459**