Responsiveness to acoustic stimulation, distribution and habitat preferences of the Grey-headed Woodpecker, *Picus canus*, and the Three-toed Woodpecker, *Picoides tridactylus*, in Friuli-Venezia Giulia (North-eastern Italy)

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Abstract - The study was carried out from 2003 to 2011 with the aim of determining the responsiveness to acoustic stimulation, the distribution and the habitat preferences of *Picus canus* and *Picoides tridactylus* in Friuli-Venezia Giulia (NE Italy). *P. canus* resulted as being more responsive than *P. tridactylus* to conspecifics stimulation, responding in 13.23% of the points where a stimulus was emitted, against 7.65% of the other species. In both *taxa,* when there was a response, it was predominantly by the male birds. The most frequent type of response in *P. canus* was song, heard in 57.89% of the points, while for *P. tridactylus,* it was drumming, which was heard in 65.38% of the points. For both species (especially for *P. tridactylus*), a tendency was recorded to expand the range and to occupy new areas within the known range. *P. canus* in Friuli-Venezia Giulia was found from altitudes close to the sea level up to the treeline (range 0-2000 m a.s.l.), while *P. tridactylus* was found in montane and subalpine woodlands (range 800-2000 m a.s.l.). The observations of *P. canus* were obtained at a mean altitude of 977 m a.s.l. (± 402 SD), located in the altitudinal belt dominated by *Fagus sylvatica* L., which is present in more than half of the woodlands in which the woodpecker was found. *P. tridactylus* was discovered at a mean altitude of 1424 m a.s.l. (± 246 SD), located in the altitudinal belt dominated by *Picea abies* (L.) H. Karst., which is present in almost 90% of the woodlands in which this species was found. In some areas, densities of 0.67-2.26 territories/100 ha were obtained for *P. canus* and 0.16-0.40 territories/100 ha for *P. tridactylus*. In Friuli-Venezia Giulia, a population of 320-390 pairs of *P. canus* and 45-60 pairs of *P. tridactylus* has been estimated, with an approximate 15% increase of *P. canus* compared to the beginning of the century, and just over 60% for the other species. Finally, some aspects concerning conservation-related problems are reported.

Key words - *Picus canus*, *Picoides tridactylus*, responsiveness, distribution, habitat preferences, density, population, conservation, Friuli-Venezia Giulia, North-eastern Italy.

Riassunto - *Reattività alle stimolazioni sonore, distribuzione e preferenze ambientali del Picchio cenerino,* Picus canus*, e del Picchio tridattilo,* Picoides tridactylus*, in Friuli-Venezia Giulia.*

Lo studio è stato condotto dall'anno 2003 all'anno 2011 allo scopo di determinare la reattività alle stimolazioni sonore, la distribuzione e le preferenze ambientali di *Picus canus* e *Picoides tridactylus* in Friuli-Venezia Giulia. *P. canus* è risultato più reattivo di *P. tridactylus* alla stimolazione di conspecifici rispondendo nel 13.23% dei punti in cui è stata emessa stimolazione contro il 7.65% dell'altra specie. In entrambi i *taxa* in caso di risposta hanno prevalso i maschi. Il tipo di risposta più frequente per *P. canus* è stato il canto udito nel 57.89% dei punti, per *P. tridactylus* è stato il tambureggiamento udito nel 65.38% dei punti. Per entrambe le specie (soprattutto per *P. tridactylus*) si è rilevata la tendenza ad espandere l'areale e ad occupare nuove aree all'interno dell'areale conosciuto. *P. canus* in Friuli-Venezia Giulia è stato trovato da altitudini prossime al livello del mare al limite degli alberi (Range 0-2000 m s.l.m.) mentre *P. tridactylus* nei boschi montani e subalpini (Range 800-2000 m s.l.m.). Le osservazioni di *P. canus* sono avvenute ad un'altitudine media di 977 m s.l.m. (± 402 DS), posta nella fascia altitudinale dominata da *Fagus sylvatica* L. che si trova in oltre metà dei boschi in cui il picchio è stato trovato. *P. tridactylus* è stato rinvenuto ad un'altitudine media di 1424 m s.l.m. (± 246 DS), posta nella fascia altitudinale dominata da *Picea abies* (L.) H. Karst. che è presente in quasi il 90% dei boschi in cui è stata trovata la specie. In alcune aree sono state ricavate densità di 0.67-2.26 territori/100 ha per *P. canus* e di 0.16-0.40 territori/100 ha per *P. tridactylus*. In Friuli-Venezia Giulia è stata stimata una popolazione di 320-390 coppie di *P. canus* e di 45-60 coppie di *P. tridactylus* con un aumento, rispetto all'inizio del secolo, di circa 15% per *P. canus* e di poco oltre 60% per l'altra specie. Sono riportati infine alcuni aspetti inerenti le problematiche legate alla conservazione.

Parole chiave - *Picus canus*, *Picoides tridactylus*, reattività, distribuzione, preferenze ambientali, densità, popolazione, conservazione, Friuli-Venezia Giulia, Italia Nord-orientale.

INTRODUCTION

The Grey-headed Woodpecker, *Picus canus*, and the Three-toed Woodpecker, *Picoides tridactylus*, are species of Palaearctic-Oriental and Eurosiberian boreoalpine chorology, respectively, which have been rarely studied in Italy because of their distribution and habitat preferences. In fact, they are only found in the north-eastern extremity, where they mainly live in montane woodlands, especially *P. tridactylus*. In Friuli-Venezia Giulia, *P. canus* is a sedentary, breeding, and irregular migrant species (Rassati, 2003a), *P. tridactylus* is a sedentary and breeding species (Rassati, 2003): their distribution has recently been studied by Rassati (2003 and 2003a) who has also provided the first data regarding the habitat preferences (see also Rassati *et al*., 2001). In recent years, a tendency has been observed, for both *taxa,* to modify their range, and to occupy new areas.

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The aims of this study were to identify the trends in distribution and the habitat preferences, and the evaluation of the responsiveness to acoustic stimulation.

STUDY AREAS AND METHODS

The investigation involved the woodlands potentially suitable for the species in Friuli-Venezia Giulia (North-eastern Italy). For *P. canus,* all wooded areas were taken into consideration, from lowland woods to subalpine woodlands, while for *P. tridactylus*, montane and subalpine woodlands were examined, in particular coniferous ones. The research also involved part of the northern sector of Veneto.

Following the first definition of the range and habitat preferences (Rassati, 2003 and 2003a), all data regarding the two species were collected and entered into a database, in order to identify the trends in distribution and to improve the knowledge on their preferred habitats. This article is based on information collected from 2003 to 2011.

The data were obtained using the playback method, from the beginning of February to mid-May for *P. canus,* and from mid-March to mid-May for *P. tridactylus*, while during the rest of the year, visits were made aimed at making visual and/or acoustic contact, as well as searching for signs of their presence, for example "holes in a line" on tree trunks, a clear indication of *P. tridactylus*. The use of acoustic stimuli was limited because, similarly to other *Picidae*, the responsiveness of the two studied species is higher in a particular period of the year (Miranda & Pasinelli, 2001; Wiktander *et al.*, 2001; Rassati, 2003, 2003a, 2008; Wübbenhorst & Südbeck, 2003; Gorman, 2004; Hardersen, 2004; Wiggins, 2004; Charman *et al.*, 2010).

Additional information was collected during the visits carried out for other purposes.

The playback method (Bibby *et al.*, 2000) was used as reported below. The emission of the calls was carried out with a broadcaster with 30W of power that was slowly rotated by 360°. For each emission point, three acoustic stimuli were played (only once), each lasting 90 seconds, with a pause of 30-40 seconds between each emission, and a listening period of 60 seconds after the third stimulus. The stimuli were interrupted in the case of a response from the stimulated species. The track, obtained by Rochè (1990), for *P. canus* included drumming, song and calls of a male while for *P. tridactylus* included drumming and typical calls. The distance between the emission points was variable, as it was characterised during the course of the visits according to the suitability of the habitat (were chosen zones of old woodland or with dead or decaying trees). The responses, the spontaneous contacts and their modalities, including other *Picidae* species (Green Woodpecker, *Picus viridis*; Black Woodpecker, *Dryocopus martius*; Great Spotted Woodpecker, *Dendrocopos major*; Lesser Spotted Woodpecker, *Dendrocopos minor*) with respect to the stimulated species, were recorded on a specially designed datasheet and on a map where the emission points were already recorded. To determine the responsiveness to the acoustic stimuli, the following parameters were calculated:

A. response to stimuli by the species subject of the visit (ratio between the number of points in which a response occurred and the total number of points in which a stimulus was emitted);
B. response per single stimulus by the species subject of the visit (ratio between the number of responses per single stimulus and the total number of responses);
C. response to stimuli by *Picidae* species not subject of the visit (ratio between the number of points in which a response occurred and the total number of points in which a stimulus was emitted) in relation to all species and for each single species;
D. spontaneous contact with *Picidae* species not subject of the visit (ratio between the number of points in which a spontaneous contact occurred and the total number of surveyed points) in relation to all species and for each single species;
E. induced or spontaneous contact with *Picidae* (ratio between the number of points in which *Picidae* were contacted and the total number of surveyed points) in relation to all species and for each single species (for *P. canus* and *P. tridactylus*, obviously only the induced contacts were considered).

For the purposes of determining the distribution and the habitat preferences, for each contact, elevation, aspect and forest type were recorded. Only the contacts having a minimum distance of 500 m from each other were taken into account.

The composition of the types of woodlands in which the two studied species were found is reported in Tables 2 and 6, while for the mixed broadleaf woodland (Hornbeam, *Carpinus betulus* L., *Quercus* spp., Sweet Chestnut, *Castanea sativa* Mill., etc.; Table 2) the main potential species were indicated, as this stand, which mainly grows in the prealpine or outer Alpine area is characterised by the presence of different broadleaf species (sometimes also including Norway spruce, *Picea abies* (L.) H. Karst., and Scots pine, *Pinus sylvestris* L.) in various percentages according to the site characteristics, where no species clearly prevails, so that it is not possible to attribute a specific forest type. It was therefore decided to group the contacts that occurred in woodlands with similar composition into a single type.

In some sample areas, the density (territories/100 ha) was obtained by the execution of three censuses in the early part of the breeding period (prior to egg laying) using playback at points placed at varying distances from each other, according to the species being surveyed and the site characteristics. The tree species indicated in Tables 4 and 8 are those that characterise the single areas in their entirety.

RESULTS

Picus canus

Acoustic stimuli were played in 862 stations, and the species responded in 114 (13.23%) stations (Parameter A).

The percentage of responses per single stimulus (Parameter B) was fairly balanced, although greater after the first and third stimuli (Table 1).

Tab. 1 - *Picus canus*. Percentage frequency of responses per single stimulus. / Frequenza percentuale di risposte per singola stimolazione.

Stimulus No.	F%
1	38.60
2	26.32
3	35.09

In the case of a response, when it was possible to determine the sex, males prevailed (this was also verified in the case of a response by *D. martius*, while for *D. minor,* females prevailed), followed by females and then by pairs. The most frequent type of response was song (sequence of fluted "fii" or "fiu"), heard in 57.89% of the points, while sighting occurred in 33.33% of the points.

In 14.73% of the stations, a response from other *Picidae* species was obtained (*D. martius* 5.68%, *D. major* 4.41%, *P. viridis* 2.78%, *D. minor* 1.39%, *P. viridis-D. major* 0.23%, *D. martius-D. major* 0.23%) (Parameter C).

In 10.90% of the stations, a spontaneous contact with other *Picidae* species occurred (*D. major* 4.76%, *D. martius* 2.32%, *P. viridis* 2.32%, *P. viridis-D. major* 0.46%, *D. martius-D. major* 0.46%, *P. viridis-D. martius-D. major* 0.23%, *D. martius-D. major-D. minor* 0.23%, *P. tridactylus* 0.12%) (Parameter D).

Picidae were contacted in 33.06% of the stations (*P. canus* 10.90%, *D. major* 6.15%, *D. martius* 5.92%, *P. viridis* 3.71%, *P. viridis-D. major* 1.39%, *P. canus-D. martius* 1.16%, *D. martius-D. major* 1.16%, *P. canus-D. major* 0.70%, *D. minor* 0.46%, *D. major-D. minor* 0.23%, *P. viridis-D. minor* 0.23%, *D. martius-D. minor* 0.23%, *P. viridis-D. martius-D. major* 0.23, *P. canus-D. martius-D. major-D. minor* 0.23%, *P. canus-P. viridis-D. martius-D. major-D. minor* 0.23%, *P. tridactylus* 0.12%) (Parameter E).

The responsiveness of *P. canus* increased from February (8.11%) to March (11.07%) and up to April (16.80%), and then decreased in May (12.63%).

In 2.67% of points in which a stimulus was emitted, a response by the Eurasian Nuthatch, *Sitta europaea*, was verified.

The spontaneous contacts with the species occurred in 134 points.

In Friuli-Venezia Giulia, *P. canus* was found from the southern limits of the Carnic Prealps and the Julian Prealps overlooking the plain to the administrative boundaries and in the south-eastern zones where the species was present in a narrower band, which includes the Province of Trieste and part of the Province of Gorizia (Fig. 1). In the central-northern part of the Region, *P. canus* was fairly evenly widespread, except for the south-western sector of the Carnic Prealps. In the Provinces of Trieste and Gorizia, it was rarer and more localised. Contacts also occurred in lowland zones.

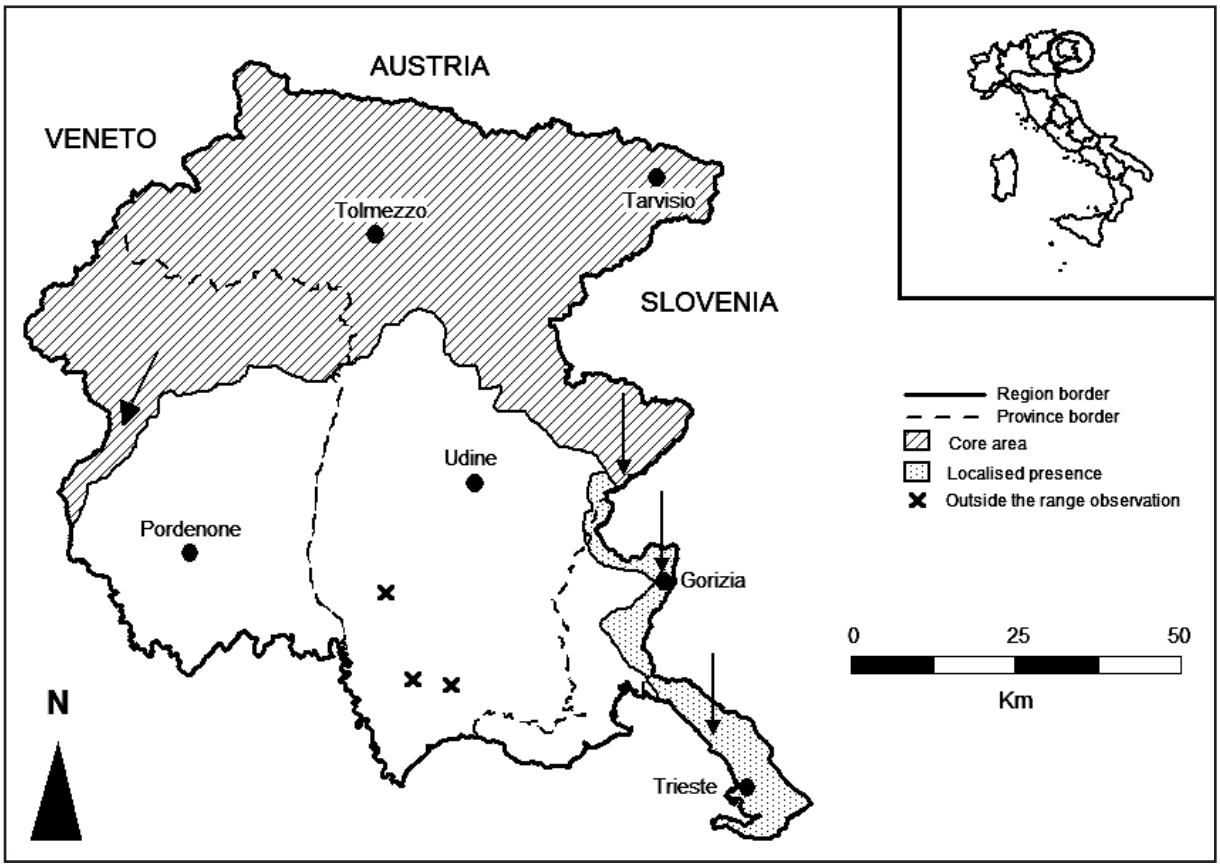

Fig. 1 - Range of *Picus canus* in Friuli-Venezia Giulia / Areale di *Picus canus* in Friuli-Venezia Giulia.

It is estimated that there are 320-390 pairs of *P. canus* in Friuli-Venezia Giulia with an increase of about 15% compared to the beginning of the century.

In the northern sector of Veneto, the species was found close to Pàdola, in several points of the Visdende Valley and its tributary valleys, in the valley of the Bigontina Stream, in several points of the Ansiei Valley, in the Diebba Valley, along the slopes of the Croda de r'Ancona, in several points of the Frison Valley, and in the area between Sappada, the Pesarine Dolomites and the Terze, along the valley of the Fedèra Stream, in several points of the Mauria Valley, in the vicinity of the Cibiana Saddle, and in the Pra di Toro Valley.

Similarly to what occurs in the rest of the range (del Hoyo *et al.* 2002), *P. canus* was found in a wide altitudinal range in Friuli-Venezia Giulia (mean altitude: 977 ± 402 SD m a.s.l.), indeed contacts were only sparse below 300 m a.s.l. and above 1700 m a.s.l. (Fig. 2). In accordance with Winkler *et al.* (1995), del Hoyo *et al.* (2002) and Gorman (2004), the frequented woodlands resulted as being very diverse, going from the thermophile and mesophile broadleaf woodlands of the southern prealpine sectors and of the Provinces of Gorizia and Trieste, to the microtherm coniferous woodlands at high altitudes (Table 2). Beech woodland was the most represented forest type, where nearly one fifth of the contacts were made, while the least represented ones were the woodlands composed of European Beech, *Fagus sylvatica* L. and *Pinus* spp. and the woodland of Black Poplar, *Populus nigra* L. and *Salix* spp., with percentage frequency less than 1. In general, other broadleaf woodlands of medium and high altitudes were well represented, while pure coniferous woodlands were less represented: concerning the latter, the woodland with the highest percentage frequency was that of *P. abies* and Silver Fir, *Abies alba* Mill. (6.05; Table 2).

The percentage frequencies of the station aspects in which the species was found varied from a minimum of 7.66 (S), to a maximum of 14.11 (N) (Table 3).

Breedings were found in *P. abies*; European Larch, *Larix decidua* Mill.; *A. alba*; *F. sylvatica*; Sycamore Maple, *Acer pseudoplatanus* L.; Littleleaf Linden, *Tilia cordata* Mill.; Sessile Oak, *Quercus petraea* (Matt.) Liebl.; and *C. sativa.*

In the investigated areas, the density (territories/100 ha) comprised values between 0.67 and 2.26 (Table 4), and the territories were located in zones with very variable slopes: from flat areas to steep slopes (sometimes overhanging on rock cliffs). In some cases, it was possible to verify that the territory included extensive scree colonised by Dwarf Pine, *Pinus mugo* Turra.

Picoides tridactylus

Acoustic stimuli were played in 340 stations and the species responded in 26 (7.65%) stations (Parameter A).

The percentage of responses per single stimulus (Parameter B) decreased in order of emission and was much higher for the first two stimuli (Table 5).

In the case of a response, when it was possible to determine the sex, males prevailed (this was also verified in the case of a response by *D. martius* and by *D. major*), followed by females. Confirming the greater importance of drumming compared to other *Picidae* species (Short, 1974; Gorman, 2004), this type of response was found to be the most frequent, heard in 65.38% of the points, while sighting occurred in 15.38% of the points.

In 12.94% of the points, a response from other *Picidae* species was obtained (*D. martius* 7.35%, *D. major* 4.41%, *D. martius-D. major* 1.18%) (Parameter C).

In 10.00% of the points, a spontaneous contact with other *Picidae* species occurred (*D. martius* 4.41%, *D. major* 3.53%, *P. canus* 1.47%, *D. martius-D. major* 0.59%) (Parameter D).

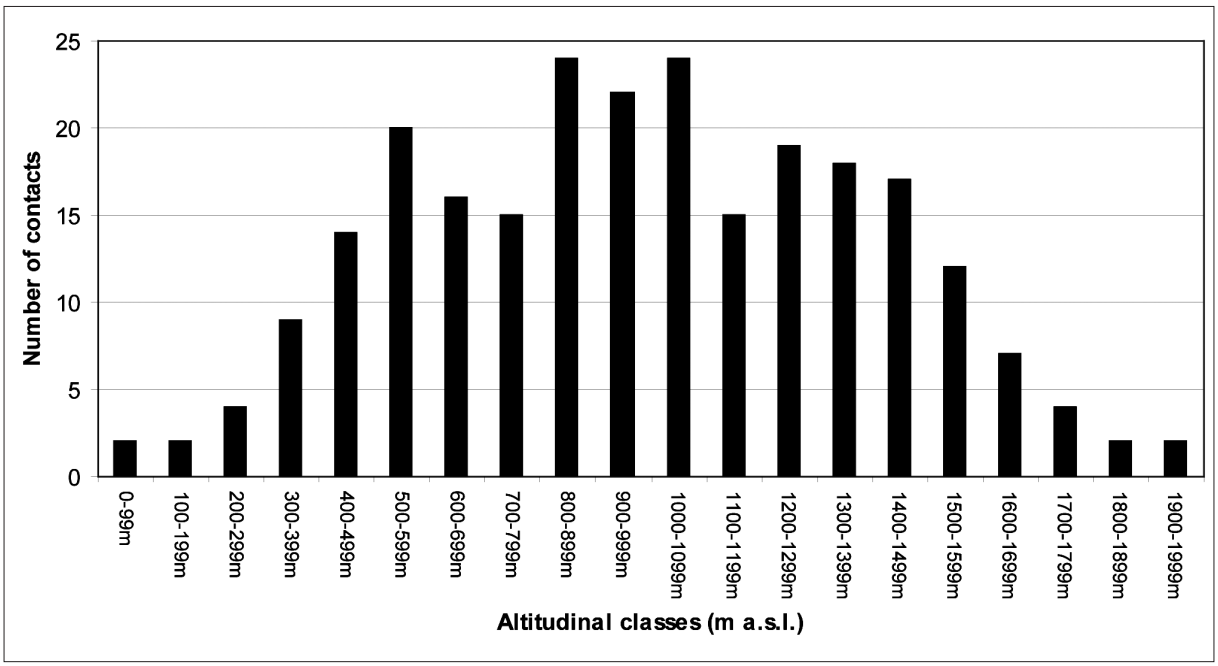

Fig. 2 - Subdivision of the contacts into altitudinal classes. / Suddivisione dei contatti in classi altitudinali.

Picidae were contacted in 28.24% of the points (*D. martius* 11.76%, *D. major* 6.18%, *P. tridactylus* 5.88%, *P. canus* 1.47%, *P. tridactylus-D. major* 1.18%, *D. martius-D. major* 1.18%, *P. tridactylus-D. martius* 0.59%) (Parameter E).

The responsiveness of *P. tridactylus* resulted in being higher in April (9.09%) and May (7.84%) with respect to March (3.23%).

In 1.47% of the points in which a stimulus was emitted, a response by *Sitta europaea* was verified.

The spontaneous contacts with the species occurred in 42 points.

A discrete variability in the back pattern was found, and individuals almost completely lack barring on the white back panel were also observed, very similar to *tridactylus* ssp.

Tab. 3 - Percentage frequency of the contacts in relation to the aspect. F = flat. / Frequenza percentuale dei contatti in rapporto all'esposizione. F = pianeggiante.

Aspect	F%
N	14.11
NE	12.50
E	12.90
SE	8.47
S	7.66
SW	12.10
W	11.29
NW	12.90
F	8.06

Tab. 2 - Subdivision of the contacts in relation to the forest types. / Suddivisione dei contatti in rapporto ai tipi forestali.

Forest type	N	F%
Fagus sylvatica	45	18.15
Picea abies, Fagus sylvatica	27	10.89
Carpinus betulus, Quercus spp., *Castanea sativa, Fraxinus ornus, Ostrya carpinifolia, Acer pseudoplatanus, Tilia* spp., *Fraxinus excelsior, Fagus sylvatica*	25	10.08
Picea abies, Abies alba, Fagus sylvatica	21	8.47
Picea abies, Abies alba	15	6.05
Picea abies, Abies alba, Larix decidua, Fagus sylvatica	15	6.05
Picea abies	13	5.24
Picea abies, Larix decidua, Fagus sylvatica	10	4.03
Larix decidua	8	3.23
Picea abies, Larix decidua	6	2.42
Quercus petraea	6	2.42
Castanea sativa	6	2.42
Larix decidua, Fagus sylvatica	5	2.02
Picea abies, Abies alba, Larix decidua	5	2.02
Picea abies, Pinus sylvestris	4	1.61
Pinus nigra	4	1.61
Acer pseudoplatanus, Fraxinus excelsior	4	1.61
Fagus sylvatica, Ostrya carpinifolia	3	1.21
Fagus sylvatica, Fraxinus ornus, Ostrya carpinifolia	3	1.21
Pinus sylvestris	3	1.21
Acer pseudoplatanus, Tilia spp.	3	1.21
Quercus petraea, Castanea sativa	3	1.21
Quercus pubescens, Fraxinus ornus, Ostrya carpinifolia	3	1.21
Quercus pubescens, Fraxinus ornus, Ostrya carpinifolia, Pinus nigra	3	1.21
Fagus sylvatica, Pinus sylvestris	2	0.81
Fagus sylvatica, Pinus nigra	2	0.81
Fagus sylvatica, Pinus sylvestris, Pinus nigra	2	0.81
Populus nigra, Salix spp.	2	0.81

Tab. 4 - Densities (territories/100 ha) in some areas. / Densità (territori/100 ha) in alcune aree.

Area	Coordinates	Forest type	Surface area (ha)	Density
Rio del Lago Valley (Julian Alps)	46°24'N 13°30'E	*Picea abies, Larix decidua, Fagus sylvatica*	310	2.26
Tagliamento Valley (Carnic Prealps)	46°27'N 12°31'E	*Picea abies, Abies alba, Larix decidua, Fagus sylvatica*	420	1.90
Tuglia (Carnic Alps)	46°33'N 12°45'E	*Picea abies, Larix decidua, Fagus sylvatica*	115	1.74
Bozzia Valley (Carnic Prealps)	46°19'N 12°23'E	*Picea abies, Abies alba, Larix decidua, Fagus sylvatica*	120	1.67
Uccea Valley (Julian Prealps)	46°19'N 13°21'E	*Picea abies, Fagus sylvatica*	425	1.65
Zemola Valley (Carnic Prealps)	46°18'N 12°22'E	*Larix decidua, Fagus sylvatica*	220	1.36
Torre Valley (Julian Prealps)	46°15'N 13°14'E	*Fraxinus excelsior, Alnus glutinosa, Acer pseudoplatanus* (mixed broadleaf woodland)	245	1.22
Pontebbana Valley (Carnic Alps)	46°32'N 13°12'E	*Picea abies, Abies alba, Fagus sylvatica*	240	0.83
Caltea Valley (Carnic Prealps)	46°10'N 12°33'E	*Fagus sylvatica*	420	0.71
Cosizza Valley (Julian Prealps)	46°09'N 13°34'E	*Castanea sativa, Ostrya carpinifolia, Carpinus betulus* (mixed broadleaf woodland)	150	0.67

Tab. 5 - *Picoides tridactylus*. Percentage frequency of responses per single stimulus. / Frequenza percentuale di risposte per singola stimolazione.

Stimulus No.	F%
1	46.15
2	38.46
3	15.38

In Friuli-Venezia Giulia, *P. tridactylus* was found along the entire Main Carnic Chain, in part of the Carnic Alps and the Julian Alps, and in a restricted area of the Carnic Prealps, still in the process of colonisation, where its presence was unstable and localised (Fig. 3). It was more evenly widespread in the eastern sector, from the eastern Carnic Alps at the east of the Creta di Aip to the Jôf di Montasio and to Mount Mangart. Occasionally, the species was observed in a band lying south of the range, which includes the most southern valley floors of Carnia and Canal del Ferro, and reaches the prealpine zone, where it does not breed (Rassati, unpubl. data).

It is estimated that there are 45-60 pairs of *P. tridactylus* in Friuli-Venezia Giulia with an increase of just over 60% compared to the beginning of the century.

In the northern sector of Veneto the species was contacted in the surroundings of the Montecroce Comelico Pass, in the high Digon Valley, in several points of the Visdende Valley and its tributary valleys, around Lake Misurina, in the valley floor of the high Ansei Valley, in several points in the area between Sappada, the Pesarine Dolomites and the Terze, in the Antelao Valley, along the slopes of the Formin di Mezzo, and along the slopes of Montanel; it was also contacted in several points of the Sesto Valley (South Tyrol).

P. tridactylus was found in a band comprised between 800 and 2000 m a.s.l. and especially from 1100 to 1700 m a.s.l. (Fig. 4), at a mean altitude of 1424 ± 246 SD m a.s.l.. Contacts mostly occurred in coniferous woodlands (67.65%) and, to a lesser extent, in mixed coniferous and broadleaf woodlands. Spruce woodland was the most represented forest type, where one quarter of the contacts were made, while the woodland composed of *P. abies*, *P. sylvestris*, *L. decidua*, and *F. sylvatica* was the least represented forest type, with a percentage frequency of 1.47 (Table 6).

The percentage frequencies of the station aspects in which the species was found varied from a minimum of 7.35 (W and SW), to a maximum of 16.18 (N and S) (Table 7).

Breedings were found in *P. abies*, *L. decidua*, and *A. alba*.

The density (territories/100 ha) in the investigated areas comprised values between 0.16 and 0.40 (Table 8) and the territories, similarly to *P. canus*, were located in zones with very variable slopes: from flat areas to steep slopes (sometimes overhanging on rock cliffs).

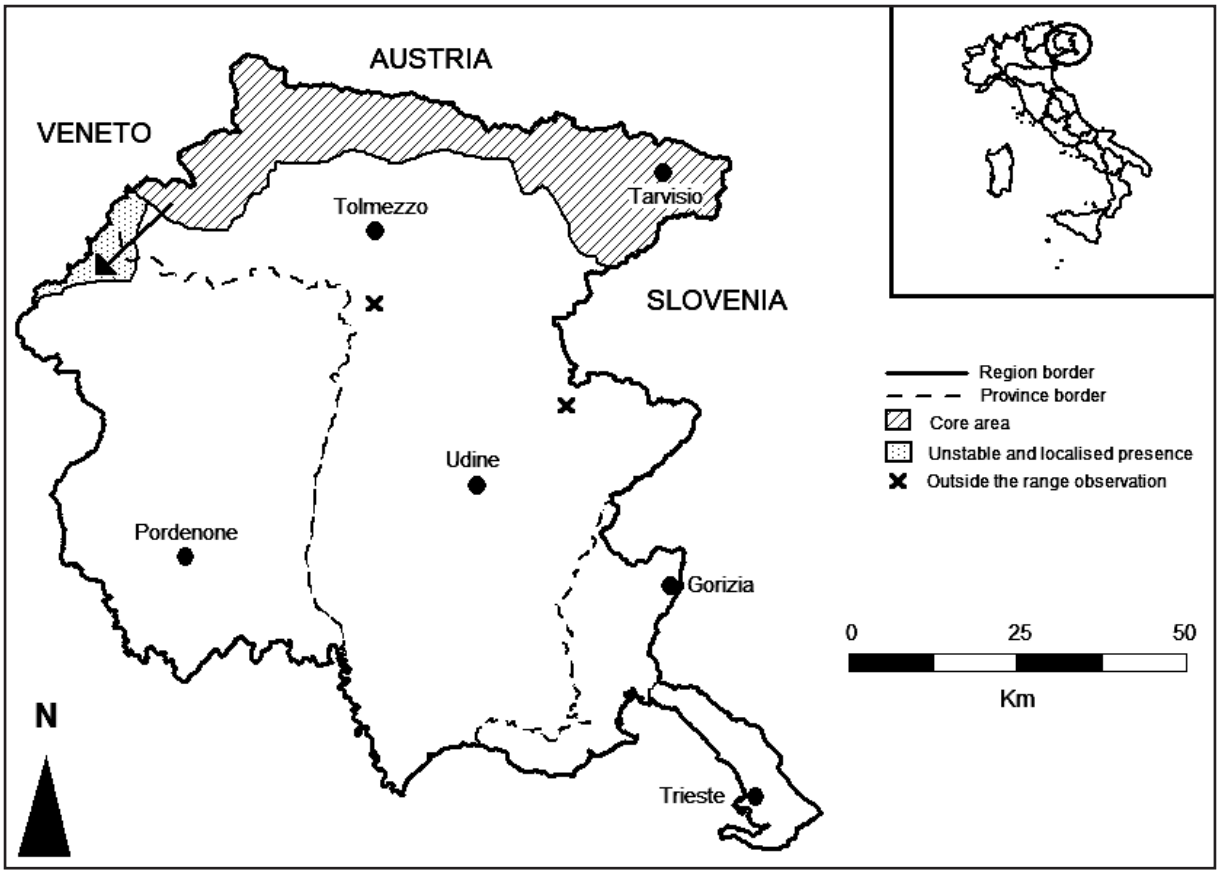

Fig. 3 - Range of *Picoides tridactylus* in Friuli-Venezia Giulia. / Areale di *Picoides tridactylus* in Friuli-Venezia Giulia.

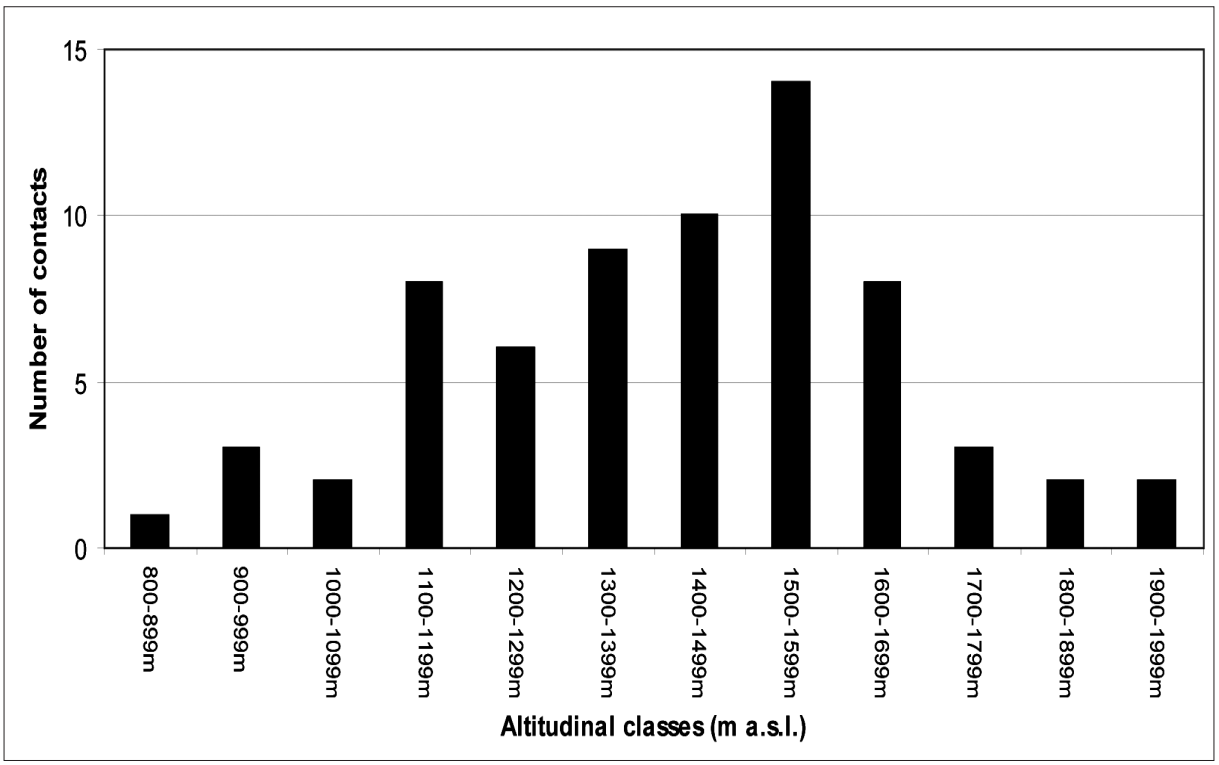

Fig. 4 - Subdivision of the contacts into altitudinal classes. / Suddivisione dei contatti in classi altitudinali.

Tab. 6 - Subdivision of the contacts in relation to the forest types. / Suddivisione dei contatti in rapporto ai tipi forestali.

Forest type	N	F%
Picea abies	17	25.00
Picea abies, Larix decidua	12	17.65
Larix decidua	8	11.76
Picea abies, Larix decidua, Fagus sylvatica	8	11.76
Picea abies, Abies alba	6	8.82
Picea abies, Abies alba, Fagus sylvatica	5	7.35
Picea abies, Fagus sylvatica	4	5.88
Picea abies, Abies alba, Larix decidua	3	4.41
Picea abies, Abies alba, Larix decidua, Fagus sylvatica	2	2.94
Picea abies, Pinus sylvestris, Fagus sylvatica	2	2.94
Picea abies, Pinus sylvestris, Larix decidua, Fagus sylvatica	1	1.47

Tab. 7 - Percentage frequency of the contacts in relation to the aspect. F = flat. / Frequenza percentuale dei contatti in rapporto all'esposizione. F = pianeggiante.

Aspect	F%
N	16.18
NE	11.76
E	10.29
SE	11.76
S	16.18
SW	7.35
W	7.35
NW	10.29
F	8.82

Tab. 8 - Densities (territories/100 ha) in some areas. / Densità (territori/100 ha) in alcune aree.

Area	Coordinates	Forest type	Surface area (ha)	Density
Lussari (Julian Alps)	46°28'N 13°31'E	*Picea abies, Larix decidua*	750	0.40
Goriane (Carnic Alps)	46°32'N 13°35'E	*Picea abies, Larix decidua, Fagus sylvatica*	790	0.38
Malborghetto Valley (Carnic Alps)	46°32'N 13°25'E	*Picea abies, Larix decidua, Fagus sylvatica*	850	0.35
San Leopoldo (Julian Alps)	46°29'N 13°21'E	*Picea abies, Abies alba, Larix decidua, Fagus sylvatica*	330	0.30
Chiarsò Valley (Carnic Alps)	46°34'N 13°08'E	*Picea abies, Larix decidua, Fagus sylvatica*	475	0.21
But Valley (Carnic Alps)	46°35'N 12°57'E	*Picea abies, Abies alba, Fagus sylvatica*	620	0.16
Degano Valley (Carnic Alps)	46°36'N 12°45'E	*Picea abies, Abies alba, Larix decidua*	615	0.16

DISCUSSION

Responsiveness

In both species, the number of spontaneous contacts exceeded that of the induced contacts (*P. canus*: 54% vs 46%; *P. tridactylus*: 62% vs 38%) given the limited time period in which the stimuli were emitted.

P. canus responded with greater frequency than *P. tridactylus* but, however, with a clearly lower percentage than that of conspecifics and other *Picidae* species in two areas of Carnia and comparable or less than that of *D. minor* (Rassati, 2008, in press). The difference with the conspecifics, *P. viridis*, *D. martius*, and *D. major*, is due to the fact that while in Carnia, an area was examined in which the investigated species were present, in this study, the researches aimed to find the species, and therefore areas uninhabited by the *taxa* were also monitored. The lower extension of the territories, together with the higher presence of spaces not frequented between them, as well as the lower acoustic power of *D. minor*, may explain the similarity in the frequency of responses (Rassati, 2008), while the relatively high density of the species may explain the greater frequency of responses in the area in Carnia (Rassati, in press).

The percentage of points in which a response by other *Picidae* species was verified (during emission of *P. canus* 14.73%, and of *P. tridactylus* 12.94%) was within the range found in an area in Carnia (Rassati, 2008). *D. martius* was the species that responded most to the calls of *P. canus* and *P. tridactylus*, and in more stations to the call of *P. tridactylus* of the latter species, confirming the disposition to frequently utter audible sounds, even over a great distance; the good responsiveness to acoustic stimulation; the lack of empty spaces between the territories, and the good level of vigilance of the owners throughout the entire territory (Rassati, in press).

The percentage of points in which there was spontaneous contact with other *Picidae* species (during emissions of *P. canus* 10.90%, and of *P. tridactylus* 10.00%) was not within the range found in an area in Carnia (Rassati, 2008), although it is only slightly lower than the minimum value.

In accordance with the fact that the males generally tend to manifest possession of the territory and to defend it more and with greater frequency than the females (Cramp, 1985; Winkler *et al.*, 1995; Rassati, 2008), in the case of a response to conspecifics stimuli, when it was possible to determine the sex, males prevailed in both the stimulated species, as well as in the case of responses by *D. martius* and *D. major*. In *P. canus*, however, only a slightly lower responsiveness was recorded for females compared to males, especially in the early part of the breeding period, while in *P. tridactylus*, females were observed as having a frequency equal to one third of that of males.

The responsiveness, especially in *P. tridactylus*, was much lower than that obtained in an area in Carnia for *D. major* and for *P. viridis* in March and April (Rassati, 2008). The high responsiveness in May, especially by *P. canus* with respect to *P. viridis*, is attributable to the fact that, in this month, areas were investigated for *P. canus* in which the reproductive period was less advanced with respect to that of the comparative study, and the responses were therefore more easily obtainable.

Regarding the low responsiveness of *P. tridactylus*: in general, the species appeared less "acoustic" and with a lower "desire to respond" with respect to the other Alpine Woodpeckers; furthermore, on various occasions the use of playback in the presence of nearby individuals did not result in a response. The same "tests" carried out with *P. canus* instead resulted in a very high percentage, a definite response.

The above results confirm frequent interspecific interactions (Cramp, 1985; Winkler *et al.*, 1995; del Hoyo *et al.* 2002; Gorman, 2004; Rassati, 2008). Moreover, in some points, five *Picidae* species were contacted at the same time (*P. canus*-*P. viridis*-*D. martius*-*D. major*-*D. minor*), and individuals of these *taxa* (which were also males) were observed to manifest the possession of the territory at the same time, even at a distance of a few tens of metres away, without further interactions other than the acoustic one.

It was also interesting to verify that even outside the ranges of *P. canus* and *P. tridactylus,* there was a response by *P. viridis*, *D. major* and *D. minor* to the stimuli of the first species, and by *D. martius* and *D. major* to the stimuli of the second. This proves that a group responsiveness in the *Picidae* exists, caused by common acoustic stimuli.

The use of the playback demonstrated to be efficient to make easier the contact particularly with *P. tridactylus*, in some areas otherwise difficult to contact, and in zones where the species had low densities.

Distribution and habitat preferences

From the comparison with the range described by Rassati (2003a), during the course of the last decade it has been possible to record the tendency of *P. canus* to occupy new areas, especially at the south-eastern end, but this expansion is still ongoing, at the south-western end as well (see arrows in Fig. 1), where, however, more than an expansion of the range, it is a consolidation of the species presence. Even within the known range, the species has tended to colonise new areas, similarly to what has been observed for other woodpecker species (Rassati, 2008, 2009) and certainly favoured by the ageing and expansion of the woodlands. As already verified by Rassati (2003a), the areas in which the species responded more frequently to the calls, and where the highest number of individuals was found were Carnia, the secondary valleys of the Canal del Ferro and Valcanale, where the species is widespread from the valley floor to the highest elevations. However, *P. canus* was also frequently found in the northern part of the Carnic Prealps and the Julian Prealps. In the south-eastern sector of Friuli-Venezia Giulia it reaches the minimum Italian altitude.

In the last decade, *P. tridactylus* has manifested a greater tendency to colonise new areas than *P. canus*, in fact it has reached and passed the Tagliamento Valley, going beyond the "old" south-western limit represented by the Lumiei Valley (Rassati, 2003), and showing a clear tendency to move towards WSW (see arrow in Fig. 3), already identified by Rassati (2005a). The first observation of the species in the Carnic Prealps in the Province of Pordenone (Rassati, 2005a) in fact, whilst not excluding other directrixes was probably due to the abovementioned tendency and source-sink dynamics. The south-eastern limit of the range of the species in Friuli (The Mount Canìn range), instead, does not

appear to be modified compared to a decade ago, also certainly due to the fact that there do not seem to be suitable environments to the south of this limit (Rassati, 2003). The colonisation of new areas within the already known range has also been verified for *P. tridactylus*, definitely favoured by the ageing and expansion of the woodlands, as in the case of *P. canus*, but probably also influenced by the movement of individuals from Carinthia. This phenomenon is likely to fall within the expansion phase that was verified in Central Europe from the 1980s (del Hoyo *et al.*, 2002). By contrast, in Northern Europe, in the past decades there has been a negative trend, probably caused by the loss of suitable habitat and a decline in the quality of the remaining habitat due to forest management (Nilsson *et al.*, 1992; Tucker & Heath, 1994; Pakkala *et al.*, 2002; BirdLife International, 2004). Instead, on the southern Alpine arch, the abandonment of silvicultural practices due to the strong decrease of human Alpine populations, and to changes in lifestyle, increased costs, and loss of the value of timber, has favoured *P. tridactylus* and *Picidae* in general. The increase of *P. tridactylus* as a result of some of the abovementioned reasons has also been verified in Switzerland (Schmid *et al.*, 1998; Bütler *et al.*, 2004). Valcanale is confirmed as the zone in which the species is most widespread and numerous (Rassati, 2003) and where it can also be more frequently found in the valley floor, but in the last decade, even the Main Carnic Chain has been colonised in a more determined manner than it was in the past and in some heads of the valleys, colonisation has reached the valley floor.

Confirming what has already been verified (Rassati, 2003a), the forest types in which *P. canus* is most widespread are those in which *F. sylvatica* is part of the composition. The beech woodland in fact resulted as being the most frequently inhabited (18.15%; Table 2), and if all forest types in which *F. sylvatica* is found are taken into account, the percentage frequency increases to 54.44, without even considering the mixed broadleaf woodland (given the impossibility of distinguishing one type from the other, as reported in study areas and methods), where some of the contacts occurred in stands also composed of *F. sylvatica*. With the exception of woodlands containing *F. sylvatica*, the mixed broadleaf woodland resulted as being the forest type, at medium-low elevations, in which *P. canus* was most frequently found (10.08). The pure coniferous woodlands were chosen by *P. canus* to a lesser extent than woodlands purely or prevalently composed of broadleaf trees and in total 23.39%. What has been reported above retraces the distribution of *P. canus*, indeed the species in Friuli-Venezia Giulia can be considered montane, and the mean altitude of 977 m a.s.l. is placed exactly in the altitudinal belt dominated by *F. sylvatica*. These results are moreover determined by the current distribution of woodlands, indeed it is of the opinion that, if the plain was mostly wooded, it would be largely colonised by *P. canus*, as in other zones of Europe (del Hoyo *et al.*, 2002; Gorman, 2004). To demonstrate this, *P. canus* was found even below 100 m a.s.l. in areas that are generally in territorial and ecological continuity with the core area. The species moreover frequents also lowland areas where it does not breed: it was indeed observed in the zone of the resurgences of the River Stella, in the Baredi Wood-Selva di Arvonchi, and in the Sacile Wood (Rassati, unpubl. data) (see "**x**" in Fig. 1), at just a few km from the Adriatic Sea.

In accordance with Svärdson (1949), *P. canus* is sympatric with *P. viridis* in Friuli-Venezia Giulia as well, but it is rarely syntopic (Rassati, pers. obs.), and it is more closely linked to inner woodland and montane zones, similarly to what is usually found (Cramp, 1985; Winkler *et al.*, 1995; del Hoyo *et al.*, 2002; Gorman, 2004). In Friuli-Venezia Giulia, *P. viridis* is moreover widely distributed in the lowlands, while not exceeding 1500 m a.s.l., and rarely occupies stands of conifers at high altitudes (Rassati, 2005 and 2009). This duality is clearly observed in the montane valleys and prealpine zones where the woodlands descend until the base of the elevations: *P. viridis* is particularly found along the valley floors, in more open woodlands and ascends the upper part of the slopes, exploiting the open areas at villages, hamlets and rural zones, while above a certain altitude (variable according to the site characteristics), and within the more extended stands, it makes way for *P. canus*. There does exist, however, a band of overlap that is often represented by residual patches of the traditional agricultural landscape where woodlands are regaining the subtracted spaces. The syntopy of *P. canus* and *P. tridactylus* is instead common, as well as syntopy of the two studied species with *D. martius* and *D. major*.

Coniferous woodlands are confirmed as the elected habitats of *P. tridactylus* in Friuli-Venezia Giulia as well (Cramp, 1985; Winkler *et al.*, 1995; Rassati *et al.*, 2001; Burdett & Niemi, 2002; del Hoyo *et al.*, 2002; Pakkala *et al.*, 2002; Rassati, 2003) (Table 6); the species also frequents forest types mostly dominated by conifers where, however, *F. sylvatica* is also present, which is one of the species used by *P. tridactylus* for trophic purposes. The extension of the researches in previously uninvestigated zones has allowed the discovery, albeit with low frequency, of *P. tridactylus* at below 1000 m a.s.l. (Fig. 4). As for the other investigated *taxon*, the mean altitude of the observations (1424 m a.s.l.) is within the altitudinal belt dominated by tree species that characterises most of the frequented woodlands: *P. abies*. This tree species is also of primary interest in the rest of the range (Gorman, 2004). In relation to this link, it is important to underline that in recent decades, *P. abies* is in decline because of climate change that, especially at medium and low elevations, favours other species, and the outbreaks of the European spruce bark beetle, *Ips typographus*; to this must be added that the favourable treatment of which *P. abies* has benefitted from until a few decades ago, and which has resulted in the expansion of the range, and the realisation of various plantations in the outer prealpine zone, is now finished. Therefore, if the opposing trends of expansion of *P. tridactylus* and the decline of *P. abies* continue, it will come to a point in which the picid can no longer expand due to a lack of suitable habitat, unless its selection of habitat changes.

P. tridactylus on the southern slope of the Alps, while positively influenced by the presence of dead or decaying trees, appeared less linked to large expanses of old woodland, with respect to what has been observed in other zones (Virkkala, 1987; Burdett & Niemi, 2002; Imbeau & Desrochers, 2002; Pakkala *et al.*, 2002; Angelstam *et al.*, 2003; Gorman, 2004; Wesołowski *et al.*, 2005). This could be related to the va-

riability of silvicultural treatment due to the fragmentation of the ownership (which favours the presence of groups of decaying or dead trees within wide areas characterised by young stands) and to the consequent high variability of the landscape but, above all, to the marginality of the southern Alpine range, and the concomitant expansive tendency, confirmed by the considerable number of observations in zones with habitat considered as being poorly suitable (see references just mentioned) in the areas of recent colonisation. This does not mean that in the Eastern Alps, *P. tridactylus* cannot be an indicator of high biodiversity, and it cannot be used as an umbrella species: this would be desirable.

The low frequency of observations above 1700 m a.s.l. is also due, similarly to *P. canus*, to the lower extension and presence of wooded areas with respect to lower altitudes. Unlike *P. canus*, the mean elevation also characterises *P. tridactylus* in a hypothetical greater presence of woodlands in the valley floors and at lower altitudes, primarily because, in part, suitable forest types already exist in at least some valley floors, and secondly because possible lowland forest stands would not be suitable, mainly because of their specific composition. For *P. tridactylus*, observations were also recorded (in broadleaf woodlands) outside the range: in two cases, the contact was particularly distant (see "**x**" in Fig. 3), demonstrating altitudinal and latitudinal erraticisms, which can also take the species to the lowlands (Moltoni, 1954).

A study carried out in Valcanale (Rassati *et al.*, 2001) indicated a mean altitude of 1263 m a.s.l. for *P. canus* and 1465 m a.s.l. for *P. tridactylus*. The lesser difference of the second species compared to the findings in this study is due to the fact that a large part of the observations were made in Valcanale and, in any case, in the Alpine sector.

The results obtained in this study confirm that in Friuli-Venezia Giulia, *P. canus*, analogously to *D. martius* and to *D. major*, breeds from altitudes close to the sea level to high elevations where it frequents, as also verified for *P. tridactylus*, the subalpine woodlands up to the treeline, and also shrublands.

Density, population and conservation

The densities of *P. canus* were variable (Table 4) and, generally, higher in the Alpine and inner prealpine zone. The value obtained in another area of the Carnic Alps (Lumiei Valley, 1.28 territories/100 ha; Rassati, in press) is within the range reported in Table 4. In other zones, very variable values (pairs/100 ha) were found, which those of the present study fall within: 0.17 in Finland (Åland Islands) (Haila & Järvinen, 1977), 1-10 in France and Switzerland (Cramp, 1985), 0.1-10 in central Europe (del Hoyo *et al.*, 2002), and 0.3-0.6 in western Poland (Kosiński & Kempa, 2007).

The density values of *P. tridactylus* were variable (Table 8) and, although having generally increased over the last decade, especially in the western sector of the range (Rassati, unpubl. data), were low when compared with those of other *Picidae* species on the extreme eastern Alpine arch (Rassati, 2008, 2009, in press), with the exception of those relating to *D. martius*. This is influenced by the ecological requirements of *P. tridactylus*, which determine relatively large territories, usually with the presence of large unoccupied spaces between each other, partly due to unsuitable or only partially suitable habitat, especially towards the margin of the range. The values (Table 8) fall within the range reported by other authors (pairs/100 ha): 0.01-1.5 (entire range; Winkler *et al.*, 1995), 0.02-5 (southern Finland; Pakkala *et al.*, 2002), 0.09-0.12 (Slovakia; Danko *et al.* in Gorman, 2004), 0.9-1 (south-eastern Germany; Pechacek, 2006).

The expansion of the range and the consolidation of the population are also due to the increase in numbers.

The current phase of growth of the two studied species should not encourage the belief that there is an apparent lack of problems regarding conservation. Indeed, the absence of silvicultural management that actually takes the needs of the animal species into consideration, and the lack of knowledge and sensitivity of wildlife issues, which translate into often superficial assessments regarding the realisation of works and infrastructures, based on a limited number of data and ecological relations, and influenced by money as well as party interests, play a large role, causing direct and indirect losses. It is therefore necessary to implement a selvicultural management that is different from the current one, for example by taking better account of the period in which the interventions are carried out, along with their modalities (e.g. in anticipation of the review of the planning instruments, avoid clearcutting of extended areas and cutting too frequently), safeguarding the maintenance of old-growth, decaying, dead or fallen trees and uneven age, giving greater possibility to the verifiers to consider the merits of what is expected from cutting projects, but especially changing the current cultural model that provides a duality between the forester and the faunist, and the progressive decline of the silvicultural management, increasingly delegated to bureaucrats and speculators, at the expense of technicians. It is also desirable that the realisation of cableways, aerial electrical and telephone lines, buildings of the "modern" type (e.g. with large reflective surfaces) and the construction or modification of infrastructures (e.g. the asphalting of roads) are only carried out in the case of actual need.

Finally, the realisation of concrete actions to safeguard key areas for the conservation of biodiversity through the identification of *P. tridactylus* and *P. canus* and, of the *Picidae* in general as a "flagship family" would be very useful to increase the knowledge of laypeople, and consequently the sensitivity regarding a world ever more distant from the majority of people, and therefore exposed to an increasingly higher degree of risk.

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