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Attracting Insectivorous Avifauna in Orchards with Artificial Nests

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Abstract Attracting useful avifauna is one of the methods used in the integrated and organic orchards to control specific pests. To create and maintain an integrated ecosystem require important and sometimes difficult activities in the fruit growing area. A solution for attracting and maintaining insectivorous avifauna is to build and place suitable nesting places. This study aims to present the results of the researches when 48 artificial nests located in different orchards were monitored. Artificial nests were built according to regulations and placed in three orchards from three different locations: Faculty of Horticulture within USAMV Bucharest, Moara Domnească Ilfov County and Nursery and Fruit Growing Farm Istrița, Buzău County. The results showed that the nesting density and diversity of occupied species were influenced by the orchard habitat but also by the technical parameters of nest construction and position of nests. The highest nests occupation rate was registered in Moara Domnească orchard and the lowest in the Bucharest, due to the windbreaks presence. In time, all the horticultural ecosystems registered an increase in the occupation rate, the wild birds getting used and the new generations grown in artificial nests accepted them more easily.

Key words

biodiversity, ecosystem, organic pest management, useful birds, windbreaks.

Globally, there are over 6,000 species of insectivorous birds species and a recent study estimated the total weight of these birds at 3 million tons; they consume about 400-500 million tons of insects in a year. This quantity seems to be similar to the human consumption of meat (around 400 million tons/ year). There was even a conversion to energy, the equivalent of 2.8 exajoules, equal to the energy consumption of New York City in one year [21].

The fruit grower is primarily interested in the impact of wild birds in the food chain, and about ecology, etiology but also aspects regarding the usefulness of birds [17, 20].

Papadopol and Petrescu [22] list from the literature researchers who have analyzed the composition of food for certain bird species.

Birds are a bio-indicator of the quality of the environment, and their presence can give us clues about the quality of agricultural practices. Birds are also involved in controlling pest populations. The abundance of wild birds in orchards is directly influenced by pest control strategies. In organic orchards from France, the negative impact of pest control strategies has been lower than in conventionally maintained orchards, the most affected being insectivorous species [1, 10, 14, 2, 9, 27].

In New Zealand, a study on the diversity and abundance of birds in kiwi orchards states that owners were interviewed how they appreciate the presence of birds in their orchards. Most responded that they are aware that birds are an indicator of the quality of farm management (bio-indicator) and are generally proud of the ornithological diversity in their orchards [25].

The favorite habitats of the great tit (*Parus major* L.) are deciduous and mixed forests, orchards, parks and gardens [11, 15, 28, 3, 7, 8, 18]. In mixed forests, it seems to exceed the density of 15 nests per hectare [5].

In France, the great tit (*Parus major* L.) has a density of 1-3 pairs per 10 ha in forests and agricultural habitats low in plant diversity, 3-8 pairs/ 10 ha in deciduous forests and lowland areas and up to 40 pairs/ 10 ha in gardens and parks where there are artificial nests [12].

A large tit family can bring as many as 1,500 caterpillars to the nest in a single day [7]. The big tit food is predominantly insectivorous, consuming insects in all stages of development, in winter it also consumes oilseeds and fruits [23].

To attract birds to an orchard, birds must find safe sources of food, water, shelter and nesting sites throughout the year. Attracting useful avifauna is one of the methods used in the integrated and organic orchards to control fruit tree specific pests [4]. Creating and maintain integrated ecosystems have important and sometimes difficult activities in the fruit growing area. In the integrated and organic orchards, a solution for attracting and maintaining the insectivorous avifauna is to build and place suitable nesting places.

This study aims to present the results of the researches conducted during the 2015 - 2017 period when 48

artificial nests located in different orchards were monitored.

Material and Method

Description of the study site and experimental design
Artificial nests were built according to regulations and placed in 3 orchards from 3 different locations: Faculty of Horticulture within USAMV Bucharest, Moara Domnească Ilfov County and Nursery and Fruit Growing Farm Istrița, Buzău County.
According to the field study, four nests types were built, noted with A, B32, B35 and C (Table 1). 48 nests were created according to the recommendations of the Romanian Ornithological Society and [16, 12, 19].

Table 1. Artificial nest characteristics

Type	Target/occupant species	Hole diameter (mm)	Inner depth (cm)	Length x width (cm)
A	*Cyanistes caeruleus* L., *Poecile palustris* L.	28	16	10 x 10
B	*Parus major* L., *Passer montanus* L., *Passer domesticus* L., *Sitta europaea* L., *Jynx torquilla* L.	32	16 – 18	12.5 x 12.5
C	*Phoenicurus phoenicurus* L., *Erithacus rubecula* L.	100 x 150	8	12.5 x 12.5

Each nest had GPS location (Figure 1 for Istrița orchard). Bird species were identified and monitored.

Figure 1. Map for the nests placed in the Istrița orchard (Google Earth)

Table 2. Location and number of artificial nests places in the three orchards

Code	Location	A	B32	B35	C	Total
L1	Exotic species orchard USAMV Bucharest	1	1	1	1	4
	Apple orchard USAMV Bucharest	1	1	1	1	4
L3	Sweet cherry and apricot orchard Moara Domnească, IF	2	2	2	1	7
	Apple orchard Moara Domnească, IF	2	2	2	2	8
L5	Orchard Istrița, BZ	6	7	6	6	25
Total		12	13	12	11	48

The artificial nests were occupied with bird species presented in Table 3.

Table 3. Identified bird species and their contributions in the economy according to literature

Species	Food consumed
Parus major L.	200.000 insect eggs/ summer plus caterpillars, adults bring to their chicks approx. 1,500 caterpillars/ day [6]. Especially Lepidoptera [26]. In France, it is considered a predator of Noctuids, especially species of the genus *Orthosia* [26]. Out of 29,000 photos, 100 species of Lepidoptera were identified in the chick menu [26].

Species	Food consumed
Cyanistes caeruleus L.	38% adults and larvae of Lepidoptera, 28% Coleoptera, 10% spiders, 9% Hemiptera, 8% Hymenoptera, 2% Ortoptera and 5% unidentifiable insect [6]. 7 – 68% Lepidoptera, 6 – 26% spiders, 6 – 66% Hemiptera, 17% Ortoptera [26]. When the peak of the breeding season is reached, the chicks are fed once every 90 seconds [23].
Passer domesticus L.	Omnivorous, chicks are fed only on insects. 96.1% insects and other invertebrates, 3.9 plant material (near Sofia); 63.6% insects and other invertebrates, 36.4 plant material (industrial area), in Germany; 88.9% insects and other invertebrates, 11% plant material (rural area); 99% (urban area); 82.3% insects and other invertebrates, 17.7% in Poland (rural area); in the USA 90.3% insects and other invertebrates, 8.6% plant material and 1.1% gravel [6].
Passer montanus L.	The chicks are fed only by insects. In Romania, during the year, it was observed that 77% weed seeds, 10% cereals and 13% invertebrates feed [6]. Sparrows in France are considered predators of cicadas (*Metcalfa pruinosa* S.) [26].

During the experiment, one of the parameters analyzed was the distance between the nest location and the nearest access road. Another parameter taken into account was the height at which the nest was mounted on the support. An important element was the diameter of the support on which the nest was installed. They were coded according to Table 4.

Table 4. Conventions used for analyzed parameters

Code	Distance	Code	Height	Code	Diameter
d1	1-10 m	i1	0-1 m	s1	0-15 cm
d2	11-20 m	i2	1-2 m	s2	16-20 cm
d3	21-30 m	i3	2-3 m	s3	21-30 cm
d4	31-40 m	i4	3-4 m	s4	over 30 cm
d5	over 40 m	i5	over 4 m	s5	unknown

Statistical analysis

Data statistical analysis was performed with Excel (MS Office) and Quattro programs. For correlation between two data sets Excel statistical functions with a significance level $p < 0.05$ were used [24].

Results and Discussions

The nest's occupation rate according to the monitored parameters was performed for each orchard. In Bucharest orchards (L1), in 2015, 25% of the nests were occupied and 37.5% in 2016 respectively 2017. At Moara Domnească orchards (L3), in the first year, 73% of the nests were occupied and 80% in the following. Windbreaks had an important role. In Istrița orchard (L5), 52% nests were occupied at the beginning and 60% in the following years (Tab. 5). Although at Istrita there is a poplar alignment and on one side a young curtain of acacia they still didn't have the efficiency of Moara Domnească windbreaks. The results were comparable with similar researches regarding occupation rate of artificial nests placed for attracting useful avifauna in orchards. Kim *et al.* [13] registered for their nest types, 28.2% in the first year and 38.5% in the second year occupation rate for great tit (*Parus major*), coal tit (*Parus ater*), varied tit (*Parus varius*), tree sparrow (*Passer montanus*) and yellow-rumped flycatcher (*Ficedula zanthopygia*) species.

Table 5. Nests occupation rate between 2015-2017 (%)

Year	L1	L2	L3
2015	25.0	73.3	52.0
2016	37.5	80.0	64.0
2017	37.5	80.0	64.0
Average	33.3±7.2	77.8±3.8	60.0±6.9

The occupation rate according to nest type was different for the three locations. In Bucharest (L1), the B35 nest type was the most occupied with 100% in the three years monitored. It was a model with an optimal hole and volume for sparrows - the field sparrow and the house sparrow being the most common species here. In Moara Domnească (L2), A, B32, B35 were 100% occupied. In Istrița (L3), B32 and B35 were 100% occupied from the beginning. A type was 50% occupied in the last years. C type registered 0%

occupation rate for all three locations.

For type A nest, the occupancy rate of the target species was quite small because the nests had a hole of 28 mm, the blue tit (*Cyanistes caeruleus* L.) competing with the field sparrow (*Passer montanus* L.). For nest types B32 and B35, the field sparrow was in the first positions, most likely because the habitat was suitable for it. The presence of the great tit and the house sparrow were quite moderate and occupied both nest type B32 and B35 (Figure 2 – 5).

Table 6. Nests occupation rate between 2015-2017 (%) according to nest type

Nest type / year	L1			L3			L5		
	2015	2016	2017	2015	2016	2017	2015	2016	2017
A	0	0	0	75	100	100	0	50	50
B32	0	50	50	100	100	100	100	100	100
B35	100	100	100	100	100	100	100	100	100
C	0	0	0	0	0	0	0	0	0

Figure 2. Blue tit (*Cyanistes caeruleus* L.) at A type nest (updated)

Figure 3. Tree sparrow (*Passer montanus* L.) at B32 type nest

Figure 4. Great tit (*Parus major* L.) at B35 type nest

Figure 5. House sparrow (*Passer domesticus* L.) at B35 type nest

Another tested parameter was the diameter of the support where the nest is placed. In Bucharest (L1), support diameter over 15 cm was best suited. At L2, 16-20 cm (s2) was the preferred size followed by s1 and at L3 location, s1 was the only possible support with an occupation rate of 64%. Comparing the ecosystems, there are no significant differences according to the support diameter on the occupation rate (Table 7).

Table 7. Nests occupation rate between 2015-2017 (%) according to support diameter

Diameter	L1			L3			L5		
	2015	2016	2017	2015	2016	2017	2015	2016	2017
s1	16.67	50	50	75	83.33	83.33	52.00	64.00	64.00
s2	-	-	-	100	100	100	-	-	-
s5	50	50	50	-	-	-	-	-	-

Nest occupation rate according to the height where the nest was placed presented the following results (Tab. 8). At the L1 location, i2 (1-2 m) was preferred, at L3 location, the nests placed at i2 (1-2 m) and i3 (2-3 m) had a 100% occupation rate. At L5 location, due to the specific of the places, most of the nests were placed at 3 m height (i4), being occupied at 69.57% in the last years.

Table 8. Nests occupation rate between 2015-2017 (%) according to the height

Height	L1			L3			L5		
	2015	2016	2017	2015	2016	2017	2015	2016	2017
i2	50	50	50	100	100	100	-	-	-
i3	-	-	-	100	100	100	-	-	-
i4	20	40	40	50	66.67	66.67	56.52	69.57	69.57

The hole orientation is very important when the nests are placed in the orchards. In all the locations, from the first year, East, North and South – East orientated nests were occupied, even with 100% (Table 9).

Table 9. Nests occupation rate between 2015-2017 (%) according to the hole orientation

	L1			**L2**			**L3**		
	2015	**2016**	**2017**	**2015**	**2016**	**2017**	**2015**	**2016**	**2017**
E	100	100	100	100	100	100	60	80	80
N	100	100	100	-	-	-	-	-	-
N-E	-	-	-	100	100	100	-	-	-
N-V	-	-	-	-	50	50	40	40	40
S-V	-	33.33	33.33	-	-	-	75	75	75
S-E	-	-	-	90	90	90	100	100	100
V	-	-	-	-	-	-	40	80	80

The occupation rate according to the distance between nest support and the nearest road or alley was significantly different between locations. In the L1 location, d2 (11-20 m) was preferred. At L3 location, the best occupation rate was at d5 (over 40 m) followed by the rest. At L5 location, d2 registered also the highest values (Table 10).

Table 10. Nests occupation rate between 2015-2017 (%) according to the distance to the nearest road

Distance	L1			L3			L5		
	2015	2016	2017	2015	2016	2017	2015	2016	2017
d1	16.67	33.33	33.33	67.00	67.00	67.00	56.00	56.00	56.00
d2	50	50	50	80	80	80	75	88	88
d3	-	-	-	-	-	-	25	50	50
d5	-	-	-	83	83	83	-	-	-

Significant correlations were observed between occupation rate with nests type A ($y = 0.59x - 21.67$; $R^2 = 0.9959$) and B35($y = 0.37x + 0.83$; $R^2 = 0.9959$); support diameter 0-15 cm (s1) and support height ($y = 1.03x – 19.67$; $R^2 = 0.9959$); support height and occupation rate for i4 ($y = 0.81x – 9.17$; $R^2 = 0.9959$) and i5 ($y = 0.15x + 0.33$; $R^2 = 0.9959$). There were also significant correlations between the nest number placed at d1-d4 distances and occupation rate.

Conclusions

The nesting density and diversity of occupied species were influenced by the orchard habitat but also by the technical parameters of nest construction and position of nests. The highest nests occupation rate was registered in Moara Domnească orchard and the lowest in the Bucharest orchard, due to the windbreaks presence. In time, all the horticultural ecosystems registered an increase in the occupation rate of the artificial nests, the wild birds getting used to them and the new generations grown in artificial nests accepted them more easily.

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