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Ecological value of wood energy plantations in the support of some animal groups

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SUMMARY

Today, some environmental problems have reached such severe proportions that it is no longer enough to recognise them, but environmentally friendly solutions must be used to reduce them. The reduction in the area of natural forests of native species is causing problems in several ways.

This research aimed to highlight how environmental, conservation and economic interests can be reconciled. In addition to natural forests, wood energy plantations are becoming increasingly important. Energy import dependency is a problem for most countries, for which wood energy plantations can partly offer an alternative. Native forests can be protected, and their area increased where possible. Meanwhile, energy plantations can be established in areas with low agricultural productivity.

In this experiment, I studied a plantation of Pedunculate Oak (Quercus robur), a Black Locust (Robinia pseudoacacia) and a Paulownia (Paulownia Shan Tong). I selected burrowing birds and ground-dwelling arthropods as indicator groups. I did this by establishing a nesting colony and soil trapping. I wanted to demonstrate that, in addition to natural forests, wood energy plantations have a role not only in economic terms but also in maintaining certain animal groups. Soil trapping tests were carried out in all three tree plantations.

The obtained results showed that in the Paulownia plantation, the occupancy rate of nest boxes was almost 100%, while in the Black Locust plantation it was around 30%. Among the species that occupied the nesting sites, the Common Starling (Sturnus vulgaris) and the Eurasian Tree Sparrow (Passer montanus) were more abundant, while Great Tit (Parus major) was present in the Black Locust plantation. These are opportunistic species for which nesting opportunity is the most important factor, since their feeding area (in the case of the Common Starling and the Eurasian Tree Sparrow) is not typical of the nesting area. The soil trap investigations show that there are no significant differences in the composition of the arthropod group (beetles, spiders) in the study areas.

Keywords: *Paulownia; wood energy plantation; nest box; soil trap; ecology of wood plantation*

INTRODUCTION

Global climate change is now a fact. Pollution has reached a level that we can no longer ignore, and we must use environmentally friendly and sustainable solutions to reduce it.

Native forests are in serious decline, depriving species of their habitats, and inappropriate forest management (inappropriate species and land use) is causing huge damage to global systems.

Energy import dependency is a problem for most countries, while in others 80% of the energy produced comes from fossil fuels. The main problem is that the CO_2 released contributes to global climate change. The European Union's energy policy aims at security of supply, competitiveness, and sustainability.

As a member of the EU, Hungary should also strive to increase the use of renewable energy sources. Given Hungary's natural resources, biomass production plays an important role among renewable energy sources, and the establishment of energy plantations is one of the obvious options. In Hungary, locust, poplar, and willow are the most planted energy plantations. Less favored areas are suitable for such plantations. A significant proportion of arable land is suitable for fast-growing tree species. Woody stem crops grown for energy can withstand extreme weather conditions (Gyuricza, 2014).

MATERIALS AND METHODS

Paulownia is an extremely fast-growing deciduous tree native to subtropical areas of China, where annual rainfall ranges from 500 to 2000 mm (Jay, 1998). There are several cultivars of the parent species, one of which is the successful hybrid Shan Tong (*Paulownia tomentosa X Paulownia fortunei*), which has the positive characteristics of the parent species, such as rapid growth, high biomass yield, high CO_2 uptake capacity, but with improved frost tolerance. It is popular in agroforestry (Kaymakci and Ayrilmis, 2013; Wang and Shogren, 1992), biomass production (Jiang et al., 1994), soil improvement (Song, 1988), and its fast growth and good yield make it suitable for biofuel production (Tisserat et al., 2013; Clatterbuck & Hodges, 2004; Joshee, 2012).

Locust is suitable and popular for domestic wood energy plantations due to its rapid juvenile growth, low moisture content and good germination. It can be harvested in 4–5 years and has a high calorific value (Csipkés, 2011). Locust requires a warmer growing environment, slightly drier than the noble summer. The best locust plantations can be found in the hornbeam-oak and shrub oak climates (Megyes, 2013).

The Pedunculate Oak is a tree species that grows to a height of 40 m but can also be found up to 50 m (OEE, 2016). The average annual rainfall in its habitats is 450-800 mm. In areas with low rainfall, it requires extra water from the soil. Of all our native tree species, the Pedunculate Oak has the highest number of insect species associated with it. There are around 600 species that feed on living tissue (herbivores) and over 200 species that help to decompose dead wood (saproxylophages). A single large specimen can support up to 200–300 insect species simultaneously.

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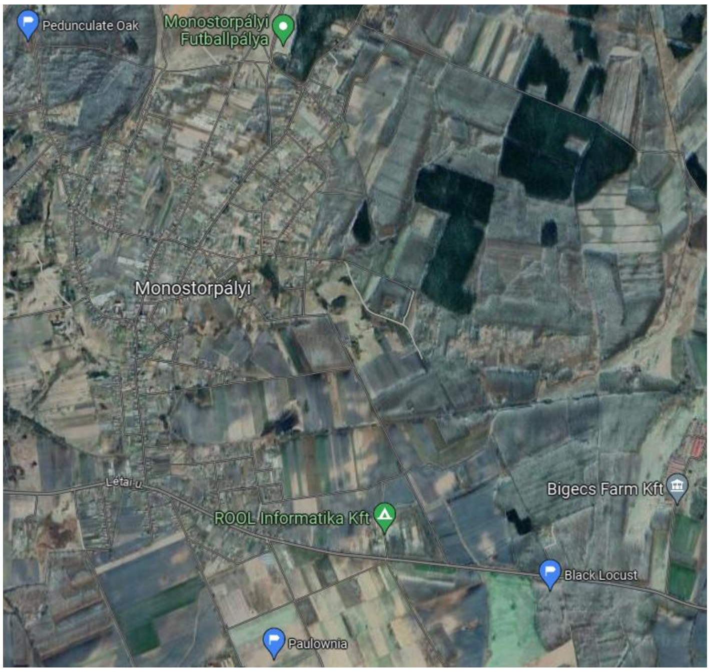
More than 40% of its herbivorous insects are found only on oak.

The research was carried out in Paulownia and Black Locust plantations and in oak stand (*Figure 1*). The Paulownia plantation was planted by the Municipality of Monostorpályi in 2014 on 1.8 ha with 1580 seedlings. Directly adjacent to the plantation, 2.1 ha were planted with 2000 seedlings one year apart. In both cases, the plantation was established in a 4x4 grid for timber production, so that the stand is harvested when it is only 8 years old (Szabó and Juhász, 2018). The plantation is well accessible, located on sandy soils, has no significant undergrowth and is less closed than the Black Locust.

The 7–8-year-old Black Locust stand (forest unit 70/B) covers 5.35 ha on sandy soils, also owned by the municipality. The area was selected with the aim of planting trees of the same height.

The stand of Pedunculate Oak in forest block 24/B covers 1.1 ha.

Figure 1. **The study sites**



The nest box colonies were established on 24 February 2018 in a Paulownia (*Paulownia Shan Tong*) and a Black Locust (*Robinia pseudoacacia*) plantation in Monostorpályi. 10 type "B" and 10 type "D" nest boxes were placed in each plantation. The number of nest boxes per type ranged from 1 to 20. The following data were recorded at the time of placement: date, type and number of nest boxes, orientation, height above ground and coordinates.

Once the nest box colonies were established, I began regular inspections. Initially, I visited the areas every 2–3 weeks, and after the first broods were detected, I visited the areas weekly until the end of the breeding season. The inspections were carried out using a ladder and an endoscope. On each occasion I documented the sightings with photographs and descriptions. Later I also recorded the data on a computer.

The results were characterized by the following reproductive indicators (Van Balen & Potting, 1990):

- hatching success: proportion of eggs hatched
- fledging success: proportion of young fledged
- breeding success: the product of hatching and fledging success

At the end of the breeding season, I thoroughly cleaned all the nest boxes to remove parasites and give the birds a chance to move in for the next season.

The traps were based on the Barber soil traps (Kádár et al., 2006). The soil traps were set monthly (April to July) with a two-day exposure. In all cases, trapped individuals were released when the traps were emptied, and no killing agent was used.

I dug ten to ten pots per row (1–1.5 m apart) in three rows per planting so that the pot opening was flush with the soil surface. In this way, I used a total of 90 traps in the three plots (Black Locust, Paulownia, Pedunculate Oak). The trapped individuals were identified to family and species level.

The experiment was carried out during the breeding season of 2018.

RESULTS AND DISCUSSION

Results of the nest box colonies

The first nesting starts were observed on 22 April. By the time of the next inspection on 29 April, nesting had started in all the "B" boxes in the Paulownia plantation, with 9 out of 10 nests breeding, except for

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the empty Eurasian Tree Sparrow (*Passer montanus*) nest in “B11”.

By 12 May I had discovered 10–12 nestlings in nest boxes “B5” and “B7” in the Black Locust and 11 nestlings in nest box “D3”. All were Great Tits (*Parus major*). In the Paulownia plantation, all nest boxes “D” were occupied by Common Starlings (*Sturnus vulgaris*), and all were laying eggs, with the number of eggs ranging from 3 to 6.

On 25 May we ringed the nestlings with the help of my supervisor Dr Lajos Juhász and PhD student Sámuel Varga. We ringed a total of 38 Common Starlings, 6 Eurasian Tree Sparrows and 11 Great Tits from the nest boxes. On the day of ringing, we found a nest of Northern Wheatear (*Oenanthe oenanthe*) on the ground in the Paulownia plantation and ringed the nestling found in the nest. This is a protected species, and its population has been declining in recent years, so it is particularly positive that this species has found the Paulownia plantation suitable for nesting.

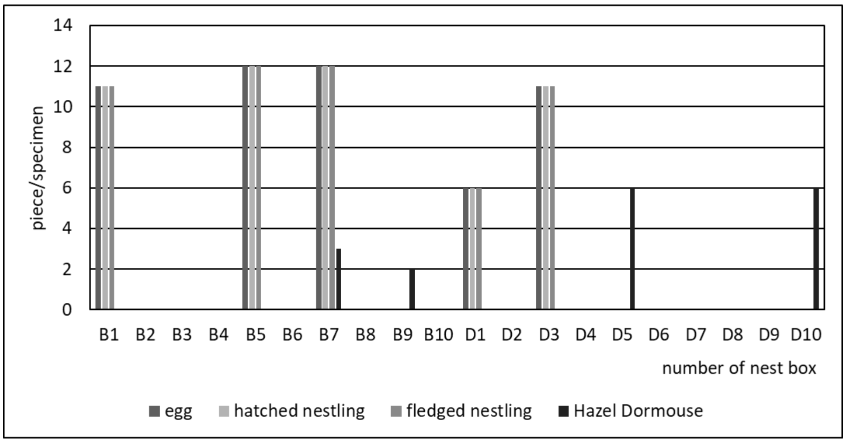
In June, Hazel Dormouse (*Muscardinus avellanarius*) occupied nest boxes “B9”, “D5” and “D10” in the Black Locust, and later nest box “B7” where a Great Tit used to nest. In total, 4 nest boxes were occupied by Hazel Dormouse.

In Paulownia, Eurasian Tree Sparrows also started to second brood in June in 5 nest boxes “B”. Boxes “D” remained empty after the starlings left.

Results of the nest box colonies in the black locust plantation

Out of 20 nest boxes, I observed nest initiation in six and actual breeding in five. In addition, four nest boxes were occupied by Hazel Dormouse. I recorded 30% occupancy in nest box “B” and 20% occupancy in nest box “D”. All five nest boxes were occupied by Great Tits. I did not observe any second breeding in the Black Locust plantation. The total number of eggs laid by the Great Tits was 52, of which all 52 hatched successfully and the nestlings fledged (*Figure 2*).

Figure 2. **Breeding season data (Black Locust, 2018)**



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Results of the nest box colonies in the Paulownia plantation

In the Paulownia plantation, nesting was observed in all 20 nest boxes, with 19 nest boxes actually breeding, 95% occupancy. The Eurasian Tree Sparrows bred in the “B” type nest boxes and the Common Starlings in the “D” type nest boxes. In the first breeding season I counted 93 eggs, of which 84 hatched and the same number fledged. Second broods started in early June and the last nestlings fledged in mid-July. Of the 10 “B” nest boxes where sparrows nested, 5 were occupied by sparrows and “D” nest boxes occupied by starlings, had no second broods. From the 5 “B” nest boxes I counted a total of 26 eggs, of which 25 hatched and all 25 fledged. In total (first and second brood) I recorded 119 eggs from the Paulownia plantation, of which 109 hatched and fledged from the nest boxes (*Figure 3*).

Comparison of the results of the two nest colonies

In the Black Locust plantation, “B” nest boxes had a 30% occupancy rate and “D” nest boxes had a 20% occupancy rate. In the Paulownia plantation, this percentage increased to 90% and 100% (*Figure 4*). The differences in occupancy can be explained by the fact that the opportunistic species breeding in the Paulownia (sparrows and starlings) are not territorial birds, they do not feed on the nesting site and for them the nesting opportunity is the priority. In contrast, the Great Tit is a territorial bird, which explains the lower percentage of net box occupancy in the Black Locust.

No artificial nest box colony had previously been established in the study areas, and the sudden appearance of nesting opportunities attracted birds from the surrounding area to the Paulownia plantation. Only agricultural areas were recorded around the Paulownia plantation. In contrast, the area around the Black Locust plantation has more nesting opportunities, with several stands of Black Locust and other trees surrounding the area. The overall results are shown in *Figure 5*.

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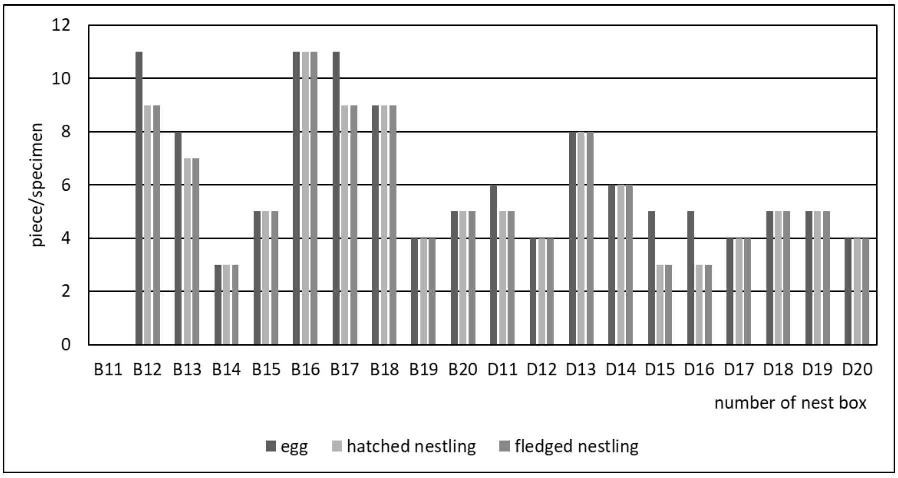
Figure 3. **Breeding season data (Paulownia, 2018)**



Source: own editing, 2018

Figure 4. **Occupancy by plantation**

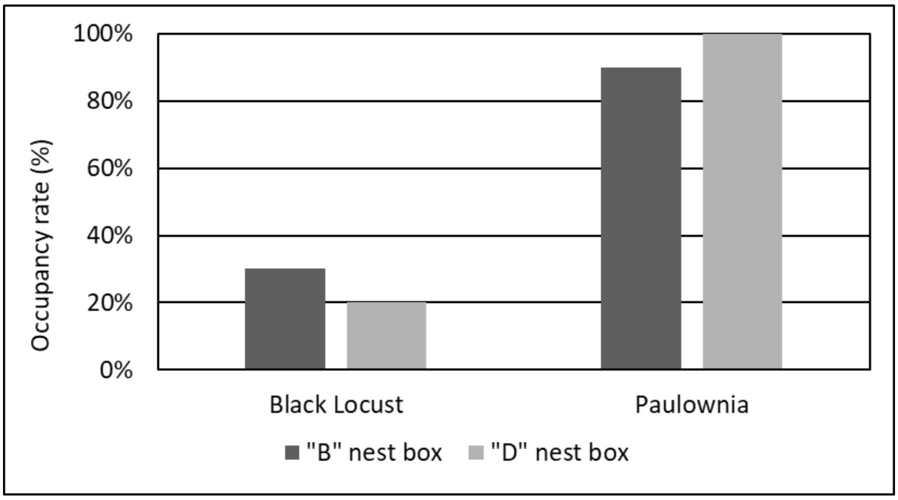


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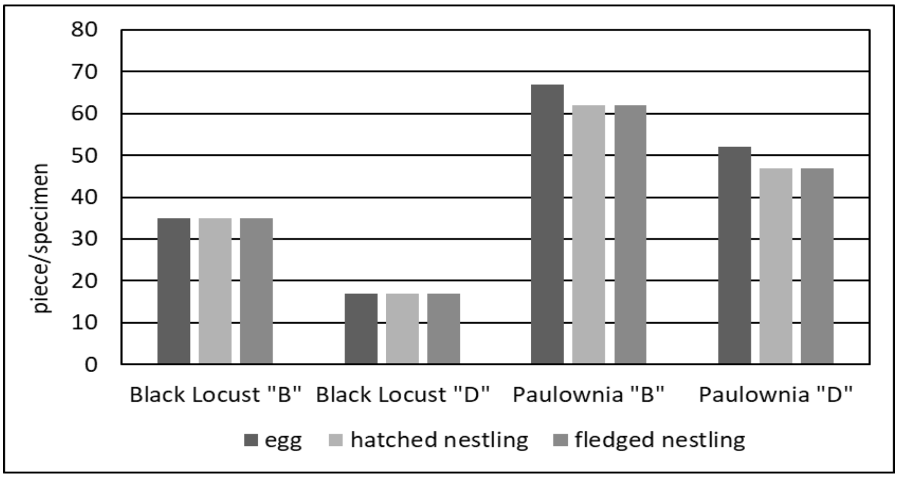
Figure 5. **Overall results for the 2018 breeding season**



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Results of soil trapping

I found no significant differences in the soil arthropod composition of the three study areas. The species captured are summarized in *Table 1*. Of particular note was the capture of two specimens of a highly protected species (*Carabus hungaricus*).

Table 1. **Results of soil trapping**

Plantation	Family/Species name	Specimen
Black Locust	*Lycosidae*	>20
Black Locust	*Carabidae*	9
Black Locust	*Formica sp*	>30
Black Locust	*Megaphyllum unilineatum*	13
Black Locust	*Pyrrhocoris apterus*	5
Black Locust	*Carabus hungaricus*	2
Paulownia	*Lycosidae*	14
Paulownia	*Carabidae*	8
Paulownia	*Formica sp*	>30
Paulownia	*Buprestidae*	4
Pedunculate Oak	*Lycosidae*	>30
Pedunculate Oak	*Carabidae*	10
Pedunculate Oak	*Formica sp*	>30
Pedunculate Oak	*Megaphyllum unilineatum*	5

Source: own editing, 2018

CONCLUSIONS

Our research was carried out in areas managed by the Municipality of Monostorpályi, with the aim of demonstrating the multifunctional role of energy tree plantations by establishing a nesting colony and trapping ground-dwelling arthropods.

The 2018 results show that by establishing a nest box colony, it is possible to successfully colonize different bird species not only in natural, semi-natural forests, but also in energy tree plantations. Energy tree plantations would remove the pressure of forest management from a significant proportion of natural and semi-natural forests. There would be an opportunity to increase their area and maintain them in their natural state, while nesting colonies in wood energy plantations could also contribute to species conservation. No differences were found in the species composition of ground-dwelling arthropods, with almost identical species being captured in relatively low numbers at all sites. However, this poor soil fauna can be used to colonize burrowing bird species.

We can say that the experiment has produced positive results on the complex, economic and conservation importance of Paulownia as an energy tree plantation. In this respect, I would recommend this level of coordination between conservation and management. On the other hand, I would recommend expanding the areas, including research, so that a nest box colony could be established in a Pedunculate Oak. A stand of pedunculate oak would be representative of the native forests in the research, so that forests/plantations of different qualities would be represented.

As a result of global climate change, different habitats are all changing. As a result, the biomass of the habitat is also changing. Some species are able to adapt, while others have to conquer new habitats. Species in energy tree plantations will respond to environmental change in a similar way to their counterparts in natural forests. Based on our observations so far, there is no difference in their behavior.

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