

Biological pest control in the forest by birds

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Pest control means reducing the effect of, moderating or controlling a pest population. Various organisms can be pests, whether plants or animals (vertebrates and invertebrates). The damage can affect organisms in a variety of habitats, such as agricultural areas or natural forests. This short survey will focus on birds and on insects that damage forest trees.

Most common pesticides are chemical compounds, which include chemicals and toxins that can significantly reduce the pest population. With time, many pests, particularly among arthropods, developed resistance to pesticides. To overcome this difficulty, the almost automatic response is to use higher concentrations and compounds that are more toxic. This usually succeeds in controlling the pest population for a short while, but at the same time increases the damage to non-target species, many of which are natural enemies of the pests. This in turn, damages the habitat further and creates health hazards in the environment, which has led to a search for alternatives to chemical pest control.

From the second half of the 20th century pest management methods based on environmentally friendly chemical compounds or biological methods. Biological pest control uses biological methods based on the pest organism's natural history to manage their populations. It uses natural enemies of the pest organism for the benefit of the environment, agriculture and people, taking care not to disturb the existing ecosystem. This review emphasizes the role of birds in biological pest control and as a natural enemy of insect pests in the forest.

Forests are the permanent natural habitat of local birds, as well as being stopovers for migrating birds, and habitats for species that breed, overwinter or spend the summer in Israel. The interactions between birds and forests are complex. The birds are a significant part of the factors that ensure the health and proper development of forests, while the forest environment provides them with food and protection. Some bird species feed on arthropods and worms, and others on fruit and seeds, helping to disperse quite a few plant species. Moreover, birds of prey in the forest feed on other birds, rodents, reptiles and even arthropods. The bird groups found in forests are varied and can be classified

according to various parameters. The birds feeding on forest pests will be classified here by their foraging strategies, the life-stage of the pests they feed on and hunting methods. Barbaro and Battisti (2011) published a list of species and the function of different bird species in the Mediterranean coniferous forest ecosystems, stressing the predators (*Thaumetopoea pityocampa*).

The major predators of the Pine Processionary in Israeli forests are the Great Spotted Cuckoo (*Clamator glandarius*), and, to a lesser extent the Great Tit (*Parus major*). Great Tits usually forage on the young Pine Processionary caterpillars before they grow their stinging hairs, but have difficulty preying on late-stage large hairy larvae, on which Great Spotted Cuckoos prey during their spring processions. Other bird species, such as jays (*Garrulus* spp.) catch the caterpillars when they leave their nests on pupation processions when they are exposed on tree trunks or on the soil surface. Mature moths, such as those of the Pine Processionary, that fly in the evening and night hours, are hunted thanks to identification of their silhouettes in the dark. They are hunted mainly in forest clearings and on forest edges, which allows them to be seen more easily than in the forest, even in low concentrations, but this has not been checked in Israel yet. The main predators of the flying moths are nightjars (*Caprimulgus* spp.), which are active at night, but only appear in Israeli forests during migration, and in small numbers. There is intensive activity of insectivorous bats in the forest that forage on nocturnal flying insects. The Eurasian Hoopoe (*Upupa epops*) characteristically pulls insects, such as larvae and pupae of beetles and moths, from the ground, using its well-developed sense of smell and long curved bill that can pull out arthropods from the ground. Another method of sensing larvae that burrow in branches and trunks relies on echoes from beak knocks, like a sonar system. If there is a sign that there are larvae in the tree trunk, it will pierce the trunk and the larva will be pulled out. This method is used mainly by woodpeckers. The Syrian Woodpecker (*Dendrocopos syriacus*), which is considered an effective controller of wood boring beetles, such as *Phoracantha* species (Mendel et al., 1984) and bark beetles, such as *Orthotomicus erosus* (Mendel, 1985), and inhibiting irruptions of pests in these groups.

Forest pests are characteristically very varied ecologically regarding where they develop and on what they feed, as well as the degree of exposure to predation by birds. Leaf miners, whose larvae live within leaf tissues, are almost not vulnerable to predation by birds, but mainly to parasitism by parasitic wasps. Moth larvae that feed on the leaf surface, such as silk

moths (*Bombyx*) and processionary moths (*Thaumetopoea*) are susceptible to predation by birds.

Over the years, many studies have been conducted on the effect of birds as natural pest control agents. Bird populations significantly reduce the larva population in the forest understory (Holmes et al., 1979). Well-developed patches of vegetation understory that cover the forest floor are a significant factor in the success of birds in a forest habitat (Dagan, 2020; Boesing et al., 2017). A study that focused on a bird population in an apple orchard in Holland examined whether the presence of birds in the orchard can replace pesticide use (Mols and Visser, 2007). The study replicated many other studies conducted in various forests to test the principle according to which the success of many bird species is significantly influenced by the abundance of nesting sites. Nest boxes were set up in the orchard to encourage Great Tit nesting. The results indicated that in orchards with nest boxes the damage to fruit was reduced by 50% compared to control plots, which did not have nest boxes. The nest boxes attract birds to nest and breed by providing a suitable and safe environment. Consequently, the bird population and biodiversity can increase in agricultural areas and the use of pesticides will be significantly reduced. A similar study conducted in Austria showed a significant reduction in pest populations in apple orchards, upon the arrival of birds considered natural pest-controllers in the region (García et al., 2018). Beyond the ecological-environmental aspect there is also economic gain for the farmers, for, as the bird population grows, the pest population declines. The birds move in the area between the forest and the orchards, and their success in one habitat, has a beneficial effect on neighboring habitats. Climate change has been ongoing for tens of years and global warming can cause flooding on one hand, and extreme drought on the other. These changes can negatively affect forest-dwelling birds and biodiversity. Both the density and composition of bird populations will be disturbed by extreme habitat change. We can already see a decline in bird populations, resulting, among other reasons, from urbanization at the expense of forest areas (forest clearing). Therefore, the conclusion is that climate change is not the sole factor causing bird population decline, but is joined by other factors as well. In either case the forest ecosystem will change (Virkkala, 2016), and therefore preserving bird populations in forests is very important. Various activities have been conducted to sustain bird populations in Israeli forests, such as planting tree species that support bird diversity, putting up nest boxes, as in the project to increase the number of Great Tits in KKL-JNF forests, such as the

project in the Ben Shemen Forest (Green Window, 2015). The KKL-JNF Wings network works to connect birds to people, and conducts bird ringing to track and monitor birds in KKL-JNF forests and open spaces it manages. KKL-JNF also conducts a variety of educational workshops to explain the importance of the subject and to increase awareness of the forest and the importance of the birds inhabiting it, such as the Flying over the Forest project (e-Yarok, 2015), the KKL-JNF Birdathon (KKL-JNF website, 2020) and KKL-JNF birdwatching clubs.

To conclude, there is extensive evidence relating to the importance of birds in the forest, both owing to the reduction of forest pest populations and thanks to their contribution to the ecosystem. With their help, it is possible to avoid using pesticides and they contribute to preserving the natural ecological balance in the forest. Preserving them in general, and in forests in particular is very important. This can be done by raising public awareness to the importance of the issue, putting up nest boxes, drinking points, preserving the forest understory and preventing hunting.

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European Cuckoo near a nest of the Pine Processionary. The larvae serve as courtship gifts. 2016.
Photo: Efrat Atalen, the Israel National Bird Database



Great Tit.
Photo: Yaron Shafrir



Bark beetle damage to Turkish Pines in
the Eshtaol Forest.
Photo: Zvika Mendel