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# Endosymbionts: Turn into a Force for Good in Agriculture Pest Management

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**SUMMARY**

In insects, endosymbionts can play a crucial role in nutrition, reproduction and resistance to insecticides or climatic variations, as well as little impact upon the ability to transmit viruses and susceptibility to predators. This mutualistic, obligate interaction gives an opportunity to use them in the benefit of our perception. Current knowledge on novel technologies can be employed to design and implement measures for the effective control of agricultural insect pests and vectors of diseases. Analyzing this information will be particularly helpful for devising endosymbiont-based strategies to intervene in insect immunity or for the efficient management of noxious insects in the field.

## INTRODUCTION

Endosymbionts contributes greater role in making the insect as dominant organisms on ecosystem. Majority of insects has symbiotic relationship with the bacteria that live within the specialized cells (bacteriocytes) in a symbiotic relationship. Endosymbionts co-evolve within their hosts over thousands (or in some cases, millions) of years and become integral to many different survival processes. In fact, some of the earliest known examples of endosymbiosis are thought to have supported the evolution of complex organisms. Symbiosis is any type of a close and long-term biological interaction between two different biological organisms, be it mutualistic, commensalistic or parasitic. The organisms, each termed a symbiont, must be of different species.

The endosymbiotic of insects are prevalent and categorized into two groups:

- Primary symbionts (P-symbionts) and
- Secondary symbionts (S-symbionts).

The P-symbionts are obligatory and mutualistic to the host as they play prominent role in insect nutritional ecology by providing essential nutrients that are limited or lacking in the diet or aid in digestion and detoxification of food. The P-symbionts typically housed in specialized host organs termed bacteriocytes and relayed within transovarial transmission from mothers to offspring with perfect fidelity. In contrast to primary symbionts, S-symbionts may not be required for host survival and the association between host and symbiont is generally not very intimate and inhabit a variety tissues including primary bacteriocytes, secondary bacteriocytes and sheath cells, salivary glands, Malpighian tubules and reproductive organs. The roles of more and more S-symbionts to their hosts have been unveiled in recent years, and these symbionts may exert diverse effects on their host, such as defense against natural enemies by enhancing host resistance, mediate thermal tolerance of their hosts, to facilitate use of novel hosts and so on. Most of these S-secondary symbionts with the primary symbiont inside the bacteriocytes, however, some S-symbionts localize outside the bacteriocytes and suffer occasional horizontal transmission, occur at low titers in hosts within and between species. Symbiotic transmission in insects occurs through different modes which includes

- Coprophagy
- Trophallaxis,
- Transmission Through Shared Environment,
- Transovarial Transmission
- Egg Smearing
- Capsule Transmission

### Role of Endosymbionts in Insects

A wide range overview of the diverse roles of endosymbionts on insect host has been discussed. Variation in resistance toward parasites and pathogens has been shown to be regulated by the secondary symbionts in a number of insects and an understanding of such mechanism is steadily increasing. Oliver *et al*. (2003) showed that both *H. defensa* and *S. symbiotica* could increase aphid host resistance against *A. ervi*, a parasitoid wasp that commonly preys on aphids. The most striking ecological character conferred to insects by endosymbionts is their role in supplying essential nutrients to their hosts. Endosymbionts can sharply influence population dynamics via various ways, such as cytoplasmic incompatibility (CI), parthenogenesis induction (PI), feminization, and male killing. Kikuchi *et al*. (2012) reported that a bacterium in the genus *Burkholderia* imparts protection against organophosphorous pesticides in stinkbugs. Some of the symbionts modify the host behavior, which is adaptive to the parasites or predators.

**Potential Application of Endosymbionts in Agriculture**

As such, numerous studies have examined the importance of the associated microorganisms to host fitness and feeding ecology in an effort to manipulate these partnerships and render insect pests more vulnerable to broad-scale measures of population control by targeting the bacterial symbionts.

**Incompatible Insect Technique (IIT)**

This procedure is analogous to the sterile insect technique (SIT). Both methods rely on the mass release of sexually active but incompatible males into the wild that will mate with virgin females resulting in non-viable eggs. Release of infected males leads to a lower female fertility and can ultimately lead to the suppression of the population given enough time and constant release of incompatible males (Bourtzis *et al*. 2014).

**Insect symbionts as probiotics**

Several studies have shown that sterile mass-reared Mediterranean fruit flies subjected to SIT are less successful than wild males at competing for wild females. In addition to this, irradiation of males for SIT also results in an altered gut microbiota as compared to nonirradiated males. Ben *et al* (2010) showed that supplementation of the diet with *Klebsiella oxytoca* as probiotics rescues male competitiveness by shortening their mating latency. Therefore, further examination of insect symbionts as probiotics could be valuable in the efforts to develop more successful SIT applications.

**Paratransgenesis**

A related strategy gaining traction in recent years is to genetically modify microbes to express desired effects in insects, known as paratransgenesis (Caragata and Walker, 2012). Instead of transforming the insects (i.e., transgenesis), paratransgenesis bypasses the disadvantages of fitness cost associated with introducing a transgene into the insects and transgene instability in insect genomes. This approach is particularly suited for microbes that can be cultured, transformed, and readily reintroduced into the insect hosts. More recently, a study has integrated paratransgenesis with RNA interference (RNAi) technology to control *Rhodnius prolixus*. Oral administration of an *Escherichia coli* strain HT115 or *R. rhodnii* engineered to express dsRNA targeting the antioxidant genes-heme-binding protein (RHBP) and catalase (CAT) genes in *R. prolixus* was shown to trigger systemic RNAi to silence these genes, resulting in poor development of nymphs and reduced fecundity of females.

**Bacterial odours as attractants**

Tephritidae is a large family that includes several fruit and vegetable pests. These organisms usually harbor a variegated bacterial community in their digestive systems. Symbiotic associations of bacteria and fruit flies have been well-studied in the genera *Anastrepha*, *Bactrocera*, *Ceratitis*, and *Rhagoletis*. The function of symbiotic bacteria provides a promising strategy for the biological control of insect pests. Gut bacteria can be used for controlling fruit fly through many ways, including attracting as odors, enhancing the success of sterile insect technique, declining the pesticide resistance, mass rearing of parasitoids and so on. New technology and recent research improved our knowledge of the gut bacteria diversity and function, which increased their potential for pest management.

**CONCLUSION**

It is well known that endosymbionts have an every part in insect host including from its biology to even offering resistance to insecticides surprisingly. The obligate reliance of many insects on their microbial partners provides a potential target for the biological control of devastating agricultural pests, management is quite easy, simple and direct effect could also be observed. Endosymbionts of insects are new tools which can use as one of the management approach for suppressing the several insect pests which are challenging the farmer's life. Culturing of these symbionts is highly difficult, however can be overcome through the novel biotechnological approaches. A thorough understanding of these interactions will lead to a better appreciation of these astonishing symbioses and may provide a new way to look for novel approaches to pest management. With the available, accurate novel techniques, it is possible to manipulate their obligate symbiotic interactions by thorough understanding to solve complex pest problems. Using symbionts as management approach accounts as bio control tool, hence they are environmentally safe, non-toxic to non-target organism and compatible. The strength of insects having symbiotic interaction with microbes can be used as powerful weapon that can cause widespread destruction of the large number of population, deter, threaten, harm, inflict some physical injuries or kill.

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