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Invisible Heroes in Insect Gastrointestinal Tract

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SUMMARY

Insects are dominant arthropods in animal kingdom having high richness and diversity in the world covering wide range of habitats from the decomposing pits to fresh waters. They have evolved gradually to feed on diverse foods which was facilitated by the presence of microbial endosymbionts especially bacteria in the gut lumen. Recent studies have elucidated that these microbes not only help their host to digest their food and provide nutrition, but also involved in various other beneficial services such as defence against other biotic organisms like predators, parasites and parasitioids, as immunomodulators, as detoxification catalysts, in inter and intra-specific communication and provide resistance against abiotic factors. These added advantages have made them invisible heroes in insects for their resistance development, evolution and dominance in the environment.

INTRODUCTION

Fungi, bacteria etc., are the microscopic organisms that are ubiquitous in nature. They have been associated with other organisms either beneficial or destructive, from ages, be it plants, invertebrates or vertebrates. For example, the Lactic Acid Bacteria present in human body helps in better digestion and they also provide essential nutrients required in turn taking shelter in human body, establishing a symbiotic relationship. Similarly, in Class Insecta, studies from ages have elucidated that insects could feed on diversified food due to the presence of their invisible symbiotic partners *i.e.*, microbes in their gut lumen. Diverse taxa of bacteria reside in specialised organs inside the insect body called mycetocytes. Hence, they are termed as microbial endosymbionts or gut microbial community. Mostly co-evolved bacteria with host play an essential role in the host nutrition and metabolic activities.

Classification:

In a broader classification, endosymbionts are of two types, 1.Obligateendosymbionts - also termed primary endosymbiont, highly fidelity partner, which has co-evolved with its host, acquired from the preceding generation, wide spread across all the related species, reduced genome, and unculturable outside host. eg.Aphid and its bacterial symbiont, *Buchnera aphidicola*. 2.Facultative endosymbionts - also termed secondary endosymbiont, non-fidelity partner, not co-evolved, acquired from the environment, not constant among the related species, and could be cultured outside the host.eg. *Wolbachia pipientis*, *Spiroplasma* species, and *Hamiltonella defensa*.

Transmission routes:

The gut microbial community in an insect is structured based on its diet and stability of the gut microbiota among the species is dependent on transmission. Transmission of gut community between host individuals of same species is very much essential for evolution of intimate associations. But one major obstacle is lack of dependable transmission routes. Social insects such as termites, ants, bees etc., provide opportunities for transmission of their most distinctive and consistent gut endosymbionts within the colony members. In such a context, there are majorly 2 transmission routes, vertical and horizontal transmission. Vertical transmission involves coprophagy, oral or anal trophallaxis and maternal smearing of endosymbionts on the egg shell for transmission to offspring. Horizontal transmission involves acquiring the required gut community from the surrounding feeding environment.

Influence of bacteria on host biology:

It's an already established fact that micro-organisms inside insects help in nutrition then why are they referred to invisible heroes? It is because this gut microbiota also influences host biology in various ways.

1. **Protection against natural enemies of host**: For instance, being selfish about its own survival and transmission, *Hamiltonella defensa* protects it host from parasitoid wasp larvae by using a bacteriophage-encoded mechanism, enabling protection against host natural enemies. Similarly, protection against RNA viruses is provided by *Wolbachia pipientis* in *Drosophila* sp.
2. **Act as immunomodulators:** Insects have their own self immune system *i.e.*, cellular and humoral responses to protect the health. These inherited microbes also act as additional exogenous immune system. Antimicrobial peptide production and melanisation are a part of humoral immune response of insects. In honeybee, *Apis mellifera*, one gut symbiont, *Frischella perrara* was observed to cause strong immune activation by melanisation in the epithelial surface of pylorus.
3. **Reproductive manipulators:** Many strains of selfish microbes such as *Wolbachia*, *Rickettsia*, *Spiroplasma*, *Cardinium*, and *Arsenophonus* interfere actively with host reproduction by amplifying sex ratio through parthenogenesis, feminization, male killing, and cytoplasmic incompatibility and thereby help increase female host fitness so as to promote their own spread within a host population.
4. **Detoxification of chemicals:** Owing to the increasing knowledge and accessibility to genomic analysis in conjunction with few other analyses, it has now been revealed that specific gut microbiota significantly gifted insect's resistance against plant secondary metabolites and pesticides.

a. Plant compounds: Diamond back moth, *Plutella xylostella*, possessing *Enterobacter asburiae* and *Enterobacter cloacae* in the gut provided resistance against host phenols as the bacterial genes for phenol degradation were elucidated in the metagenomic studies.

b. Insecticides: Pesticide degrading symbiont, *Citrobacter* sp. found in the gut of Oriental fruit fly, *Bactrocera dorsalis* provided resistance against trichlorphon.

5. **Resistance abiotic factors:**

a. Temperature: Insects metabolism and development is greatly dependent on temperature and extremity in temperatures threatens its survivability and reproduction. Under heat stress, obligate endosymbiont, *Buchnera* is usually lost which affects pea aphid fertility and developmental period. But, presence of a secondary symbiont, *Serratia symbiotica*, has compensated *Buchnera* absence by releasing certain protective metabolites that help in increasing host fitness.

b. Desiccation: Certain stored grain pests live in low ambient humidity conditions enhancing the chances of water loss or desiccation. One technique to tackle this situation is improving the insect cuticle that provides primary evaporation barrier. This requires presence of an amino acid, tyrosine which acts as precursor for cuticle strengthening. Studies have unravelled that distinct microbiota in stored grain pest taxa provide precursors for the cuticle synthesis.

c. Heavy metals: Heavy metals naturally occur in contaminated soils which enter the food web through plants and other animals. These heavy metals are either detoxified or sequestrated by the gut microbiota. For example, selenate detoxification genes were found in microbes, *Snodgrassella alvi* and *Lactobacillus bombicola* associated with two *in vitro* selenate resistant bumble bees.

6. **Communication:** Long distance communication in insects is favoured by pheromones. Studies unfolded that even microbial endosymbionts also modulate host's mate choice decisions, pheromone production, aggregation and nest mate recognition. In female earworm moths infected with virus Hz-2v, it was noticed that sex pheromone production was increased to five to seven fold and even doubled the chances of attraction of healthy males than infected males.

CONCLUSION

Few gut microbiotas have co-evolved with their host to protect its host whereas certain microbiota benefits their host while utilising them for their selfish motives. However, be it positive or negative benefits, microbial interactions with insects might be unrecognised and widespread until detected. Recent genomic analysis has provided a scope to reveal these fascinating heroes as extended helpers to insects. These microbial partners have therefore played a pivotal role in adaptation to heterogeneous environments and thereby evolution of insects.

REFERENCES

Douglas, A. E. (2015). Multiorganismal insects: diversity and function of resident microorganisms. *Annu. Rev. Entomol.*, 60: 17-34.

Engel, P. and Moran, N. A. (2013). The gut microbiota of insects – diversity in structure and function. *FEMS Microbiol. Rev.*, 37: 699-735.

Engl, T. and Kaltenpoth, M. (2018). Influence of microbial symbionts on insect pheromones. *Nat. Prod. Rep.*, 35: 386-397.