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专论与综述

寄生性膜翅目昆虫毒素的生态机制及应用前景

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摘要 膜翅目昆虫利用高效的毒素进行自身防卫、攻击猎物和调节寄主生长发育。从寄生性膜翅目昆虫毒素的产生、类别、组份、性质、毒素的生态功能以及毒素的作用机制等方面综述了寄生性膜翅目昆虫毒素的研究概况。膜翅目的泌毒器官起源于外胚层，由生殖系统的附腺演化而来。毒液由成熟雌蜂的毒腺或酸腺所分泌，并贮于毒囊中。昆虫毒素是成分复杂的混合物，已知膜翅目昆虫毒素中含有烃类、醇类、醛类、酮类、羧酸类、酯类、内酯类、酶类等多种化合物。寄生性膜翅目昆虫的毒素在提高自身适应能力方面的作用是巨大的，如通过麻痹寄主提高产卵成功的概率、通过抑制寄主的生长发育和免疫功能提高后代的存活率、通过干扰寄主的生理活动改善后代的营养需求等。体外寄生蜂毒素可造成寄主幼虫停止发育、永久性的麻痹甚至死亡，这类毒素常为抑性的、广谱的，一般作用于中枢神经系统或神经-肌肉连接点。而体内寄生蜂多为容性寄生，其毒液中含有多分DNA病毒（PDV），PDV通过抑制寄主免疫系统而巧妙地调节寄主的生理活动和发育，影响寄主的正常变态，大多数种类直到寄主结茧或做好蛹室时才将其杀死在安全的场所，从而使寄生蜂后代能够顺利完成发育。容性寄生蜂毒素对PDV的功能具有显著的增效或协同作用，而不会使寄主产生永久性麻痹。PDV对寄生蜂本身是非致病性的，与寄生蜂是一种分子水平上的共生或依生关系。寄生性膜翅目昆虫毒素显示了良好的应用前景，特别是在开发人类医药和特异性生物杀虫剂方面。但分离和纯化毒液中各个活性成分是应用的前提，也是生化和毒理研究的需要。

关键词 昆虫毒素；生态机制；膜翅目昆虫；寄生蜂；应用前景

分类号 Q965；Q968.1

Ecological mechanisms and prospects for utilization of toxins from parasitic hymenopteran

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Abstract The parasiticwasps in the order Hymenoptera defend themselves, attack preys, and regulate hosts using toxins that are effective in small quantities. Advances in the research of parasitic hymenopteran toxins are summarized in terms of the production, categories, components, properties, ecological functions and mechanisms.

The glands that produce venom are derived from ectoderm tissue and evolved from the accessory glands of reproductive system. Venoms are excreted by the poison gland or acid gland of mature female wasps and stored in reservoir. The components of insect toxins are very complicated, and hymenopteran venoms contain alkanes, alcohols, aldehydes, ketones, organic acids, esters, lactones, proteins, polypeptides, enzymes, amines, and other compounds.

Toxins of parasitic hymenoptera play an important adaptive role. They can increase the probability of successful oviposition by paralyzing the host, enhance offspring survival by inhibiting host development and immunoreaction, and improve the nutrition available for their progeny by disturbing the host physiological response. Venoms of the ectoparasitoids often lead to arrested development, permanent paralysis and even death of host. These toxins are usually broad-spectrum and act on the central nervous system or at the neuro-muscular junction. While most endoparasitoids are koinobionts, these parasitoids can regulate host physiology and development, but no longer paralyze the host permanently. And they usually kill host in the concealed but safe position after host cocooned or built its pupal cell. Venoms of koinobiont parasitoids can contain polydnaviruses (PD

V) that regulate host growth and development by inhibiting the immune system and influencing hos t metamorphosis. Thus, the PDVs are commensal and mutualistic, but non-pathogenic, with parasi toids at molecular level.
Promising prospects for the utilization of insect toxins, especially as medicines or specific bioinsect icides, are discussed. Because insect toxins are mixtures of complex ingredients and are usually pr oduced in small quantities, isolation and purifications of all the ingredients with bioactivity is neede d for biochemical and toxicological research and for practical application.

Key words Insect toxins _ ecological mechanisms _ hymenopteran _ parasitoids _ prospects for utilization

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