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粉蝶盘绒茧蜂中国和荷兰种群学习行为及EAG反应的比较

Comparative study on learning behavior and electroantennogram responses in two geographic races of *Cotesia glomerata*

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中文摘要:

昆虫的取食危害可导致植物释放的挥发物发生质和量的变化,天敌利用植物在受到植食性昆虫的危害后释放的挥发性物质来寻找寄主,这种植物挥发物在寄生蜂寻找寄主过程中扮演者重要的角色。粉蝶盘绒茧蜂 (*Cotesia glomerata*) 是菜粉蝶 (*Pieris rapae*) 主要的内寄生蜂,是优良的蜂种,在生物防治上具有广阔的应用前景。分别以中国种群和荷兰种群的粉蝶盘绒茧蜂为研究对象,利用Y型嗅觉仪和触角电位 (Electroantennogram, EAG) 技术,比较了不同地理种群粉蝶盘绒茧蜂雌蜂的学习行为和触角电生理反应差异。旨在明确虫害植株释放的挥发物在两个地理种群中的作用。Y型嗅觉仪试验结果表明,雌蜂不同的学习经历会影响其对寄主植株的趋性行为。没有学习经历的中国种群雌蜂对虫害甘蓝挥发物较虫害紫甘蓝和虫害羽衣甘蓝挥发物表现出更强烈趋性行为,无学习经历荷兰种群对虫害甘蓝挥发物同样表现出更强烈趋性行为,中国种群3次间隔产卵和3次间隔气味学习使其对经历过的寄主植物挥发物趋性明显提高。荷兰种群3次间隔气味学习也会提高该蜂对经历寄主挥发物的趋性。EAG试验结果显示,两个地理种群雌蜂对所测定三类挥发物(体积比 10^{-1})的反应强弱依次为: C_6 化合物>脂肪族化合物>萜类化合物;且在所测定的6种化合物剂量范围内,两个地理种群雌蜂均与trans-2-己醛和乙酸己酯(体积比 10^{-4} - 10^{-1}),壬醛、月桂烯和里那醇(体积比 10^{-4} - 10^{-2})化合物的活性成正相关。结果表明,中国和荷兰种群雌蜂均表现出较为一致的学习能力和电生理反应。研究显示粉蝶盘绒茧蜂雌蜂可能利用甘蓝挥发物作为利它素而寻觅适宜的寄主,学习经历会明显提高该蜂对经历的寄主挥发物的趋性的行为。实验结果为菜粉蝶的生物防治提供理论基础。

English Summary:

Plants emit volatile blends that may be quantitatively or qualitatively different in response to attackers by different herbivores. Plants that are infested by herbivores emit volatile cues that can be used by the natural enemies of the herbivores in their search for hosts. Volatiles played a vital role in their host-finding behaviour. *Cotesia glomerata* is one of the major parasitoids wasps attacking larvae of *Pieris rapae* and its application in biological control is promising. Knowledge of its chemical ecology is limited. This paper addresses the question which of these healthy plant and host larvae-damaged plant volatiles are perceived by the two geographic races of parasitoid species. By mean of electroantennogram (EAG) and Y-tube olfactometer techniques, the difference between the electrophysiological and learning behavior of two geographic races of female wasps to volatiles of cabbage treated differently were compared, one race originated from Beijing in China and the other from Wageningen in the Netherlands. The tests from Y-tube olfactometer showed that different attractive actions were detected in healthy plant and host larvae-damaged plant of two geographic races of female wasps with no learning experience, different learning experience of female wasps influenced their preference to volatiles of experienced host plant. No experiences female adult of Beijing race showed significantly preference to volatiles of host larvae-damaged cabbage (*Brassia oleracea* L. var. *capitata*) than host larvae-damaged red cabbage or collard, and the no learning experiences female adult of the Netherlands race showed same significantly preference with Beijing race of host larvae-damaged cabbage. The female adult of Beijing race with 3 oviposition experiences and 3 odors on red cabbage or collard with 10 minutes interval showed significantly preference to volatiles from the host plant that was experienced. The female adult of the Netherlands race with 3 odor experiences on red cabbage or collard infested by *P. rapae* disclosed the obvious taxis to the experienced volatiles. Three different chemical volatiles of cabbage (*Brassia oleracea* L. var. *capitata*), the EAG responses of female wasps of two geographical races to 6-carbon compounds was the strongest, followed by aliphatic compounds and terpenoid at the concentration of 10^{-1} mol/L. EAG response values of either Beijing race and Wageningen race positively correlated the dosages from 10^{-4} mol/L to 10^{-1} mol/L of trans-2-Hexenal and Hexylacetate, as well as from 10^{-4} mol/L to 10^{-2} mol/L of Nonanal, Myceneis and Linaloor. Moreover, no significant difference between two races were detected. In conclusion, our data show that the both races possess the similar learning ability and the consistent electrophysiological response characteristics. Our results indicate that the cabbage caterpillar may use cabbage volatiles as kairomone to find their optimal hosts, wasps show an increase in flight response to a previously host plant after learning experience on that plant. The experimental results provided a scientific basis for the theoretical study on the biological control of *Pieris rapae*.

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