Journal of Insect Physiology 99 (2017) 47–57

Contents lists available at ScienceDirect

Journal of Insect Physiology

journal homepage: www.elsevier.com/locate/jinsphys

Chemosensory basis of larval performance of *Papilio hospiton* on different host plants

Giorgia Sollai, Maurizio Biolchini, Paolo Solari, Roberto Crnjar *

Department of Biomedical Sciences, Section of Physiology, University of Cagliari, 09042 Monserrato (CA), Italy

ARTICLE INFO

Article history:
Received 22 December 2016
Received in revised form 17 February 2017
Accepted 21 February 2017
Available online 27 February 2017

Keywords:
Chemoreception
Host plants discrimination
Lepidopterous larvae
Feeding acceptance
Papilionidae
Neural coding

ABSTRACT

Papilio hospiton Géné is an oligophagous species, endemic of the islands of Corsica and Sardinia, using various Apiaceae and Rutaceae as host plants, such as *Ferula communis*, *Ferula arrigonii*, *Peucedanum paniculatum*, *Ruta lamarmorae* and *Pastinaca latifolia*. We previously found that the lateral maxillary styloconic sensillum in the larva has two deterrent neurons, one phagostimulant and one salt specific, while the medial sensillum has two phagostimulant neurons, one deterrent and one salt specific. In this work we studied the sensitivity of gustatory receptor neurons (GRNs) to saps of *F. communis*, *F. arrigonii*, *P. paniculatum*, *P. latifolia* and *R. lamarmorae* and evaluated the relationship between taste sensitivity to different host-plants and larval growth rate on each of them. The spike activity was recorded from medial and lateral taste sensilla stimulated with plant saps, and GRN response patterns were cross compared in the light of a different feeding acceptance. The phagodeterrent GRNs show a higher activity in response to *F. arrigonii* and *R. lamarmorae* than to *F. communis, P. paniculatum* and *P. latifolia*. Behavioral trials showed that the time to pupation is significantly longer when larvae are reared on *F. arrigonii* and *R. lamarmorae* than on the other host-plants. These results suggest that the different activity of the phagodeterrent GRNs may inhibit food acceptance and extend the duration of the larval stage.

1. Introduction

Peripheral taste sensitivity plays a crucial role in the choice of food both in invertebrates and vertebrates, including humans (Caicedo et al., 2002; Chapman, 2003; Dethier, 1976; Melis et al., 2015; Tepper, 2008; Zhang et al., 2013; Zhou et al., 2010). In insects, taste chemoreceptors respond to various chemicals present in potential food sources and their integrated activity plays a role in the balance between appetitive or aversive behavior toward foods.

In fact, herbivorous insects, and in particular the larvae of Lepidoptera, represent a suitable model to study the relationship between sensory input and Behavioral output in the choice of food, as they exhibit clear food preferences and possess a limited number of gustatory neurons, housed within sensilla in the maxillae and epipharynx. The axons of these chemoreceptors project directly to the brain, in a specific area called subesophageal ganglion (SOG) (Asaoka, 2002; del Campo and Miles, 2003; Schoonhoven and van Loon, 2002; Tang et al., 2014).

In the insect host-plant interaction, and particularly in host recognition, the acceptability of a feeding source depends on the total sensory impression obtained from the response to multiple components of plants, rather than to the presence or absence of individual phagostimulating or deterrent compounds (Dethier, 1973; Martin and Shields, 2012).

In the larvae (of lepidopterans) food assessment is performed by gustatory organs localized on the mouthparts: styloconic sensilla on the maxillary galea, basiconic sensilla at the tip of the maxillary palp and sensilla on the epipharynx (Dethier, 1973; Schoonhoven, 1969).

Most of the electrophysiological studies have been focused on the two styloconic sensilla of each maxillary galea, since they are considered the sensory organs primarily involved in feeding: in fact, they mediate the plant recognition as a food source and its selection and seem to play a particularly important role in the acceptance of the host plant (Dethier and Crnjar, 1982; Martin and Shields, 2012; Schoonhoven, 1987). Each styloconic sensillum has 4 gustatory receptor neurons (GRNs) with a specific spectrum of response to plant compounds (for a review, see Schoonhoven and van Loon, 2002). Typically, some neurons respond to phagostimulants, that is primary plant metabolites such as sugars and amino acids that promote feeding. Other GRNs are activated by deterrent compounds, secondary plant metabolites generally bitter

* Corresponding author at: Department of Biomedical Sciences, Section of Physiology, University of Cagliari, SP 8 Km 0.700, 09042 Monserrato (CA), Italy.

E-mail address: crnjar@unica.it (R. Crnjar).

http://dx.doi.org/10.1016/j.jinsphys.2017.02.007
0022-1910/

to humans, which mediate food aversive behavior. Feeding does not depend on the presence or absence of specific compounds, but rather on the balance between phagostimulants and deterrents (Dethier, 1973).

We chose, as a experimental model *Papilio hospiton* Géné, an oligophagous lepidopteran endemic of the Sardinian and Corsican islands, which uses as host plants only a few Apiaceae and Rutaceae. In Sardinia, *P. hospiton* can be considered almost monophagous since it actually uses the giant fennel (*Ferula communis*) as the only host plant: only when and where *F. communis* is unavailable, two other plants are used, one narrowly endemic (*Ferula arrigonii)* and the other rare and confined to two small stands (*Ruta lamarmorae*) (Bacchetta et al., 2006); on the contrary, in Corsica it feeds on several species: *Peucedanum paniculatum*, *Ferula communis*, *Ruta corsica* and *Pastinaca latifolia* (Aubert et al., 1996). In the peripheral taste system of *P. hospiton*, the functional characterization of larval styloconic sensilla showed that the lateral sensillum has two deterrent GRNs (L-lat and M2-lat neurons), one phagostimulant (M1-lat neuron) and one salt neuron (S-lat neuron), while the medial sensillum has two phagostimulant GRNs (L-med and M1-med neurons), one deterrent (M2-med neuron) and one salt neuron (S-med neuron) (Sollai et al., 2014). In addition, the L-lat GRN may act as a “labeled-line”, which indicates the presence of toxic compounds (Sollai et al., 2015). In this respect, larval peripheral taste sensitivity plays an important role in feeding acceptance; in fact, host specificity of lepidopterans is determined not only by

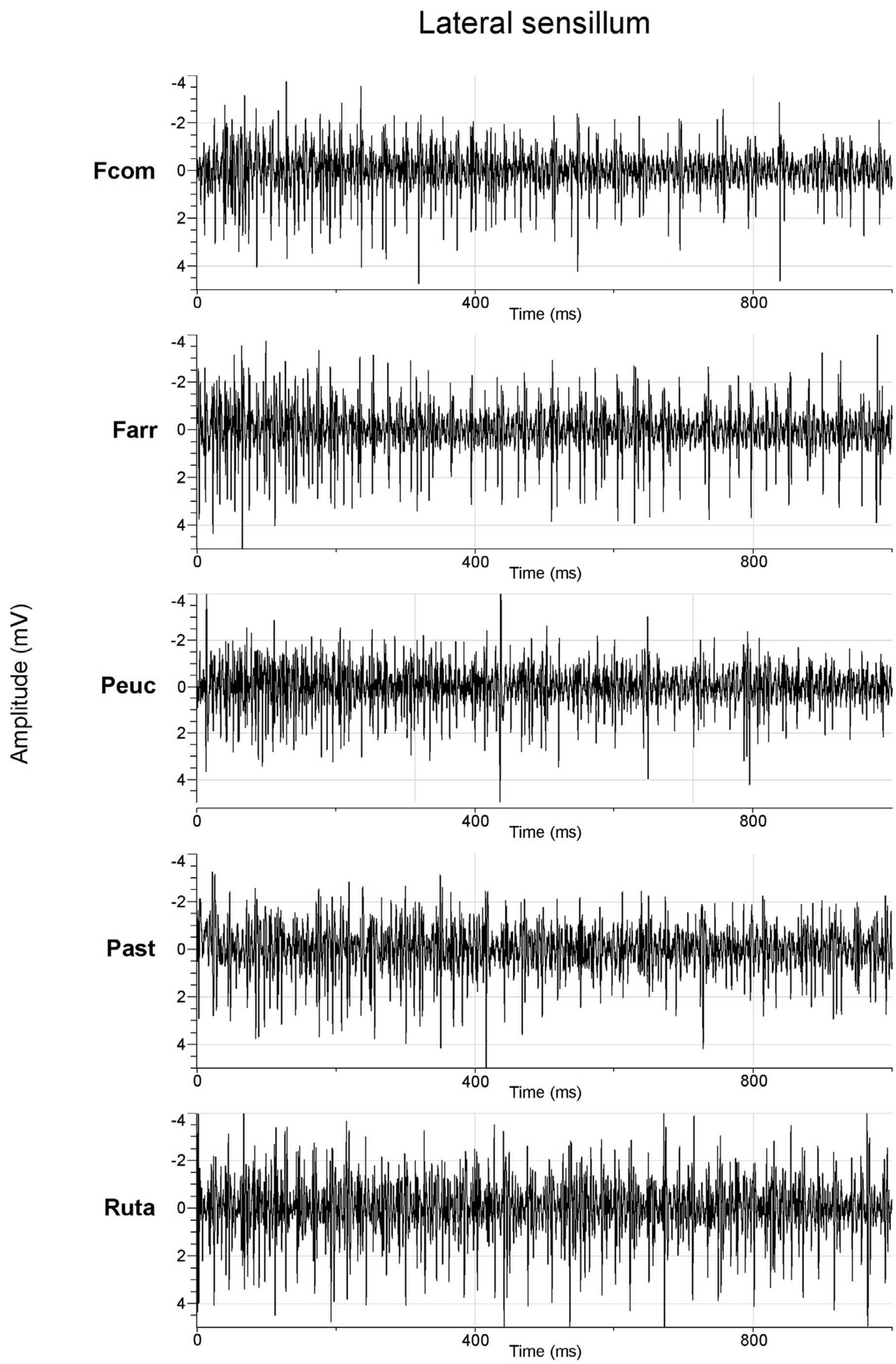

Fig. 1. Sample traces showing spike firing frequency of a lateral styloconic sensillum following stimulation with leaf sap of *F. communis* (Fcom), *F. arrigonii* (Farr), *P. paniculatum* (Peuc), *P. latifolia* (Past) and *R. lamarmorae* (Ruta).