

Wounding-mediated gene expression and accelerated viviparous reproduction of the pea aphid *Acyrtosiphon pisum*

1 Piercing of the pea aphid *Acyrtosiphon pisum* with a bacteria-contaminated needle elicits lysozyme-
2 like activity in the haemolymph but no detectable activities against live bacteria. No homologues of
3 known antimicrobial peptides were found in cDNA library generated by using the suppression subtractive
4 hybridization method or in over 90 000 public expressed sequence tag (EST) sequences, but lysozyme
5 genes have recently been described in pea aphid. Production of viviparous offspring was significantly
6 accelerated upon wounding.

7 Pea aphid showed weakened immune system. No homologues of known antimicrobial peptides were
8 found. The presence of insect defensins in other Hemiptera and in the basal apterygote insect *Thermobia*
9 *domestica* (Altincicek Vilcinskis, 2007) suggests that at least this type of antimicrobial peptides may
10 have been lost during aphid evolution. Interestingly, the observation that pierced aphids showed a limited
11 capacity to seal their wound by haemolymph coagulation and melanization agrees with the finding that
12 an encapsulation response of pea aphid to the parasitoid wasp *Aphidius ervi* is either very weak or
13 non-existent (Oliver et al., 2005).

14 Regards to weakened immunity of pea aphids: (1) Aphids and relatives of Hemiptera share the unique
15 ability to exploit exclusively phloem sap as diet, which is usually sterile (Douglas, 2006). Thus, the
16 risk of encountering pathogens in their diet is limited. (2) Aphids harbour primary symbionts that are
17 vertically transmitted and located intracellularly, as well as secondary symbionts that are both vertically
18 and horizontally transmitted and also survive extracellularly in the insect haemolymph where they face
19 the host's antimicrobial defences (Moran Dunbar, 2006; Haine, 2008). It is possible that the symbionts
20 provide protection, *e.g.* pea aphid has been reported to be protected against fungal pathogens by the
21 facultative symbiotic Gram-negative bacterium *Regiella insecticola* (Scarborough et al., 2005) and also
22 against the parasitoid wasp *Aphidius ervi* by the facultative symbiotic Gram-negative bacterium *Hamil-*
23 *tonella defensa* (Oliver et al., 2005). This may further explain why only lysozyme-like activity is present
24 in the haemolymph, as lysozymes target mainly Gram-positive bacteria, whereas aphid symbionts belong
25 to Gram-negative bacteria. (3) As immune responses are costly because they require investment of re-

sources which are shared with other fitness-relevant traits (Rolf Siva-Jothy, 2003; Schmidt-Hempel, 2005; Freitak et al., 2007), it is reasonable that aphids increase terminal reproductive investment in response to a putative survival threat such as an immune challenge.