Communicative & Integrative Biology 3:6, 629-630; November/December 2010; ©2010 Landes Bioscience

Post-mating sexual abstinence in a male moth

Romina B. Barrozo,[†] Christophe Gadenne and Sylvia Anton*

INRA; UMR 1272 Physiologie de l'Insecte; Signalisation et Communication; Route de St. Cyr; Versailles, France

[†]Present address: Depto. Biodiversidad y Biología Experimental; FCEyN; Universidad de Buenos Aires; Ciudad Universitaria, Pab. II; C1428EHA; Buenos Aires, Argentina

In most animals, male copulation is dependent on the detection and processing of female-produced sex pheromones. In males, a refractory post-ejaculatory interval (PEI) follows copulation, allowing them to avoid direct remating until they have replenished their reproductive tracts. In the moth *Agrotis ipsilon*, newly mated males show a transient inhibition of behavioral and central nervous responses to sex pheromone. Using non-pheromonal (plant) odors, pheromones and their mixture, we now show that the observed lack of pheromone response originates from differential post-mating odor processing in the brain. Although mated males still respond to plant odors alone, their response to mixtures depends on the added pheromone concentration. Below a specific threshold, sex pheromone is not detected at the brain level; above this threshold, it becomes inhibitory. This PEI can thus be interpreted as a «refusal to respond», which contradicts the generally accepted paradigm of sleep-like/exhaustion behavior during PEI.

Key words: lepidoptera, noctuidae, moth, olfaction, mating, pheromone, plant odour, antennal lobe, plasticity

Submitted: 09/02/10

Accepted: 09/02/10

Previously published online: www.landesbioscience.com/journals/cib/article/13507

DOI: 10.4161/13507

*Correspondence to: Sylvia Anton; Email: sylvia.anton@versailles.inra.fr

Addendum to: Barrozo RB, Gadenne C, Anton S. Switching from attraction to inhibition: mating-induced reversed role of sex pheromone in an insect. J Exp Biol 2010; 213:2933–9; PMID: 20709921; DOI: 10.1242/jeb.043430.

In animals, sex pheromones are generally considered as attractants and play a key role in the encountering of sexual partners, ultimately leading to copulation. During mating, males transfer sperm and seminal material from their reproductive tracts, which induce drastic behavioral and physiological post-mating effects in both sexes. In males, it induces a post-ejaculatory interval (PEI), which is characterized by a sleep-like behavior, i.e., a decrease in motor activity, probably caused by exhaustion.[1] In Vertebrates, this PEI lasts from a few seconds in hamsters to hours or days in some other mammals.[2] In insects, the PEI is often shorter, from 5 minutes in a parasitic wasp to 24 h in moths or earwigs.[3-5] This PEI allows newly mated males to "wait" until they have refilled their reproductive tracts with seminal proteins for a new potential ejaculate. By skipping unsuccessful reproduction, males might enhance their probability of surviving to the next reproductive opportunity and increase their amount of energy available to undergo a next reproductive event. Although postcoital changes in physiology are well documented in females,[6] the physiology underlying the male PEI is less studied.

In the moth, *Agrotis ipsilon*, newly-mated males are no longer attracted to sex pheromone.[4] Moreover, most newly-mated males showed the characteristic sleep-like PEI behavior (hardly any walking and no random flight).[7] This is accompanied by a decrease in the sensitivity of neurons within the primary olfactory centre, the antennal lobe (AL).[4]

To understand the nature and origin of the PEI in *A. ipsilon* males, we asked the following questions: (i) is pheromone detection switched off completely? (ii) are other odors still detected? and (iii) if they do detect the pheromone: do they ignore it or does the pheromone itself inhibit their attraction? To test these possible scenarios, we chose a strategy in which the sex pheromone was tested in combination with a non-pheromonal type of attractant (flower odor) using behavioral (wind tunnel) and electrophysiological tests (intracellular recordings in ALs).[8]

Our results show that, during the PEI, the olfactory system is not entirely switched off, as plant-odor perception is not affected. This form of neuronal plasticity seems to be restricted to the male-specific macroglomerular complex (MGC), the AL compartment processing the sex pheromone. After mating, although they do not respond, males are nevertheless still detecting the pheromone: above a level of 1 ng it elicits a response in MGC neurons. The lack of response of newly-mated males in the wind tunnel to mixtures of flower odors and different doses of pheromone might thus have different origins: below a specific threshold, males do not detect the pheromone and therefore do respond to the mixture; above this threshold, males do detect the pheromone and do not respond because it has become inhibitory.

The observed lack of response to sex pheromone of newly mated males should therefore be interpreted as a "refusal/avoidance to respond". Although newly mated males might be physically exhausted from copulation, they are certainly not "sleepy", because they still respond to plant odors alone and to mixture with an under-threshold concentration of pheromone. This is in opposition with the generally admitted paradigm of PEI being described as a sleep-like rather inactive behavior.

We are currently working on two main questions: (i) is there a specific factor (peptide, protein, hormone, neuromodulator) inducing this post-mating abstinence after mating? and (ii) how does this potential factor modulate the processing of sex pheromone in the AL?

References

1. Soulairac A. The physiological significance of the refractory period in the sexual behavior of the male rat. J Physiol 1952; 44:99-113.
2. Aversa A, Mazzilli F, Rossi T, Delfino M, Isidori AM, Fabbri A. Effects of sildenafil (Viagra (TM)) administration on seminal parameters and post-ejaculatory refractory time in normal males. Hum Reprod 2000; 15:131-4.
3. Fischer CR, King B. Sexual inhibition in *Spalangia endius* males after mating and time for ejaculate replenishment. J Insect Behav 2008; 21:1-8.
4. Gadenne C, Dufour MC, Anton S. Transient post-mating inhibition of behavioural and central nervous responses to sex pheromone in an insect. Proc Royal Soc London B 2001; 268:1631-5.
5. Rankin SM, TeBrugge VA, Murray JA, Schuler AM, Tobe SS. Effects of selected neuropeptides, mating status and castration on male reproductive tract movements and immunolocalization of neuropeptides in earwigs. Comp Biochem Phys A 2009; 152:83-90.
6. Ram KR, Wolfner MF. A network of interactions among seminal proteins underlies the long-term postmating response in Drosophila. Proc Natl Acad Sci USA 2009; 106:15384-9.
7. Barrozo RB, Jarriault D, Simeone X, Gaertner C, Gadenne C, Anton S. Mating-induced transient inhibition of responses to sex pheromone in a male moth is not mediated by octopamine or serotonin. J Exp Biol 2010; 213:1100-6.
8. Barrozo RB, Gadenne C, Anton S. Switching attraction to inhibition: mating-induced reversed role of sex pheromone in an insect. J Exp Biol 2010; 213:2933-9.