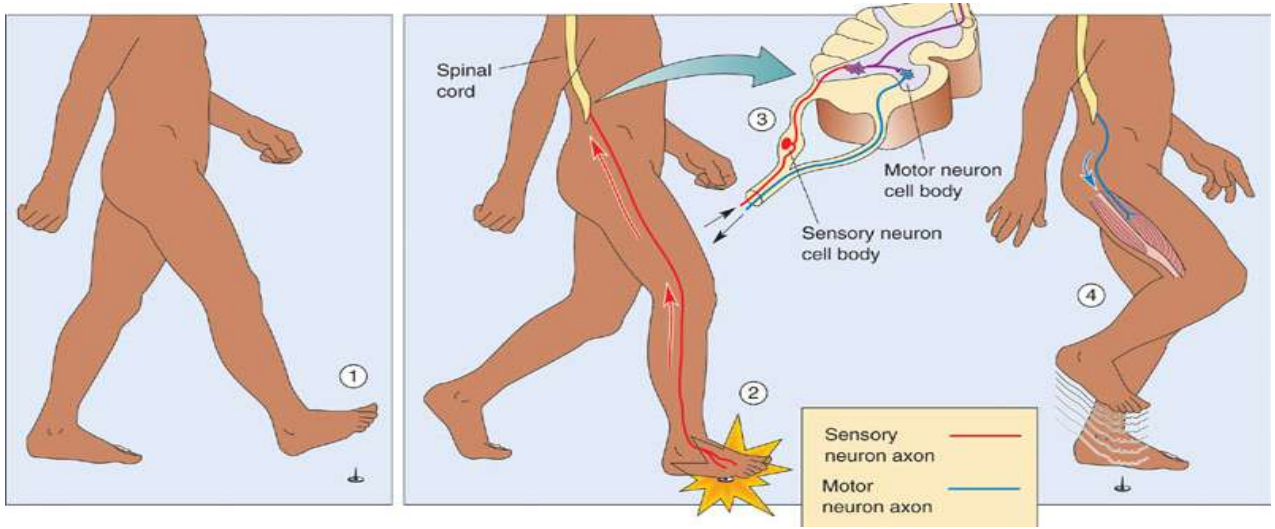
Drosophila Pheromones: From Reception to Perception

‘Por Una Cabeza’ Club

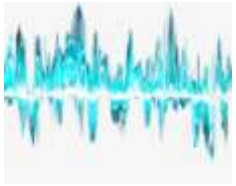
2021-3-25

神经系统的基本功能：感知环境、作出反应



刺激——感觉神经元——中枢（信息整合）——运动神经元

Chemical senses are most used and probably the first to evolve



Spread wide
Stable
Effect long
Species specificity

Pheromone

What are the pheromones and how are they perceived?

Content

Pheromones and their receptors

—— JXY

Volatile- pheromonal information processing in olfactory system

——MMZ

Nonvolatile-pheromonal information processing in gustatory system

——SMS

Pheromones and their receptors

ONE

JXY

What are the pheromones?

Pheromones are chemicals released by an organism to which a conspecific responds either behaviorally or physiologically.	a single molecule
	a mixture of many molecules

pherin (to transfer) + *hormōn* (to excite)

1879

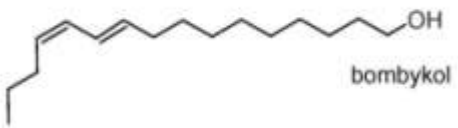
No. 4653 January 3, 1959 NATURE

BIOLOGY

'Pheromones': a New Term for a Class of Biologically Active Substances

P. Karlson and M. Lüscher

Aphrodisiac
Silkmoth (*Bombyx mori*)



the first identified pheromone

Adolf Butenandt

Nobel Prize in Chemistry in 1939

for the chemical synthesis of sex hormones

Be careful to distinguish the following chemical signals!

Hormone

Similarities：

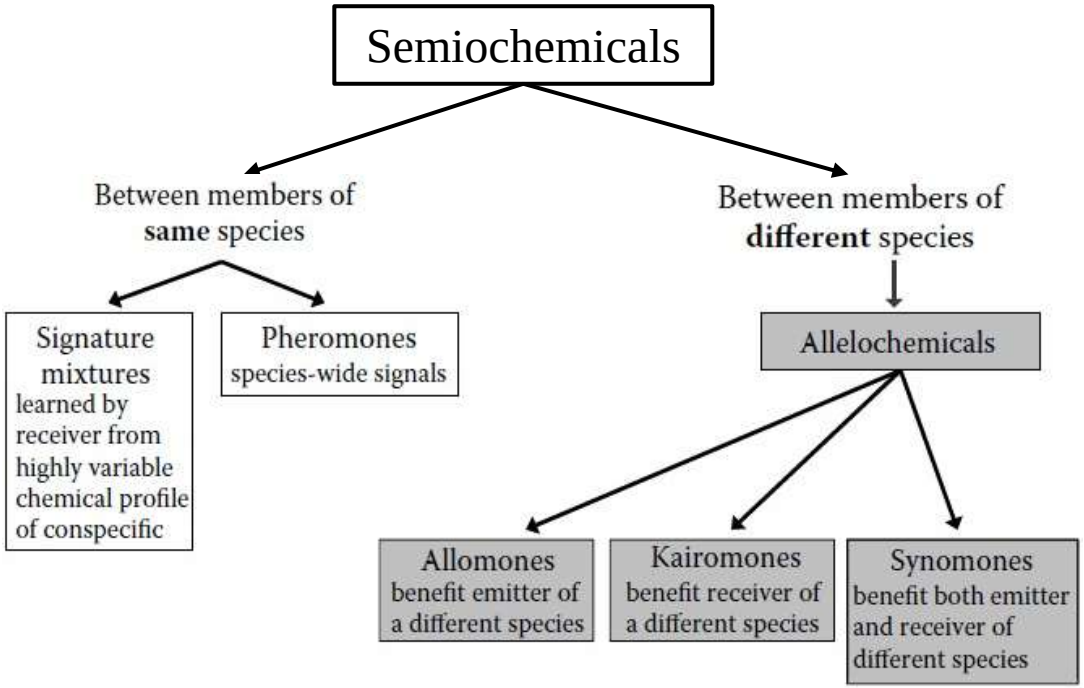
produced and secreted by special glands;

minute amounts cause a specific reaction in the receptor organ

Differences：

the substance is not secreted into the blood but outside the body;

does not serve communication within the organism but between individuals



http://www.pherobase.com/

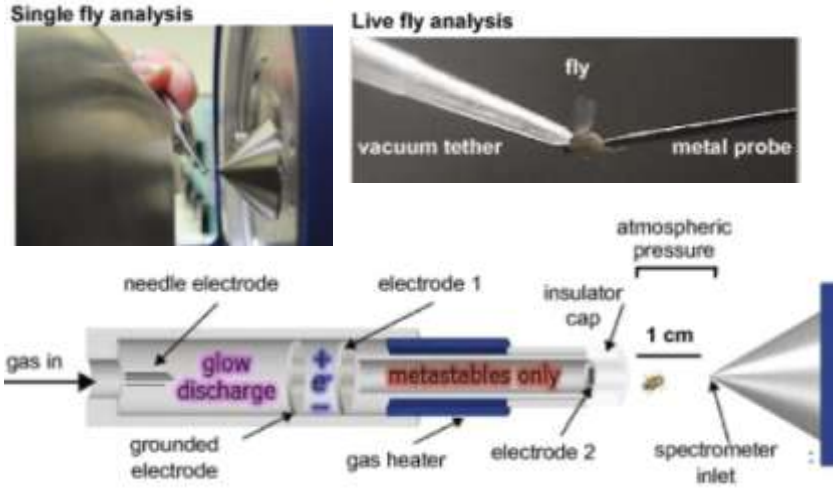
(Mucignat-Caretta C 2014)

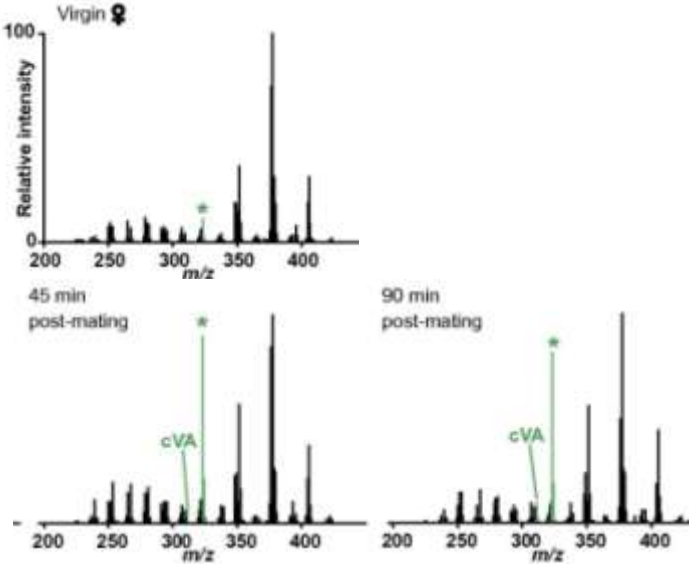
How to discover a new pheromone?

Sampling, Purification, Chemical Analysis —— pairing —— Analyzing behavioral or physiological changes

Chromatography, Mass spectroscopy, NMR

- Standard GC/MS——fully volatile non-polar hydrocarbons
- Improved MS





(Yew and Chung 2015)

Pheromones are defined by their behavioral function

This really is the molecule and other similar molecules are not equally stimulating

How to discover a new pheromone?

Characterize gene and function of pheromone receptors

Next generation sequencing

RNA interference, transgenics and genome-editing tools

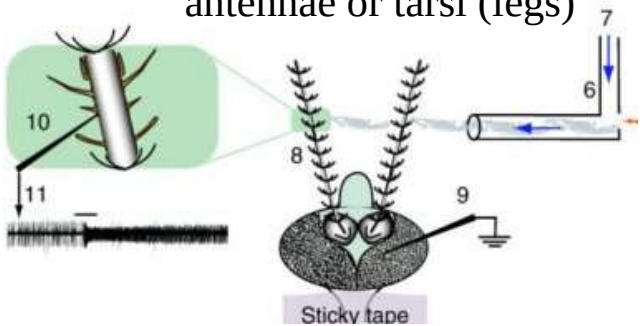
Reconstitution in heterologous expression systems

Measuring neural responses to pheromones

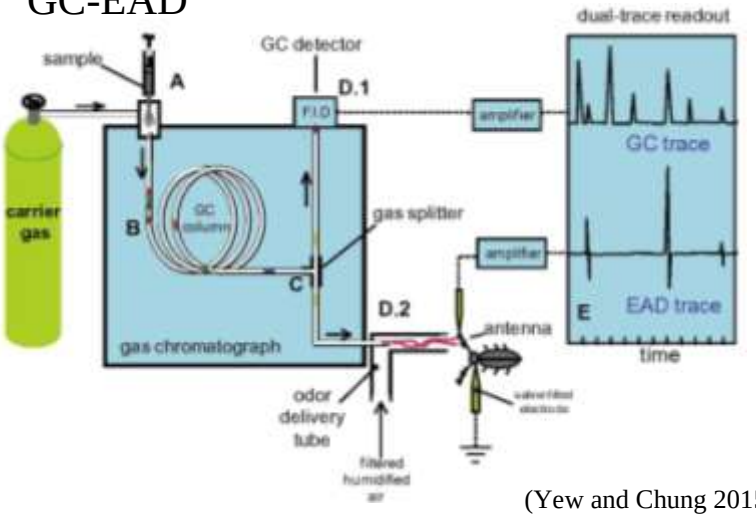
Calcium imaging

Electroantennography or Single sensillum recording

antennae or tarsi (legs)



GC-EAD



(Yew and Chung 2015)

The complexity of social functions mediated by pheromones is matched by the chemical diversity

Role

- Interindividual recognition of species and gender
  - Aggregation
  - Species identification
  - Aphrodisiacs
  - Anti-aphrodisiacs
  - Aggression
- Additionally recognition of colony membership, nestmates, caste, and kin ——social insects

Diverse chemicals

- **volatile**
  - detected by olfaction
- **non-volatile**
  - contact and detected by gustation

碳氢化合物、环氧化合物、乙醇、 酸、酮类、萜类、脂肪酸、甘油三酯、多肽

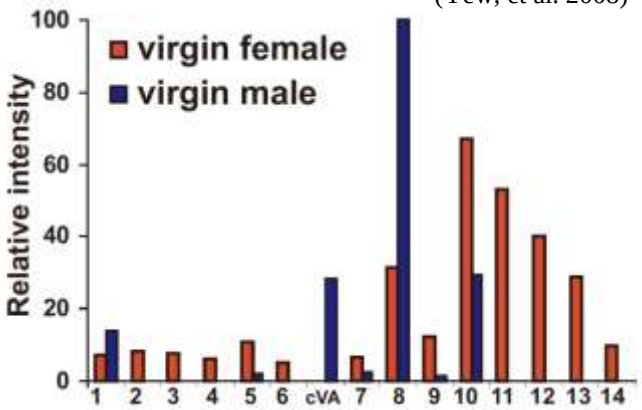
Variable chemical profile

Quantitative and Qualitative differences

Intrinsic Cues
(Species, Sex, Age, Fertility)

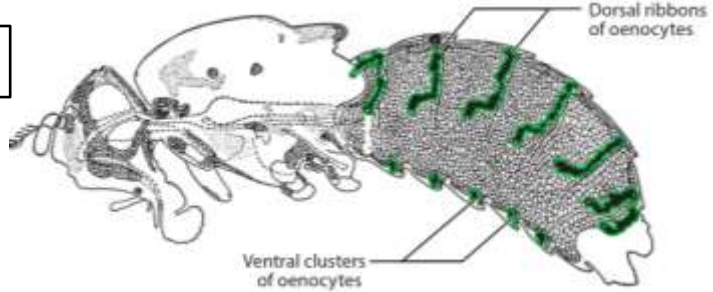
Extrinsic Cues
(Diet, Context, Experience)

(Yew, et al. 2008)



Pheromones in *Drosophila* —— cuticular hydrocarbons (CHCs)

produced in the specialized secretory cells: oenocytes

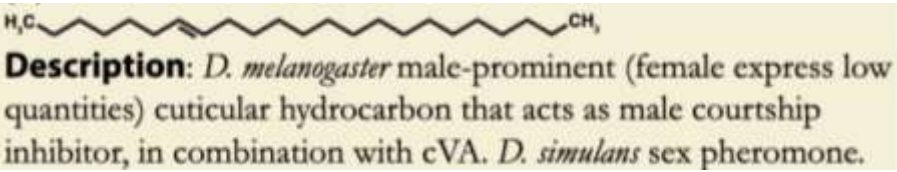


(Makki, et al. 2014)

Male

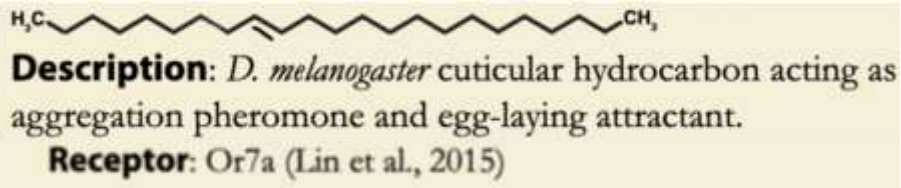
non-volatile

(Z)-7-Tricosene (7-T)



Description: *D. melanogaster* male-prominent (female express low quantities) cuticular hydrocarbon that acts as male courtship inhibitor, in combination with cVA. *D. simulans* sex pheromone.

(Z)-9-Tricosene (9-T)



Description: *D. melanogaster* cuticular hydrocarbon acting as aggregation pheromone and egg-laying attractant.

Receptor: Or7a (Lin et al., 2015)

volatile

(*Z*)-4-undecenal

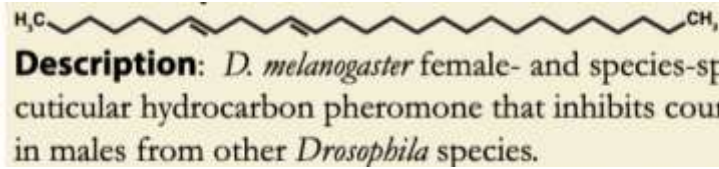
Description: Oxidization product of the *D. melanogaster* sex pheromone 7,11-HD. Long range *D. melanogaster* attractant.

Receptor: Or69aB (Lebreton *et al.*, 2017).

Female

(Z, Z)-7,11-Nonacosadiene (7,11-ND)

(Z, Z)- 7,11-Heptacosadiene (7,11-HD)



Description: *D. melanogaster* female- and species-specific cuticular hydrocarbon pheromone that inhibits courtship in males from other *Drosophila* species.

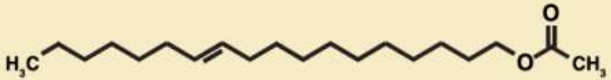
(Billeter and Wolfner 2018)

Pheromones in *Drosophila* —— male-specific signals

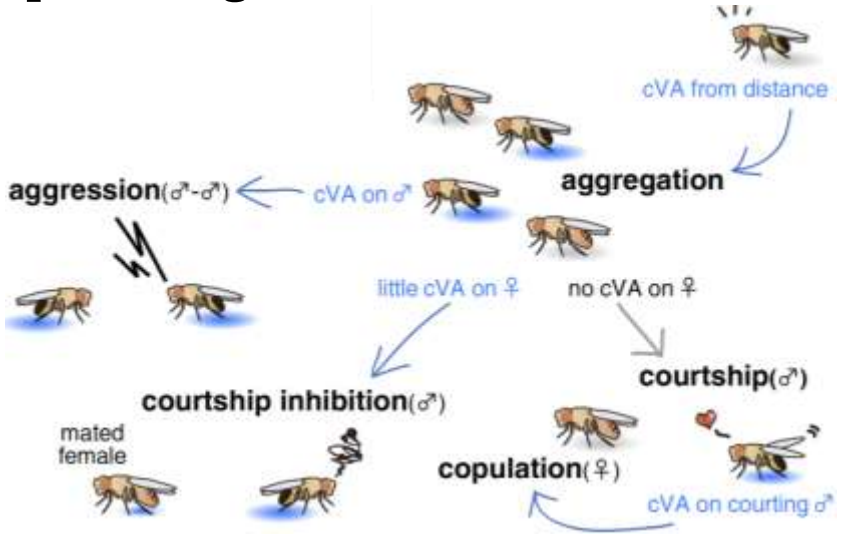
produced in the ejaculatory bulb

volatile

cis-vaccenyl acetate (cvA)



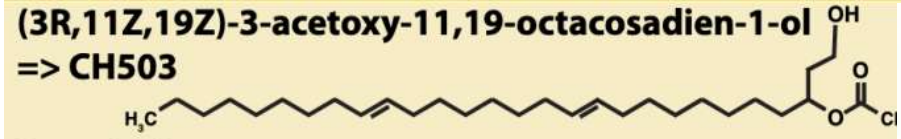
Description: *D. melanogaster* male courtship inhibitor, in combination with 7-T. Aggregation pheromone, in combination with food odors.



(Ejima 2015)

non-volatile

CH503



(3R,11Z,19Z)-3-acetoxy-11,19-octacosadien-1-ol => CH503

Description: *D. melanogaster* male courtship inhibitor.

Semen pheromones

Sex peptide

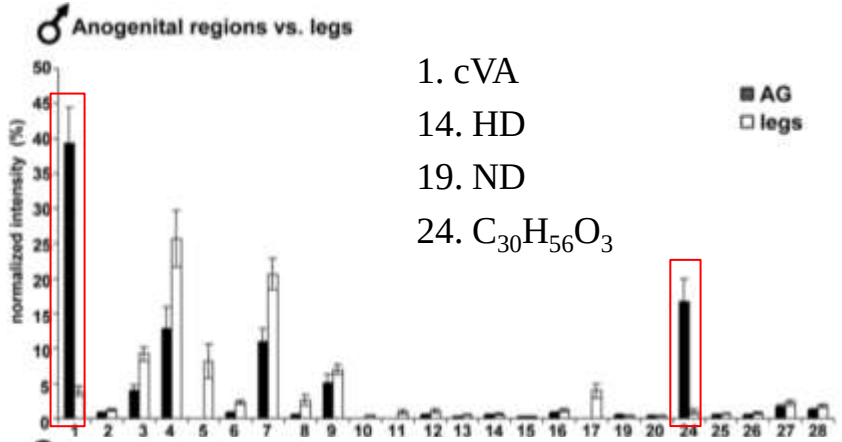
WEWPWNRKPTKFPIPSPNPRDKWCRLNLGPAWGGRC

Sperm binding + Stimulation of JH synthesis | Immune response | Sex peptide receptor mediated post mating response

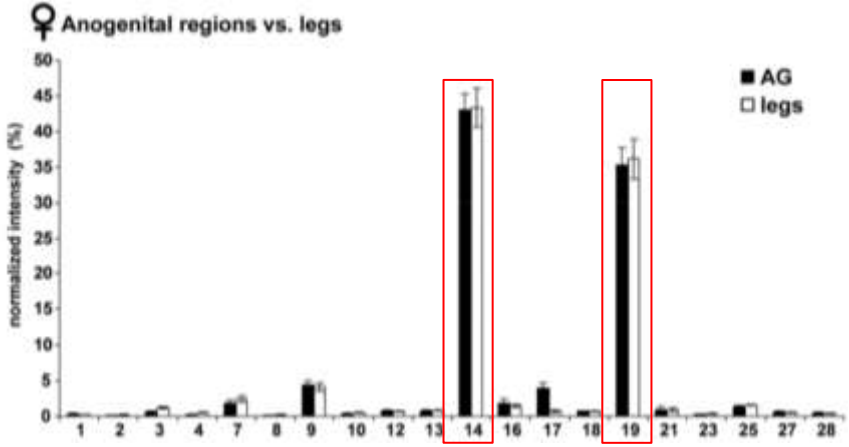
Receptor: Sex peptide Receptor (Yapici et al., 2008)

(Billeter and Wolfner 2018)

A new male pheromone CH503 in *Drosophila* is identified



1. cVA
14. HD
19. ND
24. $C_{30}H_{56}O_3$



HPTLC

triacylglycerides, other hydrocarbons

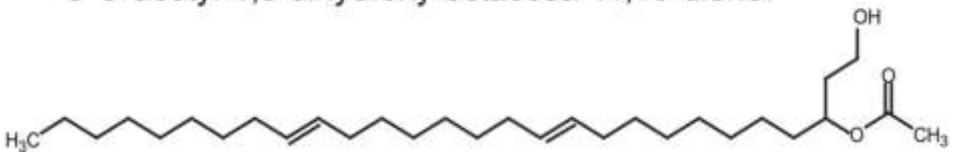
CH503

start position

MS + NMR+
chemical derivatization experiments

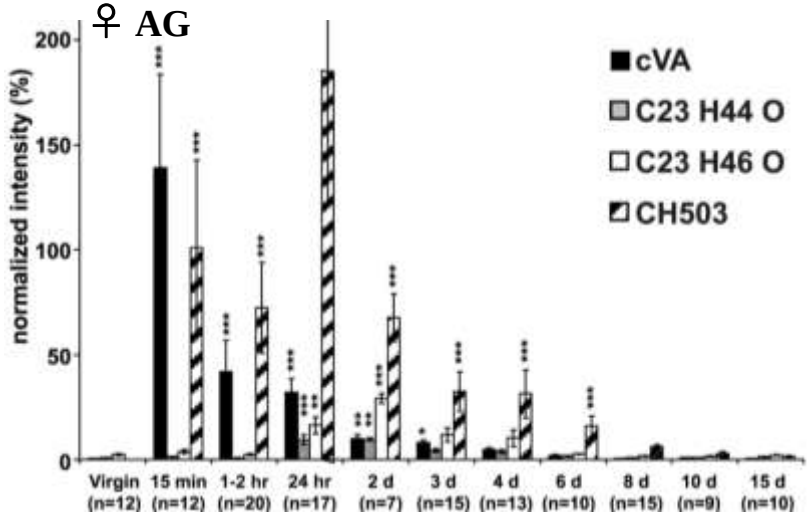
CH503

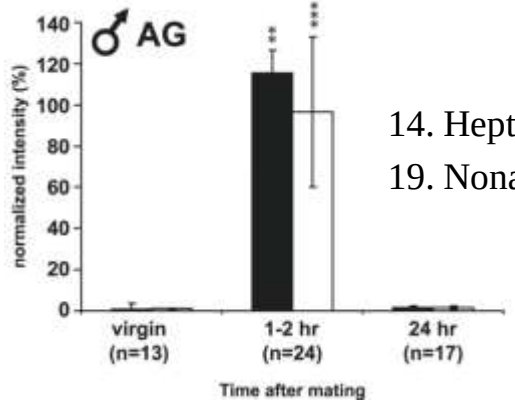
3-*O*-acetyl-1,3-dihydroxy-octacosa-11,19-diene



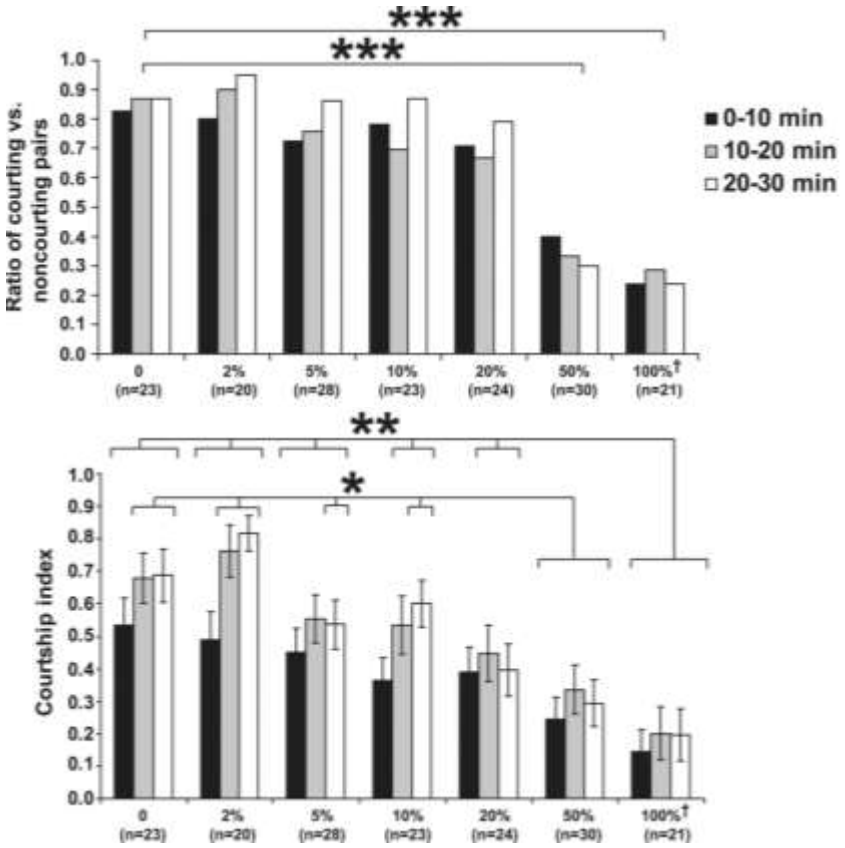
(Yew, et al. 2009)

CH503 is transferred to females during copulation and subsequent inhibits male courtship





14. Heptacosadiene
19. Nonacosadiene

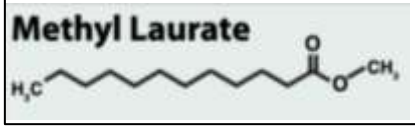


(Yew, et al. 2009)

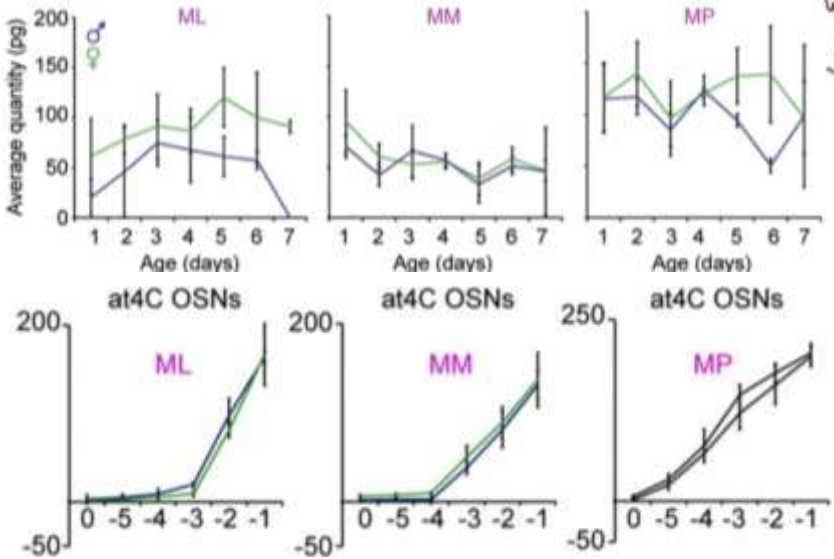
Pheromones in *Drosophila* —— common attractional signals in both sexes

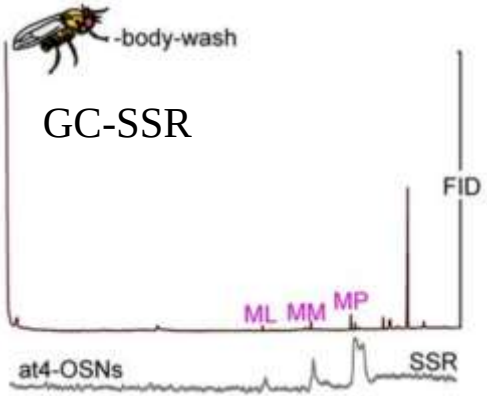
produced in unidentified organs

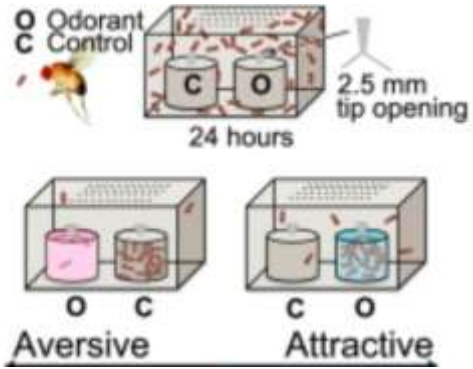
Fatty acids pheromones

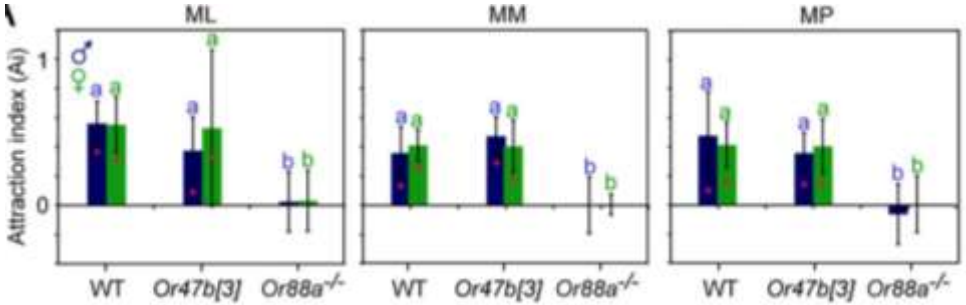


methyl myristate
&
methyl palmitate









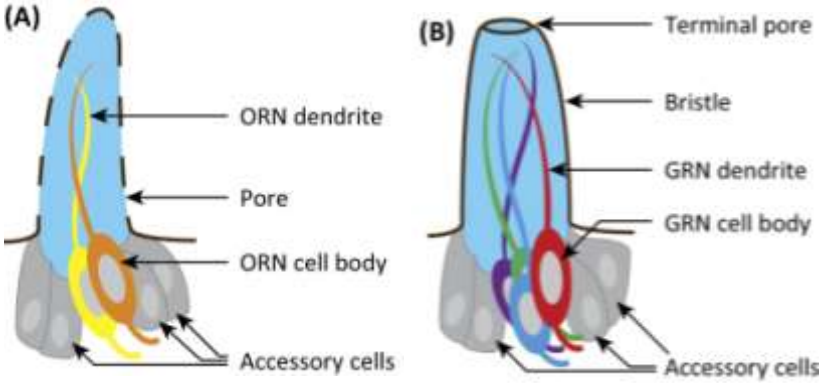
(Dweck, et al. 2015)

How are candidate pheromones received by the sense organs?
——The sensory organs house the pheromone receptors.

To ensure specificity, insects have evolved highly specialized channels of communication, both on the sending as well as the receiving side.

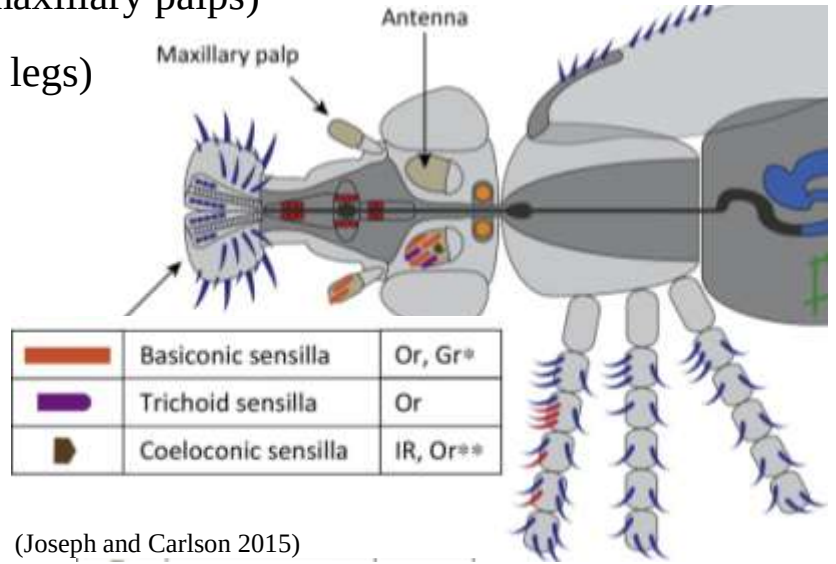
chemosensory units: sensilla ——cuticular, hair-like structures
equipped with an array of sensory neurons and specialized proteins

- Olfactory ——on head appendages (antennae and maxillary palps)
- Gustatory ——on various body parts (proboscis and legs)



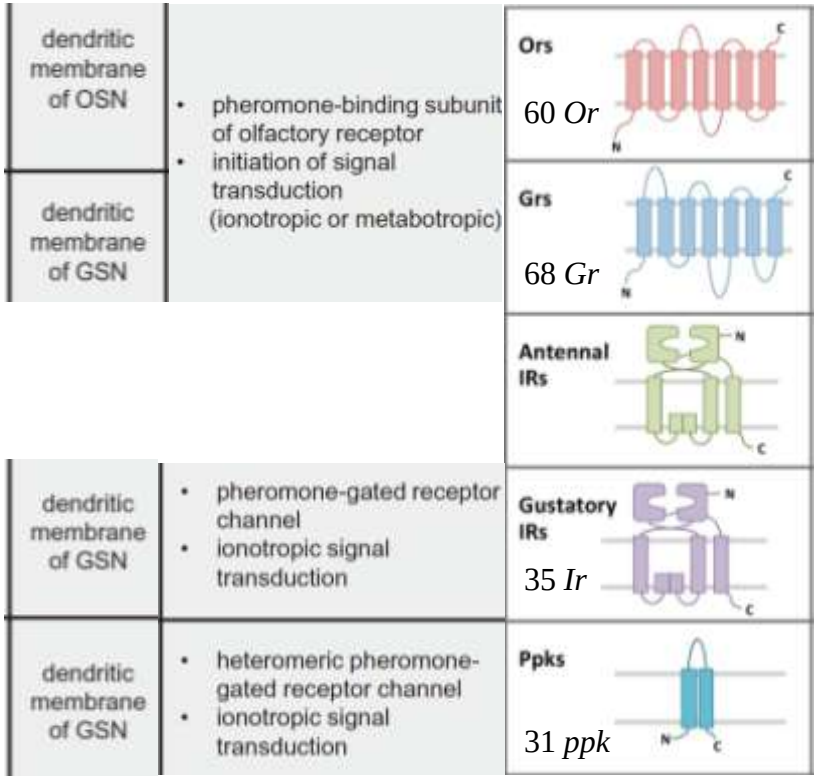
Olfactory sensilla

Gustatory sensilla



(Joseph and Carlson 2015)

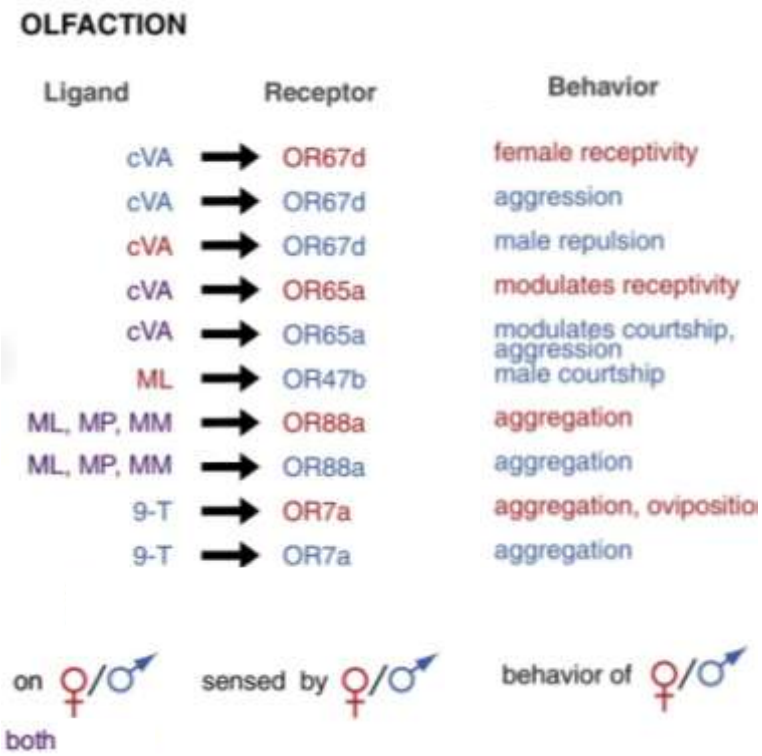
There is a large repertoire of distinct pheromone receptors in *Drosophila*.

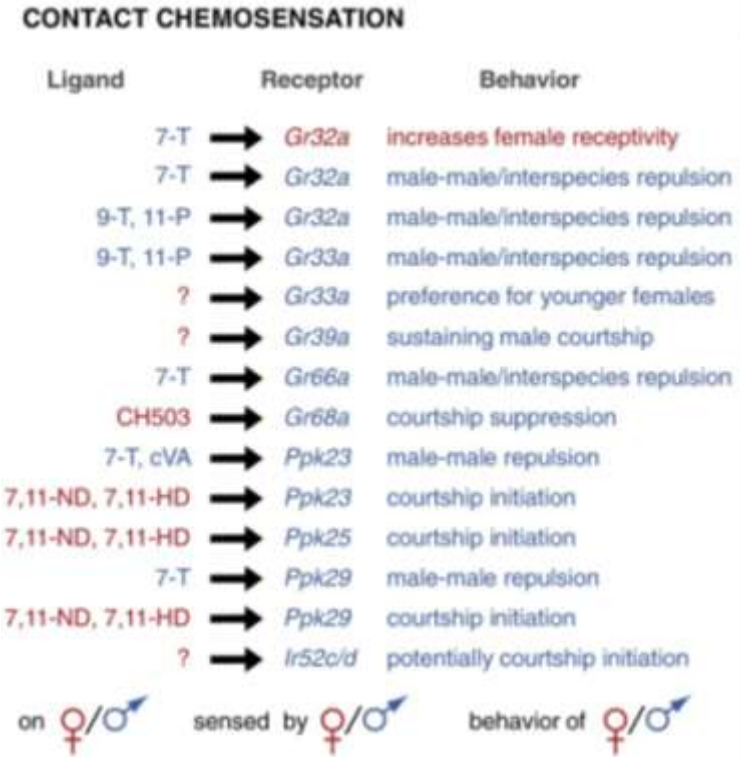


(Fleischer and Krieger 2021)

PRs mediate the specific recognition of pheromone components and trigger subsequent ionotropic or possibly metabotropic signal transduction processes

There is a large repertoire of distinct pheromone receptors in *Drosophila*.





Other molecules are also required for proper pheromone detection

Pheromone binding proteins (PBPs): Or76a

Small, soluble proteins in the sensillum lymph,

Synthesized and secreted by support cells

Binding hydrophobic pheromones for transport across the lymph towards pheromone receptors (PRs) in the dendritic membrane of OSNs

Sensory neuron membrane protein 1 (SNMP1):

Enriched in dendritic membrane

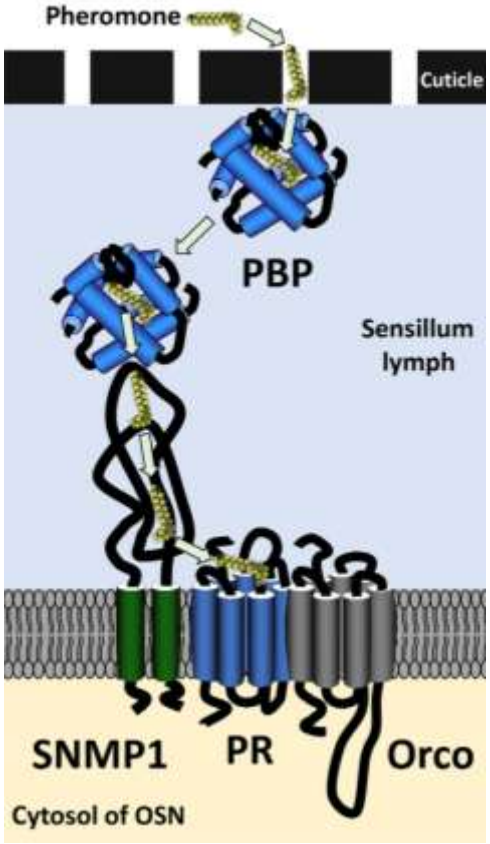
Co-receptor that may take over pheromones from PBPs and pass them on to nearby PRs

Odorant receptor co-receptor (Orco): Or83b

A noncanonical member of the OR family

Present in all OR-expressing OSNs

Forming heteromers with ORs; heteromeric OR/Orco complexes operate as ligand-gated ion channels



(Fleischer and Krieger 2021)

Summary

- Substances which are secreted to the outside by an individual and received by a second individual of the same species, in which they release a specific reaction.

- Pheromones are defined by their behavioral function. But the complex background of chemicals makes it challenging to identify pheromones. It will be necessary to perform better technologies to more fully characterize the chemical composition of fly cuticles.

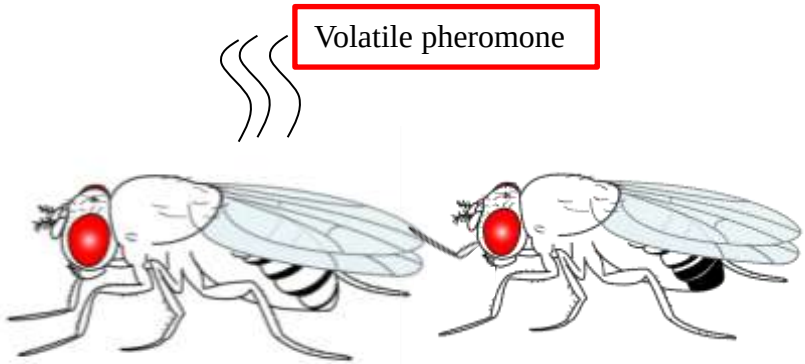
- While several PRs have been reported, the results are partly controversial. Identifying certain pheromone-receptor pairs and relevance to social behavior, and characterizing their biochemical regulation are important next steps

- ◆ How flies use their senses of smell and taste to communicate?
- ◆ Why can the same pheromone elicit different types of behaviors?

Volatile- pheromonal information processing in olfactory system

TWO

Molz

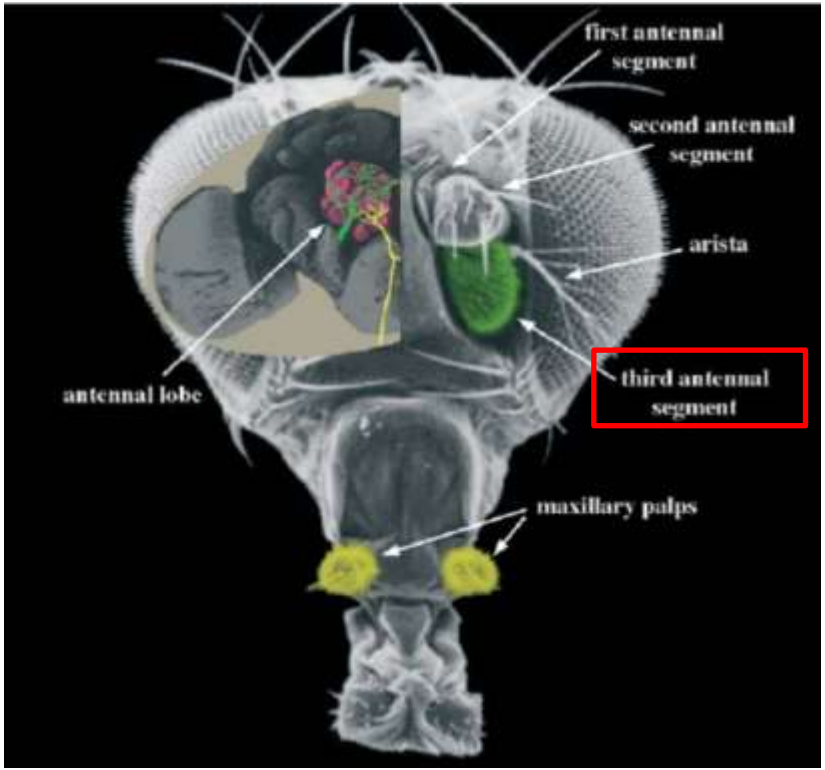


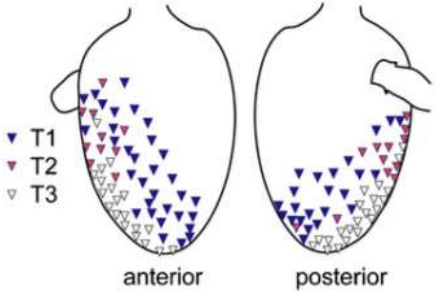
How volatile pheromones are perceived?

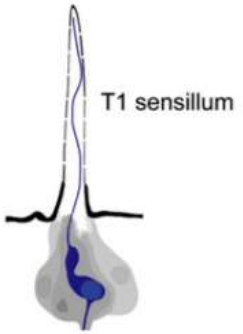
How to cause diverse behavioral output?

- Sensillas and receptors response fly odors
- cVA regulates behaviors in two sexs
- Sexually -specific cVA perceiving circuit

An important olfactory sensor—Trichoid sensilla







Martin F, et al., The Anatomical Record, 2013.

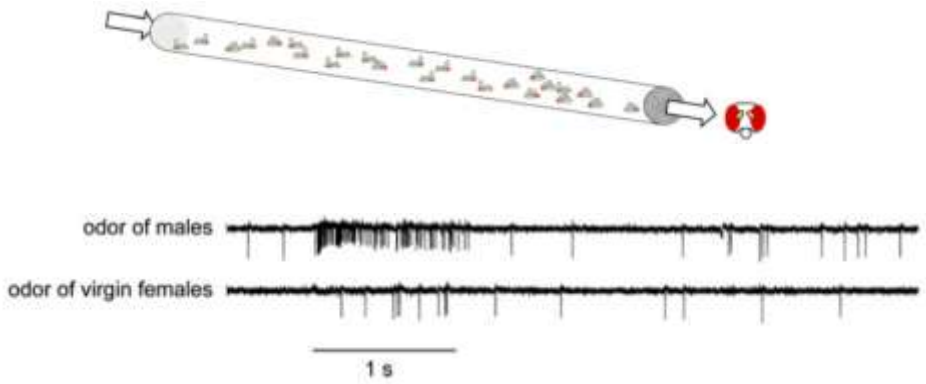
Distribution of responses to extracts and to cVA

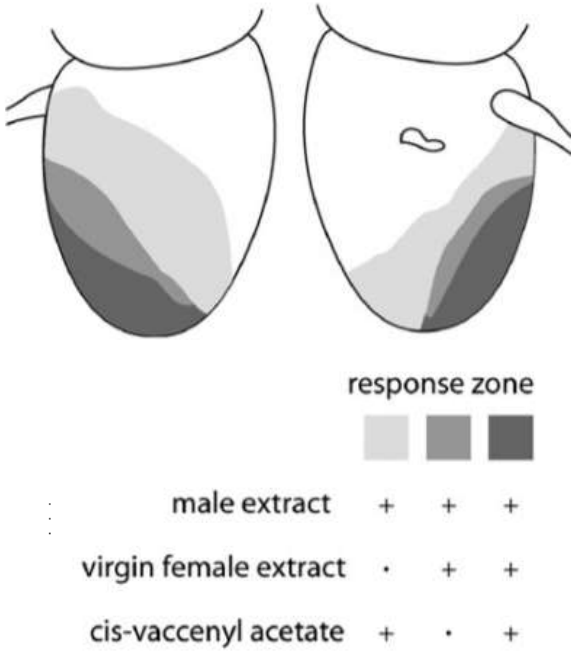
Current Biology
Volume 17, Issue 7, 3 April 2007, Pages 606-612

Report

Receptors and Neurons for Fly Odors in *Drosophila*

Wynand van der Goes van Naters [1], John R. Carlson [1]



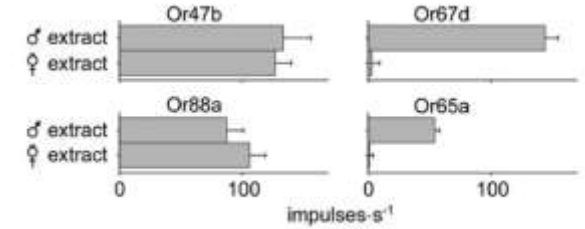


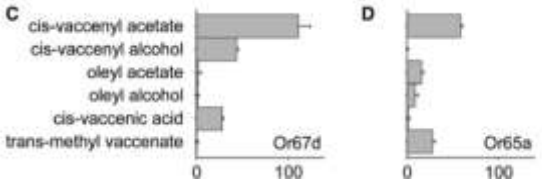
Model of the olfactory basis of mate recognition

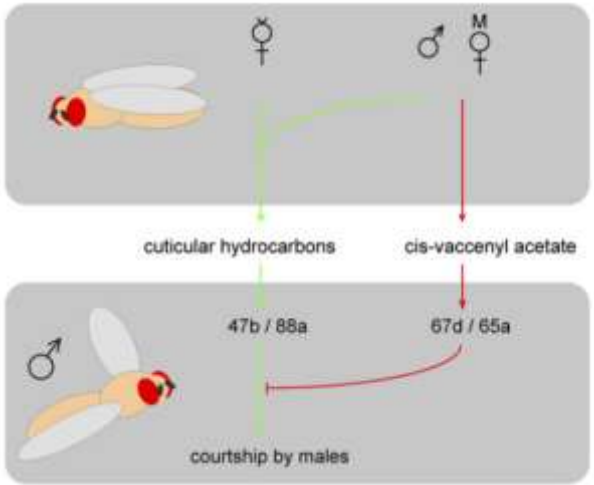
Table 1. Responses Mediated by Ectopically Expressed Receptors

	Or47b	Or88a	Or67d	Or65a
Male extract	++	+	++	+
Virgin-female extract	++	++	·	·
Male genital material	·	++	+++	++
Virgin-female genital material	·	·	·	·
Mated-female genital material	·	++	+++	++
cis-vaccenyl acetate	·	·	++	+

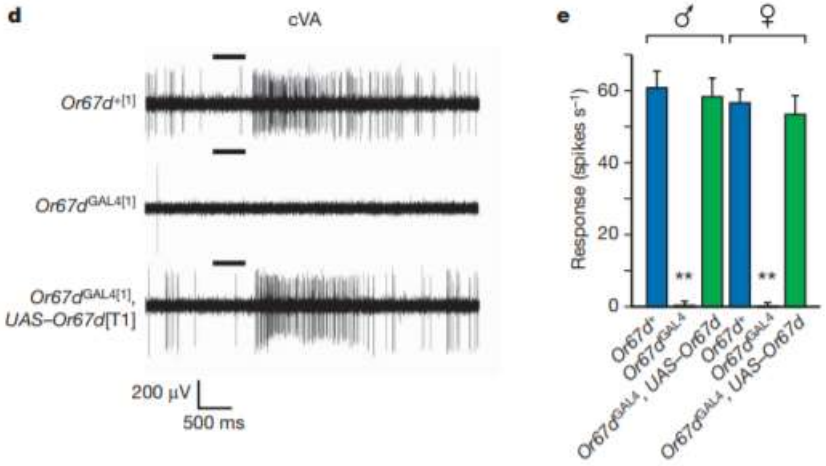
·, n < 50 impulses/s; +, 50 ≤ n < 100 impulses/s; ++, 100 ≤ n < 150 impulses/s; +++, 150 impulses/s ≤ n.

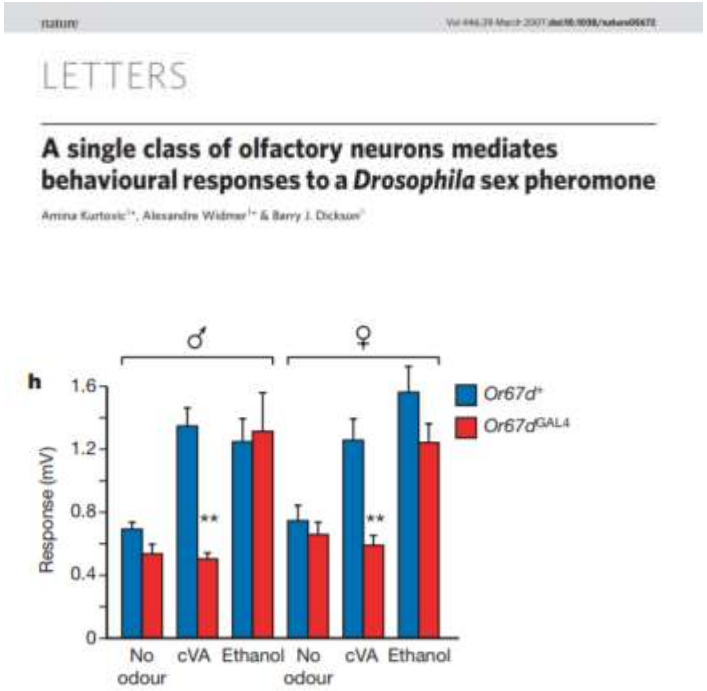




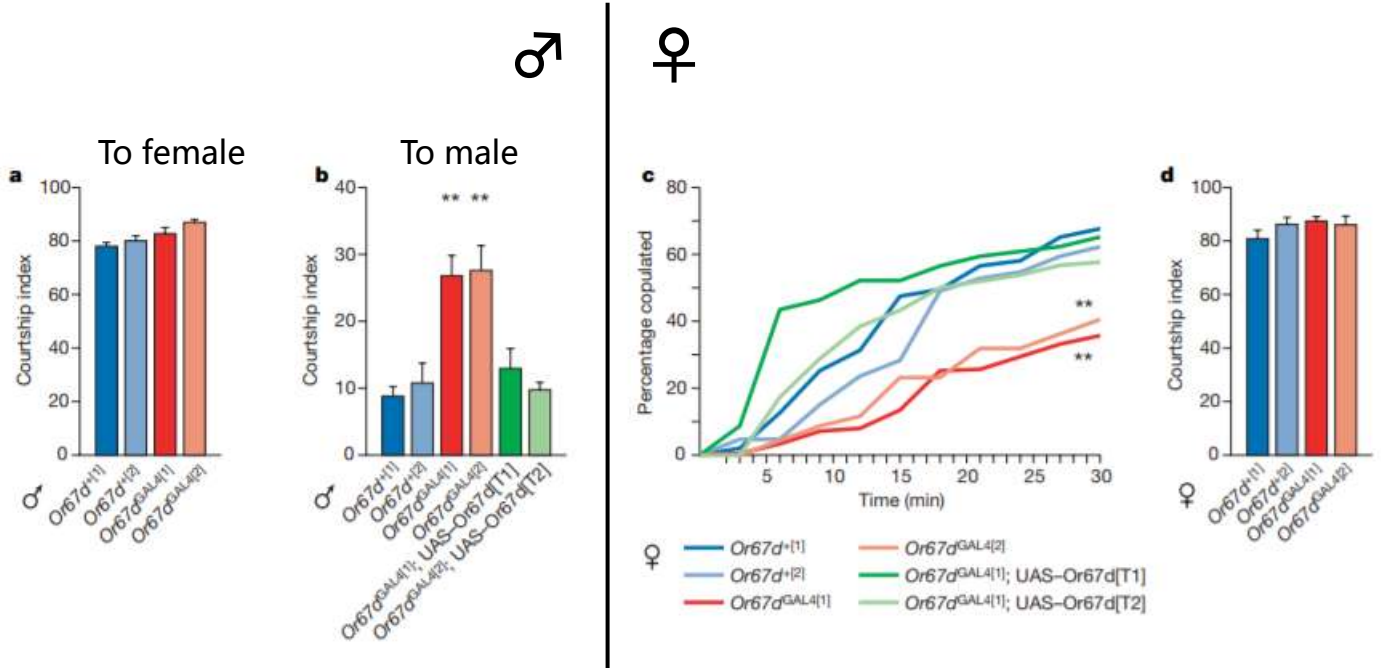


Or67d responses cVA in *Drosophila*





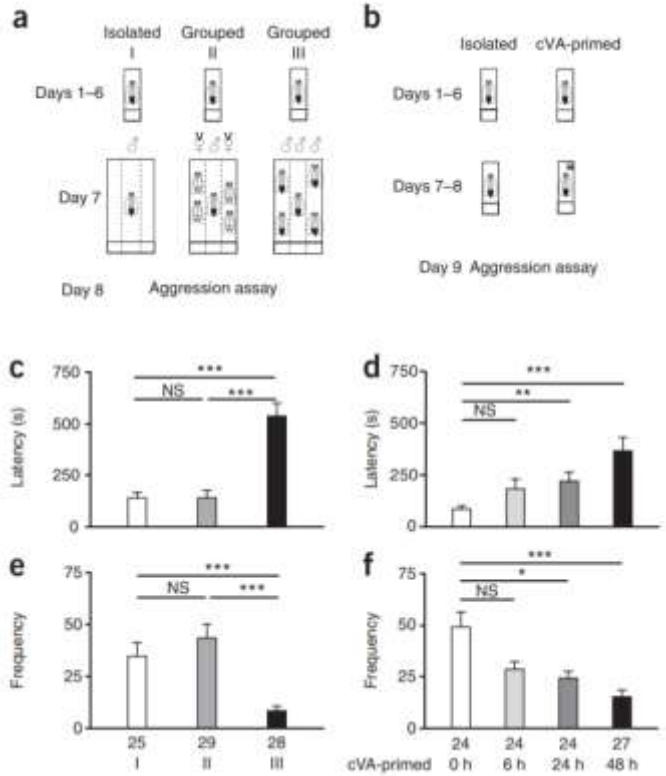
Same receptor mediates distinct behaviors in both sexs



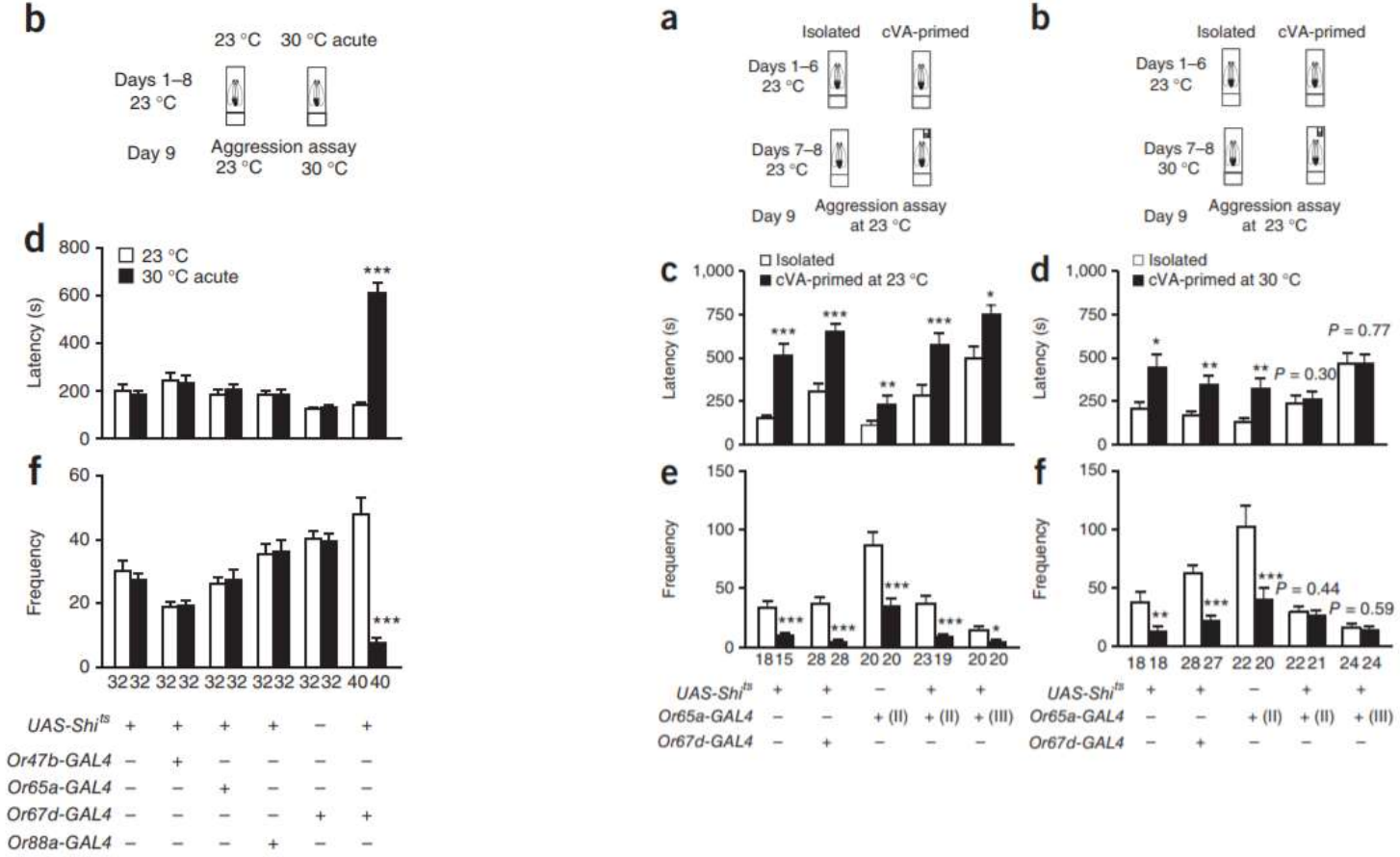
Perception of cVA is related to male aggression

Social regulation of aggression by pheromonal activation of Or65a olfactory neurons in *Drosophila*

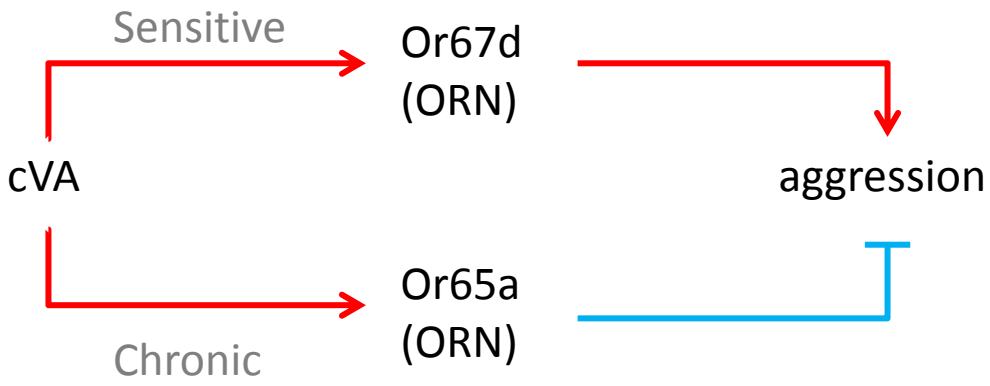
Weiwei Liu[1,3,7], Xinhua Liang[1,3,7], Jianxian Gong[4], Zhen Yang[4], Yao-Hua Zhang[3], Jian-Xu Zhang[3] & Yi Rao[1,6]



Two specific receptors of cVA regulate aggression in different ways



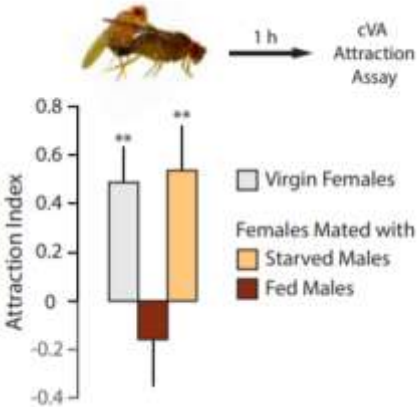
cVA regulates male aggression model

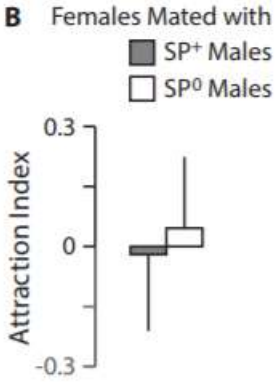


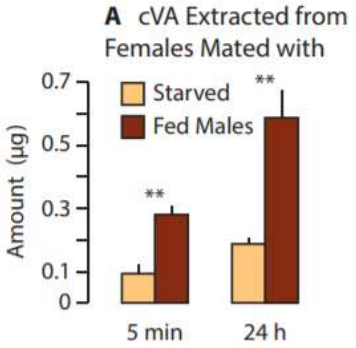
Perception of cVA is related to female receptivity

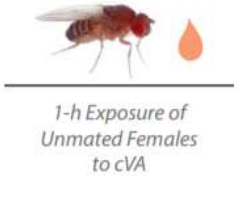
Love makes smell blind: mating suppresses pheromone attraction in *Drosophila* females via Or65a olfactory neurons

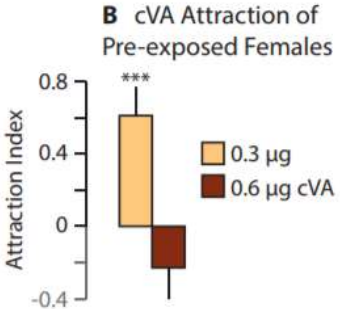
Sébastien Lebreton[1,2], Veit Grabe[2], Aman B. Omondi[1,*], Rickard Ignell[1], Paul G. Becher[1], Bill S. Hansson[2], Silke Sachse[2] & Peter Witzgall[1]

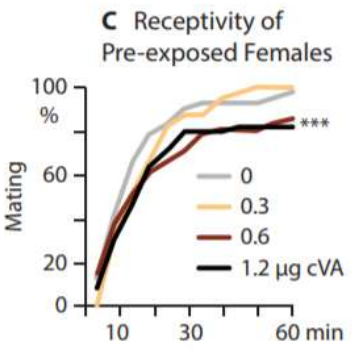




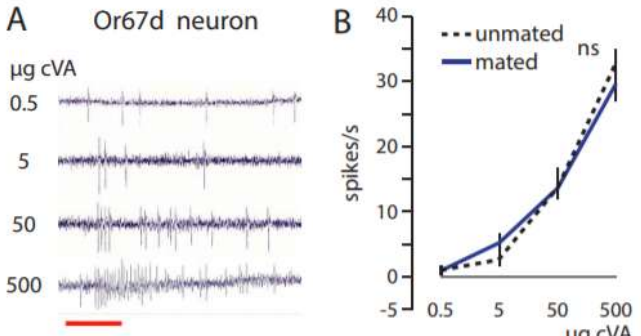






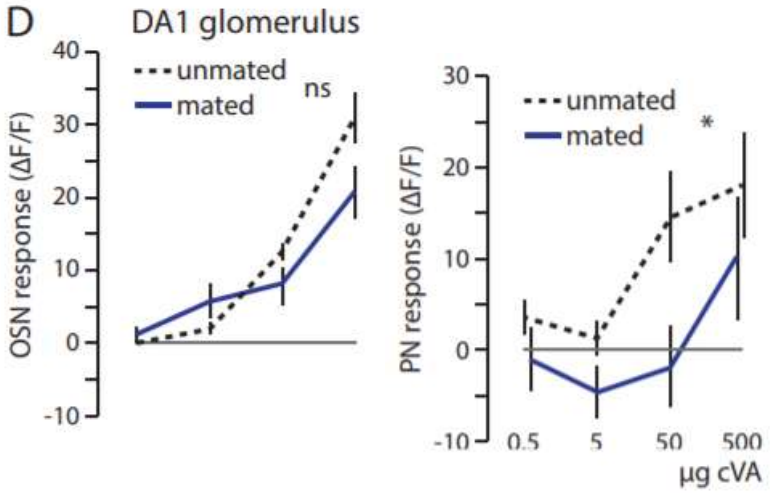


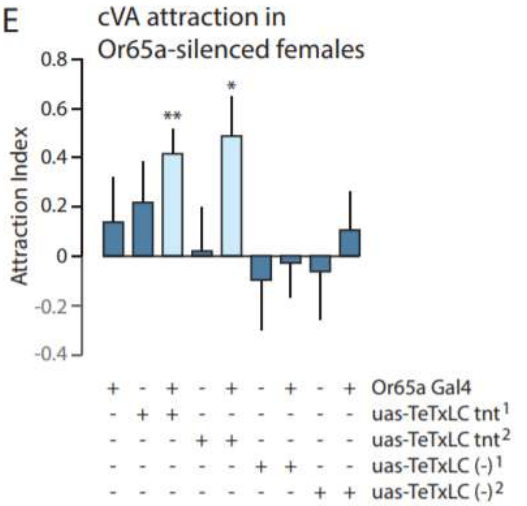
Two specific receptors of cVA regulate receptivity in different ways



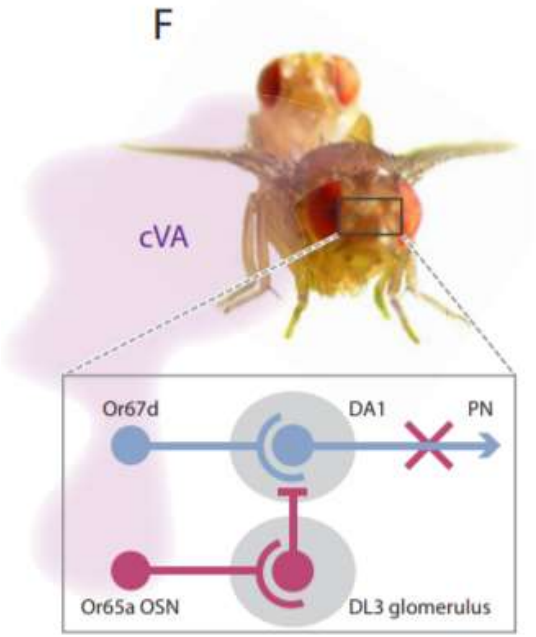
Or67d ⟶ DA1

Or65a ⟶ DL3





cVA regulates male receptivity model



Why the same signal input has different outputs in both sexes?

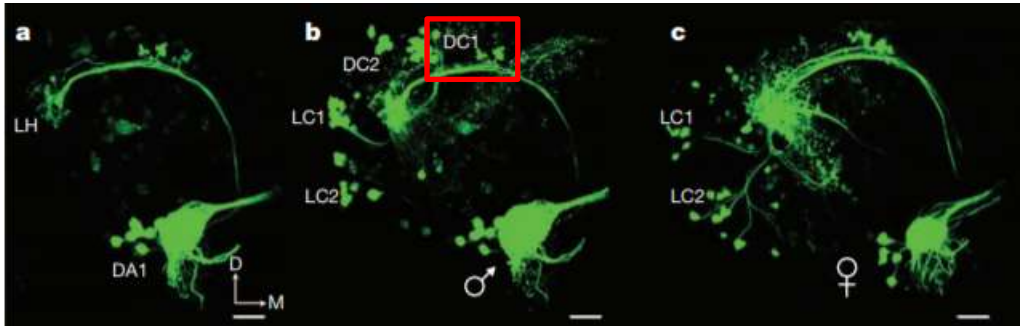
Sex-specific neurons response to DA1

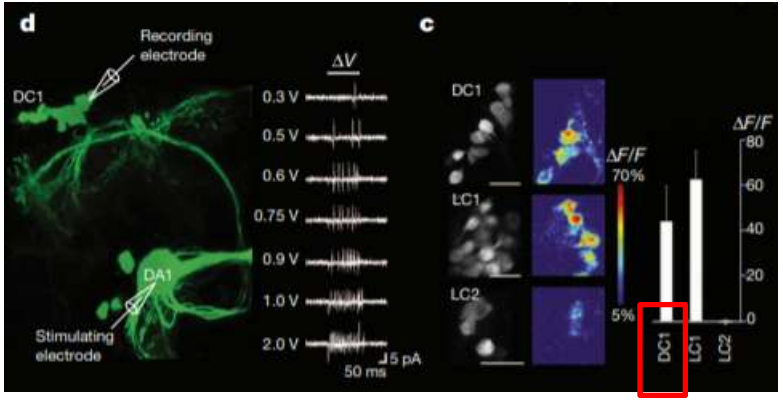
LETTER

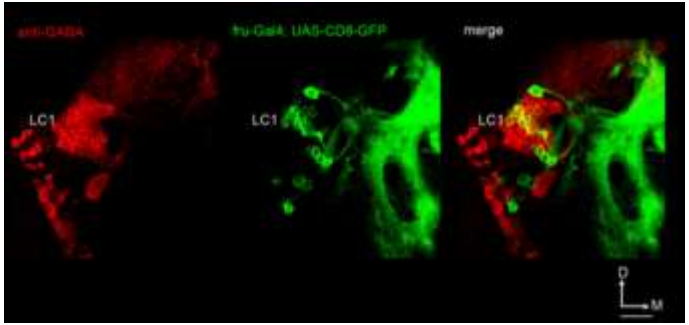
doi:10.1038/nature09554

A dimorphic pheromone circuit in *Drosophila* from sensory input to descending output

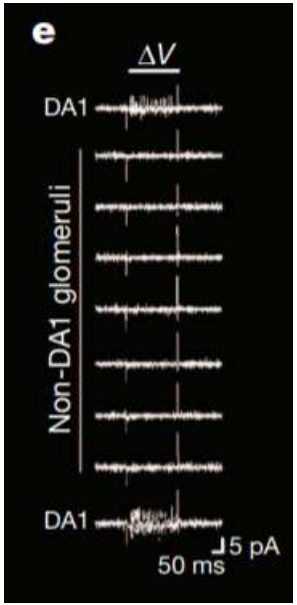
Vanessa Ruta[1], Sandeep Robert Datta[1]†, Maria Luisa Vasconcelos[1]†, Jessica Freeland[1], Loren L. Looger[2] & Richard Axel[1]

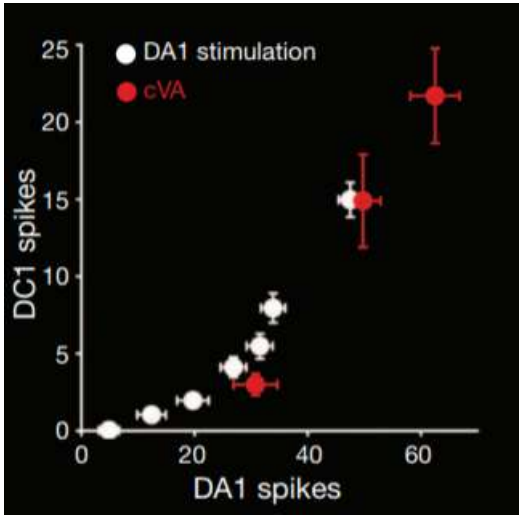


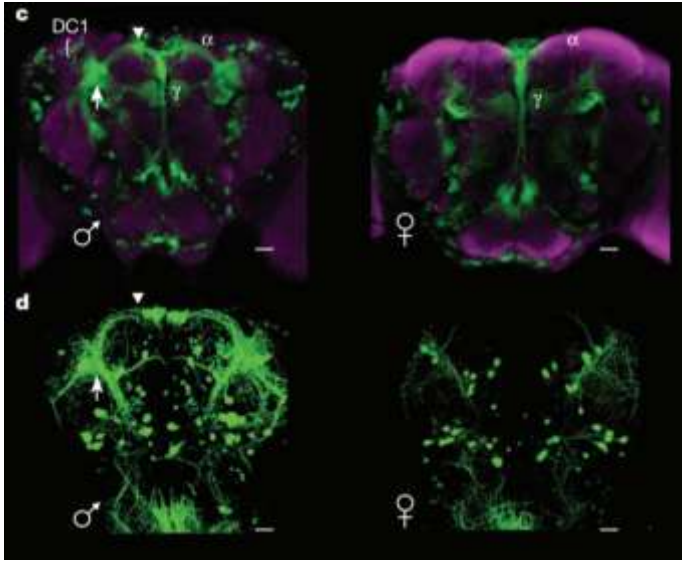




Excitatory neuron DC1 responds to cVA signal

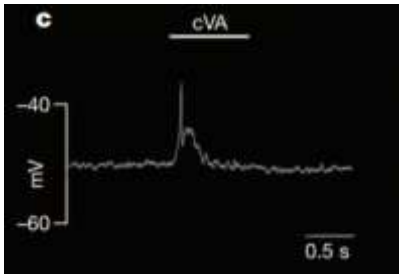


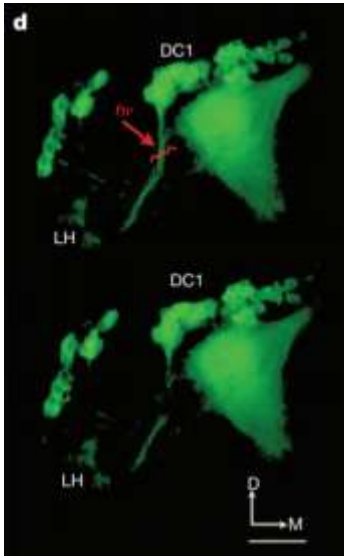


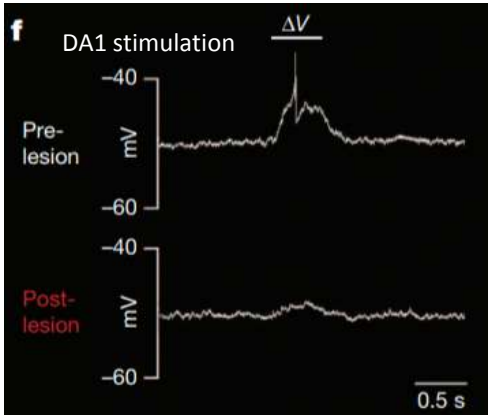


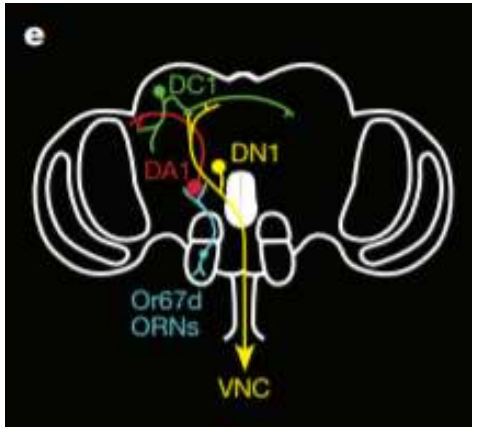
DN1 involved in male-specific circuit of processing cVA

DN1





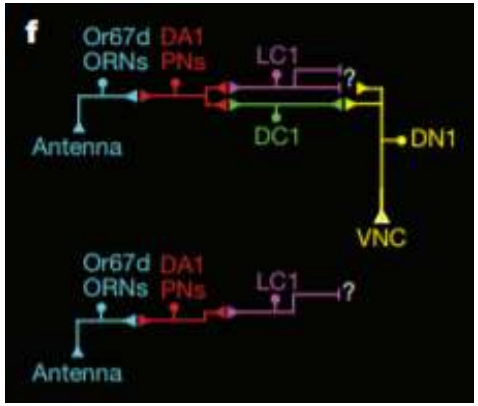




The dimorphic pheromone circuit in *Drosophila* male

♂

♀



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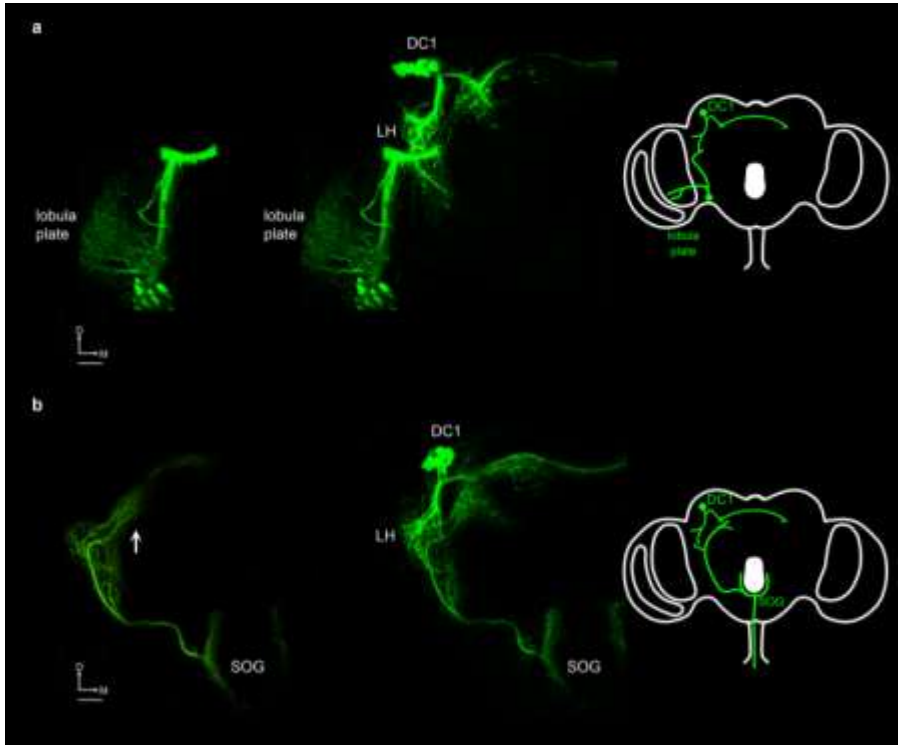


How the same signal is transmitted in different brains?

A Bidirectional Circuit Switch Reroutes Pheromone Signals in Male and Female Brains

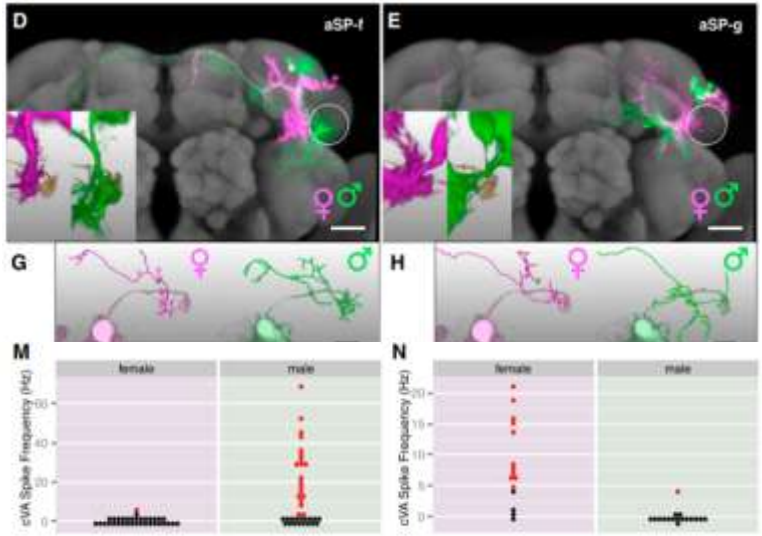
Johannes Kohl,[1,2] Aaron D. Ostrovsky,[1,2,3] Shahar Frechter,[1] and Gregory S.X.E. Jefferis[1,4]

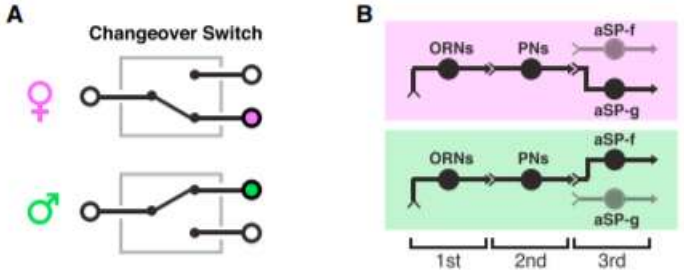
♂ ♀

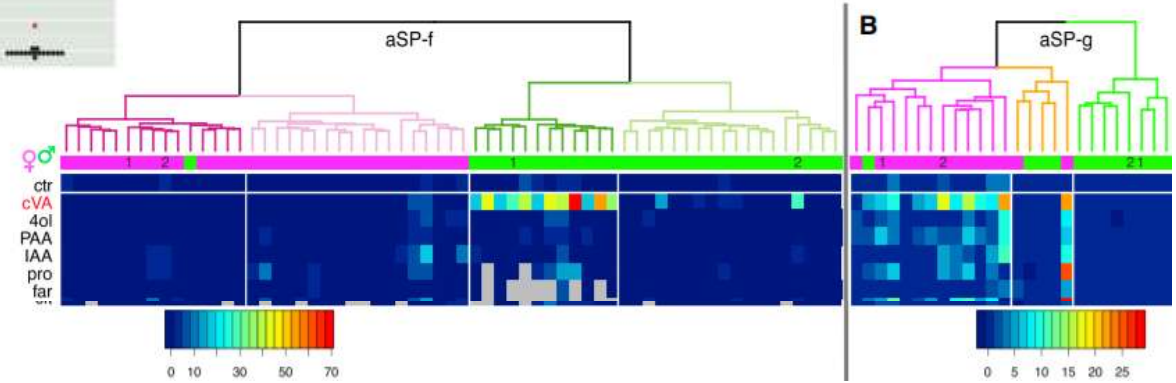
Table 1. Summary of Studies of *fru+* LHNs

Cachero et al. (2010)		aSP-f	aSP-g	aSP-h	aSP-k	aIP-e
Cell Number	male	23.2 (2.6)	13.4 (0.9)	5.0 (0.8)	29.2 (3.3)	27.0 (4.2)
	female	18.6 (5.0)	13.4 (4.9)	5.0 (0.5)	20.2 (3.5)	27.0 (2.2)
Overlap DA1	male	+++	–	+	note 1	++
	female	–	++	±	note 1	++
PA-GFP Prediction	male	yes	no	yes	yes	yes
	female	no	yes	note 2	yes	yes
Ruta et al. (2010)		**DC1**	**n/a**	**DC2**	**LC1**	**LC2**
Cell Number	male	19.7 (2.3)	n/a	Note 3	25.8 (3.4)	13.0 (2.8)
	female	n/a	n/a	n/a	15.8 (3.0)	13.3 (2.1)
PA-GFP Observed	male	yes	no	yes	yes	yes
	female	no	no	no	yes	yes
DA1 Stim. Response	male	+++	n/a	–	+++	±
	female	n/a	n/a	n/a	n/a	n/a
cVA Response	male	+++	n/a	n/a	n/a	n/a
	female	n/a	n/a	n/a	n/a	n/a

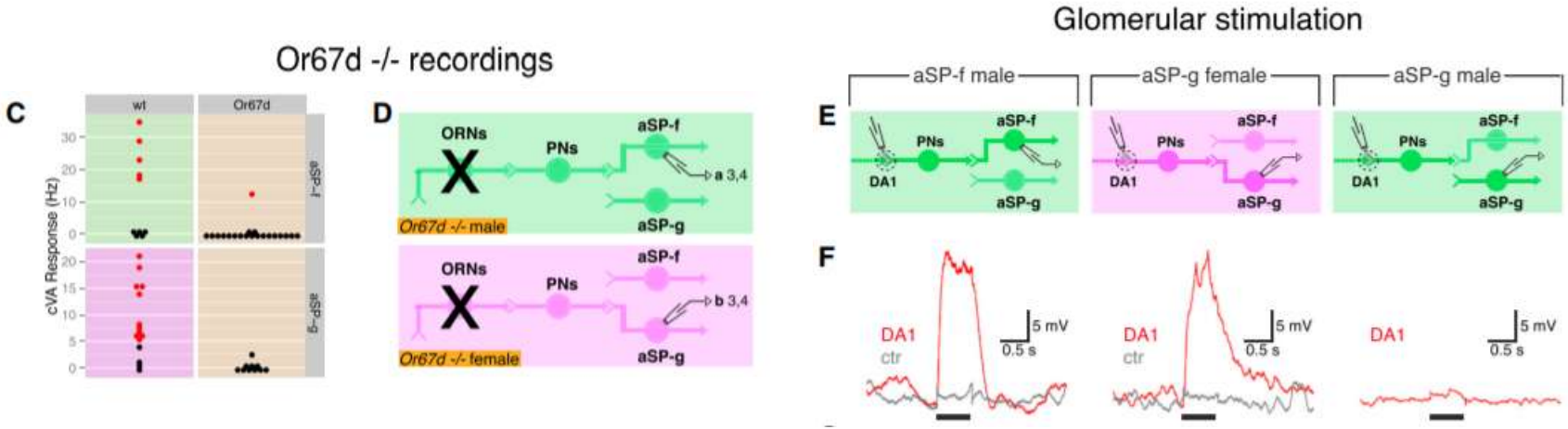
Two *fru*+ LHNs may be involved in sexually-specific circuits



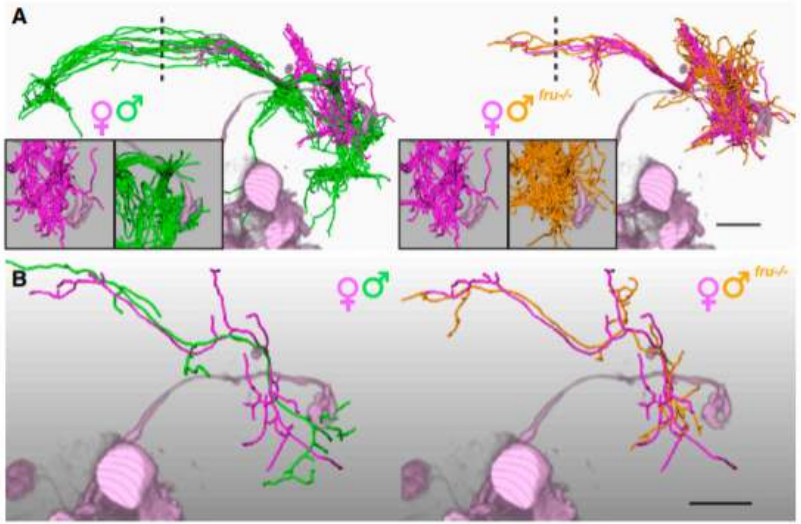




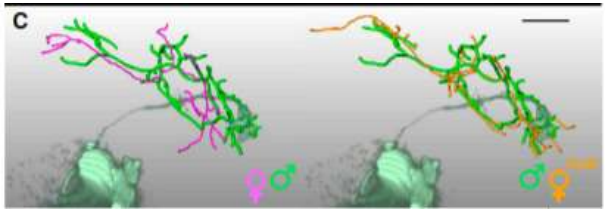
DA1 PNs form sex-specific connections with *fru*+ LHNs



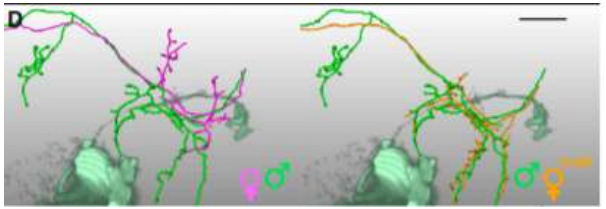
Fru^M is necessary and sufficient for the male form of the switch

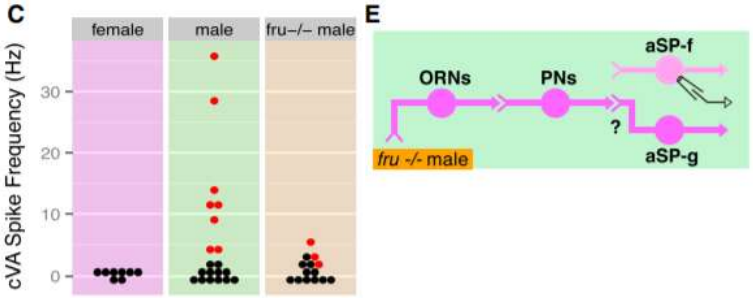


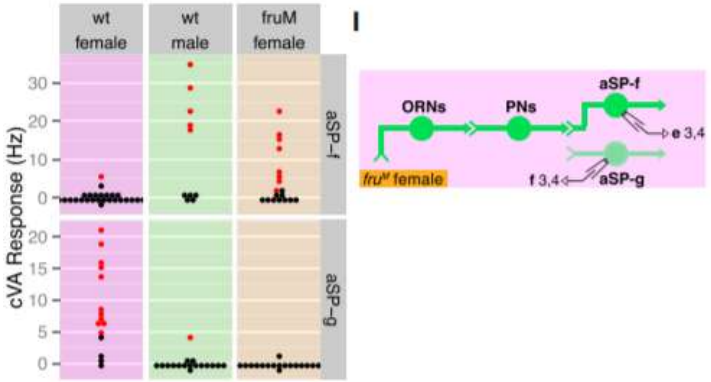
aSP-f



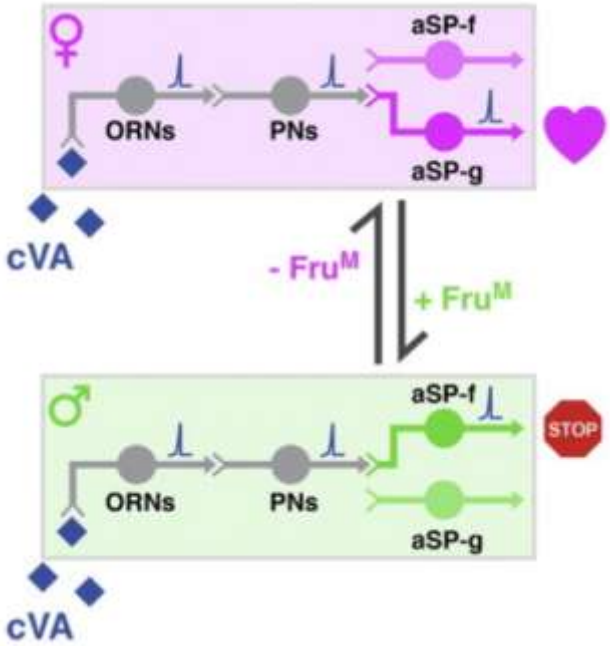
aSP-g







A bidirectional circuit switch reroutes pheromone signals in *Drosophila* brains



Take home messages

- Or65a and Or67d are specific receptors for cVA
- There are sexually dimorphic neural circuits downstream of third order neurons
- *fruitless* is necessary and sufficient in the formation of the sexually dimorphic circuit

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Ruta, V. , Datta, S. R. , Vasconcelos, M. L. , Freeland, J. , Looger, L. L. , & Axel, R. . (2010). A dimorphic pheromone circuit in drosophila from sensory input to descending output. *Nature*, *468*(7324), 686-690.

Kohl, J. , AD Ostrovsky, Frechter, S. , & Jefferis, G. . (2013). A bidirectional circuit switch reroutes pheromone signals in male and female brains. *Cell*.

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Liu, W. , Liang, X. , Gong, J. , Zhen, Y. , & Yi, R. . (2011). Social regulation of aggression by pheromonal activation of or65a olfactory neurons in drosophila. Nature Neuroscience, 14(7), 896-902.

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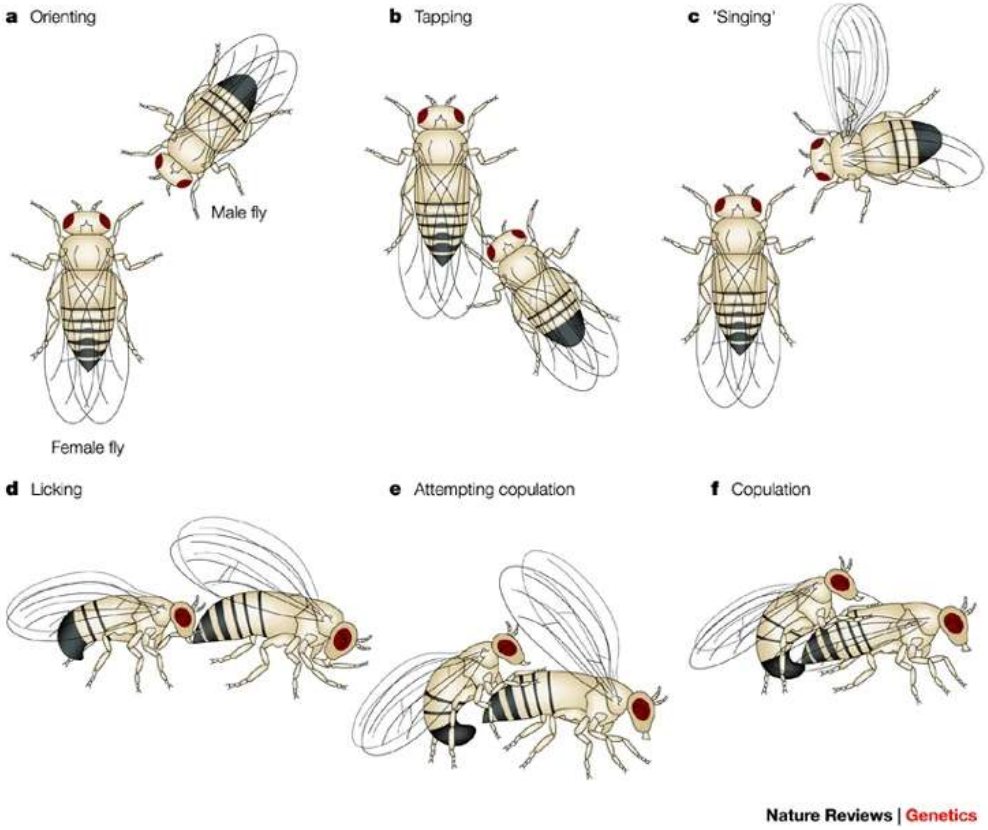
Nonvolatile-pheromonal information processing in gustatory system in male courtship behavior

THREE

SMS

Sequence of courtship behaviors shown by *Drosophila melanogaster* males towards females.



From: *Drosophila*: Genetics meets behaviour

Cell

Contact Chemoreceptors Mediate Male-Male Repulsion and Male-Female Attraction during *Drosophila* Courtship

Robert Thistle,[2,3] Peter Cameron,[2,3,4] Azeen Ghorayshi,[2] Lisa Dennison,[2] and Kristin Scott[1,2,*]
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[2]Department of Molecular and Cell Biology and Helen Wills Neuroscience Institute
16 Barker Hall, University of California, Berkeley, Berkeley, CA 94720, USA
[3]These authors contributed equally to this work
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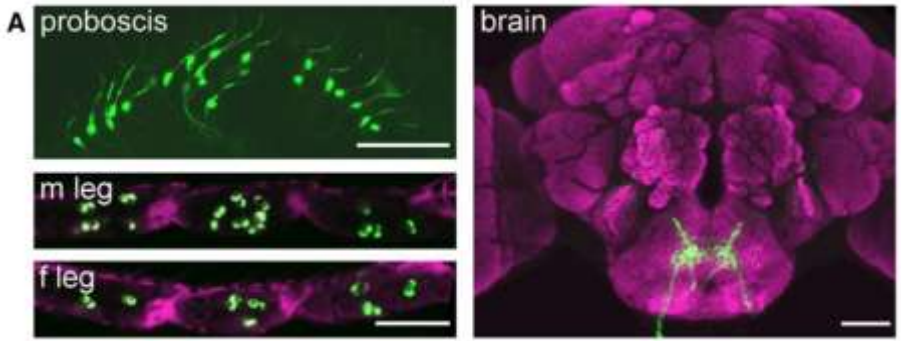
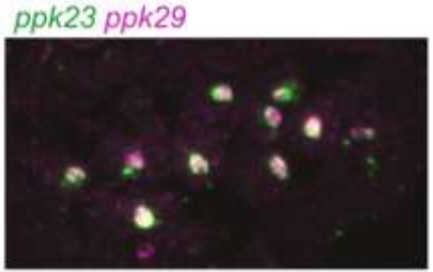
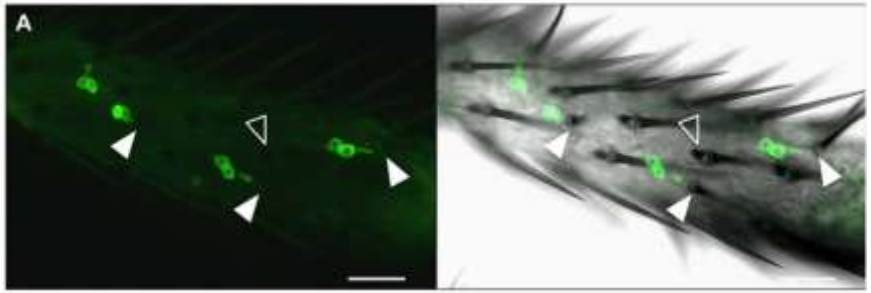
*Correspondence: kscott@berkeley.edu
DOI 10.1016/j.cell.2012.03.045

ppk23+ & ppk29+ neurons

PPK23-Gal4>uas-myrGFP



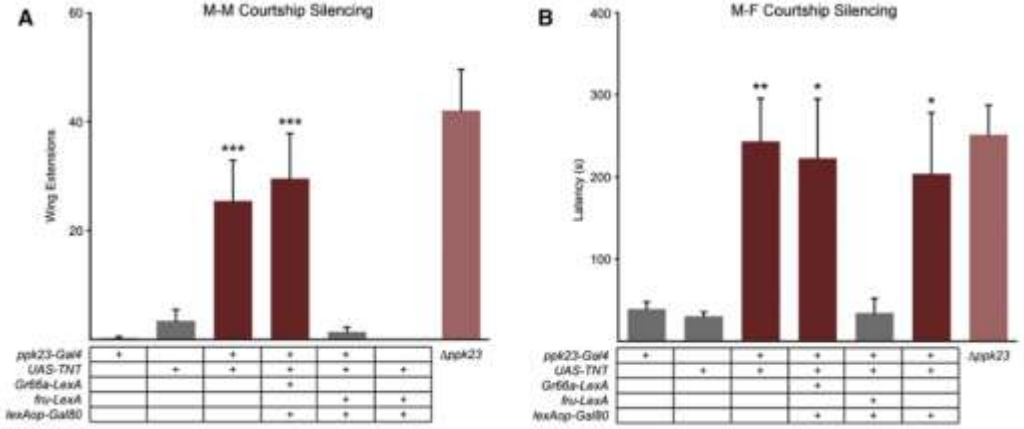




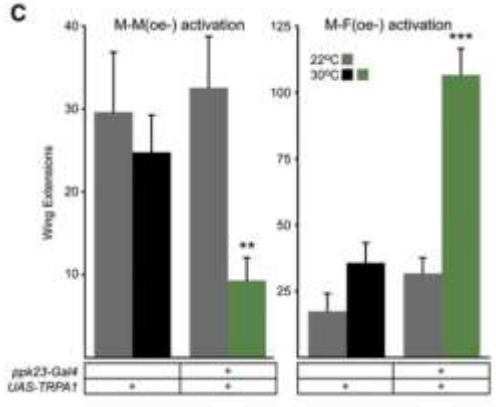
ppk23-GAL4 x UAS-CD8::GFP

B. Lu, A. LaMora, Y. Sun, M. J. Welsh, Y. Ben-Shahar, Plos Genet. 8, e1002587 (2012).

PPK23+ cells are necessary to inhibit male-male courtship and promote female courtship.

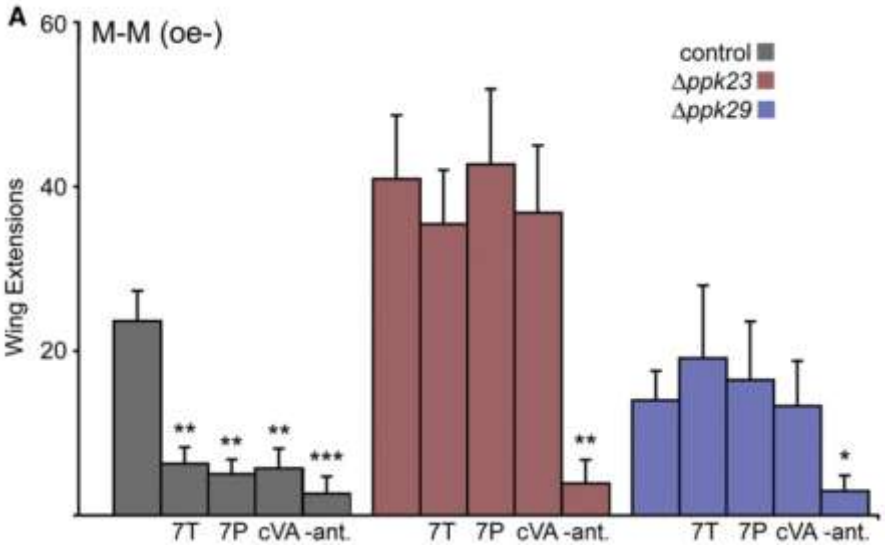


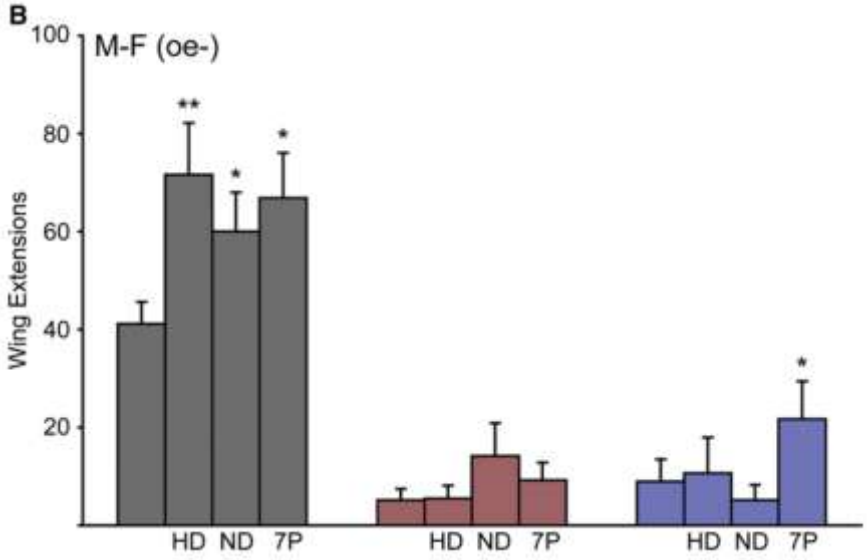
Activation of ppk23+ cells drives appropriate courtship behavior.



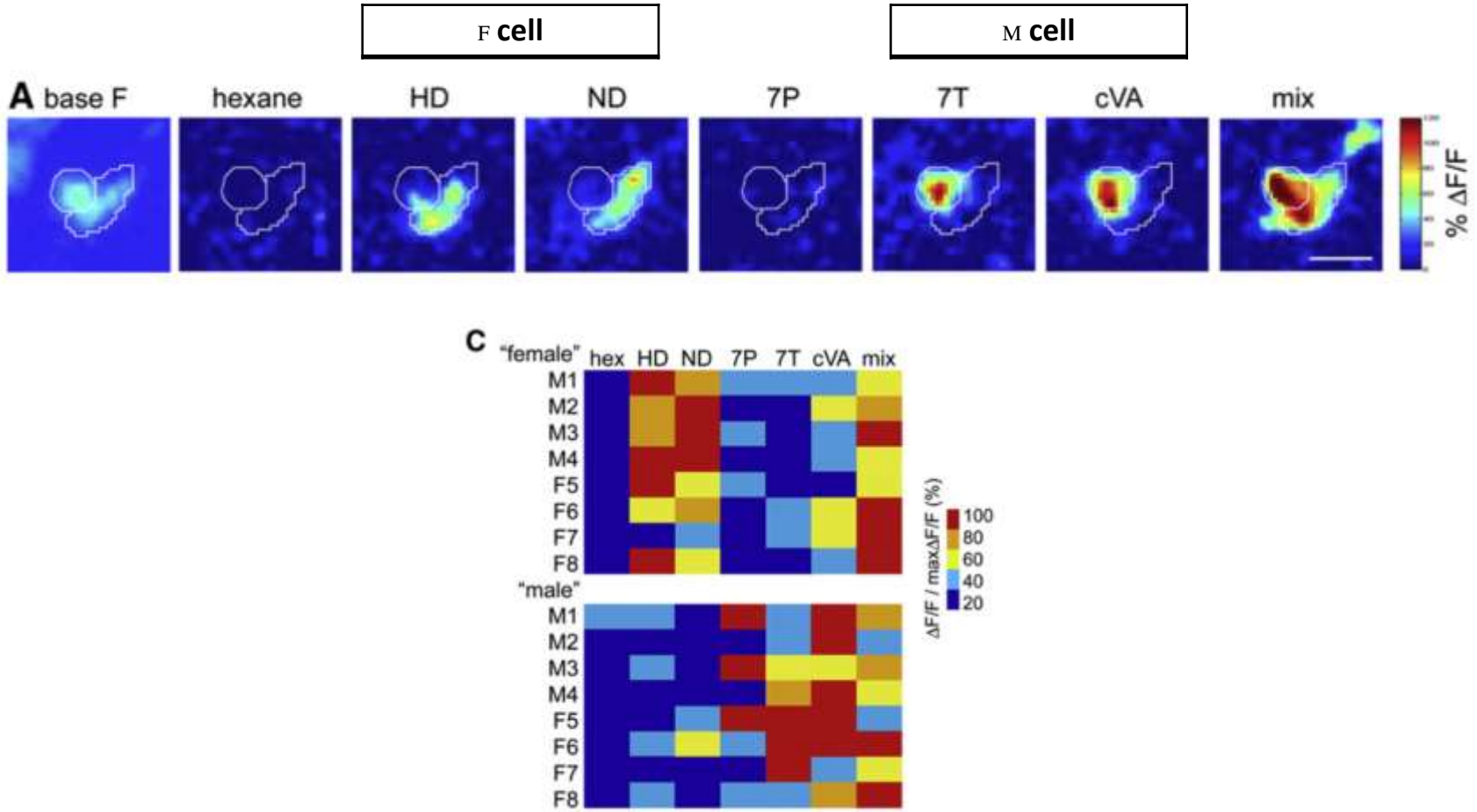
7T and cVA are inhibitorycompounds on males.
7P is abundant on males, with more complex roles in courtship.

7,11-HD and 7,11-ND are excitatorycompounds on females.





Animals lacking antennae (-ant.)


F cell
M cell
A
base F
hexane
HD
ND
7P
7T
cVA
mix
% ΔF/F
C
"female"
hex HD ND 7P 7T cVA mix
M1
M2
M3
M4
F5
F6
F7
F8
"male"
M1
M2
M3
M4
F5
F6
F7
F8
ΔF/F / maxΔF/F (%)
100
80
60
40
20

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PLOS | GENETICS

Drosophila Pheromone-Sensing Neurons Expressing the *ppk25* Ion Channel Subunit Stimulate Male Courtship and Female Receptivity

Vinoy Vijayan[1,2], Rob Thistle[3,4], Tong Liu[1,2,5], Elena Starostina[1,2], Claudio W. Pikielny[1,2]*

1 Department of Genetics, Geisel School of Medicine at Dartmouth, Hanover, New Hampshire, United States of America, **2** Neuroscience Center, Geisel School of Medicine at Dartmouth, Hanover, New Hampshire, United States of America, **3** Department of Molecular and Cell Biology and Helen Wills Neuroscience Institute, University of California, Berkeley, Berkeley, California, United States of America, **4** Howard Hughes Medical Institute, University of California, Berkeley, Berkeley, California, United States of America, **5** Institute of Neuroscience, Chinese Academy of Sciences, Shanghai, China

Cellular/Molecular

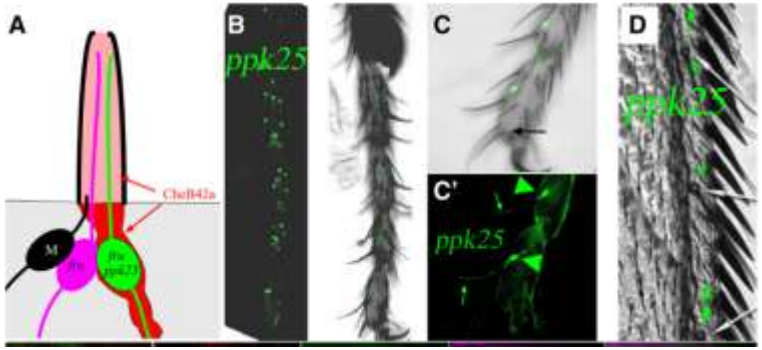
A *Drosophila* DEG/ENaC Subunit Functions Specifically in Gustatory Neurons Required for Male Courtship Behavior

Elena Starostina,[1,2] Tong Liu,[1,2] Vinoy Vijayan,[1,2] Zheng Zheng,[3] Kathleen K. Siwicki,[3] and Claudio W. Pikielny[1,2]

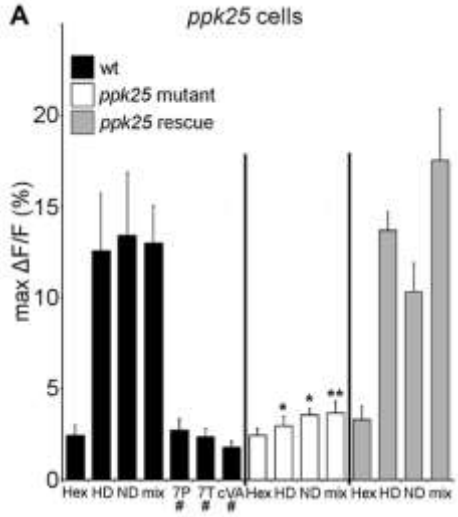
[1]Department of Genetics and [2]Neuroscience Center, Dartmouth Medical School, Hanover, New Hampshire 03755-1404 and [3]Department of Biology, Swarthmore College, Swarthmore, Pennsylvania 19081

V. Vijayan, R. Thistle, T. Liu, E. Starostina, C. W. Pikielny, PLoS Genetics. 10, e1004238 (2014).

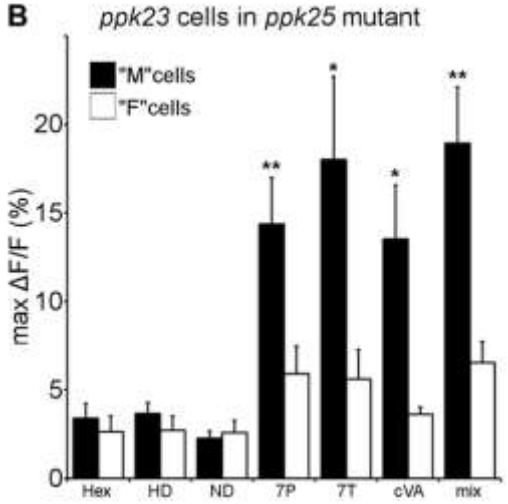
ppk25



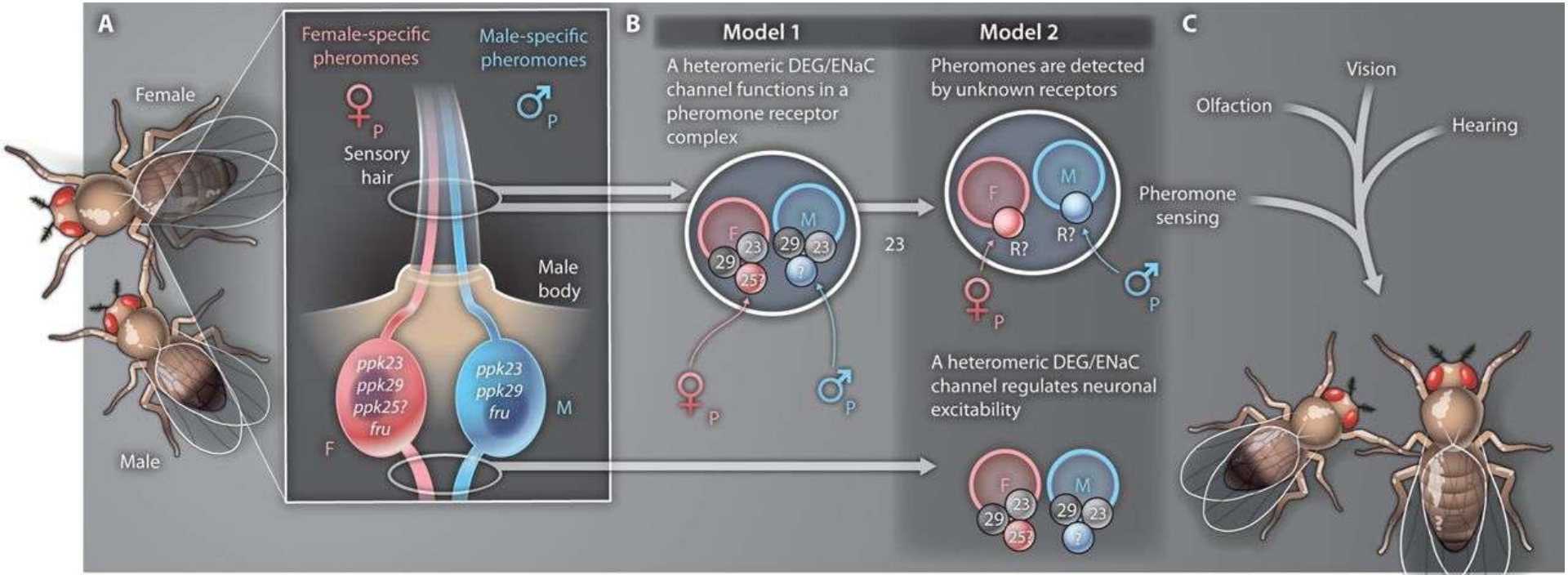
ppk25+ neuron respond to female pheromone



ppk25 is essential for the recognition of courtship-stimulating pheromone



E. Starostina et al., J Neurosci. 32, 4665−4674 (2012).



C. W. Pikielny, Sci Signal. 5, pe48−pe48 (2012).

eLIFE
elifesciences.org

RESEARCH ARTICLE

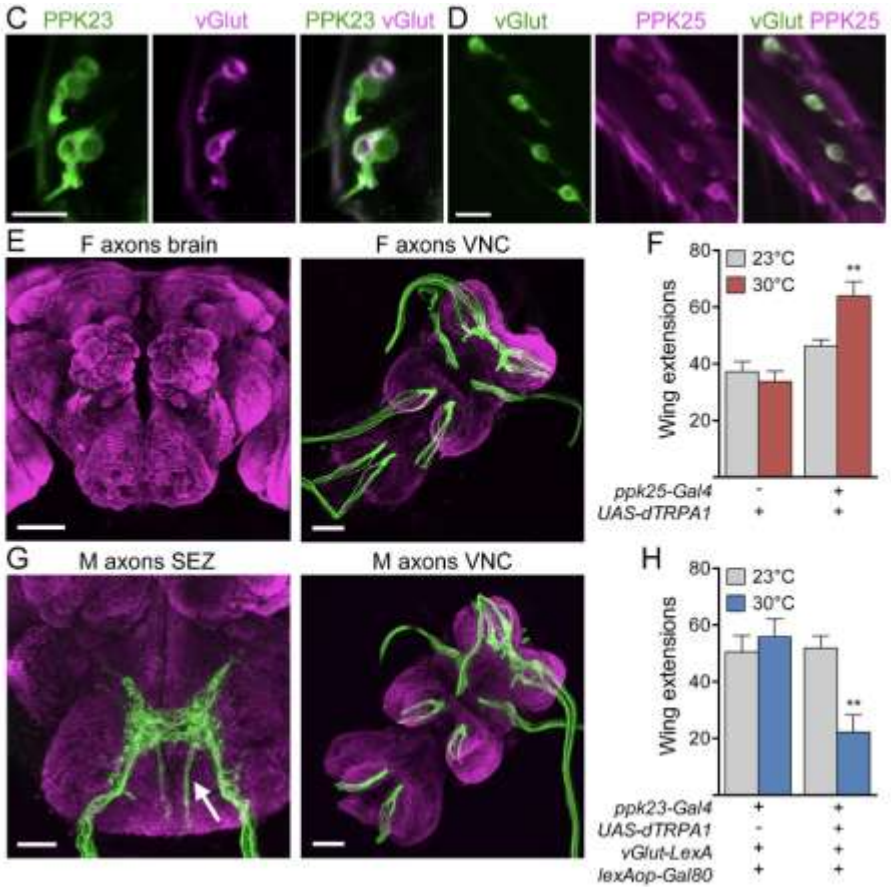
Excitation and inhibition onto central courtship neurons biases *Drosophila* mate choice

Benjamin R Kallman[1,2], Heesoo Kim[1,2], Kristin Scott[1,2]*

[1]Department of Molecular and Cell Biology, University of California, Berkeley, Berkeley, United States; [2]Helen Wills Neuroscience Institute, University of California, Berkeley, Berkeley, United States

2015

F and M cells comprise distinct chemosensory neuron classes

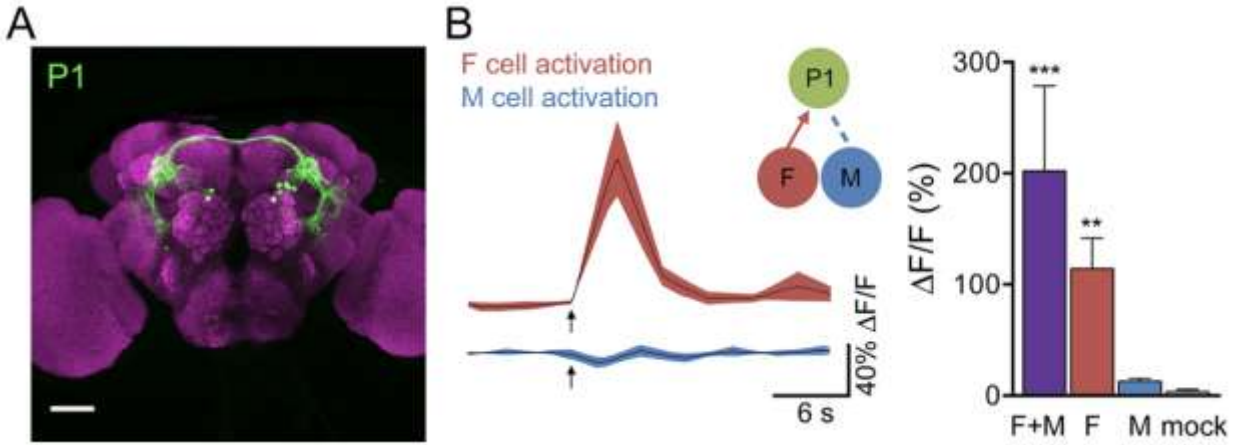


F cell, respond to female pheromone:

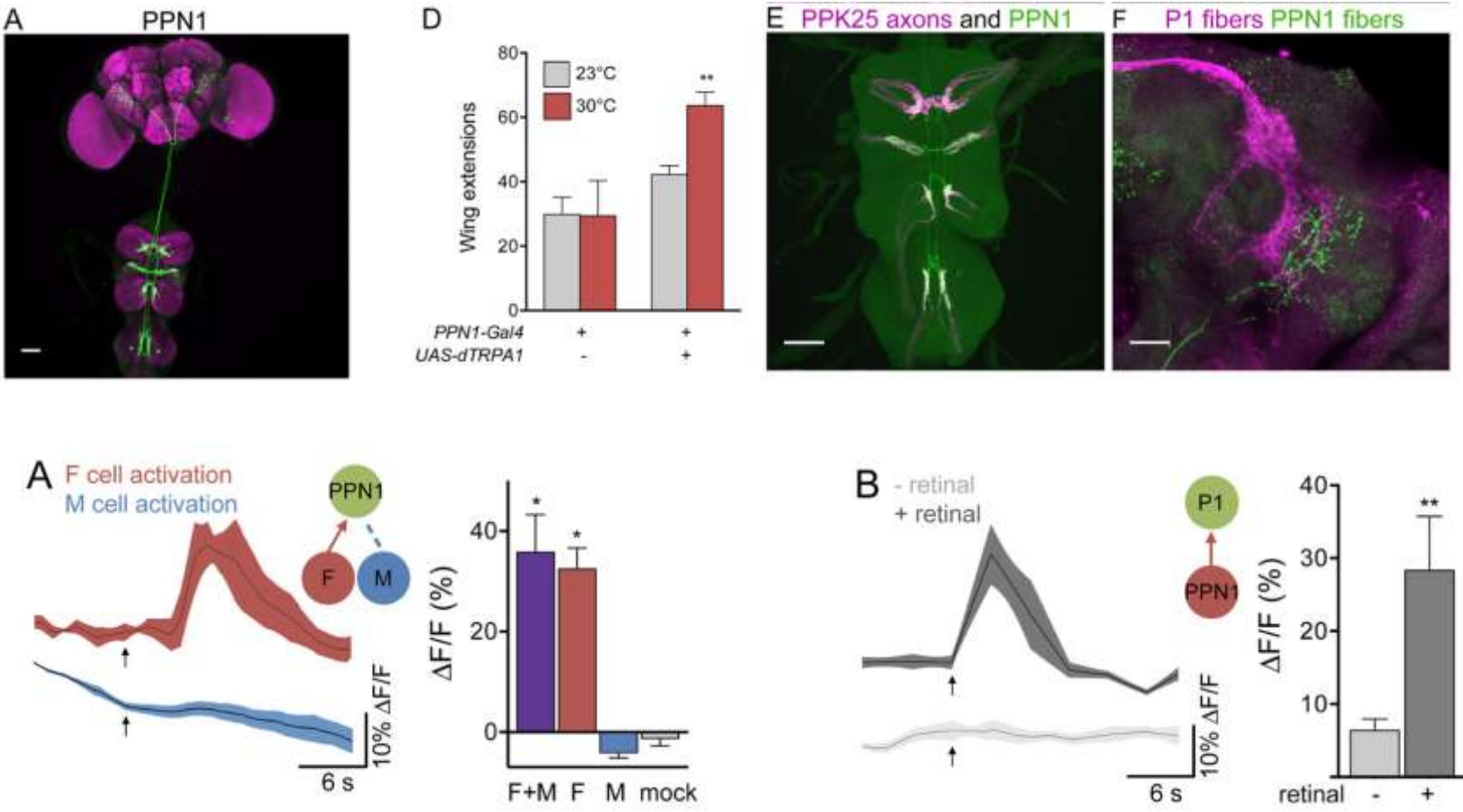
ppk25+, vGlut+

M cell, respond to male pheromone

F cell stimulation activates P1 neurons

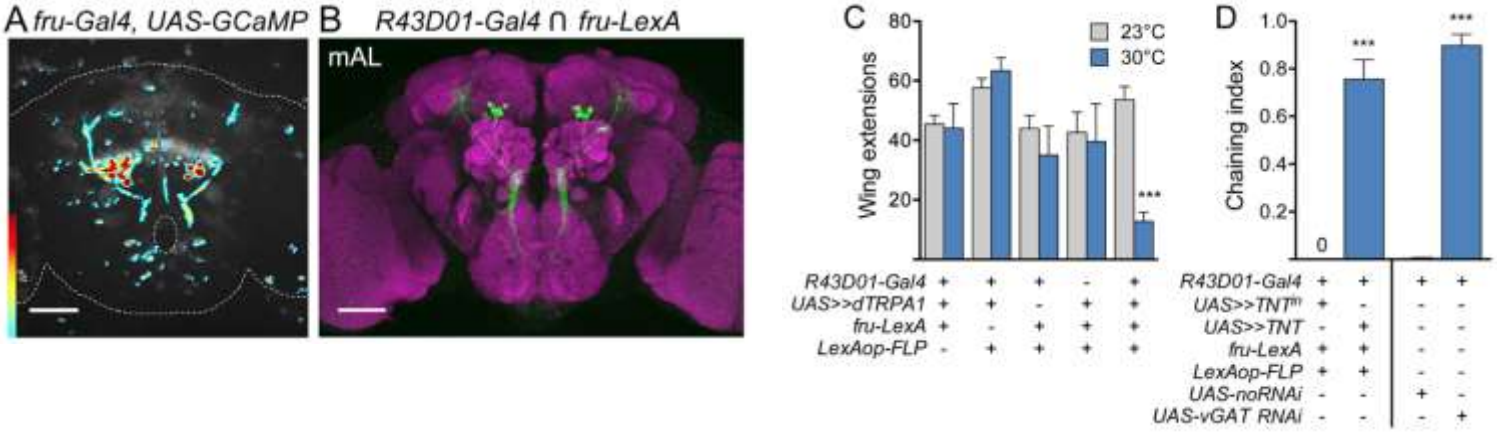


PPN1 neurons respond to F cell stimulation and activate P1 neurons



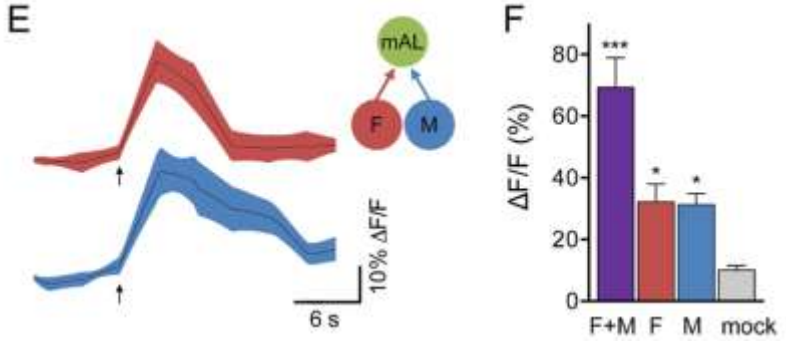
Activation of F+M cells

mAL neurons inhibit courtship via GABA

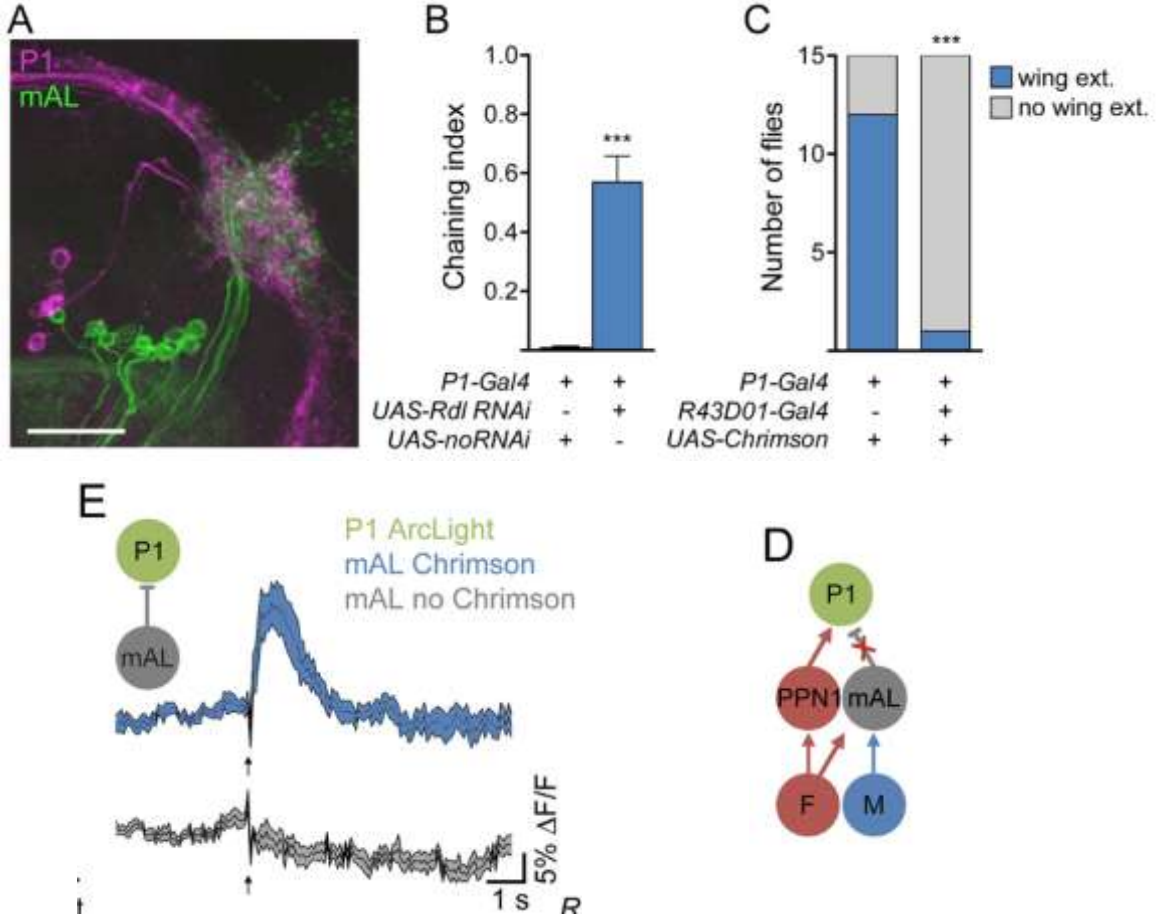


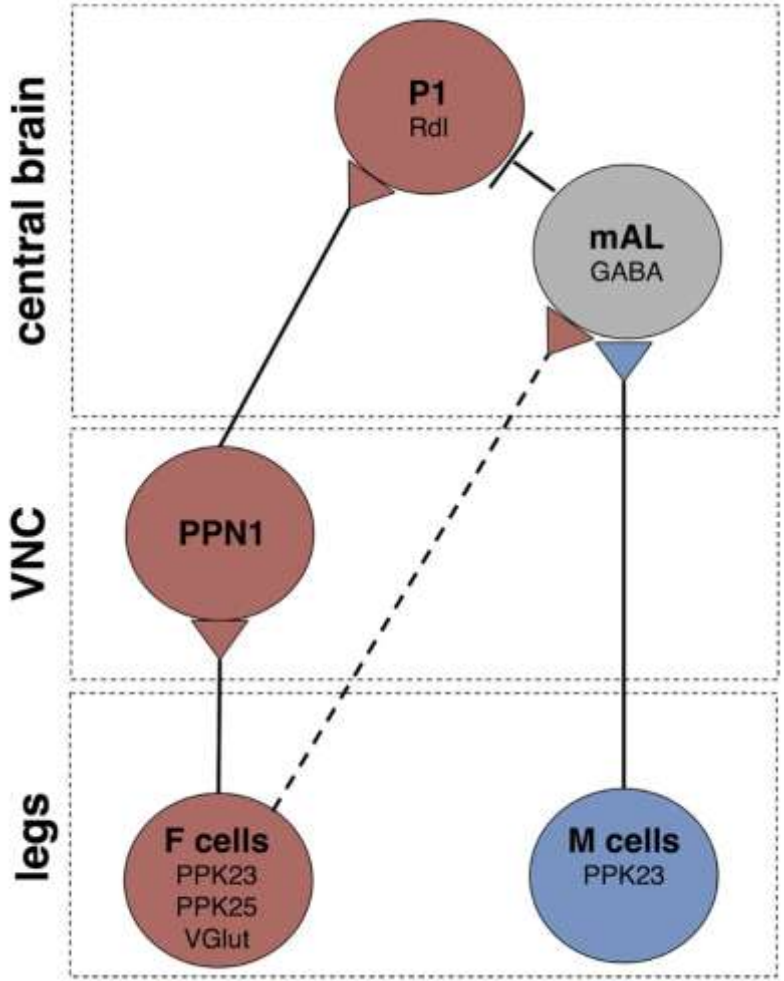
GABAergic neurons

M cells and F cells activate courtship-suppressing mAL neurons.



mAL neurons functionally and behaviorally inhibit P1 neurons.




central brain
VNC
legs
P1
Rdl
mAL
GABA
PPN1
F cells
PPK23
PPK25
VGlut
M cells
PPK23

Neuron

Multimodal Chemosensory Circuits Controlling Male Courtship in *Drosophila*

Authors

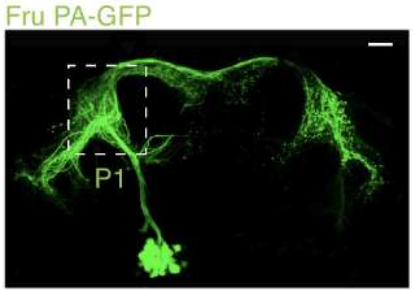
E. Josephine Clowney, Shinya Iguchi, Jennifer J. Bussell, Elias Scheer, Vanessa Ruta

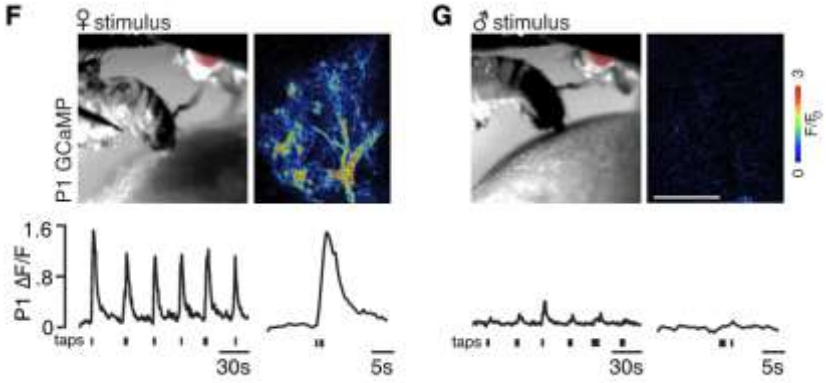
Highlights

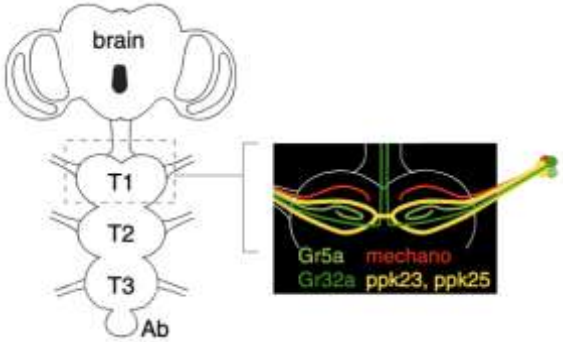
- P1 neurons are functionally tuned toward appropriate potential mates
- Gustatory and olfactory pheromone circuits converge on P1 neurons
- Pheromone signals are carried by parallel excitatory and inhibitory branches
- This neural architecture allows stringent and flexible control of courtship behavior

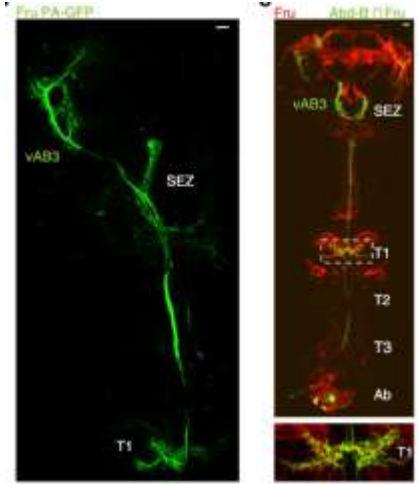
2015

P1 neuron chemosensory tuning correlates with mate preference



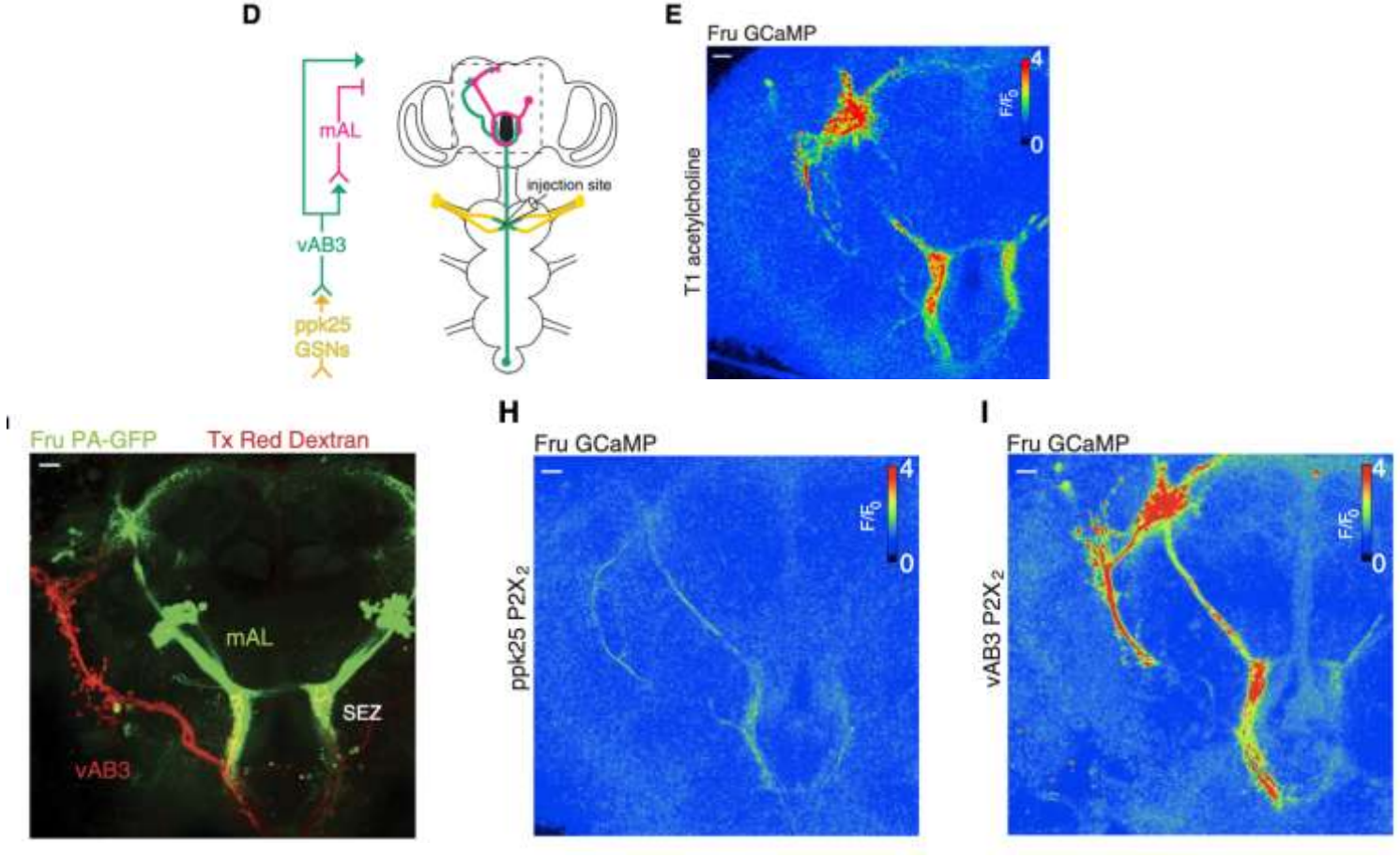




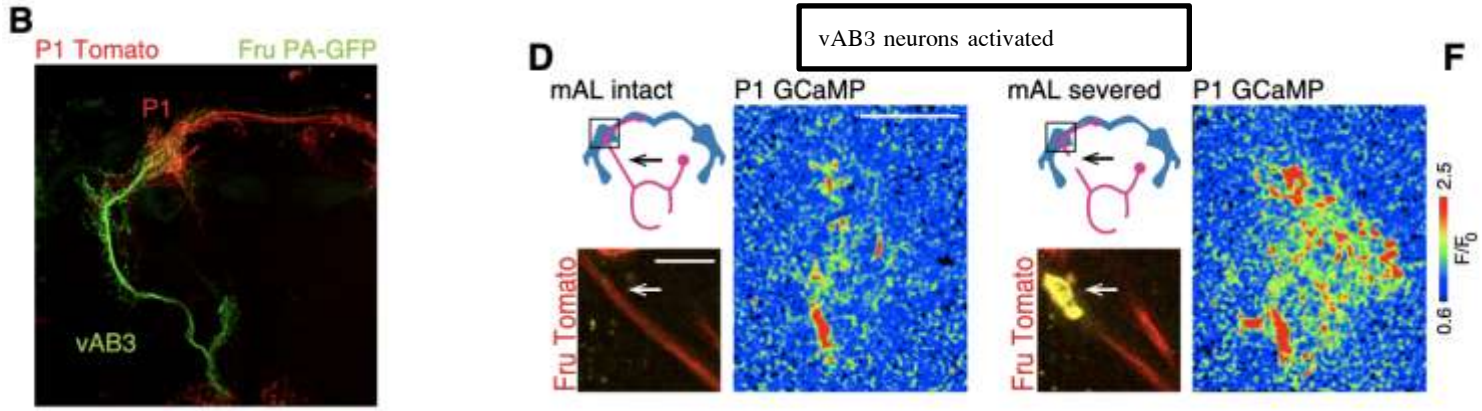


PA-GFP is a mutant form of GFP, in which fluorescent intensity can be increased over a 100-fold after activation with ~400nm light.

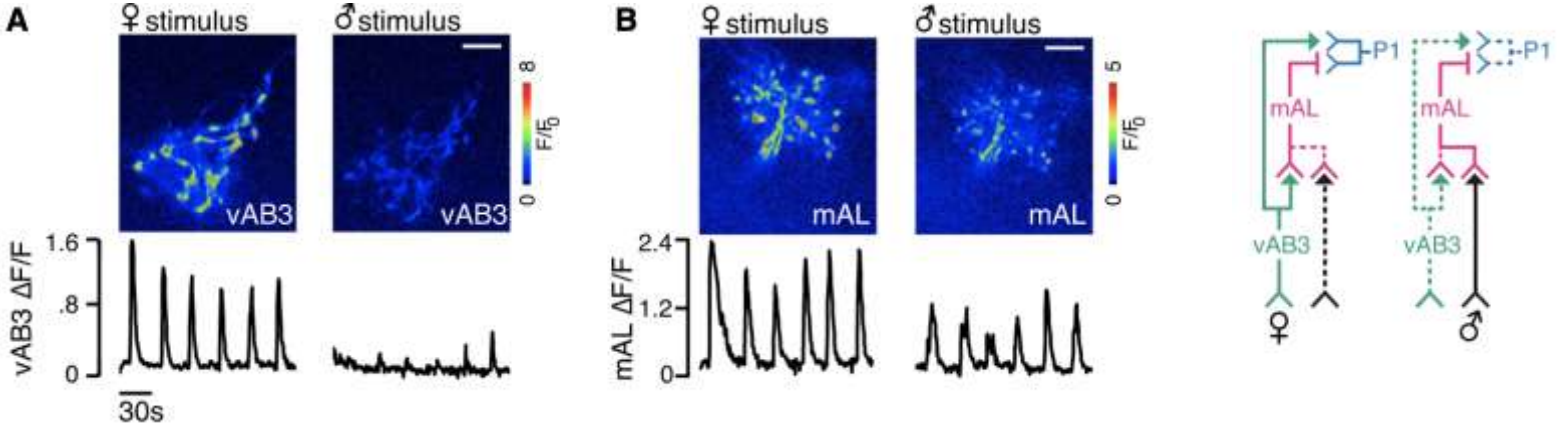
vAB3 neurons convey sensory signals from ppk25+ axons in the ventral nerve cord to mAL interneurons within the brain



Excitatory vAB3 neurons and inhibitory mAL neurons converge onto P1 Neurons



Differential pheromone tuning of vAB3 and mAL neurons



Current Biology 20, 1–8, January 12, 2010 ©2010 Elsevier Ltd All rights reserved DOI 10.1016/j.cub.2009.11.038

Article

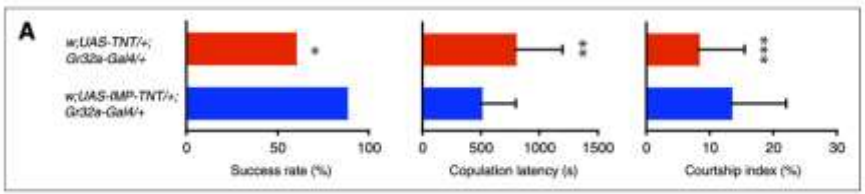
The Shaping of Male Courtship Posture by Lateralized Gustatory Inputs to Male-Specific Interneurons

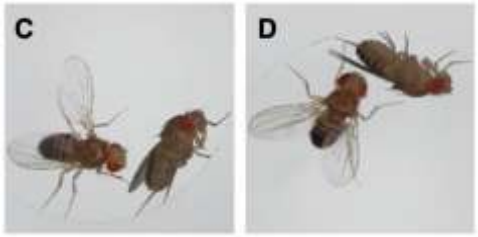
Masayuki Koganezawa,[1] Daisuke Haba,[2] Takashi Matsuo,[2] and Daisuke Yamamoto[1,*]

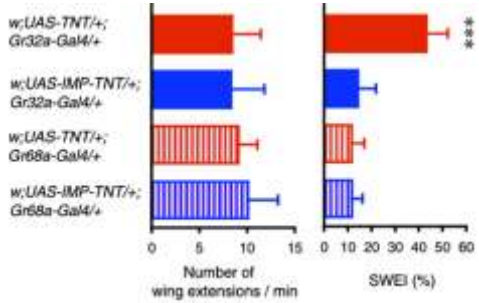
[1]Division of Neurogenetics, Tohoku University Graduate School of Life Sciences, Sendai 980-8578, Japan

[2]Department of Biological Sciences, Tokyo Metropolitan University, Hachioji, Tokyo 192-0397, Japan

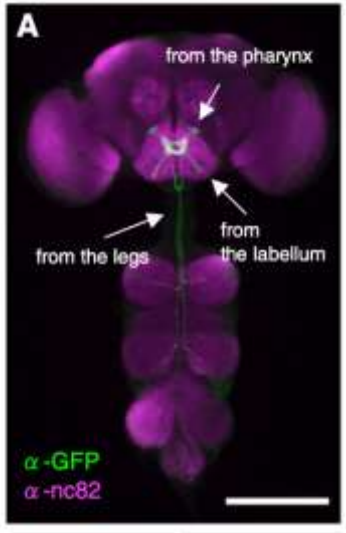
Effects of inactivation of Gr32—expression neurons on male mating behavior





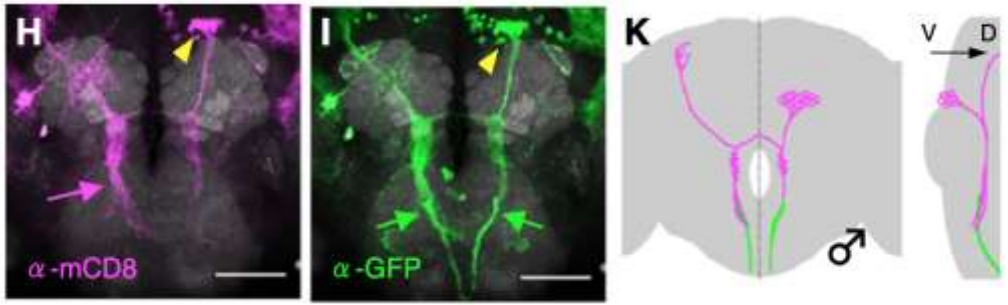


Central projection of Gr32a-expressing neurons

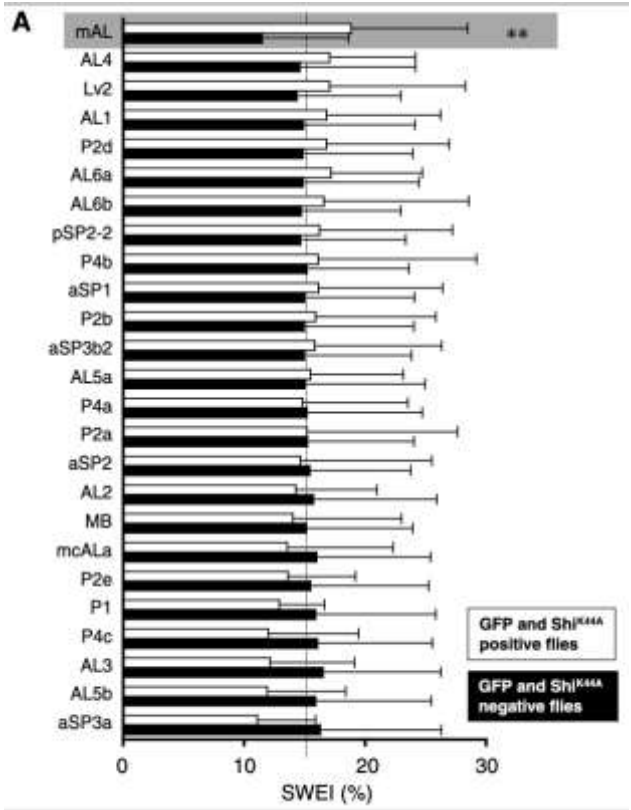


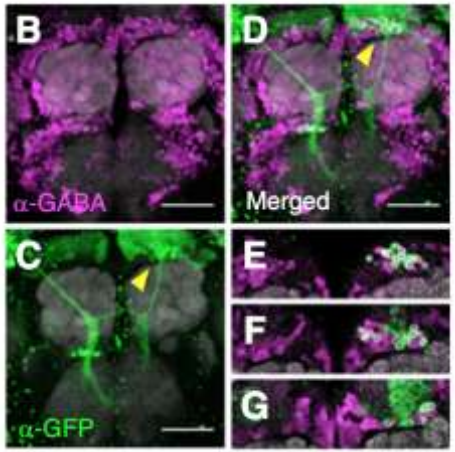
Gr32a>myrGFP

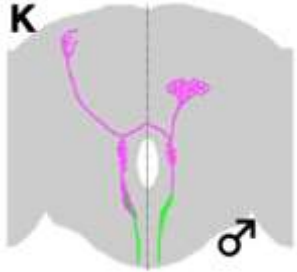
Double staining of Gr32a-expressing neurons and an mAL MARCM patch in male flies

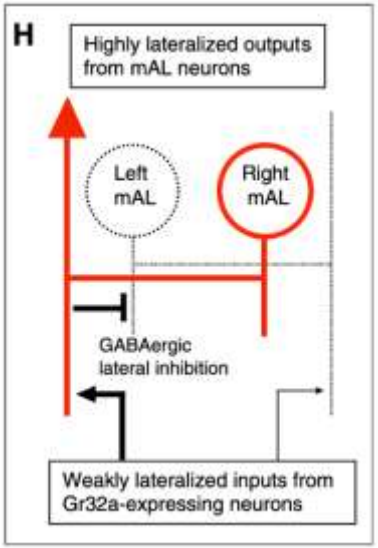


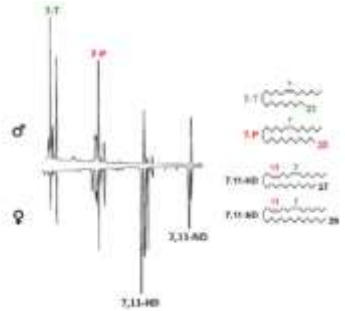
Contribution of mAL interneurons to unilateral wing extension







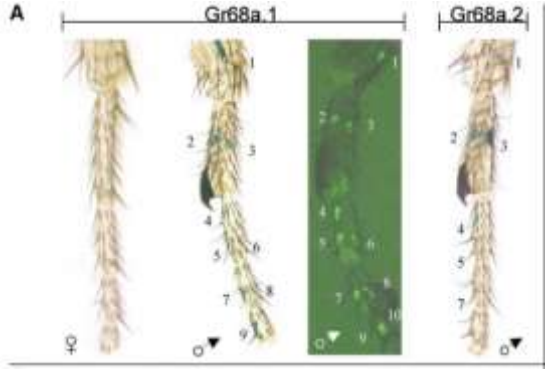


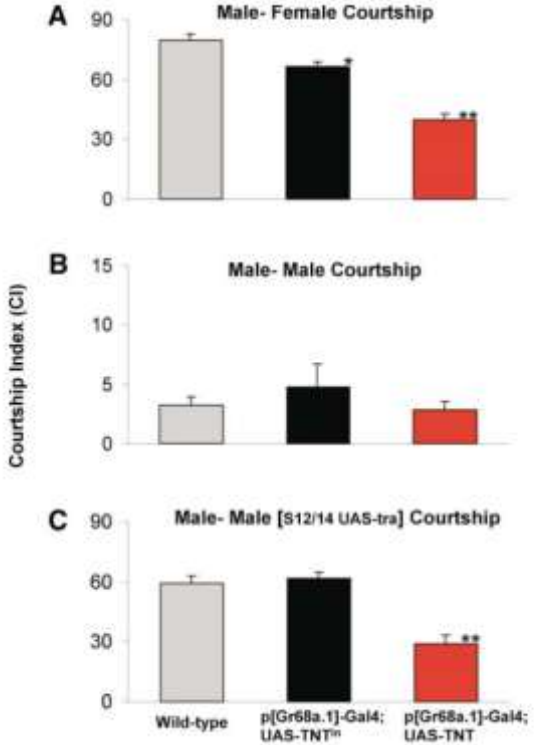


G. Bontonou, C. Wicker-Thomas, Insects. 5, 439−58 (2014).

Neuron, Vol. 39, 1019–1029, September 11, 2003, Copyright ©2003 by Cell Press

A Putative *Drosophila* Pheromone Receptor Expressed in Male-Specific Taste Neurons Is Required for Efficient Courtship





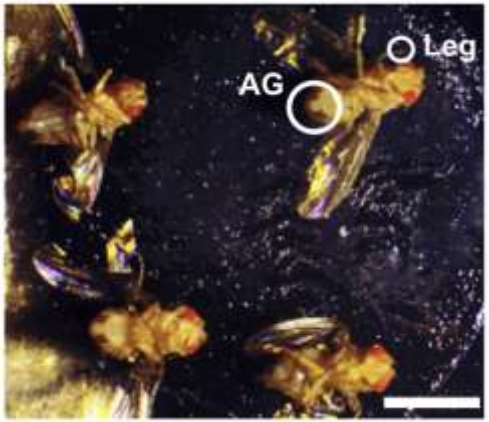
Male[S12/14 UAS-tra]: feminized oenocytes, produced female pheromone

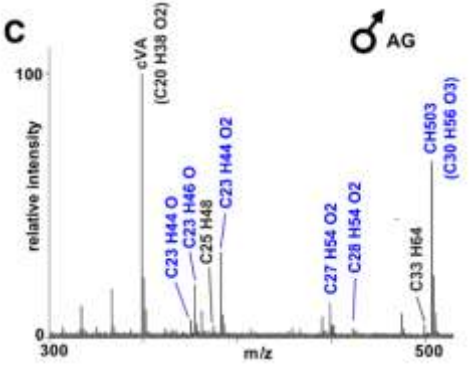
Current Biology 19, 1245–1254, August 11, 2009 ©2009 Elsevier Ltd All rights reserved DOI 10.1016/j.cub.2009.06.037

Article

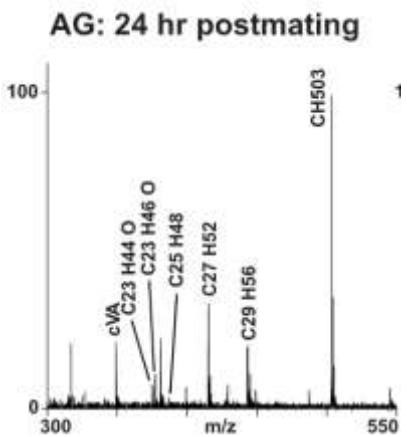
A New Male Sex Pheromone and Novel Cuticular Cues for Chemical Communication in *Drosophila*

ultraviolet laser desorption/ionization orthogonal time-of-flight mass spectrometry(UV-LDI-o-TOF MS)





female



eLIFE elifesciences.org

RESEARCH ARTICLE

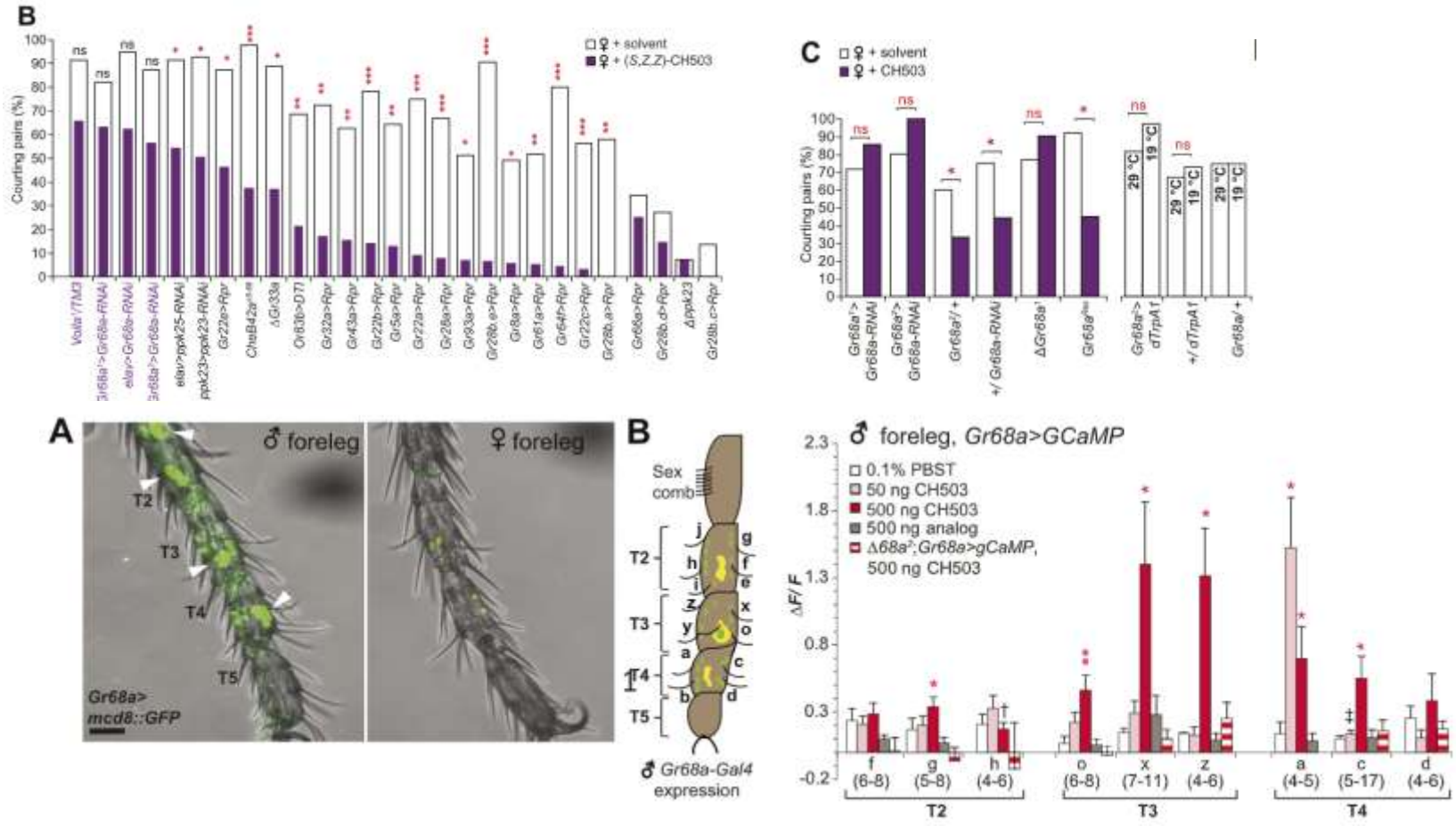
The neuropeptide tachykinin is essential for pheromone detection in a gustatory neural circuit

Shruti Shankar[1,2], Jia Yi Chua[1], Kah Junn Tan[1], Meredith EK Calvert[1†], Ruifen Weng[3], Wan Chin Ng[1], Kenji Mori[4], Joanne Y Yew[1,2,5*‡]

[1]Temasek Life Sciences Laboratory, Singapore, Singapore; [2]Department of Biological Sciences, National University of Singapore, Singapore, Singapore; [3]Institute of Molecular and Cell Biology, Singapore, Singapore; [4]Photosensitive Materials Research Center, Toyo Gosei Co., Ltd, Chiba, Japan; [5]Pacific Biosciences Research Center, University of Hawaii at Mānoa, Honolulu, United States

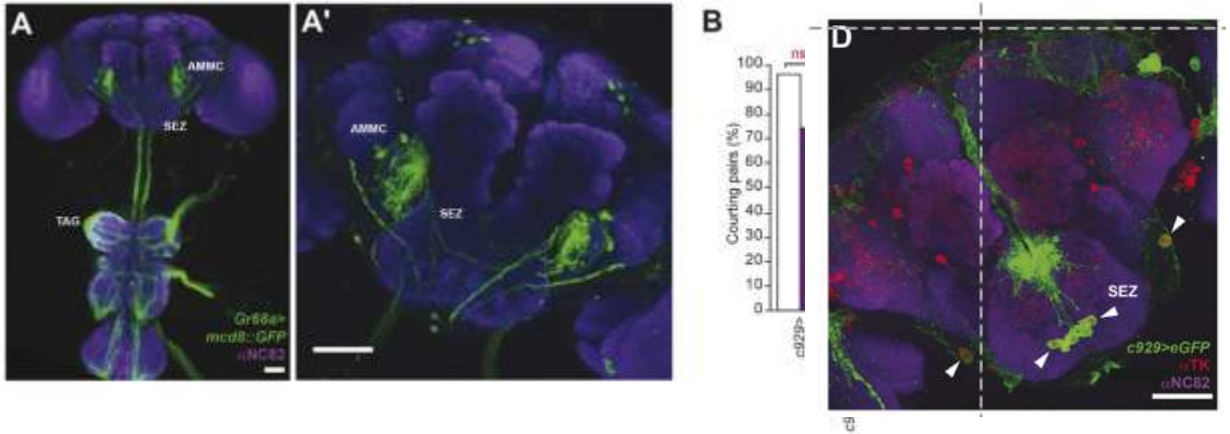
CH503: produced in male flies and transfer to female after mating

Gr68a expression in the male foreleg is required for CH503 detection.

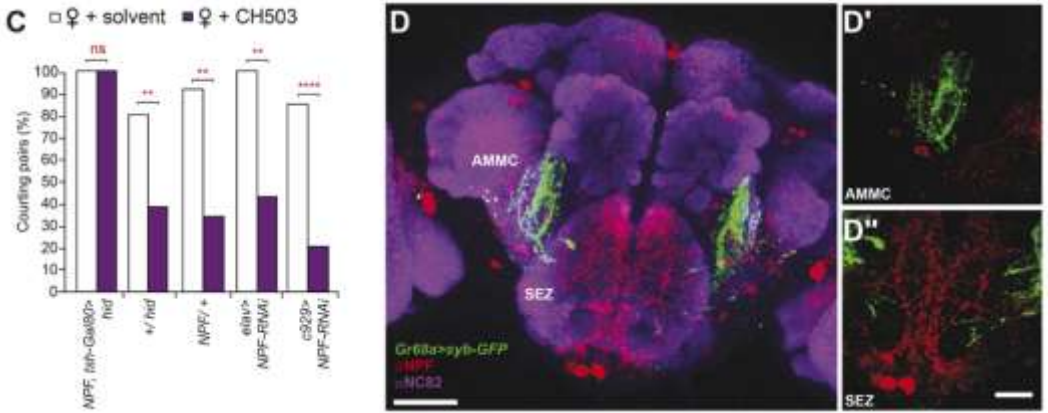


Screen Gal4 and RNAi lines targeting central brain regions, neuropeptides and transmitter system.

C929-Gal4 labeled brain region

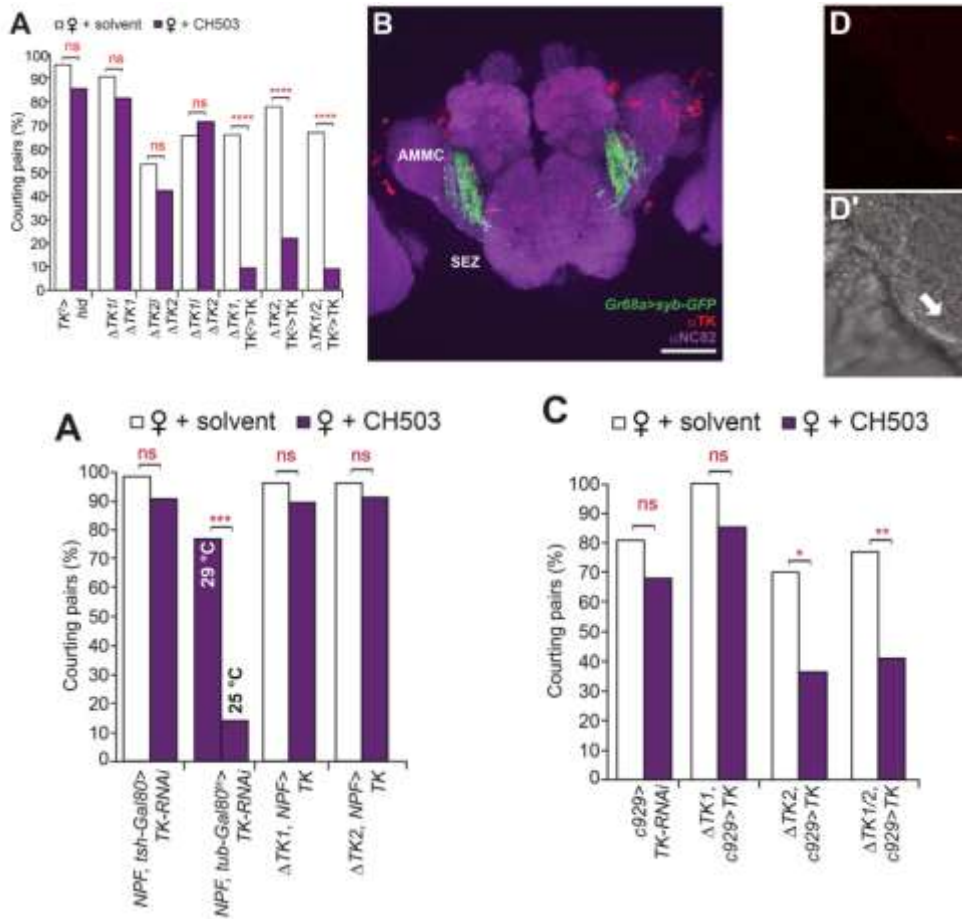


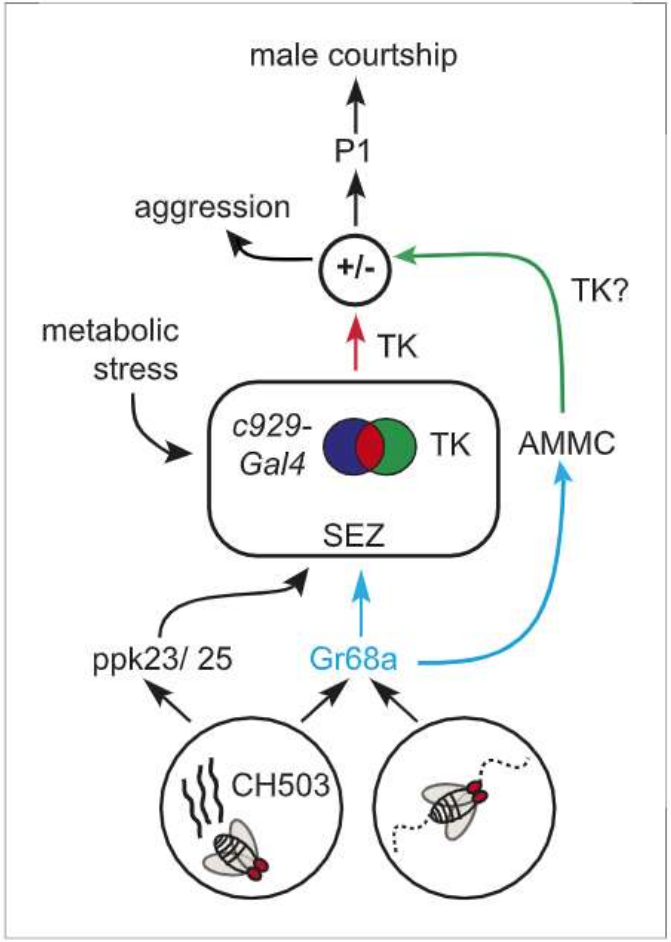
NPF-Gal4 labeled neurons



Tachykinin-expressing cells in the SEZ are a second order circuit for Gr68a neurons

TK



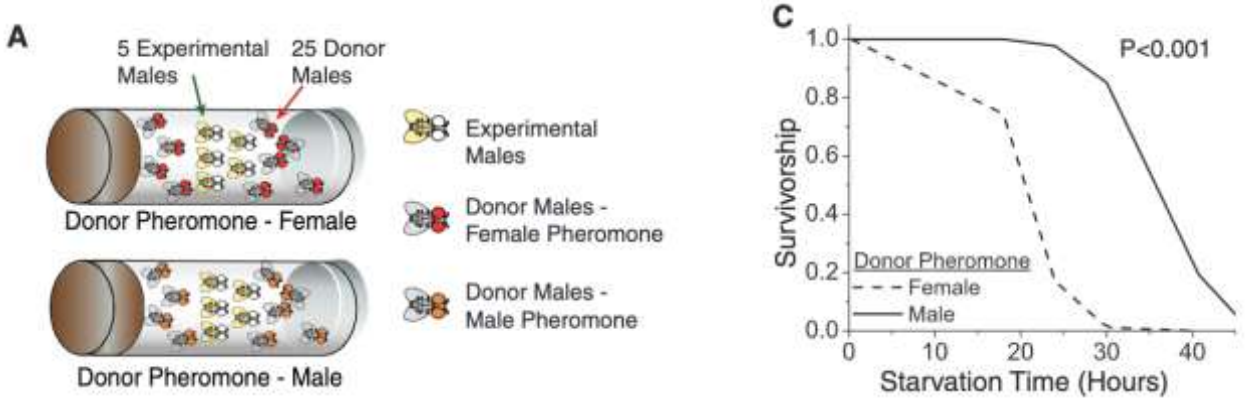


Science

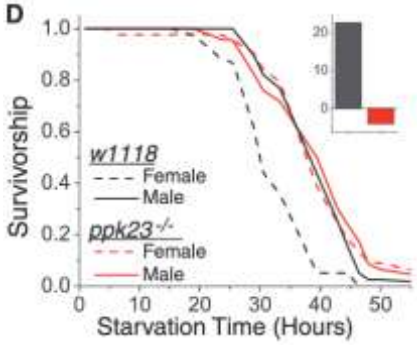
Drosophila Life Span and Physiology Are Modulated by Sexual Perception and Reward

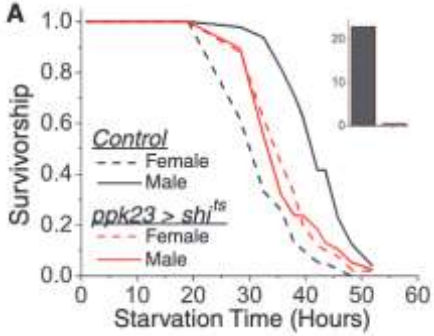
Christi M. Gendron, Tsung-Han Kuo, Zachary M. Harvanek, Brian Y. Chung, Joanne Y. Yew, Herman A. Dierick and Scott D. Pletcher

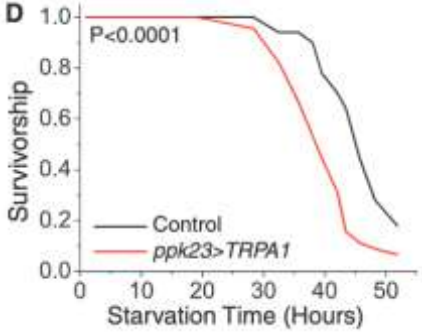
Science **343** (6170), 544-548.
DOI: 10.1126/science.1243339originally published online November 29, 2013



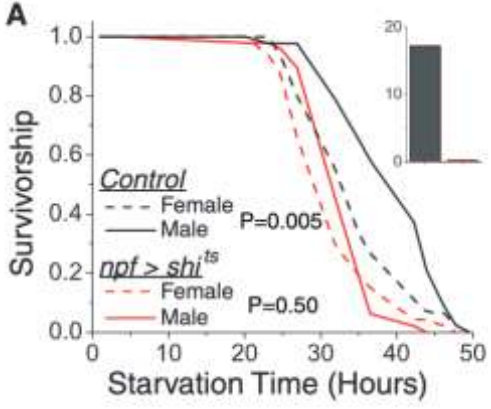
The effects of pheromone exposure are mediated by taste perception involving gustatory receptor ppk23.

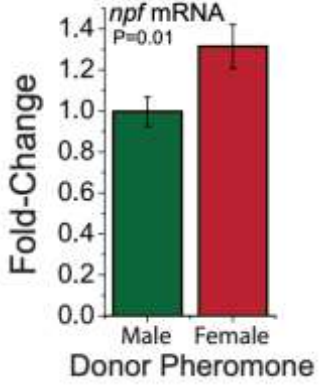






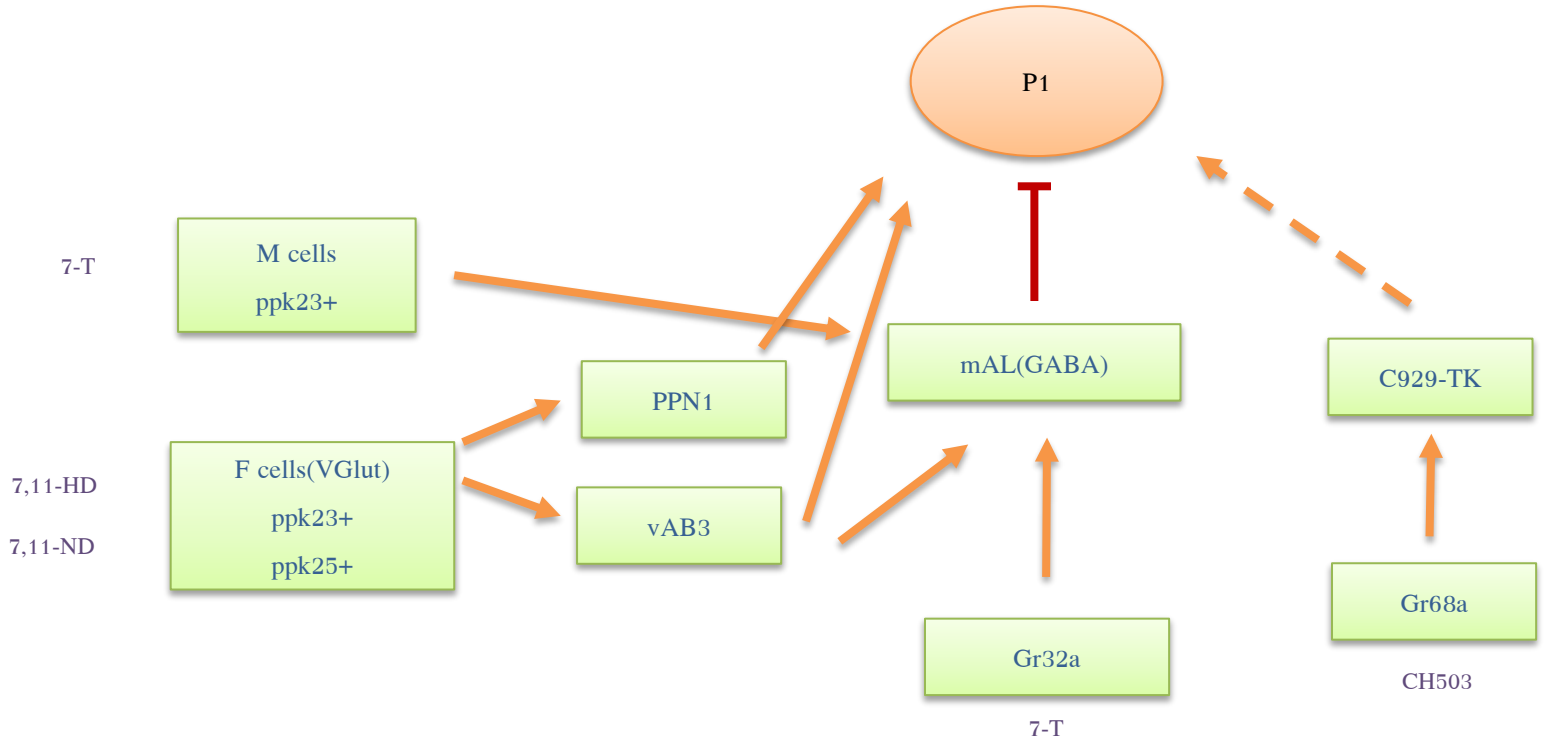
Aging and physiology are modulated by neuralmechanisms of expectation and reward.





Exposure to female donor pheromones results in a significant increase in npf mRNA levels

Summary


P1
M cells
ppk23+
7-T
PPN1
mAL(GABA)
C929-TK
F cells(VGlut)
ppk23+
ppk25+
7,11-HD
7,11-ND
vAB3
Gr68a
CH503
Gr32a
7-T

Thank you