Présentation Séminaire CBGP
27 mai 2025

Les Fondements de l'Olfaction : Évolution, Adaptation, Utilité et Perspective de recherche sur l'Olfaction dans le monde du vivant.

"The Foundations of Olfaction: Evolution, Adaptation, Utility, and Research Perspectives on Olfaction in the Living World.

Flora Gouzerh

Post-doctorante a MIVEGEC (Maladies infectieuses et vecteurs : écologie, génétique, évolution et contrôle)

Mon parcours

2012

Bac général S

2012-2014

Licence 1 and 2 : Biology at CNED and Pierre et Marie Curie

2014-2016

Licence 2 et 3 : Biologie des organismes à l'Université de Montpellier

2016-2018

Master I –II : Ecologie-Biodiversité – Evolution à l'Université de Montpellier

2018-2022

Doctorat :

Evolutionary and applied ecological consequences of body odor modifications.

Avril - juin 2023

CDD Femmes & Sciences

Juillet 2023 – Aout 2025

Post-Doctorat : Detection of odor modifications induced by 2 skin cancers in humans and animals.

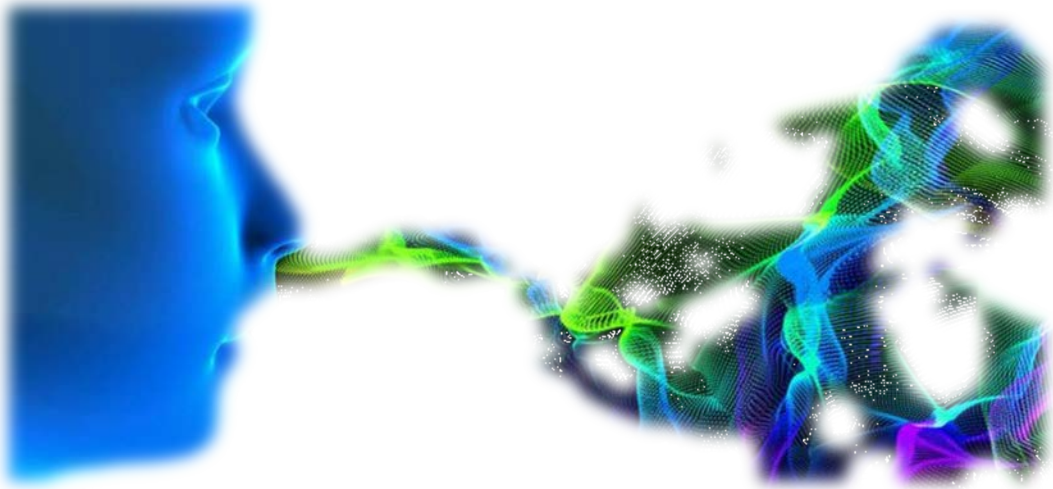
Behavioral ecology
Chemical ecology

→ Study of the influence of disease on chemical signals emitted by living organisms
Impact on social relationships

The Foundations of Olfaction: Evolution, Adaptation, Utility, and Research Perspectives on Olfaction in the Living World.

Olfactory: Definition

A sense that analyzes chemical substances (odors) in the air.



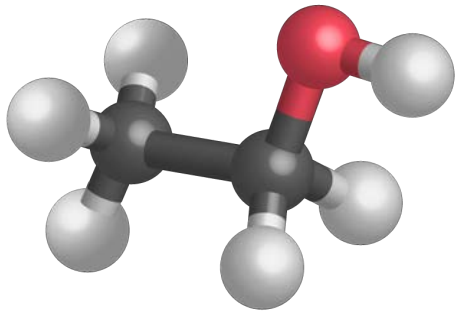
Most common sense in the living world

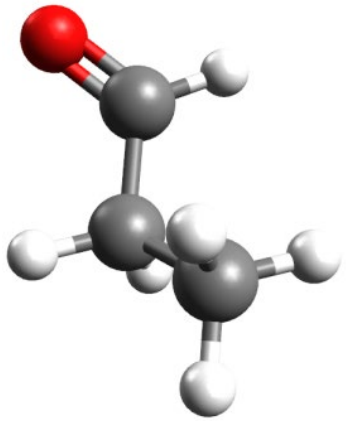
Odors

Molecules perceived by the sense of smell

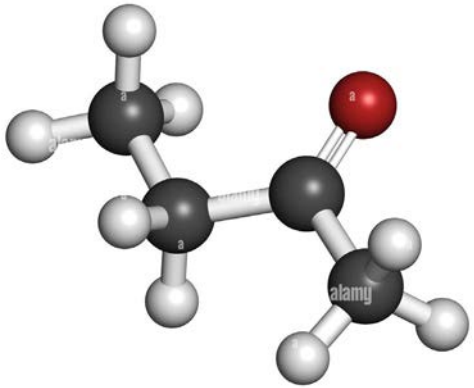
Examples of organic molecules => composed of at least one carbon

Alcool
Ethanol

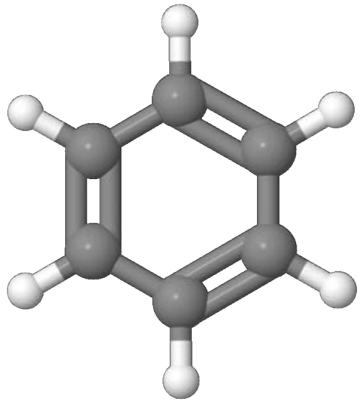




Aldéhyde
(propanol)

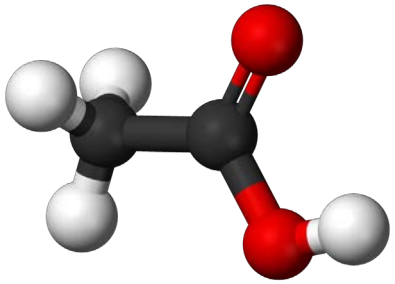


Cétone
Butanone



Composé aromatique
(Benzene)

Acide
Acide acétique

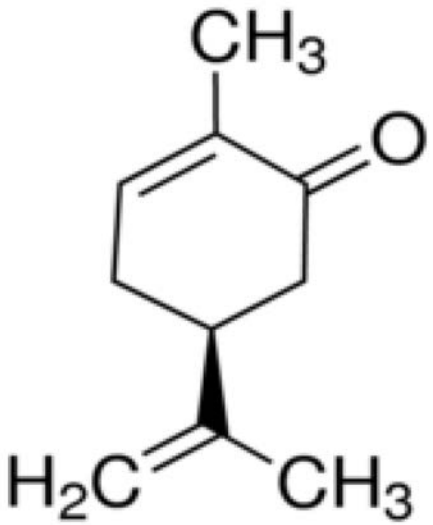


Odors

Molecules perceived by the sense of smell

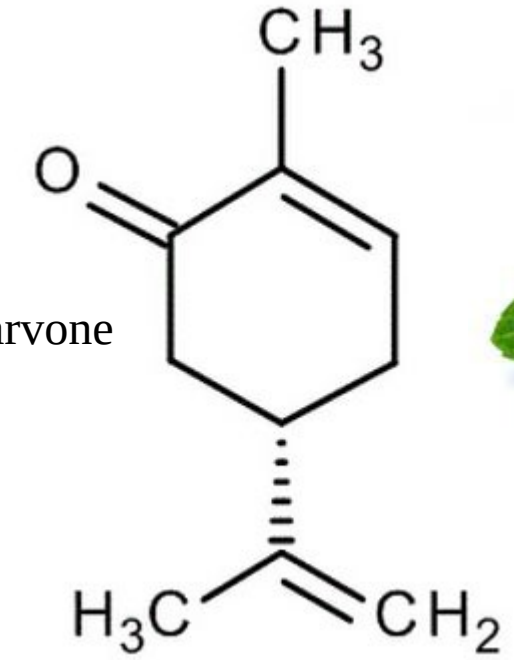
Molecular structure => small changes => big changes in perception

D-carvone



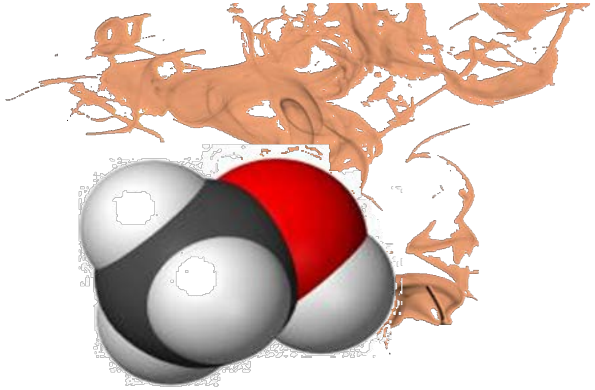
Carvi ou cumin des prés

l-carvone

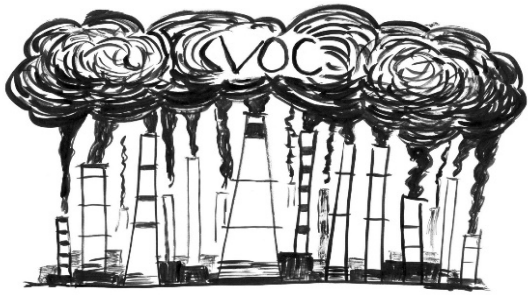


Odors

Anthropique



Biogénique



Odors

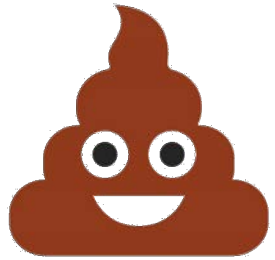
Short-distance communication

Non-volatile organic compounds

Odorant molecules → Olfactory signal

Volatile organic compounds VOCs

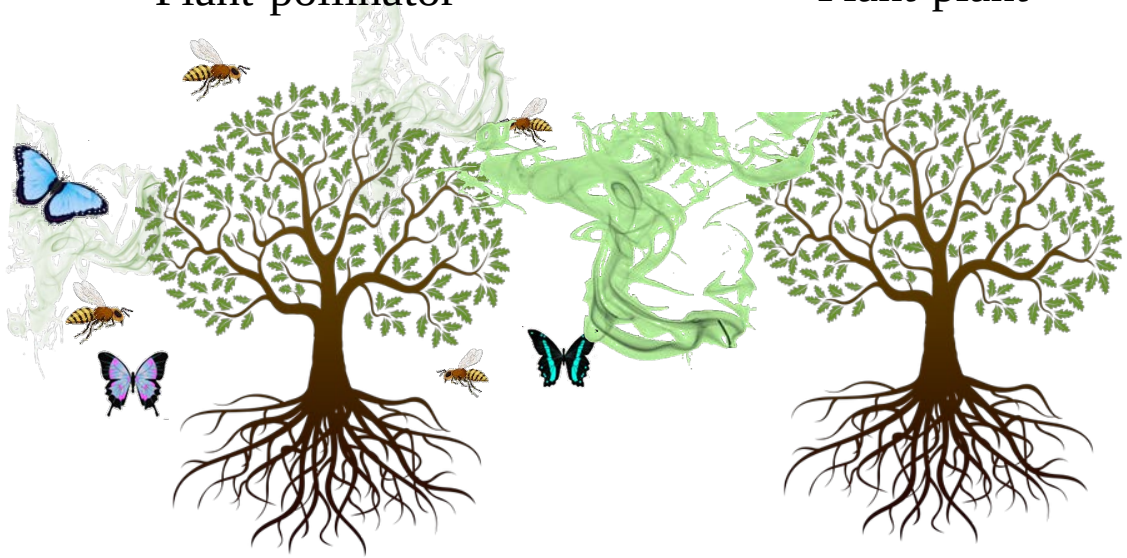
Long-distance communication

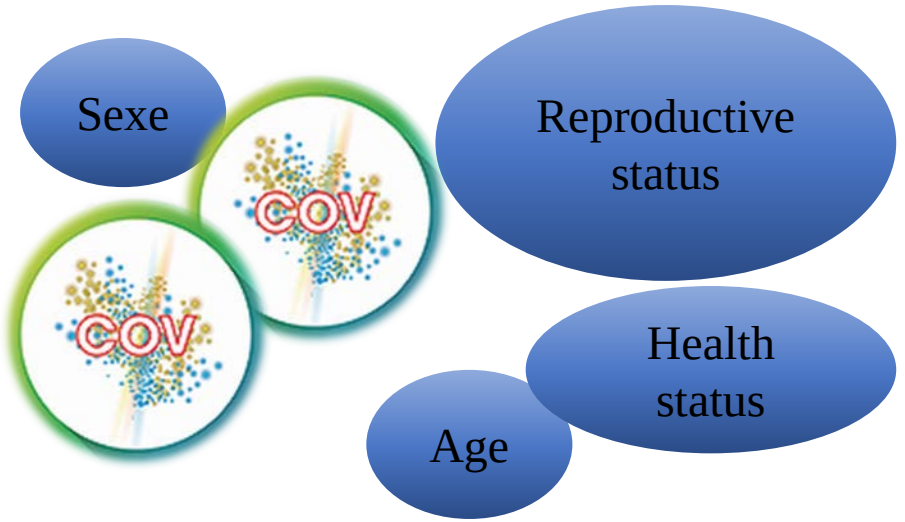


Communication between organisms

Plant-pollinator

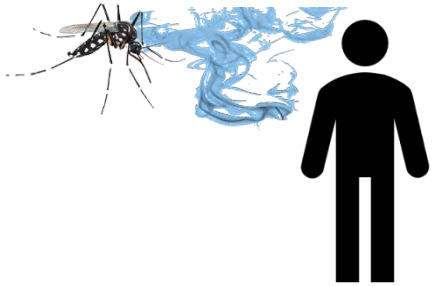
Plant-plant





Inter-specific communication

Prey-predator



Host-vector

Intra-specific communication

How the olfactory system works ?

Olfactory signal

Odorant molecules

Vertebrates

Olfactory bulb

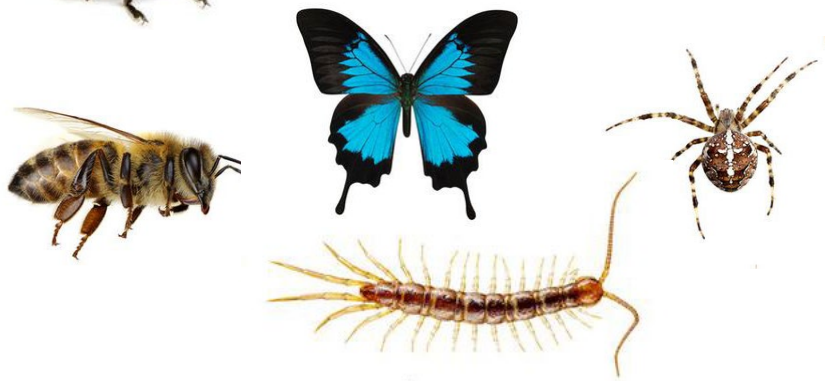
Olfactory organ (nose, antenna, etc.)

Olfactory receptor neuron

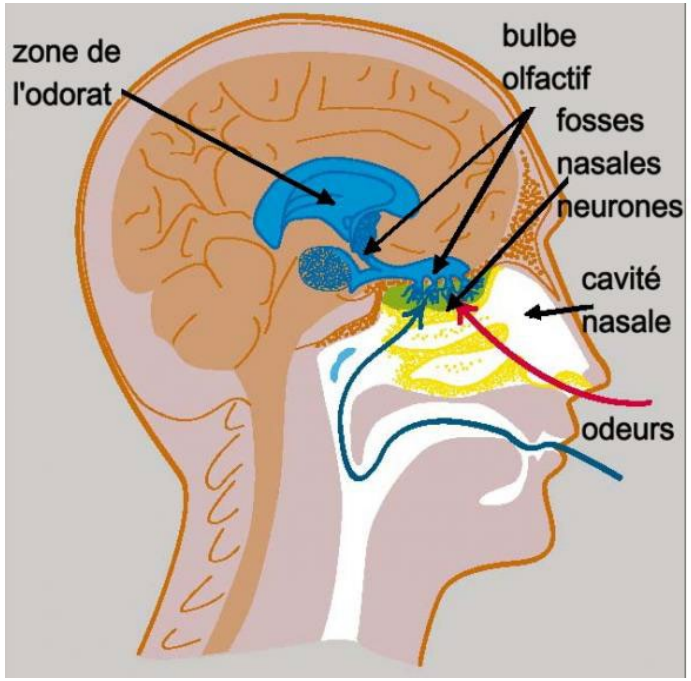
Central nervous system

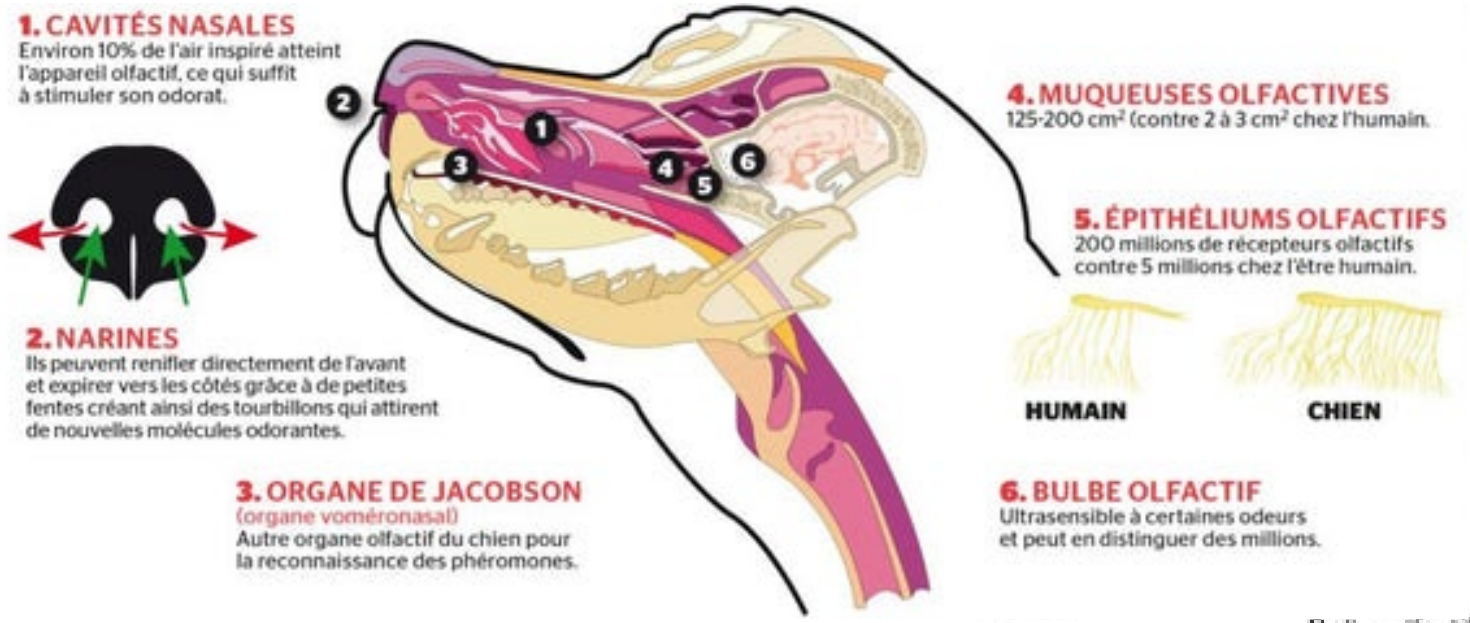
Invertebrates

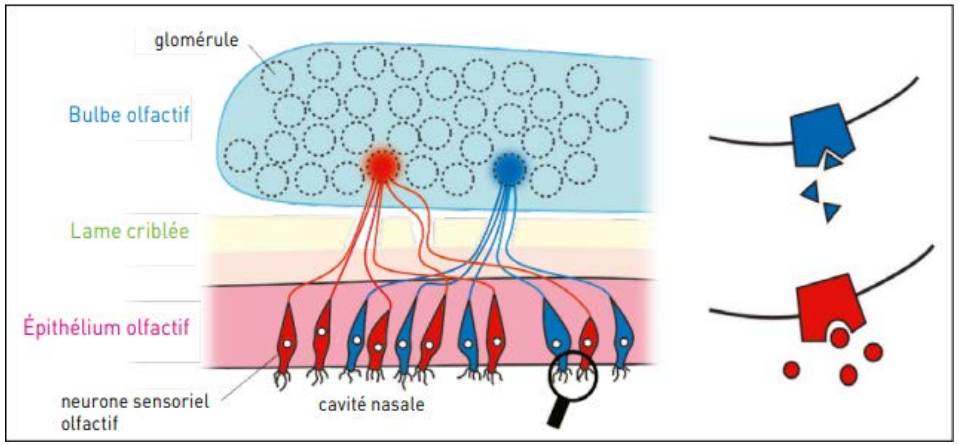
Antennal lobe

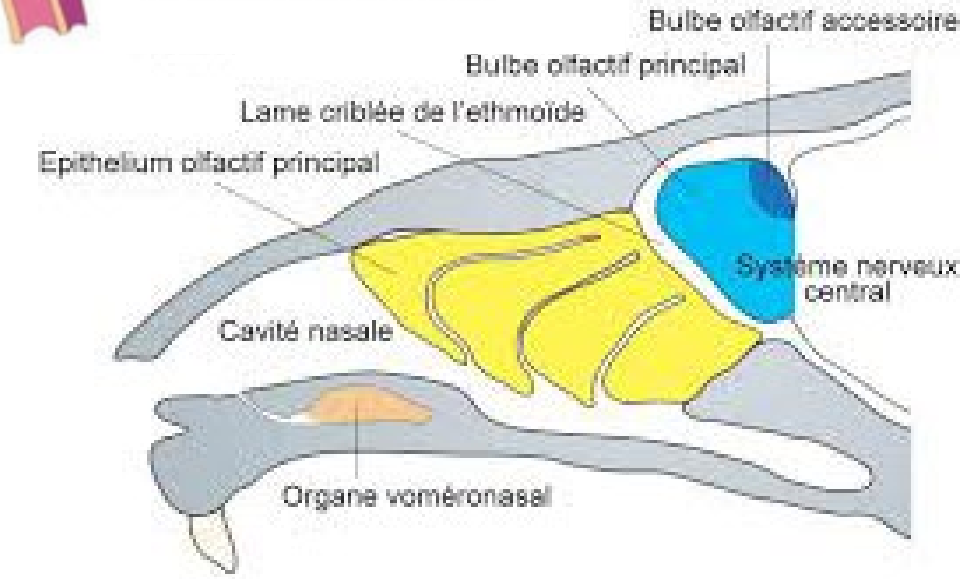


How the olfactory system works ?

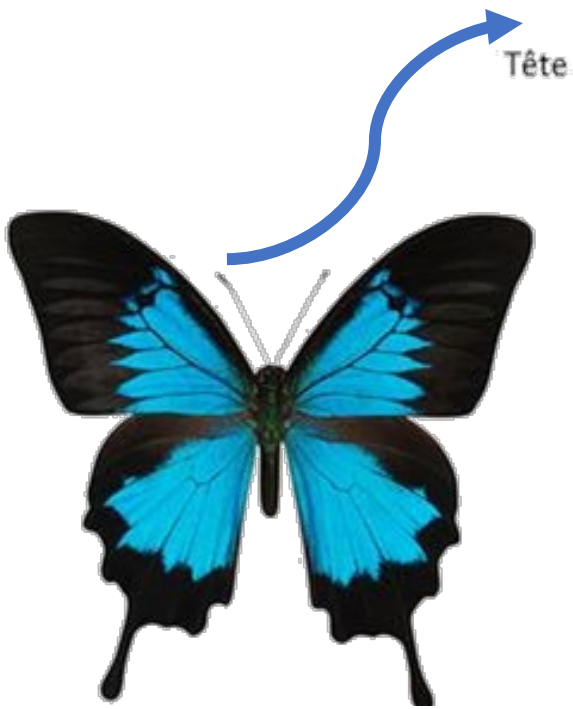




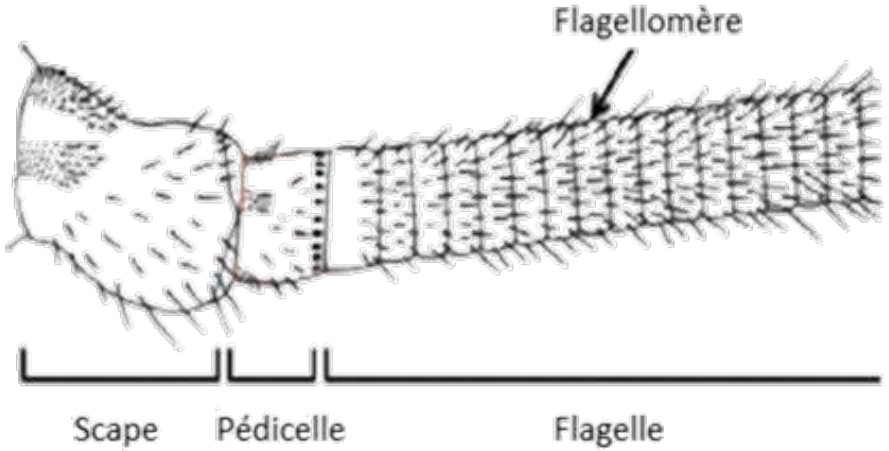




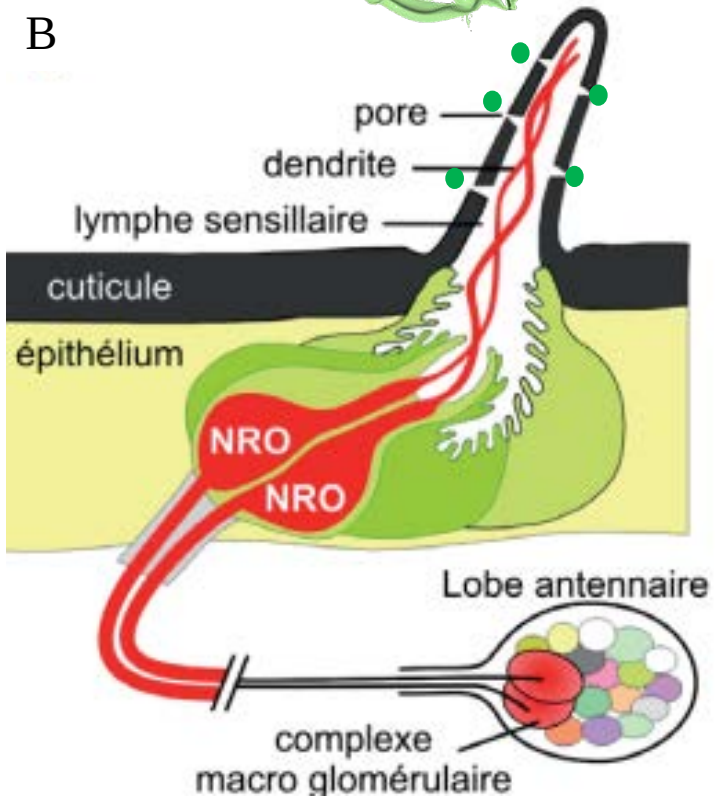
How the olfactory system works ?



A

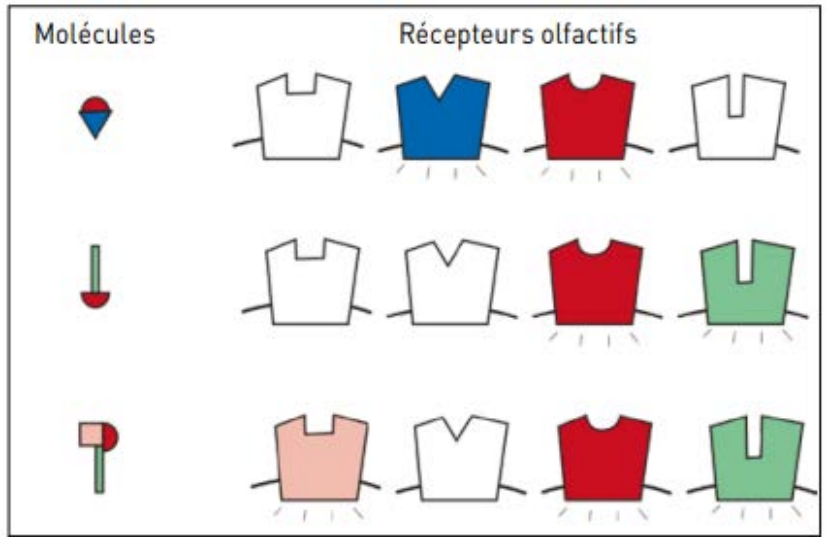


B

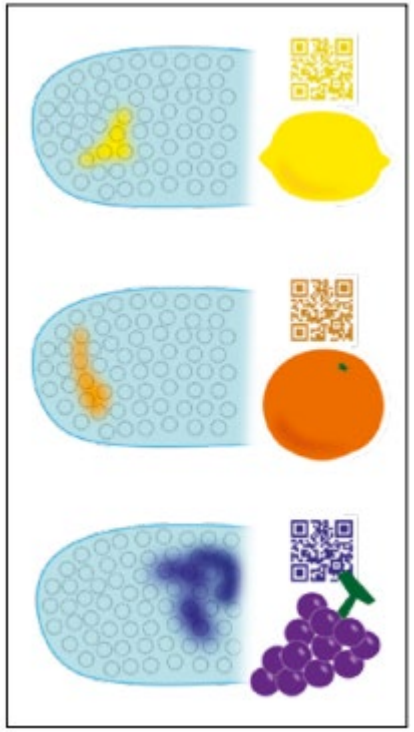


A, Schéma d'une antenne d'insecte d'après *(Jiro Okada)*. **B, Schéma d'une sensille olfactive,** ORN : Neurone Récepteur Olfactif, Th : Cellule thécogène, Tr : Cellule trichogène, To : Cellule thormogène, SNC : Système Nerveux Central.

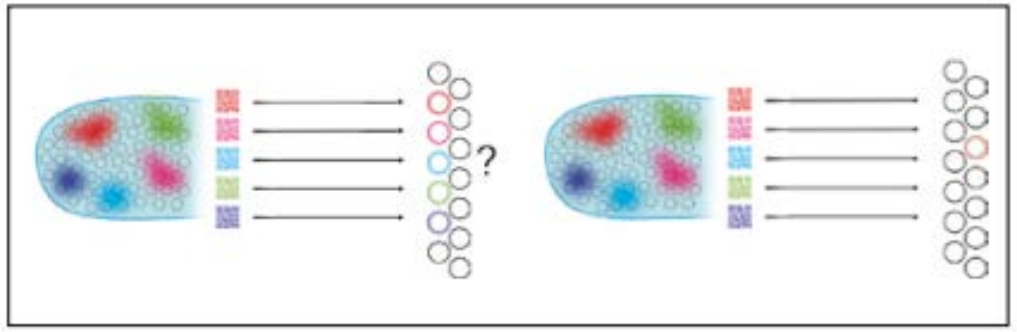
How the olfactory system works ?

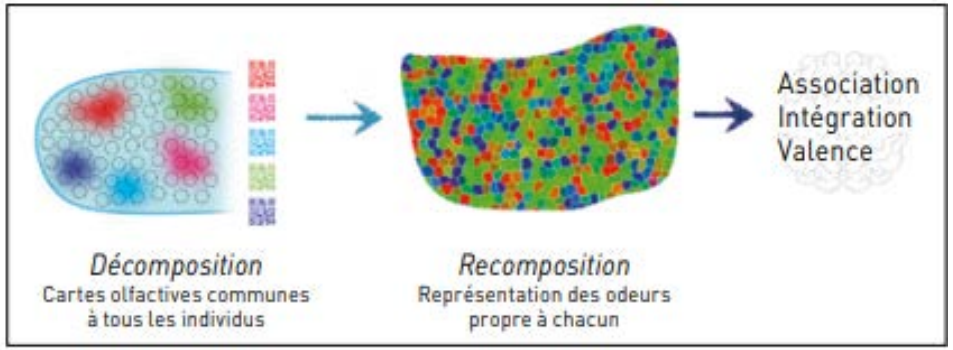


The recognition of chemical molecules by receptor cilia is a mechanism analogous to that of a key corresponding to a lock for a given motif.



Cartes olfactives.





Lledo, P.-M. Odeurs et représentations mentales.

How the olfactory system works ?

Species	OR genes	Reference
Humans	350 (560 pseudogenes)	
Mice	1000 – 1300	Glusman *et al.* (2001)
Other Mammals	4000	
Cow	2129	
Dog	1100	
Macaque	606	Niimura and Nei (2007)
Rat	1767	
Mice	1391	

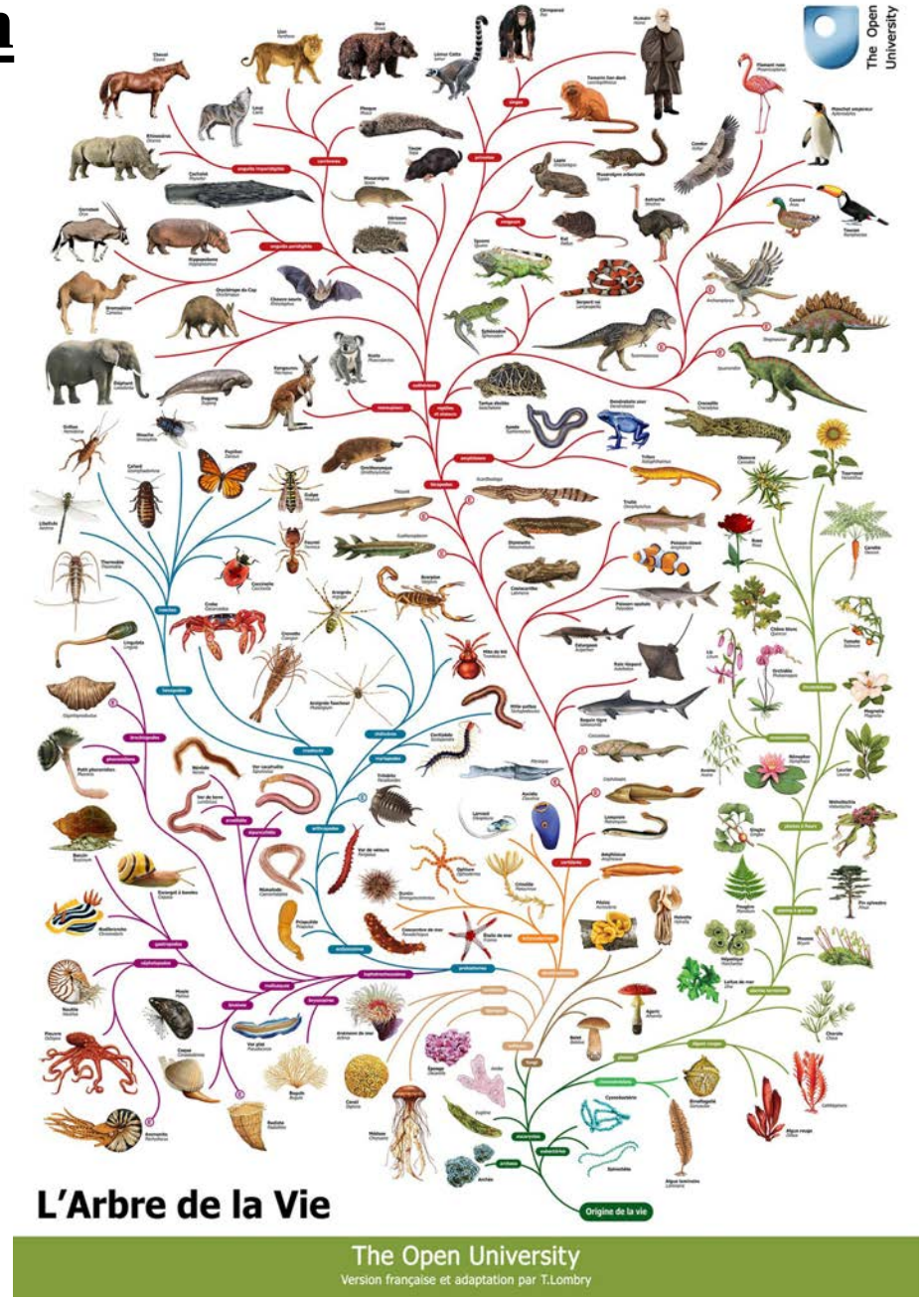
OR = Récepteur olfactif

Species	Number of Scent Receptors
Humans	5 million
Dachshund	125 million
Fox Terrier	147 million
Beagle	225 million
German Shepherd	225 million
Bloodhound	300 million

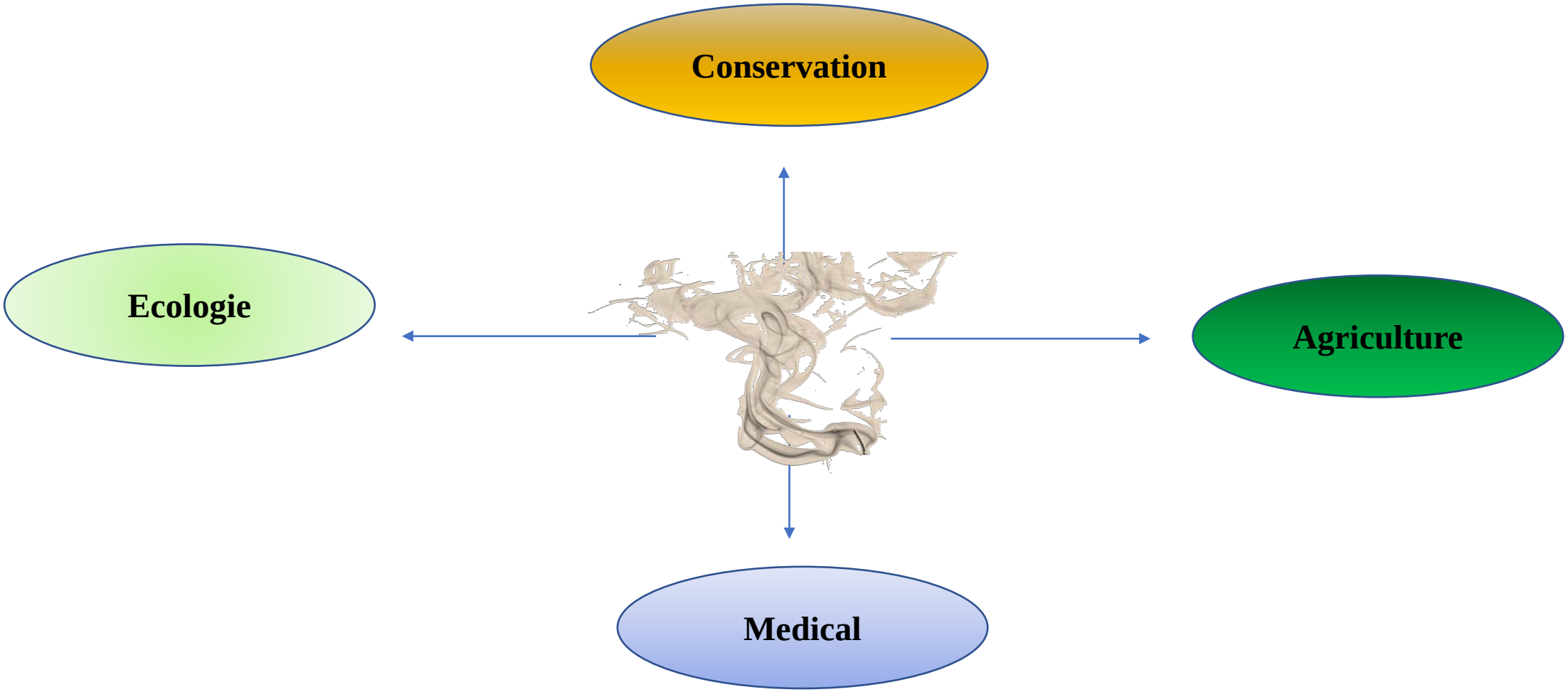
Padodara, R. J., & Jacob, N. (2014). Olfactory sense in different animals. *Indian J. Vet. Sci*, *2*(1), 1-14.

Origins of olfaction

- Convergent adaptations between different living organisms.
- Olfaction is phylogenetically the oldest sensory system.
- Most widely used means of communication among living beings



Research and olfaction



Research and olfaction

- **Early detection of human diseases**

  - ➢ Biomarker research
  - ➢ Using animals as noses

Diabetes

Dehlinger et al 2013

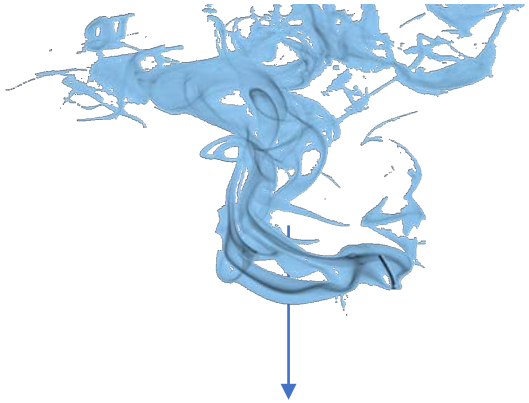
Tuberculosis

Neto et al 2016

apopo

COVID_19

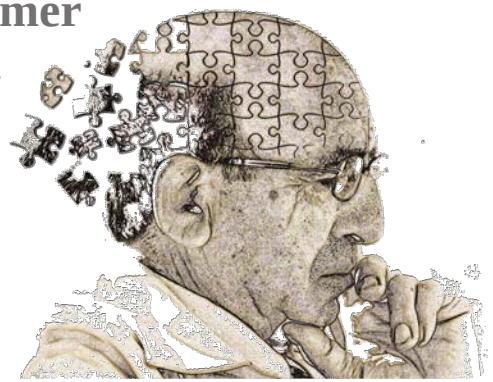
Eskandari et al 2021



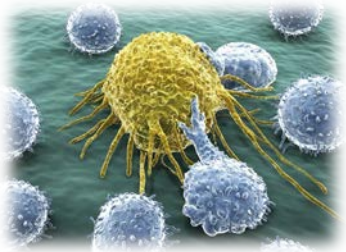
Medical

Alzheimer

Gupta et al 2024



Cancer



KDOG CANCER DETECT GROUP

institut Curie

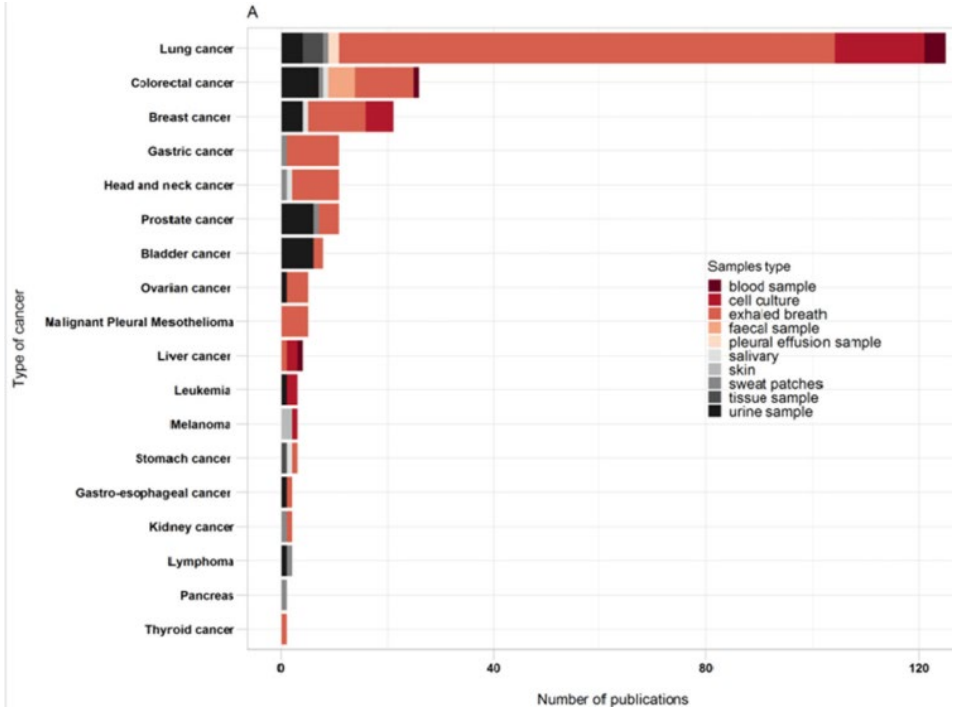
Medical

Research and olfaction

Case study on cancer:

Determine at which stage of cancer development odors are modified => use for early diagnosis

+ 208 publications



ELSEVIER

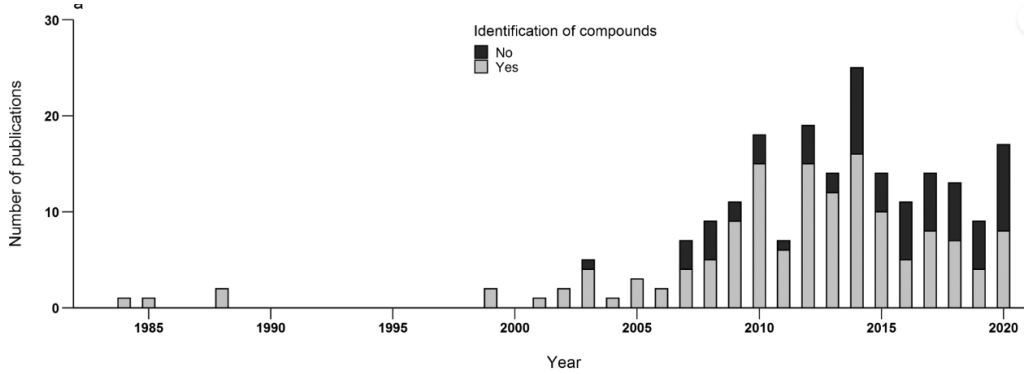
Biochimica et Biophysica Acta (BBA) - Reviews on Cancer

Volume 1877, Issue 1, January 2022, 188644

Review

Odors and cancer: Current status and future directions

Flora Gouzerh [a b c], Jean-Marie Bessière [d], Beata Ujvari [e], Frédéric Thomas [a b 1], Antoine M. Dujon [a b e 1], Laurent Dormont [c 1]



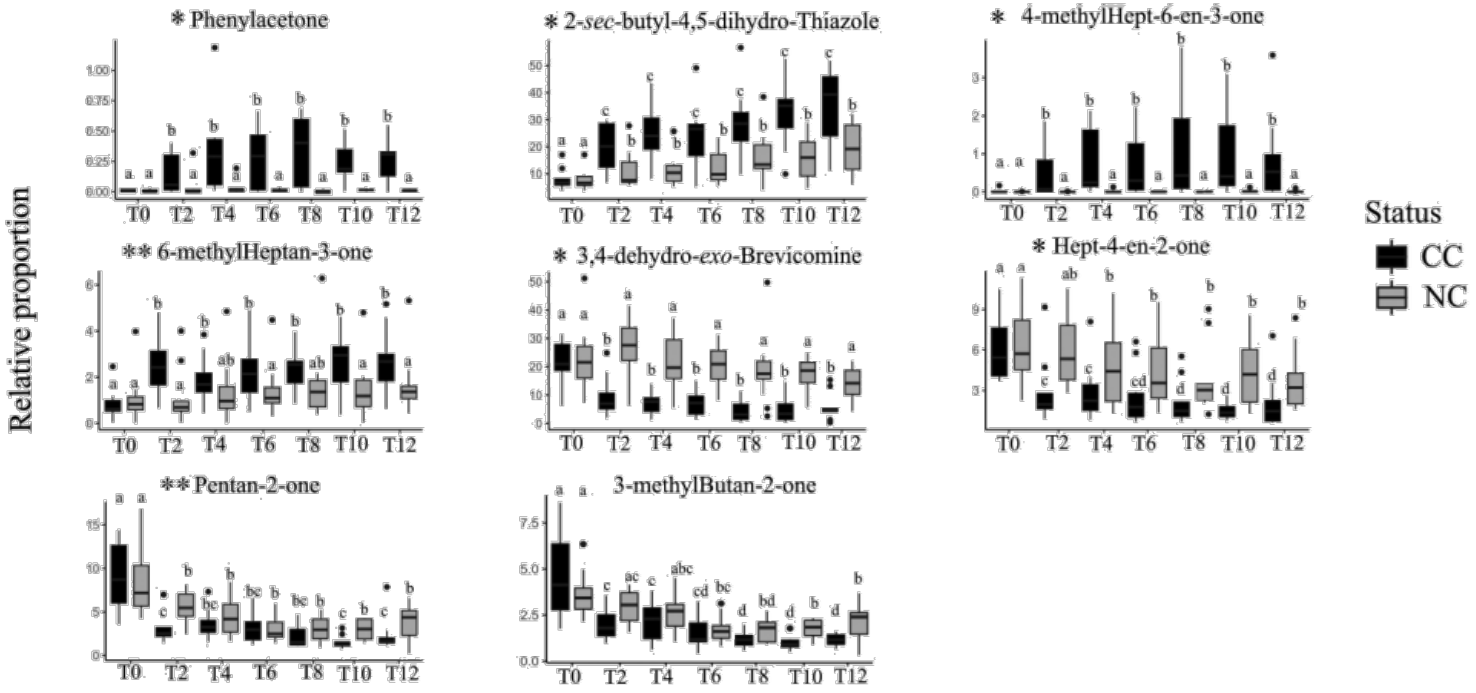
Medical

Research and olfaction

Case study on cancer:

Determine at which stage of cancer development odors are modified => use for early diagnosis

Chemical analysis in a murine lung cancer model



Cancer Biomarkers
Volume 39, Issue 2, February 2024, Pages 113-125

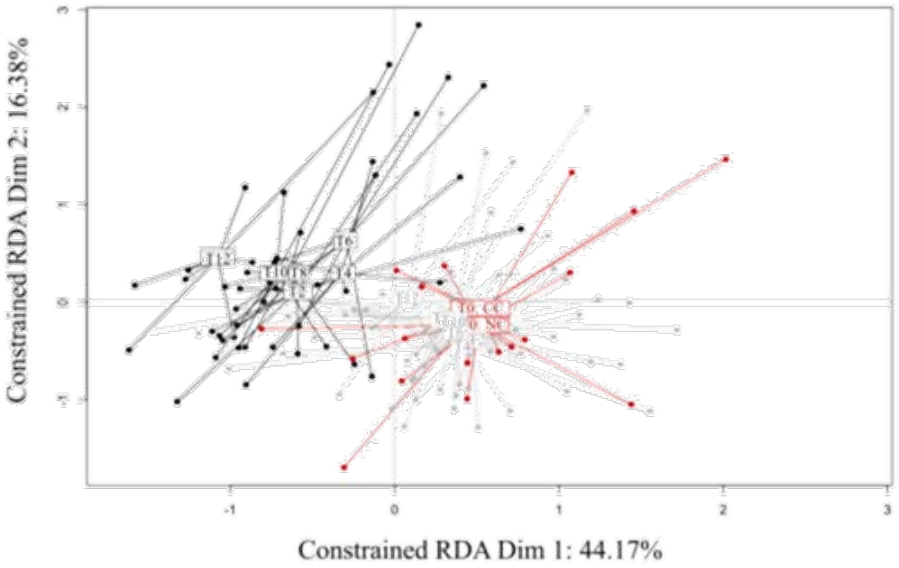
https://doi.org/10.3233/CBM-230070

Sage Journals

Research Article

Urinary VOCs as biomarkers of early stage lung tumour development in mice

Flora Gouzerh[a,b,*], Gwenaëlle Vigo[a], Laurent Dormont[b], Bruno Buatois[b], Maxime R. Hervé[c], Maicol Mancini[d], Antonio Maraver[d], Frédéric Thomas[a], and Guila Ganem[e]



Medical

Research and olfaction

BBA - Reviews on Cancer 1878 (2023) 188850

Contents lists available at ScienceDirect

BBA - Reviews on Cancer

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

Review

Ability of animals to detect cancer odors

Flora Gouzerh [a,b,*], Guila Ganem [c], Anaïs Pichevin [b], Laurent Dormont [b], Frédéric Thomas [a]

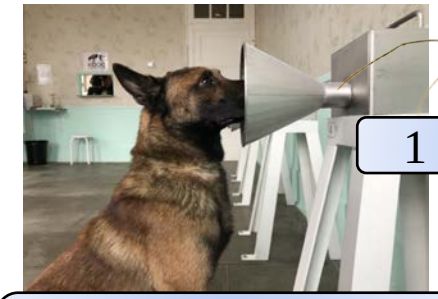
Case study on cancer:

Determine at which stage of cancer development odors are modified => use for early diagnosis

Using animals as noses

45 publications analyzed

Detection capacity > 90% in most studies.



31 publications / 28 different races

1 publication

3 publications

1 publication

1 publication

7 publications

Medical

Research and olfaction

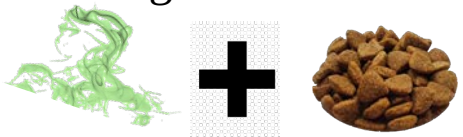
Case study on cancer:

- **Cancer detection after training :**
- Dogs, mice, rats, ants

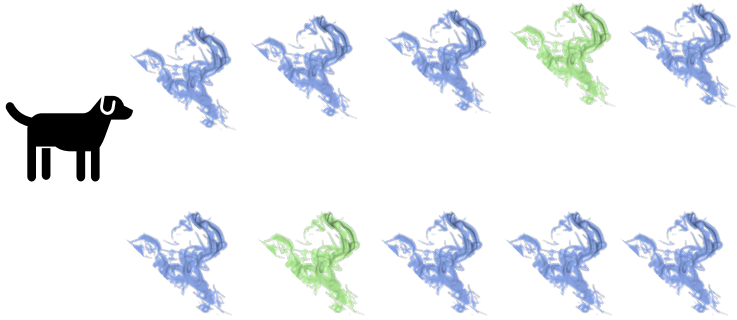
Detection capacity > 90% in most studies.

Conditioning training

Learning to smell

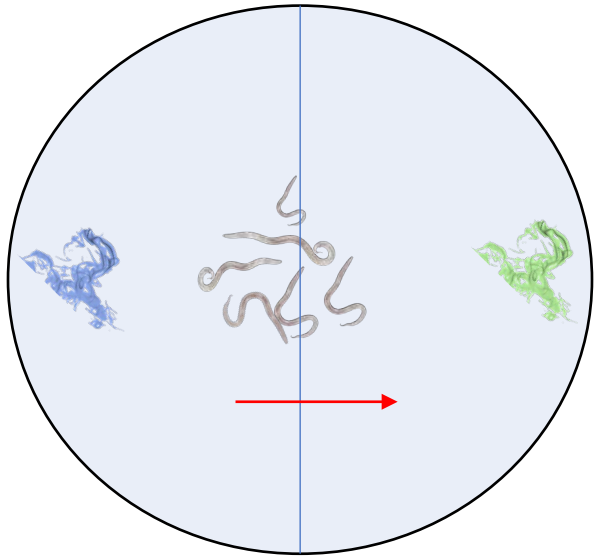


Learned odor detection

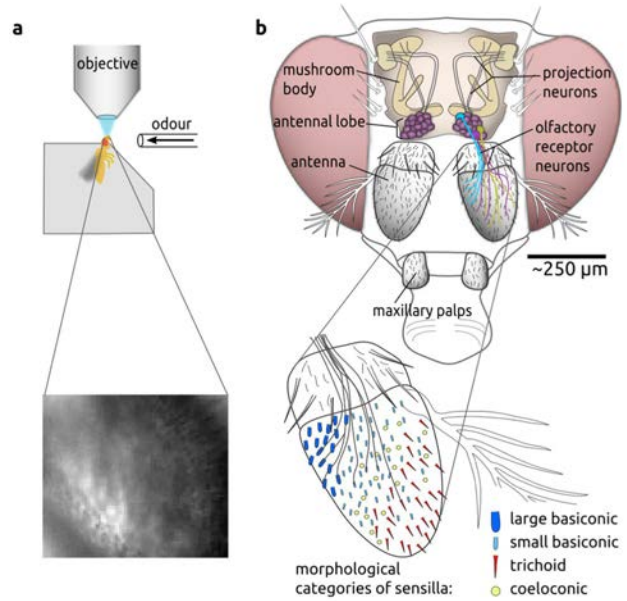


- **Innate cancer detection**

- Drosophila
- Nematodes



Nematodes move towards cancerous odors



Calcium imaging

Strauch et al 2014; Kusumoto et al 2019; Hirotsu et al 2019

Medical

Research and olfaction

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RESEARCH ARTICLE

Odours of cancerous mouse congeners: detection and attractiveness

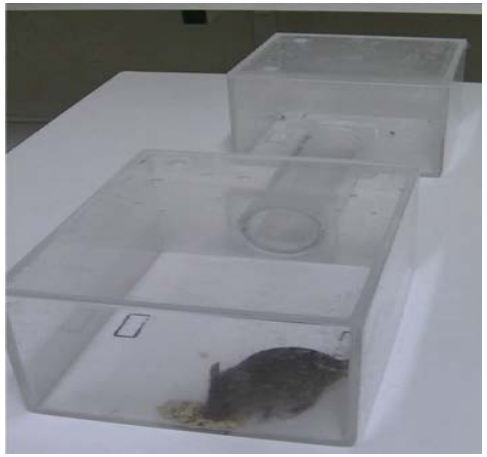
Flora Gouzerh[1,2,*], Bruno Buatois[2], Maxime R. Hervé[3], Maicol Mancini[4], Antonio Maraver[4], Laurent Dormont[2], Frédéric Thomas[1] and Guila Ganem[5,*]

Case study on cancer:

Determine at which stage of cancer development odors are modified => use for early diagnosis

Using animals as noses

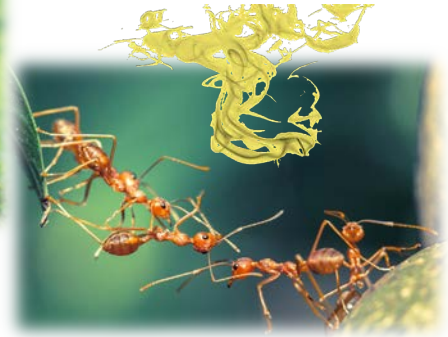
Discrimination habituation test => innate ability to discriminate at an early stage of cancer development before MRI.



Research and olfaction

Studying interactions between species

- Identify the compounds that attract or repel particular organisms.



Understanding communication between species:

- Studying sex pheromones
- Study of marking pheromones

Ecologie

Study the impact of man on these interactions:

- How can anthropogenic compounds impact these interactions?

Disease detection and use of odor information :

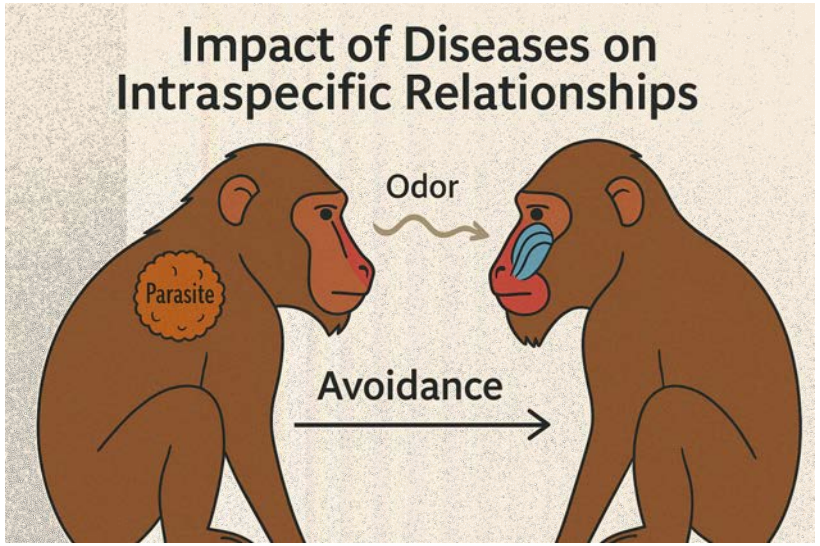
Understanding how animals use certain smells :

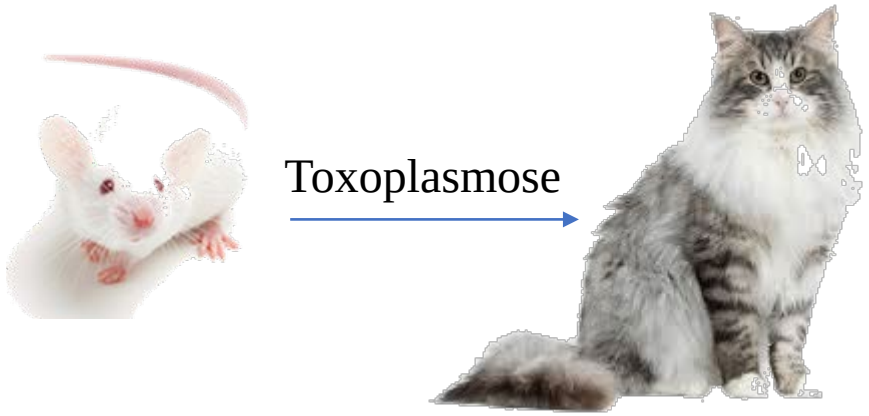
- Naturopathy
- Group exclusion
- Disease avoidance

Ecologie

Research and olfaction

Case study on diseases :





Disease	Animal	Behavior
Protozoan	Mandrills	Avoidance
Ectoparasite	Mice	Avoidance
Toxoplasma	Mice, Chimpanzees	Attraction

Poirotte et al 2017,2018 ; Kavaliers et al 2003; Flegr et al 2016

Ecologie

Research and olfaction

Case study on diseases :

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RESEARCH ARTICLE

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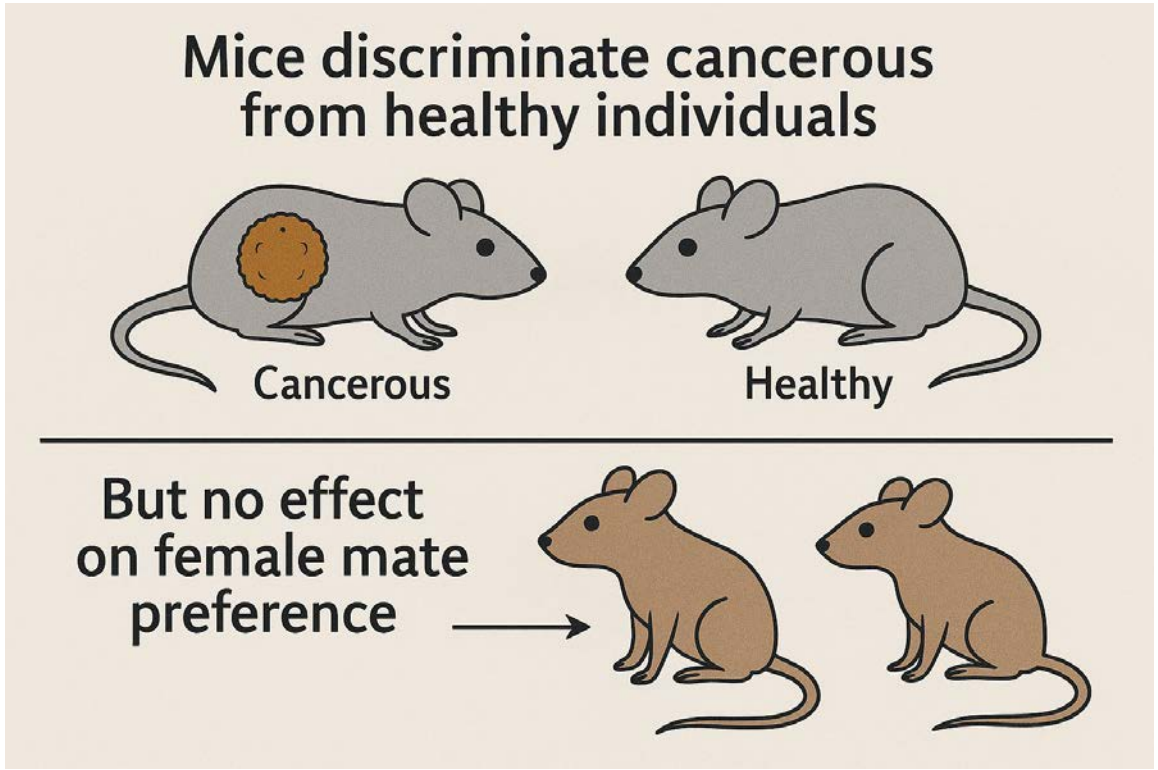
Impact of diseases on intraspecific interactions :



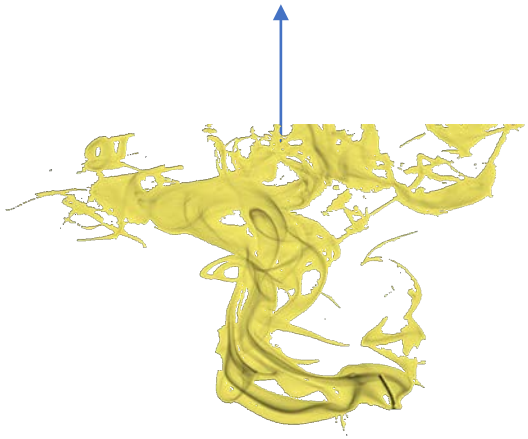
Research and olfaction

Conservation

- **Find species**

➢ Using dogs to find species

Mary E.Cablk 2008 et al



- **Protecting species**

➢ Finding and saving individuals

- Identification of wild animal disease odors.

Conservation

Research and olfaction

Case study on diseases :

Ellis et al 2019, White tailed deer
=> Chronic wasting disease

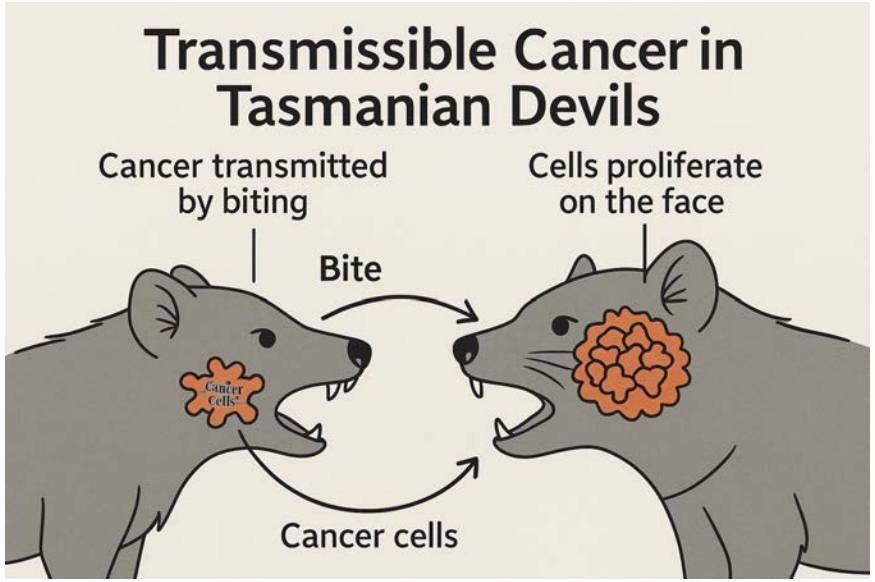
Parembeth et al 2019, Common Marmosets =>
Chronic lymphocytic enteritis

Beleno saenz et al 2021, wild boar
=> Tuberculosis

Conservation

Research and olfaction

Case study on diseases :



- Find sick individuals
- Prevent contact between wildlife and animals in protected areas.

Since 1996 => 85% of the population

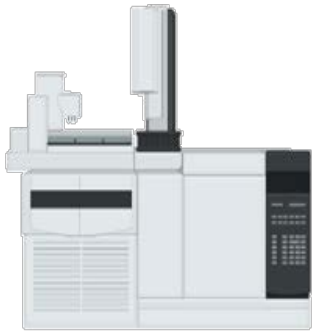
Conservation

Research and olfaction

Case study on diseases :

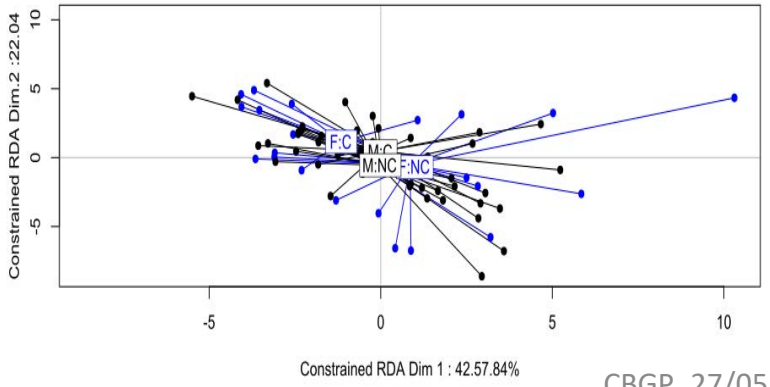
Chemical analysis

- Identification of VOCs emitted by wild devil feces.



Femelles NC ≠ Males NC

Femelles NC ≠ Femelles C



Using animals' sense of smell

- Training a dog to identify cancerous devils

Anne Xuereb (CBGP)
et Mélanie Bonnet

Sensitivity **(number of cancerous devils indicated)** **100 %**

Specificity **(number of healthy ones indicated)** **88,10%**

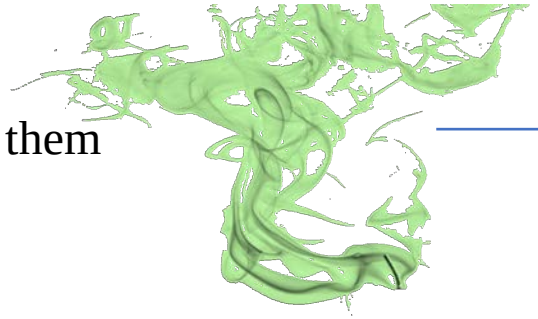
Precision **90,5%**

=> Same results 2 month later after training

Research and olfaction

- **Protecting crops from pests**
  - ➢ Finding compounds that attract or repel them
  - ➢ Biological control

- **Attracting pollinators**
  - ➢ Finding compounds that attract them



Agriculture

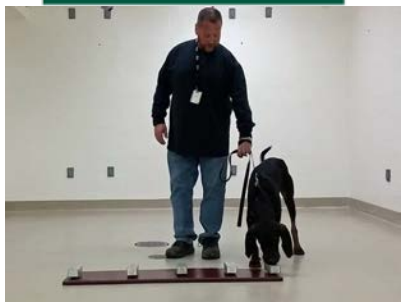
- **Detecting agricultural diseases**
  - ➢ Detect disease marker compounds
  - ➢ Early detection before symptoms appear.

Agriculture

Research and olfaction

Case study on diseases :

United States Department of Agriculture
=> Influenza aviaire



Ellis 2017;
Mycobacterium bovis

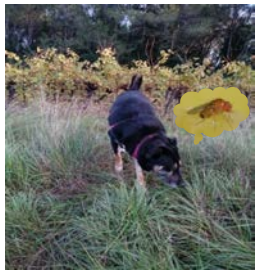
Fischer-Tenhagen 2018;
Dog detected
Staphylococcus aureus cows

Kushalappa et al 2002; potato disease

Gottwald 2020;
Dog detection
Liberibacter asiaticus Citrus

Kizil et al 2014;
Salmonella enterica
in poultry

Xuéreb 2025;
Dog detection
Drosophila suzukii,
Aphids,
Plant viruses…

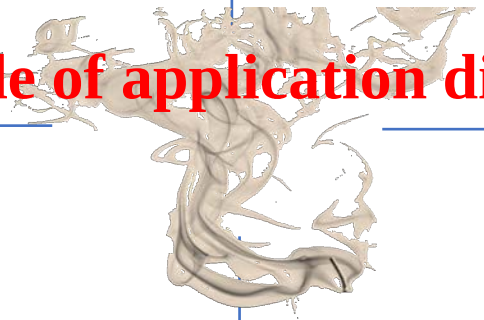


Research and olfaction

Conservation

Ecologie

Multitude of application disciplines.



Agriculture

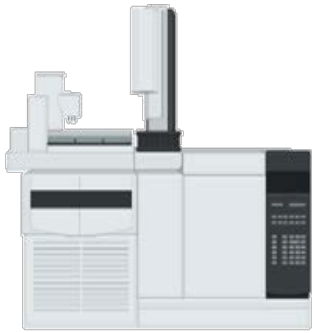
Medical

Mes projets :

Projet Poste IRD :
Toxoplasmose

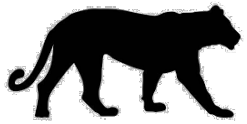
Use of detection animals

Chemical diagnostic tools



Developing the use of odors for disease detection

Humaine



Animale

Remerciements

Frédéric Thomas

Jordan Meliani

Bruno Buatois

Pascal Boutinaud

Laurent Le Cam

Matthieu Lacroix

Pierrick Dupré …..

Mélanie Bonet

Anne Xuereb

Merci pour votre attention !

Des questions ?

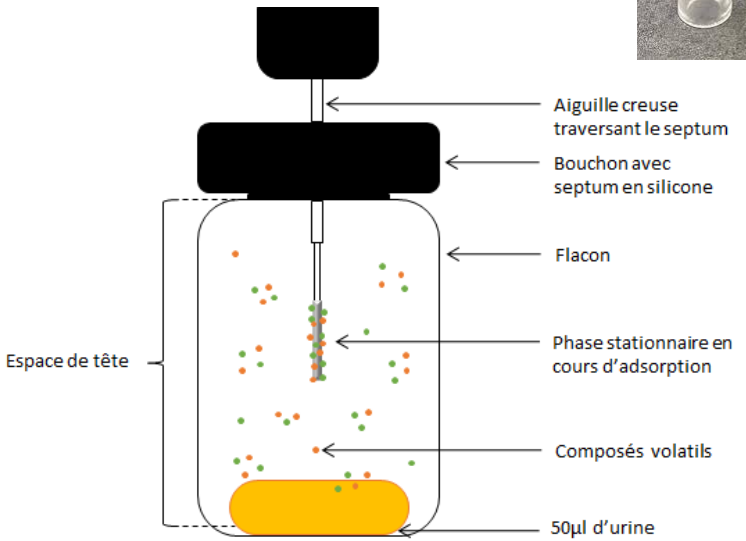
Méthode de prélèvement et d'analyse

Méthode de prélèvement

Prélèvement dit passif

Fibres SPME

Getxent => Entraînement des chiens

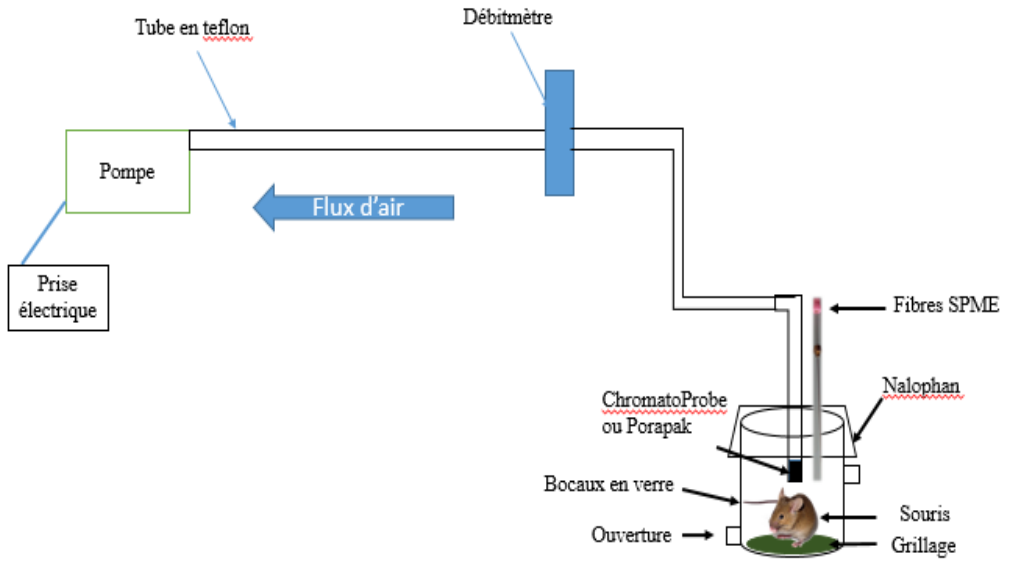


Phase adsorbants

Prélèvement dit dynamique

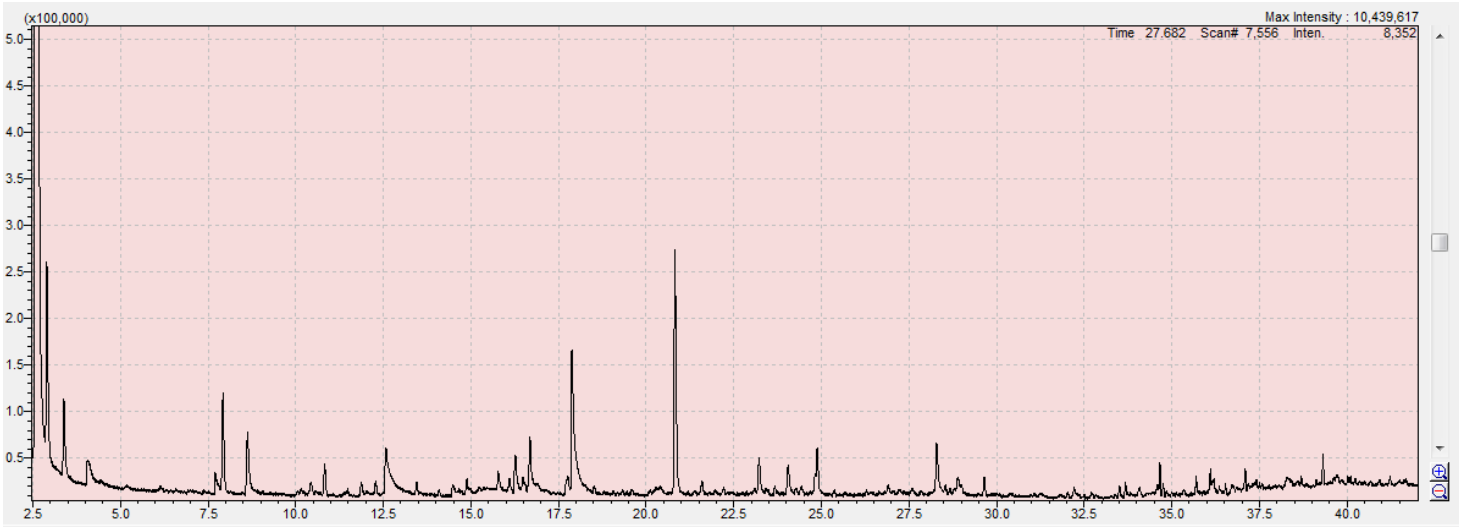
Porapack

Chromatoprobe



Méthode d’analyse d’odeur

GC-MS (chromatographie en phase gazeuse)



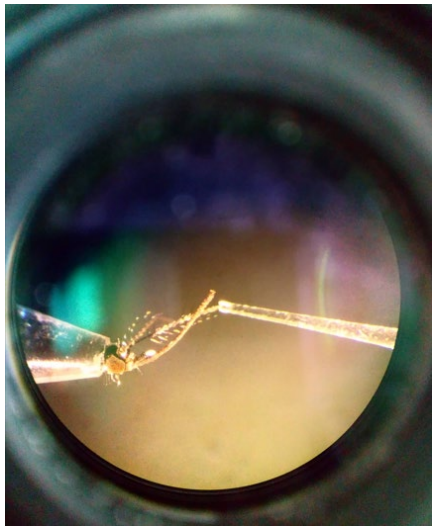
Identification des composés.
Analyse qualitative et quantitative.

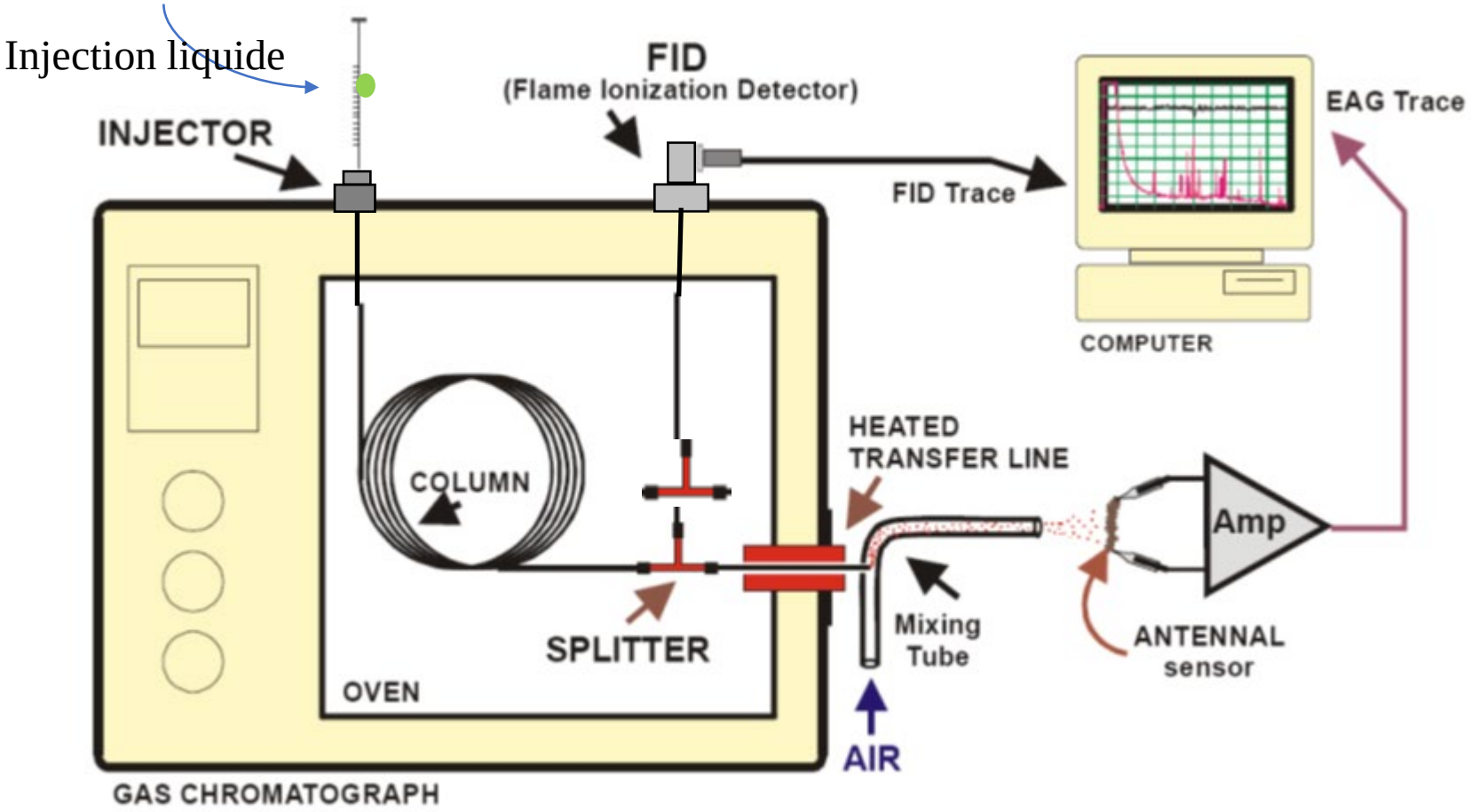
Analyse GC-EAD ou EAG

Gas Chromatography- Electroantennogram Detector ou électroantennographie

Etude des composés détectés par les insectes

Elution des porapack avec un solvant (hexane, dichloraméthane..)



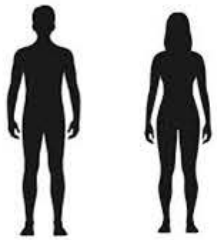


Entraînement des chiens/rats à discriminer les hôtes définitifs

Hôte définitif

Oocystes

Environnement



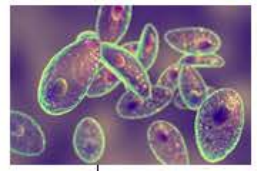
AXE I : Calibration et catalogage des profils d'odeur des hôtes définitifs et intermédiaires

Ingestion des tissus

AXE I :Identification du pathogène dans l'environnement et lien avec les odeurs

Entraînement des chiens/rats à détecter les zones de présence du parasite

AXE II : Application en santé vétérinaire

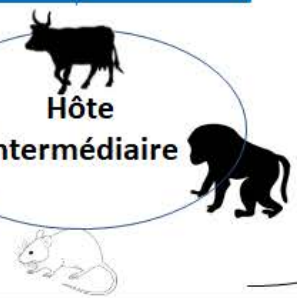


Transmission verticale à travers le placenta

Oocystes dans la nourriture, l'eau, le sol. Ingérés par les hôtes intermédiaires

Entraînement des chiens/rats à discriminer les hôtes intermédiaires

Hôte intermédiaire



AXE III : Application en conservation : la toxoplasmose et les conflits homme/faune

AXE II : Application en santé humaine chez les femmes enceintes

AXE I : Un système expérimental pour le suivi des odeurs chez un modèle murin

Entraînement des chiens/rats à discriminer les individus infectés et sains