User friendly biomarker-based animal trypanosomiasis diagnosis

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Introduction

The livestock sector supports more than 1.3 billion producers and retailers, and contributes 40–50% of agricultural GDP

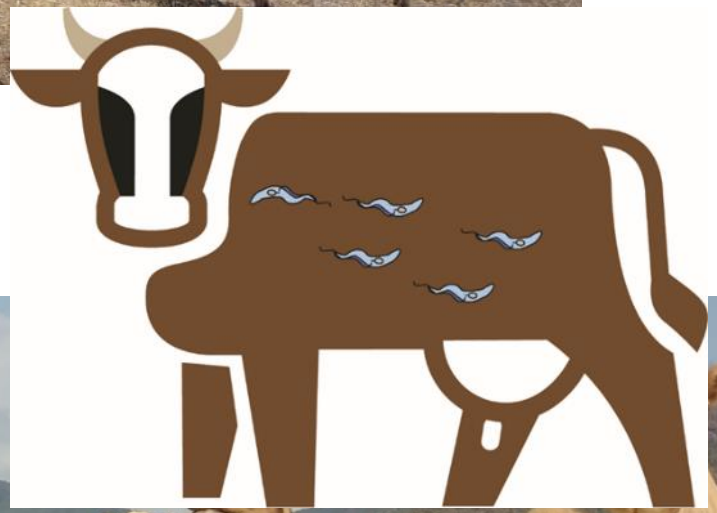
Among the various positive services that livestock farming systems provide to ecosystem is diversifying soil pathogens and nutrient that strongly influence soil health and productivity

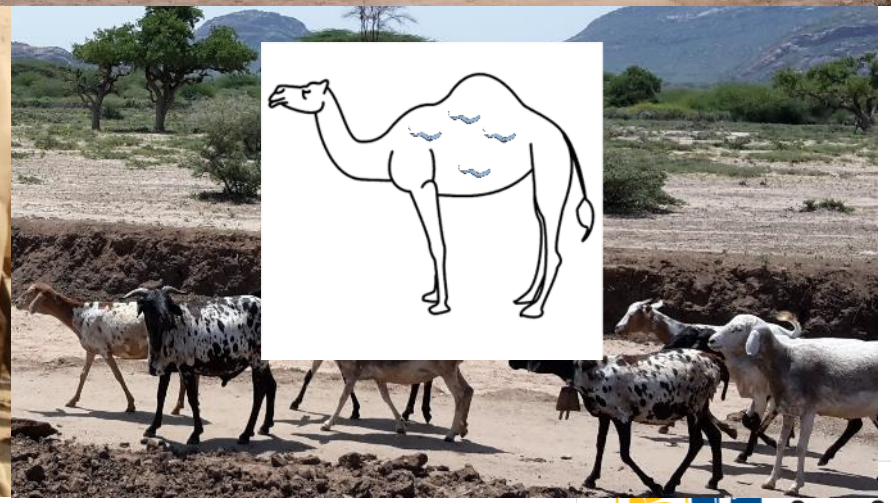
Livestock are resilient

Livestock positive role is polarized due to greenhouse gases emission, debate, need sustainable livestock farming

Livestock productivity is significantly affected by vector borne diseases (VBDs) especially in African continent

Livestock-pathogen-vectors interaction





Livestock - VBDs

Epidemiology of different trypanosomes, anaplasma in camel, cattle

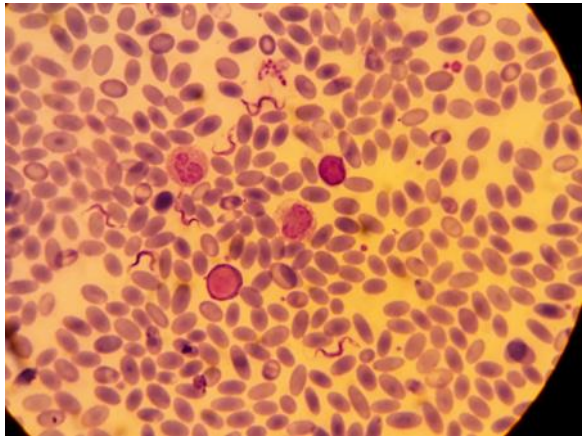
T.evansi

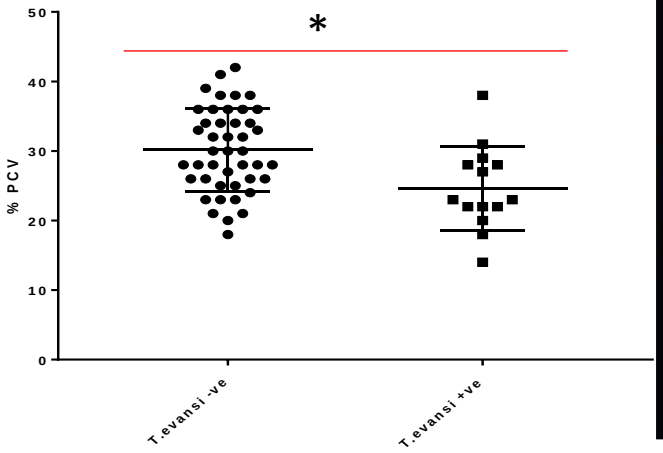
T.vivax

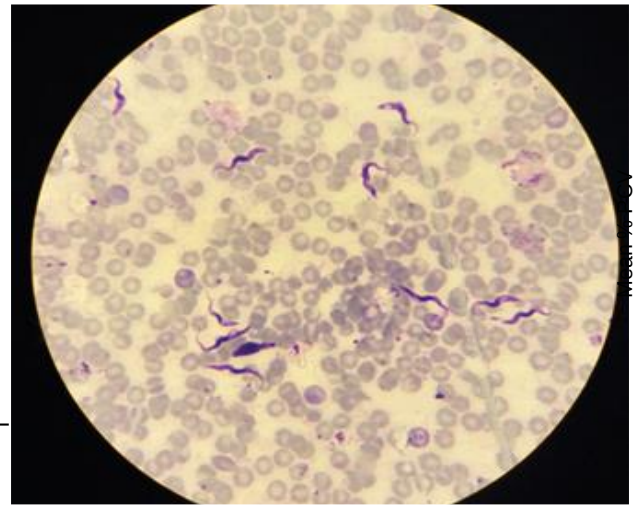
T.evansi + anaplasma

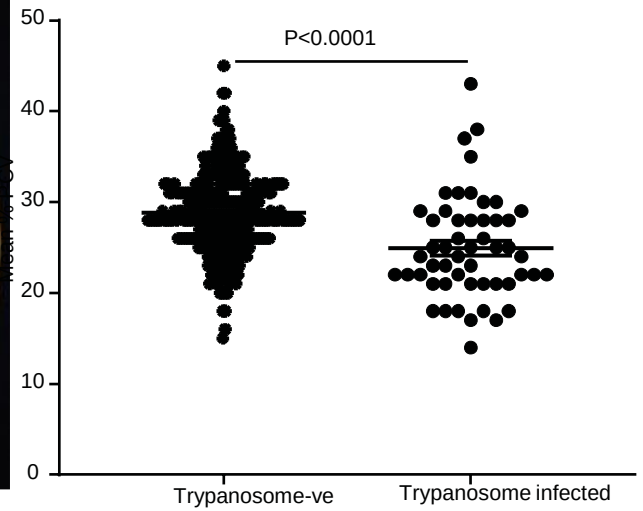
Cooperative virulenc

Pathophysiology









~15%mortality

Low productivity

35% abortion

Getahun et al., 2020, Getahun et a., 2022

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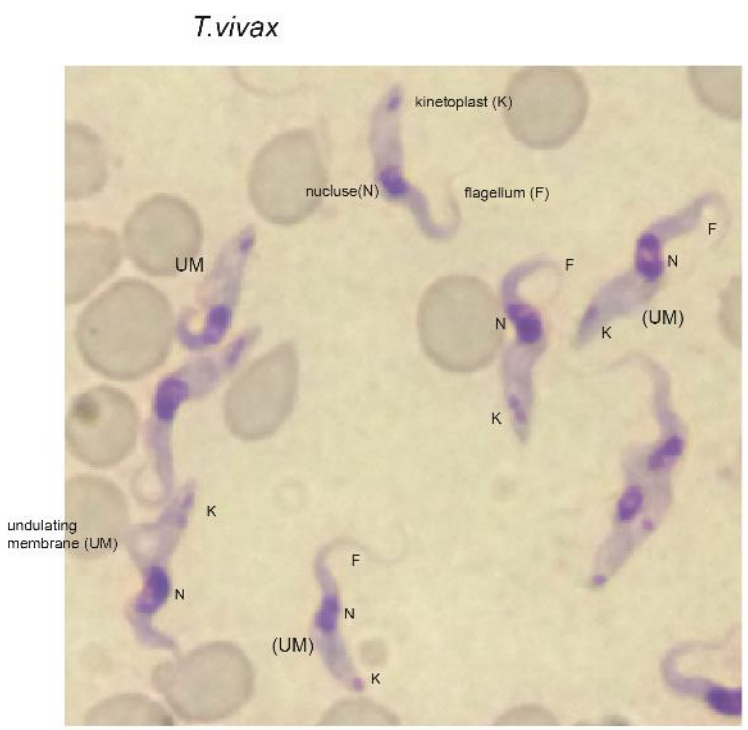
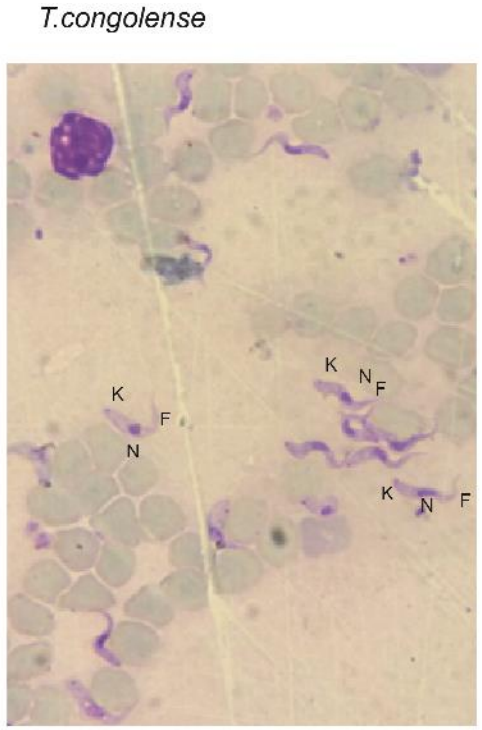
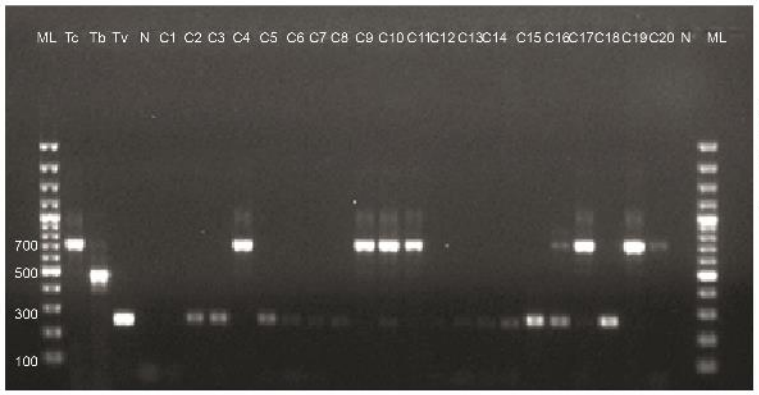
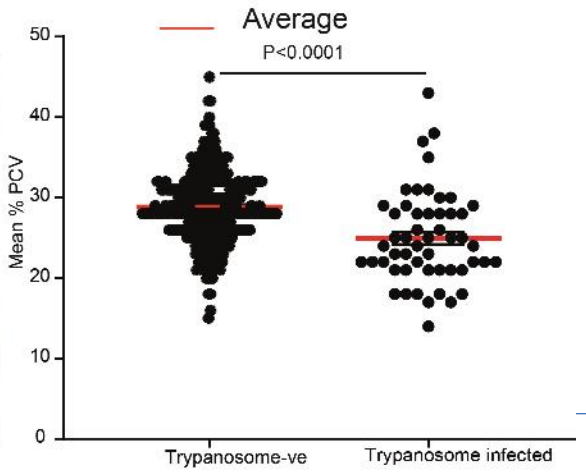
Animal trypanosomiasis remains a challenge despite all efforts



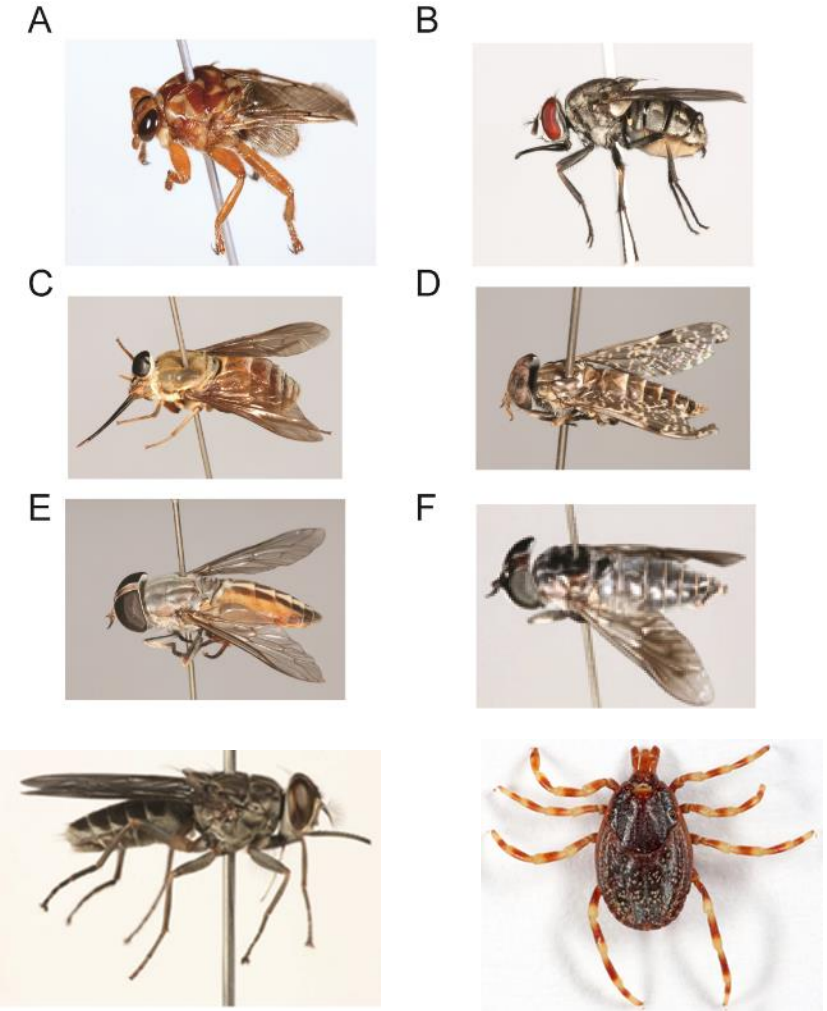


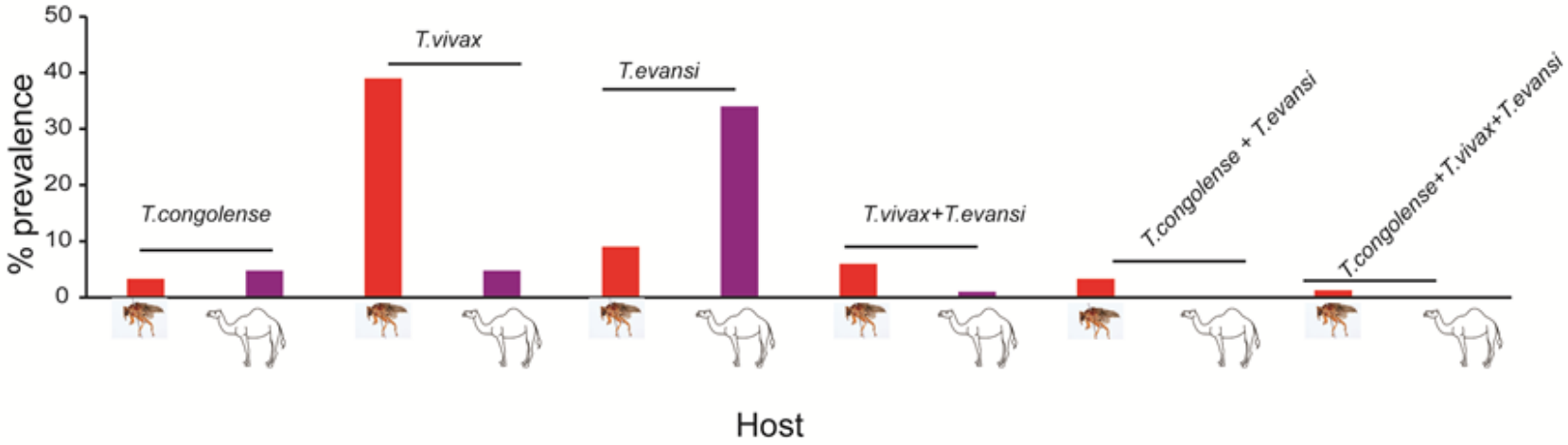




- Animal African trypanosomiasis caused by *T. congolense* and *T. vivax* is still one of the most serious livestock illnesses in sub-Saharan Africa, affecting millions of cattle every year
- High trypanosomes prevalence (14%)
- Infected cattle were considerably anemic, an indication of trypanosomosis severity

Various potential vectors of trypanosomes, anaplasma

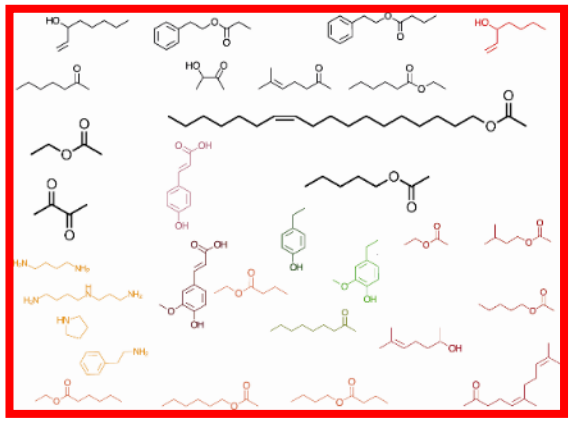


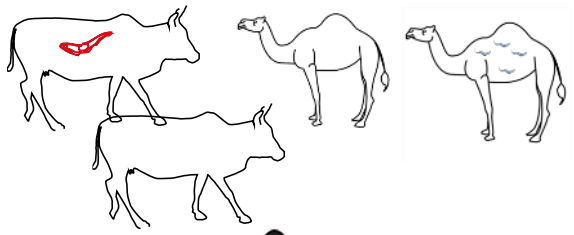


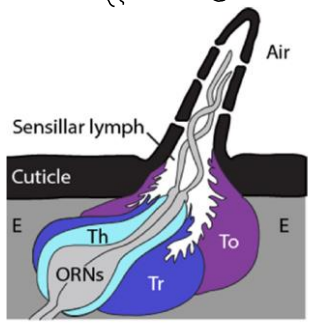
High correlation of pathogens between biting flies and camel

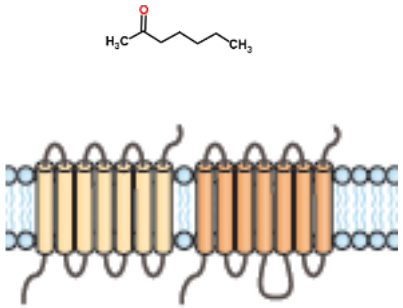
Getahun et al., 2020a

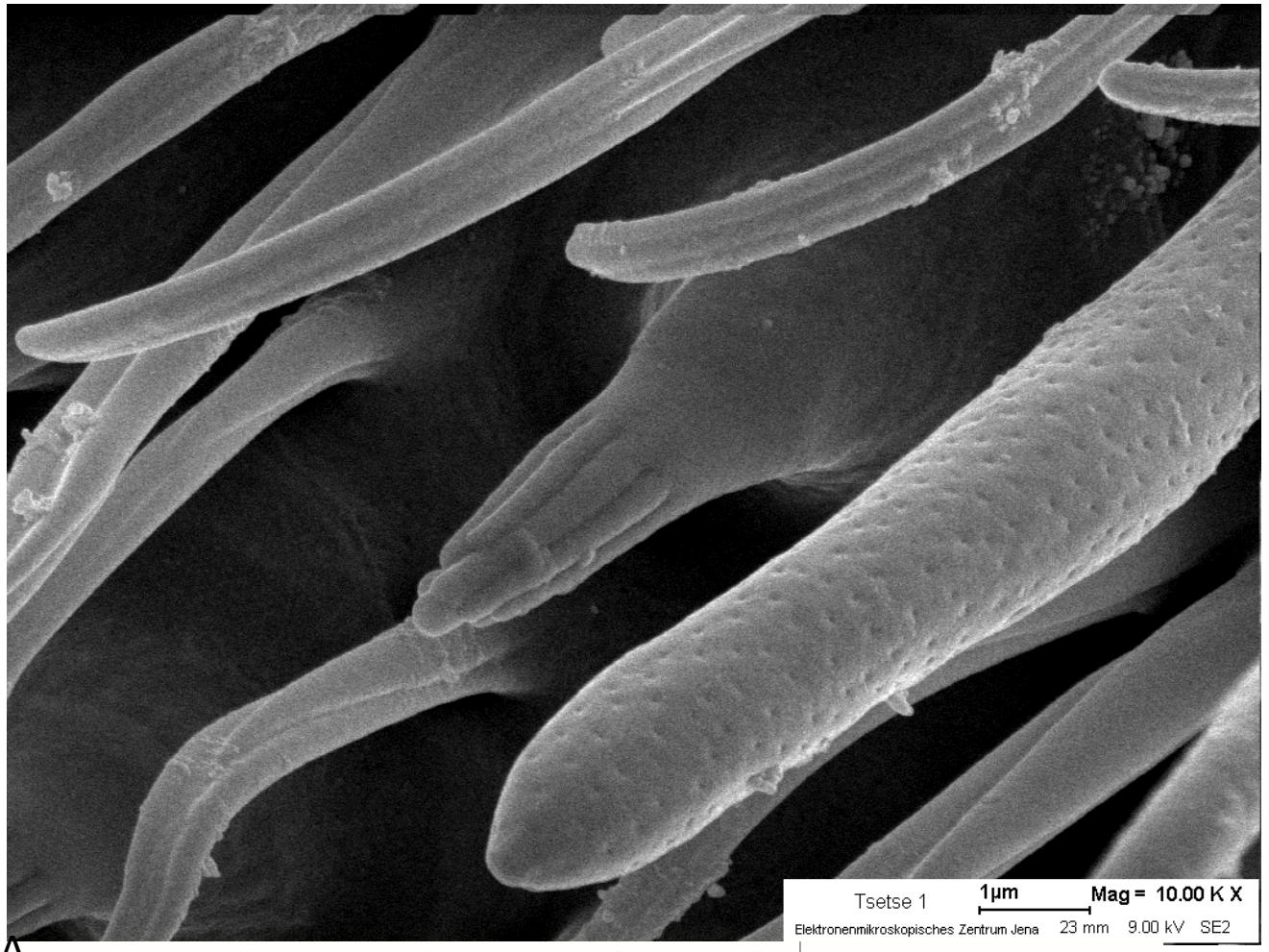
Livestock-pathogens-vectors interaction to develop tools for vector control and diseases diagnosis











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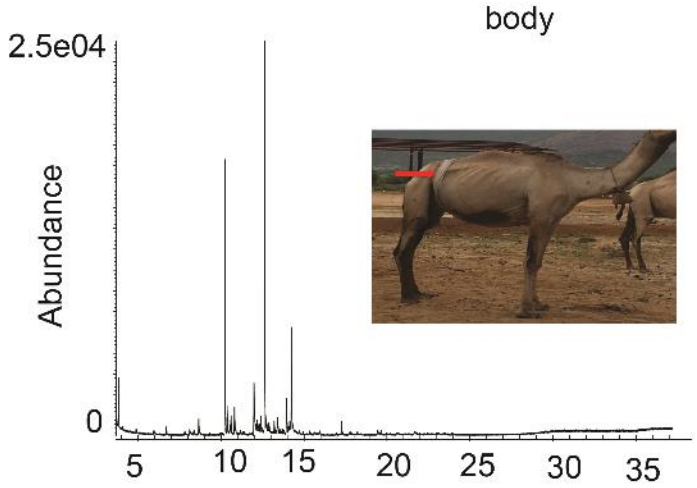
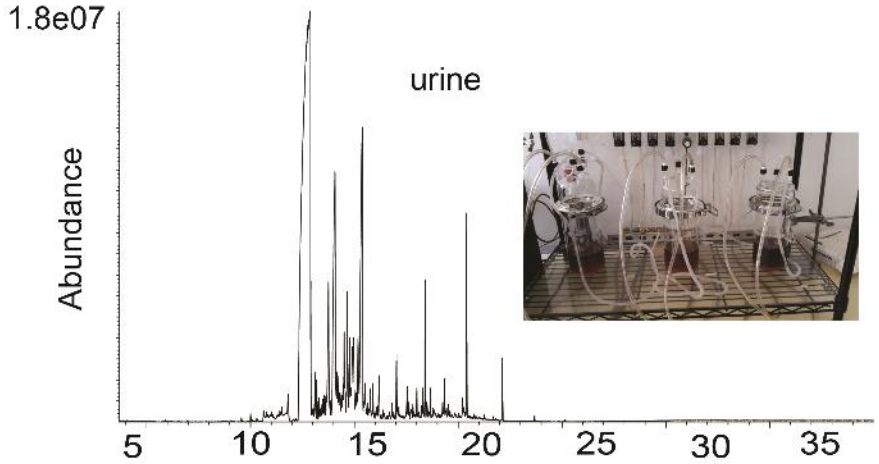
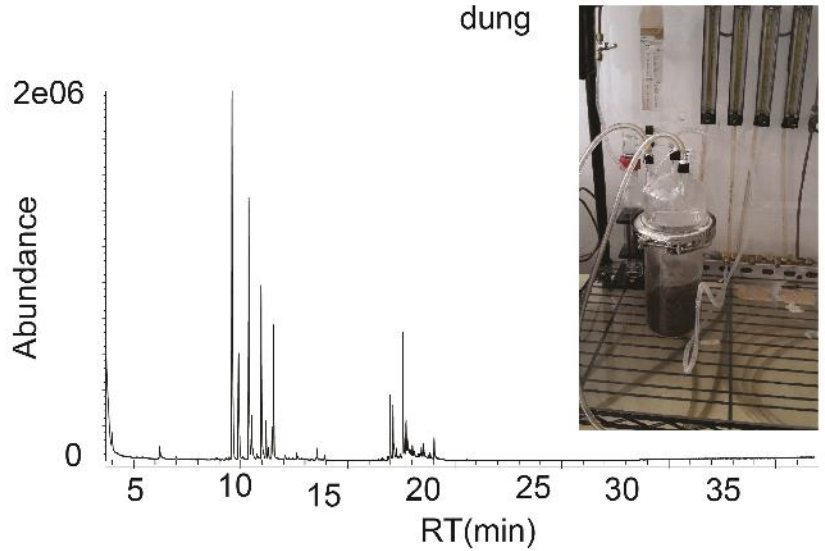
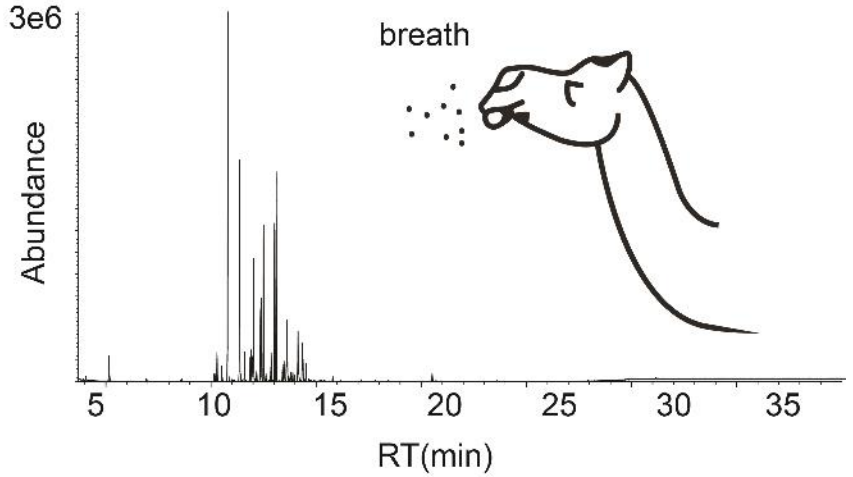
How to mimic camel by its odor?



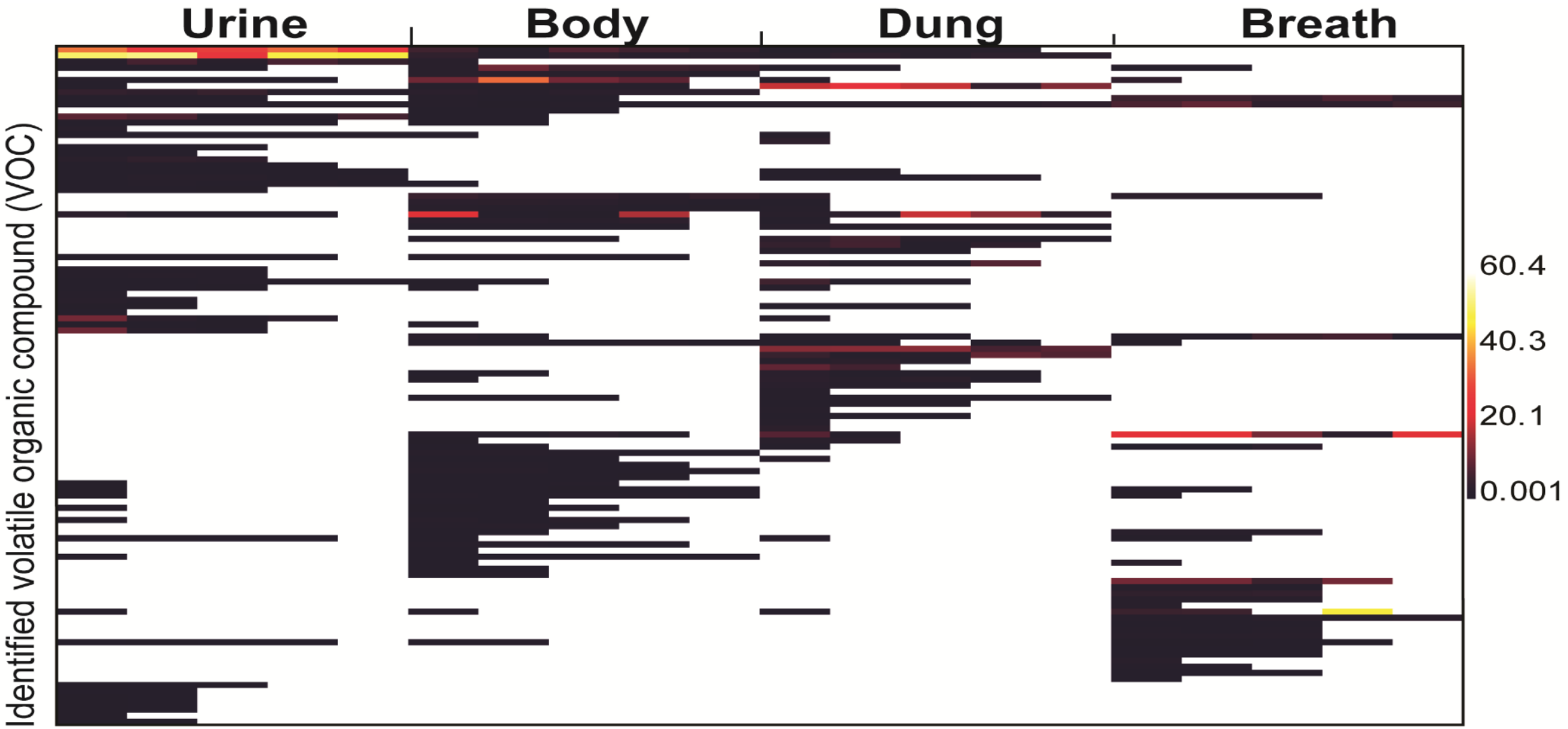






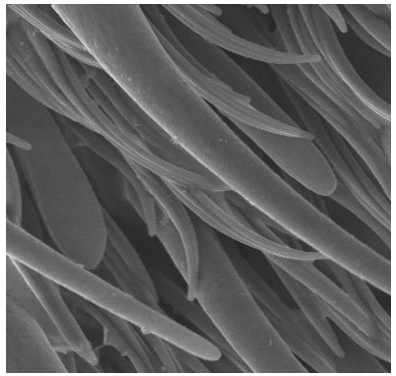
Getahun et al., 2020b

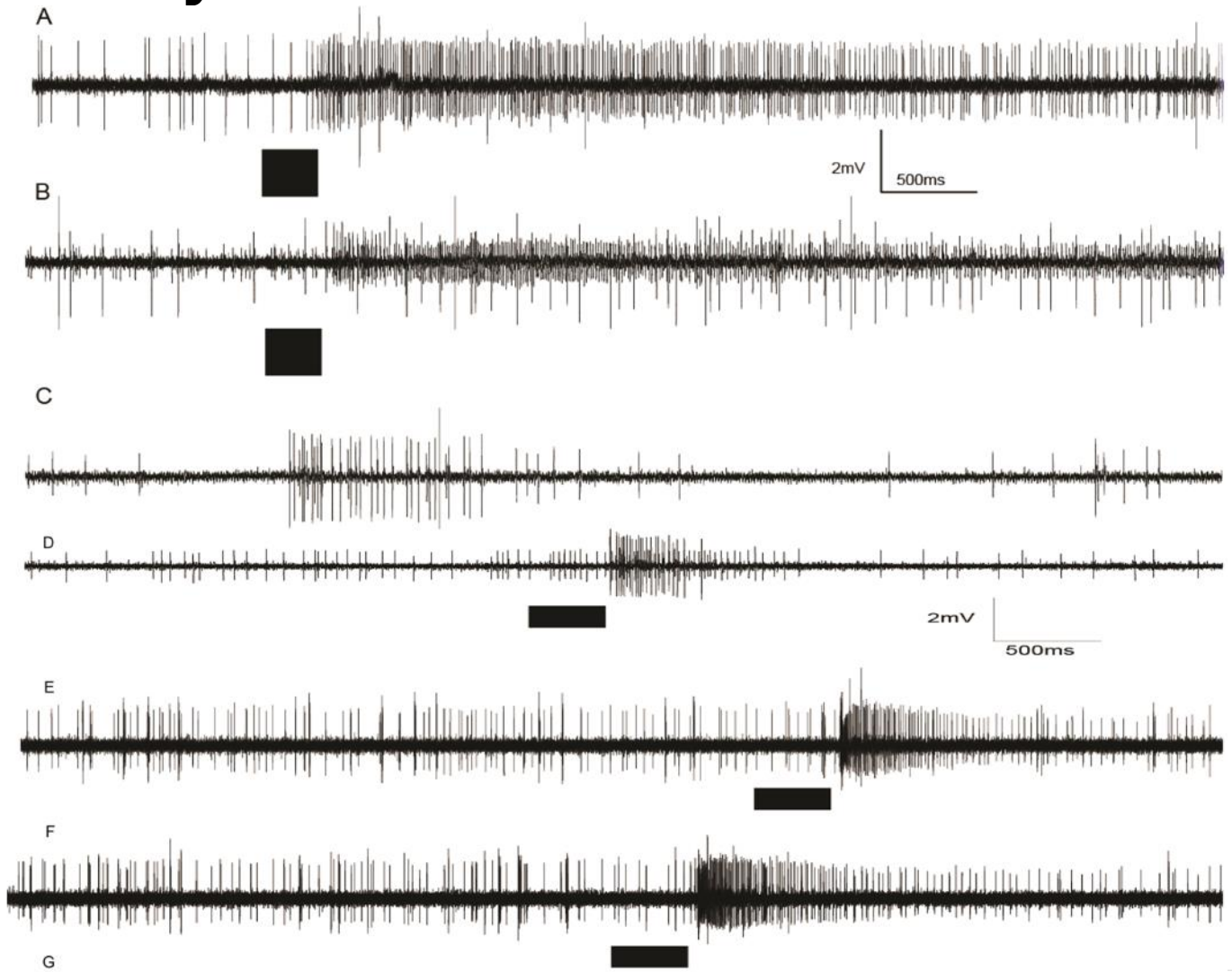
Odours between metabolic pathways are distinct with some overlaps



Getahun et al., 2020b

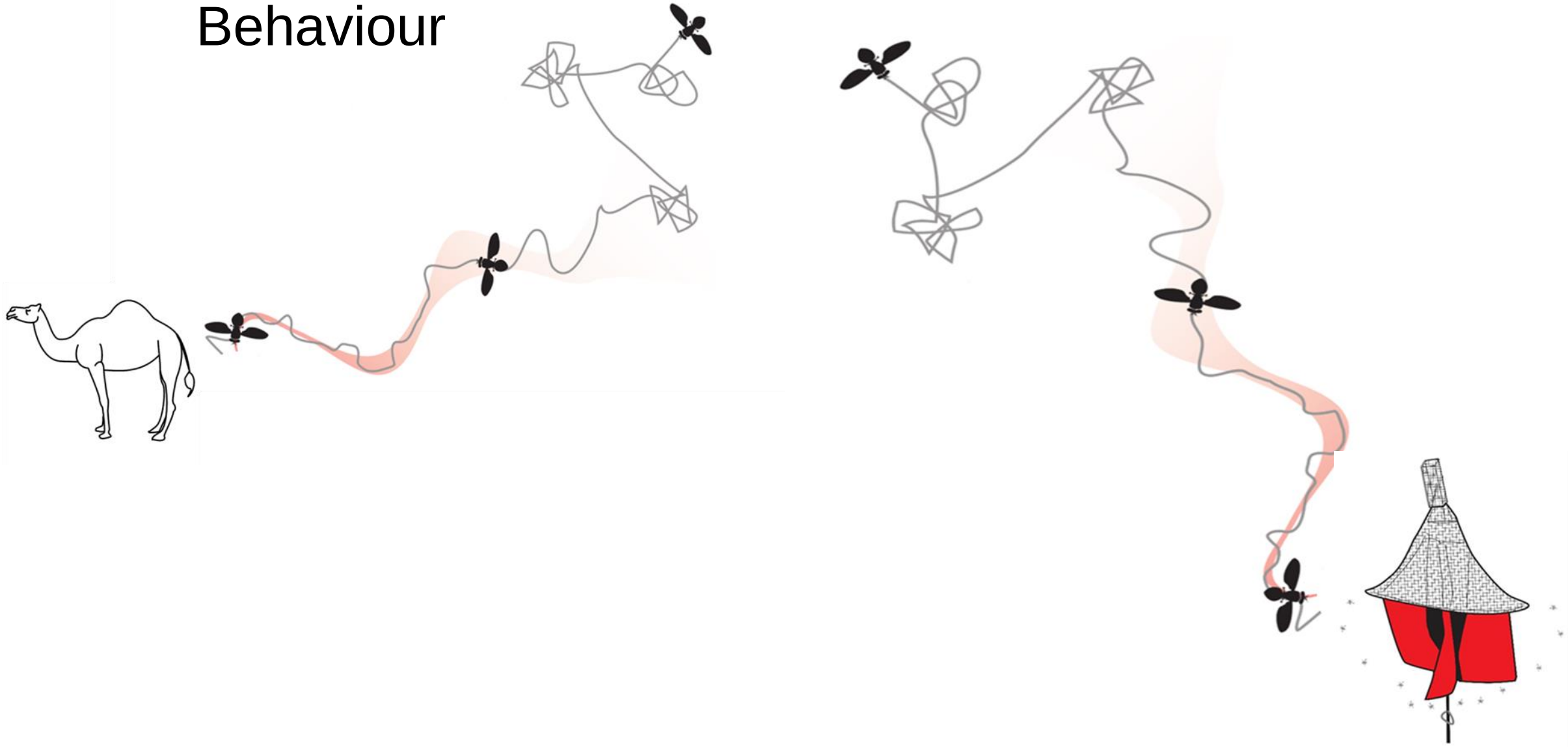
Neurobiology: Camel semio-chemicals coding by stable fly olfactory system



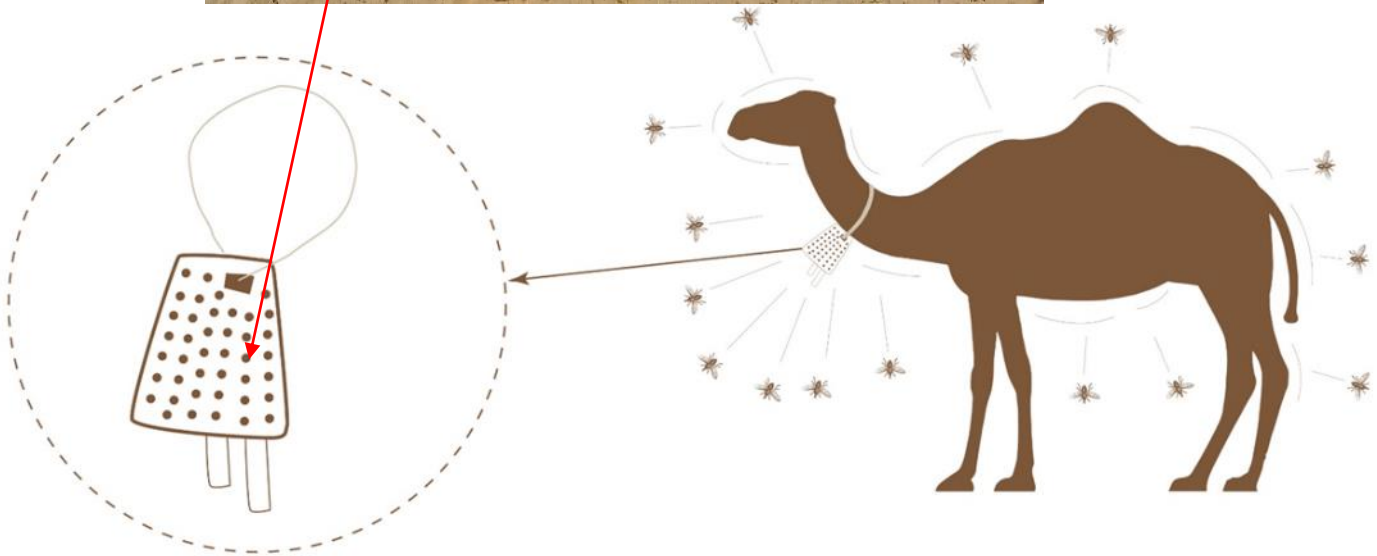


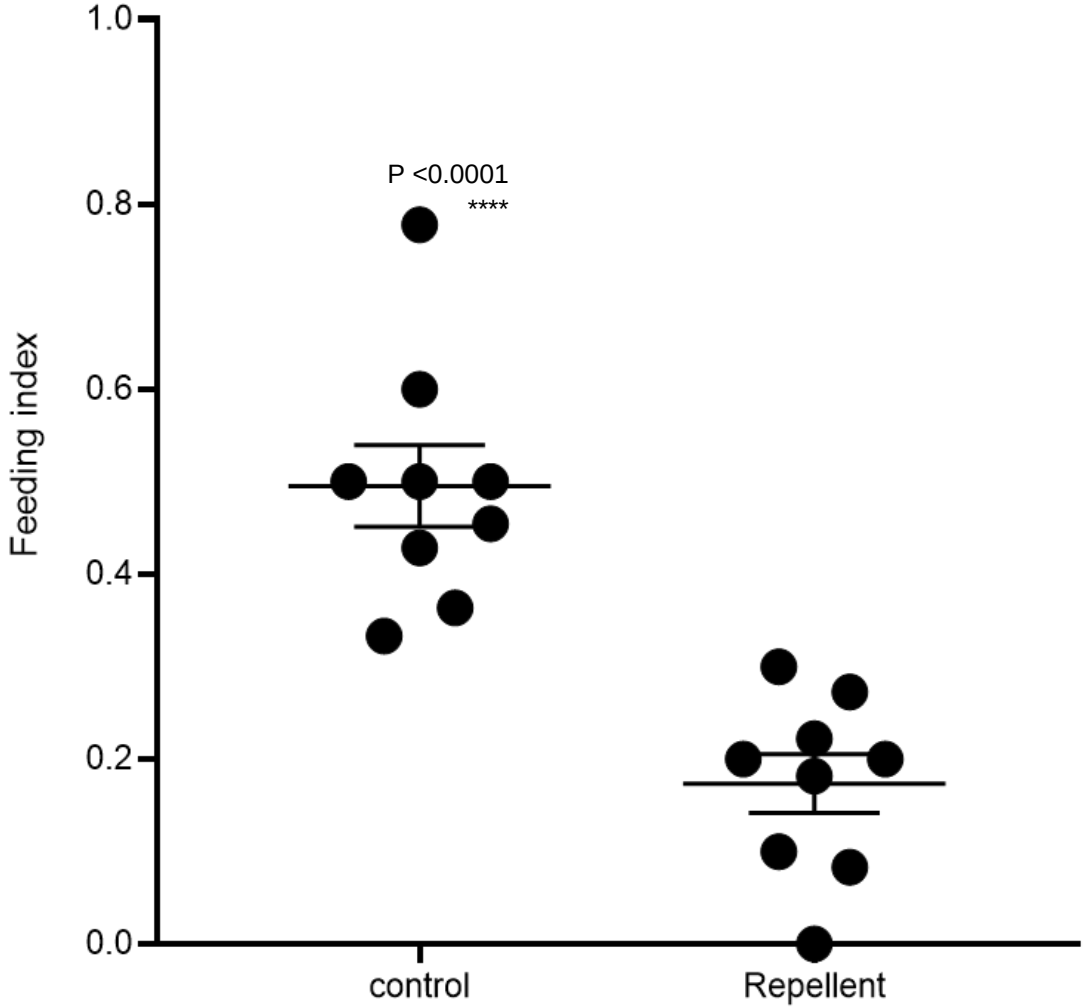
Getahun et al., 2020b

Behaviour

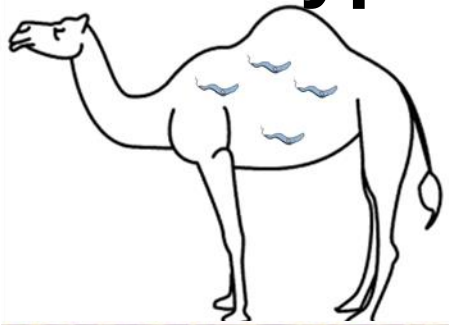


Repellent formulation…

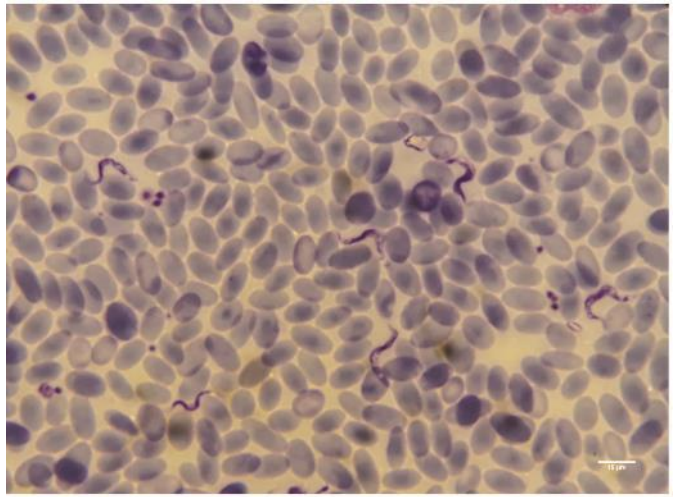


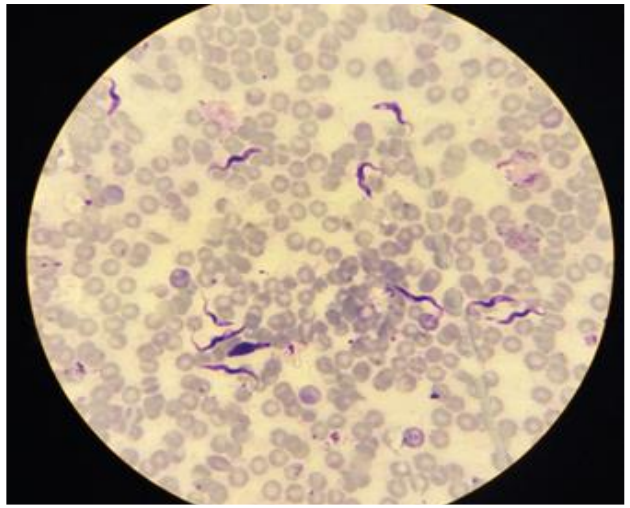


How to diagnosis animal trypanosomiasis and surra

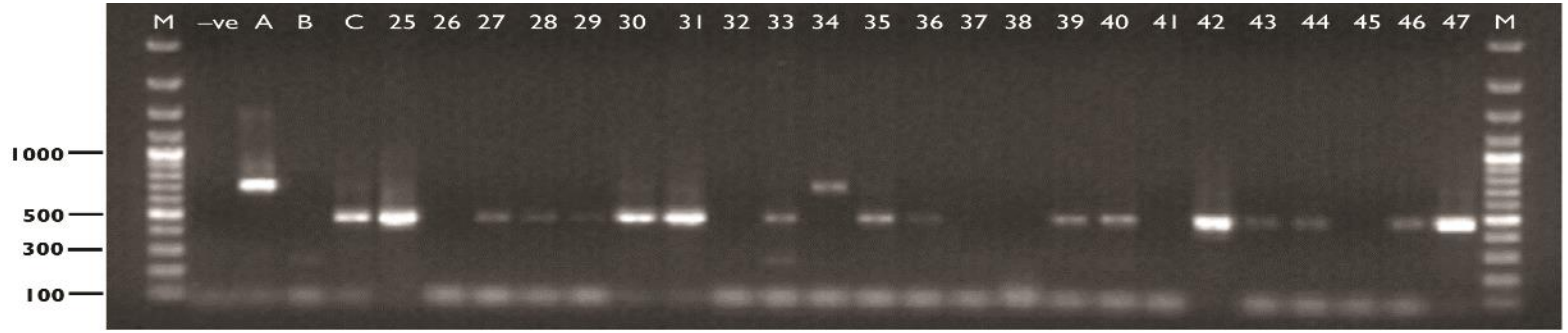


Microscopy





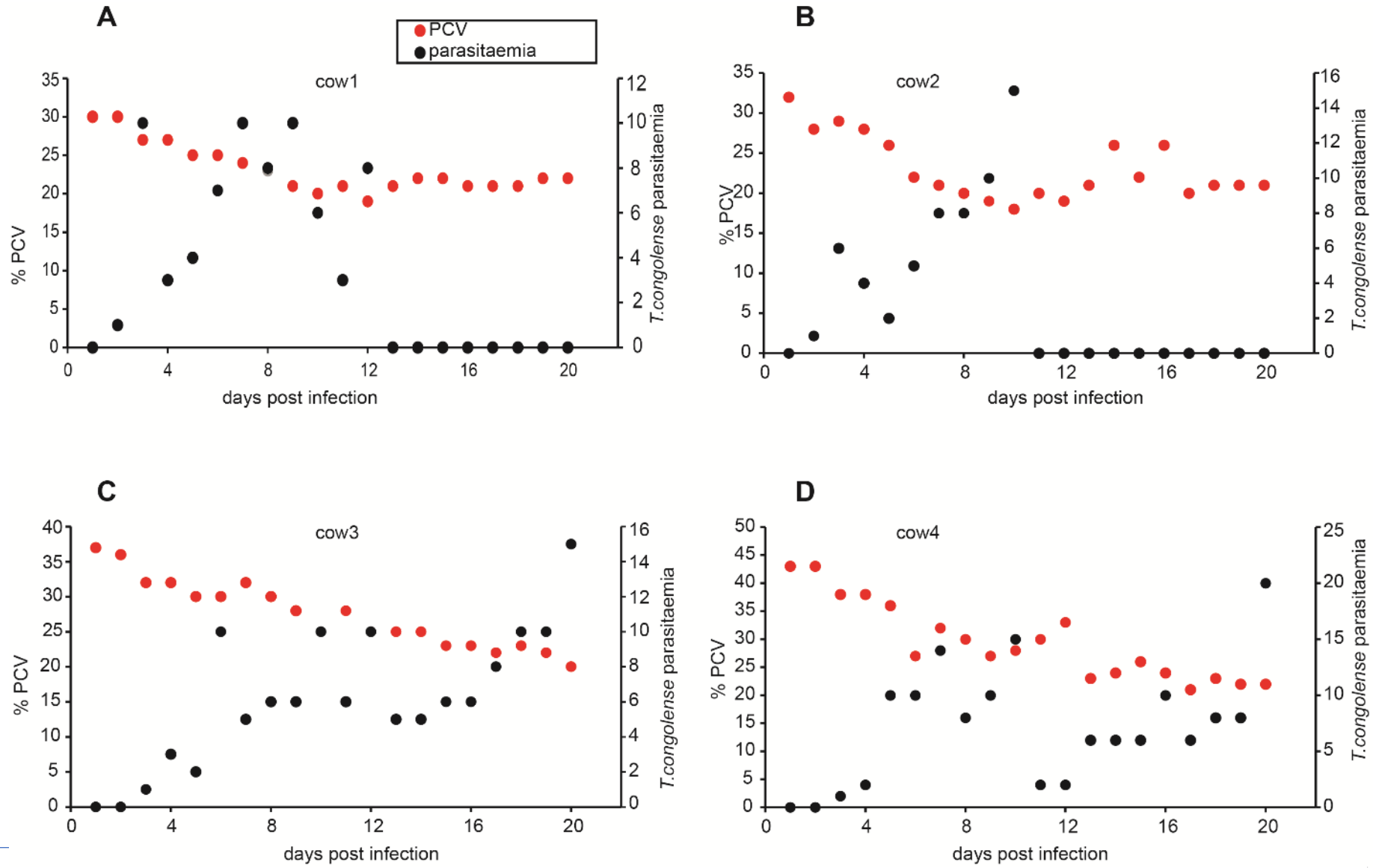
PCR



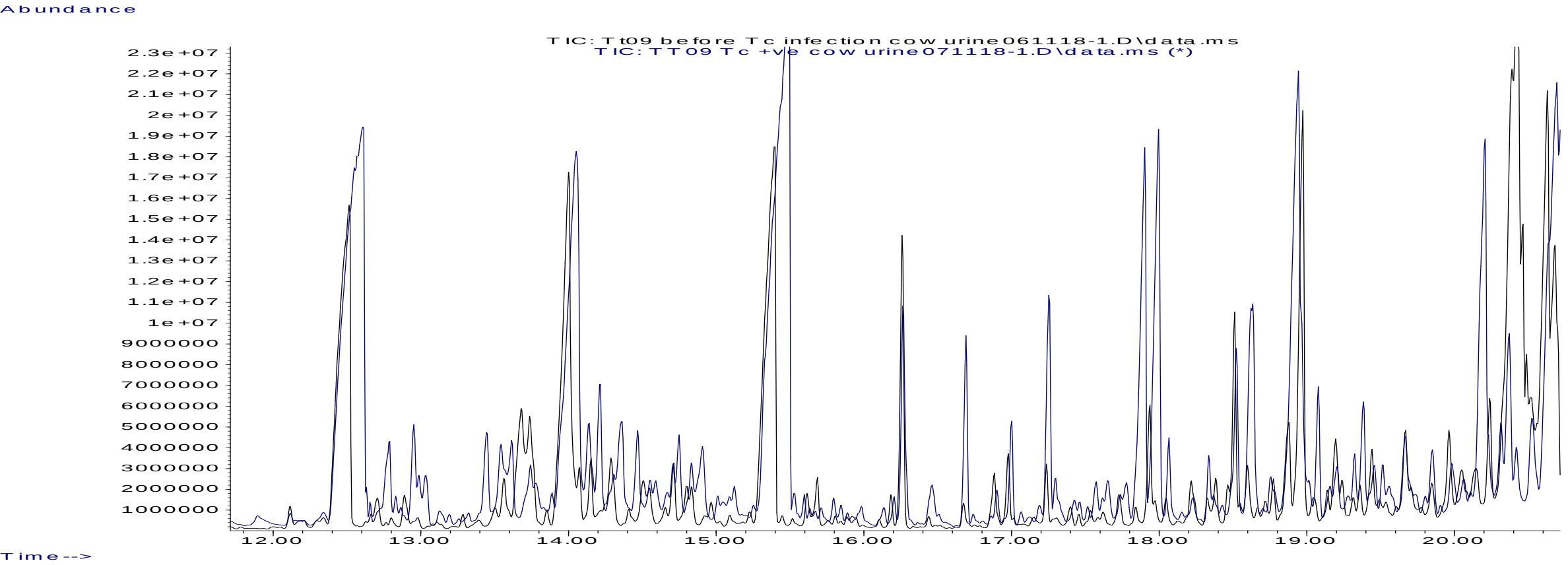
Developing simple animal trypanosomiasis diagnosis

Animal trypanosomiasis diagnosis has been challenging due to the technicality of the current diagnostic tools, PCR and microscopy. To democratize animal trypanosomiasis diagnosis we applied the use of **reliable simple organic compounds biomarkers which are the intermediate or the end products of various cell processes and closely reflect the pathophysiological changes involved in the disease on set and progression.** In our finding, trypanosome infection caused consistent changes in volatile organic compounds, in their urine and breath as reliable biomarkers of trypanosomiasis and we used those odors as diseases indicator.

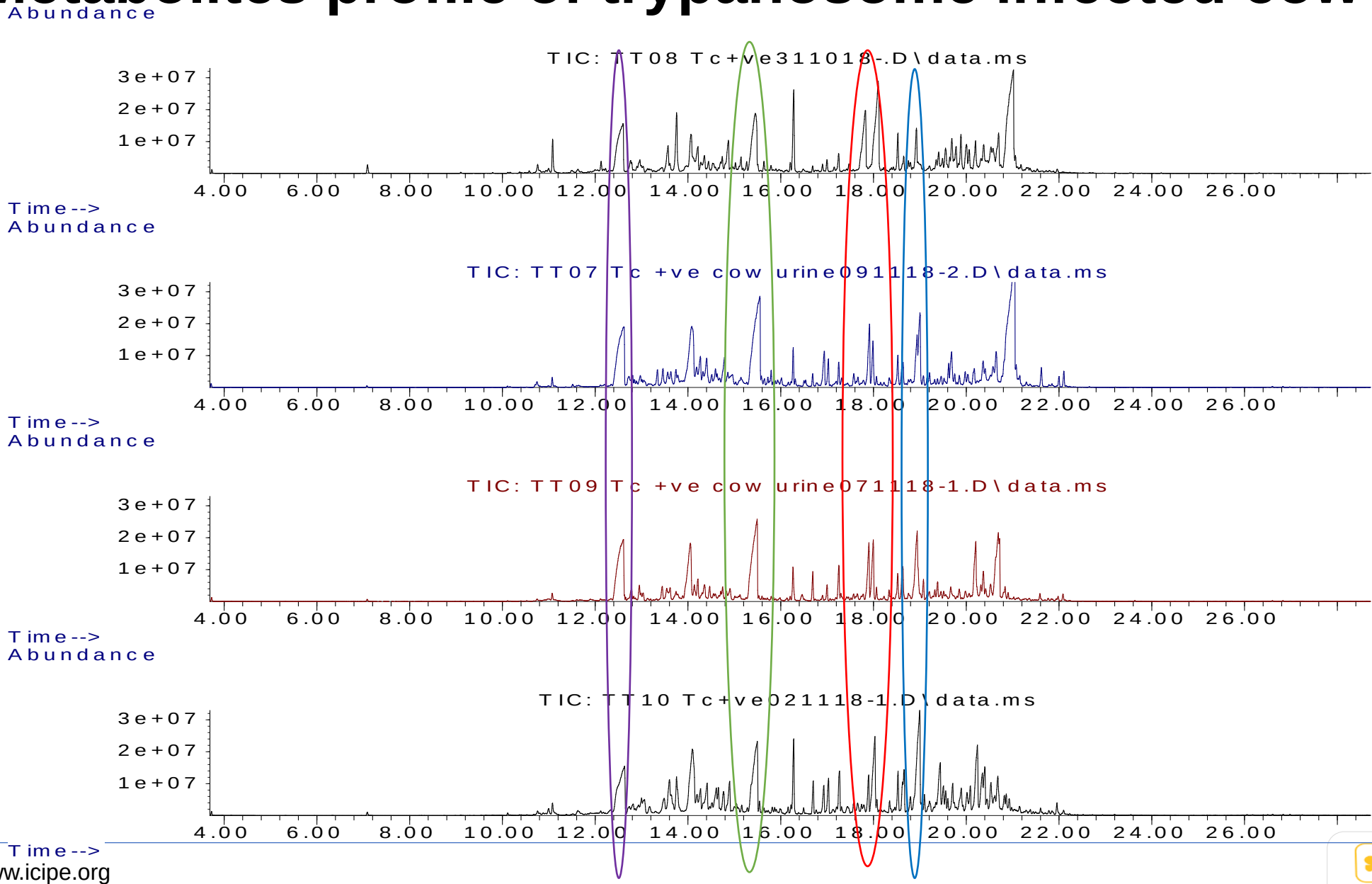
Trypanosoma congolense Infection Reduced PCV



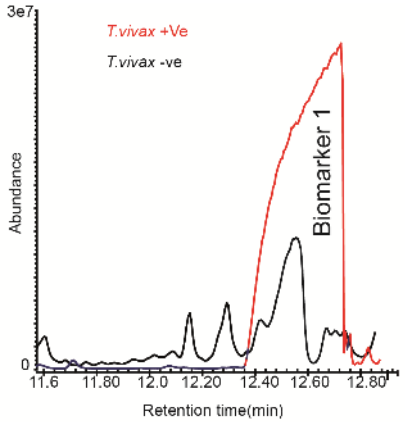
Trypanosoma congolense Infection modified cow urine odor chemistry

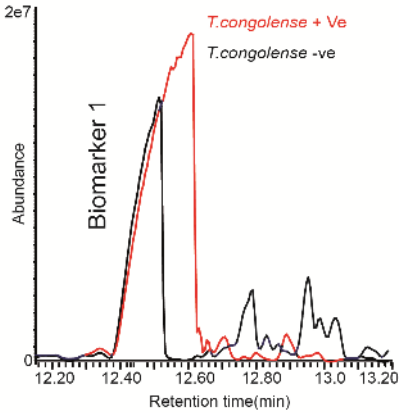


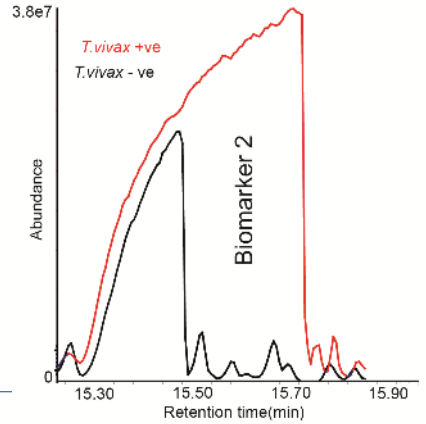
Metabolites profile of trypanosome infected cow urine

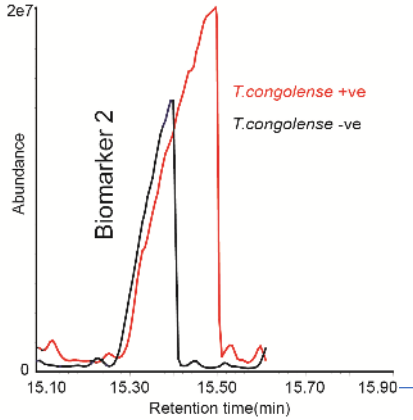


Phenolics concentration significantly increased in trypanosome infected cattle and they are potential biomarkers

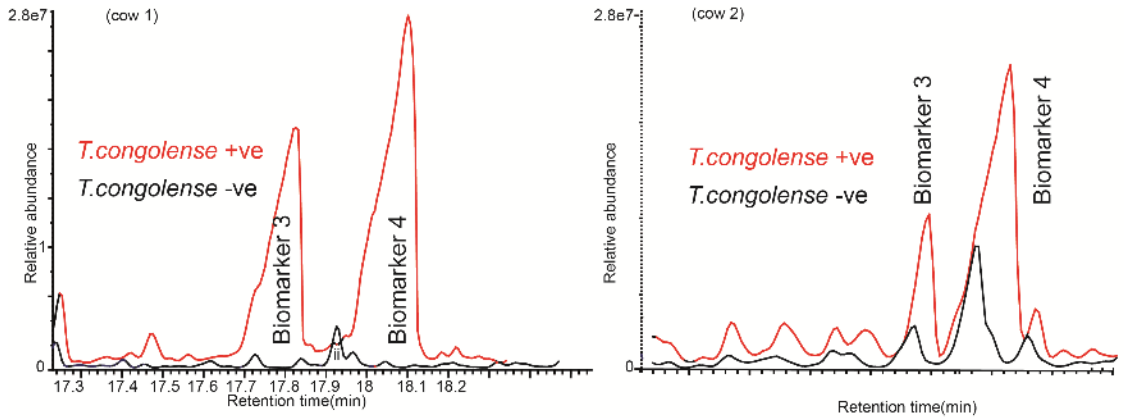


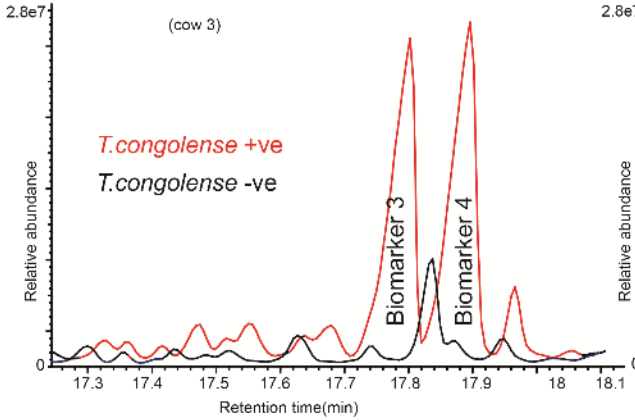


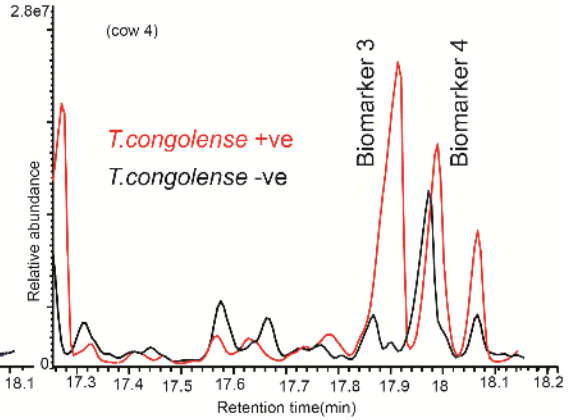




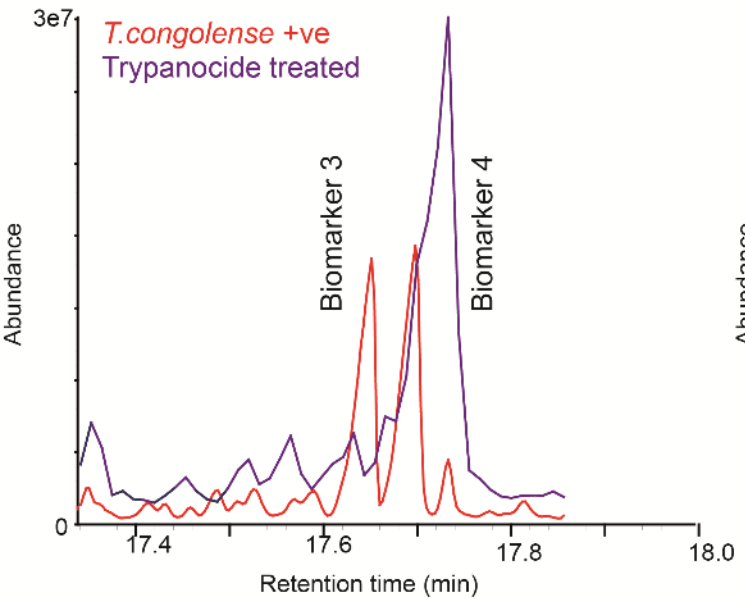
Ionones are Signature Scent of *Trypanosoma congolense* Infection

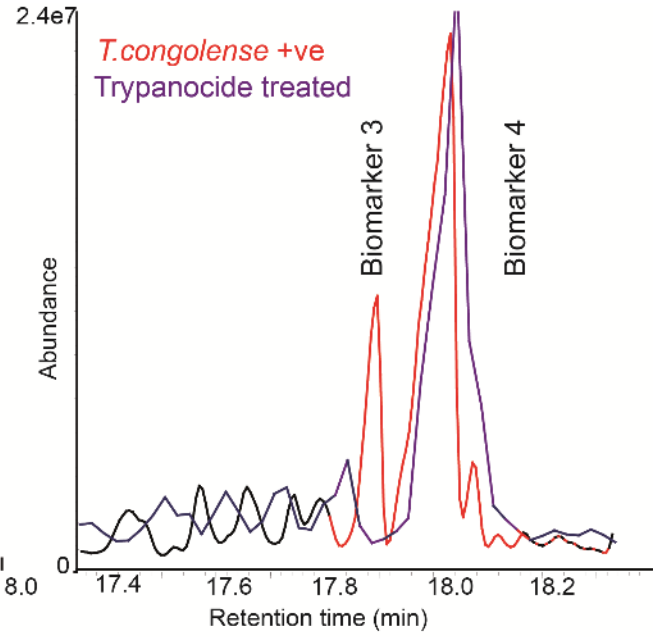


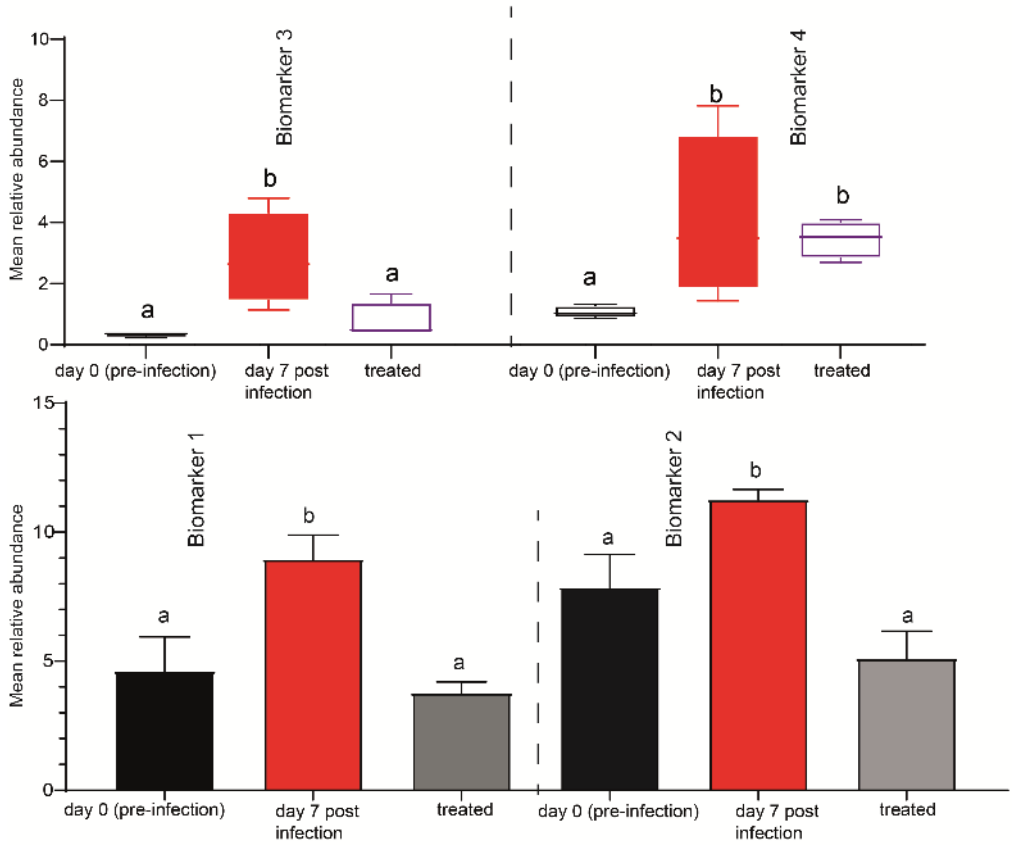




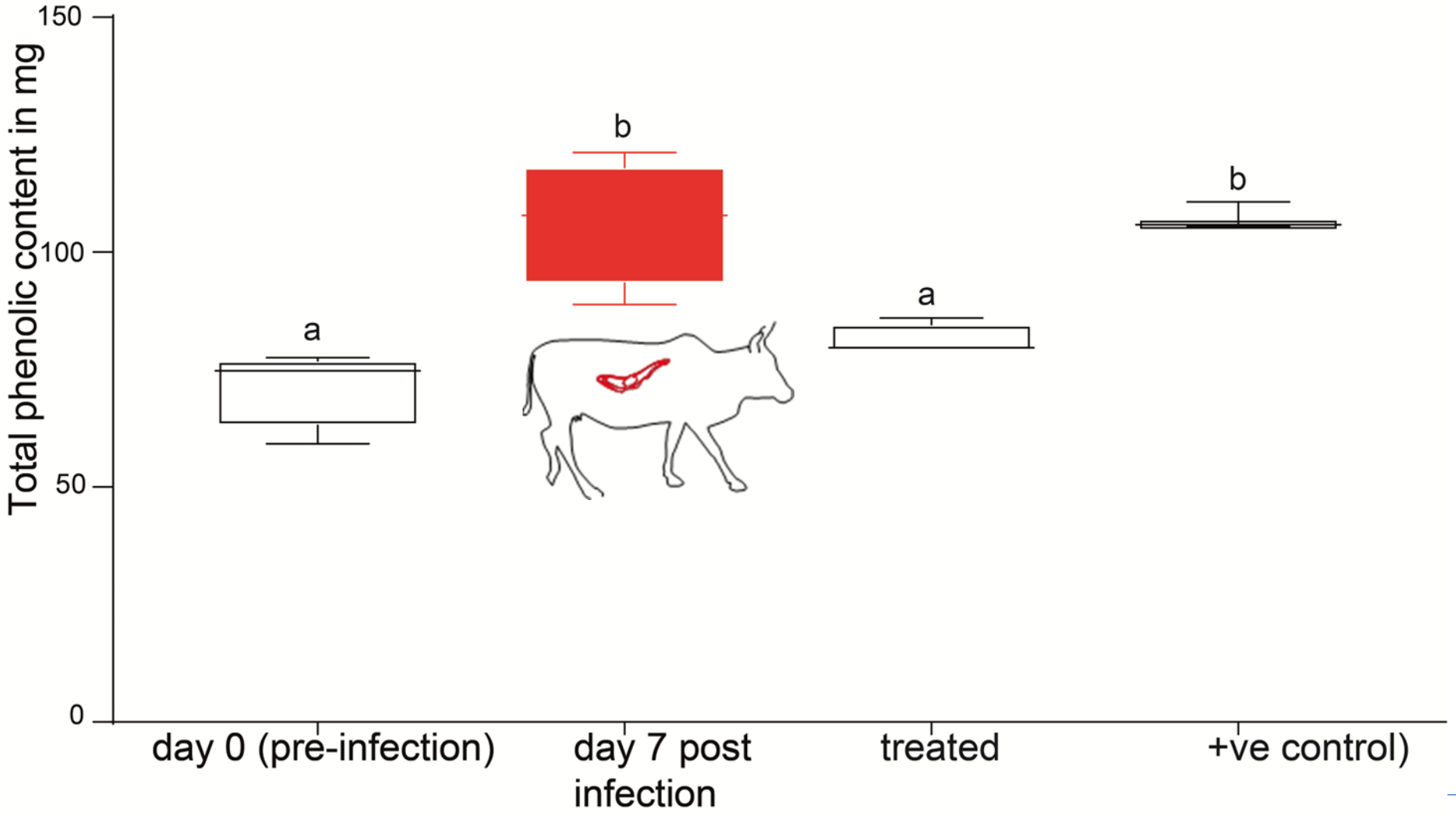
Treatment of Experimentally Infected Cow Restores Biomarkers to Pre-infection Levels







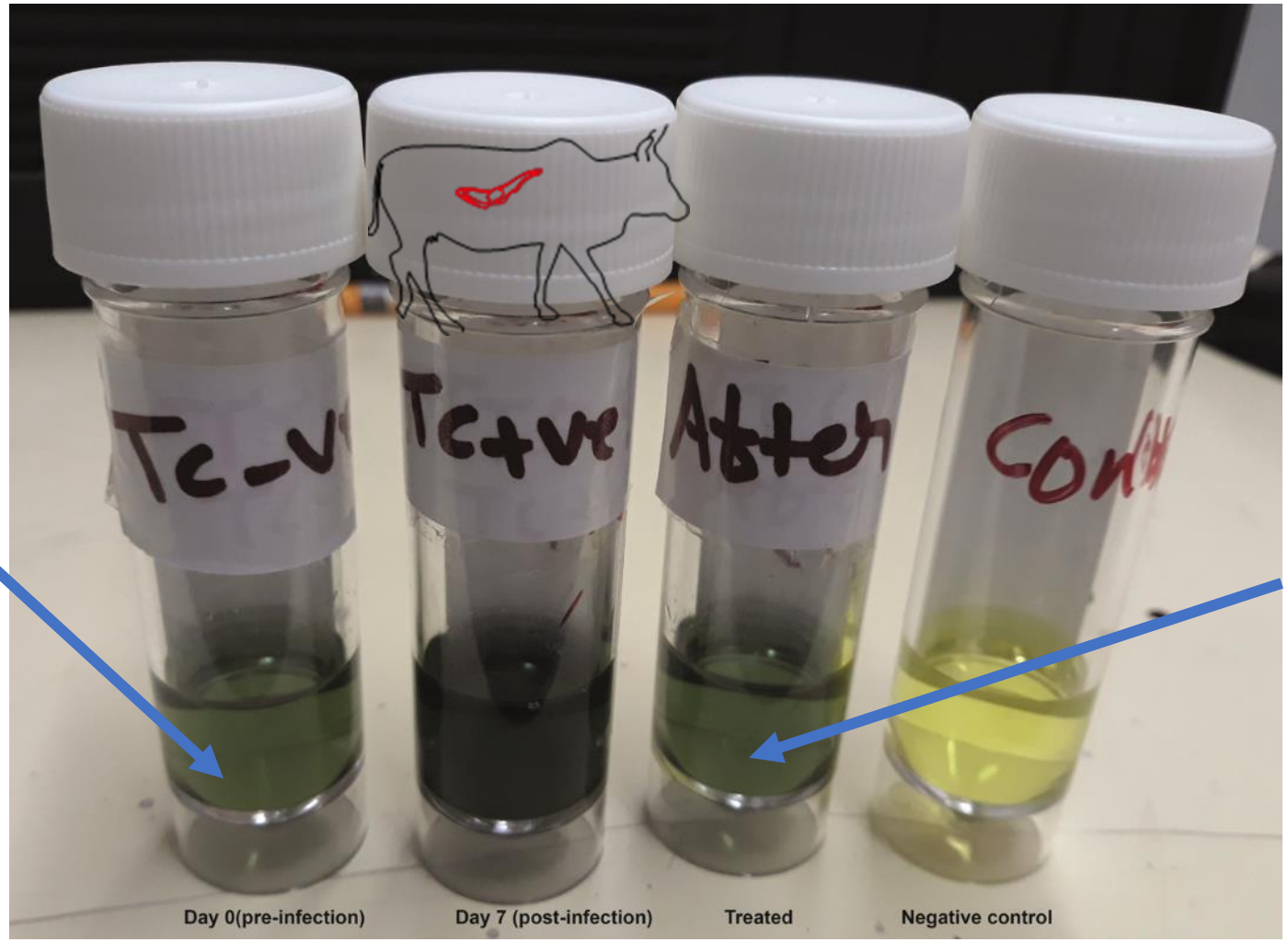
Significant increase of phenolics due to animal trypanosomosis infection



As the concentration of Phenolics biomarkers were significantly increased due to trypanosomes infection we asked as to whether our biomarkers could be used to diagnose cows suffering from trypanosomosis.

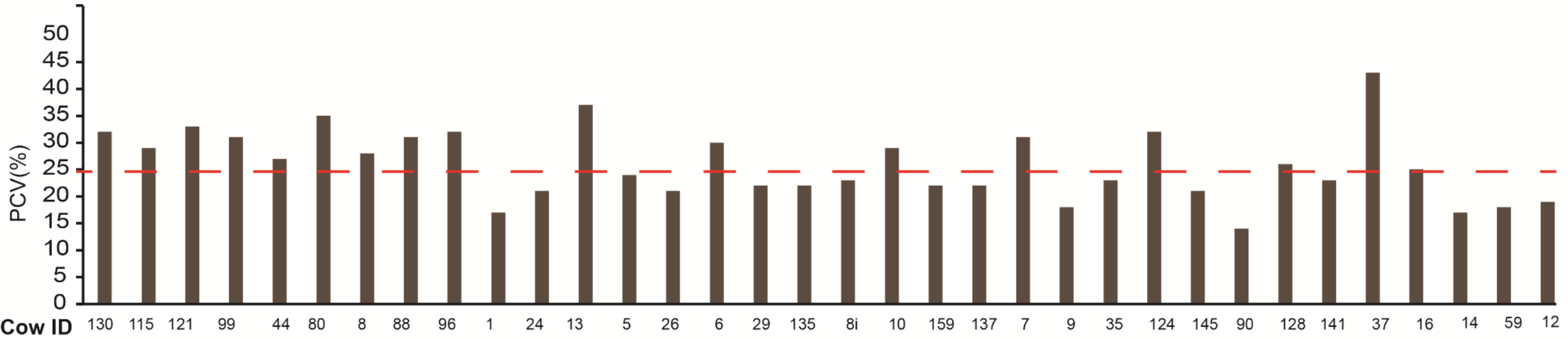
We used The **Folin–Ciocalteu reagent** to target **phenolic biomarkers** in the urine. Phenols in biological sample extracts react with Folin–Ciocalteu reagent to form a blue complex that can be quantified by visible-light spectrophotometry and visible with our eye

Phenolic Biomarkers identified trypanosome infection with high accuracy

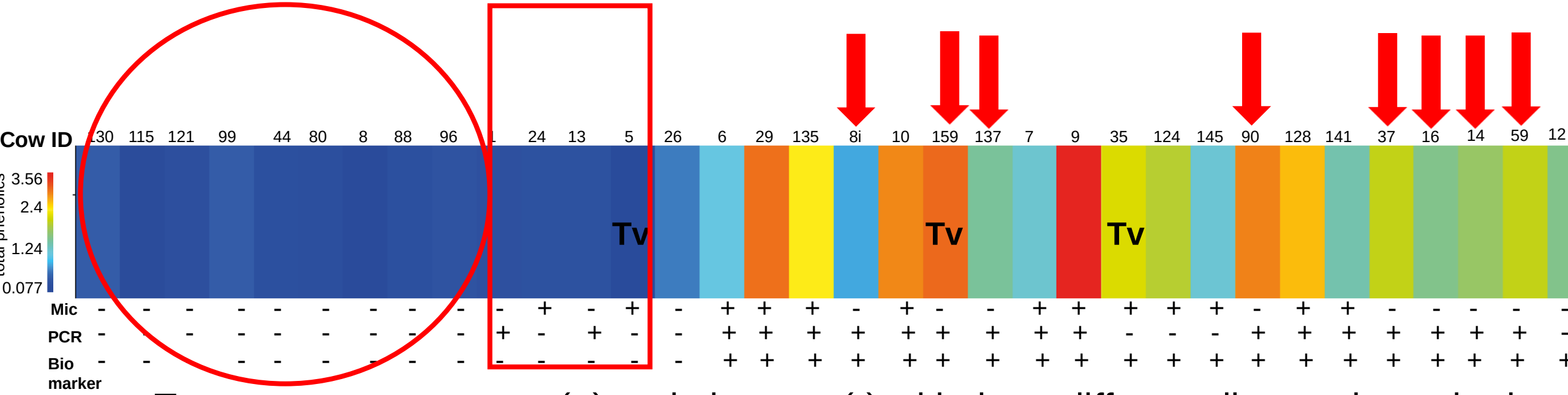


It detects an active infection as treated animals were identified as negative

To validate our novel animal trypanosomiasis diagnostic method developed using controlled experiment we challenged it with field samples



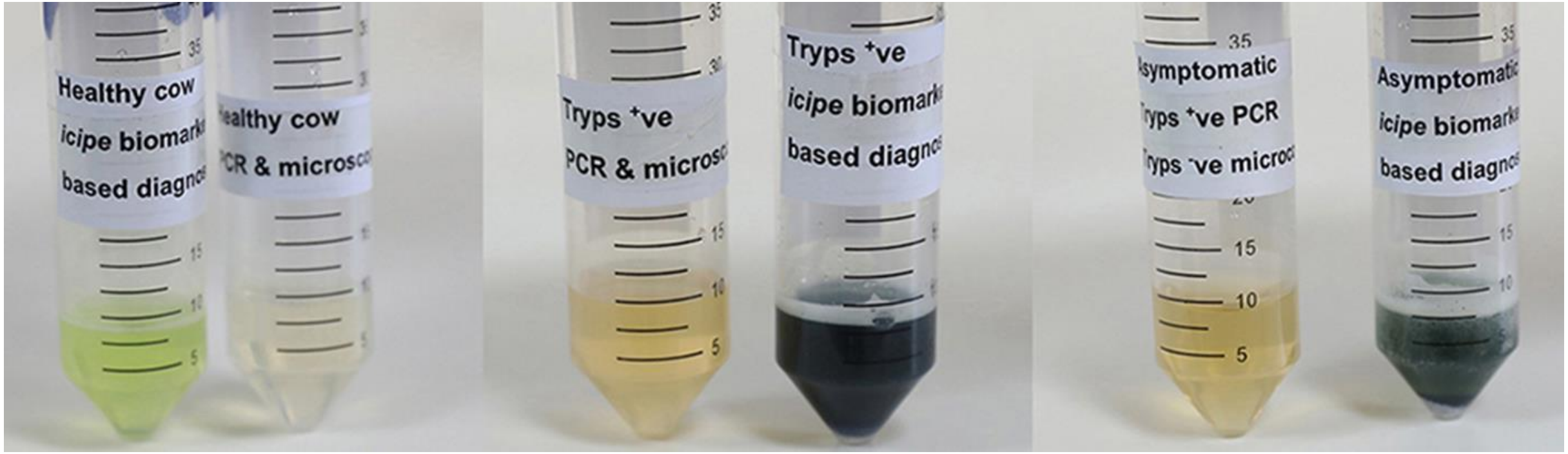
Biomarkers Identified Animal Trypanosomosis From Field Samples With High Accuracy and Sensitivity



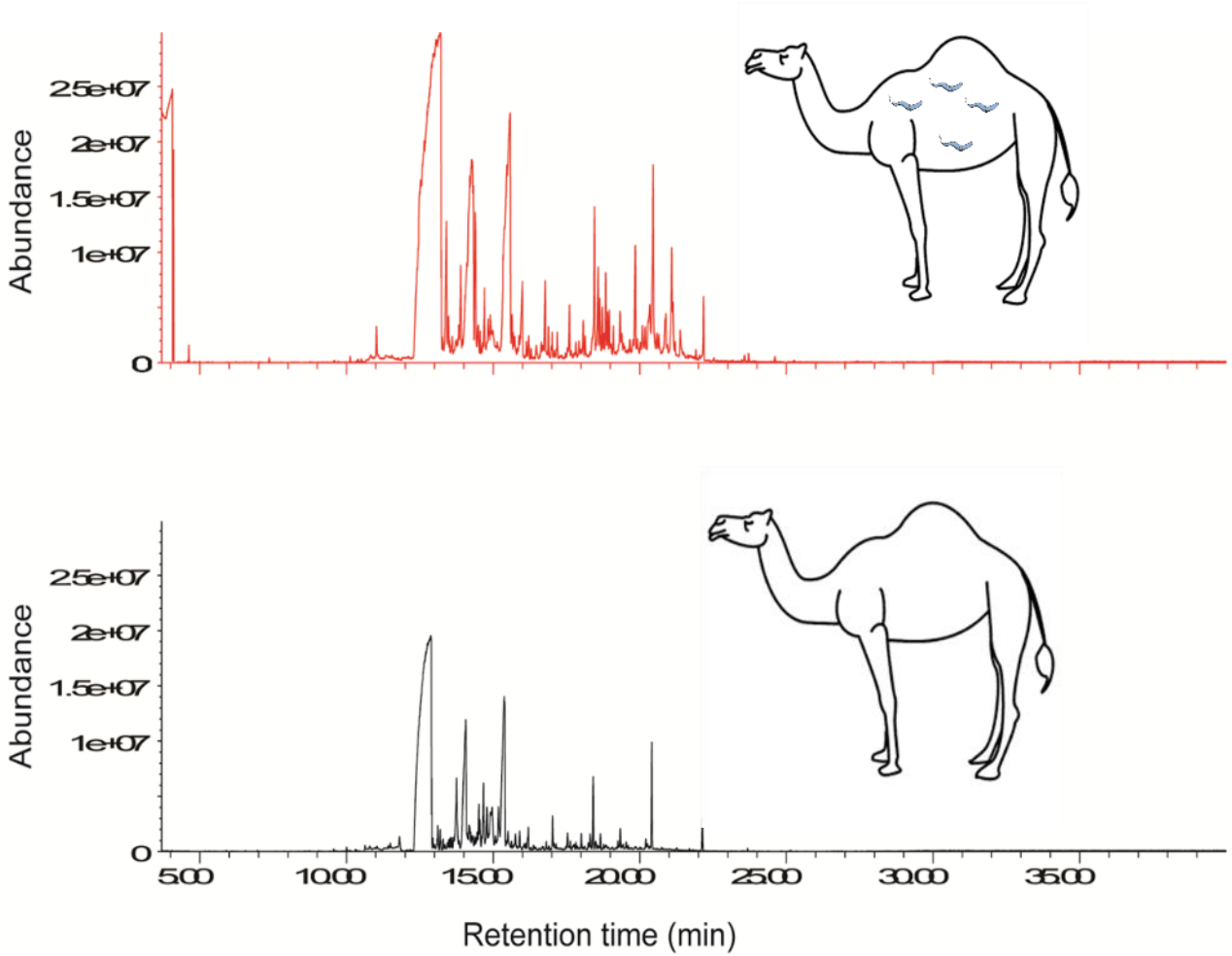
Trypanosome presence (+) and absence (-) with three different diagnostic methods

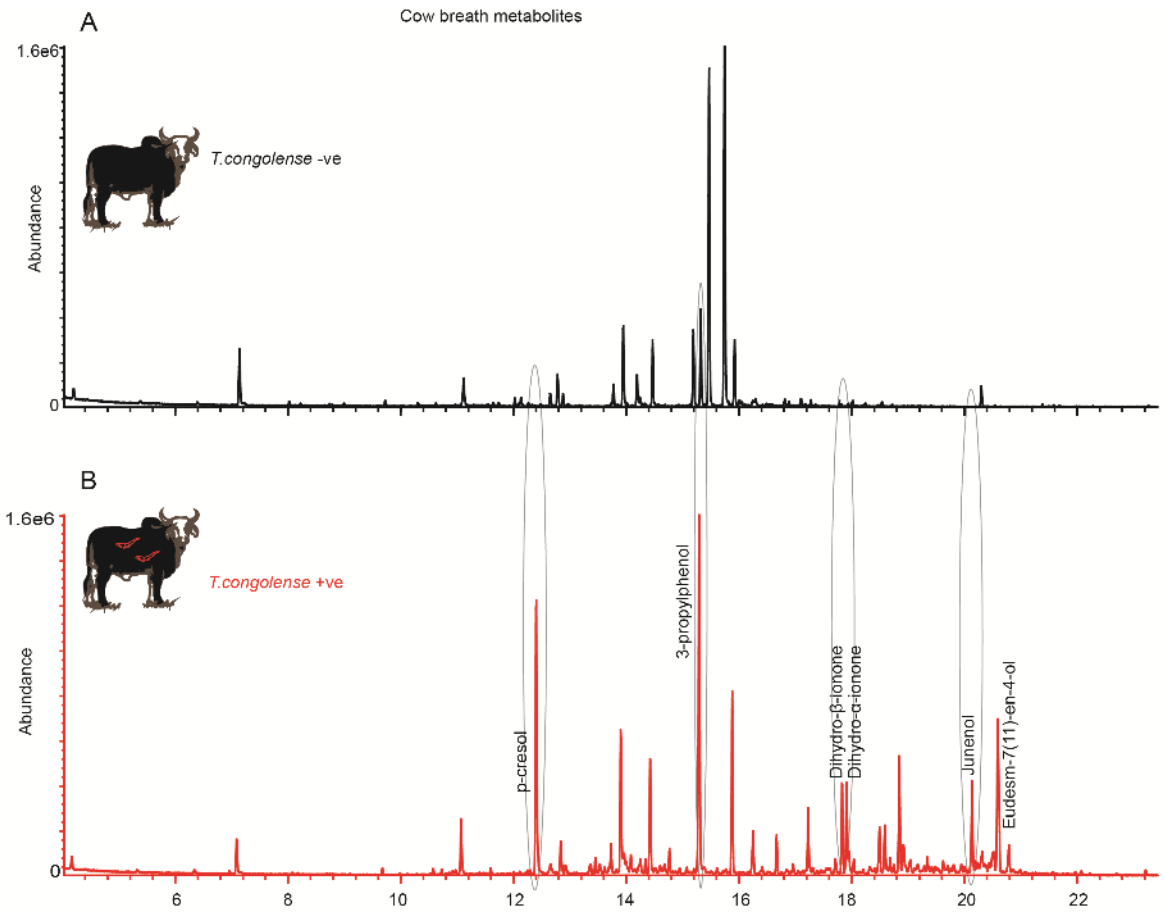
Getahun et al., 2022

Our biomarker based diagnosis detects including asymptomatic



Trypanosomes manipulate livestock metabolome



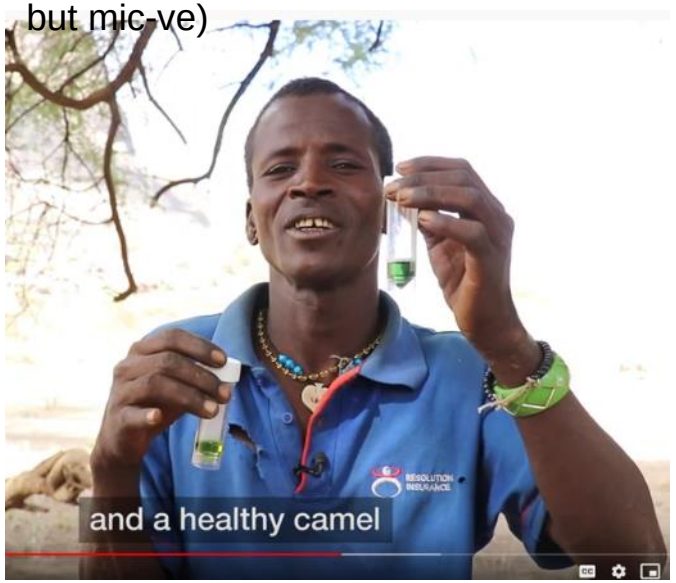


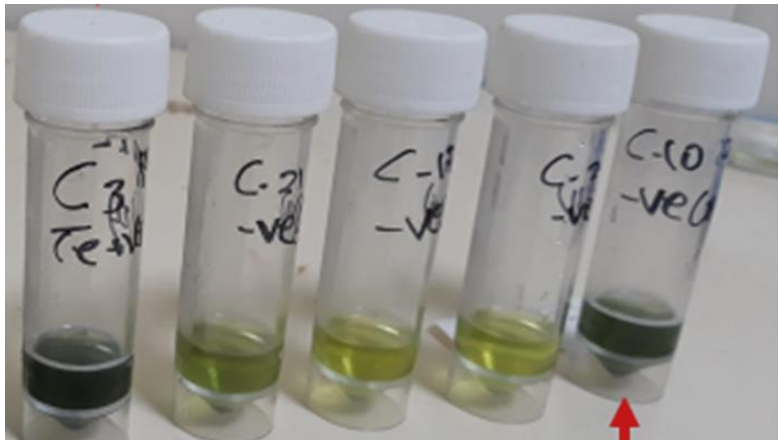
Noninvasive trypanosomiasis diagnosis…..

-ve control

Anaplasma phagocytophilum and Theileria velifera positive

T.congolense +ve(confirmed with PCR,and Biomarker, but mic-ve)





Mic	+	-	-	-	-
PCR	+	-	-	-	+
Bio marker	+	-	-	-	+

Getahun et al., 2022

Summary

VBDs are the main challenge that affect livestock resilience and productivity

A combination of attractant and repellent can minimize trypanosomiasis transmission and improve livestock health and productivity

Trypanosome rewired livestock metabolites –biomarkers may be used to diagnosis and manage surra and animal trypanosomosis

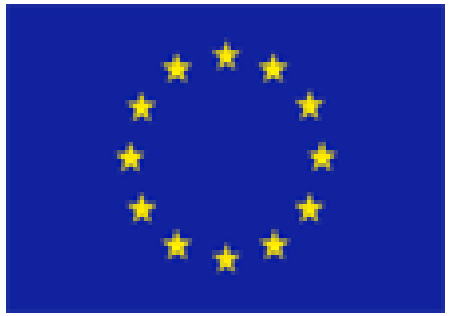
Biomarker based animal trypanosomosis diagnosis is sensitive, simple, affordable.

Such user-friendly diagnosis empower farmers/pastoralist to make decision based on knowledge, reduce livestock mortality, drug resistance

Acknowledgement

icipe

African Insect Science for Food and Health



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