# Developing methods for image acquisition and image analysis for species level identifying food contaminating beetles

**Tanmay Bera**[1], Hongjian Ding[2], Howard Semey[2], Leihong Wu[1], Zhichao Liu[1], Amy Barnes[2], Darryl Langley[2], Monica Pava-Ripoll[3], Himansu Vyas[2], Weida Tong[1], Joshua Xu[1*]

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## Introduction

**Insect Contamination & Food Safety**

**Challenges in Detection**

**Scope:**

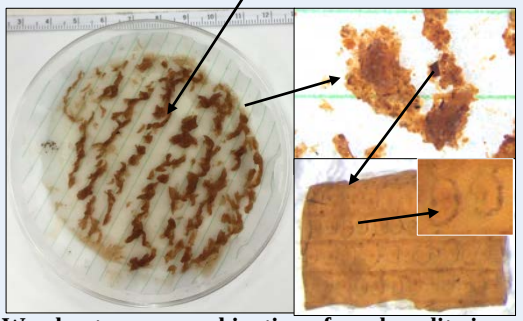
**GOAL:**

**Develop 1. Imaging Acquisition Method and 2. Image Analysis System (through Machine Learning) for accurate & efficient *species* level identification of insect based food contamination**

## Materials & Methods

**Sample collection:**

**Food products often suffer from contamination from food contaminating beetles. Food samples are routinely analyzed manually to screen for such contamination, which needs automation for better & efficient screening.**



**We plan to use a combination of good quality image acquisition and image processing for elytral pattern recognition for automated species recognition.**

Scan the QR code to access additional information online

## Results

**CNN (Average Accuracy: ~79%)**

## Conclusions

**Acknowledgments**

**References**

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## Introduction

### Insect Pests: Storage/Pantry Beetles

### Present Method of Detection and Identification

**Damages**

**Present Technique**

**Challenges**

**Requirement**

- **Efficient yet Reliable alternative for manual micro-analysis**
- **On-site/inter-mediate screening**

**Extent of damage depends on Species:**

## Approach & Aim :

**Can an Image Acquisition process be standardized to produce high quality image in a consistent manner to collect a large set of image, for a several different species of pantry beetles?**

**Can an Image Processing Algorithm be developed through Machine Learning for species level identification of insect based food contamination ?**

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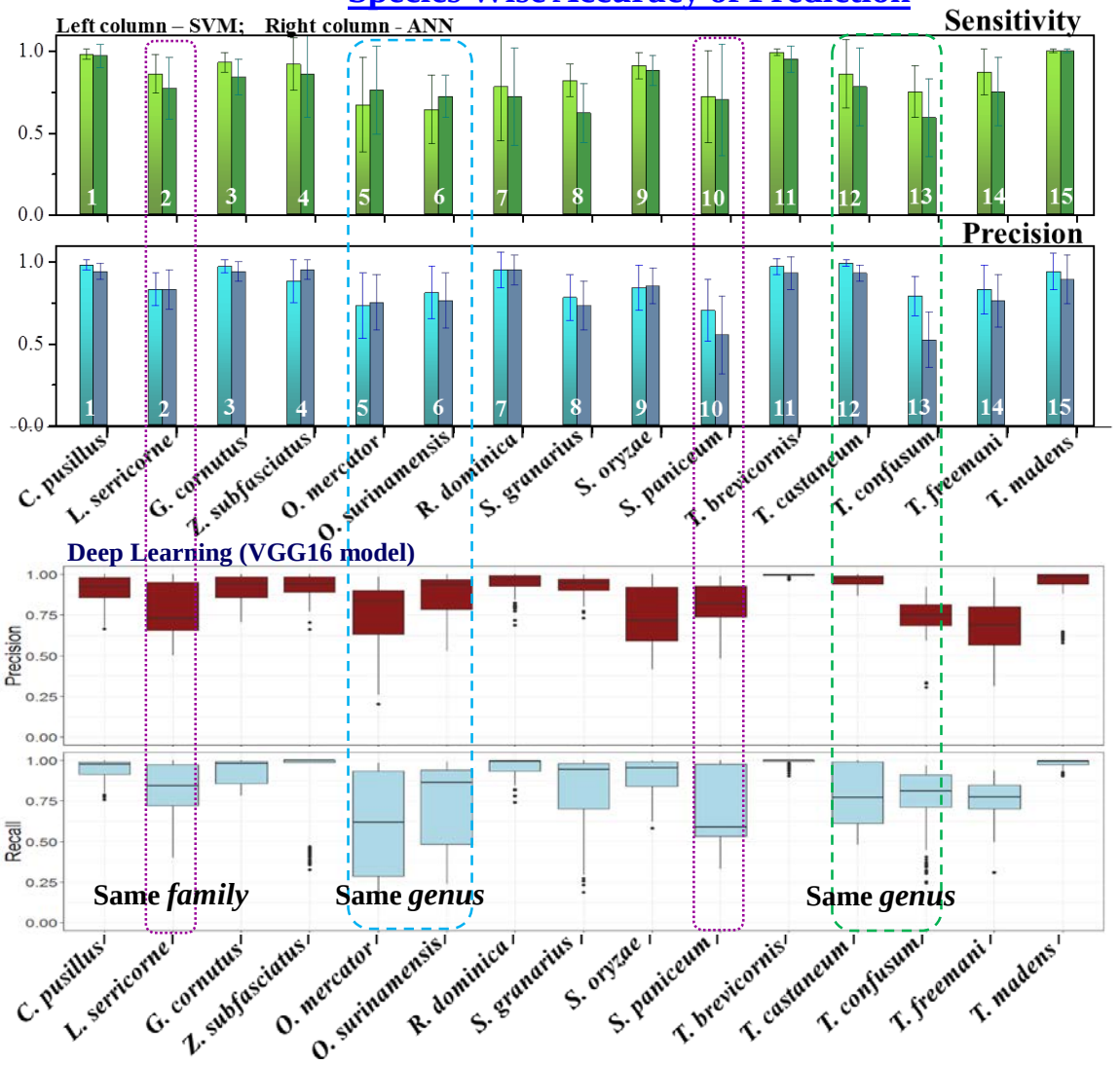
## Materials and Methods

### Microscopy & Imaging

### Image Processing

## Results

### Species Wise Accuracy of Prediction




**Poor image quality decreased accuracy**

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# Results

## Optimizing Image Acquisition

## Improving Accuracy with High Quality Images

**Overall Accuracy:**

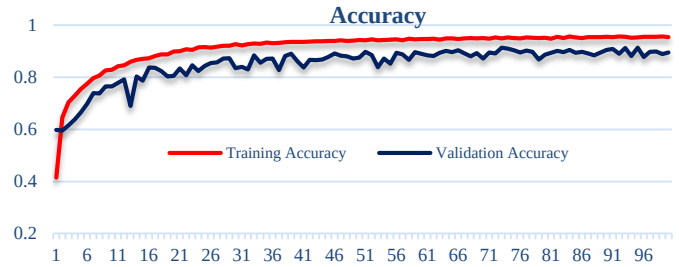
***Older Image Set with 2Pt_Rf***

- **ANN: ~79%**
- **SVM: ~84%**
- **DL: ~80%**

**(no Feature Extraction required, rotation or other image augmentation)**

***Newer HQ Image Set with Trans Light***

- **DL: ~90%**




## Reproducibility & Consistency

## Extension and Database Development

**Total ~50 different Species, 40 images/species, that covers most beetle based food contamination**

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## Conclusions

- **Machine learning was implemented for Species Identification for pantry beetles for food contamination**
- **Initial studies showed the feasibility of using elytral pattern recognition for beetle species identification**
- **The ANN classification resulted ~79% avg. accuracy of prediction**
- **SVM improves it to ~ 85%**
- **CNN(vgg16) needed no feature extraction and helped achieve ~80% accuracy**
- **However, due to poor quality of the images showed confusion between *species* with similar *family* and/or *genus***
- **Imaging is important in revealing patterns properly**
- **Imaging parameters were optimized to reveal the elytral patterns more clearly**
- **Transmitted light with 100x magnification seems to be the best combination of image acquisition**
- **Capable of distinguishing species from the same genius**
- **Method was tested by multiple operating personnel and showed minimal deviations**
- **Thus, a standard method for imaging was developed**
- **The method was extended to about 50 different species of food contaminating beetles that cover most of beetle based contaminations**
- **Database of 40 images per species are currently being constructed and will be made publicly available.**
- **These images are being used to develop AI algorithms for automated species identification through a cloud based image repository**
- **We also plan to develop a GUI (interface) to have beetle species identified when uploaded**

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