# Identification and Classification of Fault Agent Detection Strategies in Nature

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## Purpose

1. **To study how natural systems detect fault agents and prevent Byzantine fault from happening (defense traits).**

Understanding these processes will help engineers to design a multi-agent system to be resilient to Byzantine fault.

*Byzantine fault occurs when one agent of a system, or foreign intruder, which pretends to be an agent of a system, disrupt system's normal operation while "pretending" to operate normally.

2. **To fill the gap in biological inspirations for fault agent detection processes.**

Today we cannot use biologically inspired approach to design a fault tolerant system due to lack of biological inspirations.

## Research Focus

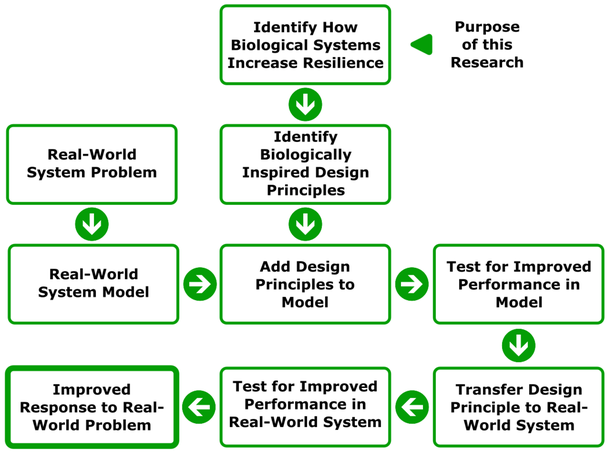


Figure 2 (reprinted). Research focus. Hernandez, IV, Watson, BC, Weissburg, M, & Bras, B. "Learning From Insects to Increase Multi-Agent System Resilience: Functional Decomposition and Transfer to Support Biologically Inspired Design." August 17–19, 2021.

## Systematic Literature Review Approach

- I am using Systematic Literature Review (SLR) approach throughout my research, to access existing knowledge on fault agent detection in nature.

*This approach tends to identify, select, evaluate, and synthesize all relevant literature on a specific research question or topic.*

*One of the major steps in SLR approach is a comprehensive search of relevant databases to identify all relevant studies that meet the inclusion criteria.*

- *Search Database:* Google Scholar was chosen as a primary database.
- *Inclusion criteria:* all natural domains within the macro world. Thus, fault agent detection processes within the micro world will not be included in this research.
- *Saturation criteria*: search term is considered saturated when the number of suggested publications which are not relevant to the topic is ten in a row, as sorted by relevancy by the database. When this state occurs, search has to proceed to the next term.

Below is the table of search terms which were used to find 57 relevant publications. As for today, 312 abstracts were reviewed. More publications will be cited as more search terms are discovered.

| Search Term | Number of Relevant Papers Found |
|---|---|
| *Social parasites* | 19 |
| *Mimicry detection* | 2 |
| *Mixed speciest nest* | 14 |
| *Social immunity* | 17 |
| *Nest usurpation resistance* | 5 |
| **Total Publications Cited** | 57 |
| **Total Publications Reviewed** | 312 |

Table 1: Completed search terms as for November 2023

## Example of Detection Traits in Ants

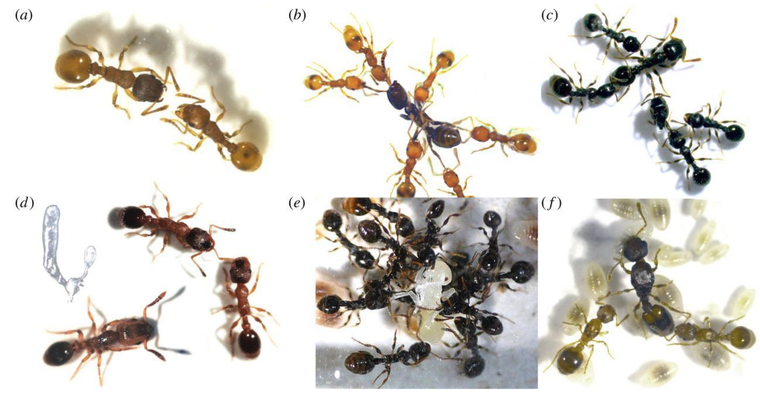


*Figure 1. Defense strategies against ant social parasites.*

(A) Parasite detection: *Temnothorax* ambiguous host worker (right) inspects an intruding *T. pillages* slavemaking worker. These slavemakers try to undermine the recognition system of their hosts: during some raids slavemaker stay undetected, in others hosts recognize the slavemakers as a parasite and respond by stinging.
(B, C) During a slave raid an intruding *T. americanus* slavemaker is attacked by *T. curvispinosus* (B) and *T. longispinosus* (C) host workers, which have to coordinate their attacks to subdue the physically stronger slavemaker.
(D) *Harpagoxenus sublaevis* slavemakers use the secretion of the Dufour gland to elicit fights among host defenders. Hosts of slavemakers vary in their resistance to this chemical manipulation.
(E) A last line of defense is slave rebellion. Here, enslaved *T. longispinosus* host workers attack and kill slavemaker brood, a behavior that can increase their indirect fitness.
(F) The small *T. minutissimus* inquiline queens coexist with the host *T. curvispinosus* host queen. Hosts could either try to expel inquiline queens or become immune to the suppression of their reproduction.

*Grüter Christoph, Jongepier Evelien and Foitzik Susanne. 2018. Insect societies fight back: the evolution of defensive traits against social parasites. Phil. Trans. R. Soc. B37320170200*

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