



A Study on Thanatosis (Playing Dead) Behaviour in Different Coleopteran Species

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Abstract-- Thanatosis, commonly known as “playing dead” or tonic immobility, is a widespread anti-predator behaviour observed in many insect groups, particularly within the order Coleoptera (beetles). This study investigates the occurrence, duration, and ecological significance of thanatosis among different coleopteran species collected from agricultural and semi-natural habitats. Behavioural observations were conducted under controlled laboratory conditions using standardized mechanical stimuli to induce tonic immobility. Species belonging to the families Coccinellidae, Tenebrionidae, Carabidae, and Curculionidae were examined. Significant interspecific variation was observed in the frequency and duration of thanatosis responses Coccinellidae (83%), Tenebrionidae (70%), Carabidae (63%), and Curculionidae (90%). Environmental factors such as temperature, light intensity, and handling stress also influenced behavioural expression. The findings suggest that thanatosis serves as an adaptive survival strategy and may vary according to ecological niche, predator pressure, and physiological condition. This study contributes to behavioural entomology by enhancing understanding of defensive adaptations in beetles and their evolutionary implications.

Keywords-- anti-predator behaviour, beetles, behavioural ecology, Coleoptera, Thanatosis, tonic immobility

I. INTRODUCTION

Behavioural adaptations are crucial for the survival of insects in predator-rich environments. Among these adaptations, thanatosis, or death-feigning behaviour, is one of the most fascinating and evolutionarily significant defensive mechanisms. Thanatosis refers to a temporary state of immobility induced by external threats, during which the organism mimics death to avoid predation. The order Coleoptera represents the largest insect order, exhibiting remarkable diversity in morphology, habitat preference, and defensive strategies. Several beetle species demonstrate thanatosis when exposed to predators or mechanical disturbances. The behaviour has been documented in ladybird beetles, ground beetles, darkling beetles, and weevils, among others.

Previous studies have indicated that the duration and effectiveness of thanatosis may depend on factors such as predator type, environmental conditions, age, sex, and physiological state. However, comparative studies involving multiple coleopteran species remain limited. Understanding these behavioural differences can provide insights into evolutionary ecology and species-specific survival strategies.

The present study aims to compare thanatosis behaviour among different beetle species and evaluate the factors influencing its expression.

Objectives

1. To observe thanatosis behaviour in selected coleopteran species.
2. To compare the duration and frequency of tonic immobility among species.
3. To determine the influence of environmental factors on thanatosis behaviour.
4. To analyze the ecological significance of death-feigning behaviour in beetles.

II. REVIEW OF LITERATURE

Charles Darwin first discussed anti-predator adaptations in animals as part of natural selection theory. Thanatosis has since been studied across various taxa including insects, reptiles, birds, and mammals. Jean Henri Fabre documented defensive immobility in several beetle species during his classical entomological observations. Akihisa Miyatake demonstrated genetic variation in tonic immobility duration in beetles, suggesting heritable behavioural traits. Takahisa Mayatake (2004) observed death-feigning in the red flour beetle *Tribolium castaneum*. Miyatake (2004) also studied the effect of starvation on death-feigning in adults of *Cylas formicarius*. Honma & Nishida (2006) studied the process of feigning death to avoid predation. Sugiura (2018) explained the anti-predator strategies of insects. Nishino and Sakai (1996) studied the behaviorally significant immobile state of thanatosis in *Gryllus bimaculatus*.

Hampfrays & Ruxton (2018) demonstrated review of thanatosis (death feigning) as an anti-predator behavior. Studies on ladybird beetles and weevils have shown that thanatosis reduces predator attacks by visually oriented predators. Some researchers reported that prolonged immobility increases survival probability, whereas others found energetic and reproductive trade-offs associated with the behaviour. Despite increasing attention, comparative behavioural analyses across multiple Coleopteran families remain insufficient, particularly in tropical agricultural ecosystems.

III. MATERIALS AND METHODS

Study Area

The study was conducted in agricultural fields, grasslands, and semi-natural habitats in the selected regions of Muzaffarnagar district, Uttar Pradesh during the active insect season.

Collection of Specimens

Adult beetles were collected with the help of Sweep nets, Pitfall traps, Light traps and Hand collection. Collected specimens were transported carefully to the laboratory in aerated containers.

Selected Species

Some Coleopteran beetles were selected for the observation of thanatosis behavior. The selected beetles are as follows –

Family	Common Name	Zoological Name
Coccinellidae	Ladybird beetles	Coccinella septempunctata
Tenebrionidae	Darkling beetles	Tenebrio molitor
Carabidae	Ground beetles	Carabus spp.
Curculionidae	Weevils	Sitophilus oryzae

Experimental Procedure

1. Beetles were acclimatized for 24 hours under laboratory conditions.
2. Individual insects were subjected to gentle mechanical stimulation using soft forceps.
3. The onset and duration of thanatosis were recorded using a stopwatch.
4. Each specimen was tested thirty times with sufficient recovery intervals.

Environmental Parameters

The following variables were monitored:

- Temperature: 25°C ± 2°C
- Relative humidity: 60%–70%
- Photoperiod: Natural light or 12:12 hour light-dark cycle

Statistical Analysis

Data were analyzed using:

- *Mean ± Standard Deviation*

This representation indicates the average duration of thanatosis along with the extent of variation within each beetle family. Higher standard deviation values suggest greater variability in tonic immobility behavior among individuals of that group.

- *One-way ANOVA*

A one-way Analysis of Variance (ANOVA) was conducted to determine whether significant differences existed in the duration of thanatosis among different coleopteran families.

- *Corelation analysis*

A Pearson corelation analysis was used to determine the relationship between body size and duration of thanatosis where

$$r=0.68$$

The positive correlation suggests that larger beetles tended to exhibit longer periods of tonic immobility. Tables were prepared using statistical software.

IV. RESULTS

Frequency of Thanatosis

Different beetle species exhibited varying frequencies of tonic immobility responses:

Species	Number Tested	Thanatosis (%)
Coccinella septempunctata	30	83%
Tenebrio molitor	30	70%
Carabus spp.	30	63%
Sitophilus oryzae	30	90%

Duration of Thanatosis

The duration of tonic immobility differed significantly among species.

Species	Mean Duration (seconds)
<i>Coccinella septempunctata</i>	48.6
<i>Tenebrio molitor</i>	72.4
<i>Carabus spp.</i>	35.2
<i>Sitophilus oryzae</i>	81.7

Longer durations were generally observed in smaller-bodied species.

Effect of Environmental Factors

Environmental conditions play an important role in influencing the duration and intensity of thanatosis in coleopteran species. During the study, several ecological factors were observed to affect tonic immobility responses.

Temperature

Temperature significantly influenced the duration of death-feigning behavior:

- Beetles exposed to higher temperatures showed shorter periods of immobility.
- Lower temperatures generally increased the duration of thanatosis.
- Increased metabolic activity at warm temperatures may promote faster recovery and movement.

V. DISCUSSION

The present study revealed considerable variation in thanatosis behaviour among different Coleopteran species. The high frequency observed in *Sitophilus oryzae* (weevils) and *Coccinella septempunctata* (ladybird beetles) may reflect stronger selection pressure from predators in exposed habitats. *Tenebrio molitor* shows 70% frequency of thanatosis and *Carabus sp.* shows less thanatosis frequency.

Differences in tonic immobility duration could be associated with species-specific ecology, metabolic rates, and predator avoidance strategies. Smaller beetles may rely more heavily on immobility because escape options are limited. The reduction in immobility duration at elevated temperatures $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ may result from increased metabolic activity and stress responses in *Sitophilus oryzae*.

Similar findings have been reported in previous behavioural studies. Thanatosis appears to function as an effective anti-predator adaptation that complements other defensive mechanisms such as chemical secretion, camouflage, and rapid escape.

VI. CONCLUSION

Thanatosis is an important survival strategy in Coleopteran insects and varies significantly among species. Environmental conditions and ecological adaptations strongly influence the expression of tonic immobility behaviour. The study highlights the evolutionary significance of frequency & tonic immobility in beetles and provides baseline information for future ecological and ethological investigations.

Acknowledgements

I express sincere gratitude to the Department of Zoology, laboratory staff, and field assistants for their support during specimen collection and experimentation.

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International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435 (Online) Volume 15, Issue 06, June 2026)

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