AgriCos e-Newsletter
ISSN: 2582-7049
www.agricosemagazine.com
Volume: 01 Issue: 01 May 2020 Article No: 18

Division of Labour: A Measure of Eusociality in Insects

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SUMMARY

The development of eusociality in insects is a much well known phenomenon, and among the eusocial characters division of labour among different castes of a eusocial insects is important. This phenomenon has been widely found in various Hymenopteran insects, inclusing bees and wasps and also in termites or white ants belong to Isoptera. Queens of different insects are specialized in reproduction and may lay up to several thousand worker eggs per day. Workers are either completely or partially sterile,evolving from the fertilised eggs, engage in little, if any, personal reproduction, and perform all tasks related to colony growth and maintenance. There is also a division of labor among the workers for tasks related to colony growth and maintenance. Colony division of labor, although highly structured, also shows great plasticity. Whereas, drones of some eusocial castes such as honey bee are only involved in mating like reproductive activities. Thus there is a need to understand the process of caste segregation or differentiation alongwith the division of labour in these socially well adapted insects.

INTRODUCTION

Division of labor is one of the defining characteristics of the most extreme form of sociality in the animal kingdom. Eusociality is defined by three traits such as cooperative care of young by members of the same colony; an overlap of at least two generations of adults in the same colony; and division of labor for reproduction, with sterile individuals working on behalf of female fecund colony members. Females dominate the functioning of insect societies in which males play more diverse roles in hymenopteran societies. There are two types of females in an insect society, queens and workers and the males are not differentiated. The development of females occure from fertilised eggs so having full complement of chromosomes and males being developed from unfertilised eggs have incomplete set of chromosomes. Queens have specialization in reproduction and can lay up to several thousand eggs per day. Workers are either completely or partially sterile, engage in little reproduction, and perform all tasks related to colony growth and maintenance.

The development of caste system in honey bee depends on the quality of diet they are provided such as only royal jelly or royal jelly mixed with bee bread. There is also a division of labor among the workers for tasks related to colony growth and maintenance such as they perform both inhive and outhive duties. Colony division of labor, although highly structured, also shows great plasticity. Colonies respond to changing needs of the eusocial insects by adjusting the ratios of individual workers engaged in different tasks. There is plasticity in age-related division of labor, with workers being able to respond to changes in colony age demography with accelerated, retarded, or reversed behavioral development. This phenotypic plasticity can lead to well developed colony structure.

Social Insect Colonies

Social insect colonies are groups of individuals that live together and reproduce as a unit. The colony represents a level of organization above the individual organism with its own

characteristic morphology, behavior, internal organization, and life history pattern (Robinson *et al.,* 1989). Social insect biologists face the challenge of integrating between the individual and colony levels of organization. Recognizing this challenge, E.O. Wilson declared that "the reconstruction of mass behavior from a knowledge of the behavior of single colony members is the central problem of insect sociology" (Wheeler, 1928). Division of labor, in which different workers specialize on subsets of the tasks performed by a colony, is one of the most prominent features of social insect colony behavior (Stuart and Page, 1991). So the proximate mechanisms of division of labor must be elucidated and there is a need to understand the decision to perform a particular task is dependent on internal and external factors, based on whether they are generated as a result of the internal state of the individual or via interactions with the colony environment.

Apartfrom, the genetic factors the environmental factors also have been reported to control the eusocial behaviour of the bees. Internal factors include genetic, neural, and hormonal factors and the effects of experience whereas, external factors include the stimuli that elicit task performance and worker-worker interactions that communicate task needs. Obviously, internal and external conditions interact. For example, interactions with other workers may affect an individual's motivational state, and performance of a task may increase its intrinsic probability of performing that task again. In turn, performance of a task by a worker affects the stimuli perceived by the rest of the colony. Thus, there are more connections and feedback loops between these factors and based on these, six classes of models have been postulated, about the causes of division of labor: response threshold, integrated information transfer, self-reinforcement, social inhibition, foraging for work (FFW), and network task allocation models. The response threshold, self-reinforcement, and social inhibition models address the question of how workers vary in their responses to information about a task. The FFW and network models seek to explain behavioural variation in terms of the flow of information about task needs and the local information available to each worker.

The threshold-information transfer model examines how integrated effects of genetic variation in response probability and of information flow affect individual worker behaviour. Social insects are proving to be ideal systems for asking questions about the design and organization of biological systems. The organizing principles of social groups and organismal components are apparently analogous in many ways, but social insect colonies are easier to observe and manipulate than cellular or subcellular systems and offer greater opportunities for characterizing "individual" behaviour. The increasing sophistication of models and techniques for studying the behaviour and physiology of individual workers promises to stimulate a new wave of research and to make the study of social insect behaviour broadly relevant within and beyond the traditional domains of biology.

CONCLUSION

There is a need to unravel the complexity of this trait of social insects, to further elucidate the detailed behaviour of the organisms for the human wellbeing. In this regard, different hypothesis, as cited above can be studied in detail for better understanding.

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