The social biology and adaptability in mycophagous tubuliferan thrips

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Mycophagous tubuliferous thrips provide adequate instances of social behaviour. Sex limited polymorphism, with structural diversity in the extreme males in populations, temporal and spatial structure combined with the mode of development have been the principal causes leading to social behaviour of these thrips. Inter-generational stability of feeding sites, with the availability of adequate fungal spores, beside their uniform distribution are additional factors favouring sociality. Sex-limited polymorphism, the diversity of structural adaptation as well as functional dynamism are discussed in relation to sociality.

Recent contributions on the social biology of gall-inducing thrips in Australia[1,2], involving adaptive consequences of egg size and variation, evolution of ecological and behavioural diversity, besides benefits of morphological dimorphism and effectiveness in full defence have evoked the need for similar studies on mycophagous Tubulifera. Factors promoting the evolution of eusociality in thrips appear intrinsic, including genetic mechanisms such as haplodiploidy, and extrinsic factors, like spatial and temporal structure of the environment. The only major exhaustive work on the evolution and maintenance of reproductive mode essential for identifying intrinsic and environmental pressures associated with maternal conc, relates to that of Kranz *et al.*[3] on *Bactrothrips brevitubus*. Considerable basic work on the bio-ecology and reproductive behaviour of mycophagous Tubulifera, including analyses of extreme foreleg allometry and their functional implications is on record[2,4–10]. The need for more intensive studies on diverse species, reproductive division of labour, besides genetic implications appears warranted.

Polymorphism and structural allometry are associated with competition for resources, including male/male combat resulting in diverse ecological and behavioural aspects, adults leading juvenile groups to particular feeding sites along pheromonal trails and leading them back again[11]. Extreme foreleg allometry and strong armature, especially more in apterous forms are indicative of the fighting abilities, the foreleg armature being mostly associated with wing polymorphism, the apterous males exhibiting diverse structural patterns in the different species. Variation in fecundity enables evolution of reproductive division of labour, while in males the extreme development of foreleg armature or lateral abdominal horns or thoracic processes enables defence against invaders – aspects significant in the species of *Ecacanthrothrips*, *Bactrothrips*, *Dinothrips*, *Elaphrothrips*, *Tiarothrips*, *Mecynothrips*, *Hoplothrips*, to mention the major genera. Increased variations in fecundity tend to favour the reproductive division of labour with such forms as oviparous, ovoviviparous and viviparous individuals with corresponding changes in the ovarian structure[8,9,12]. Fighting behaviour in males is equally characteristic of polymorphic males, with egg guarding and larval defence behaviour being typical of these species. The number of eggs laid varies with genera and species from less than 50 to over 300 in a single group, the adults guarding the eggs. In some cases predatory ants are effectively repelled by a secretion containing a gamma delactone. Females of some species of *Elaphrothrips*, where maternal care is known, use a potent defensive secretion, juglone to repel predators such as salticid spiders[13].

Developmental times also tend to vary with species, being 15–25 days in *Elaphrothrips*, 20–25 days in *Tiarothrips* and 20–40 days in *Bactrothrips*. Oocytes developed within lateral oviducts up to a fairly active stage of development in ovoviviparous females, the eggs hatching a few hours after laying; while in the partial ovoviviparous females, the oocytes developed in the lateral oviducts up to germ-band formation, with subsequent egg-laying and hatching occurring one or two days[9,12]. Patterns of seasonality, habitat stability and population structure appear to account for the evolution of advanced parasociality in many species. Both genetic factors and extreme ecological factors appear important in the evolution of such sociality. Communal resting sites have been identified when not foraging, such sites occurring in depressions or cracks on the bark. It is interesting to note while foraging, that adults keep the apex of the abdomen upward, waving them. In many species, the males are territorial at the oviposition sites.

Tiarothrips subramanii accounts for 300–400 individuals in a colony and the escalated fights by males, challenging of extreme males by subordinate males, and stabbing and wagging behaviour[8,9]. Armed extreme males are associated with territorial defence of oviposition areas, the dominant males securing 80% of the matings. Intraspecific ecological succession with macropterous forms succeeding the apterous form is evident in some species of *Hoplothrips*. Brachypterous forms are produced in some species when the fungi are fresh and vigorously growing, while the macropterae are produced as they age and deteriorate, so that there is intraspecific ecological succession, the macropterous form succeeding the apterous ones. An extreme degree of aggregation and sexual selection is evident in saprophagous idolothripines, the nature of aggregation and the population in a colony greatly depending on fungal food availability. The larger size in males appears to confer greater probabilities of success in the reproductive investment of thrips, and the behaviour of the female to choose a large male will be favoured and maintained. The temporal and spatial structure combined with the mode of development have led to the evolution of social behaviour and the highly patchy habitat provided by dead trees tends to be conducive to the evolution of eusociality with inter-generational stability of feeding sites[14,15]. Patchy, but inter-generationally stable food supply is the primary factor, which is also the reason for the promotion of social behaviour. Colony formed by multiple adults or pleometoresis typical of wasps, bees and ants, is equally evident in these species, since males develop by arrhenotokous haploid parthenogenesis from unfertilized eggs, while females develop from fertilized eggs. It is predicted that females tend to reproduce by oviparity when there is local mate competition, and by ovoviparity when constrained by predators with or without local resource competition[3]. Reproductive females which are involved in local resource competition for food and oviposition sites select ovoviviparity as they can retain eggs till a suitable rearing site is located[3].

Therefore, an indepth assessment of aggregation of species in relation to their reproductive output, behavioural diversity of gynaceoid and oedymerous females, egg size and reproductive division of labour contributes to a better understanding of eusociality. Phenotypic changes alter fitness of the genotype in terms of oviposition mediated through mating patterns. Fecundity index expressed as the number of eggs/female as in oviparous forms and number of larvae/female in viviparous forms, is an added measure of sociality. The impact of genetic, phenotypic and ecological causes relating to the structural diversity evident in apterous males as against the macropterous ones, is an aspect deserving further scrutiny in relation to better appreciation of cooperative endeavour evidenced in mycophagous colonies of thrips. The genetic relatedness of the diverse morphs, i.e. egg diversity, clutch size and output of larger eggs, besides competition by females for food and space tends to increase competition. The relationship between body size, armature and reproductive success deserves further scrutiny. According to Wilson[16], 'The transformation of an insect species from a solitary lifestyle to advanced colonial existence, requires alteration in every system of the body, coupled with sufficient plasticity in the traits prescribed by genes among adults castes'. As has been indicated by Hamilton[17], 'the coincidence of male winglessness, female-biased sex ratios, male haploidy and male fighting in spatially structured populations is probably not accidental'. Further studies are needed in relation to diverse mycophagous species to be able to appreciate the diversities expressed and it is needless to emphasize that patterns of sociality, habitat stability and social structure tend to account for sociality in thrips.

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Farmers' variety in the context of Protection of Plant Varieties and Farmers' Rights Act, 2001

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The Convention on Biological Diversity was signed at the Earth Summit in Rio de Janeiro in 1992. The Convention asserts that biological resources belong to the sovereign state in which they exist. Inevitably this stand is in conflict with patenting of live forms such as plant varieties. The prior art of this refers to publicly available existing knowledge that is relevant to an invention for which a patent applicant is seeking protection. If the prior art is too closely related to the claimed invention, the application may be rejected on the grounds of lack of an inventive step. The registration officers are required to check for the absence of prior art before awarding a patent. Now this has been well accepted by the Organization of Economic Cooperation and Development (OECD).

Australia, the world's leading advocate of neo-liberal agriculture, is facing a crisis of family farming in sectors where corporate entities are entering into horticulture and dairying, altering the nature of farmer/processor relations. The Australian tomato processing industry has been drastically altered in the last 20 years. During this period 90% of the growers got eliminated, changing the social and economic characteristics of the remaining 10%. In 1984, the average tomato output per grower was 520 t and by 2004, it was around 12,500 t. During the period 1975–2002 the price of tomato fell by almost 70%. The shift has been towards tomato hybrids production technology, large specialized farm and technology-wise, well-informed growers[1]. Clearly, liberal globalization of agriculture is likely to induce several shifts in the present system of farming. A diverse and bio-