ASCOREGARINE PARASITES AS POSSIBLE BIOCONTROL AGENTS OF MOSQUITOES

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INTRODUCTION

The seemingly ubiquitous presence of gregarine parasites in numerous mosquito taxa (Table 1; Chen 1999) suggests that consideration of these parasites as biological control agents may be a worthwhile endeavor. However, because most studies prior to 1985 did not demonstrate significant fitness (e.g., mortality, adult size) differences between infected and non-infected mosquitoes, Beier and Craig (1985) deemed in their overview of gregarine parasites of mosquitoes that

“There is no evidence that gregarines can be used to control mosquitoes, and no evidence that gregarines in their natural habitat have a significant negative impact on populations of their normal host.” (p 182)

However, the authors did suggest that because “conventional strategies for controlling container-breeding mosquitoes are not effective, the possibility of using gregarines in unnatural mosquito hosts should not be ruled out.”

A number of additional studies have since been published that have examined the pathogenicity of gregarine parasites both for natural and non-natural hosts, as well as for hosts reared in stressful vs. non-stressful environments. This paper reviews the outcomes of these studies and addresses whether the prospects of using gregarines as mosquito biological control agents have changed with these recent findings.

GREGARINE LIFE CYCLE

Much progress has been made in understanding the details of the gregarine life cycle in the last 20 years. These studies have mainly focused on the development and within-host movement of Ascogregarina taiwanensis (Chen and Yang 1996, Chen et al. 1997a, Chen 1999, Chen and Fan-Chiang 2001), the gregarine commonly found in Aedes albopictus. The life cycle is similar to other species in the same genus, and it is described briefly here (Fig. 1). Oocysts ingested by early mosquito instars release sporozoites, which then enter into host epithelial cells and develop into trophozoites. Prior to mosquito pupation, trophozoites migrate from the midgut into the Malphighian tubules, where they transform into either macro- or microgametes. During the pupal stage, 2 gametes fuse to form a gametocyst, within which hundreds of oocysts are formed (Chen 1999). Oocysts are shed into rearing containers by metamorphising adults as well as by any adults that happen to die in the containers. Greater detail on gametocyst formation, trophozoite migration, and sporogonic development can be found in Chen et al. (1997a), Chen and Fan-Chiang (2001) and Chen et al. (1997b) respectively.

IMPACT OF GREGARINE INFECTION ON MOSQUITO FITNESS

ASCOREGARINA TAIWANENSIS

The colonization and rapid expansion of Aedes albopictus in North and South America from Asia in the mid-1980s generated renewed interest in the ecology, population genetics, and breeding structure of this mosquito (Black et al. 1988, Kambhampati and Rai 1991, Kambhampati et al. 1991, Rai 1991, Ayres et al. 2002, Birungi and Munstermann 2002, de Oliveira et al. 2003). Accompanying these were studies detailing the fitness effects of A. taiwanensis infection on Ae. albopictus as well as on other mosquito species (Garcia et al. 1994, Comiskey et al. 1999a, 1999b; Tseng 2004). Three of these studies found that the severity of A. taiwanensis on Ae albopictus was often dependent on the environment of the mosquito. For example, Comiskey et al. (1999a) found that when given high nutrients, post blood-feed mortality was equal between mosquitoes that were infected or uninfected with A. taiwanensis, but when given low nutrients, post blood-feed mortality was 4 times higher in gregarine-infected mosquitoes. Similarly, Comiskey et al. (1999b) reported that mortality of infected larvae and pupae reared under low nutrients was 7 times higher than mortality of uninfected larvae reared at the same food level, but that no difference in mortality was observed between infected and uninfected larvae reared at high food levels.