Chapter 7

Genomic Conflict in Fungal Mycelia
A Subcellular Population Biology

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1. INTRODUCTION

An interplay between genetic determinacy and organizational indeterminacy (see Chapter 2) may engender conflicts or tensions which lead to evolutionarily creative instabilities or degeneration (Rayner et al., 1995). Foremost amongst these tensions is the conflict that arises following the exchange of nonself genetic information. Indeed, "Of all the challenges which a fungal mycelium faces during its potentially indefinite life-span, the one arguably bringing the most powerful combination of risk and promise to the selfish genes that it contains is an encounter with another mycelium of the same or different species" (Rayner, 1991a).

The following review explores this challenge, examining the power of genomic conflict arising from informational disparity and selfish interest to influence the range of developmental options, life-history strategies, genetic exchange systems and population structures that organisms with indeterminate life-forms can adopt. A brief overview of genomic conflict as a theoretical tenet is provided, accompanied by examples of where and when conflict might occur in fungi. Comparisons are made between the narrow issue of incompatibility and the wider issues raised by conflict. The relationships between conflict and the generation of phenotypic variation in fungi are also
examined. Lastly, consideration is given to the mechanisms that might potentially lead to conflict avoidance or resolution.

2. GENOMIC CONFLICT: AN EVOLUTIONARY BIOLOGISTS' PARADIGM

Genomic conflict has been received with great acclaim by evolutionary biologists wishing to explain major evolutionary changes (Hurst et al., 1992; Hurst, 1992; Hurst et al., 1996; Maynard-Smith and Szathmáry, 1995; Szathmáry and Maynard-Smith, 1995). Much of the emphasis for its utility has concentrated on intragenomic interactions between selfish genetic elements that further their own interests at the expense of the genome or cell within which they reside. Intragenomic conflict may account for processes as diverse as the evolution of genetic imprinting, crossing-over, the production of syncytia during gametogenesis and the presence of multicopy genes (Hurst et al., 1992).

Intergenomic conflicts between cytoplasmic genes, and between cytoplasmic genes and nuclear genes, have been proposed to have been important factors in the evolution of sex (Hurst, 1991a), the sexes (Hickey and Rose, 1988; Hoekstra, 1987; Hurst and Hamilton, 1992), anisogamy (Cosmides and Tooby, 1981; Hastings, 1992; Hurst, 1990; Law and Hutson, 1992), sex ratios (Cosmides and Tooby, 1981; Hurst, 1990; Law and Hutson, 1992), sex ratios (Cosmides and Tooby, 1981; Hurst, 1991b; Hurst and Pomiankowski, 1991; Levy, 1991) and eusociality (Haig, 1992). Studies of internuclear interactions, such as those that occur within heterokaryons of fungi, have received far less attention.

The genomic conflict paradigm itself can be well illustrated by considering the evolution of sex and the sexes. Examples will be taken from the mycological literature when appropriate to highlight the relevance of this viewpoint. Other aspects of the theory can be found in the appropriate reviews and will not be considered further.

2.1 Sexual Conflicts

Hickey and Rose (1988) proposed that sex could have arisen from conflicts between ultra-selfish genes and their host genomes. Selfish genetic elements that "encouraged" fusion between cells were proposed to be more successful than elements restricted to vertical lineages. Hurst (1991a) provided evidence for this hypothesis by highlighting the discovery of a mitochondrial plasmid in the slime mould Physarum polycephalum which promoted the fusion of mitochondria within zygotes, and the formation of recombinant mitochondrial DNAs. When gametes containing the plasmid