Locomotor Activity in the Tyr-1 Mutant of Drosophila melanogaster

Michael J. Meehan¹ and Ronnie Wilson¹

Received 7 Nov. 1985—Final 1 June 1987

The genetics and neurochemistry of locomotor activity in Drosophila have received increasing attention, although no precise relationship has been formulated, and researchers have not always distinguished the various forms of activity. In the present research, using the dopamine-deficient Tyr-1 mutant, we demonstrate that it is possible to operationally define and provide separate measures of spontaneous activity and reactivity and have also isolated a third, distinct, category of locomotor activity which we term "stimulated" activity. Our data indicate that Tyr-1 mutants do not differ from isogenic wild-type flies with respect to spontaneous activity or reactivity but that they do display significantly higher stimulated activity levels. It is suggested that low levels of dopamine in Tyr-1 may result in increased stimulated activity rather than spontaneous activity as previous research has suggested.

KEY WORDS: Drosophila melanogaster; locomotor activity; stimulated activity.

INTRODUCTION

Locomotor activity in Drosophila melanogaster has been shown to be under considerable genetic determination (Ewing, 1963; Connolly, 1966a; Angus, 1974) and is often affected by single-gene mutations (Burnet et al., 1974; Wilson et al., 1976; Kyriacou et al., 1978). There have been some attempts to elucidate the neurochemical mechanisms involved in its control, and the system which has attracted most interest is that mediating the catecholamines, dopamine and noradrenaline (Tunnicliff et al., 1969; Connolly et al., 1972; Burnell and Daly, 1982; Kamyshev et al., ²°°1

¹ Department of Psychology, Faculty of Social and Health Sciences, University of Ulster at Coleraine, Co. Londonderry BT52 1SA, Northern Ireland.
1983). Tunnicliff et al. (1969) found that differences between strains artificially selected for variation in locomotor activity were linked to the balance existing between the amines: a high ratio of dopamine to noradrenaline was associated with high levels of activity, while the inverse relationship held for low activity. Connolly et al. (1972) went on to show that pharmacological manipulation of dopamine levels in the selected lines altered their activity levels in a predictable direction.

One of the problems of this research is the complexity of the phenotype under study, and recent researchers have often failed to distinguish between various forms of locomotor activity. Burnet and Connolly (1974) have reviewed evidence which shows that *Drosophila* activity can be divided into at least two components. The first category, spontaneous activity, is said to have an endogenous source and to occur in the absence of any specific stimulus. The second category is termed reactivity (Ewing, 1963) and is said to occur in response to sensory stimulation. Connolly (1967) operationally defined reactivity in terms of the rate at which flies cease to respond to a controlled environmental stimulus and was able to show, using his selected strains, that activity and reactivity are under independent genetic control. However, although research into the neurochemistry of *Drosophila* activity continues (e.g., Burnell and Daly, 1982; Kamyshev et al., 1983), little attempt has been made since Connolly's work (1967) to distinguish between spontaneous activity and reactivity.

In our laboratory we are making behavioral and pharmacological analyses of mutants with known effects on biogenic amines and are attempting to distinguish between the different forms of activity in order to elucidate more clearly the postulated roles which amines have in its control. Two potentially interesting mutants are *DDC*, which causes a dysfunction in dopa decarboxylase, the enzyme which controls decarboxylation of dopa to dopamine (Wright et al., 1976), and *Tyr-l*, which causes an impairment in phenol oxidase, the rate-limiting enzyme in the pathway (Warner et al., 1974). The *Tyr-l* gene has recently been shown to be associated with a reduction in dopamine level (Burnell and Daly, 1982), and the experiments described in the present paper explore its influence on locomotor activity. The experiments used a novel experimental procedure which sampled the open-field behavior of flies over a sufficient time span (cf. Connolly, 1967) to generate separate measures of the differing forms of activity.

**MATERIALS AND METHODS**

Thirty wild-type males from the Canton-Special (Canton-S) strain were compared to 30 *Tyr-l* mutants from a strain which had been made