Life with others

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English summary

Group-living facilitates cooperation between individuals, but also creates competition for limited resources. Females benefit from being in a group but their future offspring may have difficulty getting access to resources in larger groups and suffer from it. Individuals may therefore benefit from modulating their reproductive output in response to the presence of others. Although social context-dependent modulation of reproduction can be found in a broad range of species, its underlying mechanisms and functions are poorly understood. The research contained in this thesis was motivated by the desire to understand not only to what extent social environment modulates reproduction, but also the mechanisms underlying such social modulation. In the fruit fly *Drosophila melanogaster*, females actively attract conspecifics to lay eggs on the same resources, generating groups in which individuals may cooperate or compete. The genetic tractability of this species gave me an opportunity to dissect the mechanisms by which females adjust their behaviour and physiology to their social environment.

In **Chapter 2**, I provided a dissection of the mechanisms for the female fruit fly's reproductive responses to the presence of a group. I demonstrated that social environment modulates reproduction and survival, two major components of fitness. Once in a group, females modulate their oogenesis and egg-laying depending on density and other environmental factors such as light. I also showed that females that initiate egg laying faster when grouped, give their offspring a better chance of survival when there is competition for food among larvae. However, despite competition, females preferred to lay their eggs with others, revealing a trade-off between finding a group to increase the chance of offspring survival via cooperation, and avoiding competition within the group as this may dramatically decrease offspring survival. I studied the mechanisms of this phenomenon and demonstrated that the presence of a group affects ovarian activity of females in a density-dependent manner. I found that these responses to the presence of others were mediated by vision through the motion detection pathway and were the result of the stimulation of the juvenile hormone pathway. While social modulation of reproduction is considered a sign of sociality and is most strongly expressed in social hymenopterans (e.g. ants, some bees, wasps), my findings thus demonstrate that a social modulation of reproductive physiology can already be found in rather solitary species such as *D. melanogaster*. I therefore argue that, when organisms as simple and solitary as a fruit fly reproductively react to their social environment this questions the validity of the term “solitary” and makes the concept of solitary vs social species a bit artificial.

To continue this line of investigation, I followed up the previous discoveries by examining whether this social facilitation of egg-laying is a widespread phenomenon among wild-type *D. melanogaster* lab strains (**Box 2**). My work revealed that social environment does not modulate reproduction in the same way in all *D. melanogaster* females, because I found variability in egg-laying behavioural responses to a group among inbred wild-type

strains, suggesting that variability in egg-laying behaviour is a plastic response to social environment that also has a genetic basis.

In **Chapter 3**, I investigated behavioural variation in the response to a group among *Drosophila* Genetic Reference Panel (DGRP) flies, a resource of wild-type inbred *D. melanogaster* lines. I proposed a new approach to explore the variation in sociability between these lines through the quantification of multiple sociability traits (i.e. three behavioural assays), and found significant variation between the lines in the strength of responses to others in each of the three assays. My study demonstrates the existence of different sociability behaviours among genetically distinct wild-type fruit fly strains and thus the existence of a sociability spectrum in this species. However, no correlation was found across the three behavioural assays, revealing that sociability is unlikely to be a personality type consisting of multiple correlated behavioural traits in *Drosophila.*

Overall, the experiments conducted during my PhD advance our understanding of both the function and mechanisms of social-context dependent modulation of female reproduction. This research reveals the sensory and physiological underpinnings of the complex interaction between social environment and female reproduction. My study highlights the importance of considering social environment as a main environmental factor when studying animal behaviour, even in species considered 'solitary'. In addition, my explorative study of the natural variation in sociability among *D. melanogaster* provides evidence that this species is a valuable model to study sociability and its neurogenetic basis.