Unique garden experiment changes understanding of behavioral mechanisms

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A unique experiment carried out in a Leicester garden, and concurrently in a garden in Italy, has yielded surprising results that has changed scientific knowledge and is published in one of the world's foremost science journals.

Research into the behaviour of flies and their sleep-wake mechanism – their 24-hour behavioural rhythms- was conducted by researchers from the Universities of Leicester and Padova. Their findings flew in the face of over 40 years' research in controlled laboratory conditions about the behaviour of these insects.

The study of fly rhythms is important because the same 24-hour clock is found in almost all organisms, including some bacteria, but the genetic basis of it is practically the same among insects and humans so has important implications for the study of many health problems which have a rhythmic component. These include sleep disorders, the impact of shift work schedules on the body, jetlag, even obesity and cardiovascular disturbances. Indeed biological rhythms can even be potentially targeted in insects of medical and agricultural importance such as flies that spoil our fruit - a big problem all over the world.

The study from Leicester and Padova is published in the Advance Online Publication on *Nature's* website. Funding for the research came predominantly from a number of sources, the European Community, the Biotechnology and Biological Sciences and Natural Environment Research Councils, the Royal Society, the Medical Research Council, the Italian Space Agency and the Ministero dell'Università e delle Ricerca

Bambos Kyriacou, Professor of Behavioural Genetics at the University of Leicester, who led the study in the UK, turned his own garden into a 'lab' for the study- using his children's playhouse as the experimental centre.

He said: "The fruitfly, *Drosophila melanogaster* is the 'workhorse' for genetic research into higher organisms. It has been the major model system for understanding how the 24 hour clock works, and how genes that control these 'biorhythms', build the 'bodyclock'. Luckily, it turns out that the clock mechanism is conserved from flies to mammals so studying these genes in the fly does the same job for the human.

"Much of the work done over the past 40 years on fly rhythms uses the flies sleep-wake cycle as a read-out for the clock, and how the fly wakes up in the morning, has a mid-day siesta, and is active again in the evenings, before falling asleep at night, has been dissected in exquisite detail both genetically and neurobiologically.

"So, for example, we know which clock neurons control the fly's wake-up call in the morning and which ones determine its evening behavioural activity. However, all this work has been done in the laboratory, under very artificial conditions where the temperature is constant, and the light comes on suddenly in the morning and goes off suddenly at night.

"This study, published in *Nature* did something different. By monitoring the behavioural rhythms of the flies and the temperature, sunlight, moonlight, humidity etc in a warm (Italian) and cold and wet (Leicester) environment, we were able to see exactly how flies react to changing light levels at dawn and dusk and to cycling temperatures during the day.

"The results were very surprising – flies simply did not do what they should. Instead of a siesta in the middle of the day, they became most active at that time. Instead of arrhythmic clock mutants showing defective rhythms, they showed perfectly good behavioural cycles, and instead of flies anticipating dawn as they do in the lab, they simply reacted to the changing light levels during the twilights.

In other words, some of the ideas we had about how rhythmic behaviour in the lab might correspond to that in the wild, turned out to be wrong.

"The clock genes identified over the past four decades have defined the field of chronobiology- however it may be that the importance of these genes for survival has been overstated. This study suggests that behaviour, which is the brain's way of changing its environment (ie if it's too cold, go somewhere where it's hot) does not need to anticipate changes in the environment - it can simply react to them.

"However, underlying physiology probably does need to anticipate regular changes. For example, peripheral tissues (liver, kidneys etc) might need to anticipate regular environmental changes because they cannot react as quickly as the brain.

"This work also suggests that studying organisms in more natural environments is important because it can be applied to animal welfare. For example, providing more natural environments for animals that are farmed indoors, may enhance their health and well-being. "

The work in the UK and Italy was done predominantly by Supriya Bhutani, who was a PhD student in the fly lab in the Genetics Department at the University of Leicester, and Stefano Vanin, an Italian postdoc in the laboratory of Prof Kyriacou's long term associate, Prof Rudi Costa from the Biology Department at the University of Padova - where Galileo did his experiments – Stefano did the same natural experiments in his garden in the nearby town of Treviso.

More information: "Unexpected features of Drosophila circadian behavioural rhythms under natural conditions" is scheduled for Advance Online Publication (AOP) in *Nature* today. DOI: 10.1038/nature10991

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