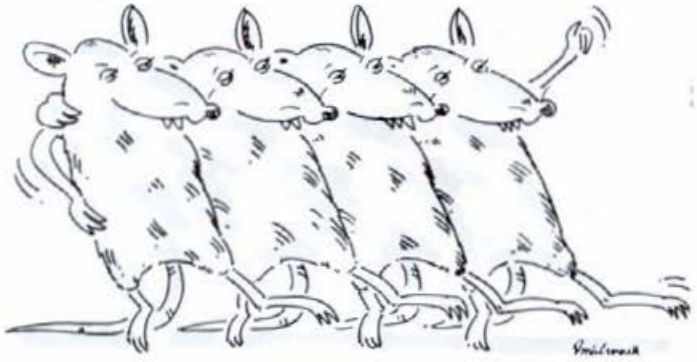


Rhythmic rats

Rats have rhythm! Now don't let that bald statement conjure up visions of teams of toe-tapping rodents — by rhythm we refer of course to biological rhythms, those regular fluctuations in an organism's physiology.

At first sight ratty rhythms don't suggest anything very surprising, because researchers have long known about rhythms in most animals (including humans) and plants. But these new ones don't seem to arise within the rats themselves; instead, some scientists believe that laboratory rats can display biological rhythms that are determined by the weekly pattern of human activity in the lab.

Biorhythms, although often influenced by the environment, are usually endogenous — that is, they arise spontaneously within the organism concerned. Our sleep–wake cycle provides a good example: after our usual hours of wakefulness, we start to feel like sleeping. This desire comes from within us and does not arise just because it is dark — hence the problem with jetlag, when we can start to feel sleepy in the middle of the morning in our new time zone. After a short while, our rhythms — responding to the cues of the environment — and our own efforts — will re-set themselves.

If we become isolated from any natural environment and any clues about the time of day, our rhythmic activity cycles and those of most other mammals will continue, although they will gradually drift out of phase with the 24-hour cycles outside.

Sleeping and being awake are just the obvious signs of diurnal (or daily) rhythms that affect many other aspects of our bodies. The production of urine, movements of the digestive system, and appetite all decrease when we are asleep. Thus scientists can use measurements of urine flow and defaecation as indicators of an organism's biological rhythms.

In the case of laboratory rats and many other creatures, biologists normally take into

account, in their experiments, the effects of the animals' own daily rhythms. But now it seems that rats may evince other, less well-known rhythms that are neither endogenous nor daily.

During an investigation into the contamination of oysters with heavy metals (see *Ecos* 50 for the full story), Mr Stephen Thrower and Dr June Olley, now of the CSIRO Division of Fisheries' Seafood Technology Section in Tasmania, fed five pairs of laboratory rats with various diets to find out to what extent heavy metals in shellfish were absorbed. It was when analysing the data from this experiment that they came across evidence of unusual fluctuations in the physiology of their subjects.

As part of the study, the scientists noted each rat's food intake, water consumption, and volume of urine produced every day. The animals' faeces were collected and weighed every Monday, Wednesday, and Friday.

At the end of the 2-month feeding trial, it became apparent from the figures that the daily volume of urine increased during the week, reaching a maximum on Friday, but dropping sharply on Saturday. Probably connected with this, the amount of water the animals drank fluctuated as well.

The weight of the faeces also showed a cycle, but the scientists couldn't be precise about it because of the pooling of the faeces for 2 or 3 days at a time. However, they could clearly see from the averaged figures that rats produced a greater weight of faeces on a weekday than on a Saturday or Sunday.

Now, was this mere chance? To help find out, they enlisted some expert assistance in the form of Mr John van der Touw of the Division of Mathematics and Statistics in Melbourne. His statistical study of the figures, using time-series analysis, showed that significant cycles were indeed occurring — the largest peak being near the frequency of one cycle per week.

The scientists wondered whether any other workers had ever noticed this effect with laboratory rats.

Dr Olley contacted somebody she had once met when working in Britain, a Czech emigre living in the United States, who studied the regulation of food intake in animals. He mentioned the work of a Czech scientist he knew, Dr J. Lát of the Prague Academy of Sciences. In 1958 this man had published — in Czech — the observation that rats kept in a busy laboratory had their greatest weight gains and food intake during the working week and least at weekends.

Dr Lát thought this might be due to environmental stimuli (noise, human and other smells, and movement), which ceased at weekends. Now, rats tend to be nocturnal and eat only at night; despite this, the day-time stimulation of the hustle and bustle of a working lab seemed to penetrate their resting hours and affect their physiology.

Dr Lát also found that public holidays in the middle of the week had the same effect as weekends, showing that the rhythm is not weekly just by coincidence, and does not originate inside the rats themselves.

For Dr Lát and the CSIRO researchers on the other side of the world these were chance observations on different aspects of physiology (the former measured weight gains and eating, the latter the production of urine and faeces). But their essential agreement supports the validity of the results. Both groups also noticed that the strength of the rhythms varied in individual rats, an effect that could possibly be genetic.

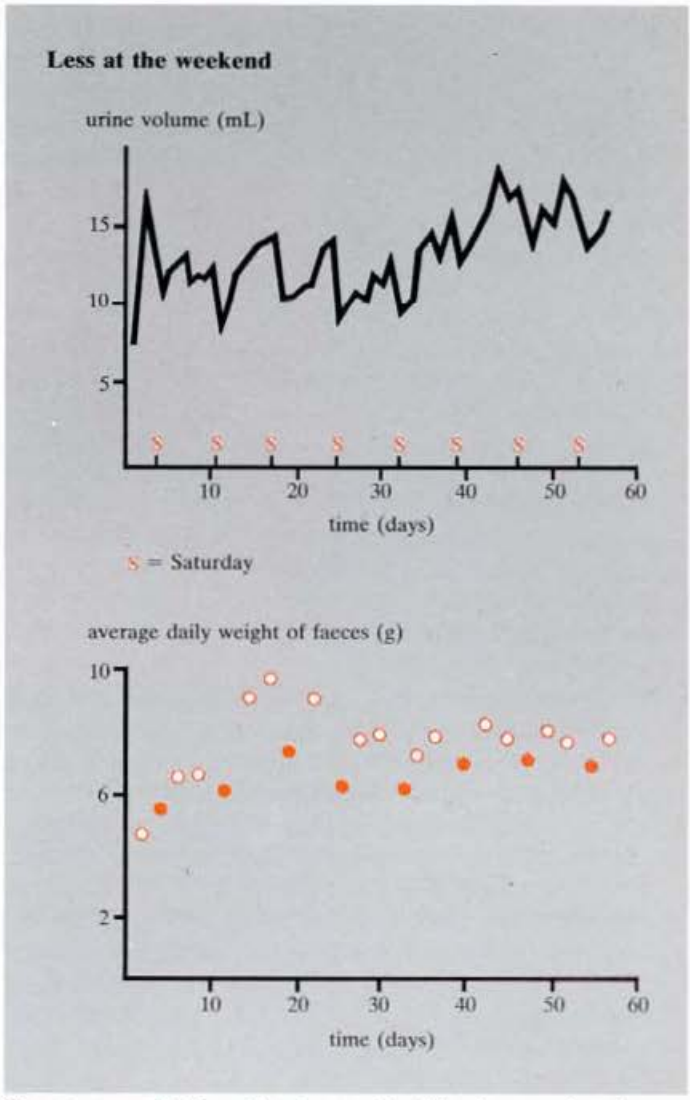
We know that the environment can influence the internal workings of animals' bodies; the increasing day length of springtime in temperate latitudes stimulates breeding in many organisms, to name but one example. But exactly how the vague stimuli of a working day translate into changes in urine flow and defaecation we don't yet know.

However, these unexpected findings — although not fully understood — are not merely an interesting scientific curiosity.

Before Mr Thrower and Dr Olley uncovered the fact of the rhythms, their figures gave the impression that the quantities of heavy metals in the faeces (which is what they were interested in) fluctuated by 40% every few days, even though the animals were on a constant and controlled diet. The cause of this artificial result was of course the experimental subjects' rhythmic defaecation.

So it is obviously very important to take these weekly cycles into account — either by collecting faeces and urine only once a week, or by pooling the daily data. Alternatively, keep your rats in a environment that, by the consistency of its stimulation, ensures that the animals don't know what day it is!

Roger Beckmann



The upper graph shows the sharp and sudden decrease in urine output that occurs each Saturday. Faeces production shows a similar drop; the outputs at weekends are represented by solid circles in the lower graph, and those on weekdays by the empty circles.

Non-specific neural stimuli and metabolic rhythms in rats. J. van der Touw, S.J. Thrower, and J. Olley. *Physiologia Bohemoslovaca*, 1978, **27**, 501–4.