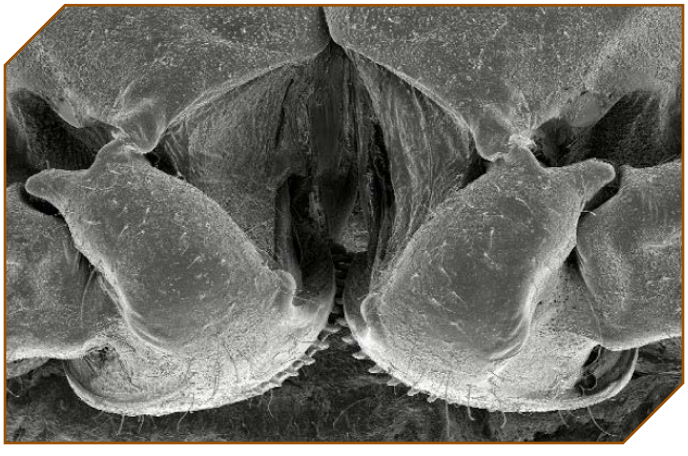
# THE NATURAL

## Issus Develops Working Gears in Response to Selective Pressure

**Which came first, the mechanical gear or the natural one?** This is a question the science community is now debating after zoologists from Cambridge discovered interesting footage that showed off some complex machining taking place in the body of one jumpy insect. Malcom Burrows, emeritus professor of Zoology, University of Cambridge, U.K., recently discovered working mechanical gears in the body of an issus, a small garden-variety bug found in backyards around the globe. "We had seen the gears when looking at the anatomy of the insect, but the exciting revelation came from the use of high speed video (5,000 images/second) that showed the gear teeth spinning past each other when the insect jumped," says Burrows. "These videos left little doubt in our mind that the structures both looked like gears, rotated and enmeshed like gears and functioned like gears."

The issus developed this gear-like structure in order to accomplish acrobatic leaps across plants—most likely to escape danger from predators. "A jump is propelled by the rapid extension of the two hind legs (insects have 3 pairs of legs). The inside of the thighs are curved and are very close to each other. They have a row of gear teeth which intermesh with each other which are not present on the other two pairs of legs. If the commands from the brain initiating the propulsive movements of one hind leg start before those of the other hind leg, then the contact between the gears will ensure that both will move in synchrony. The intermeshing of the gears during the whole of the rapid jumping movement means that the two hind legs always remain in synchrony."

The gears would appear to have evolved in response to a particular selective pressure, according to Burrows. "The movements of the propulsive legs have to be tightly synchronized to enable the insect to jump away and hence escape from predators. If the legs move asynchronously, the jump will be less effective and the predators are more likely to be successful."



There are biological structures in this world that have gear-like appearances, but this is the first discovery of actual interacting gears in any animal. "In other insects there are many mechanical devices that are similar to devices that we have invented; for example, devices like poppers (press studs) and interlocking (Velcro-like) or abrasive surfaces for holding body parts together, or grasping structures like pincers," Burrows says.

So how are these gears different than the gears covered in each issue of this magazine?

"The main difference is their asymmetric shape," Burrows says. "Synchronization and any power transference is only really necessary in one direction, during the very rapid (1-2 ms) propulsive movements of the legs. In the opposite direction, when the legs are being moved in their position in preparation for a jump, the movement is slow (several hundred ms)."

What's truly fascinating to those involved in both science and engineering is that the issus represents the possibility that the idea of gears had arrived via natural selection long before man created the first mechanical device.

"The millions of years over which evolution has worked has almost certainly produced mechanisms that we have not discovered for ourselves and which our relatively short period of technology has not independently thought about yet," Burrows says. "I think the emphasis is that animals face similar problems to those we have faced in building machines. Natural selection has resulted in a solution that is similar to that devised by humans for dealing with similar requirements of movement control."

For more information on the issus and its working gears, visit *www.cam.ac.uk*.