

A HARD-EARNED PAT FOR A TRUE DIGGER

TEXT BY JOHN FEEHAN

THE AFTERNOON SUN pierced a cluster of gum trees as I pulled up at the side of the road by John and Moira Maddrell's paddock at Garen Vale, near Braidwood, in southern New South Wales. I grabbed a couple of buckets from the back of my ute, lowered them over the fence and vaulted into lush pasture on the other side. Cows eyed me curiously as I picked up my equipment and walked into their domain, scouring the ground ahead as I went.

Within minutes I spotted what I was looking for: a fresh cow pat glistening moistly by a clump of grass. Around it were telltale soil casts that told me dung beetles were hard at work beneath, taking the pat apart and burying it in brood chambers where it would nourish their young.

For me it was a real homecoming,

because I knew that some of these beetles would be descended from 1500 that colleagues and I had released at Braidwood 15 years earlier. Others would be descendants of species that had spread from release sites elsewhere.

I lightened my stride, approaching the pat almost on tiptoe so as not to alert the insects and send them scurrying to safety. Gingerly I lifted an edge of the pat just in time to see the black head and forelegs of a male beetle retreat down a tunnel 8 millimetres wide that probably ran about 20 centimetres into the ground beneath. In the tunnel, his mate would be constructing a series of nursery chambers in each of which she would lay a single egg in a ball of dung the size of a marble. The beetles, whose ancestors came from Spain, would dig other tunnels until the pat was

completely exhausted (see page 84).

I knelt down by the pat, craning over for a closer look. From the variety of casts around it, I calculated that altogether four dung beetle species were at work. Taking a trowel from one of my buckets, I carefully prised the pat open. Within a few moments I had spotted all four types, each exquisitely formed, each equipped with four powerful, scimitar-shaped rear legs and two barbed forelegs adapted to shovelling earth and manoeuvring pieces of dung with lumbering, mechanical efficiency.

The smallest was a brown bee-sized insect that originated in the Mediterranean region. Next in size was the Spanish species, followed by an African beetle of 13 mm. Completing the quartet was a French cousin, a full 2.5 cm long and weighing 10–20 times more than any of the others.

Sparkling like gems, a cache of dung beetles (above), harvested near Canberra by entomologist John Feehan, awaits deployment in new pastures. Like all the world's 4000 dung beetle species, these 2.5 cm beauties, descendants of a French variety, are nature's recyclers, specialising in the quick, efficient disposal of animal droppings. Buried in underground tunnels, pellets of dung nourish beetle larvae and provide a pupation chamber (right, above) in which they transform into adults. Most species form their brood pellets within the tunnels, but others, like this African species now common in Queensland (right), make spheres of dung that are rolled away and pasted to the base of plants. Benefits to the environment are many – and with the dung gone, flies are unable to breed.



JOHN FEEHAN



JOHN GREEN, CSIRO ENTOMOLOGY

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Life of a down-to-earth recycler

Dung beetles spend almost their whole lives eating and breeding in dung. For the ancient Egyptians, the scarab species, from which the family derives its Latin name – *scarabaeidae* – was a sacred symbol of resurrection. In the pharaohs' spirit world, the Sun's rays radiated from a scarab's head and its dung ball was the world, caught in an eternal cycle of daily renewal.

More than 4000 of these remarkable creatures have evolved and adapted to the world's different climates and the dung of its many animals. Australia's natives are scrub and woodland dwellers, specialising in coarse marsupial droppings and they don't like the soft cattle dung in which bush flies and buffalo flies breed.

Introducing species to control dung-breeding flies was suggested in the early 1960s by George Bornemissza, then a scientist at the CSIRO. Between 1968 and 1982, the CSIRO imported about 50 species from Asia, Europe and Africa, aiming to match them to different climatic zones. So far, of the 26 species that are known to be established, only one, an African species released in northern Australia, has reached its natural boundary.

Dung beetles are effective because they share a common purpose and seldom impede each other's progress with territorial squabbles. The team effort begins when hundreds of pairs – up to 1500 in the case of smaller species – land on a dung pat (1).

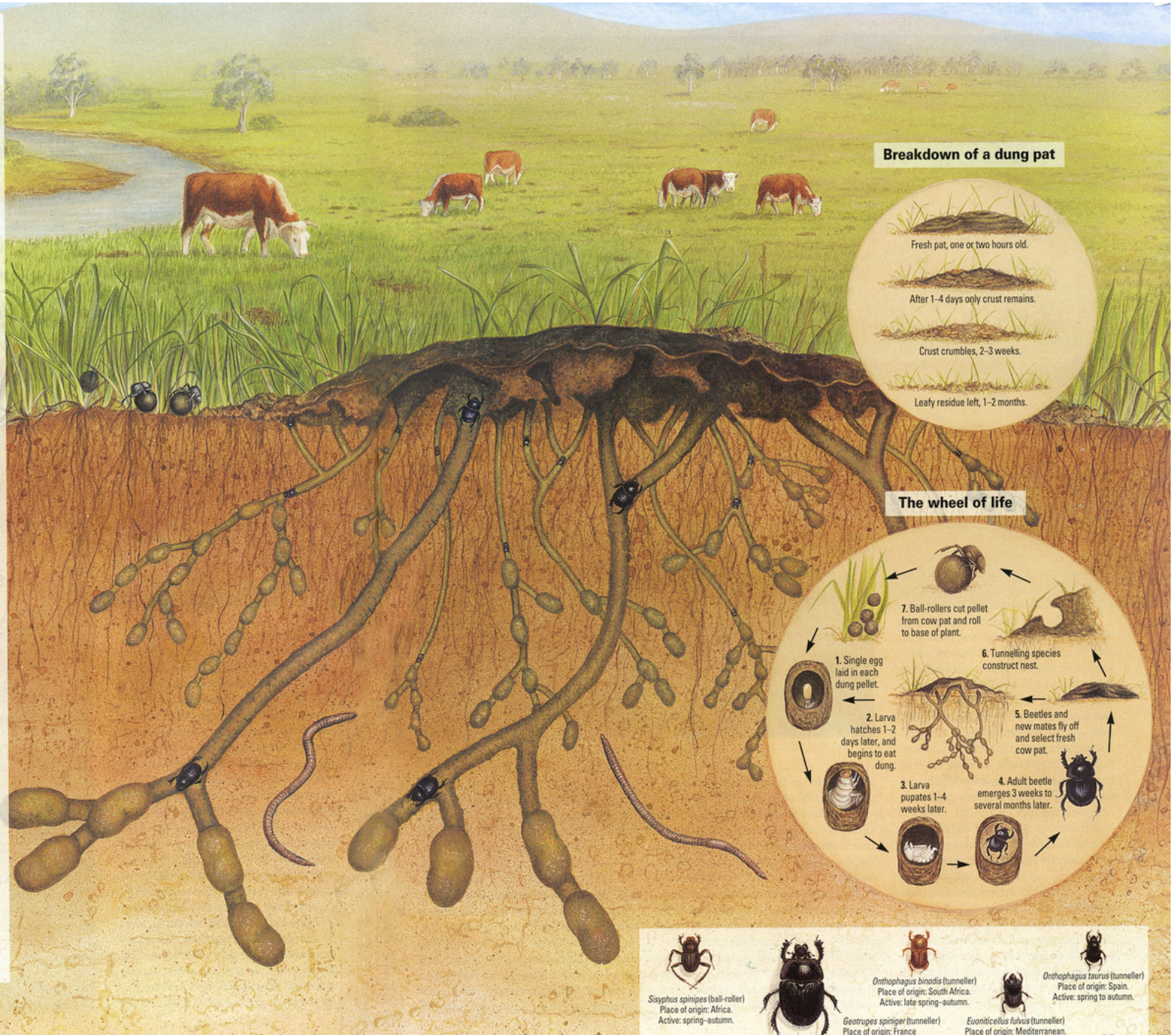
Most species are burrowers that bury dung in tunnels (2) directly underneath the pats, which are hollowed out from within (3). The largest of the species represented in the illustration originated in France and excavates the deepest tunnels (4), along which it makes sausage-shaped brood chambers. The shallowest tunnels (5) belong to a much smaller Spanish species that buries dung in chambers that hang like fruit from the branches of a pear tree. The intermediate depths are occupied by species originating in South Africa (6) and the Mediterranean (7). Some surface-dwellers, including an African species (8), cut perfectly shaped balls from the pat, which are rolled away and attached to the bases of plants.

In all species, the female lays a single egg in a hollow excavated from the finished pellet, which is then resealed. Larvae hatch within a few days and feed on the dung until they're ready to pupate within its husk. Some species with life cycles of only a few weeks produce several generations a year, but the larger ones take many months to reproduce and regenerate only once or twice a year. When the new generation of beetles has left the nest, the abandoned burrows are an attractive habitat and food supply for soil-enriching earthworms (9).

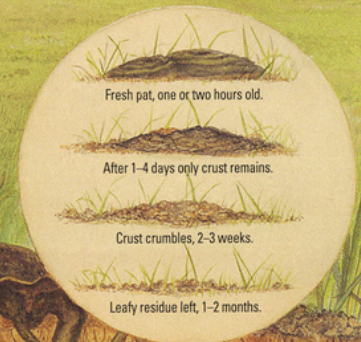
For maximum dung burial in spring, summer and autumn, it's best to have a variety of species with overlapping periods of activity. In cooler areas like that depicted, the French species – slow to recover from the winter cold, and producing one or two generations of offspring from late spring until autumn – has been matched with three temperate-climate species: the Spanish and Mediterranean types, which multiply quickly as soon as spring arrives, producing from two to several generations annually, and the South African species, which recovers from winter slowly but breeds rapidly. The African ball-rolling species prefers climates like northern coastal NSW's, where it commonly works with its tunnelling South African cousin. In warmer climates, many species are active for longer periods of the year.

Larvae of all tunnellers are vulnerable to prolonged rain – particularly in clay soils – and drought leads to inactivity. So in spring in southern parts, and in seasons following severe flood or drought, it can take several months for the beetles to reappear.

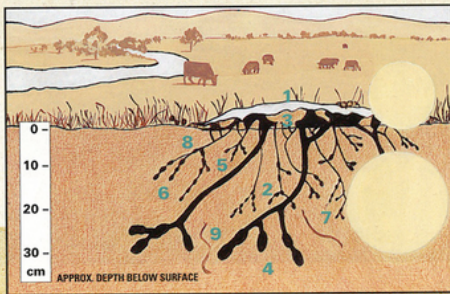
ILLUSTRATIONS: ANNE BOWMAN



Breakdown of a dung pat



The wheel of life



<i>Sisyphus spinipes</i> (ball-roller) Place of origin: Africa. Active: spring-autumn.	<i>Onthophagus binodis</i> (tunneller) Place of origin: South Africa. Active: late spring-autumn.	<i>Onthophagus taurus</i> (tunneller) Place of origin: Spain. Active: spring to autumn.
<i>Geotrupes spingeri</i> (tunneller) Place of origin: France. Active: late spring-autumn.	<i>Evoniticellus fulvus</i> (tunneller) Place of origin: Mediterranean. Active: spring to autumn.	
ACTUAL SIZE		



PHOTOS: MIKE LANGFORD

The ripe stuff. Fresh, moist droppings (left) get little chance to dry out in areas where dung beetles are abundant. Within a day or two, they will have disposed of the pat and flown to another. John, who collects and sells the introduced beetles, must be quick if he is to catch them – once they've detected his presence, they "crash dive" to the safety of their tunnels. On this occasion he's timed his approach right and is poised to lift a nicely textured pat and its bounty of beetles. With full buckets, he returns to his ute (below) and empties the contents into plastic containers for the journey home to Canberra. On hot days he packs ice around the containers to sedate the beetles and stop them wasting energy by trying to escape.

All but seven of my 32 years as an entomologist with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) had been spent with the dung-beetle team, and experience had taught me that a pat like this contained hundreds of beetles. Working from the inside so that they are sheltered from predators such as birds and foxes, they gut a pat in 1–3 days, leaving only a residual crust that soon crumbles and decays.

Initially, the beetles were viewed as a control for buffalo flies, then bush flies (*Buzz Off!*, page 72), both of which breed in cattle dung, but other benefits were soon evident. The beetles not only prevent the flies from breeding, but once the hungry larvae are finished with the dung, what's left is beautifully placed to fertilise pasture. And when the new beetles emerge from pupation, their abandoned burrows are perfect aeration and water channels for root systems.

Through my work, I developed a genuine liking for these creatures, whose entire life cycle centres on the droppings of introduced stock. I resolved to make others aware of their potential, and since leaving the CSIRO early in 1993, I have been harvesting them and selling them to farms in four States. The wheel had come full circle, and today I hoped to gather 1000–2000 beetles for brothers Andy and Colin Murdoch, who farm with their wives



Jane and Jill at Bombala in the south-eastern tip of NSW.

The Murdochs were concerned that their pasture had been depleted by the intensive farming methods popular for the past 40 years. They were also worried that chemical fertiliser was polluting rivers and causing blooms of blue-green algae. This was another reason why I knew dung beetles would appeal to them. Normally rain flushes residual fertiliser and dung into watercourses before it can soak into the hard earth, but once dung beetles have done their work, the fertiliser disperses

efficiently through their tunnels. Also, the digested dung is an excellent habitat and food supply for earthworms, which decompose it further to provide essential soil nutrients.

Dung beetles prefer only the freshest dung, and hundreds of them, either youngsters newly emerged from pupation or older pairs that have abandoned an exhausted pat, wing in on a new pat within hours. This one was just right, and I smiled with satisfaction as I scooped it up and dropped it into a bucket. Progressing through the paddock, I carefully selected only the



JOHN FEEMAN

John reckons dung beetles are the perfect ecological control, and this typical paddock near Canberra (above) illustrates his point. Australia's 30 million cattle are an incredibly messy mob, each producing 10–12 pats a day. That amounts to a staggering 1.7 billion tonnes a year, enough to smother about 110,000 sq. km – half the area of Victoria – of pasture. Here, without beetles to dispose of them, fresh pats and the remains of many others litter the ground, making grass inedible and depriving it of sunlight. But in paddocks where dung beetles are active, little evidence of droppings remains. And below the surface, the beetles' 5–30 cm tunnels are efficient aeration and water channels through which grass roots reach untapped nutrients. Importantly, the beetles don't harm our ecology.

newest pats, and when both buckets were full, I returned to the ute and emptied them into a large plastic box containing a layer of sawdust.

During my drive home to the Canberra suburb of Hackett, the beetles, prompted by the vehicle's vibrations, would abandon the dung and burrow into the sawdust. All that was left for my wife Cath and me to do was sieve out the insects and dispatch them in ventilated containers.

The rest would be up to the Murdochs, who'd only have to deposit them, a handful at a time, onto fresh cow pats. The beetles would go to work right away, disappearing beneath the pats with the purposefulness of mechanical diggers, soon to become a permanent, self-sustaining part of the area's ecology. In time they'd multiply, and within three or four years the Murdochs would notice the ben-

efits – better drainage, improved pasture, less dung cover – and fewer flies.

As I climbed into the ute I turned for a moment and gazed over the paddock. The sun had lowered, and the lengthening shadows lent the scene a mystical enchantment. Had it not been for the virgin eucalypt forest that fringed the property, I could have been standing at the edge of a European meadow.

I recalled my colleague Dr Alan Kirk commenting when we'd released the first beetles here in 1979 that, had he not known better, he'd have thought he was in the very French paddock where the largest of the four beetle species originated. We had matched the climates perfectly.

And I realised that there was something else that enhanced the illusion of being in another country – there wasn't a fly to be seen.