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Do insects have personalities?

by Patrick Honan

If you've ever seen a mating pair of Rhinoceros Beetles with their heads buried deep in soft banana, you'd have to say that Rhino Beetles know how to enjoy themselves.

A cantankerous female Blue Ant (*Diamma bicolor*), actually a Flower Wasp of the Family Tiphiidae.

But do they have personalities? The question is answerable partly from a scientific perspective, but also whether their behaviour fits the human understanding of what constitutes a personality. Individual species definitely show distinctive behavioural traits. Anyone who's met a Blue Ant (*Diamma bicolor*), for example, will know how hostile they can be, whilst Steel-blue Sawflies (*Perga dorsalis*) are contractually gregarious, and most Raspy Cricket species (Family Gryllacrididae) appear to be perpetually outraged and will come at you from across the room (which makes them so appealing).

Many people who know insects tend to anthropomorphise the species they know best. The Garden Mantid (*Orthodera ministralis*) is confident and curious, but can turn in a heartbeat into a skilled and clinical killer. Greengrocer Cicadas (*Cyclochila australasiae*) are loud and raucous – the Sulphur-crested Cockatoos of the insect world. Bushflies (*Musca vetustissima*), on the other hand, are sharp and nimble, whereas Marchflies (Family Tabanidae) are dense and clumsy, the dummkopfs of the fly world.

Steel-blue Sawfly larvae (*Perga* species) gathering on a eucalypt branch during the day. They move out to feed collectively at night.

A male Greengrocer Cicada (*Cyclochila australasiae*), the cockatoo of the insect world.

Spiders too can be anthropomorphised. Jumping Spiders (Salticidae) are the least threatening of the arachnids – alert, highly observant and very perceptive. They are the most clown-like of the spiders (*Mopsus mormon* sometimes goes by the name 'Clown Spider) and seem to be forever showing off. On the other hand funnelwebs, especially the Sydney Funnelweb (*Atrax robustus*) are infamously sinister and quick to threaten. Many people swear that huntsmans chase them, and Badge Spider (*Neosparassus diana*) even appears to have a scowl on its 'face' as it rears up with fangs agape.

It can be difficult to assess the personality traits of short-lived insects, particularly in the field, but spider-lovers with experience in exotic , long-lived, tarantulas will recognise differences between the placid Chilean Rose Tarantula (*Grammostola rosea*) and the cantankerous but harmless King Baboon Tarantula (*Pelinobius muticus*). In terms of speed, aggression and bad temper, nothing compares with the local Australian tarantulas (including *Selenocosmia*, *Selenotypus* and *Phlogiellus*).

These behaviours may be known as derived

The Clown Jumping Spider (*Mopsus mormon*)

traits, characteristics that are unique to a species and shared by all members of that species. But by definition, personalities (also classified as temperaments or behavioural syndromes) must differ between individuals of the same species, not between species.

Tarantula keepers may interact daily with their charges over many years, sometimes with several specimens of the same species at the same time, and will get to know their individual peculiarities.

It makes sense from an evolutionary perspective for there to be variation between the behaviour of individuals, no matter what the species. After all, variation is one of the means by which individuals survive or perish in highly variable environments. In a high predator environment, individuals that are more 'shy' are less likely to be eaten, whereas in a food-poor environment, the 'bold' individuals that roam further looking for food are more likely to survive.

A rearing Sydney Funnelweb Spider (*Atrax robustus*).

In fact bold vs shy is one of the easiest personality traits to measure, and therefore the most widely tested on animal species, including insects and spiders. Boldness can be measured by the time taken by an animal to resume normal behaviour after it faces a threat of some sort. A spider, for example, may curl up into a ball after being treated to a puff of breath similar to that of a foraging bird. Bold individuals will uncurl in less than a minute, whilst shy individuals may take an hour or more, and that time can be used as a direct measure of 'boldness'.

Aggression is another personality trait that can be readily measured, either towards prey, predators or members of the same species. Individual spiders within a single species are known to vary in levels of aggression, and those that reside at either end of the spectrum are unlikely to succeed in evolutionary terms. An individual that is aggressive towards prey will grow more quickly but is more likely to take on and succumb to oversized prey that can fight back. A female spider that is aggressive towards any approaching movement is likely to

March Flies (Tabanidae) are unfortunately gruesome but fortunately, unlike bushflies, slow and cumbersome.

capture sufficient prey to eat well, but will kill all potential partners and therefore fail to breed. A female that recoils from approaching movement will not only miss passing prey, she will avoid mating altogether. Somewhere in between are successful individuals that chase small prey but avoid tackling too-large prey, and allow potential suitors to approach without consuming them, at least until mating is complete.

Other personality traits are also measurable and appear to be widely expressed by insects. Within a species of insect, there may be individuals with a greater tendency to explore (a 'curious' personality, technically called explorativeness), or be more ready to defend than retreat (brave, or perhaps foolhardy), be more or less active (busy versus lazy), able to modify behaviour under varying circumstances (adaptable), or willing to be close to or tolerate other members of the same species (gregarious). All these traits would be considered part of a personality when expressed in humans, and all are adaptive traits that assist in survival of insects and spiders in the wild.

American Cockroaches (*Periplaneta americana*) feeding on compost. In these situations they can develop a 'group personality'

And the theory is backed up by recent research. Studies conducted at Universities in Hungary and Denmark found individual European Firebugs (*Pyrrhocoris apterus*) were consistently either 'shy' or 'bold', as determined by how long they took to emerge from a refuge after disturbance. Scientists studying American Cockroaches (*Periplaneta americana*) at the Universite Libre de Bruxelles in Belgium found similar patterns in behaviour, and additionally while individuals within a group demonstrated a range of behavioural traits, these were modified into a group 'personality' under certain circumstances.

Somewhere in between species and individual, social spiders may exhibit 'personality' at the colony level. Researchers at the University of Pittsburgh found that colonies of the African social spiders (*Stegodyphus sarasinorum* and *S.dumicola*) differed from each other in levels of boldness, but that within colonies, individuals behaved consistently both as a group and individually over time. When spiders with different levels of boldness where transferred between colonies, the researchers found the level of a colony's boldness was determined by that of the boldest individual within a colony. A very bold individual transferred to a shy colony would 'inspire' its new colony mates to be four times bolder than they would otherwise be.

A male and female Social Huntsman (*Delena cancerides*) courting under bark. A single colony may house up to 300 individuals.

Research on social spiders in general suggests that spiders' lower aggression levels enable them to tolerate other members of the same species and therefore live communally, but are also less aggressive towards prey and potential predators. Sociality in spiders is perhaps most highly evolved in the Australian Social Huntsman (*Delena cancerides*), which are not only tolerant of other nest members but regularly bring back prey to share with the colony. Dominant females will tolerate juvenile members of other colonies moving into the nest, but she draws the line at allowing in adult females from other nests. Research on Social Huntsmans is still in its early days, but there's every chance individual variation in personalities within a colony will be discovered.

Extending these personality traits into the hypothetical, we can speculate that consistent personality differences may lead to caste differentiation in social insects and spiders – those that are more bold or aggressive would be most effective in defending the colony, for example, whilst individuals with tendencies towards explorativeness would make excellent foragers. This is known as 'social niche specialisation', and further studies on *Stegodyphus* found that over their lifetimes, individuals became more consistent in behaviour which also became more divergent from the personalities of other individuals within the colony – that is, their personalities 'strengthened' and they became more set in their ways as they aged.

Covered in pollen, this European Honeybee (*Apis mellifera*) may be feeling particularly optimistic.

Some researchers have even speculated on the concept of 'personality speciation'. In non-social species, individuals or groups within a species that are consistently meek may never encounter those that are consistently bold. Carry this on long enough and soon there are two groups that live within the same habitat but never actually meet, therefore putting a halt to gene flow and allowing other variations over time (sympatric speciation).

From personalities we move into even more speculative questions of 'emotion'. Studies at Newcastle University in the UK and the University of Illinois in the US discovered that not only are some European Honeybee individuals (*Apis mellifera*) more 'adventurous' than others (with distinct molecular pathways associated with thrill-seeking in humans), they also demonstrated behaviour that tends to the emotional side of personality traits, such as 'pessimism' and 'agitation'. Honeybees trained to anticipate a reward versus a punishment (or lesser reward), produce lower levels of haemolymph dopamine, octopamine, and serotonin when anticipating a punishment or lesser reward, remarkably similar to the standard reaction in vertebrates.

These studies show that, in insects and spiders, behaviour not only differed between individuals, but was consistent within individuals across a range of situations. This is the very definition of a personality trait. So the short answer to the question 'Do insects have personalities?' is a definite yes.

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From the archives

Wings and Stings
Journal of the Victorian Entomological Society
Volume 1, No.2
February 1966

An Historical Outline of the Entomological Society of Victoria

by Graeme Rushworth

On April 5, 1927 fourteen people interested in entomology met at the East Malvern home of the late Mr F.E. Wilson for the purpose of forming an entomologist club, a preliminary meeting having been held previously at the home of Mr C.L. Barrett. The minutes do not record all the names of those present but mentioned are Rev. E. Nye, Messrs. C. Deane, C.H. Borch, T. Greaves, R.R. Blackwood (now Sir Robert) and W.H. Roger. Mr Wilson was elected Chairman, and this meeting and the motion quoted above, which is taken from the first Minute Book, led to the eventual formation of the Entomological Society of Victoria.

At first the organisation was known as the Entomologists' Club, this was changed in June 1930, the Minute Book entry being "The motion, notice of which was made at the last meeting Mr. Rayment seconded by Mr. V.H. Miller – That the name of the club be amended to The Entomologists' Club of Victoria – was brought forward; Mr. Rayment said that a great deal was to be gained by giving the Club a place. The motion was put to the meeting and carried."

Although references are made to office bearers in the minutes few details of these were given prior to 1929 when Mr. F.E. Wilson was elected President. Apparently the custom was to elect a Chairman at each meeting and this was most frequently Mr. Wilson.

Subscriptions were at first 2/6, later increased to 5/- and meetings were held at members' homes. The first "public" meeting was in July 1928 at the Victorian Horticultural Society Hall, attended by fourteen members and visitors, total membership at that time being twenty-six.

Meetings were later held at Latham House, until June 1933 when the venue was changed to Forester's Hall, Latrobe Street which was used until 1941 other than six meetings held at the National Museum in 1934.

In the early years of the Society, excursions – rambles – they are often called in the Minutes, were made to places such as Heathmont, Millgrove, Frankston, Ringwood, Blackburn, Noble Park and Fern Tree Gully.

Lecturers for monthly meetings were chiefly drawn from the Society members, Mr. Wilson featuring most frequently with an extraordinary variety of topics. Special meetings were often arranged for visiting entomologists, at one of these held in August 1931, an attendance of seventy was recorded to meet Dr. G.A. Waterhouse, Dr. H.J. Carter and Professor Wheeler, USA.

On various occasions attempts were made to publish a journal and in 1936 this reached the stage where Mr Blackwood presented a design for the cover of the publication and this was approved by the meeting, but at a meeting in May 1937, little progress had been made except to choose a title "Insect Life".

There is no further mention of the journal in the minutes and the writer assumes it was abandoned. Other activities embarked upon were the preparation of a list of popular names of insects (1928), apparently this remained unpublished, and a collection of members notes and observations (1940).

Special meetings were arranged for the purpose of furthering the interests of school children in entomology with members providing elaborate exhibits; that held in 1938 attracted sixty visitors from school nature clubs.

Membership of the Society in the years 1927-1940 was from 25 to 40 although attendance at meetings fell to a very low ebb at times. By 1941 attendance had fallen to an average of nine and formalities were dispensed with and no minutes kept after May 1942 when meetings at Forester's Hall ceased and reverted to being held at members' homes. Because of the presence of the war the Society lapsed about July 1942 and was not re-established until 1961

when Mr. J.C. Le Soeuf arranged a meeting at the National Herbarium Hall for this purpose.

Outstanding personalities and contributors to entomology in Australia have served as office bearers – Mr F.E. Wilson, C.L. Barrett, Sir Robert Blackwood, R.T.M. Pescott, A.N. Burns and many others. Since 1927 the Entomological Society of Victoria as a whole has done much for entomologists and entomology in this country.

(edited for space by Patrick Honan)

Account of ramble to Eltham, 15 May 1927

by T. Greaves, Hon. Sec.

(An account of the very first outing of the ESV, cited in an article by Graeme Rushworth, Wings and Stings – Journal of the Victorian Entomological Society, Volume 1, No.2, February 1966)

Eighteen members and friends of the Entomologists' Club assembled at Eltham for the first field day. The weather was perfect. We followed the Plenty River for a while, then made our way to Mr. W.C. Tonge's place on Eltham Heights. After lunch in the open, we went for a ramble towards the river, and as each member's attention was given to his own particular study, the party became scattered, the young members receiving practical lessons in field work.

The insects found were chiefly small beetles and craneflies Tipulidae. Lepidoptera were scarce. We gathered again for afternoon tea and before leaving saw Mr. Tonge's collection of bird paintings, and butterflies caught near his home. A quiet walk to the station in the beautiful twilight ended a perfect day.

Wings and Stings
Journal of the Victorian Entomological Society
Volume 1, No.2
February 1966

The Cruel Plant

by David R. Holmes

My curiosity was aroused by the finding of four Dispar compacta caught in a creeper I had planted on the outside wall of my glass-house. I had thought this creeper a Mandevillia, however subsequent investigation identified it as Araujia sericifera the Cruel Plant or the White Bladder Flower.

This creeper is a member of the family Asclepiadaceae to which is related the Hoyas. It is a native of South America and the plant is a useful source of a strong fibre used in South American textile work.

Unlike most plants the Cruel Plant contracts its stamens on contact thus firmly holding the moth or butterfly by the proboscis.

Below is a list of the insects caught by the White Bladder Flower between the 5th of March and the 14th of April 1965. These were the only butterflies in the locality while the creeper was in flower, otherwise it is quite reasonable to believe that many more varieties would have been caught.

Insects caught by *Araujia sericifera*

Date	No.	Variety
5.3.65	4	*Dispar compacta*
	1	*Trepezites symmomus soma*
6.3.65	6	*Signeta flammeata*
	2	*Dispar compacta*
	1	*Trepezites symmomus soma*
10.3.65	4	*Signeta flammeata*
	2	*Dispar compacta*
12.3.65	2	*Hesperilla idothea idothea*
	3	*Dispar compacta*
	4	*Signeta flammeata*
14.3.65	3	*Dispar compacta*
	2	*Signeta flammeata*
16.3.65	2	*Pieris rapae*
	2	*Dispar compacta*
	2	*Signeta flammeata*
17.3.65	2	*Pieris rapae*
	5	*Signeta flammeata*
	3	*Dispar compacta*
	1	*Asura cirvicalis*
20.3.65	2	*Signeta flammeata*
14.4.65	12	*Pieris rapae*
	1	*Hesperilla ornata ornata* (larva from NSW placed on Sword-Grass nearby)
Total	66	

Meet your ESV Council

Ray Besserdin
Council Member, ESV

What's your favourite group of insects?

Hymenoptera. The wasps are still my favourite group.
Mantids also fascinate me enormously because of their incredible morphological variation, like something out of a sci-fi movie. I'm especially mesmerised by cryptic morphology and mantids are masters.
I also love cicadas. Their songs intrigue me and they can be so elusive to catch! The fulgorids, too, but that's more about their form.
But there's something about wasps that command my respect. My favourite group of all are the Pompilids. They're very purposeful and good at what they do. You see them as they run across the ground, somewhere like the Big Desert, poking around in trapdoor burrows until the spider comes out. The spider hops across the ground trying to get away, but the wasp is quick enough and strong enough to overpower it.

What's your main entomological interest?

I'm working on an exhibition of insect paper sculptures I'll finish over the next few years. I intend about 20 pieces covering some of the most interesting-looking Australian species. The artworks will be presented as a way for people to step into the world of insects, meet them face to face and all the while be intrigued that the displays are paper sculptures.
After I graduated in Biological Sciences at Latrobe University I decided academia was not for me, and that art was. I was walking across the campus for the very last time, and I thought that one day I'll merge my two loves, entomology and art. That time has arrived.
The exhibition will be a landmark, with pieces up to a metre. There's nothing else like it in the world. I'm a member of scientific artists' guilds but no-one else works in paper sculpture. They mostly work in traditional media like painting and drawing. In fact there are not even other artists practicing paper sculpture, in any form, whose work is quite like mine. For me though, it all started from childhood play.
I'd like to do sculptures of Stalk-eyed Flies (Platystomatidae) and the Dinosaur Ant (*Nothomyrmecia macrops*), as most Australians don't know how amazing they are. Dinosaur Ants are so primitive and so closely related to wasps. It's the form and colour of insects that interests me most.

What's your most memorable find?

I had an experience in the Northern Territory in 1986 collecting insects around Kakadu with the support of the Northern Territory Museum, Darwin. I went out to a tributary of the East Alligator River and saw an enormous flowering tree swarming with beetles and wasps, including a monstrous Scoliid wasp, probably *Campsomeris* species. I can't forget standing at the base of the huge tree, seeing the Scoliid and recognising it by its silhouette. I caught it with my net and was blown away by the size of it!
Another time I was climbing Mt Conner in Central Australia. I found a large black and orange Mud-daubing Wasp (*Monerebia* species) (Vespidae). It hovered back and forth in front of me for some time, teasing me while eluding every attempt to net it!
I'd love to catch the Cuckoo Wasp *Stilbum splendidum* (Chrysididae), one of the biggest Chrysids in the world. I've often seen them fly past like a magnificent jewel.

When did your interest start?

I was about four years old, before school age, and we were living in Ivanhoe. I'd been watching over the course of a week a black and

yellow 'thing' go into a hole under the path at the front gate. I now know it was the English Wasp, *Vespula vulgaris*, maybe just six years after this species was first discovered in Australia at Malvern. I watched it over a number of days and was fascinated by it going in and out of the hole under the path. Eventually I couldn't help myself and naïvely stuck my finger down the hole, was duly stung and ran screaming to mum! For wasps however, it was love at first bite.
I also remember the Passion-vine Hoppers (*Scolypopa australis*) around the garden and how they were impossible to catch. (Nowadays, as a grown up I catch them just to get even)! And, lagging behind my friends on the way to school, I'd wander off into the grass looking for grasshoppers, especially the Giant Green Slant-faces (*Acrida conica*). I was teased as the Insect Man at high school. So I got a guernsey number patch, turned it white side out, painted a grasshopper face "Insect Man" logo on it that mum stitched on a jumper, went back to school and properly pulled the fuse on all the kids! From that day, they thought I was cool.
I also painted Froggatt's Buzzer (*Froggattina australis*) on my school bag and had kids asking where I got the sticker! That was at Banyule High School, surrounded by farms back then, on one of the horseshoe bends of the Yarra River. I used to jump the fence at lunchtime and go into the swamp where there was lots of flowering Sweet Bursaria (*Bursaria spinosa*). It was a fantastic opportunity for collecting insects and being out in nature…as long as teachers didn't catch me!

When did you join the ESV?

I joined in 1968 or 69. I remember going to a meeting at the Herbarium with dad for the first time. I'd been fascinated by Treehoppers (Membracidae) in our backyard, especially *Acanthicus* species, and went into the National Museum of Victoria with a drawing I did to get it identified. Arturs Neboiss said it was an excellent artwork and was able to identify it to species from the drawing alone. He was thrilled with the art and gave me a present in return, a wooden box for pinning insects. I went home and started using the box for pinned insects, and I still have the box today, which is naturally filled with wasp specimens. Arturs also gave me some literature with information about the ESV. I got my dad to take me to a meeting and I joined the ESV that night.
My membership lapsed in the 80's while I concentrated on being an artist, then I rejoined four years ago, but it was always there in my heart. I worked out a long time ago what I loved in life; arts had always been number one, but my love of insects meant I always had to come back to it.

Are there entomologists you find inspiring?

Arturs Neboiss I'll never forget but, I met Howard Evans at the National Museum of Victoria in the mid 1980s, and when he went back to Colorado he sent me back a book he'd written called *The Wasps*, with a dedication inside from him and his wife. He was quite an influence to me, and I kept in touch for the next 5-10 years.
Another was Walter Linsenmayer, a Swiss scientific illustrator, more an artist than a scientist. He did some amazing stuff back in the 1970s that influenced the artwork I do now.

Any advice for budding entomologists?

Firstly, follow your heart. Secondly, no education is too much education. Take education through as far as you can to pursue your interest. Even if you don't get a job as an entomologist, invent some way to bring entomology to the world, such as books, photography or art. Make your time worthwhile and leave your mark.

2016 City of Melbourne Urban Bioblitz

Photos by
Peter Marriott
and
Patrick Honan

Articles of interest

Big spider eyes put more insects on the menu

by Amy Middleton
Cosmos
May 2016

Biologists blindfolded net-casting spiders to see how they performed without excellent eyesight. Amy Middleton reports.

The net-casting spider's secondary eyes – the largest of any arachnid – likely evolved in part to help it capture walking prey.CREDIT: JAY STAFSTROM

The biggest eyes of any known spider may have evolved for night-time hunting prowess, say researchers.

The link was uncovered by a new study, in which net-casting spiders were effectively blindfolded, allowing researchers to gauge the value of their enormous peepers.

The net-casting spider, *Deinopis spinosa*, is a unique web-building spider found in forest areas in Australia, the Africas and parts of America.

Unlike most spiders, this species is known to have excellent eyesight, thanks in part to an enlarged pair of secondary peepers which round out a total of eight eyes.

The species is also known for its unique predation methods. At night, the net-casting spider dangles from a triangle-shaped web, holding a net made of woolly silk. When prey passes, the spider propels itself downwards, ensnaring the target in its silky trap.
The spider then wraps its prey, paralyses it with a bite, and feeds.

Jay Stafstrom, a biologist at University of Nebraska-Lincoln, set out to find why these enlarged eyes – the biggest in the spider world – may have evolved.

To effectively analyse the arachnid's hunting behaviour, Stafstrom observed the species in its natural habitat, as well as in a series of laboratory tests. In fact, Stafstrom camped out in a Florida state park for two months for field-testing.

Stafstrom studied 29 net-casting spiders in the state park, excluding mature males, which don't engage in the net-casting behaviour.

To ascertain the value of those enlarged eyes, Stafstrom used dental silicone to blindfold the spiders during some of the tests.

According to the findings published in *Biology Letters*, the massive eyes are crucial to nocturnal *D. spinosa*'s ability to hunt its ground-dwelling prey, as opposed to its flying prey.

The findings show that when blindfolded, the spider was just as capable catching flying critters. But its predation of ground-dwellers such as crickets suffered.

Stafstrom points out that a lot of energy is spent maintaining eyes on any animal, let alone eyes as big as those on the net-casting spider. This caused the researchers to hypothesise on why such an energy-costly trait may have developed.

"Vision is really expensive," says Stafstrom. "Simply keeping photoreceptors healthy and functional requires a lot of energy. Now if you wanted to grow the size of the eye to gain more visual information, it would become disproportionately more expensive as the mass of the eye increases.

"[The spiders] can still catch things out of the air [without those eyes]. Why are they, presumably, investing so much in these large eyes? One of our hypotheses is that it's because there's a lot of prey on the ground, and by having vision in these enlarged eyes, not only are they getting things off the ground, but those things are bigger and probably more nutritious."

The findings from the lab revealed a similar result: spiders with their enlarged eyes covered took 10 times longer to catch a cricket in their vicinity than those without the blindfold.

Stafstrom also reflected on the incredible camouflage tactics of *D. spinosa*, which made it difficult for him to spot the spiders out in the field during daylight.

"Not only are they really looking like a stick and [lying] completely motionless, but on their first pair of legs, they actually have some hairs that puff out a bit and cover their eyes somewhat."

This camouflage ability may be a valuable defence against predators, which could explain why this nocturnal creature evolved such powerful night-vision.

Co-author and fellow University of Nebraska-Lincoln biologist Eileen Hebets says the findings are both significant, and well-earned.

"The fact that such a large component of this was done in the field, in pretty harsh conditions, is amazing," says Hebets.

"It was a tonne of work and physical hardship and technical hardship. The data came out beautifully, but the effort behind it was monumental."

Amy Middleton is a Melbourne-based journalist.

A 'sixth sense' for humidity helps insects stay out of climatic trouble

by Marco Gallio and Marcus Stensmyr
The Conversation
May 2016

The amount of water vapor in the air – humidity – profoundly alters our experience of the environment around us. A hot, dry morning in the desert of California feels miles apart from a hot, sticky one in the Cambodian jungle.

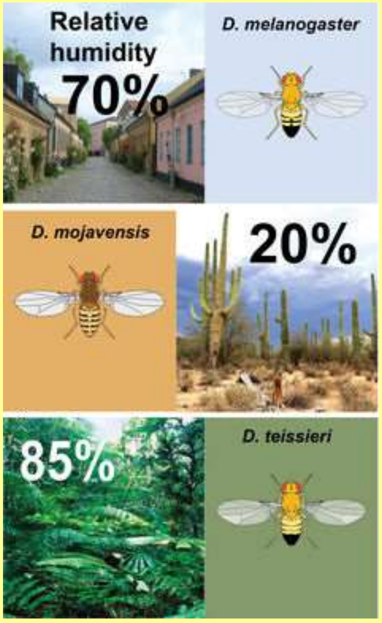
People generally dislike hot and humid conditions for good reasons. Our bodies dissipate heat through evaporation of sweat from the skin surface. When humidity is high, this process is less effective, and more blood needs to be pumped to the skin for cooling. This results in fatigue and can ultimately lead to hyperthermia ("heat stroke").

Varying levels of humidity characterize all habitats on our planet. Animal species have evolved to tolerate and even to thrive in the most extreme climates, from the frozen tundras of the north to the arid deserts of the equator. It's particularly impressive that small, cold-blooded animals such as insects can flourish in cold climates as well as in desert habitats. In part, these adaptations are made possible by sophisticated sensory systems that allow them to quickly react to potentially dangerous extremes.

When it comes to air humidity, scientists have known since the early 1900s that insects possess dedicated sensory systems that detect changes in water vapor in the air. This "sixth sense" for humidity has no direct parallels in big land mammals such as us. But it serves the small critters well as they work to avoid desiccation and to find open water: for example, a pond in which to lay eggs (crucial for many species of mosquitoes). We decided to investigate how these humidity-sensing systems work in insects.

What's the neuroscience underlying the system?

Using our favorite fruit fly *Drosophila melanogaster* as an experimental subject, we set out to determine just how insects can detect water vapor in the air. Which neurons serve as the humidity sensors in this species? Which genes and receptor mechanisms could be used to detect changes in air humidity? How is the information about external humidity relayed and ultimately processed in the fly's brain?

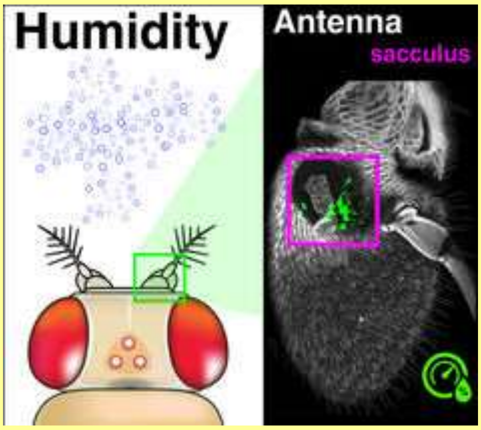


Fly species from different habitats prefer different ranges of humidity. *Drosophila melanogaster* depicted in Lund, Sweden; *D. mojavensis* depicted in the Saguaro desert of Arizona; *D. teissieri* depicted in the afrotropical rain forest. Gallio and Stensmyr, CC BY-ND

First, we had to determine the favorite humidity range for our fruit fly. Flies are human commensals – literally "share food at the same table," in this case invited or not. But though they like to live with us, it turns out fruit flies prefer humidity that is just a touch higher than we do [~70 percent relative humidity (RH) – which, on a hot day, would feel pretty sweaty to us].
We also tested two related fly species that live in different habitats. *Drosophila mojavensis* lives in the arid deserts of southern California and Mexico, and in our lab tests showed a preference for drier environs. *Drosophila teissieri* lives in the rainforest, and preferred higher humidity than the two other species. This is an important result: it suggests that humidity preference is finely tuned, reflecting specific adaptations to each species' habitat.

Next, we used the powerful tools available to fruit fly geneticists to find genes that are essential for this ability to detect and respond to air humidity. In flies, we can turn genes on or off relatively easily via mutation, as well as artificially activating or silencing specific neurons to observe what happens to behavior as a result.

The logic here was simple: if we find genes that, when missing, make the flies insensitive to changes in humidity, we know those genes are normally involved in that sensory system. Once we identify those genes, we can determine where they're active so we can pinpoint which neurons serve as humidity detectors.



The fruit fly *Drosophila* detects air humidity through hygroreceptors (green) located in a small sac-like invagination of the antenna. Gallio and Stensmyr, CC BY-ND

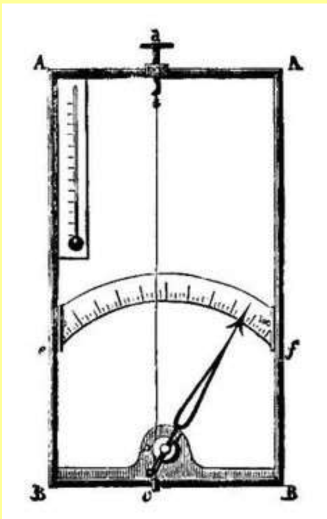
Long story short, we identified three related genes without which flies become "blind" to external humidity. Flies missing them show no preference at all for dry or humid air. It turned out that they function within key receptor neurons located in the antenna. They're found in an unusual little pouch in the back of the antenna called the "sacculus" (literally 'little sac') – well-protected from potential water splashes or other dangers.

These humidity detectors – termed "hygroreceptors" from the Greek word for humidity – rapidly respond to a puff of dry air, potentially alerting the animal to the fact that dangerous dry conditions are looming.
Next, we followed the projections of the hygroreceptor neurons into the brain, and discovered they end in a region right next to the one that we've previously shown is targeted by temperature receptors of the antenna. Indeed, in insects, temperature and humidity appear to be detected by distinct receptor systems. But the two will of course interact in the brain to determine how attractive a climate may ultimately be to the fly.

How evolution and engineers approach humidity

Discoveries like these reveal some of the clever ways evolution solved basic engineering problems. These solutions are invariably a source of inspiration to human engineers working on related areas. In fact, it is quite interesting to compare how flies measure humidity with how we do it.

Modern hygrometers often rely on changes in the electrical properties of a hygroscopic – "moisture-absorbing" – material. Before the reign of electronics, a number of clever strategies had been used to achieve this same goal. Some of the earliest hygrometers were likely inspired by the common "bad hair day" experience: human and animal hair are strongly hygroscopic and change in shape and length depending on air humidity.



The hair hygrometer, invented by de Saussure in 1783.

Leonardo da Vinci built the first-ever hygrometer on this principle in 1480. A more sophisticated instrument (that can be easily built as part of a science class) is the famous "hair-hygrometer" invented by the Swiss physicist Horace Bénédict de Saussure in 1783. Here, a single human hair is extended over a pulley that operates a needle, so that changes in the hair's length can be easily measured to keep track of changes in external humidity.

As it turns out, the fly may use a very similar strategy to measure humidity: the tips of the hygrosensory neurons we discovered are located within tiny hairs (sensilla) in the sacculus. We believe mechanical deformation of these sensilla may ultimately help the fly keep track of humidity levels.

Freshly hatched *Culex* mosquito, with swimming larvae in the background.

Applying hygrometer knowledge in the field
Understanding how animals sense and respond to key environmental parameters helps us understand how they adapt to their surroundings, and will help us predict what will happen to the distribution and survival of species as the climate changes as a result of global warming.

Moreover, an increasing knowledge of the cogs and gears that pesky insects like mosquitoes use to navigate their environment and find their "prey" suggests new ways to steer them away from us. For instance, researchers are working on scrambling the olfactory system of mosquitoes, which they use to locate their blood meals. Our new findings may lead to additional strategies for controlling insect populations, perhaps by leading them away from bodies of water near our cities.

Study of fungi-insect relationships may lead to new evolutionary discoveries

Science Daily
May 2016

Zombie ants are only one of the fungi-insect relationships studied by a team of Penn State biologists in a newly compiled database of insect fungi interactions.

"I couldn't find a place with broad information about all groups of fungi that infect insects in the same study," said Joao Araujo, graduate student in biology. "When we organized the information, we started to understand things we wouldn't see before, because the literature was so spread."

From the 150 years of literature, the researchers found that about 65 percent of insect orders can be infected by fungi and Oomycetes, fungi-like organisms that also infect insects. The results were published in the May issue of Advances in Genetics.

Sap-sucking insects, such as cicadas, are the most frequently attacked by fungi. The researchers believe this is because of the way this order of insect evolved. They have specialized mouth parts for sucking sap making them susceptible to fungi that originally infect plants.

"The fungi may have found a good environment inside the insect and then they would have established in the new host by host-jumping from plants to insects," said Araujo.

Host-jumping occurs when the fungi, in this case, are able to infect new groups of hosts like insects, animals or plants and so jump from one species or groups of hosts to others.

The researchers also discovered that flies are the only order of insects that are infected at all stages of development -- from when they are eggs until they are adults. They believe flies are especially susceptible to infection because they are found all over the world and get their food in a wide variety of ways. Their larvae often occupy a wide range of breeding sites, ranging from ponds to tree trunks. This diversity within the order is a potential explanation for the susceptibility to fungal infections in all stages of flies.

The researchers found the order of insect that includes butterflies and the order that includes

beetles to be the most likely to be infected when they are larvae.

They believe this is caused by a variety of factors. First, these insects occupy a wide variety of environments as larvae so they are exposed to a wider variety of fungi. Second, they tend to stay close to the breeding site where they were laid as eggs, making it easy for fungi to locate them. Third, in order to grow, they eat a lot of food. This means they become a large reservoir of energy for fungi. Finally, the larvae need to grow rapidly and so do not yet have a hard exoskeleton. Their softer, thinner skin makes them more susceptible to infection.

With this new database on the relationships between fungi and insects, the researchers believe much more research and and additional conclusions will be possible, and it may be a useful tool for teaching the diversity of fungi that infect insects.

Do insect infestations make fire less severe?

By Liz Kalaugher
Environmental Research Web
May 2016

Previously, researchers thought that insect outbreaks make forests more vulnerable to fire. But now a US team has found a link between infestations of mountain pine beetle and western spruce budworm across the US Pacific Northwest and less severe fires.

"In western North America, widespread insect outbreaks and wildfires have sparked concerns that insects increase wildfire activity, but recent studies suggest that insects have little influence on fire likelihood and severity," Garrett Meigs of the University of Vermont and Oregon State University told *environmentalresearchweb*. "In contrast, we found that insects generally reduce wildfire severity over a 25 year period across a large region."

Meigs and colleagues studied the severity of large wildfires across Oregon and Washington after outbreaks of mountain pine beetles (*Dendroctonus ponderosae*), which live in bark, and western spruce budworms (*Choristoneura freeman*), which eat leaves. They used satellite remote sensing and spatially explicit statistical modelling to assess 81 wildfires and multiple insect outbreaks across 20 million hectares of forest.

"This is the most extensive study to date on the effect of insect outbreaks on the severity of wildfires, and it is also the first to find that multiple insect species can reduce burn severity," said Meigs. "Our study spans a broader range of conditions than other studies, which typically focus on single insect outbreaks, wildfires, or time lags."

The researchers believe the effect is due to forest thinning. They found that the impacts of bark beetles and defoliators on burn severity changed over time. After mountain pine beetle outbreaks, burn severity decreased with time. Following western spruce budworm outbreaks, on the other hand, severity increased with time, recovering to prior levels within 20 years.

"Our finding that insect outbreaks can thin forests and reduce wildfire impacts may help forest managers prioritize firefighting and forest restoration activities in other areas, such as forests close to human communities," said Meigs. "That said, this study is only one piece of a complex puzzle, and forest managers should consider our regional findings in the context of local conditions and management objectives. In addition, our finding that mountain pine beetle and western spruce budworm effects on burn severity change over time suggests that there is not a one-size-fits-all solution for managing insect- and fire-prone forests."

Now the researchers are continuing to investigate the impacts of insects and wildfires on the ecosystem services that forests provide to society.

They would like to decipher the fine-scale mechanisms that may explain the general pattern of insects dampening burn severity.

"We are interested in the role of forest management activities such as firefighting and thinning in insect-affected forests, and how ecosystem recovery varies in forests with multiple disturbances compared to forests with either disturbance on its own," said Meigs. He and colleagues also plan to combine their regional analysis with detailed field studies, long-term tree ring records, and landscape-level strategic planning.

"We focused on the two most prevalent native insects in the Pacific Northwest, but we are interested in other important insect species and agents of change in this and other regions," said Meigs. "Given projected increases in the activity of both wildfires and insects, long-term research will be essential for sustainable forest management."

Meigs and colleagues reported their findings in *Environmental Research Letters (ERL)* as part of the *ERL Focus on Changing Fire Regimes: Interactions with Climate, Ecosystems, and Humans*.

Each of These Alien-Like Insects Was Created from Over 8,000 Photographs

By Emiko Jozuka
www.motherboard.vice.com
April 2016

When Levon Biss photographs an insect, he doesn't just use one shot. Instead, he uses "macrophotography" to shoot thousands of images of a single bug in order to come up with a 3D-like model of it.

Biss, a commercial sports photographer, started out shooting the insects that his son collected in the garden before branching out to dead insects from the archives of Oxford University's Natural History Museum. His new exhibition, "Microsculpture," opened in May.

In a bid to capture the insects in unprecedented detail and to give them a 3D illusion, each of his photographs is made up of between 8,000 to 10,000 separate shots. Biss splits the insects into multiple sections, photographing each part—whether it be an antenna or a wing—in 600 to 800 images.

"The camera is set on a rail and I automate it, so I'll program in my start-to-end point, my two focal points, and the camera's movement forward on the rail at ten microns in between each shot," Biss told me over the phone.

"When you go to this level of magnification with microscope lenses, the depth of field is so shallow that only a miniscule part of the images is in focus so you have to take a lot of shots to get focus all the way through."

"It takes three days to shoot the insect and probably another four days to process all the information, then another week to bring all the different sections together to produce one solid image of an insect," he said. The largest image in his latest exhibition will be 3 x 2 metres while the rest will be 1.25 x 2 metres.

Each of the insects photographed, according to Biss, possesses a unique color, shape, and texture

"I'm bringing my commercial lighting techniques to a very small space," he said. "If you were

standing next to me, I'd light you very differently to a six-foot guy standing next to you because you'd have different skin tones and bone structure from each other, and it's the same with insects."

Next up, Biss will be collaborating with a VR company to bring his audience an even more visceral experience with the insects that he shoots. "There'll be a virtual 3D experience where you can put on a headset and fly around a 16-metre insect," he said.

China Bug Declared World's Longest Insect

www.seeker.com
May 2016

A stick insect measuring 62.4 centimeters (24.6 inches) found in the southern province of Guangxi has broken the record for insect length.

A bug over half a meter (1.6 feet) long discovered in southern China has been declared the world's longest insect, state media said Thursday.

A stick insect measuring 62.4 centimeters (24.6 inches) found two years ago in the southern province of Guangxi has broken the record for length among the world's 807,625 known insects, the official Xinhua agency said, citing the Insect Museum of West China.

The previous record-holder was a Malaysian 56.7-centimeter-long (22.3 inches) stick insect discovered in 2008 and now on display in London's Natural History Museum.

Tipped off by locals about a huge beast half a meter long but as thick as a human index finger, scientist Zhao Li had been on the hunt for the bug for six years before he finally glimpsed and captured one.

"I was collecting insects on a 1,200-meter-tall (3,397-foot) mountain in Guangxi's Liuzhou City on the night of Aug. 16, 2014, when a dark shadow appeared in the distance, which looked like a tree twig," Zhao said, according to Xinhua.

"As I went near, I was shocked to find the huge insect's legs were as long as its body," he added.

The bug has been dubbed *Phryganistria chinensis* Zhao in his honour, and a paper about it will soon be published.

More than 3,000 varieties of stick insects have been discovered so far, Xinhua said.

Insect Astronomers? Dung Beetles 'Photograph' the Sky While Dancing

by Kacey Deamer, Staff Writer |
Live Science
May 2016

Humans have roads and infrastructure, GPS maps, and Siri to help them find their way, but creatures in the animal kingdom must rely on other tactics to navigate. For dung beetles, that means a dance and a mental photograph.

A new study finds that dung beetles take a snapshot of the positions of celestial bodies while "dancing" on top of a ball of dung. When they roll off with the ball, the beetles are able to travel in a straight line, the scientists said.

A dung beetle (*Carabaeus lamarcki*) dancing on top of its ball while reading the sky.
Credit: Basil el Jundi / Lund University

Previous research discovered that dung beetles, like other insects, use the light of the Milky Way to navigate. In the new study, however,

researchers show that dung beetles differ from other insects in their use of celestial information. While other insects rely on "an innate prediction of the natural geographical relationship between celestial cues," the study states, dung beetles' "celestial snapshot" gives the creatures an internal representation of the sky.

"In a way, you could say that the dance has a function like a trigger on a camera: At some moment during the dance, this trigger is pushed and a picture of the celestial visual scenery is taken and stored somewhere in the brain," study lead author Basil el Jundi, a researcher in the Department of Biology at Lund University in Sweden, told Live Science.

Close-up of a dung beetle.
Credit: Lund University

This snapshot can include information like the placements of the sun and moon, and the alignment of the stars. Dung beetles, despite their tiny brains, can capture this information, which allows them to travel in straight lines, the researchers said.

Though other animals can use a variety of clues in their navigation — from geographic features to sound waves — it appears that dung beetles rely solely on these snapshots, the scientists said.

"As we knew that many other insects use terrestrial cues for navigation, we extensively tested this in dung beetles over the last years, but they always failed to use these cues — even if the sky was not visible," el Jundi said. "We do not know whether the beetles can use other cues, such as wind signals, but according to our current knowledge, the sky is the only source of visual reference, and the 'celestial snapshot' strategy is the only technique they seem to use."

El Jundi said it is possible that the dung beetle's internal navigation system could be applied to the technology for driverless vehicles.
"The focus of our work is mainly to understand how animals navigate safely through their environment and how the internal compass controls the orientation behavior," el Jundi said. "Our results give us deep insights in to the compass system of an orientating animal and might help to design autonomous vehicles that are able to precisely navigate in a certain direction."

- See more at: http://www.livescience.com/54740-dung-beetles-photograph-sky-to-navigate.html#sthash.9YQ15dJm.dpuf

Insects smarter than we thought, Macquarie University academics say

by Andrew Masterson
April 24, 2016
Sydney Morning Herald

Insects may well experience fear and pain when pesticides hit, research has found. *Photo: Ajay Narendra*

Louie the Fly may have grounds for appeal. For almost 60 years, Mortein's malodorous mascot has been portrayed as a sort of insect psychopath who should be taken out without a thought to stop him from befouling foodstuffs and kitchen benches in otherwise germ-free suburban homes.

A new study from Sydney's Macquarie University, however, raises the possibility that Louie and his six-legged ilk might experience fear and pain when the pesticide cloud descends.

The research, published last week in the Proceedings of the National Academy of Sciences, was conducted by insect neurobiologist Professor Andrew Barron and philosopher Dr Colin Klein. In it, the pair suggest that certain structures in

insect brains function rather like the human midbrain, an area strongly linked to "subjective experience", which the authors identify as "the most basic form of consciousness".

The Louie The Fly character from the Mortein flyspray advertising campaigns. He may have feelings after all. *Photo: Mortein*

Klein and Barron, extending existing research on insect intelligence, contend that insect behaviour "involves multiple layers of filtering of sensory information to support selective attention to stimuli that are salient, and suppression of representation of irrelevant stimuli". In other words, Louie is likely cleverer than previously suspected – and quite possibly capable of suffering.

And that's a bit troubling. You might not want flies in your house, but do you want their agony on your conscience?

"I do have the instinct that flypaper seems more cruel than swatting," Klein says, "even if it's more convenient for us. I think if you're governed by the idea that it's just a fly, or just a bee, so it doesn't matter, then that's probably worth rethinking."

The question of whether insects are conscious – both in the sense of being able to learn and adapt from events, and of having a subjective inner life – has long been a subject of fascination. Although seemingly recondite, the answer carries some very significant implications.

Because it is impossible to know the subjective reality of another species, the question of whether consciousness is unique to humans is unanswerable. Most biologists assume it is present in many animals – mammals, at least, and probably birds – but what about fish, grasshoppers or sea slugs?

"One of the things we're very interested in is in the origins of consciousness, why consciousness might have evolved in the first place," Klein says.

"One of things that's really important about the origin is that it arises from integrating functions – taking together sensory information, the state of the body, memories of where the organism has been – and putting these together into a single point of view that allows navigation in a complicated world.

"And so we think things that are simple, such as bacteria, or don't face those pressures, won't evolve the kind of complicated brains that you need to be conscious."

Which is why, just quietly, a jellyfish will never become prime minister, but cockroaches will always know when you creep into the kitchen at night.

Based on their understanding of insect brain structure, Klein and Barron conclude that far from being a recent evolutionary development, consciousness is very ancient, emerging first in the Cambrian Period, about 500 million years ago.

If, thus, consciousness is widespread through the animal kingdom, ethical questions about how we treat even tiny household pests become a bit more complicated. It's long been recognised that there is a huge moral difference between slaughtering a lamb quickly, and letting it die slowly, even if in both cases the intention is to barbecue its meaty bits.

Does the same distinction thus apply between a cockroach stomped on, and one left to expire over time, fearful and pain-racked by pesticide?

It's a question that up until now hasn't really arisen, even among the most conscientious animal rights activists. Writing in a newspaper in 2013, philosopher Peter Singer tackled the issue of whether killing a fly or mosquito could be considered murder.

"I don't think so," he wrote. "I'm doubtful that insects such as flies and mosquitoes are conscious – that is, that they can feel pain, or enjoy their lives."

The Macquarie findings seem to invalidate that reasoning, although to what extent, Klein happily admits, remains unclear.

"Certainly for Peter Singer, the morally relevant animals are the ones that feel pain," he says. "So in Singer's view, if insects feel pain then they in some sense become part of the moral community which we have to take into account."

One key consideration, he says, is the question of to what degree "primordial emotions" such as fear and pain are experienced by insects. Subjective experience is not the same as self-awareness, he adds, the kind of keen insight enjoyed by humans. There is no suggestion that Louie the Fly is really a closet existentialist.

But what of Louie's cousin, helplessly glued to flypaper, struggling until thirst and exhaustion take their fatal toll? He might be in trauma, but, equally, Klein suggests, he might be simply experiencing "dim confusion".

So has Louie been libelled? Perhaps, but to Klein he is also an indication that his and Barron's conclusions might not be so controversial after all.

"On one hand we really want to resist the tendency to anthropomorphise flies," he says.

"On the other, the fact that people are willing to think of Louie the Fly as having internal mental states and goals and things like that, however seedy, is evidence that they are willing to accept the consciousness hypothesis even in the case of insects."

Read more: http://www.smh.com.au/national/insects-smarter-than-we-thought-macquarie-university-academics-say-20160421-gobkuv.html#ixzz49udifm9V

Hawk moths have a second nose for evaluating flowers

May 2016
Phys.Org

A choice assay revealed that the moth kept its proboscis much longer in the parts of the flower that had a scent. Credit: Alexander Haverkamp / Max Planck Institute for Chemical Ecology

Flowers without scent produce fewer seeds, although they are visited as often by pollinators as are flowers that do emit a scent. Scientists from the Max Planck Institute for Chemical Ecology in Jena, Germany, made this surprising observation, when they studied tobacco plants that have been silenced in their ability to produce floral volatiles. The researchers showed that floral scent is crucial for successful pollination: *Manduca sexta* hawk moths, the most important pollinators of the wild tobacco species *Nicotiana attenuata*, use their proboscis to smell the floral volatiles when they visit flowers. The olfactory neurons involved in the perception of these volatiles have now been discovered to be located on the *Manduca* proboscis. Only when flowers produced volatiles did the moths stay long enough to drink nectar, and only when they stayed long enough did they deliver enough pollen on their proboscis to successfully pollinate other scenting flowers. These results have now been published in the journal eLife (eLife, May 2016, DOI: 10.7554/eLife.15039).

Flowers that don't emit a scent are also visited by hawk moths

Until now, scientists thought that flowers which don't produce floral volatiles are invisible to nocturnal pollinators, such as hawk moths. Such "deceptive flowers" might benefit from neighboring, scenting flowers. Plant fitness studies have confirmed that scenting flowers produce significantly more seeds than do non-scenting flowers. Conducting semi-natural tent experiments with plants of the wild tobacco species *Nicotiana attenuata*, Danny Kessler and Felipe Yon along with their colleagues from the Department of Molecular Ecology were surprised when they observed that non-scenting flowers were visited by tobacco hawk moths (Manduca sexta) as often as were scenting flowers. Yet those without scent had fewer seeds, so the question is why is that the case. What role did the pollinators play, especially with regards to their ability to perceive flower odors? The ecologists asked their colleagues for help: Markus Knaden and Alexander Haverkamp from the Department of Evolutionary Neuroethology, who study odor-guided behavior in insects.

Behavioral assays with tobacco hawk moths

The behavioral scientists had already gained experience in behavioral assays with moths. For this particular research problem they developed a so-called y-maze experiment, a proboscis choice test in which a y-shaped tube system is used as an extension of the flower's corolla. The insect must decide which of the two tube endings it will enter with its tongue, the so-called proboscis (see graphic). One of the endings contained floral volatiles, whereas the other did not. The behavior of the moth was recorded in a wind tunnel experiment. This choice test revealed that the moth's proboscis remained much longer in the part of the "flower" that smelled than in the other part. This result was especially interesting, because the experimental set-up ensured that the antennae, the actual "nose" of the moth, were excluded from the odor source. Knaden explains: "Due to the length of the tongue, the antennae of the moths are quite far away when the moths are inserting it into the flower. Moreover, they are exposed to the wind caused by the flapping wings, which makes it even more difficult to perceive odors emitted by the flower." So how are the moths able to smell the presence of floral volatiles?

A *Manduca sexta* moth visits the flowers of *Nicotiana attenuata*, a wild tobacco species. The nocturnal moths are attracted by floral volatiles, but also visit flowers without scent. Credit: Danny Kessler / Max Planck Institute for Chemical Ecology

Active olfactory receptor genes on the proboscis

Using molecular biology techniques the scientists identified the *Manduca sexta* genes which were active on the proboscis of the moth. Among these activated genes were those of two olfactory receptors: the olfactory co-receptor ORCO and the ionotropic co-receptor IR25a. The ORCO gene was active only on the tip of the proboscis, whereas the IR25a gene was also active in the organ's upper parts. These findings show that the proboscis plays a much more important role in olfaction than previously thought.

When scrutinizing electron microscopic images of the tip of the proboscis, the researchers discovered a sensillum, a sensory hair previously unknown in *Manduca sexta*. "Single Sensillum Recording", a method which measures the response of single sensory hairs to certain odors, revealed that the proboscis sensillum responds to floral volatiles. Apparently, the hawk moth is able to smell floral scent with the tip of its tongue, Haverkamp, one of the first authors of the study, notes this surprising result: "Our study shows that the function of the proboscis is much more complex than was previously thought. Earlier studies indicated that the proboscis of most insects can only detect basic taste categories such as sweet or bitter. Now it is clear that insects can also smell specific chemical compounds with their tongue."

Plants emit floral volatiles to ensure the ecosystem service of their pollinators

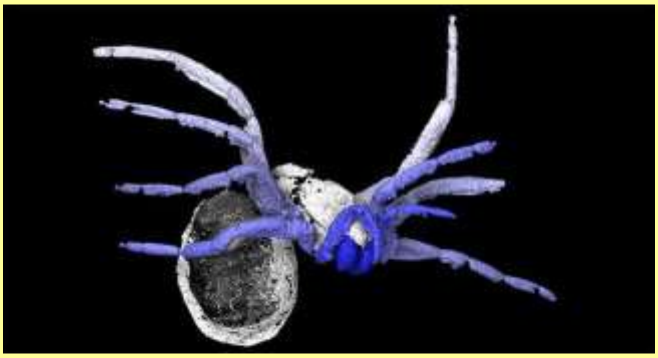
Pollinators, unfortunately, cannot directly perceive how much nectar is available in an individual flower. However, floral scent is an important indicator of the presence of nectar because it provides information about the age and physiological activity of a flower, which is strongly correlated with its nectar production. Hence, moths which correctly locate flower volatiles are also more likely to select flowers which contain enough nectar. On the plant's side, the presence of floral scent increases the fitness of individual flowers for two reasons: Scenting flowers are more likely to be perceived by pollinators than are non-scenting flowers, and floral volatiles increase the success of the hawk moths' foraging efforts and thus its eventual reproduction. Kessler, the leader of the study, summarizes the results this way: "Insects have developed incredible sensory capabilities in order to cope with their environment. Studies on the ecology of flowers have underestimated the capabilities of pollinators for a long time. The evolution of flowers is tightly linked to the evolution of pollinators. By learning more about the postmen of the pollen we learn more about the evolution and the functions of plants floral traits as well."

Explore further: Moths wired two ways to take advantage of floral potluck
More information: Alexander Haverkamp et al, Hawkmoths evaluate scenting flowers with the tip of their proboscis, eLife (2016). DOI: 10.7554/eLife.15039

Fossilised spider relative could make silk, but not spin it

by Phil Ritchie
March 2016
Cosmos

A discovery in a French mine provides insight into the evolution of modern-day spiders. Phil Ritchie reports.



A 3-D rendering of *I. Brasieri*, an ancient relative of modern-day spiders.Credit: R.J. GARWOOD ET AL/PROCEEDINGS OF THE ROYAL SOCIETY B 2016, MUSEUM NATIONAL D'HISTOIRE NATURELLE, PARIS

The discovery of an ancient, tarantula-like creature in a French mine has bridged a gap in spider lineage.

The fossilised creature, which lived 305 million years ago and was published in Proceedings of the Royal Society B: Biological Sciences, is the closest relative of modern-day spiders found so far.

With eight legs, a bloated abdomen and a pair of fangs, it looks a lot like a common spider.

But close examination of *Idmonarchne brasieri* (named in honour of Oxford geologist Martin Brasier who died in 2014) reveals telling differences from modern-day "true" spiders, which are able to spin webs using silk-spinning organ called spinnerets.

Russell Garwood from the University of Manchester and colleagues imaged the ancient creature, which was fossilised in siderite, an iron carbonate mineral, using microtomography – a high-resolution form of CT scanning that doesn't destroy the specimen.

Along with microscope images, the researchers created a 3-D computer model of the fossil. This showed a creature without spinnerets.

They were confident that they didn't snap off prior to fossilisation, as the computer model would have rendered a hole where they once attached.

Spider evolution, the researchers claim, went so: earlier spider-like creatures couldn't produce silk, but sported a pair of spikes protruding from their behind.

They gained the internal machinery to make silk but lost the spikes – which is where *I. brasieri* fits in.

They then grew spinnerets. This is illustrated by another specimen, found in the same area *I. brasieri* was discovered – Montceau-les-Mines – and described in 1996 by Paul Seldon from London's Natural History Museum, and co-author on the current study.

Being able to spin silk, the researchers write, "defines the true spiders, significantly postdates the origins of silk, and may be a key to the group's success".

How can dragonflies help a Balkan country into the European Union?

by Shaun Hurrell
Birdlife International
February 2016

How best to protect the Neretva River Basin, Bosnia & Herzegovina? © D. Kulijer

In Bosnia & Herzegovina, the Society for Biological Research and Protection of Nature are living up to their organisation's name. In a project funded by the Critical Ecosystems Partnership Fund (CEPF), the Society have first conducted a lot of biological research on freshwater biodiversity, and then are using that data to propose protected sites that are very important for nature in the country.

But it is not as simple as that.

Bosnia & Herzegovina – like many countries in the Balkans – whilst being in Europe is not a member of the European Union (EU). So when you're a local Balkan civil society organisation trying to protect nature, your country's political position on the road to EU accession can have a big influence on what protection to aim for.

The Birds and Habitats Directives form the cornerstone of the EU's nature conservation policy. They are built around two pillars: the Natura 2000 Network of protected sites and a strict system of species protection. These are the laws that protect nature in the EU, based on scientific expertise, verified raw data, and have accountability and control over their management.

Sometimes national protection is better on paper, but without proper management, corruption and vested political interests in unsustainable development can get in the way of proper environmental protection. This is all too common in the Balkans. In Bosnia & Herzegovina, Natura 2000 protection is seen as more modern, democratic and has an international element that people seem to respect.

So even though countries like Bosnia & Herzegovina, Montenegro and Albania are not EU members and are years from accession, it can be better for conservationists to propose Natura 2000 sites for the protection of some important areas (e.g. groups of smaller sites that would be too hard to combine into a National Park) because it can ensure immediate designation when the country does become an EU member state.

Field work lays the groundwork for effective site protection. © D. Kulijer

"This project aimed to identify the most important freshwater habitats for the conservation of threatened dragonfly, mollusk and fish species in the Neretva catchment, and to ensure sufficient scientific data for their efficient protection and long-term survival," said Dejan Kulijer from BIO.LOG (the short name for the Society for Biological Research and Protection of Nature). The team have proposed four new Natura 2000 sites, and three of the sites would represent the first designated for threatened dragonfly species *Coenagrion ornatum* and *Cordulegaster heros* in Mediterranean Europe.

Young specimen of *C. heros* found in Studenci © D. Kulijer

"We try to help develop projects to be as effective as possible," says Borut Rubinič, Balkans Programme Officer for the CEPF Med Regional Implementation Team. "We can help grantees' projects include some really useful extras." The protection of areas by proposing Natura 2000 sites, together with tackling the threat of hydropower development and tackling illegal hunting, are key themes for conservation projects in the Balkans.

Based at DOPPS (BirdLife Partner) in Slovenia – an EU state – Borut witnessed the hard graft involved with updating badly-protected Natura 2000 sites because the proposed sites were cut by 20% only three days before Slovenia's accession, due to bad political process. Having the sites nailed down long before accession is a key lesson.

What about helping with EU membership? Dragonfly ambassadors.

For such a small country, Bosnia & Herzegovina supports a large number of dragonflies – over 50 species in all. These flying predators are fantastic ambassadors for freshwater habitat conservation: beautiful animals that rely on clean water in all stages of their life cycles.

Just looking at the top threats to dragonflies in Europe [see below] highlights what great flagships they are for site protection in Balkan states, where fighting hydroelectric dams, pollution and tourism development is a daily struggle for Balkan conservationists.

Having Natura 2000 sites proposed is actually a pre-requisite for a country to become accepted into the EU! So the dragonflies in this study are helping Bosnia & Herzegovina tick 'Chapter 27' in the environmental protection section of EU accession.

All species matter in the Neretva River Basin. The Neretva River and its large tributaries create some of the most valuable remnants of Mediterranean wetlands on the eastern Adriatic coast, and is one of the few areas of this kind remaining in Europe.

"Of well-known importance for birds, the significance of these freshwater habitats for many other species, particularly invertebrates, is poorly recognised and largely unknown," said Dejan. Having reliable data on threatened species is also a valuable contribution against impending dam threats too. The project also discovered that Neretva Softmouth Trout – an endemic fish species – has a significantly reduced distribution in the Neretva basin due to dam and reservoir construction.

Balkan rivers: beauty worth protecting © D. Kulijer

The project also involved the participation of biodiversity experts from Bosnia and Herzegovina, Croatia and Slovenia, such as the Slovenian Odonatoligical Society (SOD).

This is good for biological scientific collaboration, but also in helping to implement this research so it is most politically valuable.

"The perfect combination for site protection would be both through Natura 2000 and a national level with expert monitors, rangers, ecotourism infrastructure, and good management!" says Borut.

"If you don't have the national protection too, then you need a good network of civil society to go there, monitor and manage on behalf of government. This is why CEPF's long-term vision for the Balkans that invests in civil society is so important."

BIO.LOG want to set up a formal monitoring programme and network of researchers to gather future dragonfly data and improve the protection of their habitats now, and onwards into the EU.

Around the Societies

Butterflies and Other Invertebrates Club

An excursion to Pooh Corner, Wacol
Take a walk through this interesting reserve which has open forest and a range of interesting host plants. It has been reported that there is a resident Platypus in a waterhole along Sandy Creek.
When: Saturday 16th July 2016 from 10 am
Where: Meet at the Pooh Corner Environmental Centre. The Centre is on the southern side of Wolston Road, which runs between Wacol Station Road and Spine Street, Sumner Park. It has a car park, public toilets, a picnic area and electric barbeques.
What to bring: Hat, walking shoes, camera, lunch.
RSVP: Register with Paul Klicin (0411 031 406)

Management Committee planning meeting
When? August 6th 2016 from 10 am
Where? West Mount Cotton

An excursion to environmental areas at Mount Cotton. Visit local bushland reserves.
When: Saturday 6th August 2016 from 12 noon.
Where: Meet at 612 West Mt Cotton Road, Mt Cotton.
What to bring: Hat, walking shoes, camera, lunch
RSVP: Register with Paul Klicin (0411 031 406).

Butterfly Conservation South Australia

2106 Annual General Meeting
When: Tuesday 2 August 2016, 6.30pm

Where: Clarence Room, Clarence Park Community Centre, 72-74 East Avenue, Black Forest, SA

Entomological Society of Queensland

Notes and Exhibits meeting
Edge effects on insects within urban fragmented eucalypt forests, presentation by Marisa Stone, 2016 ESQ Student Award winner from Griffith University;
Biological control of Parthenium weed in Southern Queensland and Southeast Queensland;
Update on the progress of the leaf-mining jewel beetle *Hedwigiella (Hylaeogena) jureceki*, a new biological control for Cat's Claw Creeper (*Macfadyena unguis-cati*)
When: Tuesday June 14 2016, 1.00pm
Where: Ground Floor Seminar Room, Ecosciences Precinct, Boggo Road, Dutton Park, Qld.
More information: www.esq.org.au/events.html

Society for Insect Studies

August meeting
Peacock Spiders, by Jurgen Otto
When: Tuesday June 14 2016, 7.30pm
Where: Australian Museum, 1 William St, Sydney, NSW
More information: Helen Smith (0448 560 255) or Graham Owen (0418 971 458)

SFIS Photographic Competition 2016
Entries will be open from the June meeting, closing at the October meeting (11 October 2016). All entries displayed at the Christmas meeting on 8 December 2016, and announce the winners.
An entry form accompanies the SFIS Circular or contact the Secretary for an additional form. Any current member of the SFIS is eligible to enter. Entries must be submitted at or before the October Members meeting.

Winter excursion
Walk with cameras, Royal Botanic Gardens, Sydney
When: Saturday 23 July 2016, 11.00am
Where: Meet at the Morshead Fountain Gate near the State Library.

June meeting
Coleoptera night. Bring some photos, give a 5-minute talk, bring some specimens. Beetles galore!
When: Tuesday August 9 2016, 7.30pm
Where: Australian Museum, 1 William St, Sydney, NSW
More information: Helen Smith (0448 560 255) or Graham Owen (0418 971 458)

Conferences

Australian Entomological Society 47th AGM and Scientific Conference and Entomological Society of New Zealand – 2016 Conference
Theme: "Understanding and managing insects for our mutual benefit."
Where: Rydges on Swanston St, Melbourne
When: Sunday 27th to Wednesday 30th November, 2016.
Our exciting scientific program will explore themes of insect and human interactions and understanding and managing the environment and landscapes for our future co-existence and mutual benefits. Symposia themes are to be announced but will cover aspects of insects and human health, agriculture, conservation, insect-plant interactions, biosecurity, biodiversity, systematics, evolution and biogeography.
The conference logo is of the clerid beetle, *Lemidia frenchi* Lea (Cleridae) which was named after the first State Government appointed Entomologist of Victoria, Charles French (1842 – 1933) and the beetle is only known to occur in Victoria.
Website: http://www.aesconferences.com.au/

XXV International Congress of Entomology
Where: Orlando, Florida, USA
When: 25-30 September, 2016
Entomology without Borders
Over 300 symposia were submitted from around the world to be considered for the ICE 2016 program, and they are currently being reviewed by the ICE Section Co-conveners. Watch for announcements of final symposia selections to be made next month.
Website: http://ice2016orlando.org/

International Symposium on the Ecology of Aphidophaga 13
The purpose of Aphidophaga conferences is to provide an international forum for the

presentation and discussion of research on the biology, ecology and behaviour of organisms contributing to mortality of aphids (Hemiptera: Aphididae).
Where: Freising, Germany
When: 29 August to 2 September 2016
Registration from 15 February 2016
Website: http://aphidophaga.de/

WAAVP 2017 Conference
The 26th International Conference of the World Association for the Advancement of Veterinary Parasitology (WAAVP 2017).
The Conference Theme is: Combating Zoonoses: Strength in East – West Partnerships.
When: 4-8 September 2017
Where: Kuala Lumpur Convention Centre, Kuala Lumpur, Malaysia
Website: www.waavp2017kl.org

ESV Calendar 2016

Tuesday 21 June 2016
Martin Lagerwey, Leaf Beetles (Chrysomelidae)
Nick Monaghan, Life Unseen

Tuesday 19 July, 2016
Council meeting, Melbourne Museum

Tuesday 16 August 2016
Mid-year excursion

Tuesday 20 September, 2016
Council meeting, Melbourne Museum

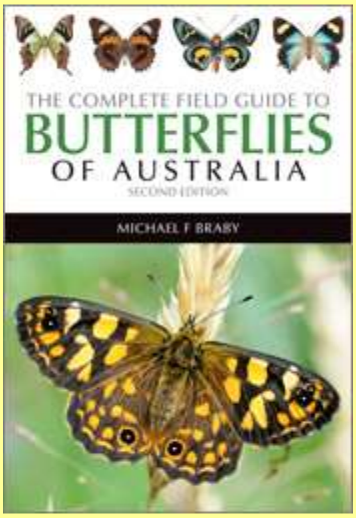
Tuesday 18 October
Members' Night

Tuesday 15 November, 2016
Council meeting, Melbourne Museum

December 2016
Christmas excursion – Braeside Metropolitan Park

New publications

The following publications will all be reviewed in upcoming editions of the *Victorian Entomologist.*

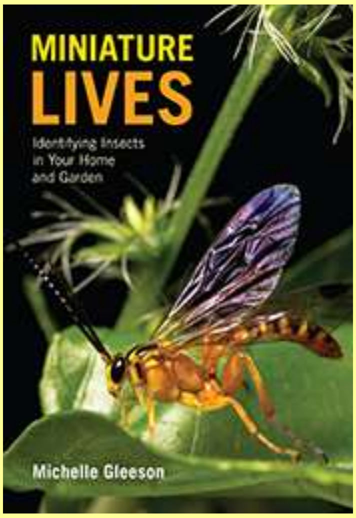


By Michael Braby
Maps, Colour plates, Colour photographs, Illustrations
400 pages
CSIRO Publishing
ISBN: 9781486301003
$ 49.95

As fascinating as they are beautiful, butterflies are a pleasure to watch and an important group of invertebrates to study. This second edition of the award-winning book The Complete Field Guide to Butterflies of Australia is a fully updated guide to all butterfly species on Australia's mainland and remote islands.

Written by one of Australia's leading lepidopterists, the book is stunningly illustrated with colour photographs, many of which are new, of each of the 435 currently recognised species. There is also a distribution map and flight chart for each species on the Australian mainland, together with information on similar species, variation, behaviour, habitat, status and larval food plants.

The introduction to the book covers adult structure, higher classification, distribution and habitats, as well as life cycle and behaviour. A new chapter on collecting and preserving butterflies is included. There is also an updated checklist of all species, a glossary, a bibliography and indexes of common and scientific names.

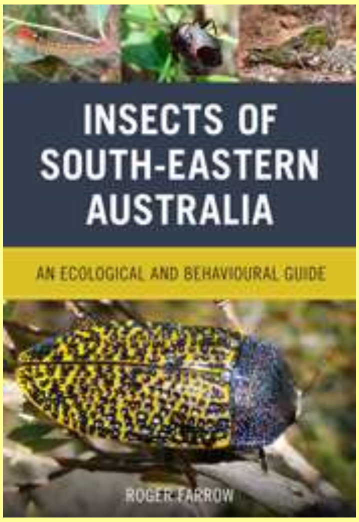


By Michelle Gleeson
Colour photographs, Illustrations
344 pages
CSIRO Publishing
ISBN: 9781486301379
$ 39.95

We can't avoid insects. They scurry past us in the kitchen, pop up in our gardens, or are presented to us in jars by inquisitive children. Despite encountering them on a daily basis, most people don't know an aphid from an antlion, and identifying an insect using field guides or internet searches can be daunting.

Miniature Lives provides a range of simple strategies that people can use to identify and learn more about the insects in their homes and gardens. Featuring a step-by-step, illustrated identification key and detailed illustrations and colour photographs, the book guides the reader through the basics of entomology (the study of insects). Simple explanations, amusing analogies and quirky facts describe where insects live, how they grow and protect themselves, the clues they leave behind and their status as friend or foe in a way that is both interesting and easy to understand.

Gardeners, nature lovers, students, teachers, and parents and grandparents of bug-crazed kids will love this comprehensive guide to the marvellous diversity of insects that surrounds us and the miniature lives they lead.



By Roger Farrow
Colour photographs
288 pages
CSIRO Publishing
ISBN: 9781486304745
$ 45.00

A walk in the bush reveals insects visiting flowers, patrolling the air, burrowing under bark and even biting your skin. Every insect has characteristic feeding preferences and behaviours.

Insects of South-Eastern Australia is a unique field guide that uses host plants and behavioural attributes as the starting point for identifying insects.

Richly illustrated with colour photographs, the different species of insects found in Australia's temperate south-east, including plant feeders, predators, parasites and decomposers, are presented.

The guide is complemented by an introduction to the insects of the region, including their environment, classification, life history, feeding strategies and behaviour. Fascinating boxes on camouflage, mimicry and many other topics are also included throughout.

Whether you are a field naturalist, entomologist or just want to know what's in your backyard, Insects of South-Eastern Australia will help you to identify the insects most likely to be encountered, as well as understand the basics of their ecology and behaviour.

By Marilyn Hewish, Peter Marriott, Ted Edwards, Axel Kallies, Stephen Williams and Catherine Byrne
Colour photographs
36 pages, includes CD ROM
Published by the Entomological Society of Victoria
ISBN: ISBN-13: 9780980580273
$12 (members' price) + $4.00 postage
Order at: http://entsocvic.org.au/wp-content/uploads/2016/02/OrderFormMov7.pdf

Number 7 in the Moths of Victoria series, this book covers more than 100 species of 'Bark Moths' in the tribes Lithinini, Caberini, Macariini and Boarmiini within the subfamily Ennominae (Geometridae), as well as unassigned species, and the one Uraniid species that has been recorded in the state. Because of the size of the family, it is the first of four books on Victorian Geometridae.

The book is easy to use and includes 850 images of living and set specimens, as well as selected caterpillar photos. The included CD provides more than 250 additional pages of information in PDF format, including adults of both sexes and distribution maps.

Moths of Victoria is a 10-12 part series that aims to cover the more than 2,000 species of moths found across the state.

Contributions to the ESV Newsletter and Bulletin are always welcome.
Contact: Patrick Honan president@entsocvic.org.au

www.entsocvic.org.au

By John T. Moss and Ross Kendall
134 pages
Colour illustrations
Published by Butterfly and Other Invertebrates Club
$30 ($25 for BOIC members)
ISBN 9780975233542

It is intended that The Mistletoes of Subtropical Queensland, New South Wales and Victoria be used as both a reference and a field guide. It provides a detailed introduction to mistletoes and their biology and deals with all 46 species known to occur in Subtropical Queensland, New South Wales and Victoria. Each species is illustrated by colour images supported by detailed plant descriptions, information on habitat and host plants. It also provides details of the 24 butterfly and 3 moth species that use various mistletoes as hosts.

STOP PRESS

Congratulations to Professor Doug Hilton, Director of the Walter and Eliza Hall Institute of Medical Research and ESV member. In this year's Queen's Birthday Honours, Doug received the Officer in the General Division of the Order of Australia for distinguished service to medical research and education as a molecular biologist and author, and as a mentor of young scientists. You may also know Doug as an enthusiastic lepidopterist, amongst many achievements his discovery of the self-described enigmatic moth family Aenigimatineidae on Kangaroo Island and its contribution to the understanding of Lepidoptera evolution.
Congratulations to Doug for this magnificent achievement on behalf of the Entomological Society of Victoria.