Chapter 1

Of light and scale – Lepidoptera (the moths and butterflies)

The phrase 'like moths to a flame' is one we all understand. Most of us have experienced insects buzzing around lights in the garden or can remember those summer evenings when moths and other insects bounce up against our lighted windows, colliding against the glass in a desperate dance to get inside, a dance that can either delight or dismay those indoors. Streetlamps will also attract flying insects on warm spring and summer evenings, a cloud of tiny specks that whirl in and out of the pools of light that hang high above our streets, a flight of tiny wings lost in the glare of our modern technology. But why does this happen, and what draws all those insects to the bright lights of human habitation? The answer is that we are not really sure.

There have been several theories, but none of them have been proven. One was that moths navigate by flying at a constant angle to the moon. As the moon is a long way off when moths do this, the moth would fly in a straight line. The advent of campfires, candles, then gas lighting and finally electric light offered many choices of bright lights to lock onto and the moths were confused. Flying at a constant angle to a nearby light means the moth would fly in an ever-decreasing circle. However, no one has ever clearly demonstrated that this is the case.

Another idea was that the chemicals that female moths emit to attract males (pheromones) reflect infrared light, so maybe artificial lights were generating just this frequency and fooling male moths

into chasing after phantom females. But male and female moths are equally attracted to artificial light, so that idea was thrown out. What we do know is that the light sources that emit light in the ultraviolet (UV) range of the spectra attract more moths, and the smaller and brighter the light source the greater the attraction. This is of course modified by several factors, such as temperature (most insects need warm nights to be able to fly), time of year (if a moth is in its larval stage it can't fly at all) and the phase of the moon (if the moon is bright, attraction to artificial lights is reduced). The reasons for these behaviours remain a mystery.

Relying on lighted windows and streetlights is one way to hunt for and collect moths, but entomologists who study them nowadays tend to use a device known as a light trap. These utilise the fact that very small bright lights that emit UV light attract large numbers of moths. For this reason, small but bright lights are mounted over a large collecting container that allows the moths to fall in and be retained. These traps are amazing; place one anywhere in the English countryside and a vast array of flying insects will loom out of the surrounding darkness, queuing up to get to the light. I have spent many nights sitting on the ground next to such a light trap watching as moth after moth spiralled out of the darkness into the intense circle of light that surrounds the trap. It is not just moths that appear but also parasitic wasps, caddis flies, true flies and beetles, to name but a few groups that are attracted.

I can still remember the first time I set up one. My friend and then colleague Nick Greatorex-Davies, a veteran moth trapper, introduced me to this almost secretive experience. We loaded up the car at dusk with a generator, light trap, collecting containers, torches, coffee and biscuits, and drove into the fading day to the quiet of a local woodland. We unpacked the equipment in complete stillness, the woodlands dampening any sound that we made – silence drifting out of the shadows. The dark silhouettes of the canopy vanished as the night crept in on our yellow circles of torchlight. We sat on the grass, the steam from our coffee rising into the night sky.

Robinson moth trap

That first time the trap we used was the deluxe version known as a Robinson trap. This is a circular container, about the diameter of a dustbin but just eight inches high; it has a mercury vapour streetlamp bulb set in the centre, a transparent plastic lid and a mass of empty egg boxes inside. These provide lots of small spaces for the insects to crawl into once they enter the trap. The mercury vapour lamp produces a cold, intense bluish light as it gives off some UV, as well as light in the visible spectrum.

We sat in this circle of icy incandescence, the darkness pressing in around us while we drank our coffee and waited for our quarry. It was not long after the light had sprung into life that the first moth passed through our bright clearing and, as if caught in some tractor beam, it turned and spiralled in towards the trap. Over that first night, insects came pouring out of the darkness. It is not just the diversity or beauty of these insects that impresses the first-time trapper. The names are the very epitome of British eccentricity, a lexicon of strange elegance. After just one night a host of exotic

names were lodged in my memory: the heart and dart, silver Y, large yellow underwing, the sword grass, dusky thorn and burnished brass. Names to conjure with, names that had come fluttering out of the woodland darkness into our oasis of light. Names that are part of the folklore of the nocturnal landscape. Names that are part of the romance of English natural history.

The numbers of insects involved can be overpowering; I have counted over five hundred moths after just one night from a light trap that I ran in my garden in Cornwall. This was not a deluxe version, just a 100 W bulb over a Tupperware cake box filled, of course, with the obligatory egg boxes. Setting my home-made trap became a weekly ritual; plugging it in on Saturday night and emptying it on Sunday morning; identifying and counting the catch before lunch and retaining a specimen of any new species to speed up identification on future occasions. I never ceased to be excited at the prospect of what those dawn walks to empty the trap might have in store.

The local sparrows also came to anticipate this activity and would line up along my guttering at dawn waiting for me to open the trap. I would sit outside my back door with a mug of tea and watch them come. There was always half a dozen already in post, but once I began to walk down the garden, more would drop onto the end of the line, black blobs falling out of a brightening sky. They jostled for position emitting the occasional call. The trap was set on the roof of my garden shed. As I lifted it down, there were always a few insects that made a break for freedom, and as soon as I opened the trap, a few more would slip out into the cold morning air. They would fly low across the garden, a rapid zigzag flight in search of cover. A frantic dash just a few inches off the ground. The squadron of sparrows was poised for action, and at the first sight of an escaping insect one would peel off the roof and swoop after its prospective breakfast. This resulted in a frantic dogfight as insect and bird swerved and spiralled across the vegetable patches towards the hedge. The sparrows came out on top, most times.

The Polytechnic's ecology field trip to the Lake District was based at the wonderful Blencathra centre at Threlkeld, just outside of Keswick. The centre was situated on the lower slopes of the mountain Blencathra and provided amazing views of the Vale of St John and Derwent Water. One of the students' tasks on this trip was to use light traps to estimate the diversity of local moth populations at different altitudes. We used portable traps powered by 12 V car batteries, so for those sites close to a road it was no problem to drop off the gear close by, a short walk to where the traps would be run. One site was a field at the foot of the mountain, another was at the centre, but the unlucky group of students who drew the short straw for the high-altitude trap had to carry their battery and trap 500 metres up the mountain with only sheep paths to navigate by. The catch in these traps was always a revelation to the students when they emptied them just after dawn. The colours and variety of wing patterns never failed to impress. From the soft, downy white ermine that almost invites one to stroke it to the amazing camouflage of the buff tip that looks for all the world like a snapped birch twig. From the black and red of the cinnabar moth to the sleek lines of hawk moths. Breakfast was always accompanied by a line of pots containing the moths that the students were not sure of. Most were no problem to identify, but there were always a couple that required a closer look, and Ken, Mick and I would huddle round the moth field guide trying to extract a name from its pages. Each day the night's catch would be released into bushes around the centre before we took the students out into the field.

The panoramic window in the hostel lounge was wonderful; it provided not only views to impress by day but also a nocturnal spectacle each evening. Once night had fallen, the lights in the lounge attracted many flying insects to this huge pane of glass; moths, beetles and flies would dance on the window a fluttering ballet, dropping in and out of the shadows. The students sat transfixed, but this intense interest in the window display was not restricted to our students. Pipistrelle bats would swoop out of the

darkness, hover a centimetre in front of the window while snatching an insect from the glass with their delicate jaws and then peel away into the night. Precision, speed and some dazzling aeronautics, which contrasted dramatically with the uncoordinated flights of the moths mesmerised by our lighted window.

Light traps always impress and nowhere more so than in the tropics. I have wonderful memories of the light trap at Danum Valley Field Centre in Borneo run by the Royal Society. Here there was no pretence at using specially designed equipment to attract insects, just a streetlamp shone onto a white sheet hung by the river. Thousands of insects arrived within the first hour. Local preying mantids took the place of my Cornish sparrows and flew in to take advantage of the banquet; they lined up along the top of the sheet to pick off a meal as a large range of insects was drawn to the light – moths, crickets, assassin bugs, wasps, thousands of small flies. In fact, if you walked between the lamp and the sheet, the cloud of flies would block your nose and send you reeling and coughing into the shadows.

It was at this light trap that I had the unusual experience of being knocked down by an insect. Rhinoceros beetles are substantial insects and, once they gather speed, possess considerable momentum; they are also clumsy fliers and usually stay close to the ground after dark. I was in a half squat with my knees bent trying to photograph the mantids at their dinner when a stray, incoming rhinoceros beetle collided with the back of my knee pushing it out from under me. Beetle and human crashed to the ground, to the great amusement of the assembled company. Humiliation indeed, the entomologist brought down by the object of his desire.

The insects captured in a trap can be literally overwhelming, giving just a hint of the enormous number of species that live in the fields, hedgerows and woods around us. I recall a night that Nick and I spent light trapping in a south Devon wood, intercepting moths as

The light trap at Danum valley, Borneo.

they came to our light and identifying them on the spot. We trapped from 11pm to dawn, which was about 6am, compiling a long list of moth species for the local Wildlife Trust. Then at dawn we decided to open the trap to see what had slipped past us. We took the trap inside our two-man tent to minimise the number of escapees. We zipped up the door of the tent and gently lifted the lid of the trap to peer inside. We could see one or two moths, and the egg boxes appeared quiet, so we thought it was safe to completely remove the lid. Then, just as we had done so, we knocked the base; it was only a gentle tap, but the effect was amazing. The trap erupted, a volcano of moths, beetles, wasps and flies swept past us, filling the air with a blurred mist of whirring wings. I could not see across the tent for insects. There were hundreds, some settling quickly, landing on us producing a coat of many shapes, sizes and colours. Most continued flying, desperately trying to escape the confines of our tent. We looked at each other, clothed in a blanket of insects, and burst out laughing.

Unzipping the tent, we stumbled into the dawn air, a 'smoke' of insects rising from our jackets. Coughing between our continued laughter, we battled to clear the clouds of shed wing scales that had caught in our throats. The liberated moths cascaded into the morning air, a storm of wings vanishing back into the woodland.

Scales and colour

The Lepidoptera, the order of moths and butterflies, is one of the few groups of insects that have scales on their flight wings (some of the weevils have scales on their wing covers, known as elytra). They are thought to be modified hairs that have evolved as a defence against spiders. If a moth gets stuck to a spider's web by a wing covered in scales, it can pull itself free, losing a few scales in the process but living 'to tell the tale' … so to speak. A neat trick, I hear you say, but the spiders are already on the case. The web built by some tropical orb web spiders (family Nephilidae and Araneidae) has a normal top half, but the bottom section is stretched downwards for up to a metre, in some cases forming a ladder-like structure. So, when a moth collides with it, it rolls downward shedding some scales and expecting to fall off the bottom, but the web keeps on going until the moth has lost all its scales, thereby ending up as a victim for the spider. That's the evolutionary arms race for you.

Scales give moths and butterflies their brilliant colours; thousands of tiny dots of colour (like the pixels on your digital camera screen) make up the patterns that we know and love. These patterns are used to camouflage the insect, act as warnings or send signals to potential mates. Butterflies often possess dull undersides and brilliant upper surfaces, so they can hide with their wings up and send coloured flashes to members of the opposite sex when they open and close their wings. Other patterns, such as large eyespots, are defensive; a quick flash of these eyes may persuade a predator to back off.

Light trapping can also take you to places you would not normally go. I was invited to join Adrian Spalding on a hunt for a rare moth,

the orange underwing, which feeds on oak leaves and is therefore found in oak woodlands. Adrian, an experienced moth trapper, was the director of the Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS). He had been looking for this moth in Cornwall but failed to find it, so he wanted to see if it could be found in the tiny fragment of ancient oak woodland on High Dartmoor known as Wistman's Wood. This isolation has made it a likely location for this rare moth. The wood is truly fantastic, with its twisted trunks and boughs climbing from between great, moss-capped granite boulders. The trees themselves drip with pendulous beards of lichens and are decked with an assortment of ferns. The effect is Tolkienesque, a magical forest that triggers the imagination. Its remote location and mysterious atmosphere have made it famous as a site with an occult connection, and locals tell many tales of mysterious goings-on.

We arranged to meet on an August evening in Princetown just before dusk. After loading the gear into Adrian's Land Rover, we drove across the boulder-strewn moor to the wood, weaving an erratic course between the granite rocks and the occasional sheep. The light trap was quickly set up and we waited for our elusive quarry. It may have been August, but by midnight the temperature had plummeted and we clutched our coffee flasks for warmth. At one o'clock some friends joined us looming out of the night bearing fresh supplies of coffee and biscuits. Still no sign of our elusive moth. Plenty of common species, but the prize remained at large.

August was also a good time to see shooting stars, and by walking a short distance from the trap, the wide empty Dartmoor sky became a black mantle scattered with luminous dust across which bright lines were drawn again and again. An ephemeral script etched by fragments from beyond our world. A script occasionally punctuated by the laborious passage of a satellite. We stayed until three in the morning, and while we recorded a large number of moths, the orange underwing failed to drop by. Driving to the wood had been fun, driving back using just the headlights of the Land Rover became a

test of nerve and stamina as we negotiated the labyrinth of rocks and gullies that now stood between us and the road. The simple drive of a few hours ago became a slow progression of backtracks and cautious advances. We eventually got out and guided the vehicle back to the road, torches and flailing arms paving the way. The cold seemed to have seeped into my very bones as I drove home; the heater was on full blast, and I was eagerly anticipating a warm duvet and sleep only to find that the moorland cattle and sheep felt the same way and had gathered on the road where the tarmac was still warm from the day. The journey slowed to a crawl as I wove between the dozing livestock that were now more than comfortable on the winding road. Flashing my lights to clear a path, I drove a laborious slalom around reluctant cattle and sheep as I crept homeward.

I should say at this point that light traps can have a downside as they can be misinterpreted. On one occasion in Cornwall I was light trapping with Nick again. We were setting up the trap at the edge of a wood, not far from the old farmhouse I was renting in the Seaton valley. This was a magical house with an enormous dining room and a huge open fireplace in which we burnt driftwood collected from the local beach. The owners had given us *carte blanche* to roam their land and the go-ahead to collect insects. Nick and I found ourselves struggling down overgrown paths with the trap and generator, then setting up on the valley side as dusk fell, the fading light retreating gracefully down the valley to the grey beach at Seaton. We sat drinking coffee as darkness stole out of the woods and swept away the landscape leaving us isolated in our pool of torchlight.

Time to fire up the generator – a few pulls on the rip cord and it purred into life. The mercury vapour bulb in the Robinson trap flickered and a dull incandescence appeared, slowly brightening into a brilliant blue sun that blazed from our trap. It was too bright to look at and can damage your eyes if you do so for long periods. Our cocoon of light stabilised and soon moths, beetles and other insects

were flying into the trap. As the night progressed, we walked around the trap, net in hand, catching, recording and storing specimens that warranted further investigation. Nick showed me several moths I had not seen before, and we quickly built up a list of moths for this area. Time slipped by and at midnight we stopped for coffee. We sat outside the circle of light looking down into the valley. House lights were still burning across the valley and the occasional car headlamps traced the road that threaded between them. A sudden burst of activity caught our attention as the blue flashing lights of two police cars drew up outside of one of the houses. We looked at each other: this was bad news for someone, we thought. A few moments later both cars moved off, the valley was still again, so maybe the incident was not that bad after all. The house lights still burned but the road was quiet.

Back to the catch. The incoming stream of insects had fallen to a trickle of species we had already recorded, so we adjourned to a bank just outside of the pool of light and waited. There was a sound behind us. I turned expecting to see a badger or fox, but instead two policemen were walking out of the darkness. We stood up, somewhat puzzled, and duly offered a greeting while they looked us over. One turned and spoke quietly into the darkness. My landlord and a group of farm workers stepped forward, shotguns and stick laid across their arms. I sensed that all was not well! "What the bloody hell is going on?" my landlord asked in an aggressive manner. Apparently, the people in the house across the valley had reported a witches coven in full session, so the local community had turned out in force to deal with it. We managed to calm everyone down and avoid the ducking stool, and to my surprise, I continued to live at the farmhouse for another year.