The Galapagos

The method of research into animals living on the Galapagos

Screen ident: ANIMAL PHYSIOLOGY

David Robinson
We're in the Pacific about 1,000 kilometres west of South America, on the Equator. Martin Wikelski, is heading for his research site. It's an island called Santa Fe, part of the Galapagos Archipelago.

Screen ident: Galapagos: Research in the field

David Robinson
Santa Fe like all the Galapagos Islands, is the tip of a volcano that became land only a few million years ago.

Many of the animals and plants that now live there, are found nowhere else on earth.

These island species have long fascinated biologists interested in evolution. But this is also a good place for animal physiologists to study. Like all animals found in isolated oceanic island groups, the species found in Galapagos are astonishingly unafraid of people because of the absence of predators.

And even on an inhabited island, on a hotel patio, marine iguanas, a Galapagos species lounge in the shade of the chairs. With few natural predators, they don't see people as a threat. They're easy to observe and study and a source of fascination.

Martin's work is on the marine iguana. He's going to Santa Fe, because it's home to more than 10% of the world's population of these animals.

And here they're undisturbed by humans. If you study the animals here, you're as close to understanding them as you can get. This is the nitty gritty of research.

What we can read in textbooks is knowledge, won from situations like this.

There's actually an easier way on to the island. There's a beach but its 4 kilometres away and that would mean carrying all the equipment to the research site so the researchers prefer the quick route.

Most of the islands in the Galapagos archipelago are uninhabited. In fact you need permission to land on them. Everywhere the human species goes, it affects the environment. This is one of the few remaining places on the planet where human influence and access is being tightly controlled. It took Martin months to secure permission to work here. More people have been up Mount Everest than have been allowed to come to this place.

This will be the group's laboratory, eating and sleeping quarters. Everything needed for the three months stay on the island, has to be brought with them and it's a condition of their permission that everything is taken away at the end. So now they're here, what are they going to do?

First catch your animal. The iguanas don't fear him, but are slightly wary. Staying beyond arms length again this remarkable lack of fear of humans. It doesn't like being handled but it

is astonishingly passive. The basic data first, body temperature obtained by putting a thermometer into the chloical pouch, which all reptile species, males and females have.

Martin
Its thirty point zero.

David Robinson
For a cold blooded animal the temperate may seem high, close to a malient blood heat but it has spent most of the day soaking up the sun. Next, length and weight. These are basic pieces of information but are crucial in understanding how this creature lives.

That's two kilos and a hundred grams. And for the next three months, this animal is one of the sample that are going to be intensively scrutinised. So it needs to be picked out from the crowd on the rocks. Each animal is given a distinctive mark and number.

The range of species found here and here alone makes these islands an endless source of fascination for biologists. Santa Cruz the main inhabited island in the archipelago is home to most of the scientific work. But at the Charles Darwin research station, a study is underway which relies as much on the geographical position of the Galapagos on the equator, as the species itself, the giant tortoise.

Beatrix Schramm collects environmental information. First thing every morning she measures temperature, humidity and takes a reading of light intensity. She's interested in the mating behaviour of the tortoises, and is trying to find out what triggers it. As the Galapagos are on the Equator, the length of day doesn't change all year round so what is triggering the mating behaviour? Beatrix is looking for measurable signs of sexual activity. For the physiologist, the starting point is sex hormones, which can be found in the urine. Collecting urine from the 70-kilogram tortoise is a bit of a problem. So she gets them from the next best thing. Fresh faeces.

Beatrix Schramm
Yes this faecal samples I'm not from where and this other one there to, I am not sure from whom it is because as you see this tortoise is just running away now and because they are so fast it could also be from another one. This morning, I don't know who else stayed here
So this will be a little bit older because it's not so humid anymore. This perhaps, yes, a little bit older, like one hour or something like that. You can check this. If there is lots of humidity, they just made it and that's why I have to run. If I see a tortoise, and she's sitting somewhere and she also saw me, they start running so I have to run too, to look at which direction from which direction she was coming. And when I just saw 'Ah yes, she is running exactly away from this faecal sample which I could see now and she's just like half a metre away, I know this is from her, but the best way is always that you can see the animal sitting exactly on the top of the faecal sample, that you can see where the tail is. There is some faeces and you can collect it. That's the best.

David Robinson
The animals produce the faeces first thing in the morning and she needs it fresh. They know she's around. So it's a bit of a game of hide and seek. Even when the animals are secure in a rock walled compound, finding them can be tricky. Tortoises can be extremely quick and are very shy. To us a sample of the faeces in her research, she has to be absolutely sure that it has come from the tortoise she has spotted.

Beatrix Schramm
See there is one. There is one.

David Robinson
And the sample really must be fresh. Any delay and the hormones in the faeces are degraded very quickly, in the heat.

Beatrix Schramm

I know where exactly where she's sitting so if she's running away, when we are coming I know that this is the faeces of her. The very fresh one. I have to collect that.

David Robinson
Success. The next job is to stabilise it, before any changes take place. In a nearby lab she teases out a four-gram sample of the material and suspends it in alcohol. The sample is now ready for analysis, which although the station has sophisticated facilities, compared to Martin Wikelski's iguana research set up in Santa Fe. We're still over a thousand kilometres from the nearest equipment capable of analysing for the testosterone and oestrogen at the extremely low concentrations found in faecal samples so the samples are chilled and stored for later analysis.

The tell sale signs of the volcanic origins of Santa Fe are littered all around. For most of the year the island is parched, desert like. Three months can seem a long time in this sort of environment. It's the sort of research you need to pace yourself for. The marine iguana is something of a curiosity. It's the only iguana in the world that lives by and in the sea. And it's only found on the Galapagos archipelago.

Iguanas probably arrived on these remote islands on rafts of vegetation and adapted to the local conditions. Some, like the land iguana on Santa Fe, adapted to eating the cactus pads. The marine iguana has adapted to eating the seaweeds on the rocks close to the shore but foraging for this food has caused them a number of problems. As they are cold blooded, and the sea is cold, they must warm up in the sun before going down to the sea to graze on the algae. The chilling effect of the sea means they must rest up for the day, warming up, passively digesting their food, with the males indulging in the occasion bit of territorial skirmishing, or having ticks picked off them by a ground finch. Until the next foraging excursion, the chilling effect of the sea is apparent in the effort that they have to make to get back onto the land. After a long excursion, holding on to the rough lava blocks and climbing to safety, is visibly draining. But how draining? What is the measurably impact on the animal?

With a simple strain gauge, the animal is pulled off the rock. Correlate this against its weight, and body temperature at the time of the experiment and you have an index of stamina.

Martin Wikelski
That's five kilos exactly.

David Robinson
But there's one problem with this experiment. If all the iguanas he can catch are hot from basking in the sun, how can he measure one as if it's just come out of the sea? Improvise. A nearby tidal pool, used a playground by sea lions, is a convenient place to bring the iguana down to a low temperature. But you have to shift the residents for a while. Another index is speed. Time trials for iguanas. They take significantly longer periods to run the course when they are colder. It's as good an index of performance as you need. What's more the experiment is conducted so close to where the animals live, the disruption to their lives, always a problem in the experiments on animals, is minimised.

Beatrix Schramm
I will put this here if you can drop off there…okay.

Beatrix needs a check on whether the sex hormones collected from the faeces are a reliable indicator. She periodically takes a blood sample from her tortoises. This week it is the turn of a large male, called 'Chico', a procedure which I am lucky enough to help with.

Beatrix Schramm
Sometimes we have to change the arm because it's the same with us. Some veins are good on one side and some are very bad so we try the other side. So you can see here this part, and these line going from there to this tendon. Here is a tendon, from the muscle and we following this line, going in this small hole. Here is the vein line going up there, and so we try to find this vein. You can't just feel it, so you have to following these lines, that's the best.

But nevertheless, sometimes it's difficult to find it, sometimes not at all. I got it. You see. When you got it, it's just a few seconds, and then you have it. Muchas Gracias Chico. Si, Por Favor. Yes. Now we have to be very fast. This is a heparin tube. Thank you very much. So this is a heparin tube. And afterwards I will centrifuge it. I will centrifuge it for about five to ten minutes. We only need the blood plasma inside so we will throw the blood cells away and in the blood plasma there are the sexual hormones and these we need.

David Robinson
At very low spring tides when rocks which are normally covered, are exposed, the iguanas graze the red algae. Martin takes the chance to sample the weed, with a watchful eye on the waves. The samples are analysed to identify the species. Each has a particular energy content and the growth rate of each is known. If you know what's in the animal's stomach you get a picture of the energy balance. What, and how much it has eaten? To an expert the chewed fragments from the stomach are identifiable. The purple colouration comes from the seaweed itself.

For a complete picture fresh faeces are collected from the rocks. Dried and analysed for energy content. Altogether the researchers have a snapshot of the energy balance of the animal over a day. What it eats. How much it eats. What it loses. And as a result, how much energy the iguana has extracted from its food.

David Robinson
It's ultrasound. The same technique used to look at human babies in mothers' wombs. The state of development of the early stages of the eggs, the follicles, is a clear indication of where the animals are in their annual sexual cycle.

Beatrix Schramm
Now you can see here it's ending. You don't see this side so good, but nevertheless you can imagine this is the follicle, growing follicle. Yes.

David Robinson
As they approach the time of readiness to mate, the follicles show up as healthy, viable. If they are not fertilised they may be reabsorbed. Beatrix can see the differences between them. The ones that are breaking down, known as attritic follicles have characteristic hollow looking features.

Beatrix Schramm:
Normally you can see very black hole inside here. So you just see some different colours, like blackish, greyish and it's not, a normal follicle is totally white. Attritic follicle has some different colours inside.

David Robinson
The Galapagos can seem like a last frontier. The difficult and sometimes primitive conditions in the islands can suggest a lack of sophistication in scientific research. But making devices like the ultra sound recorder work in these circumstances is nothing less than a research tour de force.

For Martin and his group, their efforts lie in turning their shelter into a laboratory where they can undertake the precise and meticulously detailed work, of inserting radio transmitters under the skin of selected iguanas. Why go to all this trouble? If your only means of keeping track of the iguana is by looking at them, you won't know what they're up to, when they're out of sight or when they go into the sea. What's more if you're trying to correlate the animals' activities with the information on food intake, and body temperature you need some quantitative measurement, some data. You need a monitoring device that travels with or in this case in, the animal as it goes about its daily cycle.

Once in place the transmitter sends back signals to the researchers, as a series of bleeps. These are counted off against the clock. After a few calculations the researchers have a measure of the animals body temperature throughout the day. They can start to piece together a little of its life.

Martin Wikelski
You see here the file of time against body temperature and you see immediately that with the telemetry we get some nice data sets on certain aspects and certain time periods but you see just between say about twenty hours and in the morning at six hours, we can't continuously record the body temperature and we just have to assume that there's a continuous line dropping body temperature. We have some nice information here on the time when the animal was foraging and that's also some nice aspect of the telemetry that we get immediately the data on the body temperature and we can design experiments to change certain aspects of the body temperature.

David Robinson
As the graph shows, there are gaps. The technique is flawed. The radio signal is quite weak. If the animal goes behind rocks, the signal is blocked. You only get information while the researchers are around. Martin has started to use a new invention. A device which measures heart rate, and body temperature once a minute and stores it on a microchip, sealed within the implant. The whole device is sealed in a waterproof resin. And inserted under the skin of an anaesthetised iguana. There it will stay for several weeks.

After the iguana has had a few days to recover from the operation, it is released and the data collected. Later, it will be recaptured and the device recovered. Then the information can be analysed.

Martin Wikelski
You can see that even though the temperature drops down in the night, there are some changes. And this is probably because the animal moved its position inside the rocks and you see a really smooth warm up curve so we can calculate mathematical function about this, on this warm up curve. And there is no inaccuracies in the data because people didn't count right or did take the time wrong. And you also see that during the foraging period, there is a really nice drop and then afterwards, an increase in the body temperature again. Then also the nice drop in body temperature in the evening, or in the afternoon, and a little bit of increase again when the animal moved from it's rock to a rock that was slightly further in the sun so that's what they do around four o'clock or so in the afternoon. So all this can be nicely picked up and interpreted into this file, if we combine it with our behavioural observations.

David Robinson
Among other things, science is about taking your chances when you find them. Martin has always been interested in the diving physiology of the iguana. If he understands how the heart operates, he's got a clue about the efficiency of blood flow. Quite by chance, he finds out about Beatrix ultrasound work on the main island. He jumps at this chance to look at the dynamic of a heart operating.

It's another piece of the scientific jigsaw in place, for nothing.

Beatrix Schramm:
So you can see the heart pumping here. And now we can make it like a little bit bigger. You see the movement. And here it's the largest one. Yes. And here's its ending. And here too, if you move the ultrasound with the head of the ultrasound a little bit. You can see how the blood is going through the rhythm of the heart here.

David Robinson
What we've seen here is a snapshot of research taking place. Questions being asked. Puzzled over. And experiments set up to provide answers. Some of the answers are already there but for the most part it's a long continuing process. Slowly assembling pieces of information which as a body of knowledge informs our understanding of the natural world and perhaps more importantly, allows us to conserve and manage this fragile fragment of the planet.