



pushing the limits

WORDS AND PHOTOS **JAMES CASTRISSON**

Exploring the wilderness in extreme environments – of both soaring temperatures and freezing conditions – is the ultimate test of survival for the human body.

We stop drinking when the sun sets,” laughed Ecuadorian mountaineer Ivan Vallejo, as we raised our schooners to toast our recent climbing expedition on Mt McKinley, up in Alaska. Being summer, the sun wasn’t going to set for another couple of months and I could tell we were in for a big night.

Ivan is a mountain man. The premature wrinkling of the wind-burnt skin under his eyes create an aura of some kind of wizardry; he is one of the most elite climbers in the world, having scaled all 14 peaks more than 8000 m high, and is now on a mission to climb the highest mountain on each continent – the famed seven summits.

A few days earlier I had experienced altitude sickness and really felt the debilitating effects of being up at 6000 m in temperatures colder than your average freezer – my toes felt like terracotta tiles and I was swaying back and forth as though I’d downed five bottles of tequila. Meanwhile, Ivan and his rather elderly mates from Ecuador ran up the mountain in five days. I was in awe of how these men dealt with severe conditions, as I listened to their incredible stories of adventure and survival on the most formidable mountains in the world. Through their thick accents they began to talk about winter mountaineering in the Himalaya. This was crazy talk – which involved exponentially more pain and suffering than summer climbing with its long hours of darkness making the risks of frostbite, hypothermia and avalanches more potent. It sounded as foreign to me as going bushwalking on Mars – in fact high-altitude winter mountaineering involves surviving in temperatures similar to the Mars ice caps in winter! The idea that people could live in winds roaring above 200 km/h with temperatures hitting -150°C made me wonder...

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“Ivan, how the bloody hell do people survive up there in winter?”

Without hesitation he replied, “Simple. They know how to suffer and don’t mind losing. ‘They’ being the Polish and the Russians mainly... and it’s not about the gear, in fact, the kit they use really isn’t that much different than what we just had here in summer up on McKinley.”

I was shocked. How could that be?

“They push both themselves and the gear to the limit – it’s been hardwired into their way of thinking from a long time ago. They’re just not afraid of dying. For generations their suffering had been immense,” Ivan explains. “During World War I, close to 1 million Poles were killed, then only a short time later, from 1939, much of World War II was waged on Polish soil with a fifth of the population — almost 6 million people, half of them Jews — perishing. As a people, Poles had long ago learned to bear up against terrible odds, recognising that heroes who struggle and lose may be heroes all the same.”

Could this imprint on the nation’s soul have such an impact on their ability to push physical limits in the expedition world? Surely, it wasn’t simply all in their mind – there must be a story behind the physiology as well...

If we take a look at human history, the science tells us we evolved from the ape. If so, why on earth did we lose all our hair and only keep it where it doesn’t seem to count? This isn’t going to help keep us warm out there mountaineering or hiking down in Tasmania in winter!

Anthropologists reckon around 6 million years ago our original ancestors from Africa, the apes, were having a bit of a rough time. The world was warming up and becoming much drier (sound familiar?), and as a result of the changing climate, our monkey mates were forced to adapt to areas of savannah and grassland, which naturally provided less shade. Not equipped with beach umbrellas back then, the four-legged

species were getting bombarded by the harsh equatorial sunrays on the entire length of their bodies. One theory suggests that slowly, they began to stand on two legs in order to reduce this exposure by limiting the surface area under direct rays from the sun. Fast forward a few million years, and that explains why we have hair on the tops of our head – to protect the part of our bodies that gets hit most by the sun. This adaptation also provides the answer to why we lost the hair from our bodies – to deal with warmer temperatures – but what mechanisms were kept in place to deal with the cold?

We’ve developed some pretty powerful weapons to maintain a core body temperature of an almost constant 37°C (torso temperature). The body’s thermostat was discovered back in 1885 and was found to be located in the hypothalamus, an area of the brain that lies at the base of the skull. The tools we have developed are only effective in relatively benign temperatures. In climatic extremes, without adequate shelter and clothing, we go into meltdown pretty quickly if our body starts to get too far away from that optimal temperature. The primary mechanisms we’re armed with to deal with the cold are: fat stores; homeostatic functions (things that happen automatically, like shivering); and intelligence (which has allowed us to develop clothing and shelter).

To deal with the cold on our relatively hairless bodies we developed fat stores under the skin to help act as insulation. Through the years, many adventurers have argued about the benefits of fattening up for expeditions – some say it’s a waste of time, others, like myself, tend to disagree. Before my departure, with best mate and fellow adventurer Justin Jones, on our kayak crossing of the Tasman, we had full-body dual energy x-ray absorptiometry (DEXA) scans done. These scans show exact composition of



James’ Mt McKinley climbing partner, Hugh Ward on summit day.



Climbers battle up the lower flanks of Mt McKinley with three weeks worth of food.



Approaching Mt McKinley’s 14,000 ft camp.

muscle, fat and bone density throughout your body. Before starting out, Justin had a higher weight and percentage of body fat – 100 kg and 20.7 per cent respectively – than I did, with 15.9 per cent fat at 85 kg. During the journey Justin was both more resilient to the cold and his body was less inclined to cannibalise muscle stores. These findings, combined with seeing how skinnier and more chubby mates dealt with the cold on other expeditions, have led me to believe that our fat stores play an integral role in keeping us warm when out in the elements. “Body fat is a very good insulator against the cold,” says University of South Australia Associate Professor Jon Buckley. Jon, also a co-director at Australian Technology Network Centre for Metabolic Fitness, says a study conducted more than 30 years ago and published in the *Journal of Applied Physiology* showed that a greater thickness of subcutaneous fat (found just beneath the skin) protected against heat loss when exposed to cold air or water.

This was also shown early on in our adventure lives when Justin and I, along with Andrew, another mate, set out to traverse the entire length of the 2560 km mighty Murray River – a journey we expected to take seven weeks. At the time, Justin and I were, let’s just say, well-rounded. Andrew, on the other hand, was super lean with a body like a greyhound; next to no body fat. In trying to discover the river source, we had bashed through the bush for a couple of days and after locating it, found ourselves surrounded by bluffs in scrub that was near impenetrable. This made our progress incredibly slow and difficult; at that pace we’d never have made it to our rendezvous 40 km downstream where we planned to pick up our kayaks. The only hope we had was to surf on our packs down the ever-growing and intimidating rapids, which were enough to throw us around like rag dolls and

hold us under for up to 20 seconds at the end of a run. We spent the next three days surfing these rapids, which were Grade 3 at times. The water was snowmelt, so it was bloody freezing, and as we hadn’t prepared for this, everything in our packs got drenched, including our camera, GPS, sleeping bags, food, and, unfortunately, matches...everything. Each night was spent shivering away in wet thermals hugging each other in the foetal position.

On the fourth day of the expedition Andrew was in a desperate situation. With no fat insulation between the frigid waters and his body, his core temperature began to nosedive. In the early hours of the morning he began shivering violently which wasn’t too bad – we’d all been doing that for days. However, as we continued down the rapids, he started losing coordination and began finding talking difficult. He then stopped shivering – he had become hypothermic – his body was beginning to shut down as his core body temperature fell below 35°C. We pulled him out of the river, wrapped him in a space blanket and cuddled him and tried to cover his head – something we’d been taught to do.

Although our heads provide an extremely important role to help regulate temperature control, it’s not as important as you may think. Rumours bounce around the place, which suggest warmth lost from our heads accounts for the majority of body-heat loss. This stems back to a study done by the US military in the 1950s. Recent studies have shown head heat loss at most accounts for less than one-third to one-fifth of total heat loss. So, although it’s important to whack your beanie on when you’re cold, it’s not everything – what is going on with the rest of your body also counts. “While the hair on our heads fulfils a protective purpose and reduces heat loss to some extent, clearly the heat loss from other areas must also be considered,” Jon says.

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Apart from growing the hair on our head and bulking up fat stores, what else can we do to face the cold? Fortunately, our evolution has seen us equipped with a range of defences that our body undertakes subconsciously. Heat is the by-product of life and, like other mammals, we have developed some ways of maintaining a stable body temperature regardless of the external temperature, which makes us homeothermic. The central sensor nerve cells talk to the brain when conditions get a bit chilly, which then commands the muscles of the body to shiver – these rapid muscle contractions generate heat. The brain also uses blood to help keep us warm by restricting the amount which reaches the skin. Blood vessels in the insulating fat layer are constricted, lessening the amount of blood reaching the skin and therefore less heat is lost from the body’s core.

Studies have shown that intermittent exposure to the cold seems to cause some adaptation in humans. For hundreds of years people have been doing this in order to toughen up – the Spartans bathed daily in cold water as did Henry ‘Birdie’ Bowers, a member of Robert Scott’s ill-fated expedition to the South Pole in 1911. Apparently every morning he would strip naked in the freezing Antarctic air and douse himself with icy water and slush. In preparing for the Tasman, I had cold showers every morning for six months. It definitely helped me deal with the cold – whether it was more psychological or physiological I don’t know.

All this work to keep our core temperature normal uses massive amounts of energy – it doesn’t come for free! That’s why we eat so much more when we’re in cold environments. Antarctic explorers often eat two to three times more calories than the average person does back home. “In colder temperatures our bodies try to maintain a normal core temperature – by



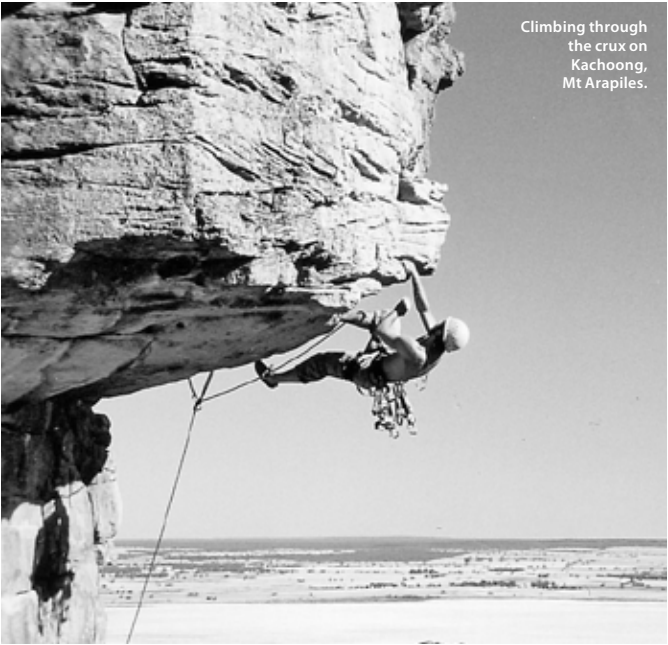
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Climbing steep, loose terrain on Aiguilles Rouges, New Zealand.



James and Justin on day 45 of their Tasman crossing in scorching heat.



Climbing through the crux on Kachoon, Mt Arapiles.



James descends the fixed lines on the intimidating headwall of Mt McKinley.

“More people have lost fingers and toes to frostbite getting camping gear set up than on any other part of a mountaineering expedition.”

processes like shivering and releasing hormones that speed up our metabolism,” Jon says. “As our metabolic rate speeds up, more heat is generated and the body needs an adequate energy intake to support this increased metabolism.” This is why high-caloric foods become more attractive – and necessary – to adventurers in the frosty extremes of the Arctic.

The final weapon we have to combat the cold is the gift of intelligence – which has allowed us to develop synthetic ‘fur’ – in the form of clothing. Apart from making us look cool at the Blackheath Bakery on a Sunday morning, outdoor clothing is essentially designed to emulate what hair does on animals, that

is, create a layer of trapped warm air between the skin and the environment. We can now pick and choose the appropriate garments for different conditions – much more convenient than altering our fat stores or growing our hair long. Layering is the fundamental principle of outdoor clothing these days where in cold climates we wear a base, mid and outer layer. Technology has aided in making this clothing more lightweight, more breathable and more effective in keeping us warm – or cool.

If you’re trekking or climbing in Australia and weight is a big concern, you’ll be happy to know that you really don’t need much warm gear if you’re staying active.

EXTREME FACTS

Coldest temperature ever recorded: -89.2°C at the Russian Vostok Station in Antarctica, in 1983.

Hottest temperature ever recorded: 70.7°C at Lut Desert, Iran, in 2005.

Only nine out of the 14 8000 m peaks have seen a winter ascent (interestingly, all except the five that are located in Pakistan).

At -50°C, bare skin freezes within a minute.

The lowest recorded body temperature from which a full recovery was made was 13.7°C. This was the temperature of Anna Bagenholm who was immersed in icy water for 80 minutes in 2000 after a skiing accident.

Although humans can (under special circumstances) survive extreme cooling, an increase in core temperature more than 5°C is fatal.

On the Tasman, Justin and I had only a couple of pairs of merino wool thermals each and a shell layer. Even down in Antarctica, when Sir Ranulph Fiennes and Dr Mike Stroud attempted their unsupported crossing of the Antarctic continent on foot back in 1993 (they were picked up on Day 95, starving and frostbitten on the Ross Ice Shelf) they didn’t carry down jackets – just a 300 g mid layer.

The reasoning for this is when you are on the move, your body heats up sufficiently – it’s when you stop that you risk exposure to the elements. Both on the Tasman and down in Antarctica it is critical that when you stop moving you hop into your sleeping bag as quickly as possible. More people have lost fingers and toes to frostbite getting their tent and camping gear set up than on any other part of a mountaineering expedition.

So we have some great defences to cold extremes, but how about the heat? Although we evolved from the plains of Africa, which provided more hot temperatures than cold, the human body is designed to deal with a core temperature rise of only a few degrees. Brain cells are extremely sensitive to heat and melt down at 42°C – and as our core temperature rises, the risk of heat stroke increases, which can be deadly.

We’ve adapted to this sensitivity by evolving mechanisms that maintain our optimal temperature level by expelling unwanted heat. Our body shape in these African environments evolved to have less fat stores and long limbs to help expel heat. Heat is then lost from the skin by four main processes: radiation, conduction, convection and evaporation of sweat. Of all these processes, Jon says the evaporation of sweat is the most effective process when it comes to cooling down in a hot environment, although its usefulness as a cooling method is reduced with increasing humidity, leading to an increased risk of overheating.

At rest in still air, radiation accounts for around 60 per cent of our body’s heat loss, with convection and evaporation contributing 20 per cent each (more when there is wind). As long as the temperature is less than that of the body core, radiation, convection and conduction are able to cool the body. What do we do when temperatures in summer rise above this?

When the air temperature is greater than that of the body, the only way our bodies lose heat is via sweat – which cools the skin, and then allows the blood

circulating near the skin to be chilled. We've got around 2.6 million sweat glands, which are most numerous on palms and the soles of the feet. Sweating can increase heat loss almost 20 fold (that's a good thing), but only at the expense of substantial water loss – as much as 2 L an hour. Such high sweat rates cannot be maintained for long periods and the usual rate of water loss for someone working in the heat is around 10–12 L a day. Lisa Tamati, New Zealand's premier ultra marathon runner, almost died in the Libyan desert back in 1997 when her expedition had only budgeted 1.5 L of water a day because of its weight.

In warm, humid environments, the body gets a little more confused. With humidity above 75 per cent the sweat drips off the skin as liquid, without evaporating. This sweat causes dehydration while its cooling effect is lost. When evaporative cooling cannot take place, the risk of hyperthermia and heat stroke is particularly high – as Justin and I discovered on our very first big jaunt in the outdoors.

Upon leaving high school, instead of getting sauced up at schoolies, we thought it would be a great idea to walk around Fraser Island for two weeks carrying all our fishing and camping gear with us. Our packs were ludicrously heavy, weighing in at just over 40 kg each (note to self: carrying 15 kg of lead sinkers round a sand island in summer isn't the smartest idea). We began our adventure and soon found that due to the humidity and sizzling temperatures our sweat just wasn't cooling us down enough.

Three days into the trek, Justin began falling further and further behind as his eyes sunk deeply into his head. After waiting for him to catch up, I noticed that he wasn't sweating much, and when I asked if he wanted a break, he was agitated and short tempered. He hadn't been drinking much water and by midday he was swaying back and forth. I got worried. We quickly found some shade and attempted to get some liquid down his throat. Initially it didn't make any difference and he remained vague and distant. Finally, after what seemed an eternity, his flushed checks began to start oozing sweat and things slowly got back to normal. It was a valuable lesson, and for the rest of the trip, we arose before sunrise and got our hard yards done before noon. "Heat exhaustion can occur when the core temperature increases above normal and common symptoms include lethargy, dizziness and lack of



Rock climbing in the Walgan Valley.



coordination," Jon says. "The best thing you can do is to try and get the person to cool down and take in fluid."

Fraser Island aside, Justin and I have had a few close calls when dealing with heat in the outdoors – paddling on the Murray River was one and the other was on a glacier in New Zealand! It can happen anywhere.

"A common mistake people make is that they wear too much clothing when undertaking physical activity in cold conditions – like climbing a mountain – and this can lead to hyperthermia, including heat stroke and heat exhaustion," Jon says. These experiences have taught us the importance of proper hydration and the effectiveness of sweating. To the horror of our expedition companions, Justin and I often wear merino wool thermals on hot days. Why? Apart from protecting us from the sun with bright, reflective colours, we find they get a little damp from our sweat, which aid its evaporation. This only seems to work up to about 30°C – anything above this we try wearing loose and breathable garments.

"This intelligence we've been gifted with provides the barrier we need to face the most brutal conditions on our planet."

Through our evolution from apes to humans, our bodies have adapted quite well to naturally deal with a relatively benign temperature range; in the cold our blood vessels constrict and our muscles begin to shiver. As it heats up, our body turns on the tap to lather the skin with sweat, which promotes evaporative cooling.

In the outdoors, keeping mindful of how your body is dealing with the temperature is imperative – it pays to stop for a moment to add or remove a layer. This intelligence we've been gifted with provides the barrier we need to face the most brutal conditions on our planet. Even though we've developed handy physiological traits that have helped

make survival in these extremes possible, Dr Mike Stroud, veteran of numerous Arctic/Antarctic expeditions, agrees with the words of Ecuadorian mountaineer Ivan – it's the story our minds tell us that make the real difference. Mike believes, as he details in his book *Survival of the Fittest, Understanding Health and Peak Physical Performance*, that he dealt with the cold by having a defective short-term memory. "We're all programmed to be incapable of remembering the pain of extreme cold; we just can't recall suffering to anywhere near the degree to which we can recall times of pleasure."

James Castrission's book detailing his Tasman expedition, *Crossing the Ditch* (\$32.95, Harper Collins), is now available.