The business end of a 155mm male *Titanus*. Prionids in general are belligerent and careless handling will result in a painful bite. The relatively short but very powerful mandibles of *Titanus* can cut pencils and biros in half and would be capable of inflicting serious damage to a human finger. Photograph by Simon Fearn.

Titanus fever.

An obsession with the world's largest beetle.

*By day, **Simon Fearn** is the Collection Officer - Natural Sciences for the Queen Victoria Museum and Art Gallery in Launceston. But in his spare time, he is compelled to indulge a consuming passion for anything vaguely 'creepy-crawly'. Here he documents, in a process that may well have been therapeutic for him, the amazing history of an extraordinary insect.*

Before my interest in reptiles came to the fore, I was a kid obsessed with insects and spiders, and I began an insect collection at a very early age. I quickly developed a desire to understand the life cycles and ecology of the insects that I was finding, but back in the early 1970s there was not a great deal of information. At around this time the first edition of 'The insects of Australia' was published by the CSIRO and it became my bible. This allowed me to identify and classify many of the insects I was finding, but there were still numerous ecological questions left unanswered. There was nothing for it but to attempt to find answers myself, so I began rearing insects from the caterpillars and grubs I found and kept detailed notebooks of my discoveries. I became especially interested in wood-boring beetles and moths, particularly longicorn beetles (family Cerambycidae) and wood moths (family Cossidae), and I became consumed with working out life cycles and how to collect perfect specimens in these groups.

"Our own museum contains more specimens of elephants that all the museums of the world do of this beetle."

Many hours spent in the bush at a young age allowed me to eventually publish some detailed accounts of the life histories of some of my favourite insects in my native Tasmania. One group that I became particularly obsessed with was the big longicorn beetles in the subfamily Prioninae. There were several reasons for this, apart from their size. I grew up in urban Launceston where the two biggest species in this group were rare or absent. The Banksia Longhorn Beetle (*Paroplites australis*) is most common in coastal woodland and a second species without a common name (*Toxeutes arcuatus*) is primarily an inhabitant of tall, wet sclerophyll forest. Both these beetles are abundant but have just limited adult emergence periods in mid-summer, and because I could only be an infrequent visitor to their core habitat, every encounter was cause for excitement. The family shack was deep in *Paroplites* territory and some relations owned a farm in core *Toxeutes* habitat. Both these beetles exceed 50mm in length and both are nocturnal, so on rare summer visits to both locations I could invariably be found checking outside lights at night, in the hope of locating my quarry. I spent a lot of time investigating the larval cycles of these beetles, chopping their big white grubs out of trees and logs and rearing them at home. It was during this period of my life, in 1974, that a chance encounter with an old copy of The National Geographic Magazine in the school library completely blew my mind.

Flipping through the May 1959 edition I came upon a life-size depiction of a prionid longicorn beetle (on page 659), along with a huge grub which blanketed the page. The accompanying article was entitled 'Giant insects of the Amazon', by Paul A. Zahl, and it was my first introduction to the world's biggest insect - the aptly named *Titanus giganteus*. The article was a fabulous mix of travel and adventure interspersed with the collection of giant exotic bugs, and I read it over and over again for months afterwards, as well as snapping up copies of the magazine in antique and second-hand shops. Zahl's article painted a romantic picture of *Titanus* as an almost mythical creature - sought after by collectors for over 100 years but with only a handful of specimens known to science. Prior to his 1957 expedition to the Amazon, sponsored by National Geographic, only a few museum specimens of *Titanus* existed, and the then curator of insects and spiders at the American Museum of Natural history, Dr C. H. Curran, informed Zahl that, "Our own museum contains more specimens of elephants than all the museums of the world do of this beetle."

Zahl timed his visit to northern Brazil to coincide with the start of the wet season, when the majority of insects are at their peak of activity. Although he collected a wide variety of insects, he only obtained one living *Titanus*, principally because the wet season was late that year and he had to return to his New York home before the main emergence period. Before he left Brazil, Zahl had recruited the assistance of employees at an American-backed manganese mine established in virgin forest at Serra do Navio to collect and mail to him any *Titanus* they discovered once the rainy season got well under way. A month later, he received a wooden box in the mail and stated, "My wife and two children gathered round, nearly as breathless as I. The smell of naphthalene filled the room as I detached the lid and carefully pulled away pad after pad of packing tissue. Finally, there they were - 15 enormous, shiny specimens of *Titanus giganteus* - to me the most beautiful sight in all the world."

Anyone who is an avid insect collector will immediately identify with Zahl's excitement at receiving this unusual package.

Titanus giganteus was first described by Linneaus in 1771, and to this day no one knows where he obtained a specimen. In the middle of the 19th century specimens were occasionally found drowned and washed up on the shores of the Rio Negro near Manaus and, even more remarkably, discovered intact in the stomachs of large fish being prepared for the table. The intrepid British entomologist Henry Walter Bates, who spent 11 years documenting the beetle fauna of the Amazon basin between 1848 and 1859, was well aware of *Titanus*. Although he tried very hard he only managed to find a few imperfect specimens to send back to England for sale. For many years the only specimens that made it to Europe resulted from these chance encounters, and so lucrative was the very limited trade in *Titanus* at the time that enterprising individuals would hoard incomplete and rotting specimens recovered from rivers to 'construct' perfect specimens for sale. To purchase a complete *Titanus* in 1914 cost the princely sum of 2,000 gold marks (the equivalent of around $11,500 US today) and wealthy collectors would hire steam vessels to meet incoming ships while still at sea to select the biggest specimens. Up until 1938 only about 30 specimens had been found, and the bulk of these were males.

Not a great deal had changed by the time of Zahl's 1957 expedition, which yielded a further 16 male specimens (all of which flew to powerful security lights around the mine site) together with, importantly, all the necessary clues as to how to collect *Titanus* in numbers. For some reason, Zahl's 1959 article failed to have much of an apparent impact on beetle collectors, because *Titanus* was still considered rare up until the mid-1980s. It was at this time that the link between powerful lights and being able to collect *Titanus* in commercial quantities began to gain widespread acceptance, after the French built a rocket-launching facility in their South American territory of French Guiana. Several facts became much better known quite quickly. Firstly, *Titanus* was far from being rare. Its rarity was a perception only and powerful light traps placed in primary rainforest during the beetle's relatively short flying period of 4-8 weeks could yield a reliable annual pulse of specimens. Today, hundreds of male specimens are collected annually from light traps set up in French Guiana and also the Peruvian Amazon. Prices have come down dramatically for average-sized specimens but really large ones still command in excess of $1,000 US each. Females have never been collected at light traps and the handful that are known have all been found opportunistically wandering on the ground or drowned in rivers; they still fetch very high prices when they occasionally come onto the market.

In spite of its legendary status over the centuries, we still have no reliable data on the beetle's life cycle and its breeding sites are not known with

Above: A 152mm *Titanus* beside some Australian prionids. Top to bottom: *Paroplites australis*; *Toxeutes arcuatus*; *Agrianome spinicollis*; and *Xixuthrus microcerus*. Note the ovipositor protruding from the tip of the abdomen on the female *P. australis*. Photograph by David Maynard.

Left: I first contracted *Titanus* fever when I saw the classic image on the left in the May, 1959, edition of The National Geographic Magazine, shortly after the 'hand' photo appeared in V. J. Stanek's 'The Pictorial Encyclopedia of Insects', published in 1969. The giant larva was later found not to be that of a *Titanus*, but of the closely related and also giant *Macrodontia cervicornis*. Photograph by Simon Fearn.

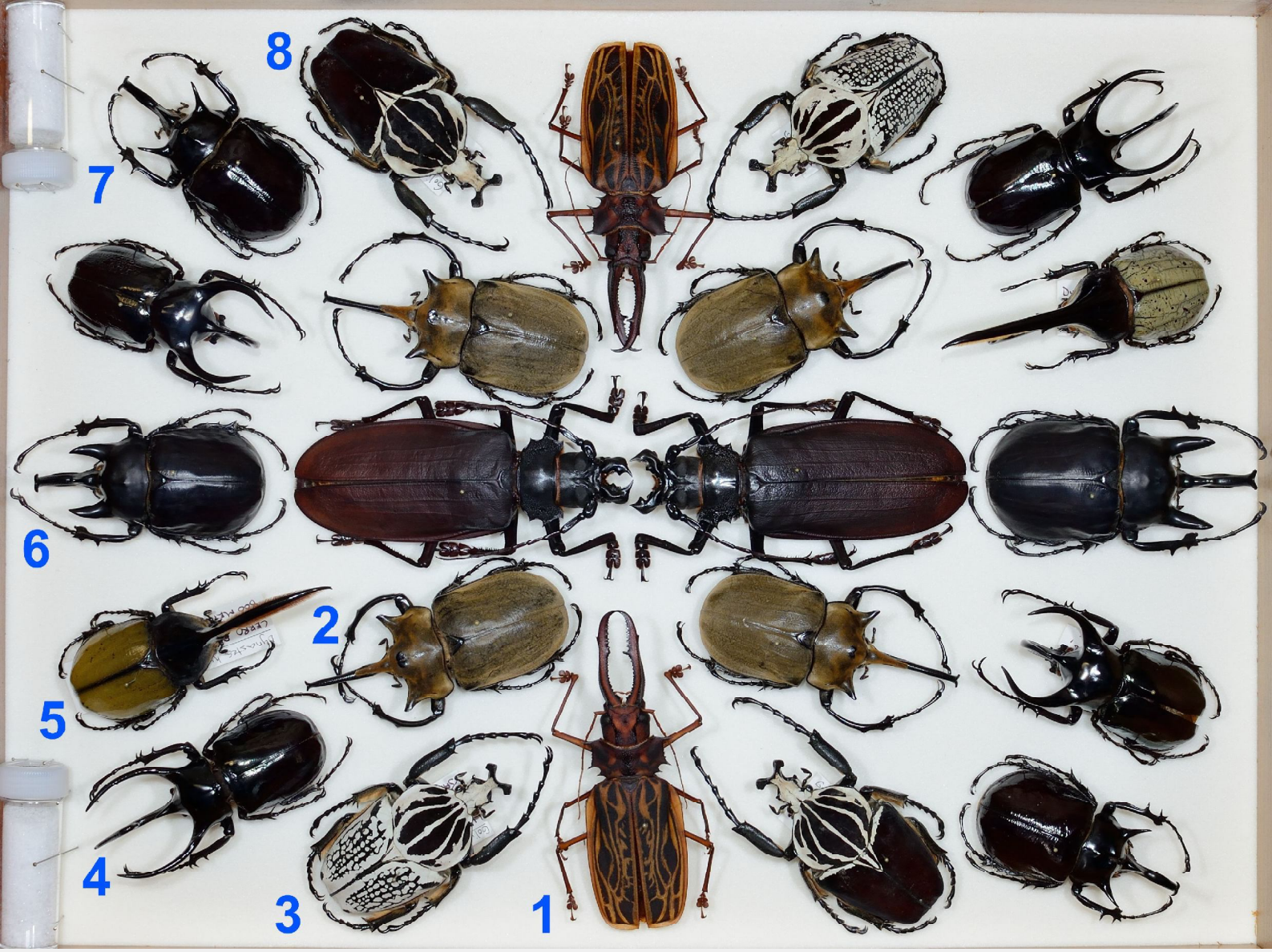
A 148mm male *Titanus* with a 233mm wing-span set in flight with an adult male sparrow (*Passer domesticus*) as a size comparison. A maximum-sized specimen of 170mm would have a wingspan of approximately 280mm. Photograph by David Maynard.

certainty, but much can be deduced with relative accuracy from what is known. *Titanus* is confined to primary rainforest close to the equator in South America, principally northern Brazil, French Guiana and Surinam but also eastern Peru, Ecuador and Colombia. The beetles are only active nocturnally during the height of the wet season between December and March. The life cycle of *Titanus* is undocumented but there is no reason to expect that it varies in any major way from the rest of the prionid longicorns. This group have wood-boring larvae (grubs) that consume both living and dead trees and form large galleries in the wood. Female prionids seek out suitable host trees and lay their eggs in bark crevices with a long, flexible ovipositor that is extended from the tip of the abdomen. The vast majority of the Prioninae are large beetles (>40mm) and in many species the larval stage lasts for several years. The mature larvae of *Titanus* must be huge, approaching 30cm in length and weighing in excess of 100g, and to the best of my knowledge have never been found. The huge larva that featured prominently in Paul Zahl's National Geographic article turned out not to be that of *Titanus*, but another giant South American prionid; *Macrodontia cervicornis*.

'Mature larvae must be huge, approaching 30cm in length and weighing in excess of 100g.'

The complete absence of any clues as to the whereabouts of the giant *Titanus* larvae leads to only one logical conclusion - that they are underground in the decaying root systems of giant, dead rainforest trees. If *Titanus* was emerging from trees, logs or stumps above ground there would be tell-tale emergence holes left in the timber large enough to get four fingers into, and such obvious signs would be hard to miss. In support of the underground root system theory is the fact that a proportion of captured *Titanus* have patches of mud adhering to them, suggesting they have emerged through sodden wet-season soil. In addition, only very large roots could nourish such enormous larvae for a number of years, and this may explain why *Titanus* is common only in primary rainforest. The adult beetle lives for just a few weeks and does not feed; clues from captured beetles indicate that their habits are similar to those of many other prionids. The mandibles of freshly-emerged male *Titanus* are tipped with a fine point, but very few males are captured with these intact. Many males are found with antennae, legs and most of the anterior portion of their mandibles sheared off, indicating that males engage in combat for breeding sites, mates or both. Larger males may therefore have an advantage in such combat bouts. From my observations of several species of prionids in Australia, combat and mating activities take place just after emergence when dozens of beetles can emerge from a single tree or log on the same evening. Males that are successful at driving off rivals copulate with females and then disperse in search of other host trees and potential mates. This may explain why *Titanus* only flies to lights very late in the evening, from about midnight to 3:00 am. Another intriguing aspect of the biology of *Titanus* is that females are not known to fly to lights and specimens are still considered a great rarity. It would be very unusual if the sex ratio was not close to 50:50, so there are a lot of giant beetles out there that no one has yet found a way to sample. Huge, dead trees suitable for *Titanus* females to oviposit on are probably relatively common in a vast rainforest, but at the same time discrete and widely dispersed, so females are probably entirely focussed on locating suitable oviposition sites. It occurs to me that one way of cracking the *Titanus* life cycle may be to deliberately ring bark some forest giants and set up remote infrared cameras on the lower trunk and exposed roots in the hope of photographing or filming mating or ovipositing beetles.

As is typical of many species of beetle whose larval stages live on decaying wood, the eventual size an adult *Titanus* can attain is determined entirely by the amount of nutrition accessed as a larva. Adult male beetles display an amazing size range, from 79mm 'runts' to a shade under 170mm at known maximum size. There are constant rumours that 180 and 200mm giants have been collected and secreted away, but no corroborative evidence has ever been forthcoming. There has been a great deal of debate about which insect is indeed the largest in the world, and *Titanus* is usually compared to other giant tropical beetles in the families Dynastinae (rhinoceros and elephant beetles) and Cetonidae (flower chafers and goliath beetles). The giant South American rhinoceros beetles in the genera *Dynastes* and *Megasoma* as well as the West African goliath beetles in the genus *Goliathus* are always put forward as contenders, but the lengths of all these giant scarab beetles are augmented by horns arising from the head or thorax or both. *Titanus*, on the other hand, is 'all beetle' and has modest but very powerful mandibles that are in proportion to the rest of its body. Two other prionids vie with *Titanus* in total length (*Macrodontia cervicornis* and *Xixuthrus heros*), but both have long mandibles and more gracile proportions. Some of the giant scarabs may beat *Titanus* in weight, but again the comparison may not be valid. As recorded earlier, *Titanus* does not eat as an adult whereas the giant scarabs can live for months and eat a great deal. A single large male *Dynastes hercules* or *Megasoma actaeon* can consume an entire avocado in one day, so the only fair comparison to *Titanus* would be on an empty stomach. Reliable 'empty



stomach' data on all these beetles is scarce, but I have weighed a fresh dead 152mm male *Titanus* at 34g and this is equal to or heavier than available data on the other contending species. Since female *Titanus* are extremely rare in collections and very few have ever been examined, it is not known if females can attain the same maximal size as males. However, if they follow the same trend as all the better-known prionids, they will prove to attain a similar size or larger. I have no doubt that a heavily-gravid female *Titanus* of around 160mm could weigh in excess of 40g. Any doubts about the status of *Titanus* as the world's largest insect are put to bed if you set a large specimen as if in flight. The overall size with the wings fully spread is breathtaking, and a maximal-sized specimen would have a wingspan approaching 28cm, making *Titanus* the insect with the largest wingspan also.

Through trading and purchase I now have 12 specimens of *Titanus* ranging from 112mm to 155mm in overall length. This has dampened the symptoms of *Titanus* fever somewhat, but I still hope to get a really big one of 160mm or more and eventually visit French Guiana to see the great beetle in its natural habitat. Perhaps paradoxically to some, it is the enduring interest in this beetle through collecting and tourism that may ultimately ensure its ongoing survival. An article by entomologist Max Barclay on *Titanus* on the Natural History Museum, London, website states: 'There are villages in French Guiana where many people supplement their income by collecting insects in general and *Titanus* in particular, for sale to dealers and collectors. This cottage industry ensures the continued survival of the forests in these areas, and all the species they support. Because female *Titanus* beetles are nearly impossible to collect, the commercial industry deals almost entirely in males. This makes the business truly sustainable, because the removal of males is less damaging to a population than removal of females (because one male can fertilise many females).'

The majority of tropical countries in South America, Africa and Asia have either banned insect collecting by non-professionals or made the process of issuing permits so onerous that most give up. This spectacularly unintelligent approach to biodiversity conservation often occurs with the backdrop of large-scale habitat destruction of forests in those countries. A recent French research report on the taxonomic status of the insect fauna of French Guiana recognised that 65% of insect faunal records and 74% of holotypes of new species were collected

by non-professional entomologists. The authors of the report went on to state: 'It should be mentioned that French Guiana is among the last countries in South America that has no constraining regulation on collecting insects over the whole territory. With no major impact on insect conservation, this has clearly favoured contributions to the description of the fauna from the amateur community, and also the collection of material, including by insect dealers, a part of which has been the basis for many significant taxonomic works.' It can only be hoped that increasingly draconian approaches to non-professional insect collecting in Australia fail to gain traction.

The next exciting frontier in the *Titanus* story will be the discovery of its larvae, and I can't wait until some intrepid beetle enthusiast finally unearths and photographs some. They will be much more massive than the adults and will truly deserve the title of the largest insects on earth.

Left: A couple of 155mm male *Titanus giganteus* (centre) surrounded by the world's largest beetles, for comparison of overall size. 1. *Macrodontia cervicornis*; 2. *Megasoma elephas*; 3. *Goliathus orientalis*; 4. *Chalcosoma caucasus*; 5. *Dynastes hercules;* 6. *Megasoma actaeon*; 7. *Megasoma mars*; 8. *Goliathus goliathus*. Photograph by David Maynard.

Below: Many references still refer to *Dynastes hercules* as the world's largest beetle, however, as can be clearly observed on this specimen from Panama, half this beetle's length is comprised of a long, narrow thoracic horn. Photograph by David Maynard.

Further Reading.

I have pretty much summarised all that is known about *Titanus* for this article (from brief references in books, online essays and even blogs on collector sites), but the following are essential reading for anyone interested in this topic.

Zahl, P. A. 1959, Giant insects of the Amazon. *The National Geographic Magazine* CXV (5): 632-669.

Williams, D. M. 2001. Largest. *Book of insect records, University of Florida.* http://entnemdept.ifas.ufl.edu/walker/ufbir/chapters/chapter_30.shtml

For more information on the giant rhinoceros beetles see the following book:

Weigelt, A. 2013. Professional Breeders Series: Giant beetles of the Genera *Dynastes* and *Megasoma*. Edition Chimaira. Frankfurt am Main.

For more information on insect collecting in French Guiana and other tropical countries see:

Brule, S. and Touroult, J. 2014. Insects of French Guiana: a baseline for diversity and taxonomic effort. *Zookeys* 434: 111-130.

http://www.theskepticalmoth.com/collecting-permits/