

HOW HUNGRY ARE CARNIVOROUS PLANTS? AN INVESTIGATION INTO THE NUTRITION OF CARNIVOROUS PLANT TAXA FROM THE KIMBERLEY REGION OF WESTERN AUSTRALIA

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The Project

The pristine Kimberley region in the north of Western Australia is a global centre of carnivorous plant diversity, well known for its abundance of *Drosera* (ca. 20-30 species), *Byblis* (four species), and *Utricularia* (at least 30 species). New taxa continue to be discovered here on a regular basis. As carnivorous plants tend to prefer sunny, moist and nutrient poor environments, the tropical monsoon climate and poor soil fertility of the Kimberley region have allowed for significant diversification of these carnivorous plant genera. The Kimberley sits on a geologically ancient landscape, with naturally old and well-weathered parent rock material and highly leached soils, thanks in part to very high levels of rainfall during the summer monsoon. From May to October, the Kimberley region experiences a hot and often fire-prone dry season, which is followed by a short but unpredictable wet season from November to April. During the 4-5 month wet season it is not uncommon for the region to experience frequent lightning storms, intense tropical cyclones and large flooding events, with rainfall in northern coastal regions during this short period frequently exceeding 2000 mm (around 80 inches). Subsequently, access during the wet season can be extremely difficult, with many areas simply remaining inaccessible until the cessation of seasonal rains.

The nutrition of carnivorous plants is an endlessly fascinating topic, especially given that these plants are able to absorb supplementary nutrients by attracting, capturing, and digesting insect prey with their specially modified leaves. Many aspects of the nutrition of carnivorous plants have been studied in great detail, with Schulze *et al.* (1991) pioneering the use of stable isotope techniques to determine how reliant West Australian species were on capturing insect prey to meet their nutritional needs, as opposed to gaining nutrients through root uptake. While this research shed some light on twelve *Drosera* species from the southwest region of Western Australia, there has been no similar research conducted on the carnivorous taxa of the Kimberley region. This is where my (LS) PhD project comes in, based at the University of Western Australia and Kings Park and Botanic Garden, Perth, Western Australia.

In order to gain an understanding of the nutrition of a wider variety of the carnivorous plant taxa that occur naturally throughout Western Australia, we proposed to expand upon the work of Schulze *et al.* (1991), with a broader range of species surveyed and greater replication. We began this project with a field trip to a remote area of the Kimberley, to collect samples under scientific license of carnivorous plants, non-carnivorous reference plants, potential insect prey, and soil. These samples will be used to determine nutritional differences between carnivorous plant species, and compare this to underlying site characteristics. Our team's research, and particularly the costs associated with remote field study, is funded by grants from Murdoch University, Kings Park and Botanic Garden, the Friends of Kings Park, and the International Carnivorous Plant Society. What follows is an account of our journey to this wonderful part of Australia and how we went about making our collections.

The Journey

To be perfectly honest, in the weeks leading up to this field trip, I was a little apprehensive. The last time I'd been on a serious field trip was nearly two years prior, but add to that the fears that many people associate with the Australian outback: ending up lost in the vast remoteness of the Kimberley (some 423,517 km² of predominantly uninhabited wilderness), suffering dehydration or heat shock, being poisoned by snakes, waking up covered in spiders, or eaten by a giant crocodile. In the wise words of Russell Coight "out here, survival is the name of the game. Only it's not a game; it's deadly serious". With a lot of preparation and a fair amount of luck, we survived our own "All Aussie Adventure" and now it's time to tell the tale!

Our journey began in late March, towards the end of the Kimberley's wet season, in the town of Kununurra. Here, sadly, the invasive cane toad species *Rhinella marina* L. (Bufonidae) has made its mark. For those that may not be aware, the cane toad was introduced to northern Queensland in 1935 in an ill-fated attempt to eradicate problematic cane beetles, and has been steadily working its way across the monsoon tropics ever since. Unfortunately, this plan has resulted in much of our native fauna falling victim to the poisonous cane toads. This was my first time seeing these creatures in person, and, I've got to say, they aren't pretty! Some other wildlife we were much happier about getting acquainted with included the TaTa lizard (*Lophognathus temporalis*), so called for the wave goodbye it does with its front legs after racing away from threats, and the beautiful big boab trees (*Adansonia gregorii*). This is definitely a place that I would like to see a bit more of one day, and maybe even climb to the top of the local hill, Bob's Knob! However, after one night's stay, we were off the next morning to our remote north Kimberley field site; a large pastoral station surrounded by pristine bushland, where we would be spending the next week.

Given that our field site is so very remote and the roads are inaccessible during the wet season, the only feasible form of transport was to charter a flight on an aptly named 12-seater Cessna Caravan (Fig. 1). We placed our luggage in amongst the packages ready to be delivered to the many remote stations along the way, and strapped ourselves in. Seeing the Kimberley from a bird's eye perspective was a definite highlight, with my favourite view being that of the Pentecost and Durack River delta, with its winding pathways and incredible colours (Fig. 2). However, it was certainly nice to find ourselves landing at our final destination, returning to solid ground and breathing some of the freshest air I've ever encountered.

Upon landing at the station, we were greeted by its caretakers, Wendy and Bruce, and their dog Bonnie, a beautiful Ridgeback-Dingo cross. First of all, I cannot thank the caretakers enough for their hospitality and generosity, and I'm also very grateful for Bonnie the dog, who became our best friend and fieldwork companion for the week (Fig. 3). We were given a quick tour of the station: the caretakers' and owner's homes had beautiful gardens with fruit trees; the nearby shed was fully equipped to make sure everything ran smoothly, including the quad bikes we would be using to



Figure 1: Our charter Cessna Caravan.

travel between sites each day; and the dongas (small portable rooms) where we would be sleeping were located right next to showers and cooking facilities. For a moment, it was easy to forget that we were staying out in the middle of nowhere... that is, until we found the frogs hanging out in the toilet and geckos crawling in the cupboards! Wildlife was not uncommon, with the howls of a dingo (*Canis lupus dingo*) in the distance, bats flying about the garden at night, a poisonous taipan (*Oxyuranus scutellatus scutellatus*) in the shower, and a big black whip-snake (*Demansia papuensis*) that was spotted near our dongas! These surprises within the pastoral station made the experience all the more exciting, and left us wondering what surprises would await us out in the pristine bushland. We got ourselves settled in for a good night's sleep, ready for the proper fieldwork to start bright and early the next morning.

The Fieldwork

Given we would be conducting our fieldwork in a remote and somewhat dangerous environment, safety was obviously our number one priority. Firstly, to avoid getting lost and to keep track of where we were in the landscape, our fieldwork leader Dr. Adam Cross carried a GPS and EPIRB at all times. Secondly, to keep safe from the hot and sunny environment, we always took plenty of water. Thirdly, we were covered from head to toe with wide-brimmed hats, long-sleeved clothing, hiking boots, sunglasses, and lots of sunscreen. Finally, to protect ourselves from snakes hiding in the tall grasses, we wore knee-high gaiters. Of course, our fieldwork companion Bonnie the dog roamed about the landscape without any worries, as if it were her personal kingdom; drinking from the rivers, resting in the shade, and chasing away any form of wildlife that we encountered, including a young dingo, a big Monitor lizard (*Varanus panoptes*), and a stubborn group of feral cattle (*Bos taurus*).

In order to get to our sites, we each drove a quad bike loaded up with all of our equipment and water, and made our way through the tall grasses, over rocks and dead tree branches. Riding about on those quad bikes was a whole lot of fun, and it's something I really miss now that I'm back in Perth and not out in the field! We would always stay on one track so as to reduce disturbance to the natural landscape, with Adam leading the way. Unfortunately for Adam, this meant he was pelted with spiky Sorghum grass seeds far more than the rest of us, and at one point managed to drive



Figure 2: The Pentecost and Durack River delta.



Figure 3: Bonnie the dog and Laura Skates.

through a large spider's web and ended up with both the web and the spider wrapped around his face! Bonnie often ran at the head of our quad bike conga line, but always doubled back to check on the last person and make sure the whole pack was okay. Over the course of the week Bonnie ran nearly 100 km, so it's no wonder that at the end of each day she would stubbornly request a lift back on the back of the last quad bike through the station's gate. Driving back to the station slowly, with Bonnie curled up behind me, was the best way to end a tough day out in the field!

Over the course of the week, we collected samples of more than ten different *Drosera* species and two *Byblis* species, across nine different sites. We also encountered several *Utricularia* species, although these were not collected as they were outside the scope of my PhD research. Unfortunately, there will have been several species that we missed, as many are quite transient in nature and only present on the landscape for a few weeks each year. Some are expected to flower for only a few days, especially given the relatively dry wet season this year. For the species that we could find, samples of leaf material were collected at each site, along with samples of non-carnivorous plant species to be used as a nutritional reference. Samples of insects and soil were also collected at each site, as these are the two major sources of nutrients for the carnivorous plant species. All of this was very exciting for me, not only to be successful in making my first collections for my research, but also to see such an incredible array of carnivorous plant species, each with different and simply beautiful life-forms.

Many of the carnivorous plants sampled occurred on shallow sands in some variation of an open herb field, surrounded by tall *Sorghum* grasses and a few *Eucalyptus* trees, adjacent to the aprons of sandstone outcrops. Open fields of *Byblis filifolia* were very common and occurred at seven out of nine sites, always accompanied by a handful of other carnivorous plant species such as *B. rorida*, *Drosera banksii*, *D. burmannii*, *D. cucullata*, *D. dilatato-petiolaris*, *D. fragrans*, *D. glabriscapa*, *D. paradoxa*, and *D. subtilis*, as well as several yet-to-be-formally-described *Drosera* taxa. Several of these species were easy to locate, with their bright purple and pink flowers, such as *Byblis filifolia* and *Drosera fragrans*. However, for many of the smaller *Drosera* taxa, such as *D. banksii* and *D. burmannii*, it was necessary to get down on hands and knees in the mud and push back the low herbs and grasses to find the dewy plants hiding beneath. As you might expect, we would often find a greater abundance and diversity of carnivorous plants at the edges of pristine sandstone creeks (Fig. 4) running through the herb lands, where soils were moister. In these areas, *D. banksii*, *D. cucullata*, and *D. paradoxa* in particular were more common.

While driving our quad bikes from one site to another, we stumbled upon a particularly interesting patch of herb land, where we spotted a different *Drosera* species. Spread like a carpet along the dry soil of this sandy herb land was *Drosera ordensis*, a gorgeous perennial species in which the white, hairy petioles contrast strongly with the blood red trapping leaves (Fig. 5). This was the only carnivorous plant species found growing in this area; perhaps the sand was too dry for the predominantly annual species that we had previously found on more moist soils. Another reason as to why this site was of particular interest was the presence of a nearby



Figure 4: Sandstone creek running through herb lands.

cave painted with Aboriginal rock art. Indigenous Australians have occupied the Kimberley region for nearly 40,000 years, and continue to be the traditional owners of the land. Many Aboriginal groups still practice traditional law in this region, as part of one of the world's oldest continuous cultures. We were incredibly lucky to have the opportunity to see this ancient artwork, and it is something that I will not soon forget.

One of the most exciting days on the field trip by far required us to cross a large river to get to our field site (Fig. 6). That's right, we stripped down to our bathers, lowered ourselves into the murky waters of the Kimberley, and crossed our fingers that there would be no crocodiles! Our fieldwork leader assured us that it would be perfectly safe; usually, crocodiles don't come this far inland. Even if they did, this particular area of the river was too shallow and rocky for their liking and located between two waterfalls, which crocodiles tend to avoid at all costs. Of course this just made me think of the possibility that a crocodile could have somehow made its way this far inland, got itself stuck between these two waterfalls, become enraged by the rocks scraping against its belly, and would be just about ready for a tasty meal. Crikey!

It was very reassuring that Bonnie jumped in the river without a care in the world, and swam back and forth the whole way while waiting for us to get our equipment ready. This was the real challenge: transporting all of

our sampling gear, hiking boots, lunch, and expensive cameras across the river, without them all becoming soaked or lost at the bottom of the murky waters! We placed everything into rubbish bags



Figure 5: *Drosera ordensis*.



Figure 6: Our crossing at the Morgan River.

and big plastic crates, which we floated out in front us as we swam the distance, Bonnie by our side. Luckily, we made it across the river without any harm and without any loss of equipment. I'm not going to lie, I felt a bit like Crocodile Dundee!

Once we'd made it to the other side of the river, the adventure was not over. We still had to trek our way across the sandstone and woodland and collect our samples. After a somewhat rainy lunch with a beautiful view, we found ourselves trapped under a fast approaching lightning storm. In such a remote place, lightning can be a big problem, as fires can be started quite easily. With our equipment, including my metal pole with an insect net attached to the end, we were basically a beacon for any stray lightning that might occur. We hurried off to find shelter under a large boulder overhang, to keep us (and Bonnie!) safe and dry.

Once the storm had passed, we were able to resume our work, and collected a variety of species including *Byblis filifolia*, *Drosera glabriscapa*, *D. serpens*, and *D. subtilis*. The rain continued to drizzle over us all day, making it quite difficult to take notes on wet paper, and leaving us soaked to the bone. As the daylight started to fade, we began heading back towards the river crossing area and prepared ourselves for the swim back to the other side. Floating our crates of equipment across was even more difficult this time around, thanks to the extra weight of all of our samples, but we made it in the end! While this day on the fieldtrip was definitely the most exciting, we were all glad to be returning to the station to dry off.

On our very last day of sampling we ventured into some swampy blacksoil areas by the roadside in the hopes of finding a few species that had been quite elusive throughout the earlier days of the trip. Success! We found *Drosera hartmeyerorum*, *D. nana* and *Byblis liniflora* growing in the shade of other herbaceous plants, small shrubs, and *Eucalyptus* trees, as well as the more prevalent species *D. banksii*, *D. burmannii*, and *D. fragrans*. Many of these species grew right up to the edge of the roadside, where vegetation began to thin out, perhaps exploiting the higher light available. Having collected as many different species as we possibly could, we returned to the station and began the arduous task of packing away all of our equipment and samples in preparation for the long journey home – a job that lasted well into the early hours of the next morning.

Final Thoughts

Once the trip had come to an end, I was able to reflect on the success of the field work, the difficulties involved in the sampling process, and the exciting adventurous aspects that we had the privilege to experience. Over the course of one week, we were able to get a significant amount of sampling done for my PhD project: nine different sites, collections of nearly 20 different carnivorous plant species, a total of 250 plant samples (including the non-carnivorous plant samples for reference), 30 collections of potential insect prey, and about 5 kg of soil. Through this process, I was also able to determine the best methods for collecting, sorting, and labelling my samples, which will come in very handy when I go to collect other carnivorous plant species in the southwest corner of Western Australia – an even more exceptionally biodiverse region harbouring more carnivorous plants than anywhere else on the planet. The next step will be to analyse and compare all of the plant, insect, and soil samples, to determine whether there are differences in the nutrition of species from different families and from different geographic locations. Until then, I feel extremely lucky to have been able to see such a great range of the native fauna and flora that makes the Kimberley region of Western Australia so unique, and I hope I can return to this beautiful part of our country again one day soon!

References

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