Quantum dots capture speciation in sandplain fynbos on the West Coast of South Africa

August 5 2019

With a tongue up to 7 cm in length, the long-tongue fly *Moegistorhynchus longirostris* often battles to fly, especially in the wind. The fly must fully insert its proboscis into the flower to obtain a tiny droplet of nectar at the bottom of the tube, and in the process pollen is placed on or removed from its head by the long-tubed iris, *Lapeirousia anceps*. Credit: Bruce Anderson

Using quantum dots as a tool to trace the pollen of the long-tubed iris, *Lapeirousia anceps*, evolutionary ecologists from Stellenbosch University have succeeded in capturing a snapshot of a plant in the process of speciation.

Professor Bruce Anderson, an evolutionary ecologist in the Department of Botany and Zoology at SU, says this is only the third time in his research career where he has found a contact zone where speciation appears to be happening right in front of our eyes."Contact zones of entities in the process of diverging may actually be quite common, but they are hard to find because you really need to know what to look for," he postulates.

For the past 15 years Anderson and his associates have been visiting a patch of West Coast sand-plain fynbos just outside the small town of Mamre on South Africa's West Coast, a 45 minute drive from Cape Town along the N7 highway.

This is one of the prime spots where the long-tubed iris, *Lapeirousia anceps* can be found, as well as its pollinator, the long-tongue fly, Moegistorhynchus longirostris.

"Think of the famous example of the Madagascar star orchid with its 30cm nectar tube and Darwin's moth with an almost equally long tongue," Anderson explains, "where the orchid and moth have coevolved in an escalating race scenario."

The same evolutionary mechanism behind matching of pollinator tongues and floral tubes is true for *Lapeirousia*.

In 2009 a fellow researcher, Professor Anton Pauw, found that *Lapeirousia* has tube lengths which have coevolved with the tongue lengths of its fly pollinator, Moegistorhynchus longirostris, where

tongues and tubes can vary from 43-86mm, depending on the study site. In other words, the tube-lengths of the plants match perfectly with the tongue-length of the pollinators, depending on the geographical location of the different populations.

Professor Bruce Anderson from Stellenbosch University has spent many hours doing fieldwork in an area of sandplain fynbos on the West Coast of South Africa, a 45 minute drive from Cape Town, trying to capture the interaction between the long-tubed iris and its enigmatice pollinator, the long-tongue fly. Credit: Christina Ewerhardy

But in 2003 Anderson stumbled upon a strange population of *Lapeirousia anceps* in the Mamre area: "Some plants had short floral

tubes and others had long tubes, and very few plants had tubes of intermediate length. Yet this population of plants was visited by only a single species of the long-tongued fly, Moegistorhynchus longirostris."

For the next 15 years, Anderson and his colleagues studied this population and found that there was little gene flow between the two plants forms, which explained why they had remained as two separate entities for so long.

"In other countries with fewer plant species, biologists would have been sorely tempted to call these forms different species, but we have so many species already that we can afford to be a little more circumspect!" he laughs.

Anderson was much more interested in finding the mechanisms that prevented the two forms from mixing in the first place.

On one of the many photographs from his field work, he noticed a long-tongued fly from that area with pollen on the top of its head and then another clump of pollen halfway down its tongue. But because these plants are so recently diverged, they couldn't tell the pollen apart.

"I was sure that the pollen on the head was from the long-tubed flowers and the other pollen from the short-tubed flowers, but I had no way of showing this."

Quantum physics to the rescue

When Corneille Minnaar joined the group as a Ph.D. student in 2015, he decided to try and find a reliable method to label and track pollen in order to answer this question. By the end of his first year, he succeeded in using quantum dots to label pollen grains, thereby breaking new ground in a field of research that has been hampered by the lack of a

universal method to track pollen for over a century.

During November 2015 and 2016, the team set off to Mamre to test the newly-designed method in the field, and, more importantly, to test Anderson's hypothesis.

In the case of *Lapeirousia* and the long-tongued fly, Minnaar and Anderson were now able to show conclusively that long- and short-tubed flowers place and receive pollen on different parts of the fly's long tongue: short tubed flowers mostly midway and long-tubed flowers on or near the head.

Consequently, pollen seldom moves between long and short tubed individuals, indicating a barrier to the flow of genes.

Professor Andersons says it looks as if they have captured these plants in the very act of speciation: "This is quite unusual, because normally when you see plants they have diverged long ago and it is very difficult to tell the processes by which they diverged. This is different. We've managed to capture these plants in the act of speciation and we were able to identify the process and mechanisms by which it is taking place."

He says it is hard to predict whether these two forms of *Lapeirousia* will remain separate forever or eventually unify. But what he does know is that this patch of land needs to be protected.

"It is severely threatened, heavily grazed and invaded by acacias and grasses," he warns. "There is a very real possibility for this unique patch of sand-plain fynbos to disappear in the not too distant future."

More information: Corneile Minnaar et al, Intraspecific divergence in floral-tube length promotes asymmetric pollen movement and reproductive isolation, *New Phytologist* (2019). DOI: 10.1111/nph.15971