Enigmatic megafauna: type D killer whale in the Southern Ocean

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In 1955, 17 killer whales (*Orcinus orca*) stranded on a beach in Paraparaumu, New Zealand. From the grainy, black and white photographs (Fig. 1), it was clear that they were not typical killer whales: they were small, with narrow, pointy dorsal fins, a bulbous head, and the prominent white eyepatch normally found on killer whales was reduced to a tiny slip. Nothing like them had ever been reported – either before the stranding or for decades afterward.

Fast forward, 50 years, to 2005. At a killer whale workshop in Seattle, Washington, a French researcher shared with one of us (RLP) photographs of killer whales that were depredating Patagonian toothfish (*Dissostichus eleginoides*) from commercial longline vessels at Crozet Island, in the southern Indian Ocean. When the researcher pointed out a group of "odd-looking" individuals, there was a flash of recognition and the kind of moment that field naturalists live for: it was the New Zealand killer whales, with their unmistakable round heads and tiny eyepatches. After a half-century, they were no longer extinct mutants, but alive and harassing fishermen. Moreover, Crozet is one-third of the way around the world from New Zealand, suggesting they were potentially widespread.

Globally, killer whales display a surprising amount of phenotypic diversity, with numerous described 'ecotypes' – forms that are morphologically, ecologically and phylogenetically distinct but ostensibly all the same species. For example, in the Southern Ocean (*i.e*., south of 60˚S), five different killer whale ecotypes are currently recognized: types A, B1, B2, C and D (Fig. 2; Pitman and Ensor 2003, Pitman *et al*. 2011, Durban *et al.* 2016). Even to laypeople, most of these are readily distinguishable in the field, in addition to having different habitat and prey preferences. Moreover, although their ranges are often sympatric, they do not mix socially, and genetic studies confirm that they rarely interbreed. Of these, type D is the most distinctive and, by far, the least well-known killer whale ecotype.

To document the distribution and relative abundance of killer whales in the Southern Ocean, 20 years ago we began collecting photographs of encounters, including many images taken by 'citizen scientists' on tour vessels visiting Antarctica. Among the scores of encounters documented during the first five years after the Seattle workshop, were six more groups of the New Zealand whales. From these, we published a short paper with a field description of what we referred to as the 'type D' killer whale, confirming that it was extant and phenotypically distinct from other killer whales (Pitman *et al.* 2011). The sighting records also indicated a well-defined geographic range - type D appeared to inhabit subantarctic waters that surround Antarctica and avoided the colder waters south of the Polar Front where the other four ecotypes regularly occurred. Therefore, we suggested the common name "subantarctic killer whale."

In addition to photographs, two skulls were preserved from the 1955 stranding. Sequencing their mitochondrial DNA (DNA inherited only from the mother) indicated a deep split between type D and most of the rest of the killer whale clade (Foote *et al*. 2013). However,

degraded DNA and low coverage during sequencing of the nuclear genome (DNA inherited from both parents) yielded a more ambiguous result. To better understand type D taxonomic status, we would need better quality genetic samples from additional individuals.

Photographs of type D encounters continued to trickle in, and by 2017 we had compiled 30 confirmed sightings, but they did not seem to reliably occur anywhere that was relatively accessible. Then, in 2018, a colleague studying killer whale depredation reported to us that fishery observers off the southern tip of South America were photographing mainly 'typical' killer whales (*cf*. type A), but that they sometimes also recorded type D, in an area along the continental shelf edge, south of Cape Horn. Now, for the first time, we had a much narrowed, relatively accessible area to search for the elusive type D. It was time to find a boat.

By happenstance, a few months later, we were contacted by an agent for a client who wanted to support killer whale research as part of a family visit to Antarctica. We pitched our project, and within two months we had the 24-m charter research vessel *Australis* at our disposal for three weeks to search for type D killer whales off Cape Horn. In early January 2019, we set out from Ushuaia, Argentina, with our international team of six researchers, Captain Ben Wallis, and his crew of two. The weather at the Cape was predictably wretched: during one stretch, we sat at anchor, pummeled by 40-60 knot winds for eight straight days. It became clear that the reason that this remarkably different-looking killer whale had escaped the attention of scientists for so long was that it lived offshore in latitudes with some of the worst weather in the world – the Roaring 40s and the Furious 50s. When the wind finally abated for a few hours one morning, we pounded our way out to "the spot" just as the eye of the storm was passing over. And there they were - a pod of 30 type Ds, blithely milling about, right where the fishing boat captains said they would be.

Our highest priority was to collect skin biopsy samples for genetic analyses. For that, we use a small crossbow to fire a floating dart that bounces off the whale after extracting a plug of skin and blubber the size of a pencil eraser. To be successful, we would need to approach within about 25 m, but we did not know how the whales would respond to *Australis*. As we closed to within 50 m, the pod turned, approached our vessel and began swimming around us. Friendlies! It might have occurred to us that a vessel drifting in this area would be a magnet for depredating killer whales. We lowered a hydrophone into the water, hoping to record their vocalizations, and the whales, perhaps hoping to pluck a 20-kg toothfish from trailing fishing lines, filed right by

the towed array, peering at our underwater cameras mounted on the recorder (https://ir.library.oregonstate.edu/concern/defaults/9w0328749).

We had to leave the group after 3.5 h as the next storm was gathering, but it was an historic encounter. We now have a reasonably accessible location for finding type D killer whales, and, more importantly, we collected three biopsy samples to help assess their phylogenetic status. In addition to being morphologically and ecologically distinct from other ecotypes, the Cape Horn fishermen told us that when type D and 'regular' killer whales occur around their vessels at the same time, the type Ds are driven off and kept at bay while the others feed (see also Tixier *et al.* 2016). Among closely related taxa, these physical and behavioral traits would be considered evidence of separate species, but killer whales are intelligent, social animals that, apparently, can choose not to interbreed with sympatric ecotypes. Over time though, these culturally mediated differences should promote speciation, and the question now is how far down that path type D has traveled.

Killer whales are a reminder of how little we know about life in the ocean. With their huge size (to 10 tons) and spectacular black and white color pattern, they are arguably the most universally recognizable animal that lives in the sea. But after decades of research, there is still no consensus as to even how many species of killer whales there are (one? six?). For type D, in particular, an unresolved taxonomy underscores some pressing conservation concerns. Killer whales have been interacting with toothfish longliners for decades with unknown consequences. Although longlining provides easy access to prey for many killer whales, the fishery could also be reducing their food supply. In addition, fishermen are widely known to vent their frustrations with depredating whales by shooting them. Type D could have been facing an existential threat from humans before scientists even knew it existed.

Our current research has shifted from parkas and the howling winds off Cape Horn, to lab coats and the hum of temperature control in the genetics lab. There, our natural history observations and taxonomic speculations about type D will be tested with laboratory science, and the results used to prioritize conservation needs for what could be the largest undescribed species left on the planet.

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Figures

Fig. 1. A mass stranding of anomalous-looking killer whales in Paraparamau, New Zealand, in 1955. Photo courtesy A. van Helden.

Fig. 2. Four of the at least five killer whale ecotypes that occur in the Southern Ocean. Photos: R. Pitman (types A, B1, C); P. Tixier (D).

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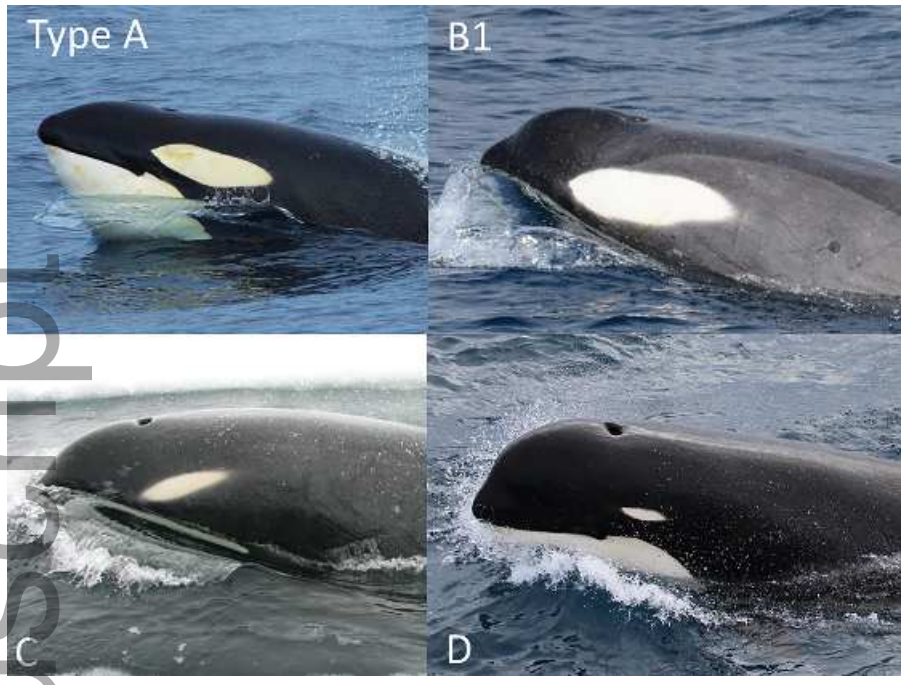

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