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Short Note

The First Records of Antarctic Type B and C Killer Whales (*Orcinus orca*) in Australian Coastal Waters

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Killer whales (*Orcinus orca*) are currently considered to constitute a single species with a cosmopolitan distribution in all the world's oceans (Leatherwood & Dahlheim, 1978; Rice, 1998; Forney & Wade, 2006). They occur more commonly in coastal temperate and polar latitudes (Dahlheim et al., 1982; Dahlheim & Heyning, 1999; Forney & Wade, 2006). Although currently accepted as a single species, recommendations have been made to genetically delineate species (Morin et al., 2010). In the Southern Hemisphere, five ecotypes of killer whale have been delineated and described based on differences in morphology, genetics, distribution, diet, and foraging patterns: Types A, B (B1 and B2), C, and D (Pitman & Ensor, 2003; Pitman et al., 2010; Pitman, 2011; Riesch et al., 2012; Fearnbach et al., 2019).

Antarctic Type A killer whales are characterized by their large body size; black and white colouration; medium-sized, horizontal post-ocular patch; and lack of a dorsal cape. This pigmentation pattern—medium-sized, horizontal post-ocular patch, and lack of dorsal cape—is the most common morphotype of killer whales worldwide (Jefferson et al., 2015). Antarctic Type A killer whales are the largest killer whale ecotype in the Southern Hemisphere, with a reported maximum length of 9.0 m for males and 7.7 m for females (Mikhalev et al., 1981; Pitman & Ensor, 2003; Fearnbach et al., 2019; Figure 1A). This ecotype has shown a preference for ice-free waters, and it exhibits a circumpolar distribution often associated with their preferred prey—Antarctic minke whales (*Balaenoptera bonaerensis*) in Antarctic waters (Fearnbach et al., 2019), and seals and penguins in Subantarctic waters (Condy et al., 1978; Guinet, 1992; de Bruyn et al., 2013; Travers et al., 2018).

Both Type B ecotypes present with a post-ocular patch that is oval in shape and is significantly larger than that of Type A, C, and D ecotypes (Figure 1B). They have a prominent dorsal cape which extends from the post-ocular patch to the anterior of the saddle. Both Type B forms regularly present with a yellow to brown colouration in high latitudes, which is attributed to diatom growth on the skin (Pitman & Ensor, 2003). These two ecotypes are typically found in Antarctic waters near or within pack ice where they are recorded to specialize in preying on marine mammals—predominantly seal species, but also minke whales (B1) and fish, squid, and penguins (B2) (Smith et al., 1981; Pitman & Ensor, 2003; Krahn et al., 2008; Visser et al., 2008; Pitman & Durban, 2010, 2012; Ainley & Ballard, 2012; Durban et al., 2017).

The Type C ecotype presents with a post-ocular patch that differs greatly from that of Type A, B, and D ecotypes. The patch is significantly smaller and narrower than that of Type A and B ecotypes and is angled forward to the eye at approximately a 45° angle (Pitman & Ensor, 2003; Figure 1C). As in Type B morphology, a prominent dorsal cape extends from the post-ocular patch to the anterior of the saddle and regularly presents with diatom coverage, giving them a yellow to brown appearance. They are the smallest known ecotype of killer whale globally, with females reaching a maximum length of 5.8 m and males 6.1 m (Pitman & Ensor, 2003; Pitman et al., 2007). Type C killer whales are predominantly sighted in East Antarctica, especially in the Ross Sea region. They are frequently encountered travelling deep

within the pack ice and along leads in fast ice, and they feed primarily on fish species (Krahn et al., 2008; Ainley & Ballard, 2009).

Type D killer whales are the most distinctive and least known killer whale ecotype globally (Pitman et al., 2019). The post-ocular patch is oriented horizontally and extremely small (Figure 1D). They lack a dorsal cape; the dorsal fin is narrow and swept back; and the head is bulbous in shape, more similar to a pilot whale (*Globicephala* spp.) than other killer whale forms (Pitman et al., 2010). This ecotype is rarely sighted, being recorded from offshore waters near the Crozet Islands (southern Indian Ocean), Drake Passage (off southern South America; Pitman et al., 2010; J. D. McInnes, unpub. data), the South Atlantic (Ensor et al., 2006), and a single mass stranding event in May 1955 in Paraparaumu, New Zealand (Visser & Mäkeläinen, 2000). From these sightings and one stranding event, it was assumed that this ecotype inhabited Subantarctic waters only. However, a recent sighting south of the Polar Front in Antarctic waters at approximately -60.755608, -56.421113 (J. D. McInnes, pers. obs., 12 December 2019) suggests this ecotype may range further south than previously thought.

Other forms not yet fully described across the range of eco-characteristics include an Antarctic form or a Type B/C variation which presents with a dorsal cape and larger than usual forward angled post-ocular patch. Observations of these animals have so far been restricted to East Antarctica (Olson et al., 2012; Figure 2).

Very little is known about the movement and distribution patterns of killer whale populations in the Southern Hemisphere. It has been suggested that killer whales inhabiting Antarctic waters may migrate north following prey during the austral winter (Mikhalev et al., 1981). Additional reports have documented killer whales in Antarctic waters during the austral winter, but it is unclear if these whales were overwintering or were trapped during the advancing sea ice (Taylor, 1957; Gill & Thiele, 1997).

Using satellite telemetry data, Andrews et al. (2008) demonstrated that the Type B and C killer whales tagged in the Ross Sea differ in movement

Figure 1. (A) Type A (*Photo credit:* David Donnelly), (B) Type B (*Photo credit:* Josh McInnes), (C) Type C (*Photo credit:* Robert L. Pitman), and (D) Type D (*Photo credit:* Josh McInnes) killer whales (*Orcinus orca*)

Figure 2. Possible new killer whale ecotype recorded in East Antarctic waters (*Photo credit:* Sanna Kuningas)

patterns and habitat use. It has been suggested these variations may be correlated to foraging behavior. A single satellite tagged Type B killer whale moved sporadically at greater distances than the tagged Type C killer whales, which tended to be more localized (Andrews et al., 2008). Similar movement patterns have been documented in mammal and fish-eating killer whales in the Northeastern Pacific (Baird, 2000).

Type B killer whales satellite tagged near the Antarctic Peninsula have been documented moving vast distances into subtropical regions. This may benefit the whales physiologically by replenishing dead skin and removing layers of diatom algae that accumulate in colder waters (Durban & Pitman, 2012). There have also been validated observations of both Type B and C killer whales from as far north as northern New Zealand (Visser, 1999; Eisert et al., 2015).

Killer whales commonly encountered in the coastal waters of Australia are represented by two forms: tropical and temperate. The key morphological differences between these two forms are that the tropical form presents with a darkened saddle and smaller post-ocular patch. Studies are currently underway to delineate these forms; therefore, we will not speculate further on this topic. For the purpose of this note, only the temperate form will be discussed.

The external morphology of the temperate form of Australian killer whale most closely resembles that of the most common morphotype worldwide, referred to in the Southern Hemisphere as Antarctic Type A (Figure 3) (D. M. Donnelly, R. L. Pitman, J. Totterdell, and R. Wellard, pers. obs.). The most notable differences for the killer whales recorded in Australian waters is the smaller size (e.g., adult male estimated 8 m maximum length [J. Totterdell, pers. comm., March 2019]) than described for the Antarctic Type A (adult male estimated 9 m; Mikhalev et al., 1981; Pitman & Ensor, 2003). Killer whales recorded so far in waters offshore of Australia are relatively poorly understood; however, based on analysis of year-round mark-recapture data on known animals, it is thought that at least well-known individual killer whales off eastern Australia are unlikely to migrate to Antarctic latitudes (Killer Whales Australia, unpub. data). Further work on mark-recapture, genetics, acoustics, and ecology is required to understand, describe, and classify the presumed temperate Australian form of killer whale.

Herein, we present data from seven validated sightings of free-swimming Antarctic Type B and C killer whales in Australian coastal waters. As outlined above, a third morphological form, closely resembling the Antarctic Type A ecotype, is also present and makes up the majority of sighting records for coastal Australian waters (Wellard et al., 2015; J. Totterdell, pers. comm., March 2019; Killer Whales Australia, unpub. data; Figure 3).

Sighting events of Antarctic type killer whales in Australian coastal waters are represented by two records of Type B (2013 & 2019) and four records of

Figure 3. Example images demonstrating the morphological similarities of Australian killer whales to the Antarctic Type A form with the Australian form at left (*Photo credit:* Jonathan Poyner) and the Antarctic Type A form at right (*Photo credit:* Carlos Olivarria)

Type C (2008, 2014, 2018 & 2021). These records confirm that at least two of the five Antarctic ecotypes described from the Southern Hemisphere (Pitman, 2011) have now been confirmed to have occurred in Australian coastal waters (Figure 3). All sightings were opportunistic in nature, collected by scientists, whale-watching vessels, recreational fishers, and land-based observers. Each event occurred within Australian coastal waters (Figure 4).

Type B

Record 1 occurred on 5 August 2013 approximately 45 nmi southwest of Dongara, Western Australia (-29.7333333, 114.216667; Figure 4). A group of six Type B killer whales (all adults) were sighted by researchers from *RV Whale Song* during a dedicated vessel-based, acoustic, and visual cetacean survey operating off the Western Australia coast. Photographs showing the distinctive large post-ocular patch, dorsal cape, and yellow diatom colouration characterized by Type B killer whales were collected (Figure 5). Images were shared with Killer Whales Australia and Mr. Robert L. Pitman with Pitman confirming they were Type B killer whales. An assessment of available sighting records confirmed this to be the first record of its type in coastal Australian waters. Based on images alone, we were not able to determine if these were Type B1 or B2 killer whales.

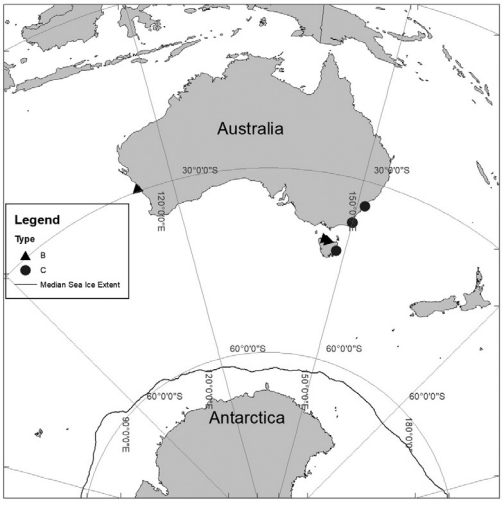

Figure 4. Sighting location map

Record 2 occurred as a series of sighting events over a 12-day period (8 to 19 December 2019) between Devonport (-41.161286, 146.375927) and Sisters Beach (-40.927907, 145.619649) in northern Tasmania (Figure 4). This extended record was validated from 24 sighting events accompanied by imagery (Figure 6). Numerous other reports were made; however, these were not supported with imagery and, therefore, they were omitted from analysis. Due to observations being made largely from land, the mark-recapture method was not always possible; however, several matches were made using imagery shared by observers. As with all other Antarctic type observations, confirmation of ecotype was validated through scrutiny of the imagery and comparing external morphology to descriptions offered in the literature (Pitman & Ensor, 2003). The group size was regularly estimated to be approximately six to eight individuals (a single adult male, five females or juvenile males, and two calves). Interestingly, the presence of the killer whales in this region coincided with fledgling little penguins (*Eudyptula minor*) leaving the burrow and entering the water (K. Carlyon, pers. comm., 20 December 2019). Despite there being observations of the Type B ecotype preying on penguins in Antarctic waters (Pitman & Durban, 2010), there is no evidence to suggest the killer whales were preying on penguins during this observation period.

Figure 5. Type B sighting, Western Australia (*Photo credit:* Micheline Jenner, CWR)

Figure 6. Type B sighting, Devonport, Tasmania (*Photo credit:* Kyle Wellard)

Type C

Record 1 occurred on 21 March 2008 off the coast of Eden, New South Wales (-37.098593, 149.956910; Figure 4). Images from this event were shared with Killer Whales Australia retrospectively (2016) and, based on morphological features, the animals were confirmed as Antarctic Type C (Figure 7). The total number of animals sighted was estimated to be approximately 15 individuals, seven of which have been added to the Killer Whales Australia catalogue. The group were reported to have been travelling slowly south and in close formation at the surface. Pod composition included at least three adult males, approximately ten females or juvenile males, and one calf.

Record 2 occurred on 5 May 2008 in a similar location to the first sighting (-37.093158, 149.955927; Figure 4). This encounter involved a pod of an estimated 20 Type C killer whales near the southern headland of Twofold Bay, Eden, New South Wales (Figure 8). The group composition included a minimum of four adult males, 12 to 15 females or juvenile males, and two calves—one calf presented with a brownish colouration to the post-ocular patch, suggesting this animal to be near to newborn. The group of killer whales were noted to be travelling south and engaging in social behavior which included spy-hopping, pectoral-slapping, and inverted swimming. Scrutiny of available images by Killer Whales Australia confirmed two matches between Records 1 and 2 (Figure 9) 16 days apart.

Record 3 occurred on 7 March 2014 near a location known as Saltwater Creek (-37.166900, 150.043750; Figure 4). The group of killer whales were encountered by recreational fishers situated approximately 5 nmi southeast of Twofold Bay, Eden, off eastern Australia. Pod size and composition were consistent with Record 1 (Figure 10). The group behaviour observed was similar to that reported in Records 1 and 2.

Record 4 occurred on 11 July 2018 off the coast of Sydney, eastern Australia (-34.017909, 151.357896; Figure 4). This large group of an estimated 50 individuals was recorded during a humpback whale watching cruise. Interestingly, several killer whales engaged with some nearby humpback whales (*Megaptera novaeangliae*) but were not recorded to have attacked them. High-quality imagery was acquired of some of the group allowing individual identification and inclusion of three new individuals to the Killer Whales Australia's eastern Australian catalogue (Figure 11).

Record 5 occurred on 8 January 2021 off the coast of Freycinet, eastern Tasmania (-42.251901, 148.374584; Figure 4). Group size was estimated at 12 to 16 individuals and included one adult male and at least one young calf (Figure 12). The pod maintained a steady southerly course and travel speed during the observation period. Image quality from this event was adequate for validation of

Figure 7. Type C sighting, Eden, New South Wales, 21 March 2008 (*Photo credit:* Ros Butt)

Figure 8. Type C sighting, Eden, New South Wales, 5 May 2008 (*Photo credit:* Nick Haenig)

Figure 9. Example images showing confirmed matches between sightings (*Photo credits:* Ros Butt and Nick Haenig)

Figure 10. Type C sighting, south of Eden, New South Wales, 30 April 2014 (*Photo credit:* Mike Lucas)

Figure 11. Type C sighting, Sydney, New South Wales, 11 July 2018 (*Photo credit:* Simon Millar)

Figure 12. Type C sighting, Freycinet, Tasmania, 8 January 2021 (*Photo credit:* Richard Chippingdale)

ecotype; however, it was not adequate for inclusion in or comparison to the eastern Australian fin identification catalogue.

These validated observations of Antarctic Type B and C killer whales in Australian coastal waters add to the growing evidence that both ecotypes may make short-term migrations between Antarctic and subtropical latitudes (Visser, 1999; Durban & Pitman, 2012). With the paucity of information available on migratory movements of Southern Hemisphere killer whales, the information presented in this note demonstrates the value of data sharing between the public, industry, and research groups. Further studies to understand morphology, diet, genetics, acoustics, movement, and behaviour will enhance our understanding of the differentiation and diversity of ecotypes in the Southern Hemisphere, and the extent and function of movements by these ecotypes.

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Literature Cited

Ainley, D. G., & Ballard, G. (2012). Trophic interactions and population trends of killer whales (*Orcinus orca*) in the southern Ross Sea. *Aquatic Mammals*, *38*(2), 153-160. https://doi.org/10.1578/AM.38.2.2012.153

Andrews, R. D., Pitman, R. L., & Ballance, L. T. (2008). Satellite tracking reveals distinct movement patterns for Type B and Type C killer whales in the southern Ross Sea, Antarctica. *Polar Biology*, *31*(12), 1461-1468. https://doi.org/10.1007/s00300-008-0487-z

Baird, R. W. (2000). The killer whale: Foraging specializations and group hunting. In J. Mann, R. C. Connor, P. L. Tyack, & H. Whitehead (Eds.), *Cetacean societies: Field studies of dolphins and whales* (pp. 127-153). The University of Chicago Press.

Condy, P. R., Van Aarde, R. J., & Bester, M. N. (1978). The seasonal occurrence and behaviour of killer whales *Orcinus orca*, at Marion Island. *Journal of Zoology*, *184*(4), 449-464. https://doi.org/10.1111/j.1469-7998.1978.tb03301.x

Dahlheim, M. E., & Heyning, J. E. (1999). Killer whale *Orcinus orca* (Linnaeus, 1758). In S. H. Ridgway & R. Harrison (Eds.), *Handbook of marine mammals: Vol. 6. The second book of dolphins and porpoises* (pp. 281-322). Academic Press.

Dahlheim, M. E., Leatherwood, S., & Perrin, W. F. (1982). Distribution of killer whales in the warm temperate and tropical eastern Pacific. *Reports of the International Whaling Commission*, *32*, 647-653.

de Bruyn, P. J. N., Tosh, C. A., & Terauds, A. (2013). Killer whale ecotypes: Is there a global model? *Biological*

Reviews, *88*, 62-80. https://doi.org/10.1111/j.1469-185X.2012.00239.x

Donnelly, D. M., McInnes, J. D., Morrice, M., & Andrews, C. (2019). *Killer whales of eastern Australia* (Photo-identification catalogue maintained by Killer Whales Australia).

Durban, J. W., & Pitman, R. L. (2012). Antarctic killer whales make rapid, round-trip movements to subtropical waters: Evidence for physiological maintenance migrations? *Biology Letters*, *8*(2), 274-277. https://doi.org/10.1098/rsbl.2011.0875

Durban, J. W., Fearnbach, H., Burrows, D. G., Ylitalo, G. M., & Pitman, R. L. (2017). Morphological and ecological evidence for two sympatric forms of Type B killer whale around the Antarctic Peninsula. *Polar Biology*, *40*(1), 231-236. https://doi.org/10.1007/s00300-016-1942-x

Eisert, R., Ovsyanikova, E., Visser, I., Ensor, P., Currey, R., & Sharp, B. (2015). *Seasonal site fidelity and movement of Type-C killer whales between Antarctica and New Zealand* (SC/66a/SM/9). Report to the International Whaling Commission.

Ensor, P., Komiya, H., Beasley, I., Fukutome, K., Olson, P., & Tsuda, Y. (2006). *2006-2007 International Whaling Commission–Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Cruise, Area III* (Paper SC/59/IA1). Submitted to the IWC Scientific Committee.

Fearnbach, H., Durban, J. W., Ellifrit, D. K., & Pitman, R. L. (2019). Abundance of Type A killer whales (*Orcinus orca*) in the coastal waters off the western Antarctic Peninsula. *Polar Biology*, *42*(8), 1477-1488. https://doi.org/10.1007/s00300-019-02534-z

Forney, K. A., & Wade, P. R. (2006). Worldwide distribution and abundance of killer whales. In J. A. Estes, R. L. Brownell, Jr., D. P. Demaster, D. F. Doak, & T. M. Williams (Eds.), *Whales, whaling and ocean ecosystems* (pp. 145-162). University of California Press. https://doi.org/10.1525/california/9780520248847.003.0012

Gill, P. C., & Thiele, D. (1997). A winter sighting of killer whales (*Orcinus orca*) in Antarctic sea ice. *Polar Biology*, *17*(5), 401-404. https://doi.org/10.1007/s003000050134

Guinet, C. (1992). Comportement de chasse des orques (*Orcinus orca*) autour des iles Crozet [Hunting behavior of killer whales (*Orcinus orca*) around the Crozet Islands]. *Canadian Journal of Zoology*, *70*, 1656-1667. https://doi.org/10.1139/z92-231

Jefferson, T. A., Webber, M. A., & Pitman, R. L. (2015). *Marine mammals of the world: A comprehensive guide to their identification* (2nd ed., pp. 186-192). Academic Press/Elsevier.

Krahn, M. M., Pitman, R. L., Burrows, D. G., Herman, D. P., & Pearce, R. W. (2008). Use of chemical tracers to assess diet and persistent organic pollutants in Antarctic Type C killer whales. *Marine Mammal Science*, *24*(3), 643-663. https://doi.org/10.1111/j.1748-7692.2008.00213.x

Leatherwood, J. S., & Dahlheim, M. E. (1978). *Worldwide distribution of pilot whales and killer whales* (No. NOSC/TR-295). Naval Ocean Systems Center.

Mikhalev, Y. A., Ivashin, M. V., Savusin, V. P., & Zelenaya, F. E. (1981). The distribution and biology of killer whales in the Southern Hemisphere. *Reports of the International Whaling Commission*, *31*, 551-566.

Morin, P. A., Archer, F. I., Foote, A. D., Vilstrup, J., Allen, E. E., Wade, P., Durban, J., Parsons, K., Pitman, R., Li, L., Bouffard, P., Abel Nielsen, S. C., Rasmussen, M., Willerslev, E., Gilbert, M. T. P., & Harkins, T. (2010). Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. *Genome Research*, *20*, 908-916. https://doi.org/10.1101/gr.102954.109

Olson, P. A., Ensor, P., & Kuningas, S. (2012). Observations of killer whales off East Antarctica, 82°-95°E, in 2009. *Journal of Cetacean Research and Management*, *12*(1), 61-64.

Pitman, R. L. (2011). Antarctic killer whales: Top of the food chain at the bottom of the world. *Journal of the American Cetacean Society*, *40*(1), 39-45.

Pitman, R. L., & Durban, J. W. (2010). Killer whale predation on penguins in Antarctica. *Polar Biology*, *33*(11), 1589-1594. https://doi.org/10.1007/s00300-010-0853-5

Pitman, R. L., & Durban, J. W. (2012). Cooperative hunting behavior, prey selectivity and prey handling by pack ice killer whales (*Orcinus orca*), Type B, in Antarctic Peninsula waters. *Marine Mammal Science*, *28*(1), 16-36. https://doi.org/10.1111/j.1748-7692.2010.00453.x

Pitman, R. L., & Ensor, P. (2003). Three forms of killer whales (*Orcinus orca*) in Antarctic waters. *Journal of Cetacean Research and Management*, *5*(2), 131-140.

Pitman, R. L., Perryman, W. L., LeRoi, D., & Eilers, E. (2007). A dwarf form of killer whale in Antarctica. *Journal of Mammalogy*, *88*(1), 43-48. https://doi.org/10.1644/06-MAMM-A-118R1.1

Pitman, R. L., Ballance, L. T., Sironi, M., Totterdell, J., Towers, J. R., & Wellard, R. (2019). Enigmatic megafauna: Type D killer whale in the Southern Ocean. *Ecology*, *101*(1), e02871. https://doi.org/10.1002/ecy.2871

Pitman, R. L., Durban, J. W., Greenfelder, M., Guinet, C., Jorgensen, M., Olson, P. A., Plana, J., Tixier, P., & Towers, J. R. (2010). Observations of a distinctive morphotype of killer whale (*Orcinus orca*), Type D, from Subantarctic waters. *Polar Biology*, *34*(2), 303-306. https://doi.org/10.1007/s00300-010-0871-3

Rice, D. W. (1998). *Marine mammals of the world: Systematics and distribution* (Special Publication 4). Society for Marine Mammalogy. 231 pp.

Riesch, R., Barrett-Lennard, L. G., Ellis, G. M., Ford, J. K. B., & Deecke, V. B. (2012). Cultural traditions and the evolution of reproductive isolation: Ecological speciation in killer whales? *Biological Journal of the Linnean Society*, *106*(1), 1-17. https://doi.org/10.1111/j.1095-8312.2012.01872.x

Smith, T. G., Siniff, D. B., Reichle, R., & Stone, S. (1981). Coordinated behavior of killer whales, *Orcinus orca*, hunting a crabeater seal, *Lobodon carcinophagus*. *Canadian Journal of Zoology*, *59*(6), 1185-1189. https://doi.org/10.1139/z81-167

Taylor, R. J. F. (1957). An unusual record of three species of whale being restricted to pools in Antarctic sea-ice. *Journal of Zoology*, *129*(3), 325-331. https://doi.org/10.1111/j.1096-3642.1957.tb00297.x

Travers, T., van den Hoff, J., Lea, M. A., Carlyon, K., Reisinger, R., de Bruyn, P. N., & Morrice, M. (2018). Aspects of the ecology of killer whale (*Orcinus orca* Linn) groups in the nearshore waters of Sub-Antarctic Macquarie Island. *Polar Biology*, *41*, 2249-2259. https://doi.org/10.1007/s00300-018-2361-y

Visser, I. N. (1999). Antarctic orca in New Zealand waters? *New Zealand Journal of Marine and Freshwater Research*, *33*, 515-520. https://doi.org/10.1080/00288330.1999.9516896

Visser, I. N., & Mäkeläinen, P. (2000). Variation in eye-patch shape of killer whales (*Orcinus orca*) in New Zealand waters. *Marine Mammal Science*, *16*(2), 459-469. https://doi.org/10.1111/j.1748-7692.2000.tb00938.x

Visser, I. N., Smith, T. G., Bullock, I. D., Green, G. D., Carlsson, O. G., & Imberti, S. (2008). Antarctic Peninsula killer whales (*Orcinus orca*) hunt seals and a penguin on floating ice. *Marine Mammal Science*, *24*(1), 225-234. https://doi.org/10.1111/j.1748-7692.2007.00163.x

Wellard, R., Erbe, C., Fouda, L., & Blewitt, M. (2015). Vocalizations of killer whales (*Orcinus orca*) in the Bremer Canyon, Western Australia. *PLOS ONE*, *10*(10), e0140738. https://doi.org/10.1371/journal.pone.0136535