

Variation in the bill colour of the white-capped mollymawk (*Thalassarche cauta steadi*)

ALAN J.D. TENNYSON

Museum of New Zealand Te Papa Tongarewa,
PO Box 467, Wellington 6140, New Zealand

ABSTRACT: The white-capped mollymawk (*Thalassarche cauta steadi*) and Tasmanian mollymawk (*T. cauta cauta*) have discreet breeding sites, but away from their breeding grounds, where their at-sea ranges overlap, they are difficult to identify. The bill colour of these taxa has recently been considered to differ, but there is much conflicting information in published accounts. Three key differences often discussed are the amount of yellow on the culminicorn, the amount of yellow on the cutting edge to the upper mandible, and the amount of darkness on the mandibular unguis. In January 2018 I assessed these characters in 100 adult white-capped mollymawks at their Disappointment Island breeding site and found that each character was variably present. The majority of white-capped mollymawks lacked a yellow base to their culminicorn and had a dark mark on their mandibular unguis. In contrast, it has been reported that the majority of adult Tasmanian mollymawks have yellow at the base of their culminicorn and lack a dark mark on their mandibular unguis. While these characters can be used as a guide to identify these taxa, a minority of individuals of each taxon show the 'typical' bill colours of the other taxon. The amount of yellow on the cutting edge to the upper mandible varied between individual white-capped mollymawks, and so this is not a useful identification character.

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Introduction

The white-capped mollymawk (*Thalassarche cauta steadi*) breeds almost exclusively in New Zealand's subantarctic, and is most closely related to the Tasmanian mollymawk (*T. cauta cauta*), which breeds on islands off Tasmania. For many decades *T. c. steadi* was not recognised as a distinct taxon, despite being described in 1933 (Falla 1933), and hence little or no attention was paid to how its bill colour might differ from the bill colour of the Tasmanian mollymawk (e.g. Oliver 1955; Harper & Kinsky 1978; Harrison 1983, 1989; Marchant & Higgins 1990; Enticott & Tipling 1997; Onley & Bartle 1999). During the past 20 years *T. c. steadi* has been increasingly recognised as a valid taxon; however, the taxonomic relationship between it and *T. c. cauta* is debated, with some authorities recognising them as subspecies and others recognising each as a full species (Gill *et al.* 2010).

The at-sea distributions of white-capped mollymawk and Tasmanian mollymawk overlap (Marchant & Higgins 1990; Tickell 2000; Brooke 2004; Abbott *et al.* 2006; Gill *et al.* 2010), but their identification remains problematic due to a lack of detailed information about their physical differences. Three key differences, often discussed in descriptions and identification guides, are the amount of yellow on the culminicorn (the horny covering of the top ridge of the bill), the amount of yellow on the cutting edge to the upper mandible (upper jaw), and the amount of darkness on the mandibular unguis (the terminal nail of the lower bill). However, the description and interpretation of these features is conflicting and confusing. No sex differences in bill colour of white-capped or Tasmanian mollymawks (or any other *Thalassarche* taxa) have been documented (Marchant & Higgins 1990).

Yellow on the dorsal base of the culminicorn and upper mandible cutting edge

The initial description of the white-capped mollymawk noted that the taxon had a 'bright[er] and more uniformly coloured' cream-yellow bill than that of the Tasmanian mollymawk (Falla 1933). Marchant & Higgins (1990) noted that the bill of both taxa is 'greyish-horn' in colour, often with a 'straw-yellow wash' across the base of the

culminicorn and with a contrasting yellow maxillary and mandibular tip. They considered that the bills of these taxa were 'seemingly identical' and that the suggestion that white-capped mollymawks had a 'bill more brightly coloured' and more 'uniform bluish-horn except for pale yellow tip' was unfounded (Marchant & Higgins 1990). Heather & Robertson (2000) described these features of the white-capped mollymawk bill in a similar way: the bill being 'pale bluish horn with yellowish top ... especially at base and tip'. Tickell (2000) noted that the bills of both taxa become 'light metallic-grey sometimes with suffused yellow at the base of the culminicorn and on the tip (unguis)'. Brooke (2004) noted that white-capped and Tasmanian mollymawks have 'bill pale grey with pale yellow upper ridge and brighter yellow tip to upper mandible'.

Parkinson's (2000) description has similarities to Falla's original description in that it notes that Tasmanian mollymawks have a 'yellowish-grey' bill with a 'yellow tip' that is paler compared with the bill of white-capped mollymawks. Somewhat ambiguously, he noted further that white-capped mollymawks have a 'bluish-grey' bill with a 'yellow tip and pale yellow culmen'. De Roy *et al.* (2008) noted more explicitly that white-capped mollymawks have a yellower culminicorn base than is found in Tasmanian mollymawks, i.e. in white-capped mollymawks the 'top ridge on [the] bill [is] slightly more yellowish, especially near [the] base, whereas in [the Tasmanian mollymawk the] bill is more uniformly coloured'. They emphasised this difference further by stating that the white-capped mollymawk has 'slightly more yellowish upper ridge to [the] bill' than the Tasmanian mollymawk.

However, they then noted also that the Tasmanian mollymawk has 'some variable yellow colouring on [the] culmen (upper ridge), slightly brighter at base'. Fitter & Merton (2011) appeared to agree that white-capped mollymawks have a yellower base to the culminicorn than do Tasmanian mollymawks, which have a 'yellowish-horn' bill colour with a 'yellow tip', and that the 'lack of yellow at [the] base [of the] bill ridge may be diagnostic'. In white-capped mollymawks they noted that the bill colour is 'greyish or horn coloured, ridge yellowish near [the] base and tip greenish yellow'.

Other authors contradict some of these points

about bill colour, describing more prominent yellow at the base of the culmicorn and a yellower cutting edge to the upper mandible in most Tasmanian mollymawks. Shirihai (2002) noted that when comparing adults of the two taxa, the white-capped mollymawk 'has reduced yellowish pigments in bill' but 'some are identical', such as a Tasmanian bird shown in a photo with no more than a hint of yellow at the base of the culmicorn. Generally, however, he noted that Tasmanian mollymawks have a 'pale yellow' culmicorn ridge, 'especially bright near the base' and 'cutting edge to upper mandible', and that the Tasmanian mollymawk bill is 'typically extensively yellowish, especially on [the] culmen (from base to level with tubes) and on cutting edge of upper mandible, and generally appears bright yellowish-grey (rather than dull bluish horn-grey)' (Shirihai 2002). In contrast to Falla's original description, he concluded that the white-capped mollymawk has 'overall duller and greyer bill ... with limited yellowish pigment'. Double *et al.* (2003) noted that 'the amount of yellow colouration at the proximal end of the culmen ... is thought to differ between taxa', with the white-capped mollymawk showing less yellow.

In their study of birds recently killed at sea in fisheries, they found that none of the 22 white-capped mollymawks had any yellow colouration here, compared with a sample of 47 Tasmanian mollymawks, which had 36% without yellow, 43% with 'some yellow', and 21% with 'strong yellow' colouration. They concluded that 'even as adults white-capped mollymawks do not develop any yellow colouration at the base of the culmen whereas the culmen of [Tasmanian mollymawks] develop a strong yellow colouration as the bird matures. However because some adult [Tasmanian mollymawks] showed no yellow at the base of the culmen this character cannot be used to identify all adult birds'. In support of these findings, Terauds & Stewart (2005) show photos of several Tasmanian mollymawks and most, but not all, show a clear yellow upper base to the bill. Onley & Scofield (2007) provide details that further back up these general conclusions: white-capped mollymawks are 'said to have [a] fairly uniformly horn-coloured bill with less intense yellow tip to upper mandible; [most] Tasmanian birds have a pale yellow dorsal plate which is especially intensely coloured near

[the] base and yellowish cutting edge to upper mandible'. However, they conclude that 'some authors suggest that [Tasmanian mollymawks have] more yellow on top of [the] bill, but this seems to be a subtle and inconsistent difference'. Scofield & Stephenson (2013) describe how Tasmanian mollymawks have the 'tip of [the] upper mandible custard-yellow and during courtship most have [a] yellow wash at [the] bill base especially on [the] dorsal surface' and that 'the absence of yellow at the base of the bill' makes it 'likely' that an adult is a white-capped, rather than a Tasmanian, mollymawk. Menkhorst *et al.* (2017) stated that adult Tasmanian mollymawks have a bill that is 'pale grey-green with yellow tip' and usually with a 'yellow wash to [the] base of [the] upper mandible, but this feature varies: completely absent in some, brightest at onset of breeding in others'; while white-capped mollymawks 'always lack ... yellow at base of bill'.

Dark tip to the mandibular unguis

Immature *Thalassarche* mollymawks of all species have darker bills than adults; as birds age and adult bill colour is attained, it is the tips of the bill that retain residual dark areas the longest (Marchant & Higgins 1990). This general colour pattern change occurs in white-capped and Tasmanian mollymawks (Marchant & Higgins 1990; Onley & Bartle 1999; Tickell 2000); however, it is unclear exactly how the presence or absence of a dark mark on the mandibular unguis relates to a bird's age.

Falla (1933) noted confusion around identifying immature white-capped mollymawks, surmising that birds that had 'pale cream bills with a dark sub-terminal patch on the mandible' might be immature white-capped mollymawks. Oliver (1955) noted that immature white-capped and Tasmanian mollymawks have a 'pale cream' bill with a 'dark subterminal patch'. Harper & Kinsky (1978) noted that the 'black tip of the lower mandible is the last area to lose its dark colouration'. Harrison (1983) stated that it is 'sub-adults' of these taxa that 'retain [a] blackish tip to [the] lower mandible'; however, the 'adult' shown in his photographic guide has a dark smudge on its mandibular unguis (Harrison 1989). Enticott & Tipling (1997) noted that adult plumage is thought to be acquired before the black tip to the bill is lost. Tickell (2000) noted that juveniles of both

taxa have *'dark spots on the ends of the mandibles (mandibular unguis) that become yellow in adults'*. Fitter & Merton (2011) stated that the bill of white-capped mollymawks has a *'dark tip to [the] lower mandible especially in younger birds'*. Hedd *et al.* (1998) noted that subadult Tasmanian mollymawks *'retain darkness at the bill tips'*.

In contrast, many recent authors have stated that a dark mandibular unguis mark is not confined to immatures and can be found in adult white-capped and Tasmanian mollymawks. Marchant & Higgins (1990) noted that the bill of some adults of both these taxa, including Tasmanian breeding birds in *'full adult plumage'*, can have a *'wholly black mandibular unguis or smaller dusky mandibular spot'*; however, they suggest that this dark area continues to reduce with age. Onley & Bartle (1999) noted that as juvenile [white-capped mollymawk and Tasmanian] mollymawks get older, their bills become *'paler grey with a yellow tip marked by blackish smudges'*, while adults often have a *'blackish smudge on the tip of the lower mandible'*. Double *et al.* (2003) stated that Tasmanian mollymawks *'lose the black or dark grey colouration of the maxillary and mandibular unguis with age ... although a few breeding adults have been recorded with a dark tip to their mandibular unguis'*.

336

They classified birds of either taxa with *'no black/dark grey in bill'* as adults and those with *'some dark colouration on the mandibular unguis'* as subadults. Brooke (2004) noted that the bills of both taxa have a *'dark spot at [the] tip of [the] lower [mandible]'*, with *'black tips to both mandibles'* in juveniles. Photos of Tasmanian mollymawks at breeding colonies in Terauds & Stewart (2005) show several birds apparently lacking any darkness on the mandibular unguis, but a few birds show some darkness in this area. De Roy *et al.* (2008) noted that white-capped mollymawk adults may *'have [a] dark patch on [the] tip of [the] lower mandible, especially in younger birds'*. Menkhorst *et al.* (2017) noted that the *'dusky tip to lower mandible [is] usually [the] last feature to be replaced, some ad[ults] (perhaps young breeders?) retain this feature'*.

Some authors have gone further, stating that the frequency of this dark mark on the mandibular unguis differs between adult white-capped and Tasmanian mollymawks. Shirihai (2002) noted that the *'dark mark at [the] lower tip [is] usually*

lacking or indistinct' in adult Tasmanian mollymawks, while the white-capped mollymawk has a *'tendency to have [a] slightly darker tip'*. Onley & Scofield (2007) noted that *'some adults of both subspecies may have a darker, smudgy tip to the lower mandible'*. However, they noted that *'fewer breeding [Tasmanian mollymawks] have any dusky tip to the lower mandible'*. Similarly, Scofield & Stephenson (2013) noted that these taxa have a *'variable black spot on tip of both upper and lower mandible'*; they show photos of white-capped mollymawks, noting for one that the *'dark marking on the tip of the lower mandible probably indicates this is an immature but birds may breed at this age'* and for another that the *'mostly yellow tip to the lower mandible indicates this is an adult'*. They noted that fewer breeding Tasmanian mollymawks have a *'dusky tip to [the] lower mandible'*.

When is adult bill colour obtained?

The age at which white-capped and Tasmanian mollymawks obtain adult bill colours is not fully documented. The adult bill colour develops gradually, with the side-plates and culminicorn becoming *'paler greyish-horn'* as the maxillary unguis becomes increasingly yellow; however, the *'mandibular unguis remains ... black or [with a] paler greyish-black spot until after [the] rest of bill and plumage [are] fully adult'* (Marchant & Higgins 1990). In Tasmanian mollymawks the bill colour begins getting paler in the second year, when the maxillary unguis turns *'dull yellow'*; by the fourth or fifth year the adult plumage is obtained but the bill retains some signs of immaturity (Marchant & Higgins 1990). Apparently, this darkness in the bill tips is lost at 5–7 years old (Hedd *et al.* 1998). Other descriptions of the age of bill-colour development are fairly similar: Shirihai (2002) noted that *'only in [the 3rd to 4th] year does [the] bill colour develop, though yellowish and greyish-horn [are] still limited and [the] tip [is] largely dark'*. He noted that *'younger ad[ult] Tasmanian mollymawks [often] [have] less yellow on bill, being generally very similar to [the] bill of ad[ult] white-capped'*. Similarly, Double *et al.* (2003) reported that Tasmanian mollymawks with paler bill tips had more yellow at the base of their culminicorn. Scofield & Stephenson (2013) stated that *'at age 3 or 4' the 'greyish-cream bill colour develops in patches ... though tips to both mandibles remain black till virtually adult'*.

These varied accounts document considerable disagreement around the bill colours of these taxa, and cause confusion about the usefulness of characters suggested for identifying them. Tasmanian mollymawks undoubtedly reach New Zealand waters; a bird banded as a chick on the Tasmanian breeding grounds in May 1987 was found dead near the Waikato River mouth in Jul 1989 (Marchant & Higgins 1990). Subsequently, a bird photographed at sea in Cook Strait in May 2016 was identified as a Tasmanian mollymawk (Miskelly *et al.* 2017) because of its brightly yellow-coloured culminicorn base (C. Miskelly, *pers. comm.* 2019). Another bird photographed off New Zealand in Jan 1998 was thought most likely to be a Tasmanian mollymawk because of the 'rather prominent yellowish tone to [the] bill' (Shirihai 2002).

Methods

In order to provide more information on the key bill identification features discussed above, I recorded the frequency of yellow at the base of the culminicorn, and the amount of dark on the mandibular unguis, of nesting white-capped mollymawks during visits to the largest breeding colony of this taxon, at Disappointment Island in the Auckland Island group, in January 2018. The amount of yellow on the cutting edge of the upper mandible was later assessed from photos.

On 16 Jan 2018 I assessed 100 birds in the breeding colony to quantify the prevalence of yellow at the base of the culminicorn. This was during the incubation period, and adults were mainly sitting on nests. Approximately a third of birds did not have an egg, and many birds were displaying at or around nests; my sample included birds in all these categories. Although not specifically examined at the time, photographs of a smaller number of birds were used subsequently to assess the amount of yellow on the cutting edge to the upper mandible.

On 18 Jan 2018 I assessed 100 birds in the same breeding colony area to quantify the prevalence of a dark mark on the mandibular unguis. In this instance I assessed only birds that were sitting on nests (most were still incubating eggs, but a few tiny chicks were being brooded, and other birds may have been sitting on empty nests).

Results

Nearly all the 100 birds counted showed no sign of yellow at the base of the culminicorn; however, two had obvious yellow in this area (Fig. 1A, B), and one other was faintly yellow here (Fig. 1C; this bird was displaying with the bird in Fig. 1A). These three individuals were attending empty nests.

Photographs revealed that the amount of yellow on the cutting edge to the upper mandible was variable, e.g. the yellow is absent in some individuals but very clear in others, such as in the individual shown in Fig. 1F (this bird was not beside a nest).

From the 100 individuals counted, birds with a dark mark on the mandibular unguis numbered 59 (Fig. 1B, D lower, G) as opposed to 41 without an obvious dark mark (Fig. 1D upper, E, F).

Discussion

These results show that yellow at the base of the culminicorn is a useful identification character for distinguishing adult white-capped and Tasmanian mollymawks because it apparently occurs more commonly in Tasmanian mollymawks (in agreement with the conclusions of Shirihai 2002, Double *et al.* 2003, Onley & Scofield 2007, and Scofield & Stephenson 2013). However, this character should be used cautiously because a small percentage of birds at the main white-capped mollymawk breeding colony also show this feature (*contra* Double *et al.* 2003; Menkhorst *et al.* 2017). Shirihai (2002) concluded that individuals 'with ... an intermediate bill [colour] should be left undetermined' to taxon. Additionally, the amount of yellow on the cutting edge of the upper mandible of white-capped mollymawks was variable, and so, contrary to Shirihai (2002), the cutting edge is not always dark in white-capped mollymawks and this character also cannot be used to separate individuals of these taxa. While it could be argued that individual birds seen on Disappointment Island with particularly yellow bills are actually vagrant Tasmanian birds, genetic studies indicate no recent gene flow between these taxa (Abbott *et al.* 2006), and so it is more parsimonious to conclude that



such birds are showing the extremes of natural variation within the white-capped mollymawk.

It is likely that the intensity of yellow on the bills of individual white-capped and Tasmanian mollymawks varies, but this needs further investigation. It is documented that the pink colour of wandering and royal albatross (*Diomedea* spp.) bills 'flushes to a brighter pink, especially in breeding birds' (Marchant & Higgins 1990), and so the colour in white-capped and Tasmanian mollymawks may vary in intensity seasonally also. The colour flushing in *Diomedea* albatross bills is largely confined to adults and is thought 'to be caused by increased flow of blood below [the] ramphotheca; perhaps breeding condition, stress and heat shedding may bring it on' (Marchant & Higgins 1990). Beak colour in dead albatrosses can fade rapidly (Marchant & Higgins 1990; author, pers. obs.), also indicating that blood flow influences bill colour intensity. In museum specimens of white-capped and Tasmanian mollymawks, the colours alter greatly as the bill dries (author, pers. obs.). However, Double *et al.* (2003) found that some dead Tasmanian mollymawks that had been frozen for several years retained strong yellow colouration at the culminicorn base. Scofield & Stephenson (2013) noted that the grey bill of adults has a

'pale yellowish wash, and yellowish tip, brighter when breeding'; they noted how Tasmanian mollymawks have the 'tip of [the] upper mandible custard-yellow and during courtship most have [a] yellow wash at [the] bill base especially on [the] dorsal surface'. Menkhorst *et al.* (2017) stated that adult Tasmanian mollymawks have a bill usually with a 'yellow wash to base of upper mandible, but this feature varies: completely absent in some, brightest at onset of breeding in others'.

The majority of adult white-capped mollymawks had dark smudging on their mandibular unguis. It is possible that the bill tip continues to become paler as adults age, so that the oldest birds have the palest beaks. However, the high percentage of birds with dark bill tips suggests that this character is not confined to younger birds or subadults (*contra* Oliver 1955; Harper & Kinsky 1978; Harrison 1983; Tickell 2000) and persists into old age in some individuals. Therefore, the at-sea distribution described for subadult white-capped mollymawks (Abbott *et al.* 2006) probably includes fully adult birds. Some adult Tasmanian mollymawks also have dark marks on their mandibular unguis (e.g. Shirihai 2002; Onley & Scofield 2007; Scofield & Stephenson 2013), and so although dark marks may be more frequent in white-capped mollymawks, this feature cannot be used to separate all adults of these taxa. Shirihai (2002) concluded that individuals 'with obvious dark on [the bill] tip ... should be left undetermined' to taxon.

Following bill colour change in white-capped mollymawks of known age, and comparative quantitative information from Tasmanian mollymawks, would further help to understand the level of difference between the bill colours of these taxa.

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FIGURE 1 (OPPOSITE). Variation in bill colour of adult white-capped mollymawks, Disappointment Island, Auckland Islands, January 2018. Note (A) obvious yellow at culminicorn base, (B) obvious yellow at culminicorn base and dark mandibular unguis mark, (C) faint yellow at culminicorn base and dark mandibular unguis mark, (D) upper bird showing neither yellow at culminicorn base nor darkness on mandibular unguis, lower bird with no yellow on culminicorn base and dark unguis mark, (E*) neither yellow at culminicorn base nor darkness on mandibular unguis, (F) neither yellow at culminicorn base nor darkness on mandibular unguis but note yellow cutting edge to upper mandible, (G**) no yellow base to culminicorn and a black mark on mandibular unguis; this was the most common combination of bill colours seen. *Bird sitting and so probably on egg; **bird incubating egg; other birds were without eggs. *Images: Alan Tennyson.*

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