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Identification of a nominate Intermediate Egret *Ardea intermedia intermedia* in south-western Australia

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Abstract. An adult Intermediate Egret in breeding plumage (pre-alternate moult) observed at Lake Joondalup, Western Australia, in January 2016 was identified as a vagrant of the Asian nominate taxon *Ardea intermedia intermedia.* Subspecific identification was established from the extent of black on the bill (which increased during the bird's stay at the site, of at least 17 days), and was confirmed independently by its proportionally short and thickly tapering bill, which was found to lie outside the range of Australian *A. i. plumifera* from an image-based analysis of the bills of each taxon. This is the first documented record of this taxon for Australia.

Introduction

On 10 January 2016, MC & JG observed an Intermediate Egret *Ardea intermedia* at the southern end of Lake Joondalup, near Perth, Western Australia (31°46′30″S, 115°47′48″E). From the extensive amount of black on the bill, and a subsequent analysis of bill proportions which we report here, the bird was identified as a vagrant of the nominate Asian subspecies *A. i. intermedia* (*sensu stricto*) rather than the resident Australian subspecies *A. i. plumifera*, which occasionally shows (at most) a small black tip to the bill (Hancock & Kushlan 1984). This is the first documented record for Australia of this taxon, which is separated at species level in some recent treatments (del Hoyo *et al.* 2014; BirdLife International 2016).

Photographs of the same bird were subsequently received from Jennie Stock [taken on 2 January (Figure 1) and 11 January (Figure 2)] and Keith Wilcox [taken on 11 January (Figure 3)], which supplement lower-quality images obtained by us (see Supplementary material available only online at www.birdlife.org.au/afo). Further field observations were made on 12 and 16 January (DM), and a further sighting was reported on 19 January (D. Baxter *in litt.*). Given the vagrant status of the species in south-western Australia, records of an Intermediate Egret from the same location dated 16 December 2015 and 1 January 2016 (BirdLife WA 2016) are likely to be of the same individual, though this could not be confirmed by the observers (i.e. they do not recall a black bill). An earlier Intermediate Egret record from the site on 16 November 2015, although also possibly of the same bird, specifically noted a "bright yellow bill with no black tip" (Oorebeek 2015) and this was later confirmed with the observers (M. Oorebeek pers. comm.). Thus, although the bird was definitely present at the site for at least 17 days, there is also circumstantial (though unverifiable) evidence that it was possibly present for >9 weeks and developed a partially black bill during this period. However, repeated visits to the site after 19 January, including a thorough survey completed for a shorebird count on 7 February 2016 (JG), failed to relocate the bird.

Description of the egret

The bird was an adult all-white egret in breeding plumage (pre-alternate moult), with moderately long aigrette plumes on the breast and back, the latter appearing stained. Its general size was judged to be intermediate between Great Egret *A. alba* and Little Egret *Egretta garzetta*, which were both present at the lake (also note size relative to Glossy Ibis *Plegadis falcinellus* in Figure 2). The outstretched neck was approximately equal to the body length, or slightly longer when fully extended; our impression is that the neck was slightly longer and more slender than typical in *plumifera*. The head was smallish, with a high rounded crown, and prominent 'jowls' (gular pouch) below the bill. The bill was shortish, heavy-based and thickly tapering. The distal two-thirds were blackish, grading below the nostrils to orange-yellow at the base. Black areas of the bill extended furthest up the bill along each cutting edge. The extent and tone of black appear to have increased slightly, especially on the top and underside of the bill (compare Figures 1 and 3, dated 2 January and 11 January, respectively). The gape extended caudally to level with the eye (posterior edge of pupil). The lores and eye-rings were yellow, and slightly paler and less orange than the base of the bill. The irides were yellow and slightly paler than the lores. The legs were black to above the tarsal joint, and mottled greyish on the remaining tibia. In one photograph (see Supplementary material), the elongated middle toe was shown to be approximately the same length as the tarsus. The bird was observed feeding along fringing aquatic vegetation rather than wading, and it moved slowly and stealthily without rapid movements. At one point it was observed to catch and eat a mid-sized frog (DM).

From one photograph of the egret adjacent to two Glossy Ibis (Figure 2) and published measures for that species locally (Johnstone & Storr 1998), the exposed bill length was crudely estimated at 58–70 mm, and total body length at 1.2x Glossy Ibis length or 60–72 cm, matching a short-billed but otherwise typical size Intermediate Egret. To further compare the bill with that of typical *plumifera* or *intermedia*, an attempt was made to quantify the relative bill proportions of each using a comparative image analysis method reported below.

Figure 1. Intermediate Egret *Ardea intermedia intermedia* at Lake Joondalup, Western Australia, 2 January 2016. Photos: Jennie Stock.

Figure 2. Intermediate Egret *Ardea intermedia intermedia* at Lake Joondalup, Western Australia, 11 January 2016, showing body and bill size relative to Glossy Ibis. Photo: Jennie Stock

Figure 3. Intermediate Egret *Ardea intermedia intermedia* at Lake Joondalup, Western Australia, 11 January 2016. Photo: Keith Wilcox

Method

Online image databases (www.flickr.com, www.pbase.com) were searched to locate images of birds confirmed to be Intermediate Egret and with accompanying metadata reliably identifying the source location. Images were selected randomly (25 for each taxon), with the only criterion for inclusion being a true lateral photograph with the bill positioned in side profile, i.e. with minimal foreshortening of any bill dimension. Images of subspecies *intermedia* were sourced from across its range (India, Sri Lanka, Japan, Singapore, Thailand, Taiwan) and *plumifera* images were sourced from most Australian states, including northern Western Australia.

Relative bill dimensions were measured using image analysis software (ImageJ, US National Institutes of Health, Bethesda, Maryland, USA, http://imagej.nih.gov/ij/). To compensate for the absence of scale, the eye–nostril distance *E* (from the centre of the eye to the caudal end of the nostril) was used as a referent for the following dimensions (Figure 4):

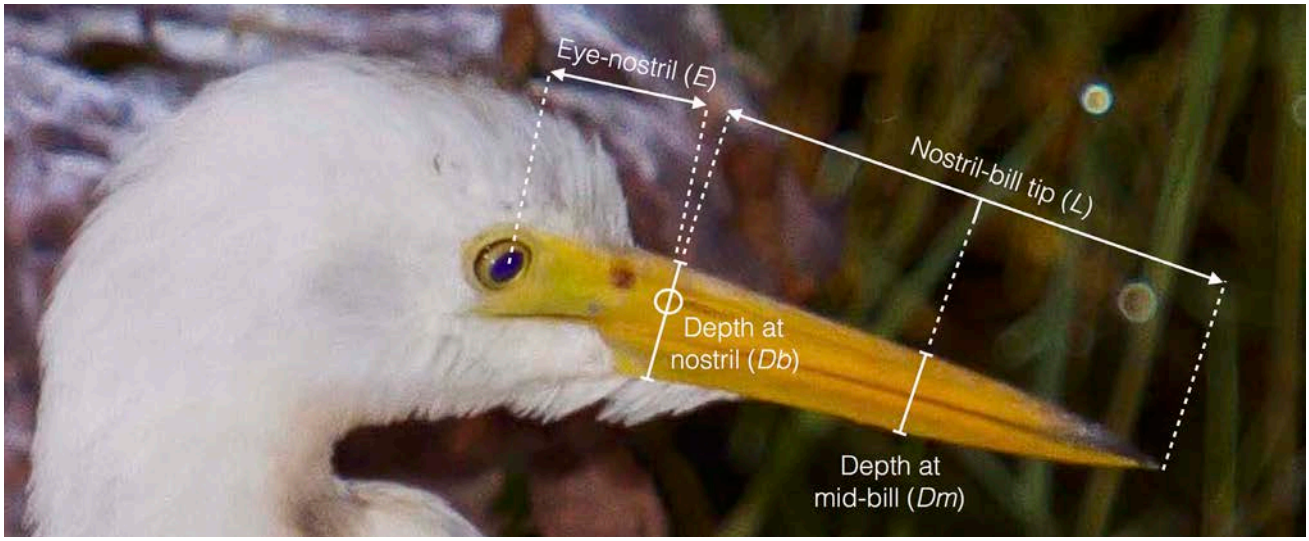

Figure 4. Bill measurements used for the proportional image analysis in this study. The image shown here is of an Australian Intermediate Egret *Ardea intermedia plumifera* at Fogg Dam, Northern Territory. Note the small black tip to the upper mandible, about the maximal amount of black seen in Australian *plumifera.* Photo: Geoff Whalan, reproduced with permission, and cropped from original.

L = length from caudal end of nostril to tip of bill

Db = depth of visible bill at base, i.e. at caudal end of nostril

Dm = depth of bill midway along the bill, i.e. mid-point of line *L*.

Each bill dimension was scaled as a ratio of eye–nostril distance *E*. Additionally, *Dm/Db* was used to estimate bill taper, and *L/Dm* to estimate length:depth ratio. Means and 99% reference ranges (calculated as ± 2.58 x standard deviation) are indicated in Figure 5. After confirming acceptable normality of data by examination of histograms and quantile–quantile plots, statistical comparisons of means using Student's *t*-test are reported.

Results

Comparative measurement of photographs showed that, when scaled to the referent eye–nostril distance (*E*), the relative bill length (nostril–tip) of the *intermedia* sample was 9% shorter than in *plumifera* (*P* <0.0001), matching the difference in published bill measures. The bill of the Joondalup bird was relatively shorter than typical *plumifera*

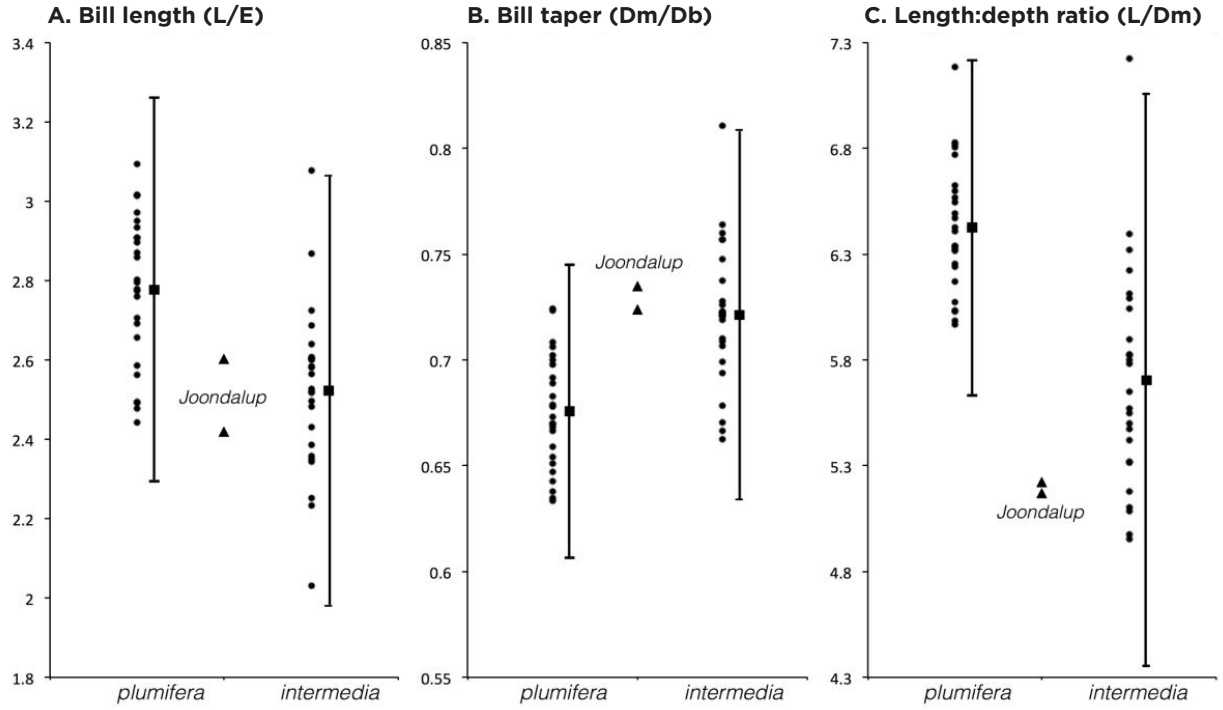

Figure 5. Relative bill proportions of Intermediate Egret subspecies *plumifera* and *intermedia* from image analysis (*n* = 25 per taxon), compared with the Joondalup egret (triangles; two measures from Figures 1 and 3). Means (squares) and 99% reference ranges (bars) are indicated. See Figure 4 for explanation of measures.

and close to the mean for *intermedia* (Figure 5A). The bill of *intermedia* was also found to be significantly more thickly tapering (i.e. greater *Dm/Db*) than in *plumifera* (*P* <0.0001), and the Joondalup bird was also found to be more thickly tapering (i.e. a 'squarer' bill) than in most *plumifera* and close to the mean of *intermedia* (Figure 5B). The length:depth ratio (*L/Dm*) was significantly lower in *intermedia* than in *plumifera* (*P* <0.0001), and this ratio was particularly discriminant between taxa, with about half the *intermedia* population falling below the predicted 99% reference range of *plumifera*. Using this ratio, the Joondalup egret was excluded from the reference range of *plumifera* and aligned again with *intermedia* (Figure 5C).

The extensive online image search completed for this study failed to locate any photograph of adult Australian *plumifera* with an extent of black on the bill exceeding a small black tip on the upper mandible (see example in Figure 4), though a blacker bill is seen in chicks and young juveniles (Marchant & Higgins 1990). We also gained the impression that *intermedia* birds often look longer-necked at full neck extension, compared with typical *plumifera*.

Discussion

Identification

Given that a black bill is atypical for Australian Intermediate Egrets *A. i. plumifera*, species other than the Intermediate Egret were considered. Other all-white egrets resident in Australia include Great Egret, Little Egret, non-breeding Eastern Cattle Egret *Bubulcus* [*ibis*] *coromandus* and white-morph Eastern Reef Egret *Egretta sacra*. Importantly, the latter two species, as well as juvenile and immature forms of all these species, can be ruled out here by the presence of adult breeding plumage with long, filamentous aigrette plumes. As already noted, the bird's relatively 'intermediate' size and neck length were seen in the field and were strongly suggestive of Intermediate Egret from jizz alone. The Great Egret is considerably larger, and has a longer and slimmer neck (about 1.5 times body length, lacking the thicker-based neck of the Intermediate Egret: Marchant & Higgins 1990). The Great Egret also lacks neck plumes in breeding plumage, and has a flatter crown, less-prominent jowls, relatively longer bill, and clear extension of the gape posterior to the eye, the latter feature often cited as a particularly strong diagnostic feature (Marchant & Higgins 1990; del Hoyo *et al.* 1992; Aspinall & Diskin 2003). The Little Egret has a partly yellow bill only in juvenile stages (which would not show breeding plumes). It also has a relatively longer and finer bill, flatter crown, shorter neck, long nuchal plumes in breeding plumage, and yellow soles on the feet (Marchant & Higgins 1990). Other features separating Intermediate from Great and Little Egrets include the observed toe length (approximately equal to tarsus) and foraging behaviour (slow, deliberate movement over floating aquatic vegetation, cf. the active, jerky feeding behaviour of Little Egret or deeper wading of Great Egret: Marchant & Higgins 1990).

Extralimital white egrets ruled out include white-morph Western Reef Heron *E. gularis,* Chinese Egret *E. eulophotes* and Snowy Egret *E. thula* (which all have a longer slimmer bill, yellow feet, and nuchal plumes in breeding plumage), and white-morph Reddish Egret *E. rufescens*, which has a pinkish bill base (del Hoyo *et al.* 1992). Finally, the possibility of a hybrid egret was considered. Hybridisation between an Intermediate Egret and an Indian Pond Heron *Ardeola grayii* has been reported (McCarthy 2006), and hybridisation between Intermediate x Great, Intermediate x Little, or Great x Little Egret might conceivably produce a hybrid with a black-tipped yellow bill. However, all these hybrids would be expected to have a proportionally longer and narrower bill than in typical Intermediate Egret, rather than the proportionally shorter and thicker bill of the Joondalup bird. The estimated bill length also suggested that the bill was much shorter in absolute terms than a typical Great Egret bill, and also shorter than might be predicted for a Great Egret hybrid. Given the absence of any other characters atypical of Intermediate Egret (with the possible exception of a slightly longer neck, which we believe may be typical of *intermedia*), hybridisation can be discounted as a source of the bill coloration observed.

Having confirmed the species, identification of the bird as *A. i. intermedia* is established by the presence of an extensively black bill in breeding plumage (to our knowledge, unknown in either *A. i. plumifera* or African *A. i. brachyrhyncha*), and the combination of a short and thickly tapering bill (see below). Published measures suggest that the bill of *intermedia* is shorter than in *plumifera* [bill length 73.8–75.8 mm (Wells 1999), 72.8 mm (range 66–76 mm) (Cramp 1977) for *intermedia*, versus 82 mm (range 79–83 mm) (Marchant & Higgins 1990), 75–81 mm (Johnstone & Storr 1998) for *plumifera*]. The bill of the Joondalup egret was estimated to be both absolutely shorter (from Figure 2), and relatively shorter than typical *plumifera*. The half-black bill, although probably a transitional state, was noted to be very similar to the illustration of *A. i. intermedia* in del Hoyo *et al.* (1992).

Also of note is the indication from available photographs, and suggested circumstantially by earlier observations, that the extent of black increased during January, and may possibly have developed from a fully yellow bill over the previous 6 weeks. This change, coincident with breeding plumage, rules out aberrant partial melanism as an alternative explanation for the bill's coloration. In full 'flush' of breeding condition, i.e. during courtship at nesting sites, the bill of *intermedia* briefly becomes fully black (after progressively blackening from tip to base) and strongly contrasts with yellow lores (cf. *plumifera* in courtship, red bill with a yellow tip and green lores). Similarly, the legs of *intermedia* are black in full breeding flush, but variable (slate grey, dark green, or brown) when not breeding (cf. *plumifera*: tibiae red during courtship, often yellowish when not breeding: Hancock & Kushlan 1984). The Joondalup egret can therefore be judged to be in fairly complete breeding plumage but not full breeding 'flush' of bare parts, given its well-developed plumes and mostly black (and blackening) bill, but still greyish upper tibiae. Although the greyish colour of the tibiae of this bird is not classically typical of breeding *intermedia*, we found several photographs of birds from Taiwan in very similar transitional states (Figure 6). We also note that this tibia colour is also not typical of breeding *plumifera*, in which the tibiae flush reddish in courtship, and are often more yellowish or pale brown outside breeding (Hancock & Kushlan 1984). Thus, tibia colour is not a useful discriminating feature in this bird, *contra* some sources implying that *intermedia* invariably has black tibiae.

Figure 6. Examples of Intermediate Egret *A. i. intermedia* from Taiwan in transitional breeding plumage. Note the long-necked appearance, half-black bill (black on tip and following cutting edges), and mottled greyish tibiae above black tarsal joints. Left: Taipei, 19 May 2015. Photo: watch-bird.blogspot.tw, retrieved from https://www.flickr.com/photos/outdoor_birding/18321443778/, cropped from original, used with permission under Creative Commons license CC BY-SA 2.0. Right: Changhua, 19 March 2006. Photo: Changhua Coast Conservation Action, retrieved from https://www.flickr.com/photos/waders/115326984/, cropped from original, used under Creative Commons license CC BY-NC-SA 2.0.

Differences in the bill

In summary, analysis of relative bill proportions from images suggested that, on average, *intermedia* has a relatively shorter bill that tapers more thickly than the longer, more finely tapering bill of *plumifera*. When reconstructed from these measures, the 'average' bills of each subspecies look noticeably different (Figure 7). However, there is much individual variation (particularly within *intermedia*), and overlap between these populations, so these measures alone were not useful in identification. However, combining these as a ratio (length:depth) produced a more discriminatory index, which could be used to exclude short- and thick-billed individuals of *intermedia* from the range of *plumifera*. The dimensions of the Joondalup egret fell well below the range of *plumifera* on this index, thus confirming its subspecific identity from a structural character likely to be independent of bill colour.

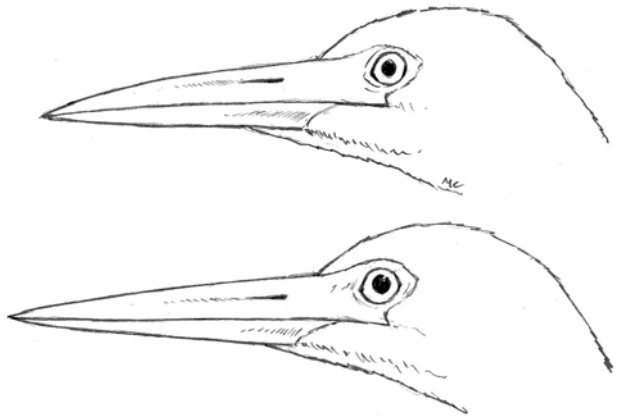

Figure 7. Reconstruction of the 'average' bill proportions of Intermediate Egret subspecies from Asia (*A. i. intermedia*), top, and Australia (*A. i. plumifera*), below, based on image analysis of photographs (n = 25 from each taxon). Note the images are scaled to the same eye–nostril distance and may not be true to scale, though published measures suggest that the bill of *intermedia* averages ~9% shorter than in *plumifera*, similar to the difference shown here.

Limited measurement data comparing subspecies are available in the literature, and Mees (1982) argued for synonymy of all forms on the basis that the ranges of bill measurements overlap. Although we freely recognise the limitations of our image-based proportional methodology, our analysis suggests that though there is broad overlap between *plumifera* and *intermedia* in both bill length and depth, the combination of these as a length:depth ratio is more discriminatory. Furthermore, we found a difference in bill shape (mid-bill taper) not recognised by traditional bill measures. We would encourage researchers with access to specimens to review such bill differences from actual measures, including ratios and two-factor or multivariate analyses.

Distribution and status

The nominate subspecies of the Intermediate Egret is found across India, China, Japan, and through south-eastern Asia at least as far as the Greater Sundas, including breeding populations in Sumatra and Java. Birds in the north of this range are migratory, leaving Japan in September–October to winter south across the Malay Peninsula, Philippines, Borneo, and possibly further (del Hoyo *et al.* 1992). The origin of the Joondalup bird can only be speculated, but is suggested by the presence of breeding plumage and soft parts in January. Although the timing of breeding changes might be deranged in a displaced bird, this may best fit a bird of south-eastern Asian origin developing breeding plumage (breeding season in Java, December–July: del Hoyo *et al.* 1992), rather than an overshooting wintering bird of the more northern migratory populations.

The migratory and widely dispersive habits of *intermedia* are known to generate long-distance movements,

including a recovery 3520 km from the banding site, and many examples of accidental vagrancy far out of range, for example Alaska (Hancock & Kushlan 1984; HeronConservation 2011). Conversely, northward movement of Australian *plumifera* into New Guinea is well established and probably regular, including an immature banded in Victoria and recovered 3991 km away in Irian Jaya (Marchant & Higgins 1990; Geering *et al.* 1998). Similar long-range vagrancy to Australia has been recorded for nominate Little Egret *E. garzetta garzetta*, including one record as far south as Werribee, Victoria (38°00′S, 144°36′E) (Carter & Menkhorst 2006). In Europe, a Little Egret has been recorded to travel more than 1500 km in 78 hours (del Hoyo *et al.* 1992). Together these long-range seasonal movements of Intermediate and similar egrets mean that distance is unlikely to be a barrier preventing vagrancy of Asian *intermedia* to Western Australia.

Conversely, it should be noted that the Intermediate Egret (i.e. subspecies *plumifera*) is considered a rare visitor to south-western Australia, though possibly increasing. The species was formerly scarce but is now moderately common in the northern Kimberley region of Western Australia, since damming of the Ord River (Johnstone & Storr 1998). In the mid-western Pilbara region, it was not recorded before the 1970s, and remains a scarce autumn–winter visitor (Johnstone & Storr 1998; Johnstone *et al.* 2013), with very few records south of the Kimberley between November and February in the *Atlas of Australian Birds* projects (accessed via www.birdata.com.au). In the south-western corner of Australia, it is essentially vagrant, with only occasional validated records (Marchant & Higgins 1990; McKilligan 2005). These include an individual in breeding plumage and soft parts, with red bill and tibiae, at Lake Joondalup in January–February 2012 (BirdLife WA 2012a,b). The rarity of *plumifera* in south-western Australia is relevant in this case when considering the likelihood of encountering vagrant *intermedia* cf. atypical *plumifera*.

Also of note is the recent history of Lake Joondalup as a trap for southward-migrating vagrants, including a Hudsonian Godwit *Limosa haemastica* in 2012 (BirdLife WA 2012b), and several Oriental Honey-buzzards *Pernis ptilorynchus* in 2015–2016 (BirdLife WA 2016). For a wandering bird following the Western Australian coast southwards, Lake Joondalup (and, to a lesser extent, nearby Yanchep Lake) is the first significant, well-vegetated freshwater body south of at least Carnarvon, a distance of >750 km. Thus, although the nearest resident population of *intermedia* lies in Indonesia nearly 2500 km north of Lake Joondalup, the occurrence of an Asian vagrant at this southerly site makes some biogeographic sense, when considering the seasonally arid nature of most of mid-western Western Australia.

Whilst this paper was under review, the identity of this bird was unanimously accepted by the Australian checklist authority, the BirdLife Australia Rarities Committee (BARC) in Case no. 906. This is the first documented record for Australia of *A. i. intermedia*, though Intermediate Egrets recorded on Cocos and Christmas Islands are also likely to be of this taxon [and we note a long-necked bird photographed on 5 January at the Settlement, Christmas Island (Fergusson 2016), is diagnosable as *intermedia* using our proportional bill criteria]. BARC currently defers to the IOC World Bird List maintained by the International Ornithological Union (Gill & Donsker 2016) when considering records of new bird species for Australia. However, we note that BirdLife International, the parent body of BirdLife Australia (which in turn is the parent of BARC) follow del Hoyo *et al.* (2014) in recognising this taxon at species level as Intermediate Egret *Ardea intermedia*, as distinct from Plumed Egret *Ardea plumifera* (BirdLife International 2016). Although normally also defaulting to the species arrangements of del Hoyo *et al.* (2014), the BirdLife Australia *Working List of Australian Birds* (BirdLife Australia 2016) deferred adoption of this split in the recent update to version 2.0 (Glenn Ehmke pers. comm.), and records the only taxon present in Australia as *A. i. plumifera*. In light of this record, we recommend that this now be amended to recognise both *A. i. plumifera* and *A. i. intermedia* as occurring in Australia, or the species-level equivalent if adopting the del Hoyo *et al.* (2014) arrangement in the future.

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