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RANGE EXTENSIONS OF DIABOLICAL NIGHTJAR *Eurostopodus diabolicus* AND INDONESIAN SERIN *Chrysocorythus estherae* ON SULAWESI OF THE WALLACEA REGION

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ABSTRACT

Sulawesi is an important endemicity hotspot in Southeast Asia, with over 100 endemic species distributed on the island. Despite a long history of avian research on Sulawesi that has played a significant role in the development of evolutionary theory, many ornithological aspects remain unknown. The last few decades have seen novel discoveries, for example, in the form of new species range extensions and species discoveries in the face of ongoing habitat loss and conversion. We here report on a range extension and notes of morphological descriptions of the endemic Diabolical Nightjar and Indonesian Serin in Southeast Sulawesi, adding to our knowledge of the distribution of Sulawesi's avifauna, especially in the southeastern part in which visits from ornithologists are less frequent. A review of recent museum collections adds another new locality for Diabolical Nightjar in South Sulawesi. Future taxonomic studies are needed to elucidate the status of both species, especially in the Indonesian Serin, as the subtle differences in the coloration of the forehead, rump, and upper tail covert may indicate more than one taxon exists in Sulawesi. In addition, we provide an annotated checklist of birds observed during the fieldwork encompassing areas around Kolaka and Makassar.

Key words: Diabolical Nightjar, Indonesian Serin, range extensions, Sulawesi

INTRODUCTION

Sulawesi, the biggest island in the Wallacean region, is one of the most important biodiversity hotspots in Southeast Asia due to its high level of endemicity with over 100 endemic species distributed in this area (Myers et al., 2000). Its avifauna is rich in terms of the number of endemic genera, attesting to its extraordinary evolutionary trajectory, which has been shaped by the island's complex geographical history (Eaton et al., 2021; BirdLife International, 2024). While Sulawesi's biota have become a cornerstone in the theory of evolution and have been subject to ample biological inquiry, many ornithological aspects surrounding this island remain unknown. Even though birds are well-studied and records from historic collectors can be traced back to between the late 18th to 19th centuries, a relatively high number of species discoveries

and novel information of species distributions have emerged from the Sulawesi Region over the last couple of decades, exceeding that of adjacent regions such as Sundaland (Harris et al., 2014; Rheindt et al., 2014; Ng et al., 2017; Garg et al., 2018; Gwee et al., 2020; Rheindt et al., 2020; O'Connell et al., 2022; Irham et al., 2023).

Despite being the least well-known part of the island, the southeastern arm of Sulawesi (henceforth: Southeast Sulawesi; Fig. 1) holds immense biological importance. Only a few modern long-term studies and surveys have been published from this region, and the records from historic collectors between 1900–1940 still serve as the major source of ornithological information (Meyer, 1904; Stresemann, 1931; Stresemann, 1939; Trochet et al., 2014; Berryman & Eaton, 2020). There is a pressing need to continue avifaunal surveys in Southeast Sulawesi, especially on mountain ranges such as Mekongga and Tangkelemboke (Fig. 1). Most lowland forests have been converted and disturbed, and increasing mining activity is threatening to encroach on the remaining habitat.

The Mekongga mountain range straddles along the northwestern flank of Southeast Sulawesi, and its highest peak (Mt. Mekongga) is 2,620 m asl. Meanwhile, the smaller Tangkelemboke mountain range is located to the east of the northernmost part of Mekongga, and harbors the second-highest peak at 2,421 m asl. Vegetation in this area generally consists of four types of forest: tropical lowland rainforest, lower montane forest, higher montane forest dominated by bryophyte cover, and subalpine forest (Widjaja & Potter, 2014). Most of the tropical lowland forests have been disturbed and converted into plantations or cultivation following logging operations that largely ceased around the 1990s. Logging activities were not always confined to lowland forests but extended to the highlands up to 2,000 m asl. The remnants of logging roads and tracks are still evident, even from satellite imagery in some areas. These tracks provide access to the interior and are frequently used by local hunters for bushmeat. At the same time, shrubs and secondary forests have grown so dense along some of the former logging tracks as to make them inaccessible.

In this paper, we report on the finding of range extensions of Diabolical Nightjar (*Eurostopodus diabolicus*) and Indonesian Serin (*Chrysocorythus estherae*) in the Mekongga region of Southeast Sulawesi, adding important information to previous work in the same area by Berryman & Eaton (2020). The Diabolical Nightjar is one of the three nightjars distributed in Sulawesi. The other two nightjars are the Great-eared Nightjar (*Lyncornis macrotis*), previously treated in the same genus of *Eurostopodus*, and the Sulawesi Nightjar (*Caprimulgus celebensis*). It was first described from female specimens collected in Gunung Klabat, North Sulawesi (Stresemann, 1931), and until recently, male description has been available only from observation (Eaton et al., 2021). Its upper parts are a mix of grey-brown, brown, and pale tawny with streaked and spotted patterns. Males have a white band around the throat, while females have a buff-colored one. Females also have small white spots on their wing feathers. Both sexes have dark brown eyes, blackish bills, and dark brown legs and feet. The known distributions are rather patchy from several mountain areas in North and Central Sulawesi, i.e. Gunung Klabat, Gunung Ambang, Panua, Lore Lindu National Park, and Gunung Rorekatimbu (Fig. 1). It occurs mainly in the clearings or edge forests within primary forests, from lowlands to mountains (Cleere & de Juana, 2020).

The Indonesian Serin (*Chrysocorythus estherae*) from the family of Estrildidae was formerly lumped with Mindanao Serin (*C. mindanensis*) of the Philippines under the genus *Serinus,* which later separated due to differences in physical traits (Eaton et al., 2021; Kirwan et al., 2024). Indonesian Serins consist of four subspecies which can be distinguished by the amount of yellow on their heads and underparts, among other characters, i.e., *E. e. estherae* and *E. e. orientalis* from Java, *E. e. vanderbilti* from North Sumatera, and *E. e. renatae* from Central Sulawesi (Eaton et al., 2021). The Sulawesi subspecies has an orange-variant observed at Lore Lindu National Park (Ottaviani, 2018). Males have orange on the forehead, crown, rump, and wingbars, while females show orange-yellow in similar regions. Young males may appear yellow-crowned until they mature. Birds in Lore Lindu have black bills, unlike the brown-billed *renatae* subspecies.

We also report on an extension of the distribution of Diabolical Nightjar to South Sulawesi based on unpublished records from a skin collection in Museum Zoologicum Bogoriense—National Agency for Research and Innovation (MZB–BRIN) and describe the male Diabolical Nightjar for the first time.

MATERIALS AND METHODS

We visited Gunung (=Mount) Bota Porehu in Desa (=Village) Porehu, North Kolaka Regency, Southeast Sulawesi, from 23 September to 2 October 2023 (Fig. 1). This mountain, approximately 55 km north of the Mekongga summit, is part of the Mekongga complex. The area is quite easily accessible via an old logging track extending over the mountain ridge, allowing motorbike travel up to 1,840 m asl. The tracks continue up to 2,000 m asl but can only be accessed on foot due to overgrowth, although some open patches are scattered along the ridge. The forest remains tall on the slopes at 2,000 m asl, although it appears naturally stunted near the dry ridge line.

We recorded every bird encountered along the track opportunistically. We occasionally played recordings to get responses from birds for better visual or aural detection and observation. We also took notes on birds observed in several places outside Gunung Bota in the same region, such as Batu Putih, Lasusua, and some places between Kolaka and Batu Putih. In addition, after finishing fieldwork on Gunung Bota, we made some observations on the way back to Makassar from Siwa Harbor, South Sulawesi, notably on Lake Tempe and some fish ponds around the city of Makassar.

We conducted a zoological expedition on Gunung Latimojong, Desa Gamaru, Luwu Regency, Province of South Sulawesi; and Gunung Galang, Dako Mountain Range, Tolitoli Regency, Province of Central Sulawesi from which a skin specimen of the Diabolical Nightjar was obtained in August of 2016 and 2018, respectively. The Latimojong mountain range is located in South Sulawesi and comprised of several peaks, the highest (Rante Mario) at 3,478 m asl; whilst, Gunung Galang lies within the Dako Mountain Range and peaked at 2,254 m asl (Fig. 1).

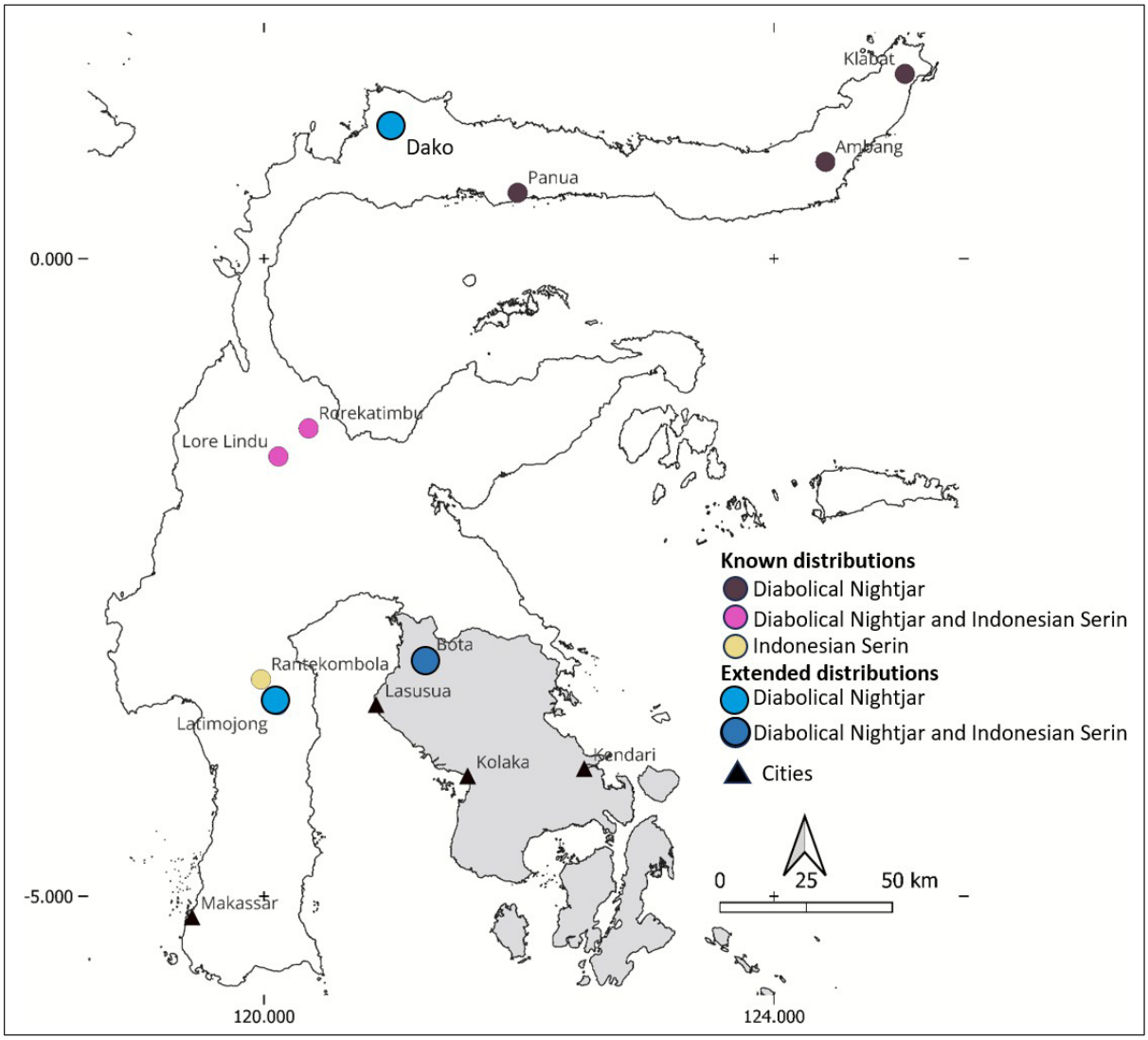

Figure 1. Location of our field site at Gunung Bota Porehu in Southeast Sulawesi (large blue circle) where Diabolical Nightjar and Indonesian Serin were observed. Previous known localities are also indicated in other areas of Sulawesi. The province of Southeast Sulawesi is shown in grey.

We employed mist nets around the main hiking tracks from approximately 1,300 m to 2,400 m asl to collect birds and prepare skin specimens and tissue samples. The average effort in each location was 280 mist net days, except for Gunung Bota, where we conducted around 60 mist net days. On Gunung Bota, we collected a maximum of five specimens for each species, and the rest of the birds were released after being measured and taken of blood samples.

RESULTS

We recorded 67 bird species in Gunung Bota and 32 species between Kolaka—Gunung Bota, Batu Putih, and Lasusua, all of them located in Southeast Sulawesi (Appendix 1). We also observed 44 species at select localities in the neighboring province of South Sulawesi on our return (Appendix 2). Although we missed 22 species observed by Berryman & Eaton (2020), we added 13 records new to Gunung Bota, including the new range extension of Diabolical Nightjar and Indonesian Serin. Therefore, the total number of birds in Gunung Bota from both studies is 93 species.

Our expedition on Gunung Latimojong and Gunung Dako recorded 40 and 36 species respectively. Except for the Diabolical Nightjar, the results will be published elsewhere. Specimens were deposited at Museum Zoologicum Bogoriense, National Research and Innovation Agency, Cibinong, West Java.

Diabolical Nightjar (*Eurostopodus diabolicus*)

On the second night of our survey (25 September 2024), during dusk, we encountered the Diabolical Nightjar around the main campsite clearing at the peak of Gunung Bota, at 1843 m asl. Three individuals were observed in flight and responding to playback. They approached the playback, and one individual perched on a post, providing opportunities to capture images and sound recordings (Fig. 2). We later photographed, caught, and measured another individual, allowing us to compare its biometric details with those of other populations. The birds' vocalizations and images allowed us unequivocal confirmation of their identification. They exhibited all the plumage features of Diabolical Nightjar: an overall dark color with white and rufous speckles, a buffy band around the throat, greyish scapulars and horns, and white spots on the primaries (Clerence & de Juana, 2020; Eaton et al., 2021).

We also report on MZB specimens of Diabolical Nightjar collected during the expedition to Gunung Latimojong at 1,500 m asl (Fig. 3) and Gunung Galang, Dako at 1,700 m asl. Gunung Latimojong is approximately 210 km south of Lore Lindu National Park in Central Sulawesi, where the species was rediscovered in 1996 (Bishop & Diamond, 1997). The label and field notes indicated that the sex of the Latimojong bird is male, which we further confirmed with DNA sexing (data not shown). Meanwhile, the later specimen, which is also male, was collected from Gunung Galang at 1,700 m asl. The location is within its known range where the closest known area is Panua approximately 135 km to the southeast.

Description of Male Diabolical Nightjar

Materials examined: Male specimen no. MZB34908, field no. TRY770, study skin prepared by Tri Haryoko, 12 August 2016. Location: Bajaja, Gamaru Village, District Latimojong, South Sulawesi, 1,500 m asl. Male specimen no. MZB36467, field no. RCKB2293, Gunung Dako, Tolitoli.

Measurements of the Latimojong specimen: bill 21.6 mm, wing 18.8 mm, tail 12.5 mm.

Figure 2. Diabolical Nightjar perched on a post on the side of the logging track at Gunung Bota, Southeast Sulawesi (photo: YCKS).

Overall color is dull, dark brownish. The upperparts are speckled and spotted brown, tawny, greyish, and white. Tawny band on the throat. The underparts feathers are similar to the upperparts but often terminally speckled. Scapulars and horns silvery grey. Tail dark with tawny narrow bands, terminally speckled. The primary wing feathers are black. Distinct white bands on the first three outermost primaries measure around 5-8 mm in width. The bird from Galang showed small white patch on first outermost primaries, and wide bands has white on subsequent primaries until the fourth outermost primary. Bill black. Feet black. Iris brown.

Indonesian Serin (*Chrysocorythus estherae*)

The first observation was made on the morning of 27 September 2024 at 1850 m along the dry ridgetop track. FER called out a fly-by as a likely serin based on call and shape. However, the bird could not be identified conclusively. Several minutes later, one individual perched distantly and took off in flight, probably the same bird as observed earlier. The only diagnosable character, its yellow wing bars, pointed to its identity as a serin. The bird later returned with a partner and called in flight before taking off again for good. During the second sighting, a number of clear images were successfully taken by YCKS, confirming identification (Fig. 4).

Figure 3. Male specimen of Diabolical Nightjar from Bajaja, Latimojong mountain range, South Sulawesi (photo: Yohanna).

Figure 4. Indonesian Serin perching on a tree branch. The color on the forehead is likely orange rather than yel- low, while on the cheek, the color shows an orangish wash, which might resemble the population in Lore Lindu National Park (photo: YCKS).

DISCUSSIONS

The extension range of Diabolical Nightjar and Indonesian Serin marks the importance of continuous surveys and research, especially on the island's rich endemics and unique past geology and biogeography, such as Sulawesi. Mountain ranges that span continuously or isolated mountains in every part of Sulawesi looming over 2,000 m asl could harbor peculiar populations that might belong to known or even new populations. Even with the compelling geography of Sulawesi, most of the mountains have not been visited by ornithologists in general, and some, if not the majority, of current records are still based on past collections. Hence, the zoological expedition becomes important to get a complete picture of Sulawesi avifauna.

The distribution of Diabolical Nightjar – hitherto mostly known from North and Central Sulawesi – extends to both South Sulawesi and Southeast Sulawesi. While the type specimen was collected around the village of Kumarsot at 250 m asl on the foot of Mount Klabat, the remaining records of the nightjar were mostly recorded above 1,000 m asl. Therefore, it is absent from the lowland, which could indicate whether the habitat alteration impacted the lowland population or they are montane birds that eventually venture to the lowland.

The availability of specimens allows us to examine the potential of morphological differences among localities. We indirectly compared the male specimen from Latimojong with images and descriptions of the female holotype (Yong et al., 2012; Stresemann, 1931). The male Latimojong individual is slightly smaller than the type specimen from Gunung Klabat, North Sulawesi. However, this could be due to measuring bias or specimen condition. The plumage features and coloration resemble those of the holotype except for the extent of the white bands on the primaries and the color of the throat band. The two outermost primaries of the female holotype are entirely black; white bands are restricted to the third and fourth primaries, while the remaining primaries exhibit narrow rusty-colored crossbars (Stresemann, 1931). Additionally, the male Latimojong specimen has a paler buff throat band than the female holotype.

Comparing the male Latimojong individual with the birds we observed in Gunung Bota – especially one that was measured – overall, plumage features appeared similar. Significant differences were observed in the extent of white bands on the primaries. The Gunung Bota individual had white bands on the third and fourth outermost primaries measuring 4-6 mm, similar to the female holotype description, which probably indicates it was a female. Our bird's second primary was not entirely black but showed a small, narrow brownish band. Further study is needed to confirm whether band coloration on the primaries is a diagnostic sex-specific plumage feature in Diabolical Nightjar. Beyond the white bands, the Latimojong, Dako and Gunung Bota individuals closely resemble the Lore Lindu population in many other traits, notably in the color of the throat band and the dimension of white spots on the breast feather tips (Yong et al., 2012).

The Indonesian Serin in Sulawesi, first observed on Mount Rantekombola in 1980 and described as a new subspecies *C. e. renatae* (Schuchmann & Wolters, 1982), presents an intriguing case for further research. Other populations were later recorded from further north in Lore Lindu National Park, more specifically Gunung Rorekatimbu, Gunung Rano Rano, and Pakuli (Bishop & King, 1986; Watling, 1983). However, the populations in Lore Lindu differ from those in Rantekombola in their orange-reddish rather than yellow color on the forehead, rump and uppertail coverts. These color differences have prompted researchers to speculate that Lore Lindu birds may be distinct (Ottaviani, 2018; van den Berg & Bosman, 1986). The birds observed in Gunung Bota may have an orangish color similar to the Lore Lindu population, albeit subtle, as suggested by the images and our brief views in the field. Therefore, the population of Indonesian Serin in Gunung Bota may have closer population-genetic ties with birds in Lore Lindu than those in Rantekombola.

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Appendix 1. Annotated list of birds observed in Gunung Bota, North Kolaka, Southeast Sulawesi.

No	Species		Berryman and Eaton (2020)	Current study
1	Sunda Teal	*Anas gibberifrons*		**
2	Diabolical Nightjar	*Eurostopodus diabolicus*		√
3	Great Eared Nightjar	*Lyncornis macrotis macropterus*	√	
4	Sulawesi Nightjar	*Caprimulgus celebensis celebensis*	*	
5	Grey-rumped Treeswift	*Hemiprocne longipennis wallacii*	√	**
6	Glossy Swiftlet	*Collocalia esculenta esculenta*	√	√
7	Sulawesi Swiftlet	*Aerodramus sororum*	√	
8	Uniform Swiftlet	*Aerodramus vanikorensis heinrichi*	√	
9	Edible-nest Swiftlet	*Aerodramus fuciphagus*		**
10	White-throated Needletail	*Hirundapus caudacutus nudipes*	√	
11	Purple Needletail	*Hirundapus celebensis*		√
12	Pacific Swift	*Apus pacificus pacificus*		**
13	Bay Coucal	*Centropus celebensis*		√
14	Lesser Coucal	*Centropus bengalensis sarasinorum*		**
15	Yellow-billed Malkoha	*Rhamphococcyx calyorhynchus*	√	√
16	Black-billed Koel	*Eudynamys melanorhynchus*	*	
17	Sulawesi Brush Cuckoo	*Cacomantis virescens*	√	√
18	Drongo-Cuckoo	*Surniculus lugubris*	*	
19	Sultan's Cuckoo-Dove	*Macropygia doreya albicapilla*	√	√
20	Pacific Emerald Dove	*Chalcophaps longirostris*	√	
21	Grey-cheeked Green Pigeon	*Treron griseicauda. wallacei*	*	√
22	Red-eared Fruit Dove	*Ptilinopus fischeri centralis*	√	√
23	Superb Fruit Dove	*Ptilinopus superbus*	*	√
24	Black-naped Fruit Dove	*Ptilinopus melanospilus melanospilus*	√	√
25	White-bellied Imperial Pigeon	*Ducula forsteni*	√	√
26	Grey-headed Imperial Pigeon	*Ducula radiata*	√	√
27	Green Imperial Pigeon	*Ducula aenea paulina*	*	**
28	Sombre Pigeon	*Cryptophaps poecilorrhoa*	√	√
29	Barred Rail	*Galliralus torquatus celebensis*	√	**
30	White-breasted Waterhen	*Amaurornis phoenicurus leucomelana*		**
31	Barred Buttonquail	*Turnix suscitator rufilatus*	√	
32	Pied Stilt	*Himantopus leucocephalus*		**
33	Javan Plover	*Anarhynchus javanicus*		**
34	Eurasian Whimbrel	*Numenius phaeopus variegatus*		**
35	Common Sandpiper	*Actitis hypoleucos*		**
36	Wood Sandpiper	*Tringa glareola*		**
37	Little Tern	*Sternula albifrons sinensis*		**
38	Whiskered Tern	*Chlidonias hybrida*		**
39	Glossy Ibis	*Plegadis falcinellus*		**
40	Little Egret	*Egretta garzetta*		**

No	Species		Berryman and Eaton (2020)	Current study
41	Striated Heron	*Butorides striata javanica*		**
42	Javan Pond Heron	*Ardeola speciosa speciosa*		**
43	Cattle Egret	*Ardea ibis*		**
44	Medium Egret	*Ardea intermedia*		**
45	Barred Honey Buzzard	*Pernis celebensis*	√	√
46	Sulawesi Serpent Eagle	*Spilornis rufipectus rufipectus*	√	√
47	Sulawesi Hawk-Eagle	*Nisaetus lanceolatus*	√	√
48	Rufous-bellied Eagle	*Lophotriorchis kienerii formosus*	√	√
49	Black Eagle	*Ictinaetus malaiensis malaiensis*	√	√
50	Sulawesi Goshawk	*Lophospiza griseiceps*	√	
51	Small Sparrowhawk	*Tachyspiza nana*	√	√
52	White-bellied Sea Eagle	*Icthyophaga leucogaster*		**
53	Sulawesi Masked Owl	*Tyto rosenbergii rosenbergii*	*	
54	Cinnabar Boobook	*Ninox ios*	√	√
55	Sulawesi Scops Owl	*Otus manadensis*	√	
56	Knobbed Hornbill	*Rhyticeros cassidix*	√	**
57	Sulawesi Hornbill	*Rhabdotorrhinus exarhatus sanfordi*		**
58	Purple-winged Roller	*Coracias temminckii*	√	√
59	Collared Kingfisher	*Todiramphus chloris chloris*	√	√
60	Sulawesi Dwarf Kingfisher	*Ceyx fallax*	*	
61	Purple-bearded Bee-eater	*Meropogon forsteni*	√	
62	Rainbow Bee-eater	*Merops ornatus*		√
63	Sulawesi Pygmy Woodpecker	*Picoides temminckii*		√
64	Ashy Woodpecker	*Dryocopus fulvus wallacei*	√	
65	Spotted Kestrel	*Falco moluccensis*	√	
66	Golden-mantled Racket-tail	*Prioniturus platurus platurus*	√	√
67	Azure-rumped Parrot	*Tanygnathus sumatranus sumatranus*	*	
68	Yellow-cheeked Lorikeet	*Saudareos meyeri*	√	√
69	Great Hanging Parrot	*Loriculus stigmatus stigmatus*	√	√
70	Pygmy Hanging Parrot	*Loriculus exilis*	√	
71	Sulawesi Pitta	*Erythropitta celebensis celebensis*	√	
72	Dark-eared Myza	*Myza celebensis*	√	√
73	White-eared Myza	*Myza sarasinorum pholidota*	√	
74	Sulawesi Myzomela	*Myzomela chloroptera*	√	√
75	Golden-bellied Gerygone	*Gerygone sulphurea flaveola*	√	√
76	White-breasted Woodswallow	*Artamus leucorynchus albiventer*	√	√
77	Ivory-backed Woodswallow	*Artamus monachus*	√	√
78	Cerulean Cuckooshrike	*Coracina temminckii rileyi*	√	√
79	White-rumped Cuckooshrike	*Coracina leucopygia*	√	
80	Common Cicadabird	*Edolisoma tenuirostre morio*		√
81	Pygmy Cicadabird	*Celebesica abbotti*	√	√
82	Lesueur's Triller	*Lalage sueurii*		**
83	Sulawesi Triller	*Lalage leucopygialis*	√	√

No	Species		Berryman and Eaton (2020)	Current study
84	Maroon-backed Whistler	*Coracornis raveni*	√	
85	Sulphur-vented Whistler	*Pachycephala sulfuriventer*	√	√
86	Black-naped Oriole	*Oriolus chinensis celebensis*	*	**
87	White-eyed Spangled Drongo	*Dicrurus leucops leucops*	√	√
88	Sulawesi Fantail	*Rhipidura teysmanni toradja*	√	√
89	Pale-blue Monarch	*Hypothymis puella puella*	√	√
90	Sulawesi Crow	*Corvus celebensis*	√	√
91	Hylocitrea	*Hylocitrea bonensis bonensis*	√	
92	Citrine Canary-flycatcher	*Culicicapa helianthea helianthea*	√	√
93	Sooty-headed Bulbul	*Pycnonotus aurigaster aurigaster*	√	√
94	Pacific Swallow	*Hirundo javanica javanica*		√
95	Mountain Tailorbird	*Phyllergates cucullatus stentor*	√	√
96	Sulawesi Leaf Warbler	*Phylloscopus nesophilus*	√	√
97	Clamorous Reed Warbler	*Acrocephalus stentoreus celebensis*		**
98	Sulawesi Bush Warbler	*Locustella castanea castanea*	√	√
99	Malia	*Malia grata stresemanni*	√	√
100	Sulawesi Heleia	*Apalopteron squamiceps analogum*	√	√
101	Warbling White-eye	*Zosterops japonicus montanus*	√	
102	Lemon-bellied White-eye	*Zosterops chloris*		**
103	Pale-bellied White-eye	*Zosterops consobrinorum*	√	√
104	Sulawesi Babbler	*Pellorneum celebense rufofuscum*	√	√
105	Sulawesi Myna	*Basilornis celebensis*	√	
106	White-necked Myna	*Streptocitta albicollis albicollis*	*	**
107	Fiery-browed Myna	*Enodes erythrophris centralis*	√	√
108	Grosbeak Starling	*Scissirostrum dubium*	√	√
109	Red-backed Thrush	*Geokichla erythronota*	*	
110	Sulawesi Thrush	*Turdus turdoides heinrichi*	√	
111	Grey-streaked Flycatcher	*Muscicapa griseisticta*	√	
112	Turquoise Flycatcher	*Eumyias panayensis*		√
113	Blue-fronted Blue Flycatcher	*Eumyias hoevelli*	√	√
114	Snowy-browed Flycatcher	*Ficedula hyperythra jugosae*	√	√
115	Little Pied Flycatcher	*Ficedula westermanni westermanni*	√	√
116	Rufous-throated Flycatcher	*Ficedula rufigula*	*	
117	Yellow-sided Flowerpecker	*Dicaeum aureolimbatum aureolimbatum*	√	√
118	Crimson-crowned Flowerpecker	*Dicaeum nehrkorni*	√	√
119	Grey-sided Flowerpecker	*Dicaeum celebicum*	*	√
120	Brown-throated Sunbird	*Anthreptes malacensis celebensis*		√
121	Sahul Sunbird	*Cinnyris frenatus plateni*	√	**
122	Crimson Sunbird	*Aethopyga siparaja beccarii*	√	√
123	Eurasian Tree Sparrow	*Passer montanus malaccensis*		√
124	Scaly-breasted Munia	*Lonchura punctulata particeps*		√
125	Black-faced Munia	*Lonchura molucca molucca*		√
126	Black-headed Munia	*Lonchura atricapilla brunneiceps*		**

No	Species		Berryman and Eaton (2020)	Current study
127	Eastern Yellow Wagtail	*Motacilla tschutschensis tschutschensis*		**
128	Grey Wagtail	*Motacilla cinerea cinerea*	√	
129	Indonesian Serin	*Chrysocorythus estherae*		√

(√ = observed in Gunung Bota, * = observed in Tolala by Berryman & Eaton (2020), ** = observed in Batu Putih, Lasusua, and road between Kolaka and Batu Putih).

Appendix 2. Additional list of birds observed in Makassar fish ponds, South Sulawesi or otherwise indicated.

No	Species	
1	Sunda Teal	*Anas gibberifrons*
2	Edible-nest Swiftlet	*Aerodramus fuciphagus*
3	House Swift*	*Apus nipalensis subfurcatus*
4	Pacific Swift	*Apus pacificus pacificus*
5	Red Collared Dove**	*Streptopelia tranquebarica humilis*
6	Buff-banded Rail	*Gallirallus philippensis philippensis*
7	White-breasted Waterhen	*Amaurornis phoenicurus leucomelana*
8	White-browed Crake	*Poliolimnas cinereus*
9	Pacific Golden Plover	*Pluvialis fulva*
10	Pied Stilt	*Himantopus leucocephalus*
11	Javan Plover	*Anarhynchus javanicus*
12	Little Ringed Plover	*Charadrius dubius curonicus*
13	Black-tailed Godwit	*Limosa limosa melanuroides*
14	Common Sandpiper	*Actitis hypoleucos*
15	Marsh Sandpiper	*Tringa stagnatilis*
16	Wood Sandpiper	*Tringa glareola*
17	Common Redshank	*Tringa totanus*
18	Common Greenshank	*Tringa nebularia*
19	Curlew Sandpiper	*Calidris ferruginea*
20	Long-toed Stint	*Calidris subminuta*
21	Red-necked Stint	*Calidris ruficollis*
22	Eurasian Whimbrel	*Numenius phaeopus variegatus*
23	Little Tern*	*Sternula albifrons sinensis*
24	Gull-billed Tern	*Gelochelidon nilotica affinis*
25	White-winged Tern*	*Chlidonias leucopterus*
26	Whiskered Tern	*Chlidonias hybrida*
27	Greater Crested Tern	*Thalasseus bergii cristatus*
28	Little Black Cormorant	*Phalacrocorax sulcirostris*
29	Glossy Ibis	*Plegadis falcinellus*
30	Yellow Bittern	*Ixobrychus sinensis*
31	Javan Pond Heron	*Ardeola speciosa speciosa*
32	Purple Heron	*Ardea purpurea manilensis*

No	Species	
33	Great Egret	*Ardea alba modesta*
34	Medium Egret	*Ardea intermedia*
35	Cattle Egret	*Ardea ibis*
36	Little Egret	*Egretta garzetta*
37	Black-winged Kite**	*Elanus caeruleus hypoleucus*
38	Brahminy Kite**	*Haliastur indus intermedius*
39	Black Kite**	*Milvus migrans affinis*
40	Spotted Harrier**	*Circus assimilis*
41	Blue-tailed Bee-eater	*Merops philippinus*
42	Sunda yellow-vented Bulbul	*Pycnonotus analis analis*
43	Lemon-bellied White-eye	*Zosterops chloris*
44	Zitting Cisticola	*Cisticola juncidis constans*

(* = Siwa Harbor, except for Little Tern also observed in Makassar; ** = Lake Tempe, except for Red Collared Dove also observed in Makassar).