Confirmation of House Crows Corvus splendens laying immaculate blue eggs

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Confirmation of House Crows *Corvus splendens* laying immaculate blue eggs

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16 Abstract

17 House Crows *Corvus splendens* lay eggs with bluish-green ground colour and black or brown
18 blotches and only one egg morph is believed to exist. Here, we confirm the existence of an
19 immaculate blue egg morph that is clearly different from the regular egg morph.

20

21 *Keywords:* House Crow, *Corvus splendens*, egg morph, egg, immaculate, blue, Bangladesh.

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Birds exhibit vast variation in egg shell colouration, spotting pattern, size and shape (Christians 2002, Kilner 2006, Deeming & Reynolds 2015, Stoddard *et al.* 2017). This variation is in many cases prominent between species, but in a range of species there is also significant variation between individuals within a species (i.e. intraspecific variation). Interestingly, only two types of pigments are responsible for ground colouration and patterning of eggshells. Protoporphyrin is responsible for brownish hues, and biliverdin produces blue and green hues (Kilner 2006, Brulez *et al.* 2015).

House Crows *Corvus splendens* lay eggs with bluish-green ground colour and black or brown blotches and only one egg morph is believed to exist (Fig. 1) (Whistler 1949, Lamba 1976, Ali & Ripley 1983, Begum *et al.* 2011b, Madge 2018). However, an old study reports the existence of bright blue and pure pale blue immaculate eggs in House Crow nests (Hume 1889). This finding has been questioned in a subsequent publication (Lamba 1976), stating that no one had reported nor encountered this type of crow egg since Hume. Lamba (1976) referred to Hume's eggs as "extremely rare freaks or represented cases of mistaken identity". In this study, we report the discovery of immaculate blue eggs laid by House Crows in Bangladesh, supporting the finding of the 129 years old report of Hume.

This study was carried out at Jahangirnagar university campus (23˚52′ N and 90˚16′ E), an area of approximately 280 hectares and located 32 km north of Dhaka, the capital of Bangladesh.

The House Crow is distributed throughout south and southeast Asia and has increased its geographic range to Africa, Middle east and some parts of Europe and North-America (BirdLifeInternational 2017). As a colonial breeder, the House Crow builds open shallow-cup shape nests close to human habitations where food availability is high (Begum *et al.* 2011a). The

breeding season is mainly from January to September and varies locally (Grimmett *et al.* 1999, Begum *et al.* 2011b), although it can breed throughout the year (Lamba 1963). The House Crow usually lays 3-6 eggs in a clutch, the incubation period is 16-17 days while the nestling stays in the nest around 30 days (Lamba 1976, Ali & Ripley 1987). In the study area, House Crows are parasitised by Asian Koels *Eudynamys scolopaceus* (Begum *et al.* 2011a, 2011b). Parasitism rate in House Crows in this area is 10.8% and the Asian Koel shows quite good mimicry with the typical House Crow egg morph based on human vision (Begum *et al.* 2011b).

The study was carried out in two successive breeding seasons of 2016 to 2017. The data was collected from January to August as most House Crows breed within that period in the study area. Nests were systematically searched for during the breeding season within the campus area. We used a hand-held Garmin GPS (eTrex20) to plot each nest position. After finding a nest, we checked each nest regularly (almost daily during the egg laying and nestling period) to record breeding variables.

A total of 64 House Crow nests were found in the study area during the breeding seasons of 2016 and 2017. Surprisingly, four nests (6.3%) contained immaculate blue eggs (Table 1, Fig. 1). In addition, we also found a freshly broken egg shell of similar color on the ground below an empty House Crow nest in 2016. This nest was probably predated, but since we could not establish the full history we omitted this nest from the calculations. Two crow chicks successfully hatched and fledged from one nest, while the other three nests were predated (Table 1). During the study period, predation rate was 28.3% (17 out of 60 nests) in nests with regular eggs, and 75% (3 out of 4 nest) in nests with blue eggs (sample size too small to be tested statistically). The mean ± SD size and volume of the blue immaculate eggs was 33.71±1.2mm (length) x 27.10±1.1mm (breadth) (n = 13) and 13.79±1.0 cm^3 (volume; n = 13), respectively. The mean ± SD regular crow egg size and

volume was 37.91±2.3mm (length) x 26.34±1mm (breadth) (n = 99) and 14.72±1.7 cm^3 (volume; n = 99). There was no significant difference in egg volume between the two types of eggs (Linear Mixed Model controlling for nest identity as a random factor and year as fixed factor: N = 112 eggs, 35 nests, t = 0.19, P = 0.32). Nests containing blue eggs were in both years located in two different colonies, close to human buildings (Table 1).

Several theories or hypotheses have been proposed to explain the variation in appearance among bird eggs (Underwood & Sealy 2002, Kilner 2006, Brulez *et al.* 2015). For instance, the amount of spotting may be reduced in eggs of females suffering dietary deficiency. Female dietary deficiency and soil calcium level was found to influence spotting pattern in Great Tits *Parus major*, but only variation in the amount of spotting (Gosler *et al.* 2005, Gosler & Wilkin 2017). Egg predation can affect egg colouration and spotting pattern as the House Crow nests are open shallow-cup shaped and the predation rate was very high in our study area. Since immaculate blue eggs are more conspicuous than the regular House Crow eggs, selection due to nest predation could work against this egg morph (Underwood & Sealy 2002). Our results indeed showed that predation rate was higher for nests containing blue eggs than nests with the regular egg morph.

Brood parasitism may have a strong influence on the evolution of egg polymorphism in both parasites and hosts (Øien *et al.* 1995, Vikan *et al.* 2011, Spottiswoode & Stevens 2012, Nahid *et al.* 2016, Yang *et al.* 2016). In theory, since Asian Koels lay eggs that resembles ordinary House Crow eggs, crows laying immaculate blue eggs could have a selective advantage because it would be easier to recognize the parasite egg and reject it from their nests. However, a study on House Crows based on egg experiments found that only 9.1% of the experimental immaculate blue and brown eggs were ejected. Furthermore, there was no difference in rejection between these two experimental egg types (Begum *et al.* 2012). Hence, there is apparently no strong selection for

evolving mimetic eggs in Asian Koels utilizing House Crows in the study area. In addition, since immaculate blue eggs in House Crows were also found in small numbers more than 100 years ago, they should have become more common with time if they resulted in a selective advantage. Hence, brood parasitism probably plays a minor role for explaining the occurrence of immaculate blue eggs in House Crows. Based on the results from the present study, showing higher nest predation rates of blue eggs than speckled eggs, and the former egg experiment study, showing low egg rejection probability of non-mimetic eggs, one can speculate if the selective force behind the apparent resemblance of Asian Koel eggs and *Corvus* species eggs is nest predation rather than egg rejection. This warrants further investigations.

We could not find any published evidence of other *Corvus* species laying immaculate blue eggs. It is well-know, however, that there can be a pronounced intraclutch variation (i.e. within clutches) in egg appearance in several *Corvus* species (Harrison & Castell 1998). Often, a minority of the eggs are paler and clearly different from the rest of the clutch. Some *Corvus* species are parasitised by the Great Spotted Cuckoo *Clamator glandarius* and the Asian Koel, and both these parasites lay eggs with blue to green or olive ground colour with blotches (Soler *et al.* 2003, Payne 2005, Begum *et al.* 2011b, Erritzøe *et al.* 2012). House Crows are also parasitised by the Great Spotted Cuckoo in Israel (Yosef 1997, Yosef 2002).

It is possible that the blue egg morph observed by Hume went extinct shortly after his observations, and the blue eggs we report in this study is the result of a new more recent mutation. However, we cannot exclude the possibility that blue House Crow eggs have existed without being observed or reported in the literature. In our study area, at least two House Crow females exist that lay blue immaculate eggs. Furthermore, two nestlings from the blue immaculate eggs fledged successfully.

Future studies will reveal whether the blue egg morph will continue to exist in this area or disappear again.

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Table 1. Description of House Crow nests containing immaculate blue eggs.

No	Nest found date	No of eggs when found	Total eggs	Nest height (meter)	Nesting tree	Final fate	Predation stage	No of eggs when predated	Date of predation /chick fledged	Nest GPS position
1	24 February, 2016	5	5	11	Mango (*Mangifera indica*)	Predated	Incubation	4	11 March, 2016	23°53.696′ 90°16.038′
2	1 March, 2016	1	5	8	Mango (*Mangifera indica*)	2 chicks successfully fledged	-	-	21 April, 2016	23°53.475′ 90°16.131′
3	9 March, 2017	2	2	8	Mango (*Mangifera indica*)	Predated	Egg laying	2	12 March, 2017	23°53.477′ 90°16.140′
4	4 April, 2017	2	2	11	Jackfrruit (*Artocarpus heterophylus*)	Predated	Egg laying	2	6 April, 2017	23°53.708′ 90°16.028′

Fig. 1: Top: Regular egg morph of House Crow; Down: House Crow nest with immaculate blue eggs found on 24th February 2016. The greyish markings on the egg surface are caused by dirt and not egg pigments.