How aggressive are Egyptian Geese *Alopochen aegyptiaca*? Interactions with Greylag Geese *Anser anser* and other birds in an urban environment

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Abstract

Under European Union legislation, the Egyptian Goose *Alopochen aegyptiaca* is listed as an invasive species of concern to member states, because of the adverse impacts which it has on native species. One of the reasons for this classification is interspecific competition, and the supposed aggressiveness of Egyptian Geese towards other birds, yet there are few data published on this behaviour. Here we compare the agonistic behaviour of Egyptian Geese with that of resident Greylag Geese *Anser anser* in a recently colonised urban area of southern Germany. For both species, aggression consisted mostly of a threat posture with extended neck (95.8% of Greylag Goose threats; 97.8% of Egyptian Goose threats), whilst hissing regardless of neck posture occurred only occasionally (3.8% in Greylag Geese; 1% in Egyptian Geese). Threatened birds mostly avoided the opponent, and encounters rarely resulted in a physical fight (0.4% in Greylag Geese; 2.4% in Egyptian Geese). Intraspecific aggression was significantly more frequent among Egyptian Geese than among Greylag Geese occurring in the same area, but the overall frequency of interspecific aggression did not differ between the two species. There were, however, differences in the species affected: among Greylag Geese, the most frequent targets of interspecific aggression were Egyptian Geese, whereas Mallard *Anas plathyrhynchos* were most frequently targeted by Egyptian Geese.

Key words: competition, invasive species, Mallard, urban geese.

Aggressive behaviour between animals of the same or different species is widespread, and has ecological and evolutionary consequences for both winners and losers (Peimann & Robinson 2010; Wood *et al.* 2017). It occurs primarily during competition for resources (notably food, nest sites and mates), but is also manifest when animals protect themselves from predators (Archer 1988; Wood *et al.* 2017). The frequency and intensity of aggressive behaviour varies throughout the annual cycle, a feature

which may be influenced by hormone levels (Akesson & Raveling 1981; Hirschenhauser *et al.* 2000), as well as by social conditions (*e.g.* migratory birds arriving at a wintering site, sex ratio in the flocks and the dominance ranks of the opponents; Scott 1978; Black & Owen 1989; Rees 2006; Weiß *et al.* 2011). All Anseriformes are known to protect their nests and broods from intruders, usually conspecifics (Black & Owen 1989; Wood *et al.* 2017), although interspecific aggression also occurs. For instance, Mute Swans *Cygnus olor* not only defend their breeding territory from other swans, but have occasionally been reported threatening and even attacking people (Conover & Kania 1994).

Throughout Europe, numbers of introduced Egyptian Geese *Alopochen aegyptiaca* have increased notably and the species is still spreading (Gyimesi & Lensink 2012). The European Union (EU) has classified the Egyptian Goose as a non-native invasive (European Commission 2017) because its aggressive behaviour and competitive abilities appear to pose a threat to native species. Yet few systematic studies exist on this issue (Hüppeler 2000). The Egyptian Goose belongs to the shelduck and sheldgoose (Tadorninae) sub-family, but in Europe they share similar habitat preferences with Mallards *Anas plathrhynchos* (Anatinae) and Common Coots *Fulica atra* (Rallidae), with which they might compete (Lever 2005), although their feeding preferences only partly overlap. They also nest in a variety of locations, ranging from islands to tree canopies where they use old nests of other birds (Bauer *et al.* 2012), and therefore potentially may compete with a range of species for nest sites.

Egyptian Goose aggression towards other bird species, especially during the breeding season, is thought sometimes to prevent smaller waterbirds such as ducks or rails from establishing a nesting territory or rearing young. In Germany there have been occasional reports of individual Egyptian Geese displacing or fighting over the nest sites of Mute Swans, Ruddy Shelducks *Tadorna ferruginea* (itself a non-native), Greylag Geese *Anser anser*, Coot, Moorhens *Gallinula chloropus*, Curlew *Numenius arquata* (at the roost), Peregrine Falcons *Falco peregrinus*, Kestrels *Falco tinnunculus*, Barn Owls *Tyto alba*, other raptor species (*e.g.* Black Kite *Milvus migrans*), Grey and Purple Heron *Ardea cinerea* and *A. purpurea*, and White Stork *Ciconia ciconia* (summarised in Andris *et al.* 2011; Bauer *et al.* 2018; also F. Woog, pers. obs.). They may even kill other birds, albeit rarely, *e.g.* Mallard adults and ducklings (G. Rode, pers. comm.), Moorhen, Coot and Shelduck *Tadorna tadorna* chicks, and perhaps most notably a Greater Flamingo *Phoenicopterus roseus* at the local zoo in Stuttgart (Woog *et al.* 2010). In Britain, Egyptian Geese have been known to displace Ospreys *Pandion haliaetus* from artificial nesting platforms (Rehfish *et al.* 2010).

In their native range of sub-Saharan Africa and along the River Nile, Egyptian Geese have also been shown to take over the nests of many different species by chasing them away, or less commonly by killing the original occupants (reviewed by Thompson *et al.* 2019), even when their opponents are much larger, such as Verreaux's Eagle *Aquila*

verreauxii (Martin 2012) or the African Fish Eagle *Haliaeetus vocifer* (Simmons 2005). Sometimes they lay their clutch in an active nest of a large raptor (Thompson *et al.* 2019) and breed simultaneously. Interactions between Black Sparrowhawks *Accipiter melanoleucus* and Egyptian Geese often resulted in the displacement of the breeding raptors (Tate & Amar 2012), reducing their breeding success (Curtis *et al.* 2007) or even resulting in the death of adults and juveniles (Koeslag 2012). Egyptian Geese had an even greater impact on the reproductive success of Black Sparrowhawks than other factors, such as climate, habitat or nest site characteristics (Koeslag 2012).

Although Egyptian Geese are originally from Africa (Bauer *et al.* 2012), introduced birds have spread from the Netherlands throughout the rest of Europe, and the species is now established in many European countries (Gyimesi & Lensink 2012). The geese use a variety of nesting sites near water bodies, and often use nests built by other birds in trees, which they sometimes take over forcefully (Bauer *et al.* 2012). The success of the Egyptian Goose in colonising new habitats therefore may be at least partly due to their competitive abilities, resulting from strong and frequent aggressive behaviour, yet there are few studies to confirm that this occurs. Stuttgart was only recently colonised by Egyptian Geese, with a first brood recorded in 2010 (Woog *et al.* 2010), and Egyptian Goose numbers have since increased relatively rapidly (Hohmann & Woog 2021). By 2019 at least 16 Egyptian Goose nest sites were known, but they were not found in Greylag Goose breeding areas, with the latter vigorously excluding Egyptian Geese from their nesting islands in Stuttgart (F. Woog, unpubl. data). In contrast, introduced Greylag Geese are considered as established regionally in Germany (Bauer *et al.* 2016), and initially settled in Stuttgart during the 1980s (Hölzinger *et al.* 2018). The first brood in Stuttgart was not recorded until 1995 however (Woog *et al.* 2008), and the population increased slowly thereafter. This may be explained by there being a limited number of safe nesting sites in the city (Woog *et al.* 2008; Hohmann & Woog 2021).

Greylag Geese are slightly larger (length: 76–89 cm, weight: 2,500–4,100 g) than Egyptian Geese (length: 71–73 cm, weight: 1,500–2,250 g; Del Hoyo *et al.* 1992). The two species share the short grasslands of Stuttgart's public parks, where the frequently mown grass and herb pastures with high protein content are feeding areas for the birds, and the small water bodies are used for daytime roosting and preening. This habitat is also shared with Mallards (length: 50–65 cm; weight: 750–1,575 g; Del Hoyo *et al.* 1992) and Moorhens (length: 30–38 cm; weight: 192–493 g; Del Hoyo *et al.* 1996), which nest in the area. Carrion Crows *Corvus corone* mainly come into contact with the geese when people are feeding them.

Conditions in Stuttgart provided a unique opportunity to study the aggressive interactions between the two species in an urban area only recently colonised by Egyptian Geese, and also their interactions with other species. We tested the following hypotheses: (1) aggressive encounters are most frequent within species, because their individuals are competing for the same resources (Peimann & Robinson 2010); (2)

Egyptian Geese show more intraspecific aggression than Greylag Geese, because the latter are more gregarious (Lorenz 1991); (3) Egyptian Geese are more aggressive towards other bird species in comparison to Greylag Geese, which may explain their success in colonising new areas; and (4) body size determines initiation of agonistic interactions with other waterbirds (following Wood *et al.* 2017).

Methods

Study site

The study was carried out in Stuttgart, the state capital of Baden-Wuerttemberg, southwest Germany (48°46'N,09°10'E), which is 230–550 m above sea level in a hilly landscape. Public parks extend along a 8 km corridor in the city with a total area of 5.6 km^2, including lawns which provide ample grazing for the geese, many small lakes which offer safe roosting places, and large trees which provide nesting opportunities for Egyptian Geese. Greylag Goose nesting sites in the same area are restricted almost entirely to the few islands at the Max-Eyth Lake. Both sites are heavily used for recreational purposes.

Description of agonistic behaviour

Various behaviours associated with aggression differ only slightly between goose species (Johnsgard 1961). The most common posture is a vertical neck extended towards an opponent, sometimes accompanied by hissing, and this behaviour is well understood by individuals both within and between species. Within goose flocks, such threats are often enough to keep others at a distance, and when carried out by a paired Greylag Goose male the display is often followed by a triumph ceremony (Fischer 1965; Lorenz 1966). Such ritualised behaviour is thought to strengthen the pair bond in geese (Bigot *et al.* 1995). In Egyptian Geese this behaviour is less ritualised and their next strongest threat (usually incited by the female) is a sudden opening of the wings by the male, accompanied by a call that resembles strong breathing notes (Johnsgard 1965). In the next step of escalation, when two geese face each other with a vertically stretched neck, usually one gives up and retreats. If both opponents have no rank in the flock's dominance hierarchy, however, or are of similar strength and similar motivation, a fight may ensue where birds use the hard edges of their wings to beat each other, as well as biting the opponent (Lorenz 1991). In the true geese, this happens very rarely and is usually followed by a triumph ceremony. The triumph ceremony is divided into two main parts: rolling (where the geese make loud honking calls, whilst extending their head and neck), and cackling (where the geese make a snoring sound, with head and neck horizontal to the ground; Radesäter 1974). For more detailed descriptions of agonistic behaviour and triumph displays see Johnsgard (1965).

Behavioural observations

Between 5 June–22 August 2018, observations were made in hourly blocks (total n = 192 h) between 8:30–10:30 h and 12:00–15:00 h. All intraspecific and interspecific encounters involving one or

both of the two main study species were recorded during each of the 60 min observation periods, together with the time of day, the species involved, the species that initiated the aggression, and the type of aggressive behaviour. Observations were conducted at feeding and roosting areas where both species occurred, but not at their nest sites. Aggressive behaviour was divided in three categories: (1) threat posture with extended neck; (2) hissing regardless of neck posture; and (3) other (*e.g.* aggression in the water). The birds were viewed from a distance (> 50 m) from the start of each hourly observation period, so as not to influence their behaviour (Martin & Bateson 2007). Because very few of the Egyptian Geese were ringed, we were not able to distinguish between individuals.

Statistics

Statistical analysis was undertaken using SPSS software (IBM SPSS Statistics 24). To determine whether Egyptian Geese show significantly more intraspecific (hypothesis 2) and interspecific aggression (hypothesis 3) than Greylag Geese, chi-square tests were used to compare the total number of inter- and intraspecific aggressive encounters by the two species during the 192 h of observations. Additionally, the numbers of aggressive encounters (intra- and interspecific) per hour by the two species were compared using unpaired t-tests for two independent samples with equal variances (Levene test). Mean values (number of encounters) are presented with standard errors (s.e.). The total number of agonistic interactions with other waterbirds, recorded over the entire 192 h observation period, is presented for each species, for considering whether body size may affect the frequency of interspecific encounters.

Results

Agonistic behaviour consisted mostly of the threat posture with extended neck (95.8% of 240 Greylag Goose encounters; 97.8% of 414 Egyptian Goose encounters), and hissing without the extended neck posture occurred only occasionally (3.8% for Greylag Geese; 1% for Egyptian Geese). Threatened birds mostly avoided the opponent; it was quite rare for the encounter to result in physical combat (0.4% for Greylag Geese; 2.4% for Egyptian Geese).

Greylag Geese showed aggressive behaviour in 77% of the hourly observation periods (86 out of 112); Egyptian Geese in 81% (65 out of 80). Egyptian Geese also initiated more aggressive encounters per hour (mean ± s.e. = 2.02 ± 0.22 for Greylag Geese; 4.95 ± 0.80 for Egyptian Geese; $t_{91} = -3.50$, $P \leq 0.001$). Considering only interspecific encounters ($n = 43$ for Egyptian Geese; $n = 38$ for Greylag Geese), there was no difference between the two species (mean ± s.e. = 1.56 ± 0.20 for Greylag Geese; 1.72 ± 0.22 for EG; $t_{48} = -0.53$, $P = 0.30$, n.s.). Analysis of differences in the frequency of intra- and inter-specific aggression recorded for the two species, however, indicated that Greylag Geese initiated a slightly larger proportion of aggressive encounters with other species than did Egyptian Geese ($\chi^2_1 = 5.06$, $P = 0.02$; Fig. 1).

Interspecific aggressive behaviour by the two species targeted different taxa ($\chi^2_1 = 22.94$, $P < 0.001$; Fig. 2) with Greylag

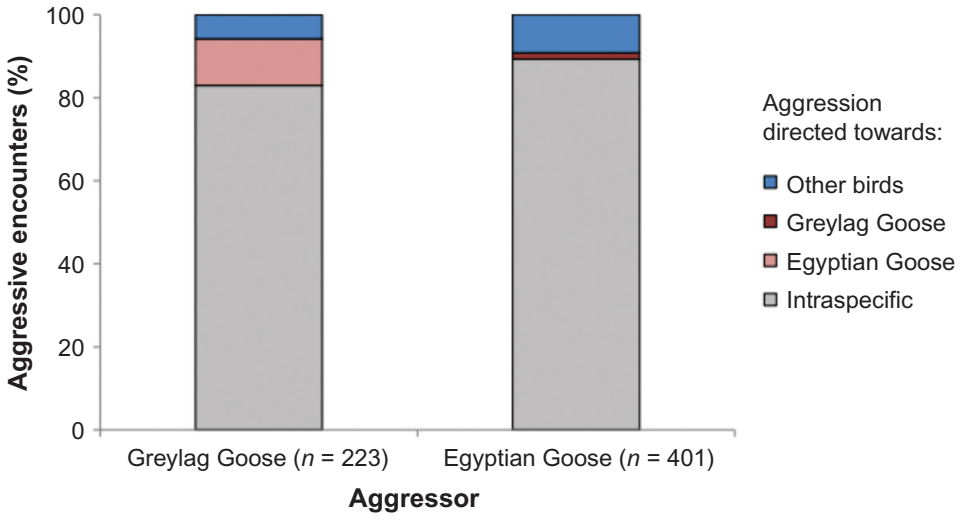

Figure 1. Percentage of aggressive encounters initiated by Greylag Geese and Egyptian Geese towards own species (intraspecific) and other species (interspecific). Data are sums of all occurrences recorded during 192 one-hour observation periods.

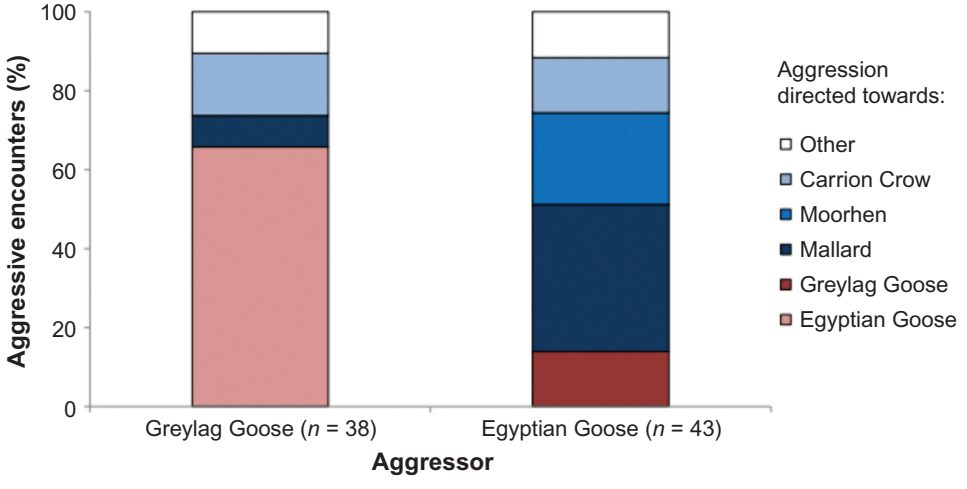

Figure 2. Percentage of interspecific aggressive encounters by Greylag Geese (n = 38) and Egyptian Geese (n = 43) and the main species involved (Carrion Crow, Moorhen, Mallard). Other species attacked by the Greylag Geese were: Bean Goose *Anser fabalis*, Grey Heron and Red Squirrel *Sciurus vulgaris*; and by the Egyptian Geese: Grey Heron and Feral Pigeon *Columba livia*. Data are sums of all occurrences recorded during 192 one-hour observation periods.

Geese attacking predominantly Egyptian Geese in about two thirds of the cases, plus a few Mallards and Carrion Crows. Egyptian Geese attacked mainly Mallards, Moorhens and some corvids, with only 14% of attacks directed against Greylag Geese.

Discussion

Both species were most frequently aggressive towards their conspecifics, which may reflect the greatest overlap in resource use within species. This is also the case for other species such as swans *Cygnus* sp. (Wood *et al.* 2020). Egyptian Geese showed more aggression towards conspecifics than Greylag Geese, but the frequency of interspecific encounters was similar. In comparison to Egyptian Geese, Greylag Geese are a very social species, where individuals form long-term relationships with relatively fixed dominance relationships within a flock (Lorenz 1991) and family groups with goslings often join, forming creches. Such stable, social groups are unknown in Egyptian Geese, which tend to be territorial against other Egyptian Geese during brood rearing, and usually a small lake holds only one family group (Bauer *et al.* 2018). These behavioural differences may explain why we saw more intraspecific aggression in Egyptian Geese than in Greylag Geese.

In about two-thirds of interspecific encounters, Greylag Geese attacked Egyptian Geese, but in only 14% of cases did the reverse occur. Hence, the larger Greylag Geese had relatively little interference from the smaller Egyptian Geese, whereas the latter had to avoid Greylag Geese in order not to be attacked. Greylag Geese also had a slightly larger proportion of aggressive encounters with other species than Egyptian Geese. We therefore have to reject our hypothesis that the latter show aggressive behaviour more often than Greylag Geese.

In our study, interspecific aggressions were mostly directed to the next smaller species, *i.e.* Greylag Geese attacked Egyptian Geese whereas Mallards, Moorhens and Carrion Crows were prone to attacks by Egyptian Geese. Among waterfowl, this is a common pattern (reviewed by Wood *et al.* 2017); to attack someone smaller is less risky. On the other hand, similar-sized species may compete for similar resources, and it may be more profitable to exclude them. Interspecific competition may not always be visible, with smaller species being pushed to less profitable areas (Owen & Black 1990) or avoiding areas with larger species altogether.

Body size has determined the number of aggressive encounters in other species of wildfowl. For example, in North America where Mute Swans are also considered a non-native invasive (Gayet *et al.* 2019), swans attacked similar-sized birds such as Canada Geese *Branta canadensis* most often, followed by introduced Mallards (Conover & Kania 1994). Tundra Swans *Cygnus columbianus columbianus* have been reported to kill Greater White-fronted Goose *Anser albifrons frontalis* goslings during the breeding season, where agonistic interactions were always initiated by the larger swans (Ely *et al.* 1987). Although Mute Swans have also been known on rare occasions to kill waterbirds that intrude into their breeding territory, studies have found that in general swan behaviour does not have a significant effect on waterbird distribution (Gayet *et al.*

2011). Studies of interspecific conflicts between goose species found that smaller Cackling Canada Geese *Branta hutchinsoni* invariably retreated from Emperor Goose *Anser canagicus* families (Frazer & Kirchpatrick 1979), and that smaller Greenland White-fronted Geese *Anser albifrons flavirostris* always retreated after encounters with Canada Geese *Branta canadensis* (Kristiansen & Jarret 2002). The only account of a *Branta* goose killing another species is of a nesting male Canada Goose killing a Brent Goose *Branta bernicla*, which has a much smaller body size in comparison (Krauss & Salame 2012).

Whereas highly aggressive behaviour by some individual Egyptian Geese during brood rearing is undisputed, our study does not support the view that they disrupt waterfowl communities (also see Hüppeler 2000; Geberth 2011; Kenmogne & Schindler 2011). Our systematic observations may not present a complete picture, however, because it is site-specific. Moreover, a small number of very aggressive Egyptian Goose individuals may indeed disrupt smaller species considerably, but this is rarely witnessed. In our urban study area, Egyptian Geese showed more aggression towards conspecifics than Greylag Geese, but the amount of interspecific encounters was similar. Hence, there is no evidence to suggest that Egyptian Geese would be more successful and invasive than Greylag Geese because of their higher aggressiveness, but other differences in their biology such as the large variety of possible nesting sites they can use, and their larger broods with higher survival rates, may explain their success in colonising new areas.

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