Cattle Egrets *Ardea ibis* use human-made habitat in a newly colonised area in northern Algeria

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The Cattle Egret *Ardea ibis* is a species of Indo-African origin (Kushlan and Hafner 2000) whose biological plasticity is certainly one of the key causes of its worldwide expansion (Franchimont 1986a, Hancock and Kushlan 2005), making it a good model species with which to study the factors that allow colonisation of new environments by invasive birds.

We studied the use of natural and human-made feeding habitats by Cattle Egrets in a newly colonised area in the Soummam Kabylie region (36°43′ N, 05°04′ E), northern Algeria, where the species has bred since 1993, to better understand the relationships between habitat features and the distribution of populations during the entire biological cycle. Until the nineteenth century, the species was breeding in localised areas in northern Algeria (Heim de Balsac and Mayaud 1962). More recently, it started breeding and wintering in a much larger area (Isenmann and Moali 2000, Si Bachir et al. 2008), including semiarid and arid areas in the Sahara (Siegfried 1971, Hancock and Kushlan 2005).

Assuming that in North Africa artificial habitats such as crops and orchards are more stable and resource-rich environments than natural habitats (Boukhemza et al. 2000, Kushlan and Hafner 2000, Hancock and Kushlan 2005), we hypothesised that man-made agroecosystems promote the expansion of the species in the recently colonised subhumid and semiarid regions.

Habitats and Cattle Egrets were sampled along a 60 km route transect. The route criss-crosses a diversified and fragmented landscape covering most of the Soummam valley and the coastal plain of Béjaia, which is characterised by greenhouse cultures, orchards and temporary ponds. Roadsides in this area are generally similar to the general landscape of the region and we assumed that our results can therefore be at least extended to all roadsides in the region.

Surveys were performed fortnightly under the same meteorological conditions between February 1996 and March 1997 using a vehicle travelling at c. 40–50 km h^{-1}. The transect was generally covered in <3 h. Surveys were not conducted during early mornings when Cattle Egrets gather close to the colonies before dispersion to the foraging areas, and during evenings when they meet in the colonies or roosts. During surveys, we searched for feeding groups of Cattle Egrets and recorded:

(1) The number of individuals within the group, defined as ≥1 individual feeding in the same location, with birds not being more than c. 20 m away from their neighbours considered as belonging to the same group (Siegfried 1971, Bredin 1984).
(2) The types of habitat where the birds were observed feeding: (i) river and stream edges; (ii) grass and fallow lands – grounds that are generally mowed, characterised by a permanent cover of herbaceous vegetation dominated by *Atriplex hastata*, *Borrago officinalis*, *Echium australe*, *Hordeum murinum* and *Triticum* sp.; (iii) temporary ponds – small stretches of open water or invaded by vegetation appearing temporarily after heavy rains in autumn and spring; (iv) arable ground – present during the entire year but with larger bare surfaces in autumn before cereal sowing; (v) low crops – mainly dry cereals during their early growth stage and various low irrigated cultivation; (vi) young orchards – mainly citrus fruits and other fruit-bearing cultivars; (vii) rubbish dumps – mainly organic wastes from poultry breeders and domestic garbage dumps; and (viii) gardens – located in urban zones.
(3) The approximate surface of the feeding locality (in hectares, ±10–20%), corresponding to a homogeneous habitat surrounding each feeding group and estimated according to its geometrical form, which was recorded on a map.
(4) The presence (i) or absence (ii) of water.
(5) The type of vegetation layer where the birds were feeding: bare ground (i), herbaceous (ii), shrubby (iii), and raised (iv).
(6) Distance (±10 m) of the feeding group to the nearest road, to the nearest Cattle Egret breeding colony (±0.5 km), and wintering roost (±0.5 km). The area covered by the survey transect has two breeding colonies and 11 wintering roosts (Si Bachir et al. 2008).

Effects of habitat variables and phenological season (breeding: March–August; non-breeding: September–February) on the size of feeding groups were tested using a generalised linear model (Poisson distribution, log link function, Type 3 tests; McCullagh and Nelder 1989). Data used for the analyses were habitat patches where a group of Cattle Egrets was observed feeding at least once during the entire study period. All variables and the interactions phenological season×type of habitat/vegetation were included in the model to test for potential changes in habitat use between phenological seasons. Values presented are the mean ± SD.

From a total of 1 079 observation events, 652 feeding groups of Cattle Egrets were detected corresponding to a total of 6 105 birds. The mean group size was 5.7 ± 7.0 individuals (minimum = 0, maximum = 38). Cattle Egrets were mainly observed foraging in grass and fallow lands (Figure 1). Other habitats were also used, although less frequently. There was no significant effect of the phenological season, presence of water, type of vegetation, distance to the nearest roost and the interaction terms on the size of the feeding groups (Table 1). Habitat type, surface of the habitat, distance to the nearest colony and to the nearest route affected the size of groups. Average group size was larger in grass and fallow lands (8.3 ± 8.2 individuals) compared to the other feeding habitats (5.2 ± 6.2 individuals), except for young orchards where feeding groups were much smaller (1.4 ± 3.2 individuals; Table 2). Larger groups used large feeding habitats situated further from the roads, whereas the size of the foraging groups decreased with increasing distance from the colonies (Table 2).

Cattle Egrets forage in a variety of natural or anthropised habitats in the area of Béjaia. Higher numbers of birds were observed feeding in grass and fallow lands, and to a lesser extent arable ground, and river and stream edges. These feeding habitats represent the most abundant areas of the region and the most constant in time. Grass and fallow lands are particularly favourable because of their opened aspect, low and persistent vegetation, and frequent use by cattle. They also offer the most availability and accessibility of prey, both invertebrate and vertebrate (Si Bachir et al. 2001). In this habitat, association of Cattle Egrets with cattle and/or agricultural machinery is frequent, which may facilitate the capture of prey (Boukhemza et al. 2000, Si Bachir et al. 2001). Cattle Egrets also exploit other habitats such as young citrus orchards, olive groves, and vineyards as well as gardens and rubbish dumps. This demonstrates the plasticity of this heron species in its feeding habitats in Algeria.

In Europe the species generally feeds in marshes, ponds, rice fields and coastal wetlands (Hafner 1980, Bredin 1984, Marion et al. 1993), whereas dry areas are used only in hard winters. In Ouezzane, Morocco, the ponds represent the most commonly used habitats for feeding (Franchimont 1986b). Rubbish dumps constitute an increasingly used feeding habitat by the Cattle Egret (Rencurel 1972, Dean 1978, Franchimont 1986b, Boukhemza et al. 2000), but also by other species such as the White Stork *Ciconia ciconia* (Blanco 1996).

The lack of significant difference in group size between seasons for a given habitat suggests that despite increased energetic needs during the breeding season, the birds do not seem to modify their use of feeding habitats. Not surprisingly, group size of feeding birds increased with increasing surface area of the feeding localities. The increase in size of feeding groups with increasing distance from roads suggests an effect of human disturbance because of road traffic. Finally, the negative relationship between the size of feeding groups and the distance to the nearest colony is probably a direct consequence of the central place foraging strategy of this colonial breeder (Hafner 1980).

The variety of habitats used for feeding by Cattle Egrets is consistent with its opportunistic diet (Bredin 1984, Si

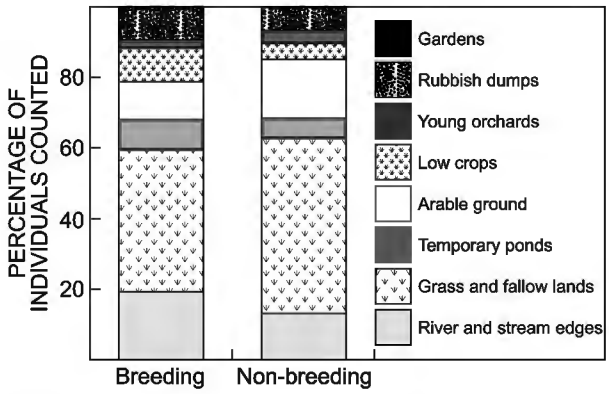

Figure 1: Proportion of feeding Cattle Egrets counted in different habitat types during the breeding and non breeding seasons in the Soummam Kabylie region, Algeria

Table 1: Modeling the effects of habitat and season on the number of feeding Cattle Egrets in the Soummam Kabylie region, Algeria. Only significant terms are shown. Goodness of fit: χ^2 = 5 270.3, df = 1 052 (overdispersion factor = 5.01)

Source	df	χ^2	*p*
Type of habitat	7	206.96	<0.001
Surface	1	9.43	<0.01
Distance to the nearest colony	1	70.31	<0.001
Distance to the nearest road	1	193.40	<0.001

Table 2: Results from the model for the effects of habitat and season on the number of feeding Cattle Egrets in the Soummam Kabylie region, Algeria. Only significant terms are shown

Variable	Estimate	SE	Wald statistic	*p*
Intercept	0.93	0.37	6.37	<0.05
Shrubby layer	−0.39	0.18	4.70	<0.05
Grass and fallow land	1.07	0.19	31.82	<0.001
Young orchard	−1.37	0.41	11.11	<0.001
Surface	0.01	0.003	9.82	<0.01
Distance to the nearest colony	−0.05	0.005	79.75	<0.001
Distance to the nearest road	0.03	0.002	195.53	<0.001

Bachir et al. 2001). This opportunistic behaviour is similar to that observed in successful invasive species, whose success may depend on the ability to utilise a wider variety of habitats and resources than non-invasive species (Carol Eunmi 2002).

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