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The occupation of an ecological niche by cattle egrets

TD St George 35 White St, Graceville, Queensland 4075, Australia.

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INTRODUCTION

In the course of the 20th century, the cattle egret has expanded to three more continents and many islands of the Pacific and Atlantic Oceans. (Fig 1) This bird is described as *Ardea ibis ibis*, in Africa, America and Europe and as *Ardea ibis coromandus* in eastern Asia, Australia and the Pacific. The cattle egret is closely associated with large grazing animals including domestic cattle and buffalo as they feed principally on insects disturbed from grasslands by the grazing animals. They also pick ticks attached to the skin of these animals. Colonies are established close to water as resting or breeding rookeries. Many of the bird populations have an annual migration pattern while others can be resident year round.

THE EXPANSION

The sub species *Ardea ibis coromandus* may have entered Australia as early as the 1920s (McKilligan 1985) although other reports cite a later date (1948) in the sub-coastal plain east of Darwin. These birds spread around the continent much later and by the 1960s were visiting New Zealand. They migrate annually between northern New South Wales and New Zealand. Occasionally they are seen on Macquarie Island. In a southward movement the *Ardea ibis ibis* reached Cape Province in South Africa in 1908. They crossed the Atlantic from Africa and entered Suriname in 1933. Herons have been observed from planes, flying steadily across the mid-Atlantic (Martinez – Vilata *et al* 1992). From northern South America they expanded via the Caribbean islands to Florida in 1941 and bred there in 1953 (Gilbert 1972). They were first reported in Texas in July 1948. They had reached their present limits in North and South America by 1970 as shown in Fig 1. In Europe prior to 1930, they were confined

to southern Portugal and south-western Spain. They are now visiting most northern European countries. Migration from central Africa occurs.

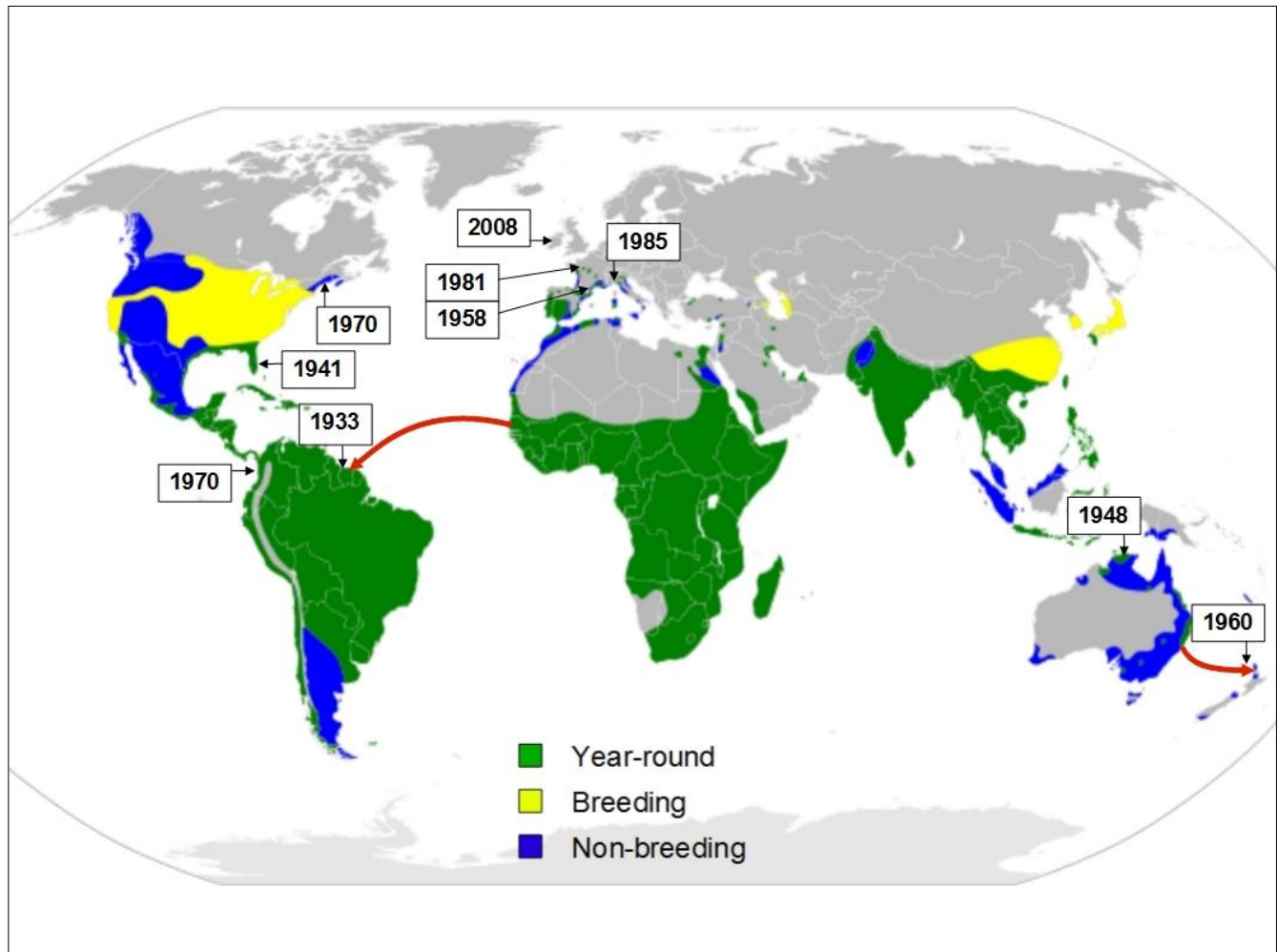


Figure 1. The present approximate distribution of cattle egrets. The dates shown for their arrival may be for either small or for large numbers.

ARBOVIRUSES ASSOCIATED WITH CATTLE EGRETS

In Australia, three arboviruses have been isolated from *Argas robertsi* ticks that were collected in cattle egret heronries, namely Kao Shaun (Doherty *et al* 1976), Lake Clarendon virus, (St George *et al* 1984) and CSIRO 1499 (unidentified). Lake Clarendon virus was isolated from pools of 8 adult ticks or nymphs. It is an icosahedral virus 65-75 nm in size. Neutralising antibodies to this virus were found in adults and chicks in the same colony. Humphrey-Smith *et al* (1986) reported links with seabirds

for CSIRO 1499 virus. Quarantil and Nyamnini viruses have been isolated from cattle egrets. Nyamnini virus was first isolated from cattle egrets in the Sudan in 1957 (Haig *et al* 1965) and subsequently Nigeria, Egypt, India and Thailand. It thus infects both subspecies. It has also been isolated from *Argas walkerae* ticks. (Mihindukulasuriya *et al* 2009)

Experimental infections

The experimental infections of cattle egrets were described by Standfast *et al* (1986). Many egret chicks are pushed out of their nests by other chicks. They would normally starve or be killed by predators. Young egrets collected below heronries without tick infestations, near Brisbane, were infected with a range of arboviruses. Four bird associated viruses Thimiri (Simbu group) Lake Clarendon, Kununnura and CSIRO 1499 viruses were reisolated from blood 1-19 days post-inoculation. Some multiplication of virus as judged by the generation of neutralising antibodies occurred 18 days after infection with BTV1 and EHDV 5. Only Thimiri and Lake Clarendon viruses were reisolated from *Argas robertsi* ticks infected experimentally.

Four species of *Ixodid* ticks were infected with BTV8 by Van Bouwknegt *et al* (2010). The virus passed transovarially in the soft tick *Ornithodoros savignyi*.

TICKS ASSOCIATED WITH CATTLE EGRETS

Amblyomma variegatum is an African origin tick that is considered to be spread from island to island in the Caribbean by cattle egrets (Barre *et al* 1995). *Argas robertsi* occurs in Thailand. It seems to be a relatively recent arrival in Australia as it is still spreading. Only one of four egret colonies near Brisbane colonised by *Ar. robertsi* (Standfast *et al* 1986).

DISCUSSION

The two subspecies of cattle egret made a massive expansion to three continents in the 20th century. Presumably individual birds had visited in the past but the local conditions were unsuitable for establishment. A major change in development of large herds of cattle in North and South America and Australia where

formerly populations of large ruminants were low or non-existent. It is more difficult to explain why the small egret population that was confined to a southwest strip of Spain and Portugal has invaded much of Europe, at least for summer months.

The association between cattle egrets and tick species bearing arboviruses is strong, as this bird is capable of spreading both. The adult *Argas* species ticks spend a very short time feeding on chicks or adults at night but larval ticks can be carried long distances in egret migrations. This has the potential to spread arboviruses within the tick larvae and, if the ticks establish, for the viruses to persist. At least five arboviruses have been isolated from egrets or ticks associated with them, namely, Quaranfil, Nyamnini, Kao Shaun, Lake Clarendon and CSIRO 1499 (unidentified). A new taxon has been proposed for Nyamnini and Midway viruses by Mihindukulasuriya *et al* (2009). The taxonomic status of other viruses is not finalised.

Egrets arrived in the USA in 1941. Bluetongue as a new entity was first diagnosed in Texas in July 1948. Only about 20 sheep were found to have the disease at that time. The disease reappeared on a much larger scale in June 1951 (Cox 1954). Each of the three bluetongue epidemics originated along the Rio Grande and began in May or June. No cattle developed clinical bluetongue. The main proven *Culicoides* vector of bluetongue in the United States is *C. sonorensis* (formerly *C. variipennis*) and a second vector species in Florida (*C. insignis*) has a subtropical distribution (Gibbs *et al* 1989). Gibbs suggested that the possibility of BTV vectors being blown across the Atlantic to the West Indies could not be excluded though the transfer would take 6 days.

Stott *et al* (1985) have shown that American bluetongue virus can multiply in *Ornithodoros coriaceus*. Bouwknecht *et al* (2010) have raised the potential for ticks to account for the over-wintering of BTV in Europe. This leaves open the link between birds and cattle or sheep. There is a very close association between cattle egrets and cattle but the tick infestations are not usually shared. There are species of *Culicoides* that will feed on birds and cattle to provide a link for lateral spread. Standfast *et al* (1956) collected 12 species of mosquitoes and 8 species of *Culicoides* with light traps

that were set close to cattle egret nests in trees (Table 1). The adult ticks, larvae, mosquitoes and *Culicoides* can be feeding simultaneously, especially on the poorly feathered young chicks. Thus virus can be injected into the bloodstream or be present in the lymph and available to other blood feeding arthropods without any lag time for multiplication.

Table 1 Species of insects in Egret heronry

<i>Culicoides</i>	Hosts
<i>C. austropalpalis</i>	Birds
<i>C. brevitarsis</i>	Cattle & horses
<i>C. bundyensis</i>	Cattle & macropods
<i>C. dycei</i>	Cattle, horses, rabbits, sheep. Birds unlikely.
<i>C. marksi</i>	General mammalian feeder, birds unlikely
<i>C. narrabeenensis</i>	Not known, rare
<i>C. victoriae</i>	General mammalian feeder, birds unlikely
<i>C. "Willi Willi"</i>	Not known, rare

Mosquitoes

<i>Anopheles annulipes</i>	General mammalian, probably occasional bird
<i>Aedes vittiger</i>	Anything that moves
<i>Ae. theobaldi</i>	General mammalian, probably occasional bird
<i>Coquillettidia xanthogaster</i>	General mammalian, probably occasional bird
<i>Culex annulirostris</i>	Cattle and birds
<i>Cx. australicus</i>	Birds
<i>Cx. bitaeniorhynchus</i>	Cattle and birds
<i>Cx. orbostiensis</i>	General mammalian, probably occasional bird
<i>Mansonia uniformis</i>	General mammalian, probably occasional bird
<i>Mimomyia elegans</i>	Birds & frogs

Uranotaenia nivipes Frogs

Aedeomyia catasticta Birds

Such a transfer of arboviruses has been demonstrated experimentally by two groups. Jones *et al* (1984) used ticks (*Rhipicephalus appendiculatus*) and Thogoto virus and guinea pigs. Thogoto virus was first isolated from ticks in Africa (Haig *et al* 1965) and has been associated with cattle egrets. McGee *et al* (2009) were able to transfer West Nile virus from infected to uninfected mosquitoes by feeding them simultaneously on mice. Infection occurred at a maximum spacing of 40mm and persisted for up to 45 minutes after a donor feed. BTV is abundant in the dermis of the skin during experimental disease and thus available in blood and lymph flowing into the wound produced by a tick or a *Culicoides*. (Darpel *et al* 2012)

The discovery of bluetongue (BTV8) in Belgium and Holland in August 2006 without a spread from adjacent countries to the south created a mystery. The virus was unusual in that it killed cattle and its closest antigenic relatives were south of the Sahara. BTV can multiply in egrets (Standfast, unpublished data). More recently, Schmallerberg virus in the Simbu group has arrived in approximately the same region of Europe (Hoffmann *et al* 2012). A Simbu group virus (Thimiri virus) that exists in a wide range from Africa, through Asia to Australia was shown to multiply in cattle egret chicks (Standfast *et al* 1986). It was first isolated in Australia from a bird associated species of *Culicoides* (*C. histrio* Standfast *et al* 1984).

It is possible for BTV8 and Schmallerberg viruses to have arrived in egrets, or in ticks or larvae associated with them, migrating from central Africa. The cattle egret is capable of crossing oceans or deserts and could be a factor in the long distance movements of arboviruses and other pathogens. Virus transfer, with or without a viraemia in the cattle egrets, from a tick or tick larvae to a flying vector on arrival from Africa at night when the birds are resting or nesting is possible. During the day, the very close proximity of cattle egrets to cattle, different species of vector may be involved to transfer arboviruses.

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