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ABSTRACT

Transmissible gastro-enteritis (TGE) is an economically important viral disease of pigs in Britain, particularly in East Anglia. Starlings are often abundant at pig farms where they feed on pig food. The close association between starlings and pigs has led farmers to believe that starlings transmit TGE from one farm to another, but evidence has been circumstantial. The following study was designed to establish whether starlings do move between farms. Starlings which were wing-tagged at a pig farm were relocated at 25 other sites, including eleven other pig farms, so the possibility that starlings can transmit TGE from one farm to another cannot be ruled out.

INTRODUCTION

Transmissible gastro-enteritis (TGE) is an economically important viral disease of pigs that has been reported in many countries of the northern hemisphere. Since the first recognized outbreak in Britain in 1956 (Gibson and Harris, 1963), epidemics have occurred at five-seven year intervals, usually during the winter months between December and April. Throughout the history of TGE in Britain, East Anglia, with its dense pig population, has usually been the area most affected. The main features of the most recent TGE epidemic in East Anglia, in 1980-81, were described by Pritchard (1982).

TGE causes a watery diarrhoea in pigs of all ages. This infectious material is potentially available for transmission by vectors such as starlings (*Sturnus vulgaris*). Starlings are often abundant on pig farms, feeding on pig food in troughs and creep feeders, on spilt food by storage bins, or in surface soil turned over by pigs. The close association between starlings and pigs has led farmers and veterinarians in both Britain and the USA to believe that starlings transmit TGE from one farm to another (Ferris, 1973; Giles, 1976; Pritchard, 1981; 1983; Bohl, 1981). The term "starling disease" has been used by farmers in some areas of Britain to describe TGE (E.A. Gibson, Personal Communication). However, before starlings can be regarded as vectors of TGE, several conditions must be fulfilled:

1. Starlings must be able to pick up the disease, either externally (e.g. on the feathers or feet) or internally (e.g. via the alimentary tract).
2. TGE virus must be able to survive in or on the starlings during the time they take to travel between pig farms.
3. Starlings must be able to pass on the virus to recipient pigs in a dose sufficient to be infective.
4. Starlings must visit more than one pig farm.

Gough and Beyer (1980), working in Iowa (USA), isolated TGE visus on the external surface of 4% of starlings at farms with and without TGE, and from the alimentary tract of 17% of birds. Pilchard (1965) had shown earlier that starlings excreted the virus in their faeces up to 32 hours after experimental infection, suggesting that viral replication was occurring in this species. The fact that starlings can be infected implies that there will be a longer period over which they are a threat to pigs than if they carried the TGE virus only mechanically. Gough and Beyer (1980) found that starlings visited 2.1 pig farms per day and that, under artificial conditions, an infected starling could pass on sufficient TGE virus to a pig to constitute an infectious dose. They concluded that starlings do have the potential to serve as vectors of TGE.

Although the studies in Iowa clearly implicate starlings in the spread of TGE, it is possible that the above conditions are not fulfilled elsewhere. For example, in Hampshire, England, Feare (1980) found that few starlings fed more than 400 m from a calf-rearing unit where they were originally caught and tagged. That study suggested that starlings ranged over such short distances that they were unlikely to be vectors of diseases of farm livestock. However, the pattern of movement of starlings may show regional variations within England so our first aim was to establish the extent of starling movements in a TGE infected area in East Anglia.

TGE virus is relatively fragile, being readily inactivated by heat, light and disinfectants (Bohl, 1981). Several studies have shown that pigs are more susceptible to infection during colder weather (Shimizu et al., 1978; Shimizu and Shimizu, 1979) when it has been observed that starlings are more prevalent on pig farms, particularly when snow covers the ground (Ferris, 1973; Gough and Beyer, 1980). Winter is also the season when a large immigrant population visits Britain (Feare, 1984). Hence contact between birds and pigs is likely to increase at a time when TGE virus is more able to survive and the pigs are most susceptible. However, the cause and effect relationship between these factors is not known. Our second aim was to describe the pattern of attendance of starlings at a pig farm in relation to weather.

STUDY AREA AND METHODS

The study was carried out from November 1982 to March 1983 around the town of Swaffham, West Norfolk, England (52° 39 N, 0° 42 E). Starlings were marked at an extensive pig farm in Shingham (Figure 1) where TGE had been intermittently active for the two years prior to the commencement of these observations. Birds were caught in Chardonneret traps (Spencer, 1972) set on tracks between the paddocks of the farm, and baited with pig food. Most captured birds (344) were aged and sexed (Kessel, 1951), and fitted with single-coloured "Saflag" wing-tags (Feare, 1978). A small number of birds (31) were fitted with radio transmitters (Biotrack SRI) clamped to the base of the four central tail feathers. An AVM LA 12 receiver and a three element hand-held Yagi antenna were used to locate radio-tagged birds.

Local pig farmers were personally informed of the study and asked to report sightings. A radio and television broadcast and an article in a pig-farming journal were also used to publicize the study. Marked birds were also searched for along a selected road transect within 10 km of Shingham. This was carried out around mid-day at regular intervals throughout the study period. It was possible that a major change in the roosting habits of the local starling population might influence the diurnal pattern of dispersion and searches were therefore also made for night-time roosts, and their locations noted.

Air temperature records were obtained from RAF Marham, 7 km from Shingham.

RESULTS

The percentages of adult males, adult females, first-year males and first-year females in the trapped samples were 19.2, 16.8, 40.8 and 23.2 respectively, showing a bias towards first-year males. It was not known if this age and sex distribution was representative of the whole population present at the farm. The proportions of each age/sex class captured during November and December were not significantly different from those for January and February ($\chi^2_3 = 4.82$, $p > 0.10$) suggesting a relatively stable population structure throughout the winter.

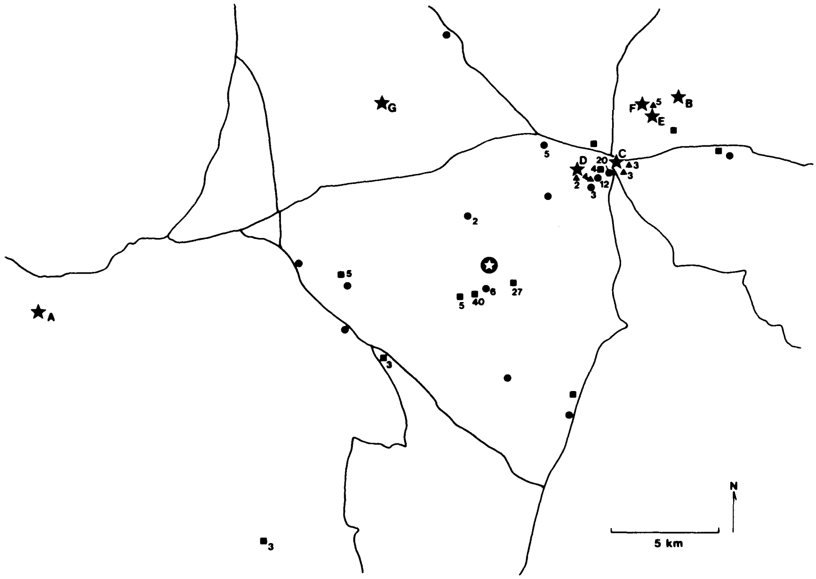

FIGURE 1. The study site in west Norfolk showing the pig farm at Shingham (white star), roost sites (black stars) and localities where birds marked at Shingham were subsequently seen - other pig farms (squares), at pre-roost gatherings (triangles) and other locations (circles). Numbers indicate the number of sightings at a given locality. Lines show main roads.

The starlings fed in a variety of situations in and around creep-feeders and open troughs. They also foraged on patches of grass in the pig paddocks and along the tracks between the paddocks. There were marked diurnal and seasonal variations in the populations of starlings on this farm. The largest numbers were present shortly after daylight and numbers decreased, on average, by 71% (SD ± 23%, n = 26) by late morning. The peak in numbers coincided with the feeding of the pigs in the open troughs. The seasonal pattern of numbers can be seen in Figure 2. Generally there were about a thousand birds present throughout the winter with a period in mid-December when between 3,000 and 5,000 were present soon after daybreak.

We found no relationship between the numbers of birds and minimum air temperatures ($r^2 = 0.02$). Furthermore, we found no correlation between the changes in numbers from one day to the next and changes in the minimum or mean air temperatures ($r^2 = 0.10$ and 0.08 respectively). However, the winter of 1982-83 was relatively mild, especially during January (Figure 2) and snow was scarce. There was a shift in the location of the pig farm in late December, and human disturbance increased when paddock fences were taken down and re-erected. This may have affected the number of birds at the farm. However, paddocks were only shifted to a neighbouring field and there was no change in the distance the birds had to fly from the roost to reach the farm in the morning.

Each day starlings left the farm at dusk to roost in a wood. When the study commenced two roosts were known, one in a mixed plantation (Figure 1A) and the other in hawthorn scrub (Figure 1B). Two birds which were radio-tagged at Shingham were relocated at roost A (a distance of 21 km) and one was again located at Shingham. It was not known if birds from Shingham were also using roost B at this time. Roost A was disturbed by farmers on 8 November and abandoned by 10 November 1982 and roost B was also abandoned by 12 November 1982.

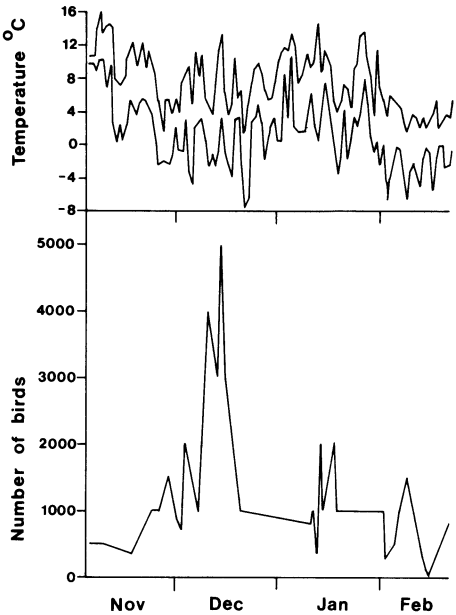

FIGURE 2. Seasonal changes in the number of starlings present at Shingham pig farm within an hour after sunrise (lower graph), and minimum and maximum air temperatures (upper graphs).

The next major roost to be used (C) was in conifers in a large garden at Swaffham. Approximately 100,000 birds used this wood for 14 weeks until it too was disturbed by farmers on 14 February 1983. All 22 birds which were marked with radio-tags at Shingham during this period used this roost. Thus we concluded that for much of the study period the population which fed at Shingham roosted at or near Swaffham, 8 km away. The birds then roosted at localities D, E, F and G over the next few weeks, each shift in location being due to disturbance by farmers. Seventeen tagged birds were relocated in the pre-roost gatherings within 2 km of these roosts (Figure 1). These gatherings were located on grass, stubble and ploughed fields, at a pig farm, a cattle farm and in trees.

During the day, 143 records of tagged starlings were made at 25 localities away from Shingham (Figure 1). These included 12 other pig farms (extensive and intensive), two duck farms, cattle farms, surburban gardens and grass and ploughed fields. The 12 pig farms included seven which had reported TGE outbreaks during the previous two years. Most of the records were made within 10 km of Shingham and the longest recorded movements were 16 km to the south-west and 32 km to the east.

DISCUSSION

Gough and Beyer's (1980) study in the USA showed that starlings have the potential to serve as vectors of TGE. In west Norfolk we showed that starlings do move between pig farms during the winter period and if we accept that the other conditions, mentioned in the Introduction, are unlikely to vary between countries, then it would indicate that starlings have the potential to act as vectors of TGE in Britain. The only weakness in the argument is that we do not know, as yet, the rate at which starlings visit other pig farms, and how this is related to the survival times of TGE virus in and on starlings. This will be the basis of further research.

The observed difference between our results and those of Feare (1980) may have been due to different patterns of food availability at the two farms or to differences in age/sex distribution of the captured birds in the two studies. At Shingham, the pig food was super-abundant in troughs for only a short period in the morning, though continually present in the creep-feeders where it was less accessible to the starlings. At the calf unit in Hampshire, studied by Feare, food was continually abundant and he found that 67-77% (in different winters) of his trapped sample were males and most of these (76%) were adults. In our study 60% were males but only 32% of these were adults. Adult birds, which predominated in the Hampshire study, tend to show greater fidelity to particular localities than do young birds (Baker, 1978).

Although disease transmission is most likely to occur directly from one farm to another, there is also the possibility that it might be routed via the roost. The communal roosting behaviour of starlings involves the congregation of birds which have fed over an area of an average 13 km radius (Wynne-Edwards, 1929). At dusk, the huge flocks combine at localities around the roost in pre-roost gatherings in order to feed or rest prior to entering the roost. Thus, both at these pre-roost gatherings and in the roost itself birds may be able to pass disease between themselves. Should a pre-roost gathering occur at a pig farm, as was the case in this study, then this farm would be highly susceptible to receiving infection through contaminated birds from other farms.

SUMMARY

The pattern of attendance and dispersal of starlings was studied in west Norfolk in the winter of 1982-83 at an extensive pig farm where transmissible gastro-enteritis (TGE) had been a recurrent problem. Starling numbers were largest in the early morning, coinciding with the times the sows were being fed in open troughs. No relationship was found between starling numbers and air temperatures, possibly because of the relatively mild winter. A total of 375 starlings (36% adult, 60% male) were tagged and 143 re-sightings were made at 25 localities including 12 other pig farms (seven of which had had TGE in the past two years). The findings from this study supported the contention that starlings are potential vectors of TGE in Britain.

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