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S31-4 Eared dove outbreaks in South America: patterns and characteristics

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Abstract Information on eared dove (*Zenaida auriculata*) outbreaks in South America is analyzed towards finding common factors and processes for developing a conceptual model that may help to predict future outbreaks. Between 1950 and 2000, eared dove populations exploded in a number of regions in Argentina (Córdoba, Entre Ríos, San Luis, Chaco, and Salta), Colombia (Cauca valley), Uruguay, Bolivia (Santa Cruz) and Brazil (Sao Paulo and Paraná). We found a consistent association between the outbreaks and particular habitat characteristics at the landscape level caused by agricultural expansion in forested areas. Specifically, dove populations respond to (1) increased availability of grain from crops, spilled harvest grain and weed seeds, (2) forest fragments suitable for colonial breeding, and (3) handy water sources. Eared doves appear to shift from isolated nesting to colonial breeding once the local population passes a particular threshold. Predation, and control measures based on massive killing, do not appear to affect population levels in all studied cases. The observed ability of the doves to take advantage of landscape-scale changes is linked to several adaptations in *Zenaida* doves, including crop-milk production, colonial breeding, and nomadism.

Key words Sorghum, Forest fragmentation, Agricultural expansion, Colonial breeding

1 Introduction

The eared dove (*Zenaida auriculata*) is a widespread species in South America that occurs in nearly all types of ecosystems except tropical rainforest. Prior to 1950, it was a common, though not particularly abundant dove throughout its range except in Caatinga in northwest Brazil where it had been breeding in large colonies for a long time (Bucher, 1982). At the end of the 1950s, a rapid and large growth in numbers was recorded in Córdoba, Argentina, accompanied by the development of large breeding and roosting colonies of up to 1–5 million birds (Murton et al., 1974).

This initial upsurge was followed by further population outbreaks and colony development in other regions of Argentina, including the provinces of Entre Ríos, Chaco, and Salta from 1970 to 1990. Moreover, similar explosions were also recorded in other countries, notably Uruguay, Colombia, Bolivia, and Brazil. In all cases, these outbreaks happened in areas of developing agriculture (Bucher, 1990). In all cases, too, crop damage caused by the doves reached significant proportions. It led to the implementation of massive killing campaigns using poisoned baits and other lethal methods, without achieving any significant reduction in population levels (Murton et al., 1974; Bucher, 1990).

Agricultural changes are amongst the most drastic and widespread man-induced alterations of land, and may thus be seen as unplanned, large-scale environmental experiments. Unfortunately, detailed studies to elucidate the impacts at the regional level are often hindered by methodological and practical difficulties. In their absence, all that can be done is to accumulate corroborating evidence from repeated observations of modifications resulting from changes in land-use patterns. From this aspect, eared dove outbreaks, being restricted to specific areas and times as well as closely related to agricultural expansion, provide a unique opportunity to advance understanding about the catalysts and processes underlying bird population explosions in agro-ecosystems.

Here we analyze available information on Eared Dove outbreaks in South America to find common factors and patterns that will help to develop conceptual models capable of predicting possible future outbreaks.

2 Eared dove population outbreaks

Between 1950 and 2000, eared dove population outbreaks occurred in several regions of South America: Argentina, Colombia, Uruguay, Bolivia and Brazil. Information on them differs considerably, from abundant in a few to scarce in most. The available data allow, nevertheless, a general comparison of the historical aspects of the outbreaks, agro-ecosystem dynamics, and eared dove breeding and feeding habits. In the following sections we analyze the known outbreaks in each of the countries where they were recorded.

2.1 Argentina

Córdoba: Eared dove outbreaks in Córdoba devel-

oped on a semi-arid plain, originally covered by dry woodland. Annual rainfall is about 600–700 m, concentrated in the summer months (October–March). During the 1950s, grain sorghum was introduced and its area under agriculture increasing rapidly. As a consequence, agriculture expanded into previously forested areas, creating a mosaic of croplands and fragments of original woodland (Murton et al., 1974).

Eared dove colonies occupied forest fragments there that ranged between 100 and 600 ha, the doves preferring patches with dense secondary thorn-scrub. From there they dispersed in daily movements of up to 100 km to obtain food. All colonies lived near water sources such as rivers or irrigation channels. Nest density averaged between 1 000 and 2 000 nests/ha, reaching in some cases over 4 000 nests/ha in some patches. Active nests were found in all months of the year, the colonies being eventually abandoned only for short periods (Bucher and Orueta, 1977).

Population increase and colony development did not include, however, the whole region planted to sorghum. Instead, it was restricted to a well defined zone of mosaic landscape where food patches (sorghum cropland) and breeding habitat (patches of secondary thorn-scrub woodland) were present in obviously suitable proportions.

Colonies neither developed to the east, where sorghum was abundant but without intermingled woods, nor to the west, where woodland was predominant (Murton et al., 1974). More specifically, colonies were confined to forest patches of some 100 ha or more, located at distances no greater than 100 km from food sources and less than 10 km from water sources. In the affected areas, the proportion of land covered with crops was in nearly all cases higher than 10%. In those cases where total cropland was less than 10%, the area under grain sorghum reached at least 3%.

The sorghum-planted area and eared dove population continued to increase in parallel. In 1972–1973, sorghum expansion peaked at 1 044 000 ha, ranging from 6% to 15% of the landscape in the dove-affected area, where eight colonies were developing (Bucher, 1990). In subsequent years, soybean became more and more attractive to farmers and consequently the sorghum-planted area began a steady decline which continues today. This inflection was closely followed by the dove population, which was reduced to only two colonies by the 1990s (Fig. 1; Bucher, 1990). The connection between eared doves and cultivated grain was eventually made evident when dove crop contents were analyzed. In the early 1970s, most of the diet comprised the seeds of cultivated plants, particularly sorghum, wheat, millet, and secondarily weed seeds (Murton et al., 1974).

The eared dove has become a major pest of agriculture in Córdoba, particularly of grain sorghum (Murton et al., 1974). Although the birds can damage standing plants, they prefer to feed on spilled grain in harvested crops. Due to the inefficiency of mechanical harvesters, a considerable amount of wasted grain (between 160 and 500 kg/ha in the case of sorghum) remains in the fields and supports a huge dove population. Weed seeds are important at certain times of the year, particularly early spring when cultivated grains are not available. Grain sorghum has nevertheless proved to be a key factor in maintaining a substantial level of food availability during a time of shortage of other food sources, given that its stubble remains for 5–6 months before being ploughed at the start of the next spring (Bucher, 1990). Following reports of severe damage, local authorities implemented massive control campaigns during the 1960s and 1970s, using poisoned baits distributed around the roosts. Although millions of doves were killed (pers. obs.), there was neither a noticeable reduction in overall population level, nor in colony numbers (Bucher, 1990).

2.2 Other outbreaks in Argentina

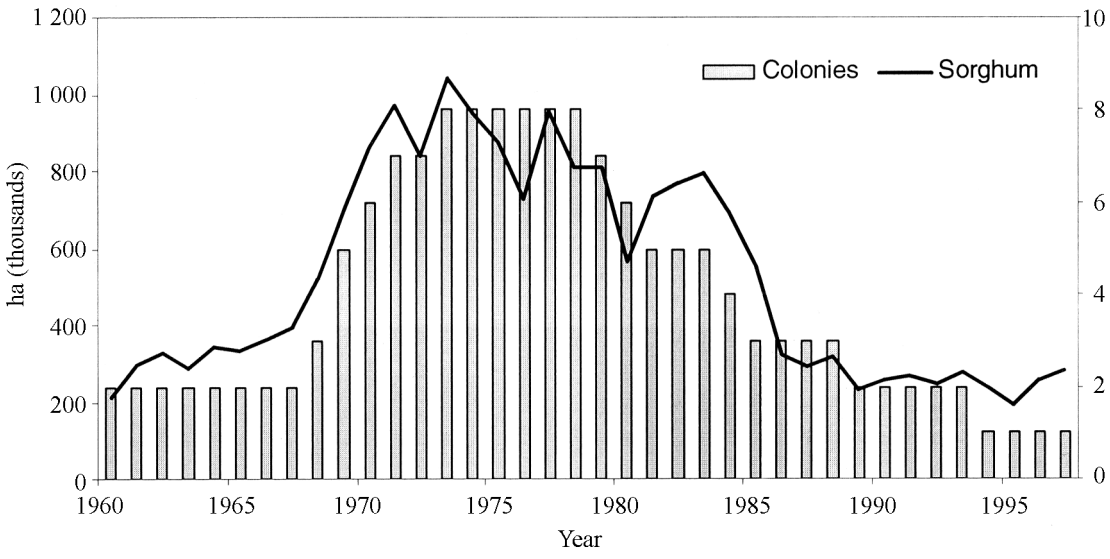

Fig. 1 Temporal changes in sorghum-cultivated area and numbers in eared dove colonies (< 1 millon birds) in Córdoba, Argentina

Population outbreaks similar to those in Córdoba developed elsewhere in Argentina after 1960. In Entre Ríos province, at least two huge colonies developed in the riparian vegetation of the Paraná River, close to Paraná city. Main crops affected were sorghum, sunflower, and to a lesser extent rice (Bucher, 1985). Another significant outbreak occurred in Chaco province at the end of the 1960s, where at least two colonies were detected. This population exploded following a dramatic increase in the area cultivated with sorghum, which increased from 23 000 ha in 1966 to 150 000 ha in 1987, though remaining stable for more than a decade afterwards (E.H. Bucher, unpublished data).

The agricultural frontier continued expanding west in most of Argentina from the late 1980s, associated with a marked increase in rainfall and irrigation that allowed cultivation of new areas previously covered with woodland and thorn-scrub. In San Luis province, development of commercial seed production farms, mostly sorghum and maize, coupled with non-tillage practices that allowed seeds to remain on the ground for a long time, catalyzed a rapid increase in eared and spotted (*Columba maculosa*) doves.

In Salta province, a rapid and massive expansion of soybean cultivation in previously forested areas resulted in the development of at least one eared dove colony. In this case, it is possible that the reduced area dedicated to sorghum has limited dove expansion (E.H. Bucher, unpublished data).

2.3 Uruguay

At least six significant eared dove colonies developed in western Uruguay in the 1970–1980s. All were located in gallery forests along the coast and main rivers, particularly the Uruguay and Negro (Bucher, 1985). Agricultural land in Uruguay is restricted to the western part of the country. Sorghum is far less widespread than in Argentina, with only 42 000 ha planted (2% of the land in some places) (Bucher, 1990). Cultivated crop seeds made up over 70% of dove diet, dominant items being wheat, sunflower, sorghum, and barley (Bucher, 1990). Offsetting the limited area of sorghum were inefficient farming practices which left year-round food for the doves. Of particular importance was the significant proportion of seed left uncovered during wheat and barley sowing, as well as the many sunflower fields left unharvested in marginally suitable land (Bucher, 1985). Damage control was based on dispersion of poisoned baits, which failed to reduce population levels despite achieving high mortality on occasion (Bucher, 1985).

2.4 Colombia

An upsurge in eared dove populations was first noticed in the Cauca Valley during the 1960s. The Cauca Valley in southwest Colombia is one of the major agricultural areas in the country. Elevation is about 1 000 m asl. Average annual temperature is 23°C with little seasonal variation. Annual rainfall is around 800 mm, with two dry seasons, one in winter, the other in summer. The original vegetation was a semi-deciduous forest, but today most of the land has been cleared for agriculture and cattle breeding.

Eared doves were first reported as a serious problem during 1969–1970 after a buildup during the previous five years. This upsurge coincided with a period of marked expansion in the amount of land devoted to crops. From 1960 to 1984, cultivated areas under soybean in the Cauca valley increased from 7% to 23%, and under sorghum from 0 to 20%, whereas maize decreased from 23% to 5% and rice from 9% to 4%. By 1984 the area dedicated to grain crops was around 50 000 ha, including soybean (48%), sorghum (41%), and rice (11%). The proportion of crop plantation in relation to total valley area was around 7% for soybean, 6% for sorghum and 2% for rice, but the two harvests per year there may almost double productivity per hectare. Moreover, the harvesting of the crops is staggered throughout the year, making substantial amounts of waste grain available to birds in all months (Bucher, 1990).

Seeds of cultivated plants constituted 92% by volume of eared dove diet in 1973–1974. Maize, rice, and sorghum were most important, in high frequency and volume throughout the year. At the same time, the thorny xeric vegetation, which the doves seem to prefer for nesting sites, also increased as a result of overgrazing and deforestation, particularly in the foothills and river canyons. The limited evidence available from periodic samples of testis weight and crop milk gland activity indicates that there is at least some breeding in all months, with two peaks shortly after rainfall maxima (July–August and December–February). This coincides with the two annual harvests produced in the area.

The population outbreak in Colombia may be attributed to an increase in year-round availability of food that results from expansion of suitable crops (mostly sorghum), together with an expansion of preferred nesting sites as a consequence of deforestation of the tropical forest and its replacement by scrubland (Aguilera and Hoyos, 1986; Bucher, 1990).

2.5 Bolivia

In Bolivia, a significant eared dove outbreak was recorded in the eastern lowlands (Departamento de Santa Cruz) during the 1990s. This upsurge coincided with a rapid and intense process of deforestation and agricultural expansion. Dominant crops today include soybean, sunflower, sorghum, maize, rice, and wheat. About 15 colonies were identified in the area. Recorded dove food is dominated by cultivated grains (84%), including sunflower (31%), sorghum (26%), soybean (25%), maize (2%), and rice and wheat (<1%) (Rojas and Davies, 2001). Here again, the eared dove explosion is associated with a marked rise in food availability due to agricultural expansion into areas where adequate breeding habitat is still available.

2.6 Brazil

Explosions in southeast Brazil are a relatively recent

event, with unique characteristics that separate them from other known outbreaks. Most significant is the development of breeding colonies in sugarcane plantations, instead of fragments of scrubland or dry woodland as elsewhere. This situation, which has been studied in detail, provides an opportunity for testing the conceptual model developed in this paper from the analysis of previous outbreaks. It is therefore analyzed separately in the final paper in this symposium.

3 Common factors and patterns in eared dove outbreaks

The cases analyzed here suggest a consistent association between dove outbreaks and particular habitat characteristics at landscape level driven by agricultural expansion in forested areas. More specifically, dove populations appear to be controlled by the following key factors:

(1) an increase in food (grain) availability that is relatively stable throughout the year. Sustained availability is usually the consequence of wastage caused by poor harvesting practices, stubble left for long periods for grazing, multiple harvests during the year in tropical irrigated areas, and weed seed availability, at least until weed control measures improve;

(2) availability of adequate areas for colonial breeding. These are secondary patches of the original woodland or natural forest land unsuitable for cultivation, such as gallery forests or mountain slope forests. In some if not all cases, the available patches may eventually disappear, preventing the development of large colonies. However, even non-woody vegetation may be used, as has been recorded in Sao Paulo, Brazil, where colonies nest in sugarcane plantations (Ranvaud and Bucher, this symposium);

(3) availability of water for drinking, usually from rivers, ponds, or irrigation canals.

To become effective, the above three factors each need to reach a threshold before colonies develop. Specifically, a minimal proportion of the landscape surface has to be converted to cropland, which can be estimated, from recorded data, as follows:

(i) a minimal proportion of land covered with crops of at least 3% of grain sorghum, or 10% of other suitable grain crops combinations; (ii) patches of breeding and roosting habitat of at least a hundred ha and at distances no greater than 100 km from the food source; and (iii) water sources at a distance no further than 10 km from roosts.

Given the above mentioned conditions, increases in dove colonies are apparently independent of other environmental factors, such as rainfall, land relief, and vegetation composition. Predation and control measures so far do not appear to check population levels significantly. A detailed analysis of the Brazilian population outbreak in Sao Paulo supports this preliminary model (Ranvaud and Bucher, this symposium).

From the perspective of population regulation, the direct correlation between dove numbers and food supply provides circumstantial evidence supporting the hypotheses that food is the limiting factor in eared dove outbreaks, providing that breeding habitat requirements are satisfied. The importance of the present evidence lies in the fact that it involves regional scale manipulations of supplementary food, under different geographic scenarios. Moreover, it reveals a direct correlation between resource and population both when food increases and decreases (Fig. 1). On the other hand predation, either by natural predators or by man, does not seem to play a primary role in checking population growth when food availability increases.

The relationship between agricultural land-use and the dove has important practical implications. First, our conceptual model predicts that expansion of grain-crop agriculture in originally wooded areas will favor a marked increase in eared dove populations, providing that enough breeding habitat is available. Many potential situations of this kind are widespread in Latin America, where agricultural frontiers are still expanding. Secondly, the same predictive approach can be applied in conservation problems. There are indications, for example, that eared doves in northeast Brazil are declining (Bucher, 1982). Accordingly, protective measures have been proposed based on the preservation of woodland patches where the doves breed. These measures, however, will not work unless a food supply of adequate proportion and quality is conserved too. Information gained from the study of eared doves, moreover, may provide important insights into the understanding of the causes of population crashes, such as that which caused the extinction of the passenger pigeon (*Ectopistes migratorius*), a closely related species.

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