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The Application of Radiotelemetry for Locating and Controlling Concentrations of Red-billed Quelea in Africa

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Abstract. Radio transmitters weighing 1.8 g were attached to red-billed quelea (*Quelea quelea* (L.)) in southwestern Ethiopia during May and June 1981 to determine the feasibility of this technique for rapidly locating nesting colonies and following local movements. Queleas are probably the smallest birds to which external radio transmitters have been successfully attached. Radio-equipped birds were tracked to four nesting colonies, three of which were in the nest construction stage which occurs during the first three days of colony establishment. This early stage is not normally found using conventional survey methods. Adults usually foraged within 3 km of the colony at the nestling and fledgling stages, indicating that surveys must pass within this distance if the colony is to be located by conventional techniques. The study showed that quelea nesting colonies could be more easily and inexpensively located in remote areas using radiotelemetry than by using only ground or aerial surveys. The early detection of colonies allows almost 30 days for the organisation of control operations and permits increased flexibility in selecting colonies for control. The implications of radiotelemetry for use in various quelea damage situations in Africa are discussed.

Introduction

The red-billed quelea (*Quelea quelea* (L.)) is considered to be the most serious avian pest to cereals, and perhaps even to agricultural development, in Africa. The birds adversely affect agriculture in more than 25 African nations (De Grazio and Besser, 1974). In those countries for which reliable damage assessments are available, birds are responsible for annual estimated losses ranging between US$ 1 million and US$ 6.5 million (Bruggers, 1980; Jaeger and Erickson, 1980; Bruggers and Ruelle, 1981; Anon., 1981).

Several regional and national quelea control organisations, encompassing about 16 countries, have been formed during the past two decades (Ward, 1979). In a strategy apparently aimed at population reduction, these organisations attempt to locate and destroy many of the large roosts and nesting colonies. Population reduction is a common strategy in avian pest management (Dyer and Ward, 1977), and the techniques used by these organisations in Africa are estimated to destroy more than one billion queleas annually (Ward, 1979). A strategy of total or even regional population reduction seems impossible for quelea control, however, because of their high reproductive potential, opportunistic feeding behaviour, migratory behaviour and widespread distribution in vast inaccessible areas. Quelea control operations are also expensive and require a high level of organisation. More localised population reduction, aimed at preventing damage in important agricultural areas by trying to eliminate mainly birds that are suspected to cause damage or whose migration patterns will bring them into areas when crops are vulnerable, would be more practical. The need for this strategy has been evident for several years (Ward, 1973; Dyer and Ward, 1977; Ward, 1979), but the tools and knowledge for its practical implementation have been unavailable until recently. Local control is now beginning to be practised in some countries, particularly in Ethiopia (Jaeger and Erickson, 1980).

For the effective control of quelea breeding colonies in areas where they are known to threaten cereal crops, it is important that the colonies are located as soon as they start to be formed to give the maximum time to assess

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whether a spray operation would be justified and, if so, to make appropriate preparations. The difficulties associated with locating quelea concentrations have been accurately described by Ward (1979). The logistics involved are formidable whether overland vehicle or low-flying aircraft survey methods are used, given the vastness of the quelea breeding range. Most colonies are located two to three weeks after their inception, when the grass nests have dried and their tan colour contrasts with the surrounding vegetation, and when the adults are actively searching for food to feed nestlings and fledglings.

We have tried to locate quelea nesting colonies using radiotelemetry. Radio transmitters have been used in the USA to monitor the movements of roosting blackbirds (Icteridae) (Bray, 1973; Bray *et al.*, 1975) and to evaluate lethal control (Lefebvre *et al.*, 1980) and repellent crop protection efforts (Besser, 1978). However, their use on quelea in Africa appears to be unique. Quelea are probably the smallest birds (18–22 g) to which external radio-tracking transmitters have been attached.

Methods

Survey and nesting areas

We conducted the study in the Sidamo and Gama Gofa Provinces in the Rift Valley of southwestern Ethiopia during May and June 1981. Six quelea breeding colonies were located there during 1979 and 1980 using about 50 h of helicopter time during several weeks of ground and aerial survey. We suspect that the birds nesting in these provinces during May and June migrate up the Rift Valley and renest during September and October in the agricultural areas of the middle and upper Awash River valley (Fig. 1) (Jaeger and Erickson, 1980). Because of the remote, extensive area associated with the Waito and Sagon Rivers (*c.* 1200 km^2) and the Omo River (*c.* 2775 km^2), approximately 160 h of helicopter time at US $350–550/h was needed for the 1981 survey and related field activities. Less expensive fixed-wing aircraft were inappropriate for this area, because of the absence of landing strips and the need to work in the nesting colonies. Roads were virtually non-existent in the area.

Only 5 h (3%) of the helicopter time were directly related to the objective of locating colonies using radio-equipped birds. The remainder of the time was spent in normal survey and colony description activities in the Omo River valley and the plains between Tertele and Mega in southern Sidamo Province, and in studies of the local movements of radio-equipped quelea (Bruggers and Jaeger, in preparation) and village weavers (*Ploceus cucullatus* (Müller)) (Bruggers *et al.*, in preparation), and mass-marking quelea with fluorescent particles (Jaeger *et al.*, in preparation).

Radio transmitters

The Denver Wildlife Center designed and built the radio transmitters (Bruggers *et al.*, 1981). They weighed 1.8 g, had a battery life of between 2.5 and 3.5 weeks and a reception distance of 4–8 km at survey altitudes of 300–700 m and 31 km at 1525 m. The radios were attached with Hot-Melt Glue®* to the base of the tail of two quelea males on 17 May prior to nesting, and to 17 additional birds (13 males and four females) between 21 May and 10 June during advanced stages of the nesting cycle.

The location and movements of the 19 radio-equipped birds were monitored between 17 May (pre-nesting) and 28 June (juvenile fledging and colony abandonment) in the Waito and Sagon River valleys using a Bell 47 helicopter to which a pair of three-element Yagi antennas were fixed. The antennas were connected by a coaxial cable to a 12-channel AVM battery-operated receiver. We used a left/right directional switch box to determine signal direction and a Clark headset to eliminate the noise of the helicopter.

Nesting colony detection and daily movement patterns

Although the radio transmitter weighed 7–9% of the quelea's body weight, it did not appear to impair the flying ability or to adversely affect the normal activity patterns of the birds following an adjustment period of several hours to one day. Females feeding nestlings resumed foraging within 3–4 h, although males marked during nest construction tended to sit in the bushes for as long as 24 h. However, neither response presents a problem to

*Reference to trade names does not imply US Government endorsement.

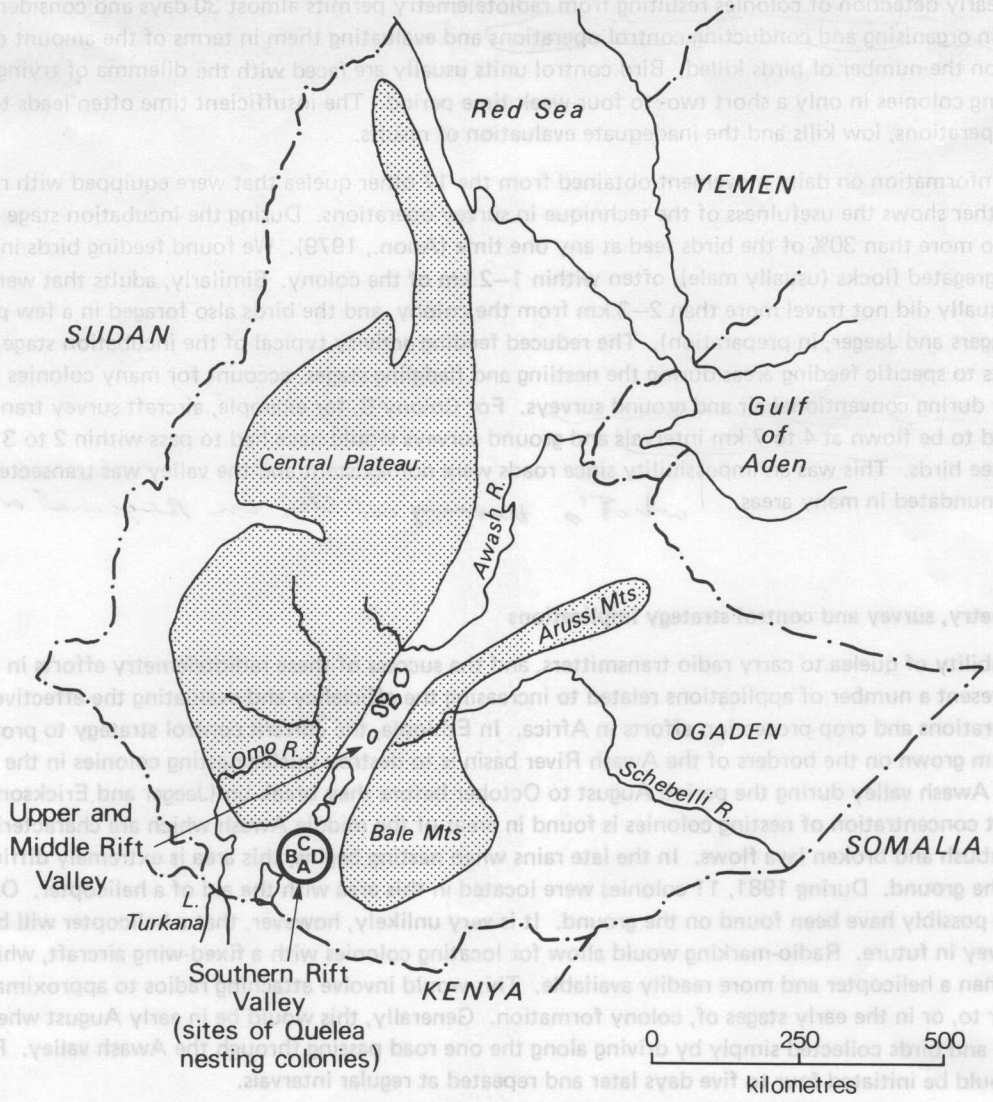

Fig. 1. Map of Ethiopia illustrating general area of radiotelemetry studies and relative locations of the quelea nesting colonies (A, B, C and D) found by following radio-equipped birds during May and June 1981.

the usefulness of the technique in locating concentrations of birds. In a study in Colorado, USA radio transmitters weighing an equivalent 7–9% of 28 g weight house sparrows (*Passer domesticus* L.) did not appear to disrupt their normal daily movements following a short adjustment period (Bruggers *et al.*, 1981).

The two males that had been mistnetted on 17 May from the pre-nesting feeding flock and radio-equipped were relocated on 21 May during 2 h of aerial surveying in a two-day-old nesting colony (Colony B) of 12.4 ha area and comprising over one million birds. This colony was only 0.5 km from a smaller 0.25 ha colony (Colony A) in which the birds were fledging and which had been overlooked during the initial 10 h of pre-radio-tracking surveys of the valley. During the next two weeks these two males (which did not nest, probably because of the radio package) were tracked to two other colonies (Colony C and D) travelling distances of at least 25 km, both of which colonies were again only two to three-days-old (Fig. 1). The colonies were forming sequentially as the birds reached reproductive condition (Bruggers and Jaeger, in preparation). Quelea colonies are seldom discovered during fixed-wing aerial survey operations until they reach the nestling stage, when the tan colour of the dried grass nests contrasts with the surrounding vegetation or later when the adults are actively feeding nestlings. For example, during two surveys in May and June totalling 12–15 h in the adjacent Omo River valley, no nesting colonies were located although several million quelea in reproductive condition were present which suggests these birds must have been breeding somewhere.

The early detection of colonies resulting from radiotelemetry permits almost 30 days and considerable flexibility in organising and conducting control operations and evaluating them in terms of the amount of crop saved, not solely on the number of birds killed. Bird control units usually are faced with the dilemma of trying to control many nesting colonies in only a short two- to four-week time period. The insufficient time often leads to poorly executed operations, low kills and the inadequate evaluation of results.

The information on daily movement obtained from the 17 other quelea that were equipped with radios during nesting further shows the usefulness of the technique in survey operations. During the incubation stage of a colony, normally no more than 30% of the birds feed at any one time (Anon., 1979). We found feeding birds in large, sexually segregated flocks (usually male), often within 1–2 km of the colony. Similarly, adults that were feeding nestlings usually did not travel more than 2–3 km from the colony, and the birds also foraged in a few preferred areas (Bruggers and Jaeger, in preparation). The reduced feeding activity typical of the incubation stage, and the short flights to specific feeding areas during the nestling and fledgling stages, account for many colonies being overlooked during conventional air and ground surveys. For Colony B, for example, aircraft survey transects would have needed to be flown at 4 to 7 km intervals and ground surveys would have had to pass within 2 to 3 km of the colony to see birds. This was an impossibility since roads were non-existent and the valley was transected by two rivers and inundated in many areas.

Radiotelemetry, survey and control strategy implications

The ability of quelea to carry radio transmitters, and the success of these radiotelemetry efforts in survey activities present a number of applications related to increasing the efficiency and evaluating the effectiveness of control operations and crop protection efforts in Africa. In Ethiopia, the current control strategy to protect low-land sorghum grown on the borders of the Awash River basin is to destroy quelea nesting colonies in the upper and middle Awash valley during the period August to October before they break up (Jaeger and Erickson, 1980). The greatest concentration of nesting colonies is found in areas of the middle Awash which are characterised by dense thornbush and broken lava flows. In the late rains when nesting begins, this area is extremely difficult to survey on the ground. During 1981, 11 colonies were located in this area with the aid of a helicopter. Only five of these could possibly have been found on the ground. It is very unlikely, however, that a helicopter will be available for this survey in future. Radio-marking would allow for locating colonies with a fixed-wing aircraft, which is less expensive than a helicopter and more readily available. This would involve attaching radios to approximately ten quelea prior to, or in the early stages of, colony formation. Generally, this would be in early August when flocks can be seen and birds collected simply by driving along the one road passing through the Awash valley. Radio-tracking would be initiated four to five days later and repeated at regular intervals.

Another useful application may be the use of radiotelemetry in locating roosts in agricultural areas. These roosts, which are transient, unpredictable, often composed of several species, and usually not detectable from the air can be even more difficult to locate than nesting colonies (Ward, 1979). Unless they are in traditional known locations, considerable time (often several days) and manpower must be spent trying to locate them or in organising the assistance of farmers. By equipping pest birds in the fields, they could be followed to the roost in the evening by aircraft or overland vehicles.

For example, at Jijiga, Ethiopia in 1976, five to six weeks were spent in ground and aerial surveys to locate roosts which were responsible for extensive damage to local sorghum (Jaeger and Erickson, 1980). Similarly, in other areas of Ethiopia and Mozambique, the actual or estimated costs of locating nesting colonies with radio-equipped birds could have been between three and ten times less (Table 1). Using only traditional means, some of these colonies may not have been located.

Difficulty in locating multiple quelea roosts in marshlands associated with the Limpopo River in southern Mozambique has resulted in poor control, along with considerable expense and unnecessary destruction of wildlife (Jaeger, 1980). Approximately 25,000 ha of rice, which is susceptible to bird attack from April to July, are grown on government farms along the river. Night roosts of quelea are difficult to find by either ground or air as they are formed at dusk and disperse at dawn, and usually occur in dense stands of *Phragmites* spp. over water. Aircraft frequently undertake spray sorties on suspected roosts, but because of the uncertainty of locating roosts, respraying is often necessary. Use of radio-tracking to locate and evaluate the size and importance of these aggregations would be much more efficient in terms of time and resources, while minimising damage to the environment.

Radiotelemetry has interesting applications in at least two other aspects of bird pest management. A frequently voiced concern about using the avicide fenthion (Queletox®), and more recently cyanophos (Toritox®),

TABLE 1. NUMBER OF HELICOPTER HOURS USED FOR TRADITIONAL QUELEA GROUND/AERIAL SURVEYS AND RADIO-TRACKING SURVEYS IN ETHIOPIA AND MOZAMBIQUE DURING 1980 AND 1981

		Helicopter requirement (h)[a]	
Year	Location	Traditional	Radio-tracking
1981	Waito, Ethiopia	17[b]	5[c]
1981	Middle Awash, Ethiopia	25[b]	8[d]
1980	Chockwe, Mozambique	>100[e]	10[d]

[a] Cost per flying hour = US$ 350.00.
[b] Search interval of 2 km with one repetition.
[c] Search interval of 5 km for initially locating quelea plus radio-tracking.
[d] Estimated requirements. Intervals could be increased beyond 5 km with increased radio transmitting distance.
[e] Not systematic survey.

is the difficulty in accurately assessing the effectiveness of the spray because of the delayed mortality (up to 24 to 36 h) associated with these chemicals (Elliott, 1981). Although the success of sprays with either chemical is directly related to the timing of the spray and the expertise of the pilot, it often is unknown whether birds die outside the colony or roost, or whether they reassemble in another location. The success of these spray operations could be better evaluated if several birds were radio-equipped in the roost a day or two before the spray and their location then determined afterwards. This technique has been used in avicide sprays of blackbird roosts in the USA (Lefebvre *et al.*, 1980).

A related concern about the use of chemical repellents is the notion that birds 'repelled' from one farm only move to and damage the crops on another farm (Dyer and Ward, 1977). By incorporating the techniques of radiotelemetry with repellent applications, the behaviour of the pest birds can be better understood. For example, Besser (1978), using radio-equipped red-winged blackbirds (*Agelaius phoeniceus* (L.)), found that on 21 (61.8%) of 34 occasions flocks frightened from vulnerable sunflower fields next fed in stubble fields (9), weed patches (5), nonvulnerable sunflowers (5), maize (1) and swathed wheat (1). Radiotelemetry could be similarly used in African bird pest damage situations to determine the movements of 'repelled' birds and to understand the relationship of alternate food sources and adjacent cropping areas to the outcome of crop protection efforts.

Conclusions

We consider this demonstration of the feasibility of using radio-tracking in studies of red-billed quelea (and village weavers) to have important implications for future investigations on pest birds in Africa. The information that could be collected on local daily movements could make a significant impact on our understanding of the quelea's crop-damaging behaviour. The use of the technique to locate roosts and colonies more easily and at early developmental stages, could greatly increase the efficiency of survey and control operations. It is entirely possible that further technological advances will be made that will allow the weight of the radios to be reduced, the reception distance to be increased, the battery life to be extended and the overall reliability to be improved (Kolz, personal communication), all of which will increase field effectiveness. However, radiotelemetry must be used in the context of a well defined avian agricultural problem to achieve its maximum potential.

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References

ANON. (1979). Crop protection manual: African grain-eating birds. *UNDP/FAO Report RAF 73/055,* Research into control of grain-eating birds. Food and Agriculture Organization of the United Nations, Rome.

ANON. (1981). An assessment of the bird pest problem in Sudan, Ethiopia, Somalia, Kenya, Tanzania. *UNDP/FAO Report RAF 77/042.* Food and Agriculture Organization of the United Nations, Rome. pp. 32.

BESSER, J. (1978). Improvements in the use of 4-aminopyridine for protecting agricultural crops from birds. pp. 51–53. In *Proceedings of the 8th Vertebrate Pest Conference,* Sacramento, California, 7–9 March 1978. Ed. W. E. Howard. University of California, Davis, California.

BRAY, O. E. (1973). Radiotelemetry for studying problem birds. pp. 198–200. In *Proceedings of the 6th Bird Control Seminar,* Bowling Green, Ohio, 30 October–1 November 1973. Ed. H. N. Cones Jr and W. B. Jackson. Environmental Studies Center, Bowling Green State University, Bowling Green, Ohio.

BRAY, O. E., LARSEN, K. H. and MOTT, D. F. (1975). Winter movements and activities of radio-equipped starlings. *Journal of Wildlife Management* 39(4): 795–801.

BRUGGERS, R. L. (1980). The situation of grain-eating birds in Somalia. pp. 5–16. In *Proceedings of the 9th Vertebrate Pest Conference,* Fresno, California, March 1980. University of California, Davis, California.

BRUGGERS, R., ELLIS, J., SEDGWICK, J. and BOURASSA, J. (1981). A radio transmitter for monitoring the movements of small passerine birds. pp. 69–79. In *Proceedings of the 3rd International Conference on Wildlife Biotelemetry,* Laramie, Wyoming, 1981.

BRUGGERS, R. L. and RUELLE, P. (1981). Economic impact of pest birds on ripening cereals in Senegal. *Protection Ecology* 3: 7–16.

DE GRAZIO, J. W. and BESSER, J. F. (1974). Wild birds eat millions of dollars. *World Farming* 16(10): 14.

DYER, M. I. and WARD, P. (1977). Management of pest situations. pp. 267–300. In *Granivorous birds in ecosystems.* Ed. J. Pinowski and S. C. Kendeigh. Cambridge University Press, Cambridge.

ELLIOTT, C. C. H. (1981). Methods for assessing the efficiency of aerial spraying control operations on quelea colonies and roosts. pp. 62–73. In *Vertebrate Pest Control and Management Materials: Third Conference, ASTM STP 752,* 1981. Ed. E. W. Schafer Jr and C. R. Walker. American Society for Testing and Materials, Philadelphia.

JAEGER, M. M. (1980). Progress reports. Consultancies to Mozambique. *UNDP/FAO Reports TCP/MOZ/9001* (Unpublished). Food and Agriculture Organization of the United Nations, Rome. pp. 7 and 9.

JAEGER, M. M. and ERICKSON, W. A. (1980). Levels of bird damage to sorghum in the Awash basin of Ethiopia and the effects of the control of quelea nesting colonies (1976–1979). pp. 21–28. In *Proceedings of the 9th Vertebrate Pest Conference,* Fresno, California, March 1980. University of California, Davis, California.

LEFEBVRE, P. W., DOLBEER, R. A., HOLLER, N. R., HOOD, G. A., KNITTLE, C. E., MATTESON, R. E., SCHAFER, E. W. Jr and STEHN, R. A. (1980). Second field trial of CAT as a blackbird/starling roost toxicant. *Bird Damage Research Report* No. 145. Denver Wildlife Research Center, Denver, Colorado. pp. 44.

WARD, P. (1973). A new strategy for the control of damage by queleas. *PANS* 19(1): 97–106.

WARD, P. (1979). Rational strategies for the control of queleas and other immigrant bird pests in Africa. *Philosophical Transactions of the Royal Society of London* (Series B) 287: 289–300.