Diet composition of young and adult Northern Grey-headed Sparrow *Passer griseus* and adult Southern Red Bishop *Euplectes orix* in Burundi

by Régine Pacis NASASAGARE[1,2], Gaspard NTAKIMAZI[3] & Roland LIBOIS[1]

[1]Zoogeographic Research Unit, Dept of Sciences "Biology, Ecology, Evolution", Univ. of Liège, Boulevard du Rectorat 27, 4000 Liège, Belgium. <rpnas@yahoo.fr>
[2]Dept of Natural Sciences, High Teacher Training School, Boulevard du 28 Novembre, BP 6983, Burundi
[3]Dept of Biological Sciences, University of Burundi, Bujumbura, Burundi

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Summary

We studied the diet composition of Northern Grey-headed Sparrow *Passer griseus* and Southern Red Bishop *Euplectes orix* in four localities of the Rusizi Plain, northwest Burundi. We analyzed crop contents of 100 adults from each of the two species and the composition of food brought by parents to nestlings of the sparrow at ten nests. In all four sites, the sparrow's diet consisted primarily of rice. The bishop also fed mostly on rice grains but also ate Lepidoptera caterpillars, some other insects and wild grass seeds such as *Panicum* sp. and *Brachiaria* sp. For adults of both bird species, there was no significant variation in diet throughout the year. However, the diet of young sparrows was much more diverse and changed from the day of hatching until fledging. On the day of hatching, chicks ate mainly caterpillars but by the tenth day, food items comprised one third caterpillars, one third Orthoptera and the rest of other insects including Odonata, Dictyoptera, Isoptera and adult Lepidoptera. After this and until fledging, the chicks were fed increasingly on rice seeds. Simultaneously, the proportion of caterpillars taken gradually decreased until none was fed to the nestlings at the end of the nestling period. The items brought by parents also varied with time of day, with caterpillars and grasshoppers in higher proportions in the morning, decreasing around mid-day and then increasing in the evening.

Résumé

Composition du regime alimentaire des adultes et jeunes du Moineau gris *Passer griseus* et des adultes de l'Euplecte ignicolore *Euplectes orix* au Burundi. La composition des aliments des adultes du Moineau gris *Passer*

griseus et de l'Euplecte ignicolore *Euplectes orix* ainsi que le menu des jeunes du moineau ont été identifiés dans quatre localités de la plaine de la Rusizi au nord-ouest du Burundi. Les contenus des jabots de 100 adultes de chaque espèce ont été analysés. Le contenu de becquées apportées aux jeunes du moineau par les parents a été étudié également chez dix nids. Le régime alimentaire des adultes du moineau se compose essentiellement de riz sur l'ensemble des quatre sites. L'euplecte se nourrit également pour la majorité des grains de riz. Il complète son alimentation par des larves de lépidoptères, quelques autres insectes et surtout de graines des graminées sauvages *Panicum* sp. et *Brachiaria* sp. En revanche, le menu des jeunes moineaux est beaucoup plus diversifié et varie dès l'éclosion à l'envol. Le jour de leur éclosion, les oisillons mangent essentiellement des chenilles de lépidoptères, mais le dixième jour, le régime comprend un tiers des chenilles, un tiers des orthoptères et un tiers d'insectes variés, y compris odonates, dictyoptères, isoptères et papillons. Après cette période et jusqu'à l'envol, les oisillons sont nourris progressivement avec des graines de riz. Parallèlement, la proportion des chenilles diminue pour s'annuler au moment de l'envol. Les items apportés par les parents variaient pendant la journée, les proportions des chenilles et des criquets étaient plus importantes le matin, diminuant à la mi-journée et réaugmentant le soir.

Introduction

The diets of various granivorous birds have been studied in several parts of Africa. Spanish Sparrow *Passer hispaniolensis* adults and nestlings have been studied in Libya (Mirza *et al*.1975) and those of young and adult Spanish Sparrows and House Sparrows *P. domesticus* in Algeria (Metzmacher 1985). During the first days of their life, both species eat mainly insects, in contrast to the mainly vegetable adult diet (Mirza *et al*. 1975, Metzmacher 1985). The young of Red-billed Quelea *Quelea quelea* are fed insects during the first five days and progress to grains of wild grasses (Disney *et al*. 1956, Morel & Morel 1974). In Nigeria, the analysis of stomach contents of adult queleas during the dry season showed that the food was 54 % wild grass seeds and 46 % cultivated cereal grains (Yusufu *et al*. 2004), and the queleas may prefer wild seeds compared to cultivated cereals (Ward 1965a) even when the latter are plentiful (Yusufu *et al*. 2004). These authors did not find animal prey in the stomachs of adult quelea. The Village Weaver *Ploceus cucullatus* feeds on animal and plant food in Nigeria, including various arthropods, seeds of wild and cultivated origin, and the mesocarp of ripe oil palm *Elaeis guineensis* (Adegoke 1983). In the Sudan Golden Sparrow *Passer luteus*, stomach content analysis at different stages of breeding showed that nestlings were fed almost exclusively on insects (Morel & Morel 1976). Thompson (1989) investigated the importance of crops such as rice in the diets of the

Bronze Mannikin *Lonchura cucullata* and the Black-and-White Mannikin *L. bicolor* in Sierra Leone, and found that both species mainly ate wild seeds, with rice in small proportion. The proportions of these items changed with season but Bronze Mannikin still consumed rice even outside the cultivation period (Thompson 1989). In central Africa, the Village Weaver feeds on small wild seeds during the dry season and larger seeds during the wet season, with cultivated seeds eaten throughout the year even outside the period of maturation and harvest (Camara-Smeets & Manikowski 1981). In Ethiopia, the Red-billed Quelea feeds on several varieties of wild and cultivated seeds according to their size and availability (Erickson 1979), with diet varying from one region to another depending on the climate, and variation in diet affected by age and sex. In southern African, both male and female quelea consume more seeds than insects and the proportions vary during the day (Berry *et al*. 2004).

All of these studies reveal that young sparrows feed primarily on arthropods, especially insects, whereas young quelea consume much more vegetable matter. Adult Village Weaver and quelea feed on grass seeds of wild grains. In some localities, the Village Weaver shows a preference for arthropods while the quelea and sparrows prefer vegetable matter.

In Burundi and in the African Great Lakes region in general, rice farmers are in conflict with granivorous birds due to their perceived impacts on cereals fields. Determining the diet of granivorous birds could contribute to improving their management. We studied the diet of adult Southern Red Bishop *Euplectes orix* and Northern Grey-headed Sparrow *Passer griseus*, at four sites in the rice fields of the Rusizi Plain, in northwest Burundi, where they are the commonest granivorous birds. The diet composition of nestling Northern Grey-headed Sparrows, its daily variation and its variation with age was also studied. Due to inaccessibility of the nests of the bishop, diet of their nestlings was not studied. We found no published details on the diet of these two species. The information collected permits an evaluation of the damage the two species cause to cereal crops, particularly rice.

Study Area

The study was carried out near rice fields in the Rusizi Plain. The climate is dry tropical, with annual rainfall *c.* 600 mm, and a dry season of 4–5 months (May–August and sometimes September). The vegetation is largely degraded savanna of low herbaceous growth with bare soil in places and scattered spiny shrubs and Euphorbiaceae (Cazenave-Pierrot *et al*. 1979). Palm savanna, of *Hyphaena banguelensis* var. *ventricosa*, is an endemic vegetation type, found only in the lower Rusizi. The Rusizi Delta is covered with vast reed-beds, an almost pure association of *Phragmites mauritianus*. Farmlands are devoted mainly to rice, cotton and coffee.

Study site 1 was in the town of Gihanga (3°11′S, 29°17′E), Bubanza Province. This area is composed of *Acacia* trees scattered in a savanna. Site 2 (3°19′S,

29°14´E), in Mutimbuzi Commune, Bujumbura Province, consisted of *Acacia*, thickets of *Lantana camara* and clumps of *Phragmites*. Site 3 was in Buterere Commune (3°19´S, 29°21´E), Bujumbura. It was surrounded by banana plants *Musa* sp., sugarcane fields *Saccharum officinarum*. and mango trees *Mangifera indica*. Site 4 was in Kinama Commune (3°18´S, 29°23´E), Bujumbura, and contained mango and banana trees and some *Euphorbia candelabrum*. In all four sites, in addition to rice fields, there were also fields of sweet potatoes, beans and corn.

Methods

Adult birds were sampled in the four sites during 2009. Birds were captured with mist nets, around 7h00 GMT, two hours after sunrise. The presence of armed militias in the Rusizi Plain prevented us from trapping at dusk. Birds which were determined, by tactile pressure of their crops, to have not yet eaten were immediately released. Others were sacrificed and their crop opened. At each site, 25 birds of each species were sampled, making a total of 100 for each species. Six individuals of each species were taken at each site in February, April and September, and seven at each site in November. We did not capture birds during their breeding season (May–August). Crops were labelled and preserved individually in bottles containing 70 % denatured alcohol. In the laboratory, food items were identified using a dissecting microscope, then the items were dried to constant weight and weighed using a precision balance (to 0.01 g). Proportions of food items are expressed as the percentage of crops that contained each item type.

Since Northern Grey-headed Sparrows carry food to young in their beak, we employed the use of direct observation to determine the food intake of nestlings, in order to minimize disturbance of the birds. With food in the beak, adults paused to scan the area carefully before entering the nest. A camouflaged observer, 3–5 m from the nest, could thus observe with binoculars what adults took into the nest. Between May and July 2009, ten broods were observed and 887 prey loads recorded, at the four sites. At the time of the study, rice in plantations was ripening. Each day, 30-min. observation periods were made in the morning, mid-day and evening, at each nest from the first day of hatching (determined by when the parents began bringing food to the nest) until fledging. Identification of Lepidoptera caterpillars was carried out using Autrique & Perreaux (1989).

XLStat software (ANOVA) was used to calculate diet variation between the four sites and with season. Statistica (Pearson correlation) was used to study the relationship between proportion of rice in the diet of nestlings and their age. G-tests (Sokal & Rohlf 1981) were used to calculate the diet variation in nestlings according to age and time of day, and to test the variation in the bishop's diet at different dates or seasons. For the adult sparrows, only two out of 100 crops contained items other than rice, and statistical testing of seasonal variation was not possible. Means are given ± S.D. The notation "ns" means not significant ($P > 0.05$).

Results

Adult Northern Grey-headed Sparrows ate mainly rice and seldom insects, and diet composition did not change with season ($F_{3,3} = 0.711$; ns) or with site ($F_{3,3} = 0.941$, ns) Rice made up 98 % of the diet, caterpillars 1 % and other insects 1 %. Analysis of variance showed that food mass in crops did not vary significantly with season.

Adult Southern Red Bishops ate mainly rice (75 %), supplemented with seeds of the wild grasses *Panicum* sp. (9 %) and *Brachiaria* sp. (8 %) They also occasionally fed on insects (total 8 %), especially Lepidoptera caterpillars (5 %), dragonflies Odonata (1 %) and Lepdoptera adults (butterflies, 1 %). Neither period of the year ($G_9 = 6.03$, ns) nor collection site ($G_9 = 13.21$, ns) had a significant effect on food composition in crops (four food categories: rice, *Brachiaria*, *Panicum*, insects). However, analysis of variance of food mass in crops of birds that had eaten showed that food intake varied with season ($F_{3,3} = 3.456$, $P = 0.020$), with crops from site 1 full in April and emptier in August (Table 1). There was no variation in food mass between study sites ($F_{3,3} = 0.161$, $P = 0.923$); at this P value, we can conclude that food intake was homogeneous across sites.

Table 1. Food mass (g) in crops of Southern Red Bishop adults.

	Site 1	Site 2	Site 3	Site 4
February	0.29 ± 0.194	0.32 ± 0.137	0.54 ± 0.434	0.38 ± 0.431
April	0.83 ± 0.256	0.31 ± 0.266	0.57 ± 0.386	0.52 ± 0.248
August	0.09 ± 0.095	0.53 ± 0.360	0.32 ± 0.342	0.32 ± 0.194
November	0.26 ± 0.210	0.36 ± 0.525	0.28 ± 0.434	0.31 ± 0.231

Young Northern Grey-headed Sparrows had a varied diet, of grasshoppers Orthoptera, dragonflies, mantids Dictyoptera, butterflies, termites Isoptera, flies Diptera and caterpillars. They were also fed raw rice seeds, cooked rice, bits of cassava and sweet potatoes, from discarded human food. Day by day, the composition of the diet of young changed gradually (G-test between six food groups comprising crickets, termites, mantids and three groups formed by combining food categories to avoid zeros as follows: rice and other vegetable matter, caterpillars and butterflies, flies and dragonflies, $G_{100} = 459.7$, $P < 0.001$) (Fig. 1), with three main periods identified. The first day, the diet was mainly composed of caterpillars (85 %), with the dietary proportions between the first and the second day significantly different (G-test grouping flies and dragonflies: $G_5 = 23.7$, $P < 0.001$). The second period, from day 2 to 10, was relatively stable (G-test grouping flies and butterflies with rice: $G_{40} = 44.4$, ns), with the young fed caterpillars (35 %) and grasshoppers (35 %), with other insects (30 %). During this period, there was a significant diurnal change in proportions ($G_{12} = 27.8$, $P < 0.001$), with the proportion of caterpillars highest in the morning, decreasing at mid-day and then increasing again in the evening. The third

period of feeding was from day 11, when the diet switched from being > 80 % insects, until fledging when it was predominantly rice (70 %) (G-test grouping caterpillars with butterflies, rice with other vegetable matter: $G_{50} = 54.8$, ns), although at fledging, young birds still ate insects (30 %).

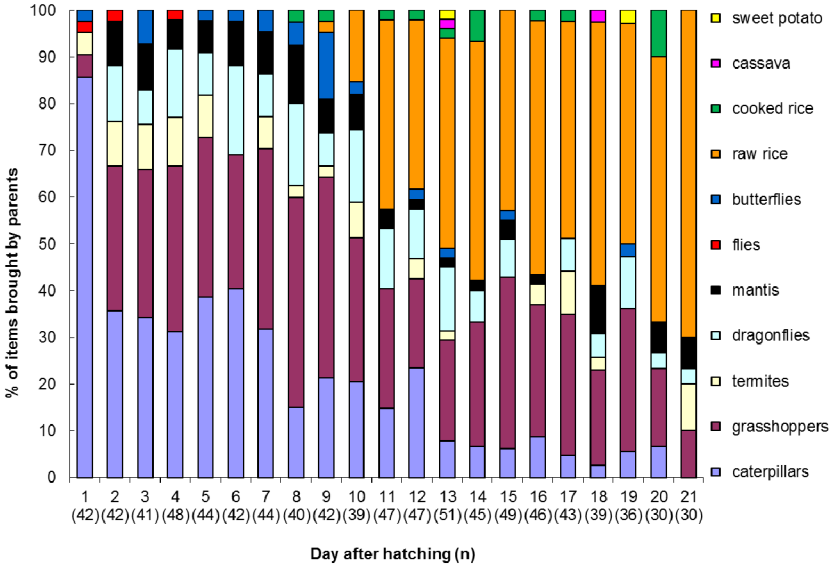

Figure 1. Diet composition of nestling Northern Grey-headed Sparrows; (n) = number of beak-loads.

From the moment that the young sparrows became no longer exclusively insectivorous, there was a strong positive correlation between the proportion of rice in the diet and their age (Fig. 2; $y = -21.36 + 4.41x$, $r = 0.886$, $P < 0.0001$). During this period too, the food provided by parents differed at different times of the day ($G_{12} = 24.6$, $P = 0.05$), with more grasshoppers in the morning than during the day and in the evening.

Discussion

Adult Northern Grey-headed Sparrows ate rice during the whole study period in the four study sites, with insects being insignificant in their diet. This differs from other species of *Passer*. The House Sparrow feeds on seeds of wild or cultivated plants, fruits, flowers, leaves and insects, or leftovers from human food (Clark 1976, Gionfriddo

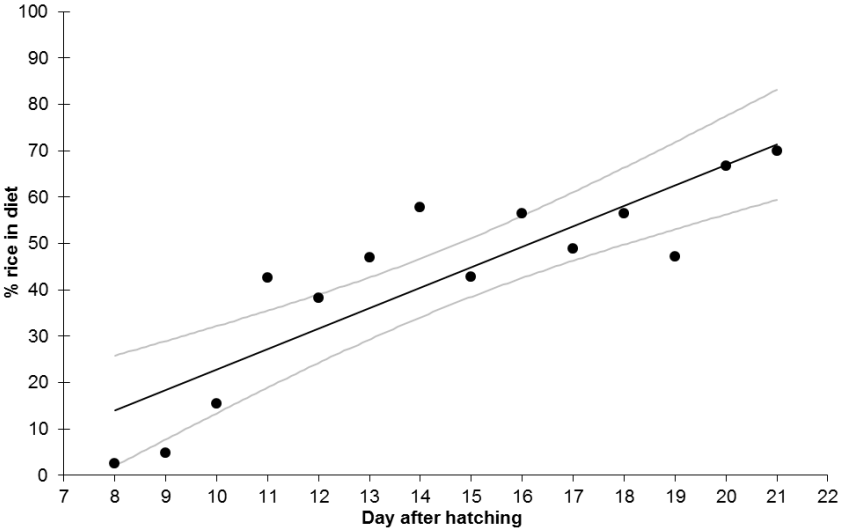

Figure 2. The proportion of rice in the diet of nestling Northern Grey-headed Sparrows, depending on their age (regression and 95 % C.I.).

& Best 1995, Marion 2000, Centre d'Expertise en Analyse Environnementale du Québec 2005, chapter 4 of Vincent 2005). Sagrario *et al*. (2007) even suggested that it is useful for people by removing damaging insects from crops. Indeed, in China, the massive destruction of sparrows by people may have led to a super-abundance of crickets Orthoptera, which caused famine by feeding on crops (Shapiro 2001). Metzmacher (1985) found that the Spanish Sparrow feeds mainly on plants, with dietary composition depending on whether the bird is in breeding season or not. According to Morel & Morel (1970), the adult Sudan Golden Sparrow moves from a diet purely of or dominated by seeds while breeding, to a mixed diet or even pure insects afterwards. The consumption of insects during breeding provides a protein supplement to meet the requirements of reproduction (Avery 1980). In this study, adult birds were not captured during breeding and it is possible that their diet was different at that time.

The Northern Grey-headed Sparrows of Rusizi Plain, where rice is plentiful throughout the year, fed almost exclusively on rice. After the harvest, some rice spikes are left on the fields and birds may continue to exploit them. Others germinate in the fallows, providing grains until the following farming season. Moreover, in the Risizi Plain, some rice is also cultivated after the main growing season so that this resource is permanently available to the birds.

The diet of the Southern Red Bishop was identical in all study sites, reflecting their fairly uniform habitat with essentially identical food resources. Their diet also

consisted of rice, supplemented by seeds of wild grasses. This is similar to the diet of Red-billed Quelea, except that in the latter species the seeds of wild grasses are more abundant than those of cereals, even during periods of grain maturity (Yusufu *et al.* 2004). It seems that the quelea's diet is strongly influenced by the presence of *Panicum* and consumption of cultivated grains occurs during periods where the wild seeds are not abundant (Erickson 1979). However, the Village Weaver consumes cultivated seeds all year round, even outside periods of maturation and harvest (Camara-Smeets & Manikowski 1981), although the damage it causes to crops may be minimal when the seeds of certain wild plants are available (Adegoke 1983).

The contrast of our study with others, with our birds eating mostly rice, is not surprising because our field work was carried out near rice fields. This simply confirms the opportunistic feeding behaviour of sparrows of the genus *Passer*, as does the fact that adult Grey-headed Sparrows feed on leftover human food in Bujumbura city (pers. obs.).

During the early nestling period of Northern Grey-headed Sparrow, the diet of the young was composed mainly of caterpillars, which are a high-energy, easily digestible food (Pinkowski 1978). On the second day, the range of insects brought by the parents diversified. The high lipid and especially protein content of insects contributes to the development of the nestlings while their high water content provides a larger part of their water requirements too (Morel & Morel 1978). Seeds appeared in the diet later. Many studies have shown that chicks with a mixed diet are first fed mainly on insects and then progress gradually to seeds (Ward 1965b, Morel & Morel 1974, Akinpelu 1994, Kharrim *et al.* 1997, Kharrim *et al*. 1998, Marques *et al*. 2003, Akinpelu 2005, Vincent 2005). However, the detailed pattern differs from one species to another. House Sparrow nestlings eat mainly insects during the first three days of life while plant items increase gradually during the following days (Anderson 2006).

The diurnal variations observed in the diet of young sparrows may be related to the behaviour of the prey, as many insects are active during the coolest moments of the day, but this might also be due the needs of the nestlings, which might be greater before and after fasting during the night (Biermann & Sealy 1982).

The predominance of rice in the diet of these birds suggests they may cause significant damage to the rice crop of the Rusizi Plain. However, Northern Grey-headed Sparrows fed their young on large quantities of invertebrates which are pests in agricultural fields, which may help farmers. Study of the diet of young Southern Red Bishops would help to verify if they too could be important in the fight against insect pests. At this point, the balance of the positive and negative effects of these two bird species on agricultural production is not known.

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