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Short research contribution

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SEGREGATION IN SYMPATRICALLY NESTING RED-WINGED STARLING *ONYCHOGNATHUS MORIO* (L.) AND EUROPEAN STARLING *STURNUS VULGARIS* L.

ABSTRACT: If two related species come into contact, it could be expected that, in order to co-exist, they will either shift their niches apart from each other or one species will replace the other in the course of ever growing competition. Recently, two starling species, the indigenous Red-winged Starling and the exotic European Starling, came into contact in some places in Lesotho (southern Africa). In this paper, some breeding parameters of these species have been compared in an area of their co-occurrence. Studies were carried out in an urbanised habitat in Lesotho, in four consecutive breeding seasons (August–March) during the years 1998–2001. The average density of the Red-winged Starling was 13.8 pairs 100 ha⁻¹, while that of the European Starling was 9.3 pairs 100 ha⁻¹. The proportion of the Red-winged Starling to European Starling breeding pairs (1.0:0.7) was strikingly constant over the four consecutive breeding seasons. Most Red-winged Starling breeding territories (78%, N = 56) were located within built-up areas, while most European Starling territories were located either within built-up areas (25%) or on the border of built-up areas and open areas (59%, N = 41). Most Red-winged Starling nests (96%) were situated in buildings (N = 46), while European Starling nests were located both in tree holes (43%) and in buildings (57%, N = 28). Both starling species show high nest site tenacity. The Red-winged Starling daily activity pattern during the nestling phase differed considerably from that of the European Starling. Although both starling

species do not overlap their feeding niches and daily and seasonal activities, their sympatric occurrence in urbanised habitats may be limited, if suitable nesting sites are lacking.

KEY WORDS: Red-winged Starling *Onychognathus morio*, European Starling *Sturnus vulgaris*, invasion, breeding, competition, nest-site selection, nest-site tenacity, breeding density, territoriality, activity.

If two related species come into contact, it could be expected that, in order to coexist, they will either shift their niches apart from each other or one species will replace the other in the course of ever growing competition. From the conservation point of view such competition is especially interesting between indigenous and introduced species. Recently, two starling species came into contact in some places in Lesotho (South Africa). One of these species, the Red-winged Starling *Onychognathus morio* (L. 1766) is indigenous, while the other one, the European Starling *Sturnus vulgaris*, L. 1758, is exotic. In South Africa, it was introduced in 1897 at Cape Town and by the year 1950, it was already widespread in the whole Western Cape province. In the 1960's it reached the Eastern Cape, in the 1970's KwaZulu/Natal (Hockey *et al.* 2005), and in

the 1980's the Free State (Kopij 2001a). For about 10 years it expands its range in Lesotho (Kopij 2000, 2001b, 2006). Apart from South Africa, it became well-established in Australia, New Zealand, North America, and Argentina (Feare and Craig 1998).

The European Starling is well known as an invasive species. Its natural range includes large parts of the Palaearctic region from British Islands in the west to Transbaikalia in the east, and from Lapland in the north to Syria in the south. The northern population is declining, while the southern tends to expand (Feare and Craig 1998). Although it is well documented that European Starling population is expanding in South Africa (Feare and Craig 1998, Hockey *et al.* 2005), little is known about the relationship between this species and other starlings occurring in this region. The purpose of this study was to investigate relationships in sympatrically breeding European and Red-winged Starlings.

The National University of Lesotho (NUL) campus, with the area of 82 ha, was designed as the main study plot. The campus is situated at Roma, 32 km E of Maseru, Lesotho, southern Africa (29°28'S; 27°44'E); at the altitude of 1 650 m a.s.l. The town Roma which includes a few settlements (i.e. the NUL campus, Thoteng, Mafekeng and Mafeoana), is nestled against foothills of the Maloti in a wide valley surrounded by sandstone cliffs. The valley is situated between the longitude 29°32'–29°26'S and the latitude 28°42'–28°48'E, at 1500 to 2000 m a.s.l. The major settlement in the valley, Roma, was founded in 1863 and in 1945 the university was established. Later two catholic seminaries, two high schools and a hospital were also funded. Around these modern buildings, there is a striking rural setting, and cultivated fields further afield, with the maize as the dominant crop. About 30 village settlements are situated around the sandstone cliffs.

Although the NUL campus began as an open grassland, at present it represents a kind of urbanised parkland. There are 210 buildings of various size and height, tarred roads with a total length of c. 7 km, 12 oxidation dams varying in size from 1000 to 10000 m², cultivated field of c. 2 ha and multitude of small gardens with vegetables, peaches and plums. The whole area of the campus is also

well endowed with various exotic trees, such as gum trees *Eucalyptus* spp. (mostly *E. camaldulensis* Dehnh.), cedars *Cedrus atlantica* (Endl.), pines *Pinus* spp. (mostly *P. radiata* D. Don), oaks *Quercus* spp. (mostly *Q. robur* L.), poplars *Populus* spp. (mainly *P. nigra* L. 'italica' and *P. deltoids* W. Bartram), acacias *Accacia* spp. (mainly *A. dealbata* Link), peaches *Prunus persica* L., she-oaks *Casuarina equisetifolia* L., false cypresses *Chamaecyparis* spp., cypresses *Cupressus* spp., weeping willows *Salix babylonica* L., Persian lilacs *Melia azedarach* L., sweet chestnuts *Castanea sativa* Mill., Canary palm *Phoenix canarensis* Chabaud and others (Talukdar and Ambrose 2003). There are also clumps and hedgerows of cotoneasters *Cotoneaster* spp. and yellow fire-thorns *Pyracantha angustifolia* C. K. Schneid. in several places (Kopij 2004).

Lesotho climate has four distinct seasons, namely summer (November–January) characterised by high temperature (January mean monthly temperature 20.9°C) and precipitation; winter (May–July) characterised by the lack of precipitation, warm temperature (June mean monthly temperature 6.8°C) during the day and sudden drop after sunset; autumn (February–April) and spring (August–October) as transient periods between summer and winter (McLeod 1995). Both summer and winter weather pattern can occur in these two seasons. 75% of precipitation occurs between October and March (Sekoli 1999). Rainfall during the years 1998–2001 and a long-term average monthly rainfall for Roma are shown in Figure 1.

Red-winged and European Starling nests were searched for in four consecutive breeding seasons (August–March) during the years 1998–2001. The location of each nest was described and their height was estimated. In order to determine breeding success each nest was checked on a weekly or two-week intervals. Parents bringing food to nest were regarded as having chicks. A bird firmly sitting on the nest for a longer time under sunny conditions was assumed as incubating eggs. Fledglings with parents around the nest indicated nesting and fledgling success. Nest site tenacity were studied in three consecutive seasons during the years 1999–2002. For each season all nests found were plotted on a map and its exact location was described and illus-

trated. Only nests located exactly in the same site were taken to calculate average nest site tenacity during the three consecutive seasons.

The mapping method (Bibby *et al.* 1992) has been used to estimate population densities. In each breeding season (September–January), 6–8 counts were conducted over the whole campus. In the course of counting, an attempt was made to locate occupied nests. For both starling species, the number of breeding pairs was assumed to be equal to the number of occupied nests.

Daily activity was investigated in the time when birds had chicks. A site was selected where both starling species nested, the European Starling had chicks in September, while the Red-winged Starling in November. All activities of parents bringing up their offspring, were scored and timed, with separate records kept for male and female. The sexes of the Red-winged Starling were recognizable by blackish head in male and greyish head in female, while sexes of the European Starling, by more intense greenish gloss in male plumage. All observations were aided with 10 × 50 binoculars.

During the years 1998–2002, breeding densities of the Red-winged Starling varied from 12.2 pairs 100 ha⁻¹ to 19.5 pairs 100 ha⁻¹, while that of the European Starling varied from 8.5 pairs 100 ha⁻¹ to 13.4 pairs 100 ha⁻¹. The average density of the Red-winged Starling during the four consecutive breeding seasons was 13.8 pairs 100 ha⁻¹, while that of the European Starling was 9.3 pairs 100 ha⁻¹. The proportion of the Red-winged Starling to European Starling breeding pairs (1.0:0.7) was strikingly constant over the four consecutive

breeding seasons (Fig. 2). There were, however, no statistically significant differences in the number of breeding pairs of both species in particular year.

Most Red-winged Starling breeding territories (78%, N = 56) were located within built-up areas, while most European Starling territories either within built-up areas (25%) or on the edge of built-up and open areas, such as arable grounds, orchards, lawns and wastelands (59%, N = 41).

Among breeding territories located within built-up areas 46% of Red-winged Starling territories were located within the centre of densely built-up areas, while only 10% of European Starling territories were found under such conditions; 23 and 10% breeding territories of the Red-winged Starling and the European Starling respectively, were located within residential areas with flats, gardens and orchards (Table 1).

Red-winged Starling clearly preferred built-up over edge and open areas ($x = 20.2$; $P < 0.01$), while in the case of the European Starling the reverse was true ($x = 7.5$; $P < 0.01$). Within built-up areas no clear preference was recorded. The Red-winged Starling more often inhabited densely built-up areas than residential areas, while in the case of the European Starling again the reverse was true (Table 1). These differences were, however, not statistically significant ($x = 1.1$; $P > 0.05$ for the Red-winged Starling and $x = 0.1$; $P > 0.05$ for European Starling respectively).

Most Red-winged Starling nests (96%, N = 46) were situated in buildings ($x = 36.5$; $P < 0.01$), while European Starling nests were located both in tree holes (43%) and in build-

Table 1. Nesting habitat in the Red-winged Starling and the European Starling. All territories located during the years 1998–2001 were taken into account.

Habitat type	Red-winged Starling		European Starling	
	N	%	N	%
Within built-up areas				
Densely built-up areas with sparse trees	26	46	4	10
Residential areas with flats, gardens and orchards	13	23	4	10
Residential areas with 1–2 storied houses, sparse trees	5	9	2	5
On the border of built-up and open areas				
On the border with wastelands	6	11	11	27
On the border with arable fields	4	7	13	32
Outside built-up areas	2	4	7	17
Total	56		41	

Table 2. Nest sites in the Red-winged Starling (N = 46) and European Starling (N = 28). All nests found during the years 1998–2001 were taken into account.

Site	Height	Red-winged Starling		European Starling	
		N	%	N	%
Low buildings	3–4 m	15	33	2	7
Medium-sized buildings	5–7 m	7	15	14	50
High buildings	>7 m	10	22	–	–
Under wooden roof	12 m	2	4	–	–
Under iron roof	7–9 m	2	4	–	–
On a lamp	5 m	2	4	–	–
On concrete mould	5 m	3	7	–	–
In electrical construction	3 m	2	4	–	–
On a garage pole	3 m	1	2	–	–
Man-made structures – total		44	96	16	57
Weeping Willow <i>Salix babylonica</i>	3–6 m	–	–	10	36
Black Poplar <i>Populus nigra</i>	2 m	–	–	2	7
Canary Palm <i>Phoenix canarensis</i>	4–5 m	2	4	–	–
Trees – total		2	4	12	43

Table 3. Nest site tenacity in the Red-winged and the European Starling. Nest site tenacity indicates the number of years, out of three consecutive years investigated, in which occupied nest was found in the same site. The abbreviation 'AVG' denotes the average number of years, out of three consecutive years investigated, during which a nest was recorded in the same site.

Species	Number of years						Total	
	one		two		three		N	AVG
	N	%	N	%	N	%		
Red-winged Starling	10	35	14	48	5	17	29	1.8
European Starling	10	48	6	29	5	24	21	1.8

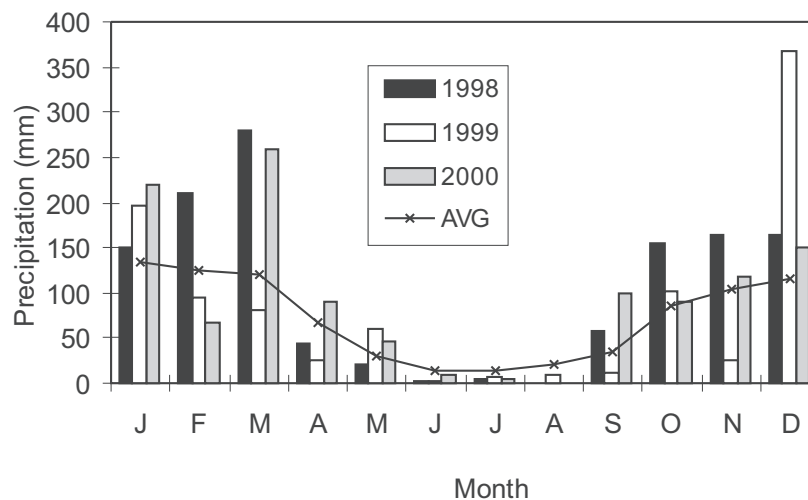


Fig. 1. Monthly rainfall in Roma (place of study near Lesotho, South Africa) during the years 1998–2000 and a long term (1970–2000) average.

ings (57%, $N = 28$) ($x = 0.3$; $P > 0.05$). Both in the Red-winged Starling and the European Starling approximate height of nests located on buildings was 5 m, but only Red-winged Starling nests were located higher than 7 m (Table 2).

Nest site tenacity was much the same in the Red-winged Starling and the European Starling (Table 3).

Breeding season extended from the late August to the late December in the European Starling and from the early October to the early April in the Red-winged Starling (Fig. 3). In the Red-winged Starling the interval between the first egg-laying in the first clutch and that of the second clutch ranged from 60 to 85 days ($x = 70.7$; $SD = 9.50$, $N = 6$). Incubation lasted 27–32 days ($x = 29.5$;

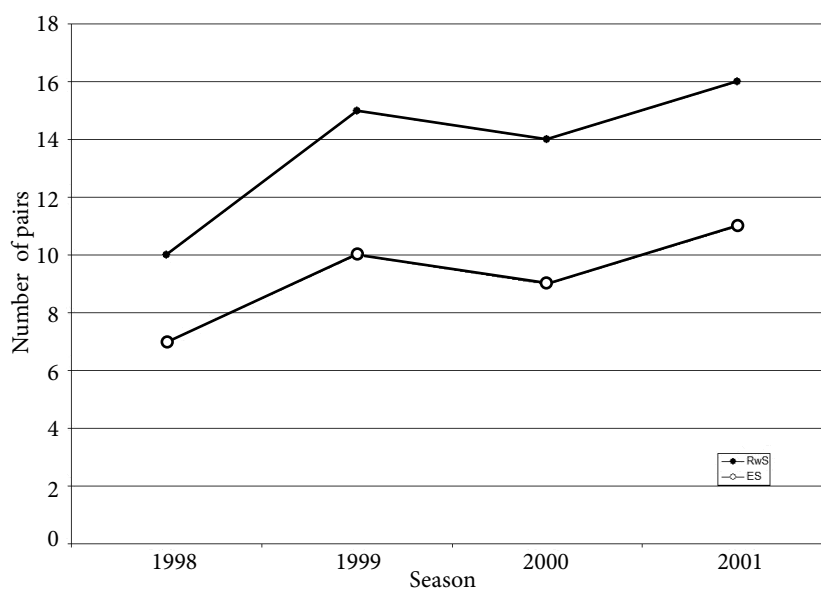


Fig. 2. Number of breeding pairs per 100 ha of the Red-winged Starling (RwS) and European Starling (ES).

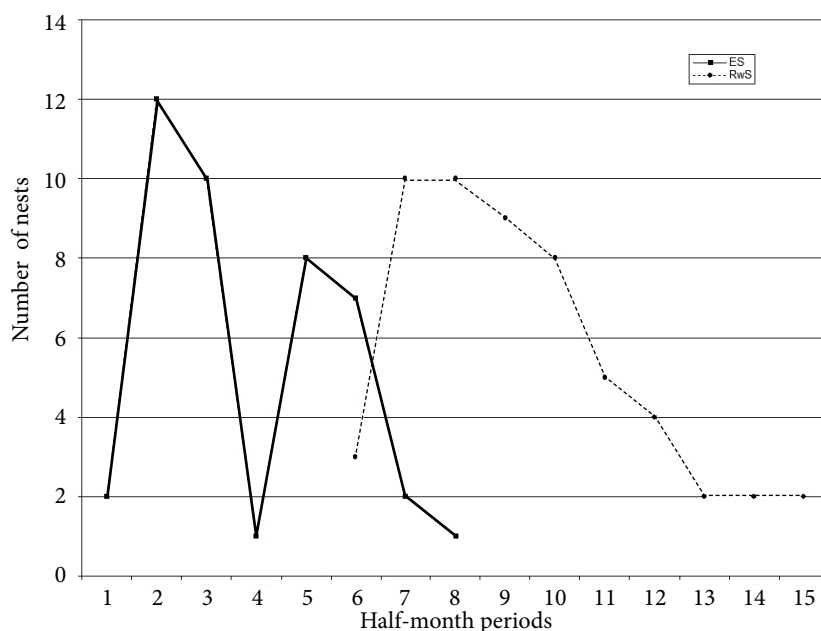


Fig. 3. Egg-laying dates in the Red-winged (RwS) and the European Starling (ES). 1 – first half of August, 15 – first half of March. All clutches recorded during the years 1998–2001 were taken into account.

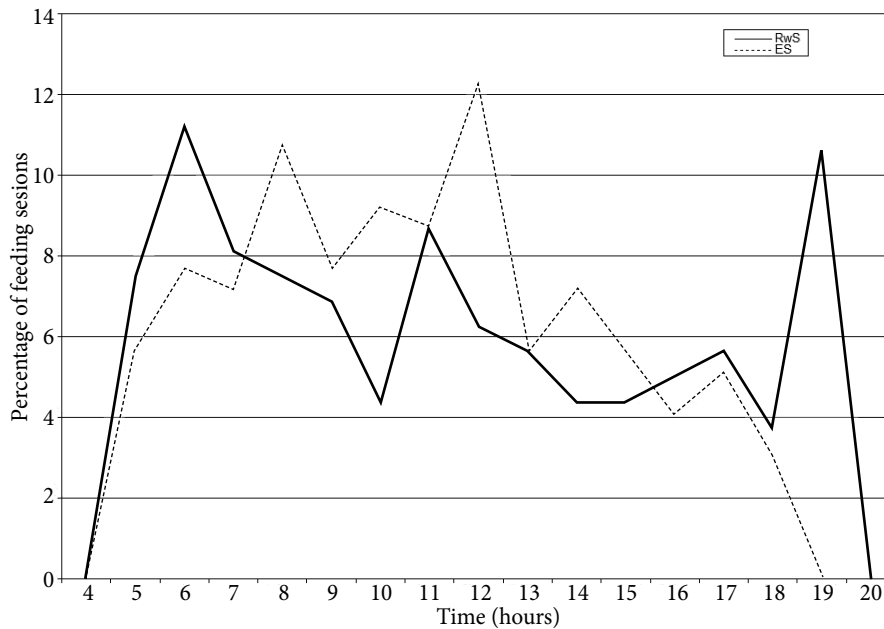


Fig. 4. Daily activity pattern in the Red-winged (RwS) (N = 160 feeding sessions) and the European (ES) Starling (N = 195 feeding sessions).

SD = 1.87; N = 6) and nestling phase – 40–43 days ($x = 41.3$; SD = 1.53; N = 3) in the Red-winged Starling. No such data were available for the European Starling.

During 2000/2001 breeding season, in 5 out of 14 Red-winged Starling nests (36%), the second clutch was initiated, while during the years 2001/2002 in 6 out of 16 nests (38%) such clutches were recorded. Therefore, the second clutch was initiated, on average, by 37% pairs. The second clutch was laid to slightly refurbished nests utilised by first broods. During 2001/2002 breeding season, in two out of 16 nests (13%) chicks did not hatch. As Figure 3 suggests about 2/3 of European Starling pairs had two broods per season: first one in August–September and the second one in October–November.

At one site, the Red-winged Starling nested in November–December (first breeding), but in January, the Rock Pigeon *Columba guinea* usurped the nest and from February to 23 March the Red-winged Starling had reclaimed the nesting site and nested there again (second breeding). In the other site, three clutches were laid during one breeding season. Although all three clutches hatched, none produced fledglings. All chicks died several days after hatching.

The Red-winged Starling daily activity pattern during the nestling phase differed considerably from that of the European Starling. Over much of the day, the European Starling appeared to be more active than the Red-winged Starling. Only shortly after sunrise and around sunset Red-winged Starlings were more active than European Starlings (Fig. 4).

In the Palaearctic Region, the European Starling is an early breeder. In the Free State and in Lesotho it also starts to breed in the end of dry season (Maclean 1993, Cramp and Perrins 1994, this study). The Red-winged Starling, on the other hand, is rather a late breeder both in natural and in urbanised habitats (Craig *et al.* 1989, Maclean 1993). These marked differences in the timing of breeding are related to periods of the highest abundance of their main food. European Starlings feed chicks mainly on insects and other small invertebrates (Cramp and Perrins 1994, Hocky *et al.* 2005) and these are in plenty when they have chicks in nests, i.e. in October. The Red-winged Starlings feed chicks both on insects and on fruits (Kopij 2008) and fruits are available much latter in the wet season.

In two *Onychognathus* starling species, living in sympatry under natural conditions

in the Eastern Cape province, South Africa, breeding season in the Red-winged Starling is earlier than that of the Pale-winged Starling *O. naboroupp* (Daudin 1800). However, both species show the same pattern of major and minor peaks in breeding (Craig *et al.* 1989). It appears therefore that, as in sympatrically nesting Red-winged and European Starling, also in sympatrically breeding Red-winged and Pale-winged Starlings, the difference in timing of breeding has evolved in allopatry.

The Red-winged Starling is originally rock-nesting, while the European Starling is hole-nesting species. As most rock-nesting species, the Red-winged Starling may easily adopt buildings as nesting sites while living in urbanised habitats. In the western Palearctic region, the European Starling uses buildings as nesting sites only occasionally, occupying predominately tree holes (Cramp and Perrins 1994). Its widespread habit to locate nests in buildings in Lesotho is probably an adaptation for living in urbanised habitat, where there is a lack of tree-holes and nesting boxes. Therefore, in areas where both starling species co-occur, a competition for nesting sites can be expected. On a few occasions, fights for nesting sites between pairs belonging to these species were witnessed on the campus. It is plausible that the availability of suitable nesting sites prevent the European Starling to colonise areas firmly occupied by the Red-winged Starling.

Nest sites of Red-winged Starlings breeding under natural conditions are traditional and are used by the same individuals over a number of years (Craig *et al.* 1989), but traditional are also nesting sites of the Red-winged and European Starlings in buildings, as shown in this study. This behaviour may, therefore, additionally considerable limit sympatric occurrence of both starling species in such urbanised landscape, where suitable nesting sites in buildings are limited.

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