

HOW DO TWO STURNIDS, *Leucopsar rothschildi* AND *Gracupica nigricollis*, GET ALONG TOGETHER IN LIMITED SPACE?

by Walter A Sontag, Jr.

Introduction

In my study of habitat use by *Leucopsar*, Bali Starlings *Leucopsar rothschildi* were kept together in an aviary with another (though non-sympatric) south Asian sturnid, the closely related Black-collared Starling *Gracupica nigricollis* (Sontag, 2001b). The former are known to be highly aggressive towards conspecifics (e.g. Sieber, 1978; Sontag, 2001b). In order to avoid or reduce intra- and potential interspecific aggression the aviary was spacious and highly structured. Moreover, the number of inhabitants never exceeded six individuals. No severe aggression was observed between the two species.

The Black-collared Starlings generally spent more time on the ground layer than *L. rothschildi*, but the frequency of individual ground visits was distinctly higher in the latter (cf. Sontag, 2001b). This study addressed the question if and what type of correlation may exist between these two sturnids when sharing the same aviary? Theoretically, Bali Starlings might use the ground space more when Black-collared Starlings spend more time on the ground, or the opposite may be the case. Note also that in the wild mixed aggregations of starling species have often been described. For instance, Brahminy Starlings *Sturnus pagodarum* associate freely with Grey-headed Starlings *S. malabaricus* when feeding on flowering and fruiting trees and with Asian Pied Starlings *S. contra*, Common *Acridotheres tristis* and Jungle Mynahs *A. fuscus* when hunting grasshoppers etc. on the ground layer (Ali & Ripley, 1972: 161); *S. pagodarum* also roost communally with Rosy Pastors *S. roseus* and Common Mynahs (Ali & Ripley, 1972). In Thailand I have seen mixed starling associations such as *tristis/javanicus* (frequently), *tristis/javanicus/nigricollis* (regularly in wet cultivated areas also intensely used by *contra*, Bang Pra area, s. e. Thailand) and *tristis/javanicus/contra* (regularly, Chiang Mai district) (Sontag, 1997). Bali Starlings were recorded using the same roost sites as Asian Pied Starlings and Black-winged Starlings *A. melanopterus* (Ash, 1984). On the other hand, Sieber (1978) stated that the latter was a food competitor of *Leucopsar* in the Bali Barat Nature Reserve.

As the Bali Starling and Black-collared Starling are close relatives, I first discuss phylogenetic aspects. I will present information from the literature and my own observations. This may help to better understand (a) some similarities and discrepancies between the two species, including

habitat use and (b) corresponding properties that are potentially relevant to interspecific behaviour. Secondly, I will report on the interspecific impact in the study aviary, i.e. in the particular environmental (= experimental) design to which the mixed species groups were exposed. Such knowledge is useful for the aviculturist when maintaining mixed species groups.

The relationship of both species

Both belong to a complex of ca. 25 sturnids grouped around the genera *Sturnus* and *Acridotheres*. The members of this group typically occur in open habitats, move largely on the ground or exploit this part of the environment, have a tendency for 'prying' (i.e. 'open-bill probing', due to anatomical adaptations to the jaw muscles and skull), and form flocks (Beecher, 1978; Sontag, 1992; Wickler, 1961; and others). Harrison (1963) described characteristic behaviour patterns and compared them interspecifically in order to propose a reliable scheme of the relationships within the group. In a parasitological investigation apparently overlooked by Feare & Craig (1998), unknown Ischnocera have recently been described from four closely related sturnids including the Bali Starling and the Black-collared Starling (Mey, 1989). Mey arranged these mallophags according to their morphological characters: with respect to the male genitalia (a key mallophagan identification feature) the feather louse discovered on the Black-collared Starling deviated strikingly from the mallophaga found on the other three sturnid species, all of which are attributed to the genus *Leucopsar* in Wolters' (1975-1982) checklist. Within this sub-set, the Ischnocera collected from the Bali Starling clearly differed from the mallophaga settling on the Black-winged Starling and the Vinous-breasted Starling *A. burmannicus*. However, *Sturnidoecus stresemanni*, the Bali Starling feather louse, differed completely from the other mallophaga in having a reduced subgenital plate and in its overall colour (almost perfectly white) (Mey, 1989). This fits in with the set of particularities found in *L. rothschildi*, i.e. its appearance, peculiar bobbing style (Harrison, 1963; see below), shyness in the wild (different from Black-winged Starling, Sieber, 1978), and its probable adaptation to living in open forest (Sontag, 2001b).

My own observations made in the aviary and in the field (Nepal, Thailand) support and even extend Harrison's contribution concerning the nodding display. I saw the up-down movements of the head and bill along the underparts in the Common Mynah and Jungle Mynah in Nepal and in the Common and White-vented Mynah *A. javanicus* in Thailand (taxonomy according to Ali & Ripley, 1972 and Lekagul & Round, 1991). Moreover, in 1988 I observed a single Vinous-breasted Starling kept in a cage move its head in a similar manner (see photo p.163). During later fieldwork in Thailand I confirmed this type of nodding display in that species (which, as

mentioned above, Wolters (1975-1982) had placed in the genus *Leucopsar* as he had the Black-winged Starling). Harrison (1963), however, had already reported the same nodding behaviour by the latter. Thus, the Bali Starling is the only known member of the *Sturnus-Acridotheres* complex *sensu* Sontag (1992) whose bobbing style involves the characteristic 'head back movement' and 'body up thrusts'.

Specific behaviours of the Black-collared Starling

I studied Black-collared Starlings (four individuals + one juvenile from a 'natural brood' that died before fledging) from 1985-1988 at the Institute for Comparative Ethology of the Austrian Academy of Sciences in Vienna. Thereafter, I observed this species under natural conditions in the wild in Thailand.

To the best of my knowledge, the 'bobbing' display of the Black-collared Starling is completely different from the displays of all the other sturnids of the aforementioned group. This species raises the head feathers, bristling the black feathers on the back of the neck, lowers the body, swells out the plumage of the underparts, thrusts the bill 'cautiously' and repeatedly down towards the substrate, and coos 'hoarsely' and in a low tone (see photo p.163). This behaviour is presented close to the companion. However, no copulation has been observed at this time. The slow motion of the 'bowing movement sequence', the type of 'cooing' and the momentary maintenance of the bowed position clearly differentiate the display from the nodding modes mentioned earlier.

In another characteristic display Black-collared Starlings behave in a conspicuous manner based on visual and acoustic elements. An individual screams harshly and very loudly, opening the bill widely and directing it forward, i.e. \pm parallel to the ground. The white feathers on top of the head and the black plumage at the back of the neck are ruffled, and the plumage of the head and underparts is raised. Simultaneously, a short wing quiver-beat was often observed. Generally speaking, wing-flicking and sideward tail-flicking were frequently observed under captive conditions. Such behaviour rapidly modifies the presentation of the complex blackish-greyish-black-white wing pattern, the blackish rectrices with the white tail-tip and the white rump-marking might suddenly become visible.

A striking feature of the Black-collared Starling is its voice. While the above mentioned, strange nasal sounds - uttered in the bowing display - are soft, three categories of high intensity vocalizations may roughly be distinguished mainly by ear: (a) loud 'pure-tone' fluting, (b) vigorous harsh 'noisy' screaming (cf. above), and (c) harsh high-amplitude screaming (very loud) when individuals join, rejoin or settle at a site (however, this behavioural complex remains unclear). More detailed research may lead to an increased

number of distinguishable high-intensity vocalisation classes and find connections between (b) and (c).

Apart from potential differences between captive and free-living individuals, both the bowing display and the acoustic behaviours mentioned may possibly occur in different contexts and accordingly may vary in their particular expressions.

On one occasion I noticed a Black-collared Starling perform an anting movement in the aviary. Such behaviour was observed in a group of three (one adult, two young) wild and four released captive-bred Bali Starlings, which were 5m-6m (approx.16ft-19ft) above the ground in a Pilang tree *Acacia leucophloea* (van Balen, 1996).

Rationale of the experimental design, aviary, subjects and groups, statistical analyses

Based on the assumption of constant aviary and keeping conditions, a clear positive correlation in using the same 'enclosure segments' by both species would be interpreted as interspecific attraction; on the other hand, a clear negative interspecific relation in habitat use would indicate that at least one species avoids the other or both do. A third possibility was that there would be no clear trend, which would be equally intriguing. In this case an interspecific connection would be largely lacking, especially when overt conflicts (aggression, flight, etc.) were rare. Floor use appeared to be a good measure for testing this issue. Stays on the floor vs. the other parts of the aviary were recorded for both species.

The starlings studied were housed in a partly roofed, spacious, richly structured aviary subdivided into two sections at the Institute for Comparative Ethology of the Austrian Academy of Sciences in Vienna (for details see Sontag, 2001b). Food was offered on the floor and on a board at an upper level. The structural variety provided an abundance of environmental conditions in the aviary which were intended to reduce aggression.

Subjects (six individuals), group compositions, study periods and chronological order were the same as reported by Sontag (2001b). Three mixed species groups were studied: Group 1 consisted of an adult pair of Bali Starlings and an adult pair of Black-collared Starlings (the Bali Starling nestlings were disregarded); Group 2 consisted of the same individuals plus the two recently fledged offspring of the Bali Starlings; Group 3 consisted of the aforementioned pair of Black-collared Starlings and the two by then young (subadult) Bali Starlings.

The cumulative time spent on the ground per observation session was determined for each sub-group (i.e. adult Black-collared Starlings; adult Bali Starlings; young Bali Starlings). The result from the summation of the individual ground stay durations of the sub-group, independent of whether

one or both members of the sub-group were on the ground (i.e. if both individuals were simultaneously on the ground, this period was taken into account only once). This calculation was possible because all sub-groups consisted of the same number of individuals (two). Correspondingly, one ground visit was defined as the continuous presence of a sub-group on the ground (again independent of whether one or both members of the sub-group visited the ground). The respective number of observation sessions is given in the tables and the text. The potential within-group-relations between the ground stay values of both species were tested using Spearman's coefficients of rank correlation. For all statistical analyses SPSS was used.

Total-time budgets of ground visits

As pointed out earlier (cf. Sontag, 2001a), in total, Black-collared Starlings spent more time on the ground than Bali Starlings. However, this difference was statistically significant only in half of the interspecific comparisons. This may have been due partly to the difficult observation conditions: free-running dogs were often present and disturbed observation sessions had to be terminated and excluded from further investigation, reducing the data set. This handicap becomes evident when reconsidering the data of Groups 1 and 2. When both study groups are analyzed separately, no statistical difference is detectable between the Black-collared Starlings and the adult Bali Starlings in either group: the significance level is missed by far in Group 1 ($p = 0.245$, $N_1 = N_2 = 20$ sessions; U test, two-tailed), whereas in Group 2 the difference is marginally short of being significant ($p = 0.065$, $N_1 = N_2 = 12$ sessions; U test, two-tailed). Pooling the data of both groups, however, yields a statistically substantiated distinction between the same individuals based on the same test algorithm ($p = 0.034$, $N_1 = N_2 = 32$ sessions).

In order to roughly assess the potential importance of the ground section in aviary use, the arithmetic means of the time spent on the ground (in percent of the observation time) are given. The range was between 15.9% and 22.6% in the Bali Starlings (adults: 19.6 ± 13.9 SD, 15.9 ± 10.0 SD; juveniles: 22.6 ± 16.9 SD, 19.0 ± 14.0 SD), and between 28.6% and 34.1% in the Black-collared Starlings (28.6 ± 23.3 SD, 28.6 ± 18.4 SD, 34.1 ± 20.5 SD).

Correlations of cumulative ground stay time: yes or no? (Table 1)

Surprisingly, no negative correlation coefficient was ever calculated for the cumulative ground stay times of the compared birds (including the pooled data of different groups). Rather, only definite positive correlation coefficients ($r_s = 0.150$ to 0.608) occurred. Thus, apart from the respective absolute total-time sums, this expresses the following tendency: the more time the Black-collared Starlings spent on the ground, the more so did both

the adult and juvenile Bali Starlings (and *vice versa*) in all comparisons. Nonetheless, for most comparisons *no* significant correlation could be confirmed (including the comparison between the adult and juvenile Bali Starlings). A positive correlation coefficient for the time-sums was statistically relevant only between the Black-collared Starlings and the juvenile Bali Starlings, rather weakly in Group 3 ($p < 0.05$), and very strongly in the lumped Groups 2 + 3 ($p = 0.005$), although the coefficient itself remained rather low ($r_s = 0.557$; theoretically 1 would be the highest possible value) (Table 1). Why did a relationship exist just between the young Bali Starlings and the members of the other species? Perhaps young birds are *per se* more 'curious' than older individuals and their exploratory behaviour was facilitated or even partially elicited by the - generally speaking - non-hostile, different looking Black-collared Starlings.

Correlations of ground visit frequencies: yes or no? (Table 2)

Not a single case showed evidence of a significant rank correlation between the ground visit frequencies of the compared group members, including the combined data of different groups. Moreover, with one exception, the correlation coefficients were very low (i.e. $r_s = < 0.16$), and in one case even marginally negative. The only comparison which may suggest a (positive) trend was that of the Black-collared Starlings and adult Bali Starlings in Group 2 ($r_s = 0.495$, $p = 0.102$).

These results fit in with the fact that the individual ground visits of the Black-collared Starlings were highly variable in duration, while those of *Leucopsar* were short and rather constant (Sontag, 1992, 2001b).

Overt interspecific effects

Both sturnids were observed on the ground at the same time. Some incidents suggest that one species occasionally caused the other to take flight from the floor of the aviary. In one case, for example, a Bali Starling flew up and called harshly; immediately, a Black-collared Starling that was also on the aviary floor was seen flying off (Group 2). Shortly after the hatching of the Bali Starlings, interspecific antagonistic interactions frequently took place between the adult birds, and the Black-collared Starlings often withdrew when confronted by their smaller sized counterparts. Unfortunately, I did not make a separate note of which individuals were involved in these interactions.

General discussion and conclusion

On one hand, starlings (Sturnidae) represent a very social group of birds that often form interspecific aggregations (cf. Feare & Craig, 1998; also see Introduction); on the other hand, severe intraspecific aggression has been

reported in the Bali Starling (e.g. Hughes & Turner, 1975: 116; Sieber, 1983; Sontag, 2001b). An example of fatal aggression can be added from my own experience with groups of another sturnid, the Brahminy Starling. The birds were kept in spacious indoor-outdoor aviaries measuring ca. 4.5m x 3m x 2m (approx. 14ft 6in x 9ft 9in x 6ft 6in) at the University of Mainz and in a much larger enclosure (the inside of which was hexagonal and the outside pentagonal with dense vegetation) at Mainz Municipal Park, Germany. At least four of the deceased, crested, at least nearly adult individuals, died as the result of intraspecific fighting. Attacks were initiated by short singing, which was followed by a physical assault. An attacking individual selectively pecked at the head of the conspecific. In at least one case, attacks continued on the corpse. The case of *S. pagodarum*, which also belongs to the *Sturnus-Acridotheres* complex, stresses the importance of comparative studies in systematics and phylogeny among that group.

Based on the general behaviour patterns, the mixed species study groups appeared to coexist without problems. These semi-qualitative observations require a quantitative method to verify the general impression. Due to methodological restrictions, only a few measures could be selected. Both the cumulative ground use periods and ground visit frequencies seemed appropriate for examining the potential connection between the behaviour of the sub-groups. First, the cumulative and frequency measures never provided the slightest evidence of any true trend in a sub-group to avoid visiting and using the aviary floor when the coexisting sub-group(s) spent more time at floor level (or went there more often; note the relations of the individual ground visit durations to the total times on the ground, Sontag, 2001b). Second (and surprisingly), most comparisons also yielded no positive connection between the sub-groups. Furthermore, the absence of detectable behavioural relations was more prominent in the case of ground visit frequencies. For this parameter, no statistically significant value occurred at all; its correlation coefficients were much lower in almost all sub-group comparisons than those of the cumulative ground stay times (see Tables 1 & 2). In summary, the results support the idea that the sub-groups representing different species obeyed their own activity patterns rather than the impact of the other group members. Accordingly, the fact that both species are closely related biased the interaction between these sturnids only minimally if at all. This finding is important in the light of the strong intraspecific aggression that often has been described in *L. rothschildi* (see above). The results are also in accordance with literature reports that coexistence between different sturnids is a widespread phenomenon (see above). This may be due partly to similarities in the flocking tendency within this family and similar roosting requirements and feeding niches (see Feare & Craig, 1998).

Based on the presented data, other interpretations cannot be excluded *per se*. However, there is not sufficient evidence for an antithetic conclusion. The exception was the juvenile Bali Starlings that tended to spend more time on the ground, the more the Black-collared Starlings used that part of the aviary, which remains to be explained. The juvenile birds might have been attracted to inspect the ground segment of their enclosure by the presence there of the similar-sized Black-collared Starlings. This potential attraction may be related to the fact that the latter species is less conspicuous on the ground than the Bali Starling.

Summary

Sturnids of the *Sturnus-Acridothores* complex *sensu lato* (= *S.-A.* complex) are social birds and often form mixed associations with members of the same species complex under natural conditions. The Bali Starling, however, is known for its severe intraspecific aggression. Examples of fatal intraspecific aggression under aviary conditions have been reported, the species involved being the Brahminy Starling, also a member of the *S.-A.* complex.

Three groups of Bali Starlings and Black-collared Starlings, two species which belong to the *S.-A.* complex, were kept together in a spacious, richly structured aviary and coexisted without any major problems. Here, cumulative ground stay time and the ground visit frequency were the parameters selected to quantify habitat use, specifically whether the activity of one species was influenced by the other. With two exceptions no behavioural connections were evident between the compared group members (not even between the adult and juvenile Bali Starlings). The two significant, positive cases (Spearman's coefficients of rank correlation) were for the cumulative ground stay times of the Black-collared Starlings and juvenile Bali Starlings in Group 3 and Groups 2+3 (combined). Thus, both sturnids generally tended to follow their own activity pattern.

In addition, the phylogenetic relations of both species and closely related allies within the *S.-A.* complex are discussed including parasitological findings from the literature. Different bobbing and nodding displays occur in the group; the *A. burmannicus*, *G. nigricollis* and *L. rothschildi* patterns are characterised. Specific behaviours of the Black-collared Starling are presented, based partly on studies in the field.

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Table 1. Spearman's coefficients of rank correlation r_s for total time spent on the ground per observation session by Black-collared Starlings and Bali Starlings in different groups (including data combined groups). See methods. N number of sessions, p probability of error. **Significant probabilities in bold type.**

Group 1			
Black-collared vs ad. Bali	N=20	$r_s=0.150$	$p=0.527$
Group 2			
Black-collared vs ad. Bali	N=12	$r_s=0.455$	$p=0.138$
Black-collared vs juv. Bali	N=12	$r_s=0.462$	$p=0.131$
ad. Bali vs juv. Bali	N=12	$r_s=0.448$	$p=0.145$
Groups 1 + 2			
Black-collared vs ad. Bali	N=32	$r_s=0.263$	$p=0.146$
Group 3			
Black-collared vs juv. Bali	N=12	$r_s=0.608$	$p=0.036$
Groups 2 + 3			
Black-collared vs juv. Bali	N=24	$r_s=0.557$	$p=0.005$

Table 2. Spearman's coefficients of rank correlation r_s for ground visit frequencies of Black-collared Starlings and Bali Starlings in different groups (including data combined groups). See methods. N number of sessions, p probability of error.

Group 1			
Black-collared vs ad. Bali	N=20	$r_s=0.063$	$p=0.792$
Group 2			
Black-collared vs ad. Bali	N=12	$r_s=0.495$	$p=0.102$
Black-collared vs juv. Bali	N=12	$r_s=0.011$	$p=0.974$
ad. Bali vs juv. Bali	N=12	$r_s=0.039$	$p=0.905$
Groups 1 + 2			
Black-collared vs ad. Bali	N=32	$r_s=0.154$	$p=0.400$
Group 3			
Black-collared vs juv. Bali	N=12	$r_s=0.127$	$p=0.694$
Groups 2 + 3			
Black-collared vs juv. Bali	N=24	$r_s=0.101$	$p=0.639$



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Probably the first photo of a Vinous-breasted Starling 'nodding'. It was housed with Black-collared Starlings in an aviary in Thailand



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A Black-collared Starling in its 'bowing' position while its companion stands besides it.

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BREEDING THE SCARLET IBIS *Eudocimus ruber* AT BELO HORIZONTE ZOO, MINAS GERAIS, BRAZIL

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and João Bôsko Ferraz

Introduction

The red or reddish plumage of the Scarlet Ibis *Eudocimus ruber* always arouses interest. Owing to its scarcity in bird collections here though, it is not well known (Antas, 1979). A bird characteristic of mangroves, it was found along the Brazilian coast, from Santa Catarina in the south, to Amapá in the north (Teixeira & Best, 1981). However, despite suitable ecosystem stretching along almost the entire Brazilian coast, there are no records of Scarlet Ibis in the States of Espírito Santo and Rio Grande do Norte (Marcondes-Machado & Filho, 1989). In the past, this species nested in Guanabara Bay, Rio de Janeiro, but due to hunting and habitat loss, the ibis were forced to occupy only the northern part of their original distribution. Nowadays, the Scarlet Ibis is a threatened species in Brazil (IBAMA, 2002).

Reproduction is a rare event in captivity in Brazil. According to records in the birds census, only São Paulo Zoo (SP Zoo) 1981, Porto Alegre Zoo (RS Zoo) 1983 and Emílio Goeldi Museum (EGM) 1999 have achieved reproduction in recent years, with one chick being reared in each institution. Earlier, Rio de Janeiro Zoo (RJ Zoo) in the 1970s, obtained a good rate of reproduction, with 15 chicks reared (Antas, 1979). The Scarlet Ibis is a species that nests colonially, but is extremely territorial, defending its nest from conspecifics. At the above institutions, the number of individuals kept was not high, but sufficient (eight SP Zoo, 10 RS Zoo, 17 EGM and 30 RJ Zoo) to trigger successful reproductive behaviour. Belo Horizonte Zoo (BH Zoo) has three Scarlet Ibis, a male which has been here since 1985, and a pair which arrived in 2000.

The first breeding of *E. ruber* at Belo Horizonte Zoo

The enclosure

The Scarlet Ibis are kept in a large, outdoor enclosure 590 sq m (approx. 6,350sq ft). It has a freshwater lake 113sq m x 20cm deep (approx. 1,215sq ft x 8in deep), one clay island 7sq m (approx. 75sq ft) and a grassed area 470 sq m (approx. 5,000sq ft), planted with ornamental shrubs and trees, such as *Ficus* sp. (Moraceae), *Oreodoxo oleracea* (Palmae), *Sanchesia nobilis* (Acanthaceae), *Eugenia sprengelii* (Myrtaceae), *Impatiens walleriana* (Balsaminaceae), *Zantedeschia aethiopica* (Araceae) and *Cuphea gracilis* (Lythraceae). The enclosure is surrounded by a 1.4m (approx. 4ft 9in) high fence.



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