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**Dialects in the song of the Splendid Sunbird
Cinnyris coccinigastra at the University of Ghana,
Legon, Ghana, February–April 2004**

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Summary

Songs of male Splendid Sunbirds were recorded periodically at nine locations where territorial males sang regularly at dawn usually within audible distance of each other, sometimes < 30 m apart. Dialects were distinguished by visual inspection of spectrograms and the mean time interval between the start of consecutive notes in a song (the mean time interval pattern) also characterised dialects. Three dialects were recorded at localities up to 500 m apart. Competing males at four locations sang the same dialect but at three others a sharp dialect boundary occurred and each male, no more than 40 m apart, sang its own distinct dialect. The spectrograms and mean time interval patterns obtained at each location remained unchanged for the duration of the study but none matched those obtained in the same area 30 years earlier. The estimated mean density of male Splendid Sunbirds in areas where they occurred at Legon was 0.45 ha⁻¹ but their distribution was not uniform (range c. 0.25–1.85 ha⁻¹). Dialects may have arisen due to the patchy distribution of suitable habitat at Legon.

Résumé

Dialectes du chant du Soui-Manga éclatant *Cinnyris coccinigastra* à l'Université du Ghana, Legon, Ghana, février–avril 2004. Les chants de mâles du Soui-Manga éclatant ont été enregistrés périodiquement à neuf places où, régulièrement à l'aube, les mâles cantonnés chantaient habituellement à portée de voix, parfois à < 30 m les uns des autres. Les dialectes étaient distingués à l'examen visuel des spectrogrammes; l'intervalle de temps moyen au départ des notes consécutives du chant (type de l'intervalle de temps moyen) caractérisait aussi les dialectes. Trois dialectes ont été enregistrés à des places séparées de moins de 500 m. Les mâles rivaux de quatre endroits chantaient dans le même dialecte mais à trois autres endroits on observait une démarcation marquée des dialectes, et chaque mâle,

distant de moins de 40 m, chantait dans son propre dialecte. Les spectrogrammes et le type de l'intervalle de temps moyen obtenus au même endroit restèrent stables pendant la durée de l'étude mais sans aucune correspondance avec ceux obtenus au même endroit 30 ans auparavant. La densité moyenne estimée de Soui-Mangas éclatants mâles dans ces régions où on les rencontrait à Legon était de $0,45 \text{ ha}^{-1}$ mais leur distribution n'était pas uniforme (écart-type *c.* $0,25\text{--}1,85 \text{ ha}^{-1}$). Les dialectes ont pu se développer à la faveur de la distribution morcelée de l'habitat favorable à Legon.

Introduction

During the years 1970–3 I studied the song of the Splendid Sunbird *Cinnyris coccinigastra* in Ghana (Grimes 1974). Marked geographic variation in the song occurred between Accra and Cape Coast, but more surprising was the presence of distinct and readily discernible dialects spatially distributed on the campus of the University of Ghana at Legon. These were discovered early in the 1970s, when sample spectrograms of the songs of Splendid Sunbirds, tape recorded at four localities on the campus, were visually compared. In 1972, songs of a colour-ringed male, which sang regularly in the same tree, were tape recorded on 10 occasions over the period 30 May to 3 August 1972. The sound spectrograms and mean time interval patterns of his song (Fig. 8 and Table 3 in Grimes 1974) were similar throughout these two months. At one locality near the Department of Agriculture, the sound spectrograms were preserved over three years (the duration of the 1970s study). As visual inspection was sufficient to separate the dialects no other data were abstracted from the spectrograms.

A typical song of the Splendid Sunbird consists of 6–7 consecutive glissando notes (range 4–11), each lasting *c.* 0.2 sec (Fig. 1), and is repeated as the male advertises his presence and territory (mean rate in 2004 was 8.95 ± 1.63 songs/min. (range 6.25–12.83, $n = 34$). The structural simplicity of the song lends itself to the detection and study of dialects in a population.

In January 2004, I returned to the University of Ghana after an interval of 30 years and was able to investigate dialects and their distribution on the campus. Snatches of territorial song were first heard in early February but it was not until mid-March that males sang for prolonged periods in competition with others. A summary of the results is presented here. A report (subsequently termed the *Report*) containing all the data apart from spectrograms showing the dialects of competing males which have been added to this revised edition, has been sent to the Edward Grey Institute at Oxford, the Natural History Museum at Tring, the British Library in London, the Percy FitzPatrick Institute at the University of Cape Town, South Africa and the Department of Zoology, University of Ghana at Legon. Copies of the visual and sound recordings made have also been deposited at these Institutions.

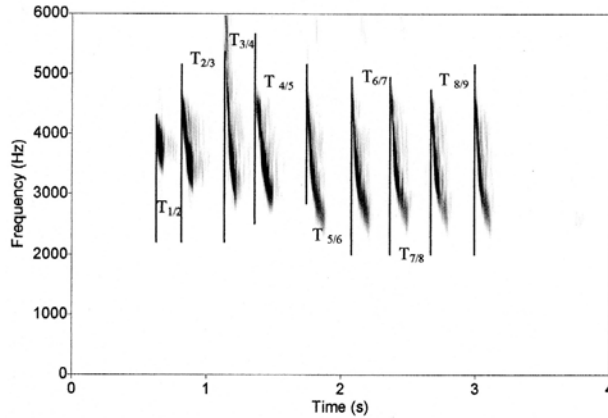


Figure 1. Spectrogram of a song sequence of Splendid Sunbird showing time differences ($T_{1/2}$, $T_{2/3}$ etc) between the start of consecutive notes, as measured for all sequences recorded.

Methods

All recordings of singing males were made between 5h40 and 6h10, when singing was prolonged and intense, apart from three (one at 8h00 in the Botanical Gardens; two briefly mid-morning near Commonwealth Hall and the University Library). The equipment was usually ready before the first male began singing. The locations chosen were those where Splendid Sunbirds were found singing at dawn in competition with each other, found by systematically walking around the campus. Many were singing in Little Legon and on Lower Hill but only two in East Legon near the Department of Agriculture and only three within the extensive Botanical Gardens.

Four of the locations where birds were tape recorded were close to areas where dialects were recorded in the 1970s (near 20 Little Legon, on Legon Hill, near the Department of Agriculture and within the Botanical Gardens). These and five others (Fig. 2, Table 1) were visited periodically during my three-month stay and songs of males, singing on each occasion from within the same tree or clump of trees at each locality, were tape recorded. Although none was colour ringed, the 1972 observations of the colour-ringed male suggest that any male Splendid Sunbird singing at dawn from the same tree or clump of trees was the same individual on each occasion.

Singing males were tape recorded and filmed using a Sennheiser MKE 300 directional microphone attached to a Sony video recorder (CCD-TR840E). Males often sang from exposed perches in the canopy when they were usually visible but sometimes obscured. On 12 separate occasions (Table 1) I recorded long unambiguous sequences of competing males in one session by systematically moving from one singing

male to the next while the first bird continued to sing. In addition, the songs of other more distant males were picked up by the microphone and were audible on play-back.

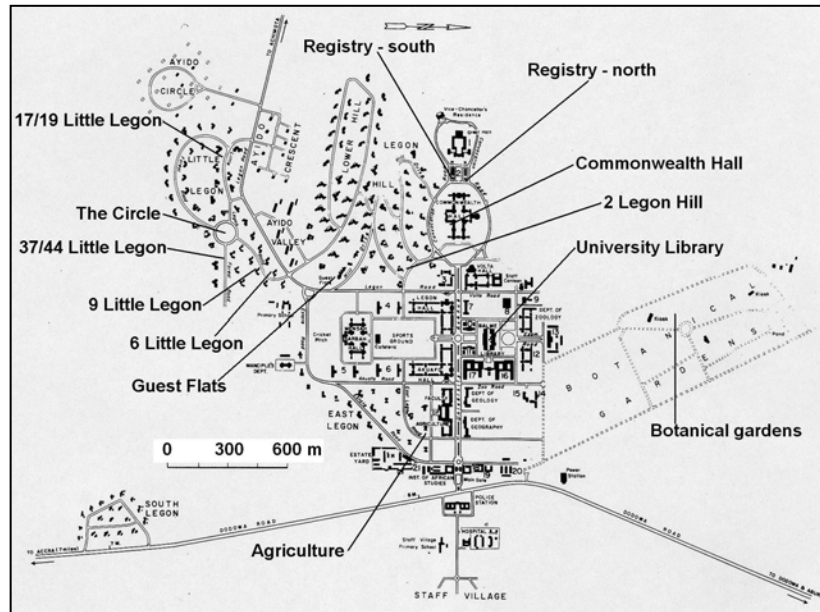


Figure 2. The locations where songs of male Splendid Sunbirds were tape recorded on the campus of the University of Ghana, Feb–Apr 2004.

Table 1. Locations and dates of sound recordings obtained in 2004 and numbers of males recorded.

Location	Dates (F = Feb, M = Mar, A = Apr) and no. of males recorded	Max. no. males recorded at site
2 Legon Hill	8F (1), 28F (1), 12M (1), 16M (1), 24M (1), 11A (2)	3
Registry (north)	28M (1), 29M (1), 30M (1), 11A (1), 14A (1)	3
Registry (south)	30M (1), 11A (1)	2
Botanical Gardens	3A (2), 10A (1), 16A (1)	3
Agriculture	1A (1), 2A (2), 10A (2)	2
6–9 Little Legon	3A (2), 6A (3)	3
17–19 Little Legon	31M (2), 5A (2)	2
37–44 Little Legon and Circle	14M (1), 19M (1), 7A (3)	2
Guest Flats	14M (2), 24M (1), 27M (2), 8A (2)	3

The camcorder data for each recording session (total 44) made at the nine locations were copied to a Sony high resolution videotape (E-180HR1), rendering both visual and audio data accessible when played on a television (Matsui TVR 185). Each session was analysed separately by feeding its audio signal from the television into a computer and producing a spectrogram of each song, using Praat.exe software (University of Amsterdam). The sampling rate was 44,100 Hz, which allowed 22 s of a recording — usually three or four song sequences — to be transferred each time for analysis. The start time of each note in a song sequence was read directly from its spectrogram and the time difference between the start of consecutive notes obtained. Each spectrogram of a given male yielded similar data and all spectrograms for a given male were used to calculate the mean time difference between the start of consecutive notes of its songs (the mean time interval pattern). Mean time interval patterns were obtained for all males recorded (Table 1). Spectrograms of songs of competing males were often present on a 22 s sample and many were clear enough to provide data on the time differences between the start of the notes in their songs. Thus it was possible to obtain an unambiguous sound spectrogram and time interval pattern of the songs of two or more competing males counter-singing. I did not abstract frequency characteristics of each note in a song sequence, though the software provided these data.

Results

Visual inspection of the frequency-time profile of male's dawn songs at the nine locations (spectrograms from all nine are illustrated in Figs 3, 5, 7 and 9) is sufficient to identify eight distinct dialects (A, B, C, D, E, F, G and H). Spectrograms of recordings made on different dates at each location confirmed the presence of the same dialect and these are illustrated in the *Report*. Some dialects were recorded at more than one location, *e.g.* Dialect C at 17/19 Little Legon and 550 m further east at 9 Little Legon (Figs 3 and 7), and Dialect D at the Guest Flats and *c.* 400 m south near 6 Little Legon (Figs 5 and 7). In addition, the male recorded briefly near Commonwealth Hall (27 Feb) sang four sequences of Dialect H (Fig. 9 and *Report*), which was the dialect recorded south of the Registry (30 Mar and 11 Apr) some 300 m to the west.

The corresponding mean time interval patterns of each song in Figs 3, 5 and 7 are given in Figures 4, 6 and 8, in which 41 of the 42 recording sessions at these eight locations have been used. The remaining one (11 April at 2 Legon Hill) appears in the *Report* and follows closely the pattern in Fig. 4. The mean time interval patterns for the two males recorded on the south side of the Registry (30 March and 11 April) appear in the *Report*. The mean time difference patterns were reproducible at each location but whereas some were quite different from each other, *e.g.* those at 2 Legon Hill (Fig. 4), 17/19 Little Legon (Fig. 4), Agriculture (Fig. 6), and Botanical Gardens (Fig. 6), others were more similar, *e.g.* at 17/19 Little Legon (Fig. 4) and the Guest Flats (Fig. 6), although the spectrograms of songs recorded at these two locations were not.

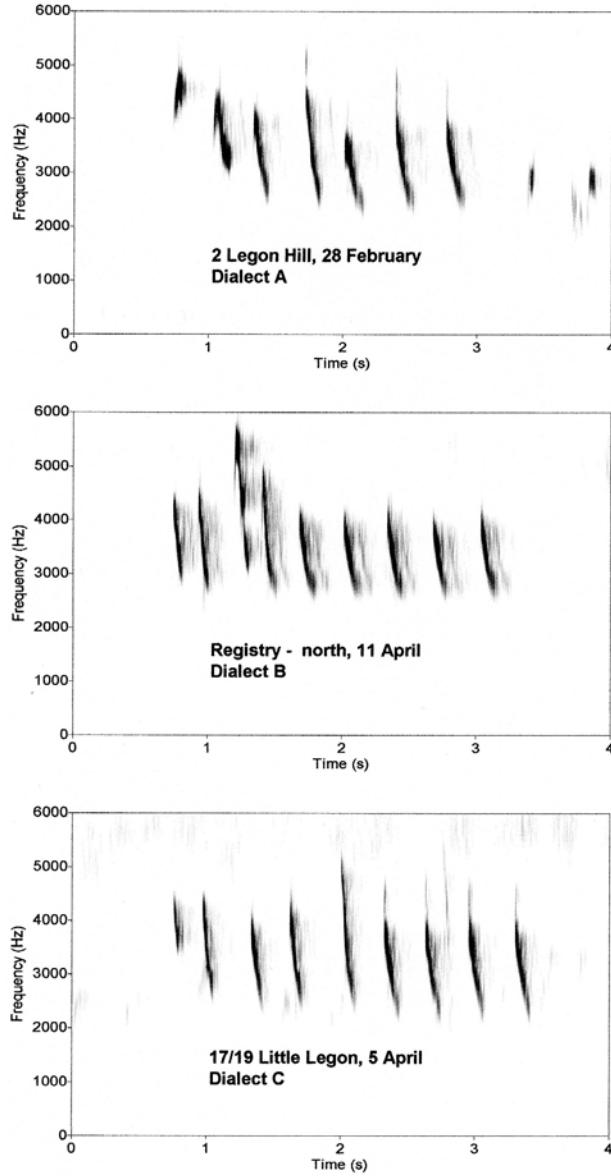


Figure 3. Typical spectrograms of song dialects of male Splendid Sunbirds recorded in 2004 at three localities at the University of Ghana, Legon.

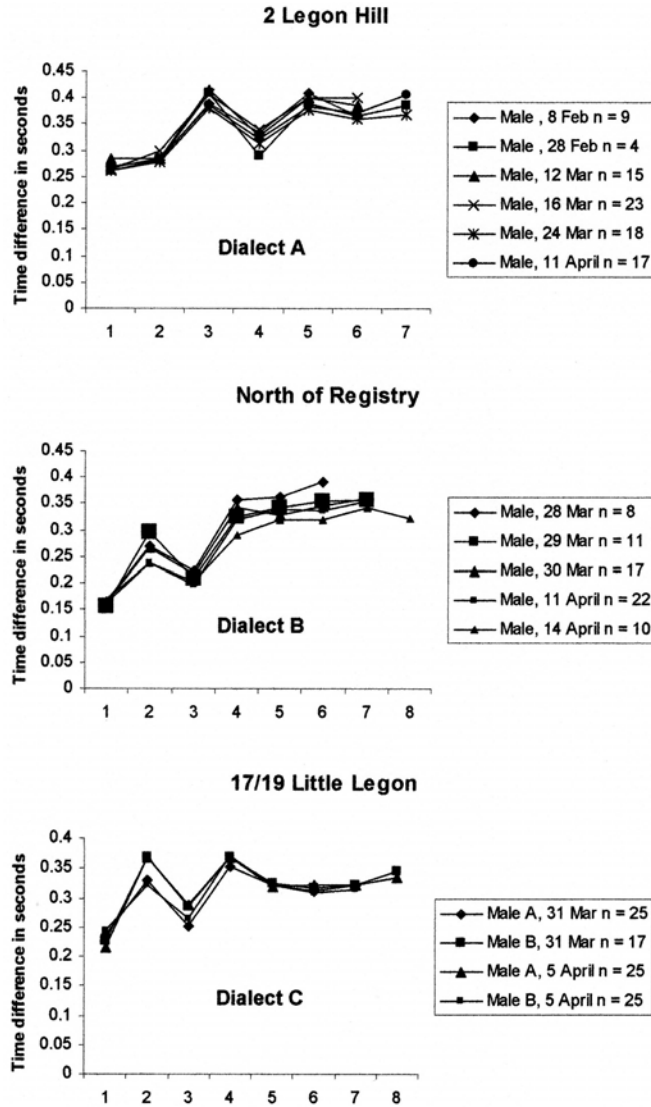


Figure 4. The mean time differences between the start of consecutive notes in the songs of Splendid Sunbirds recorded in 2004 at the three localities from which spectrograms are illustrated in Fig. 3. The x-axis identifies the note pairs used in obtaining the time difference (1 = first and second notes, 2 = second and third notes, etc.).

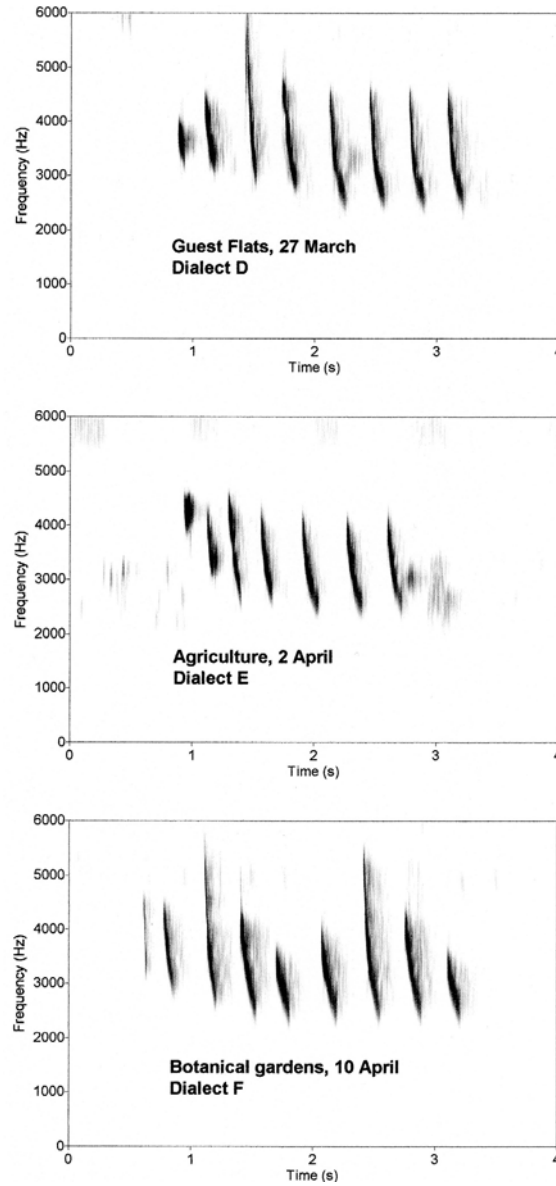


Figure 5. Typical spectrograms of song dialects of male Splendid Sunbirds recorded in 2004 at three localities on the campus of the University of Ghana, Legon.

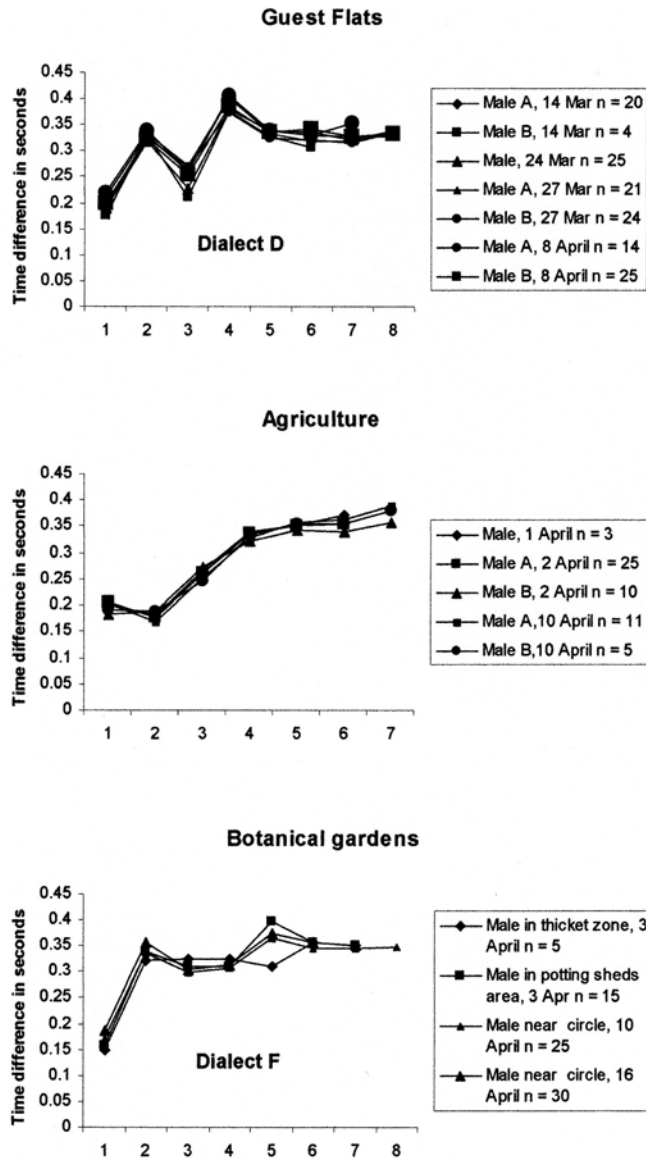


Figure 6. The mean time differences between the start of consecutive notes in the songs of Splendid Sunbirds recorded in 2004 at the three localities from which spectrograms are illustrated in Fig. 5. X-axis labelling as Fig. 4.

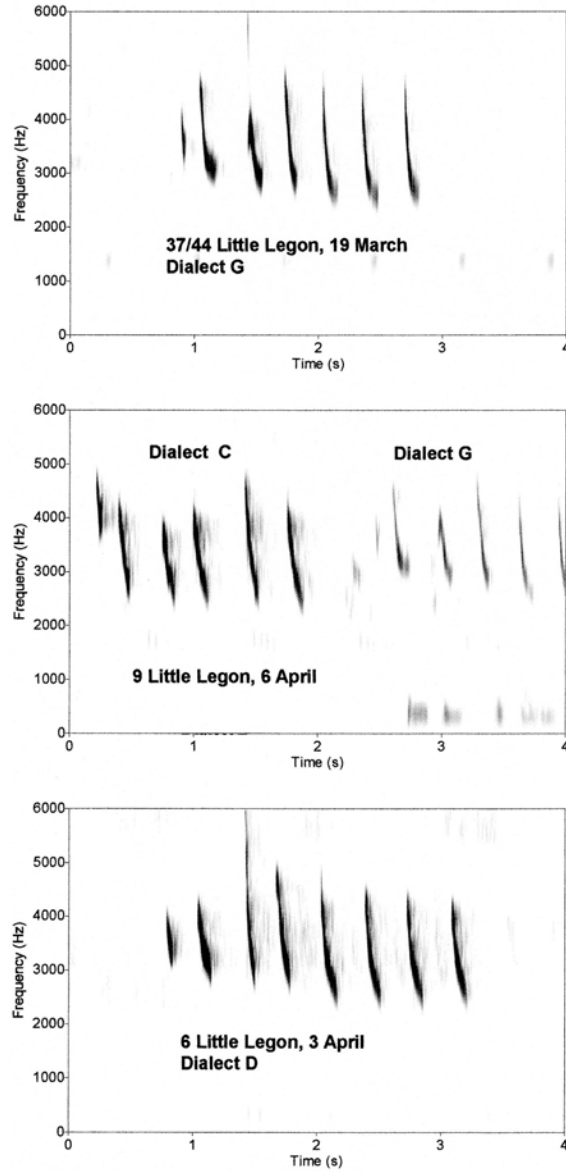


Figure 7. Typical spectrograms of song dialects of male Splendid Sunbirds recorded in 2004 at three localities on the campus of the University of Ghana, Legon.

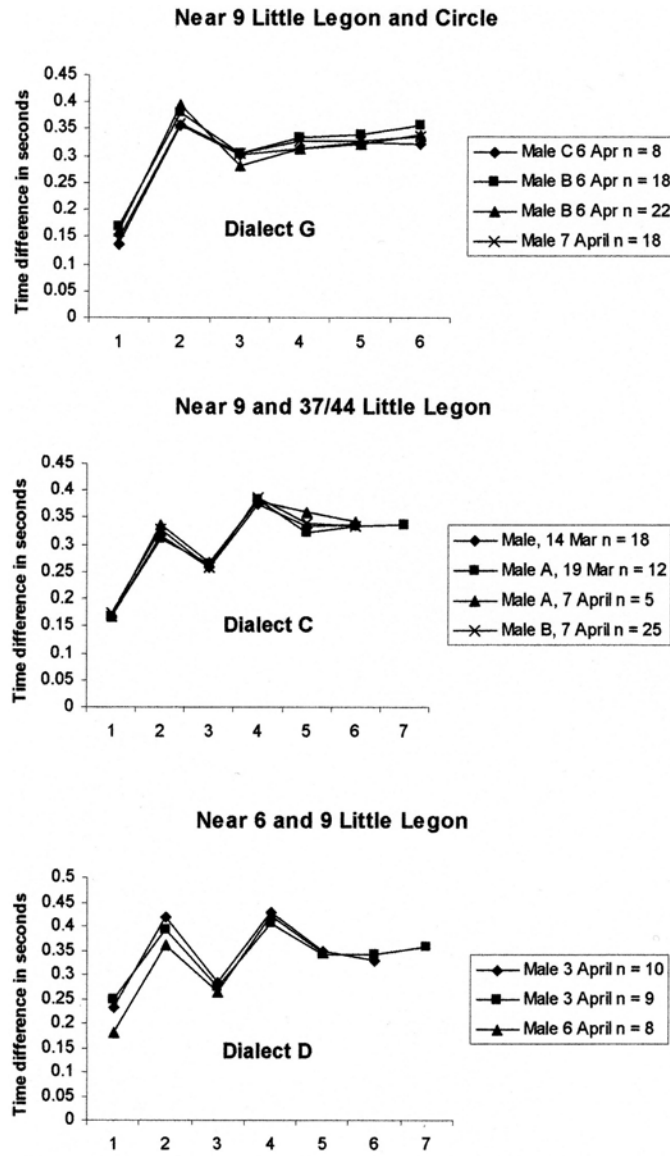


Figure 8. The mean time difference patterns for dialects C, D and G recorded in 2004 at the three localities from which spectrograms are illustrated in Fig.7. X-axis labelling as Fig. 4.

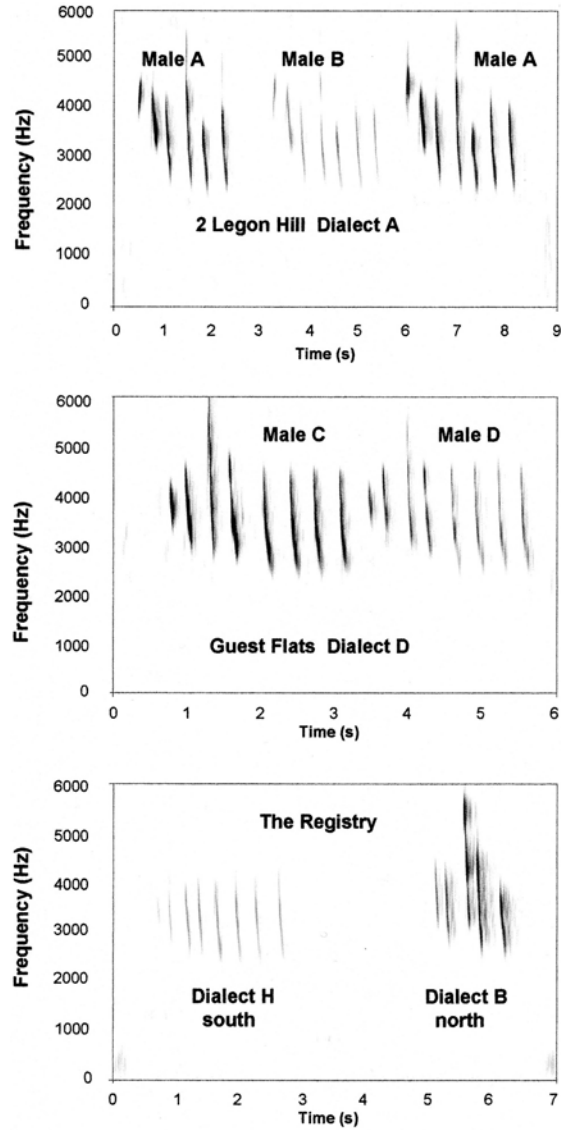


Figure 9. Spectrograms of songs of male Splendid Sunbirds singing in competition with each other at 2 Legon Hill, at Guest Flats and at the Registry. Competing males sang the same dialect at the first two locations (dialects A and D respectively) but different dialects (B and H) at the Registry.

Competing males some 20–40 m apart were recorded singing an identical dialect at 2 Legon Hill (Dialect A in Figs 3 and 9), and at the Guest Flats (Dialect D in Figs 5 and 9), and also, but not illustrated here, at 17/19 Little Legon and at Agriculture. In contrast, competing males sang quite different dialects on the north and south side of the Registry (Dialects B and H in Fig. 9), while in Little Legon at least three dialects (C, D and G in Fig. 7) were detected within a small area (*c.* 2.7 ha) which included gardens of houses 6, 9, 37 and 44 and the parkland bordering the eastern edge of the Circle (Fig. 2).

The spectrograms ($n = 6$) and mean time difference pattern (see *Report*) of the male's song briefly recorded near the University Library complex (26 Mar) matched none recorded elsewhere on the campus. In addition, the frequency/time slope of its first note was positive whereas in all other songs recorded, except those at 2 Legon Hill (Figs 3 and 9), the slope was negative.

No playback experiments involving “foreign” dialects were undertaken but on three occasions playback of a male's own song was followed by the singing male stopping soon after the playback began and remaining silent for some time after the playback was stopped before beginning to sing again.

The area of the campus within which Splendid Sunbirds were tape recorded at the eight locations was *c.* 51 ha and the number of sunbirds that could be heard on the tape recordings at each of the eight locations was never more than three. Since the microphone was directional, this yields a population estimate of 23 (Table 1) and a minimum mean density of males of 0.45 ha^{-1} . However the sunbird was not uniformly distributed. Thus in the restricted area (*c.* 2.7 ha) of Little Legon (total area *c.* 25 ha), where three dialects were detected, at least five males occurred (density *c.* 1.85 ha^{-1}) whereas within the Botanical gardens only three males occurred within an area of *c.* 12 ha (density 0.25 ha^{-1}).

Discussion

Neither mean time difference patterns nor spectrograms of the songs of the Splendid Sunbird recorded on the campus in the 1970s (Figs 3 and 6 in Grimes 1974) match those obtained in 2004, although there are some similarities in the mean time difference patterns of the sunbirds singing near the Agriculture Department (Fig. 5 of this paper and Fig. 3 of Grimes 1974). This is perhaps not surprising as the interval of time represents at least 30 generations of sunbirds.

The new data confirm the earlier findings (Grimes 1974) that the spectrograms of songs recorded at a given location were reproducible over time, and that competing sunbirds may sing the same dialect (Fig. 9), or different ones, in which case the dialect boundary is relatively sharp (Figs 7 and 9). Recently, two distinct dialects have been found in a colour-ringed urban population of Orange-tufted Sunbirds *Nectarinia osea* in Israel (Leader *et al.* 2000). One was sung by 37 males the other by 21, and

four males used a hybrid song. A male's song type did not change over the breeding season or from year to year, and males of both dialect groups responded more positively to playback of their own dialect than to playback of the other. Their data indicate a higher population density of Orange-tufted Sunbirds (6.4 males/ha) than of the Splendid Sunbird at Legon, with a distribution remarkably uniform compared with that of the Splendid Sunbird at Legon.

The presence of distinct dialects in the population of Splendid Sunbirds at Legon is in marked contrast to what Payne (1978) found in the population on the campus of Cape Coast University in September 1975. He sampled the songs of most, if not all, sunbirds singing on the 6 km² campus and was not able to distinguish dialects in most of his birds. Although he confirmed local song variation, he found that variations in space were not grouped into discrete dialects. Subsequently Schnell *et al.* (1985) have re-analysed Payne's data and were able to attach measures of statistical significance to Payne's evaluation. Their conclusions were the same as Payne's, that males furthest apart had the most dissimilar songs whereas those of close neighbours were relatively more similar to each other than predicted by chance, and that differences in song were not due to differences in habitat. At Cape Coast, 39 males occupied *c.* 237 ha which gives a density of 0.164 males/ha.

Payne (1978) thought that the differences in the results of his study at Cape Coast and the one at Legon were due to differences in sampling methods. He made a short visit to Legon in November 1975, when Splendid Sunbirds were silent, and considered the whole of the campus a uniform habitat suitable for Splendid Sunbirds. Although he does not indicate how many he saw he considered it more than likely that many more Splendid Sunbirds may have occurred on the campus and in the surrounding areas than were recorded in the 1970s. That is true as it was not intended to sample all singing sunbirds in the 1970s but rather concentrate on those singing in one location over a period. However, whether or not discrete dialects occur should not depend on sampling techniques: they are either present or absent. The present data substantiate that of the 1970s, and suggest that the differences between the findings of the two studies at Legon and at Cape Coast are real and merit further study.

My observations also suggest that the campus was and is not uniformly attractive to sunbirds as thought by Payne. In 2004, as in the 1970s, no singing sunbirds were located at dawn in the area of thicket between the southern border of the Botanical Garden and the Zoology and Botany departments and lecture room complex (Fig. 2), nor between these buildings and the University Library. In terms of tree cover, the staff residential areas of Legon Hill, Little Legon, Lower Hill, East Legon and Ayido valley appear uniform and have changed little from the 1970s, though trees are taller and their canopies more extensive. A variety of flowering trees is present in the older residential areas of Legon Hill, Little Legon and East Legon and this is where sunbirds were found singing in the 1970s and in 2004. In contrast, on Lower Hill and in Ayido Valley the Neem *Azadiracta indica* tree dominates the landscape and flowering trees suitable for sunbirds are scarce. The rest of the campus is and was,

although to a lesser extent, equally unfavourable to Splendid Sunbird as much of it consists of faculty buildings, student Halls and Annexes, and playing fields which are criss-crossed with foot paths used throughout the day by students. Although flowering Copper Pods *Peltophorum pterocarpum* occurred along roads and Rain Trees *Samanea saman* around playing fields in the centre of the campus, the increase in noise level due to traffic and a 10-fold increase in student numbers do not create a suitable environment for Splendid Sunbirds.

There is no generally accepted explanation of the mechanism maintaining local dialects or of their functional significance (Catchpole & Slater 1995), nor how they develop. Leader *et al.* (2000) suggested that dialects in the Orange-tufted Sunbird may have arisen from the pattern of human settlement which had begun in the early 1950s and that the spatial distribution of the two dialect populations and a low dispersal rate from dialect areas has helped to maintain them. Interestingly, the area of the Accra Plains now occupied by the University campus consisted of a mixture of grassland and thicket patches until the late 1950s when the present campus was landscaped. Although the distinctive dialects on the campus at Legon appear genuine and the sunbird distribution is not uniform, the number of males singing the same dialect and the spatial extent of each remain unknown. Their existence and development may be due to the patchy nature at Legon of the habitat suitable for sunbirds (P. McGregor pers. comm.).

Acknowledgments

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