

A new species of firefinch *Lagonosticta* from northern Nigeria and its association with the Jos Plateau Indigobird *Vidua maryae*

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A firefinch of the Jos Plateau, northern Nigeria, is described as a new species, Rock Firefinch *Lagonosticta sanguinodorsalis*. This firefinch has distinctive songs and a distinctive habitat—bushy and grassy rocky outcrops on the plateau and inselbergs to the north and east. It has a blue-grey bill, red back in the male and reddish brown back in the female and juvenile and broad primaries in both the adult and juvenile. It appears most closely related to the Mali Firefinch *Lagonosticta virata* and the Chad Firefinch *Lagonosticta umbriodorsalis*. Its songs are mimicked by the brood-parasitic Jos Plateau Indigobird *Vidua maryae*, which occurs within the range of the firefinch and whose songs led to the discovery of the firefinch. The songs of the firefinch, the song mimicry of the indigobird and the apparent continuity of song mimicry across 27 years indicate a unique association of this distinct pair of species.

During recent fieldwork on the African brood parasitic indigobirds *Vidua*, several populations have been recognized as distinct species, where they mimic the songs of different estrildid host species and are morphologically distinct from populations with other mimicry songs (Payne 1996). Although the indigobirds were previously thought to be associated only with host firefinch species *Lagonosticta* (Nicolai 1964, 1967, 1968, 1972, Payne 1968, 1973, 1982, 1990), additional species of hosts are now known, and these hosts either have their own distinct indigobird species or share one with other sympatric populations of indigobirds that are not morphologically distinct from each other. These recently recognized species of indigobirds first came to notice when their songs were found to be different from any firefinch songs. In West Africa, the bright green-plumaged Goldbreast Indigobirds *Vidua raricola* mimic songs of Goldbreast *Amandava subflava* and the dull green Quail-finch Indigobirds *Vidua nigeriae* mimic songs of Quail-finch *Ortygospiza atricollis* (Payne & Payne 1994). In south central Africa, the bright green Peters' Twin-spot Indigobird *Vidua codringtoni* mimics songs of Peters' Twin-spot *Hypargos niveoguttatus* (Payne *et al.* 1992, 1993). In two of these *Vidua* species, the songs tape-recorded were identified in error as mimicry of firefinch songs, and only later were the songs recognized as mimicry of other estrildid finches when the songs of the other estrildids were tape-recorded and audio-spectrographed; in the third *Vidua* species (*V. nigeriae*), the mimicry songs were not identified until they were compared

with the songs of the correct host species, 12 years after the songs of the indigobirds were first tape-recorded. Thus, new species of indigobirds have been discovered when song mimicry of host species other than the firefinches was recognized. Another host-parasite association has come to light through the discovery that a song mimicked by a morphologically distinctive indigobird, the Jos Plateau Indigobird *Vidua maryae*, is the song of a previously unrecognized species of firefinch.

From September to November 1995, fieldwork was carried out on the Jos Plateau in northern Nigeria at Taboru Hill near Jos and at Panshanu. During earlier fieldwork at Panshanu, green indigobirds then called "*Vidua nigeriae*" that mimicked a firefinch then called African Firefinch "*Lagonosticta rubricata*" were noted (Payne 1968). The indigobirds were later described as a subspecies *maryae* (Payne 1982) of Dusky Indigobird *Vidua funerea*, the species that mimics *L. rubricata* in southern Africa (Payne 1973). Although the mimicry songs of the plateau indigobirds include trills somewhat like the firefinch *L. rubricata*, the distinctive songs of the plateau birds have not been found elsewhere in Africa (Payne 1973, 1976, 1982, Payne *et al.* 1993, Payne & Payne 1994). Also, the holotype of *V. nigeriae* (Boyd Alexander 1908), taken on the Gongola River near the Benue River flood plain in Nigeria, is dull green and small rather than bright green and large as are the Jos Plateau Indigobirds. On the Benue flood plain in northern Cameroon, the smaller *V. nigeriae* are associated in song and hab-

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Plate 1. Rock Firefinch *Lagonosticta sanguinodorsalis*. (a) Male; (b) Female (a,b, Taboru, Plateau Province, Nigeria, November 1995); (c) Male at Kagoro, 1981, photograph by M. E. Gartshore; (d) Juvenile mouth pattern, Taboru.

it is not with a firefinch but with Quail-finch *O. atricollis* (Payne & Payne 1994). The firefinch with the descending trill like that of *V. maryae* is a previously unrecognized species.

***Lagonosticta sanguinodorsalis*, sp. nov.**
Rock Firefinch

HOLOTYPE

University of Michigan Museum of Zoology (UMMZ), Bird Division no. 233,840, collected at Taboru Hill, 9°53'N, 8°59'E, 10 km east of Jos, Plateau State, Nigeria, at 1280 m (4200 feet).

ETYMOLOGY

The name *sanguinodorsalis*, blood-red back, is descriptive of the red back colour of the male plumage. The name draws a comparison with the firefinch of northern Cameroon and Chad, the Chad Firefinch *Lagonosticta umbrinodorsalis* Reichenow 1910, which has a brown back (Payne & Louette 1983). *Lagonosticta rhodopareia bruneli* Erard & Roche 1977 is a synonym of *L. umbrinodorsalis* Reichenow 1910 (see Payne & Louette 1983).

DESCRIPTION OF HOLOTYPE

Male UMMZ 233,840 (field number RBP A313), netted 1 November 1995, has the skull pneumatized, the testes 5 × 3 mm and no fat, is not in moult and has no brood patch. The eye ring is pink (11A5, colour names and codes of Methuen reference; Kornerup & Wanscher 1978), the iris dark brown (8B4), the bill black with a bluish-grey base to the lower mandible (20B3) and the feet medium grey (20E1). The back and upper wing coverts are brownish red (10D–E7), and the crown is brownish grey (10E2). The rump and upper tail coverts are deep red (10C–D8); the tail is black with red edges on the outer rectrices (Frontispiece). The face over the eye to the underparts from throat to breast and belly is deep red (11C–D8), the flanks have fine, 1-mm white spots bordered by dark grey, and the under tail coverts are black. The wings are dark reddish brown (8E–F4), paler on the outer margins of primaries and secondaries. The outermost primaries are spatulate, 2.4 mm wide 5 mm from the tip and 3.8 mm wide 10 mm from the tip. The under wing coverts are dark grey with white spots. The wing-length (measured with wing flattened and straightened, the bend of the wing firm against the stop of a shouldered rule) is 54 mm, the tail 51 mm, the bill 9.0 mm from the nostril, the tarsus 15 mm; the weight was 10.6 g. The wing formula from longest primary to shortest is 3 > 4 > 5 > 2 = 6 > 7 > 8 > 9 > 1.

Compared with other male firefinches that are most sim-

ilar to this form in West Africa, the male *L. sanguinodorsalis* is bright reddish not brownish grey on the back as in African Firefinch *L. rubricata polionota* from Nigeria at Loko (1 male, Hartert 1886) in ZMB, from Enugu (14 males; Serle 1957) and Ankpa (1 male) in BMNH and a male ("female" on label, NMS 1938.9) taken 20 August 1937 by W. Serle (no. 37/115) at Kafanchan. *Lagonosticta r. polionota* from Togo, Ghana, Ivory Coast, Liberia, Sierra Leone and Guinea-Bissau (BMNH, FMNH, MRAC, UMMZ, USNM) also lack red on the back (Immelmann *et al.* 1965, Goodwin 1982) and, like the Nigerian birds at Loko, Enugu, Ankpa and Kafanchan, have a narrow tip to the emarginate outer primary. *Lagonosticta rubricata congica* in Cameroon are brown or pinkish brown on the back the crown is more red than the back, and the outer primaries are emarginate with a narrow tip (AMNH, FMNH, MRAC, UMMZ). Mali Firefinches *Lagonosticta virata* (Bates 1934, Goodwin 1982, Clement *et al.* 1993, Payne 1997) are similar in colour to *L. r. polionota* but have broad outer primaries as in *L. sanguinodorsalis* (BMNH, ORSTOM Mbour, ZMUC). Chad Firefinches *L. umbrinodorsalis* (Payne & Louette 1983) are brown on the back (MNHN 1979.634) and less bright red below than the Jos birds. Black-bellied Firefinches *Lagonosticta rara* throughout their range are red on the back but red not grey on the crown, have a narrow tip to the outer primaries, are black on the belly and are purplish red not bluish grey below and at the base of the blackish bill (BMNH, DMNH, FMNH, MNHN, SMNS, UMMZ, USNM).

PARATYPES

Female UMMZ 233,841 (RBP A328), netted 12 November 1995, has a small ovary with follicles 1–2 mm, the oviduct is twisted, indicating the bird had laid, no postovulatory follicles are apparent and the brood patch is bare, slightly edematous and wrinkled. The bird has no fat and is not in moult, the skull is pneumatized. The eye-ring is grey (20B2), the iris dark brown (8F4), the bill black with bluish grey (20B3) base to the lower mandible and the feet medium grey (20E1). The back and upper wing coverts are reddish brown (9E5), the crown and face are brownish grey (10E2) and the lores are greyish red (10C5). The rump and upper tail coverts are deep red (10C–D8), the tail is black with red edges on the outer rectrices. The underparts from throat to breast and upper belly are greyish red (10C5), the flanks have fine white spots bordered by dark grey, the lower belly is deep red (10C–D8) and the under tail coverts are black. The wings are dark reddish brown (8E–F4), paler brown on the outer margins of the primaries and secondaries. The outer primaries are broad, not emarginate (Fig. 1), 3.2 mm wide 5 mm from the tip and 3.8 mm 10 mm from the tip. The wing-length is 52 mm, the tail 48 mm, the bill 8.0 mm, the tarsus 14 mm; the weight was 10.6 g.

The adult female is darker and more reddish above and richer red on the belly than buff-bellied female *L. r. polionota* from the type locality, Cape Coast in Ghana (UMMZ), females



Figure 1. Photograph of spread wing from below illustrating the broad shape of the primaries, Taboru female *Lagonosticta sanguinodorsalis* UMMZ 233.841.

from Sierra Leone, Guinea-Bissau and Liberia (BMNH, ZMFK), Ivory Coast (FMNH) and Togo (MRAC), and females from Aza in Benue Province and Enugu in Nigeria (BMNH). It is darker and more reddish above, has a grey not pinkish-grey crown and is more reddish (less buff) below than breeding female *L. r. congica* from Yoko, Ngaoundere and Tibati in Cameroon (BMNH, UMMZ) and female *L. virata* from Mali (BMNH) (adult *L. rubricata* have emarginate outer primaries, whereas *L. virata* is similar in primary shape to *L. sanguinodorsalis*). Its back is darker reddish (less yellowish) and underparts more reddish (less buffy) than *L. umbrinodorsalis* from Chad (MNHN 1977.826). It is similar to female *L. rara* (BMNH, DMNH, FMNH, MNHN, SMNS, UMMZ, USNM) in the reddish back but differs in colour of the bill (black with purplish-red base in *L. rara*) and underparts (buff throat, pinkish-buff breast and belly dark grey in *L. rara*).

Juvenile UMMZ 233,842 (RBP A327) was netted 12 November 1995. The skull is unpneumatized, the testes 1 mm. The eye-ring is light grey (12B-C1), the iris dark brown (8F4). The mouth gape flange is pale grey (12B1), the anterior palate is pale grey (12B1) with three large blackish spots anteriorly and two smaller spots posteriorly, all in a ring as in other firefinches (Payne 1973); the posterior pal-

ate is pink (11A3). The bill is black, the base of the lower mandible bluish grey (20B3), the feet medium grey (20E1). The back and upper wing coverts are reddish brown (9E5), slightly less red than in the female, and the crown is more greyish brown (9E3-4) than the back and more brown than in the female. The rump and upper tail coverts are deep red (10C-D8), the tail is black with red edges on the outer rectrices. The face and underparts are light greyish brown to reddish brown (9C3-9E4), paler on the throat, and lack a reddish patch in front of the eye; the flanks are reddish brown (9D6) and the under tail coverts are black. The wings are dark reddish brown (8E-F4), paler brown on the outer margins of the primaries and secondaries. The outer primaries are broad. Growing feathers in sheath on the throat and lores are the same red colour as in the adult male. The wing-length is 52 mm, the tail 47 mm, the bill 8.0 mm, the tarsus 14 mm; the weight was 9.8 g.

The juvenile is slightly darker and more reddish above than three juvenile *L. r. polionota* from Mt. Nimba, Liberia (BMNH); it is browner (less reddish) above and more pinkish grey (less yellowish buff) below than four juvenile *L. r. congica* from Banyo in northern Cameroon (UMMZ); it is greyer (less brown) on the crown than juvenile *L. rara* (Payne 1982, UMMZ) and it is slightly more reddish above and below and with more red on the rump and a darker black tail than three juvenile *Lagonosticta rufopicta* from Kabala, Sierra Leone (UMMZ). The mouth pattern of the gape and colours on the palate differ from those of *Lagonosticta rhodopareia jamesoni*, which is pinkish and has a purplish gape with small bluish papillae at either end; from *L. rubricata* in Cameroon and Malawi by the absence of blue and white gape papillae and yellow on the palate (though the juvenile *L. sanguinodorsalis* may have lost some mouth colour and gape structure) and from *L. rara* and *L. rufopicta* (Payne 1973, 1982, Nicolai 1987, Payne et al. 1993). Juvenile *L. virata* and *L. umbrinodorsalis* are unknown.

OTHER SPECIMENS

Two adult males were netted 1 November 1995, examined in the hand at Taboru and released (one was photographed). Both had a bright reddish back and brownish grey crown and looked similar to the holotype male.

FIELD CHARACTERISTICS

The combination of blue-grey bill in the adult, red back and grey head in the male and bright reddish-brown back in the female is distinctive and allows this firefinch to be identified and distinguished from other firefinches. Also, the songs are distinctive, as described below.

VOCALIZATIONS

Songs and calls of the firefinches *L. sanguinodorsalis* in Nigeria were tape-recorded at Taboru on 29 September, 9, 12

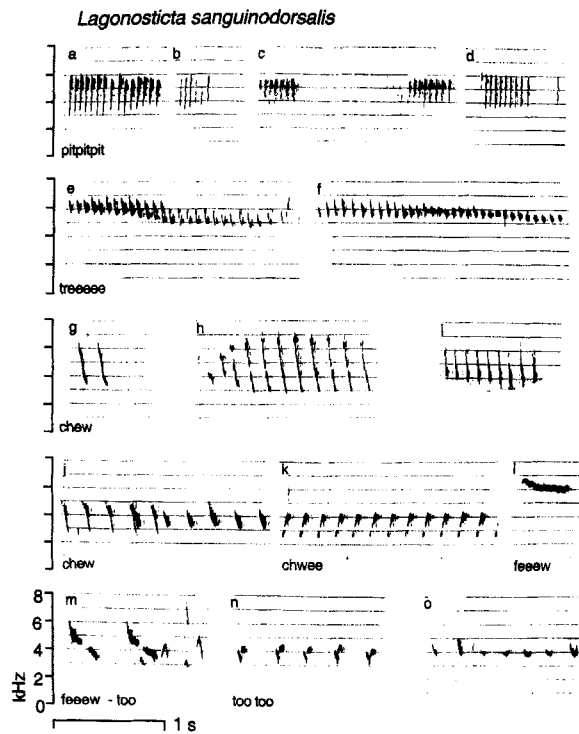


Figure 2. Calls and songs of male and female firefinches *Lagonosticta sanguinodorsalis* at Taboru, Panshanu and Kagoro. (a–d) *Pitpitpit* (a, Taboru; b, Vom; c, Panshanu 1995; d, Rano); (e, f) *Treeeee* trills (e, Panshanu; f, Taboru); (g–j) *Chew* trills (g, h, Taboru; i, Rano; j, *Chew* duet, Taboru); (k) *Chwee*, Taboru; (l) *Feeew*, Taboru; (m) *Feeew-too* variant, Taboru; (n) *Too* variant, Taboru; (o) *Too* series, Panshanu.

and 22 October and 1 November, at Vom on 12 October, at Panshanu on 9 and 17 October 1995 and at Rano on 16 November 1980. Audiospectrograms were compared with songs and calls of other firefinches from my tape-recordings in Sierra Leone, Cameroon, Malawi and Zambia, other song recordings and audiospectrograms (Nicolai 1965, 1982, Güttinger & Nicolai 1973, Brunel *et al.* 1980, Stjernstedt 1993) and verbal descriptions (Goodwin 1982).

(1) *Pitpitpit*, the alarm call heard in contexts where the firefinch is disturbed and flies, is a short rising element *pit* given in a series *pitpitpit* delivered at a rate of 14–18 per s (Fig. 2a–d), in contrast to the more rapid series *purr*, which is repeated at 22–24 per s as in *Lagonosticta rhodopareia rhodopareia* (Payne 1973:audiospectrogram 6c) and *L. r. jamesoni* (Payne 1973:audiospectrogram 6a, b, Payne *et al.* 1993: fig. 2a, b). The rate was as slow as 14 per s in *L. umbrinodorsalis* (Brunel *et al.* 1980:fig. 2A), and the *pit* element (Brunel *et al.* 1980:fig. 2E) was repeated as slowly as 1.4 per s (C. Chappuis, tape). Similar calls repeated at 8–16 per s were given by *L. rubricata* in Sierra Leone and Cameroon and in Zambia (Stjernstedt 1993, R.B.P.'s captive from Danger Hill). The element is similar and rises from 3–3.4 to 5.8–6 kHz, with most sound energy at the high end in all these forms.

(2) *Treeeee*, a rapid descending trill, with the first ele-

ments on a pitch of 5–6 kHz, then the elements descend to 5 kHz, the notes are delivered at a rate of 12–13 per s (Fig. 2e, f). The elements vary in shape within a trill; in some they drop, then rise in pitch. Descending trills were tape-recorded from a male at Taboru, Vom and Panshanu, in each case when the male was together with a female. A female at Taboru gave a trill with the same shape and elevated in pitch by 0.5 kHz. This trill is unknown in other firefinch species.

(3) *Chew*, a descending whistle element, drops in pitch from 4.8 to 3.2 kHz, 0.06 s in duration and is repeated both in pairs and in a slow trill at 4 per s (Fig. 2g–j). *Chew* was tape-recorded at Taboru, Panshanu and Rano. A *chew* trill was answered by the mate in an overlapping trill of *chew* notes with a narrower frequency range and longer intervals between elements (Fig. 2j). A similar element in *L. umbrinodorsalis* (Brunel *et al.* 1980:fig. 2B) is repeated at 6 per s (C. Chappuis, tape). Similar elements are known in other firefinches: a shorter *chew* element was repeated in a trill by a captive *L. r. congica* (Nicolai 1982:fig. 2-1), and a longer element was given by *Lagonosticta rubricata haematocephala* in captivity (Goodwin 1982) and in the field in Malawi (Payne 1973:audiospectrogram 13f). It was not noted in *L. r. jamesoni* (Payne 1973, Payne *et al.* 1993).

(4) *Chwee*, an ascending whistle element, rises in pitch from 2.5 to 4.2 kHz and lasts 0.06 s and is repeated in a trill at 0.16 s (Fig. 2k). Other variants of *chwee* are suggested below in the song mimicry of the indigobirds. *Lagonosticta r. jamesoni* have a whistle *chwee* given in a slow trill (R.B. Payne, Zambia). Goodwin (1982) called *chew* and *chwee* variations on a common theme of contact calls in *L. r. haematocephala*, and Stjernstedt (1993) taped a similar *chwee* slow trill in Zambia.

(5) *Feeew*, a prolonged unmodulated whistle, rises rapidly, then falls slowly from 6.8 to 6.1 kHz, then remains mainly at this pitch and lasts for 0.45–0.75 s (Fig. 2l); it was given by a female at Taboru. A similar whistle was given by female *L. r. jamesoni* in southern Africa (Payne 1973:audiospectrogram 6i, Payne *et al.* 1993:fig. 2j), and Goodwin (1982) heard it from a captive male. *Lagonosticta virata* has a whistle at 5.5 dropping to 4 kHz of 0.9 s (Nicolai 1982:fig. 2B), and Goodwin (1982) heard a female give a plaintive *feeeeee*. Nicolai (1965) tape-recorded a whistle at 4 kHz of 0.7 s in a male *L. r. haematocephala* (Payne 1973: audiospectrogram 12k), Stjernstedt (1993) had calls at 4 kHz and 2.8–2.3 kHz of 0.4 s and Goodwin (1982) noted a whistle in a female; I had none in *L. r. congica* in Cameroon (Payne 1982:fig. 23a–n).

A variant *feeee-eeee* slurred whistle drops rapidly from 6 to 4.8 kHz, then plateaus, breaks and drops to 3.2 kHz, is 0.32 s in duration and is repeated in series at 0.6 s and is sometimes combined with a low whistled inverted V or *too* element (Fig. 2m). The whistled element appears to be similar to a two-note distance contact call described by Goodwin (1982) in *L. virata*. *Lagonosticta umbrinodorsalis* has a short, 0.1-s whistle which in audiospectrogram format does not look similar; it drops in pitch from 6.8 to 4 kHz, then rises

at the end in a reverse *J* and is given in a slow trill at 4.2 per s (Brunel *et al.* 1980:fig. 2D, C. Chappuis, tape). The call was not noted in *L. r. jamesoni* (Payne 1973, Payne *et al.* 1993).

(6) *Too*, a trill consisting of a repeated, low whistle *too* element of about 3–4 kHz and lasting 0.1 s, is given in contact calls between members of a pair (Fig. 2m–o). Variations on the *too* theme were tape-recorded at Panshanu and Taboru. An intergrading series of elements that are repeated at 3–4 per s appear to be variations on this theme. Variations include an inverted *V* which is sometimes broken into two or three notes (Fig. 2m). Some elements with modulated frequency (as Fig. 2n) are similar to the frequency-modulated notes in the more elaborate *treeeee* trills. Series of *too* elements are given as low whistles, sometimes introduced by a higher whistle (Fig. 2o). Element 2n is similar to an element in a song of *L. rubricata* in Cameroon (Payne 1982:audiospectrogram 23f); it was not noted in *L. umbrinodorsalis* (Brunel *et al.* 1980, C. Chappuis, tape), *L. virata* (Nicolai 1982), *L. r. jamesoni* (Payne 1973, Payne *et al.* 1992, 1993) or *L. rubricata haematocephala* (Stjernstedt 1993). *Too* as a short, low whistle repeated in series is similar to phrases in *L. virata* (Güttinger & Nicolai 1973), *L. r. jamesoni* (Payne 1973:audiospectrogram 6h) and *L. r. haematocephala* (Payne 1973:audiospectrogram 13d, Payne *et al.* 1993:fig. 3k [too-too], Stjernstedt 1993).

No elements in *L. sanguinodorsalis* in Nigeria closely matched *L. umbrinodorsalis* elements 2C1–2–3 or 2D of fig. 2 in Brunel *et al.* (1980) in Chad.

The song elements of *L. sanguinodorsalis* are unique in the descending whistled trill *treeeee*. The alarm call is similar to that of *L. umbrinodorsalis*, and *L. rubricata* has a similar alarm; the alarm calls of *L. r. rhodopareia* and *L. r. jamesoni* are more rapid *purr* phrases. The prolonged whistled distance contact calls *feew* and disyllabic *feee-eeee* are most like *L. virata* but also like *L. rhodopareia*. The rapid and slow whistled trills are individualistic or more similar to *L. rhodopareia* than to *L. rubricata*, though *too* and *chew* in these two firefinches are similar in southern Africa. The available tape-recordings of song and call repertoires of all the firefinches are probably incomplete. The *treeeee* descending trill and alarm calls indicate that the Jos Plateau birds are most similar to *L. virata*, *L. umbrinodorsalis* and *L. rhodopareia* but are distinct. The descending trill is used by a male in social contact with his mate, and from this context, the call may be important in mate choice and keeping the breeding pair together. Although a species of firefinch might have regional variations in song, in fact no regional variations have been found in other firefinch species wherever they have been tape-recorded. The songs of *L. rhodopareia* are similar over most of the species' range in northern Kenya, Zambia, Malawi, Zimbabwe and Transvaal (Payne 1973, Payne *et al.* 1993), the songs of *L. rubricata* and their indigobird song mimics are similar in Transvaal, eastern Zimbabwe, northeastern Zambia, Malawi, Tanzania, Kenya, Cameroon and Sierra Leone, and the songs of Red-billed Fire-

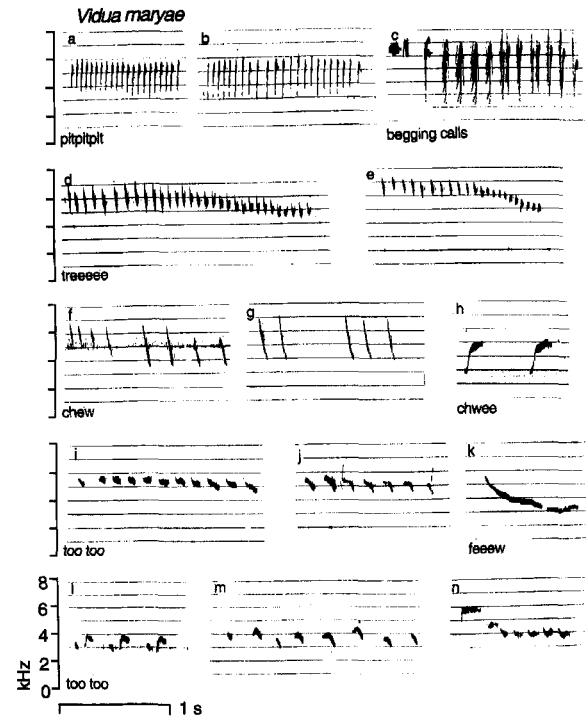


Figure 3. Mimicry calls and songs of Jos Plateau Indigobirds *Vidua maryae*. (a, b) *Pitpitpit* (a, Taboru; b, Kagoro); (c) *Begging calls*, Panshanu; (d, e) *Treeeee* trills (d, Taboru; e, Kagoro); (f, g) *Chew* (f, Taboru; g, Kagoro); (h) *Chwee*, Kagoro; (i, j, l, m, n) *Too* (i, l, m, Taboru; j, n, Kagoro); (k) *Feew*, Taboru.

finch *Lagonosticta senegala* and their Village Indigobird *Vidua chalybeata* mimics are similar throughout their range as well (Payne 1973, 1976, 1982, 1990, Payne *et al.* 1992, 1993).

DISTRIBUTION

In addition to their occurrence at Taboru, Plateau State, *L. sanguinodorsalis* were seen in woods, thickets and grass at Panshanu, Bauchi State, 10°03'N, 8°58'E, on 9 and 17 October and 5 and 9 November 1995 and were identified by their partly blue bill, the distinctive red back colour in the male and the reddish-brown back colour in the female. This site was known as Magama Forest Reserve in 1968 when in late August the green grass was 1.5 m high; grass also grew in cracks in the rocky outcrops, and water was in a stream and in deep holes or wells in the rocks (Payne 1973, p. 201); these holes were full after the rains had ended and the stream was dry in November 1995. The firefinches were also seen on a wooded, grassy inselberg 5 km north of Vom, Plateau State, at 9°46'N, 8°46'E, on 12 October 1995. Also, I tape-recorded a pair of blue-billed firefinches, the male with a reddish back and bright red breast and the female brown or grey and pink, apparently this species, on rock outcroppings near Rano, Kano State, at 11°33'N, 8°34'E,

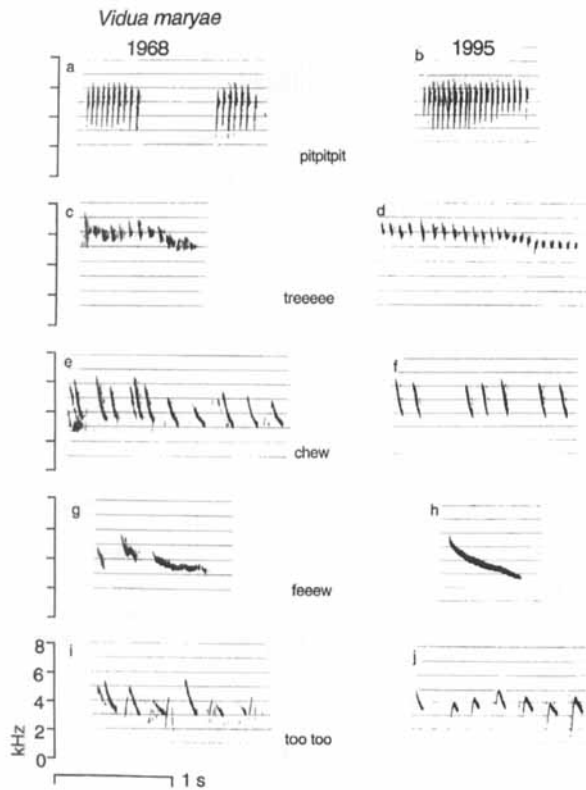


Figure 4. Mimicry calls and songs of Jos Plateau Indigobirds *Vidua maryae* recorded in the same tree at Panshanu, Nigeria, in 1968 (a, c, e, g, i) and in 1995 (b, d, f, h, j). (a, b) *Pitpitpit*; (c, d) *Treeeee* trills; (e, f) *Chew*; (g, h) *Feeew*; (i, j) *Too too*.

on 16 November 1980 ("*L. rubricata*" in Sharland & Wilkinson 1981).

M.E. Gartshore netted and photographed two red-backed, blue-billed firefinches *L. sanguinodorsalis* 1 km south of Kagoro, Kaduna State, at 9°32'N, 8°30'E, in April 1980 and February 1981 at a site where the stream emerges from the wooded rocky hillside by the old Boy Scout Camp (in Dyer *et al.* 1986, Wilkinson *et al.* 1987), the same site where in December 1976 she tape-recorded a green-plumaged Jos Plateau Indigobird *V. maryae* (Payne 1982) which mimicked the songs of this firefinch. The photographs of the Kagoro firefinches and the Taboru adult male firefinch are nearly identical and lack grey on the back (Plate 1). Kagoro is only 10 km from Kafanchan where Serle collected grey-backed *L. r. polionota*, indicating that the two firefinches occur in near sympatry and in the small sample available they show no introgression.

Field observations by M.T.E. Hopkins apparently of this firefinch are from Kagoro, Assop (9°32'N 8°37'E), Miango (9°51'N, 8°41'E), Jos (9°56'N, 8°53'E), TCNN (Bukuru [9°47'N, 8°53'E]), Shen Hill (9°47'N, 8°55'E), Taboru, Pan-yam (9°24'N, 9°12'E), the Sara Hills (9°35'N, 9°22'E) and Felak Farm (10°32'N, 9°27'E). "This last is the most interesting, well off the plateau to the north. It is northern Guinea savannah traversed by the River Dilimi on its way from Jos to Lake Chad. By then the river has descended below 800 m, and is dropping quite fast through rocky surroundings. . . . The relief is on a much smaller scale, but in other respects the habitat is quite similar to Panshanu. All of these sites contain plenty of rock. I first saw these birds on rocky



Figure 5. Habitat of *Lagonosticta sanguinodorsalis* and *Vidua maryae* at Taboru, Nigeria, 31 October 1995. Finches drank at the stream in the laterite gully in the foreground and sang there and in the grass in the rocky Taboru hills in the background with haze of harmattan.



Figure 6. Habitat of *Lagonosticta sanguinodorsalis* and *Vidua maryae* at Panshanu, Nigeria, 9 October 1995; compare with same site on 30 August 1968 (Payne 1973, p. 201).

outcrops in Jos, and many, possibly the majority, of sightings since then have been of birds feeding or moving about on exposed rock; I think all have been in rocky habitat. I have come to consider them as quite as typical of inselberg habitat as Stone Partridge [*Ptilopachus petrosus*], Cliff-chat [*Myrmecocichla cinnamomeiventris*] or Rock-loving Cisticola [*Cisticola aberrans*]. . . . My closest sighting of what must be authentic African Firefinch [*L. rubricata*] is from Pandam Game Reserve (8°40'N, 9°00'E), some 30 km south of the southern foothills of the Jos Plateau" (M.T.E. Hopkins *in litt.*, 7 August 1996). In addition, he has sighted Rock Firefinch in NE Nigeria near the Cameroon border in the Mandara mountains (11°07'N, 13°46'E and 11°02'N, 13°44'E) in similar habitat, "slopes with plenty of loose rock, with a mixture of bushy vegetation on rock-walled terraces" (M.T.E. Hopkins, *in litt.*, 1 August 1997).

Lagonosticta sanguinodorsalis on the Jos Plateau may have been mistaken in the past as *L. rubricata* (Ebbutt *et al.* 1964, Payne 1968, 1973, Elgood *et al.* 1994) because no museum specimens were available. Serle (1940, p. 43) observed "*L. rubricata polionota*" "in the remote rocky hills as well as in the grassy plains, as, for instance, on the Kagoro Hills at an elevation of 3500 feet and on the Afu Hills at an elevation of 1500 feet", but it now appears that the Kagoro Hills birds were the red-backed *L. sanguinodorsalis*, or that both kinds of firefinches occur there; the Kagoro Hills are a westward extension of the Jos Plateau. Additional northern Nigerian observations of "*L. rubricata*" (Elgood *et al.* 1994) from Ririwai (10°40'N, 8°45'E) and Aliya (11°10'N, 10°55'E, the latter is nearly

as far north as Rano and well into the Sudan savanna) also may refer to *L. sanguinodorsalis*.

SYSTEMATIC AFFINITIES

The Rock Firefinch *L. sanguinodorsalis* is most similar in plumage colour, feather shape and song to *L. virata* and *L. umbrinodorsalis*. These three are West African counterparts, *L. virata* in Mali and Senegal (Morel & Morel 1990, Payne 1997) and *L. umbrinodorsalis* in Cameroon and Chad (Erard & Roche 1977, Brunel *et al.* 1980, Payne & Louette 1983). Together, the three are the West African counterparts of *L. rhodopareia*, which occurs from Ethiopia to South Africa in dry bushy woodland habitat. Possibly all these firefinches had a common ancestor; *L. virata* and *L. umbrinodorsalis* have also been considered allopatric forms of *L. rhodopareia* (Erard & Roche 1977, Brunel *et al.* 1980, Payne & Louette 1983). The three West African forms are closely associated with rocky slopes of hillsides in shrubby vegetation, patches of grasses and scattered clumps of large trees (Bates 1934, Payne 1973, Erard & Roche 1977, Brunel *et al.* 1980, Nicolai 1982, Wheatley 1995, Payne 1997), whereas the eastern and southern African forms *L. r. rhodopareia*, *L. r. ansorgei* and *L. r. jamesoni* occur in grassy alluvial bush and flatlands (Heinrich 1958, Immelmann *et al.* 1965, Payne 1973).

Preliminary analysis (M.D. Sorenson & R.B. Payne, unpubl.) of mitochondrial DNA sequences indicates that *L. sanguinodorsalis* is more closely related to *L. umbrinodorsalis* than to the other firefinches. Both are more similar to *L.*

rhodopareia than to *L. rubricata*; several subspecies were sequenced for both of these species.

SONG AND HOST-PARASITE ASSOCIATION OF *L. SANGUINODORSALIS* AND *V. MARYAE*

Mimicry of vocalizations by Jos Plateau Indigobirds *V. maryae*

The songs and calls of *L. sanguinodorsalis* are mimicked by Jos Plateau Indigobirds *V. maryae*. Although the songs of these indigobirds were described earlier as mimicry of *L. rubricata*, the songs differ from those of West African *L. rubricata* (Payne 1968, 1973, 1976, 1982, 1996, Payne & Payne 1994, 1995).

Mimicry songs of *V. maryae* with recognizable or identical firefinch elements and series were tape-recorded at Panshanu (elements 1, 2, 3, 4, 5, 6), Taboru (elements 1, 2, 3, 4, 5, 6) and Kagoro (elements 1, 2, 3, 4, 6; Figs 3 and 4). These songs included (1) *pitpitpit* alarm trills, (2) *treeeee* descending trills, (3) *chew* contact notes (often delivered in pairs as an introduction to a nonmimetic song), (4) *chwee*, (5) *feeew* prolonged whistles and (6) *too* contact notes and trills. The contact notes sometimes grade into each other within a series in the mimicry songs; Figure 3f suggests intermediates of (3) *chew* and (6) *too*; Figure 3h suggests intermediates of (4) *chwee* and (6) *too* and the more complex series of (6) *too* notes sometimes suggest a (2) trill (Fig. 3j). Elements that were not mimicked precisely by the indigobirds also may be firefinch variations on the theme of contact notes, as not all variations of the firefinches were tape-recorded. In addition to the calls like those of the adult firefinch *L. sanguinodorsalis*, male indigobirds at Panshanu, Taboru and Kagoro also gave mimetic begging calls (Fig. 3c) like the begging calls of firefinch young (Payne 1973, Payne *et al.* 1993).

Indigobirds were tape-recorded at Panshanu in the same tree in 1968 and in 1995, and their songs were similar though not identical over this period (Fig. 4). Within a year, some of these calls varied also, either as distinct song types or as intergrading variations on a theme; only a few hundred calls were tape-recorded each year. Because indigobirds have large song repertoires (each individual male has about 24 distinct song themes, Payne 1985), more recordings (thousands) are needed to distinguish song types from variations on a theme. All the major categories of songs were tape-recorded at Panshanu in both years, as were the begging calls like those of firefinch young.

The similarity of the songs, especially the distinctive descending *treeeee* trills given by the indigobirds at Panshanu in 1968 and 1995 and the songs of the indigobirds at Kagoro, Taboru and Panshanu, with the songs of the firefinches at Taboru, Panshanu, Vom and Rano indicates that the songs of the firefinches and of the indigobirds are stable over time and are widespread over the region, though the songs of the indigobirds may undergo gradual changes from year to year as in other species (Payne 1985).



Figure 7. Call-site tree of *Vidua maryae* at Panshanu, Nigeria, 9 October 1995; a male sang from the branch over the road in 1995, where other males sang 23–30 August 1968.

Species distinctiveness of *V. maryae*

Jos Plateau Indigobirds *V. maryae* are distinct in plumage, though like all indigobirds the males in breeding plumage are black with white flank spots. A colour photograph of a specimen is illustrated in Payne and Payne (1994). The plumage colour and size of most indigobird species are distinct. Table 1 summarizes the colour and size for males whose songs were tape-recorded in the field in West Africa, including a male *V. maryae* that was captured, colour-ringed and released for observation at Taboru, and six males of other species captured and released or held for song in Nigeria, Cameroon and The Gambia. Plumage colour is glossy bluish green to green (Methuen reference 24–25E8), brighter than in the most green Black-faced Firefinch Indigobird *Vidua larvaticola* and in *V. nigeriae*; the wings are longer than in other West African birds including the green *V. ruficollis*. Wing-length and colour gloss of breeding male indigobirds are consistent through the season; *V. maryae* are bright from August through November, *V. nigeriae* in July to October do not differ from birds in November and January. *V. ruficollis* are bright from October to January and *V. larvaticola* are the same gloss of blue or bluish green from July to October. *Vidua maryae* differ from Cameroon Indigobirds *Vidua came-*

Table 1. Morphology and song mimicry behaviour of West African indigobirds *Vidua* spp.

<i>Vidua</i> species	n	Locality ^a	Plumage colour ^b	Mean wing-length (mm) ± s.d.	Song mimicry
<i>maryae</i>	6	N	Green (bright)	68.67 ± 0.52	<i>Lagonosticta sanguinodorsalis</i>
<i>nigeriae</i>	13	N, C	Green (dull)	64.77 ± 1.42	<i>Ortygospiza atricollis</i>
<i>raricola</i>	20	S, N, C	Green (bright)	64.10 ± 1.65	<i>Amandava subflava</i>
<i>larvaticola</i>	18	N, C	Blue to blue-green	66.44 ± 1.12	<i>Lagonosticta larvata</i>
<i>camerunensis</i>	2	G	Blue	62.50 ± 0.71	<i>Lagonosticta rara</i>
<i>camerunensis</i>	14	C	Blue	64.86 ± 0.95	<i>Lagonosticta rubricata</i>
<i>camerunensis</i>	9	N, C	Blue	65.22 ± 1.39	<i>Clytospiza monteiri</i>
<i>camerunensis</i>	—	S ^c	Blue	—	<i>Euschistospiza dybowskii</i>
<i>wilsoni</i>	16	G, N, C	Purple	63.81 ± 1.87	<i>Lagonosticta rufopicta</i>
<i>chalybeata</i>	17	T, S	Blue to green (bright)	62.41 ± 1.91	<i>Lagonosticta senegala</i>
<i>chalybeata</i>	7	N, C	Blue (purplish)	64.57 ± 1.27	<i>Lagonosticta senegala</i>

^a T = The Gambia, S = Sierra Leone, G = Ghana, N = Nigeria, C = Cameroon.

^b Male breeding plumage colours refer to the Methuen reference (Payne 1973, Kornerup & Wanscher 1978, Payne & Payne 1994). Wing colour is black in *V. chalybeata*, dark brown in *V. larvaticola* and brown in the other species, palest in *V. wilsoni* (Payne 1996); foot colour is orange red in *V. chalybeata* and pale purplish in the others. Other details are in Payne (1982, 1996) and Payne and Payne (1994, 1995).

^c No specimens are available for the observed song mimics of *Euschistospiza dybowskii* (Payne & Payne 1995).

runensis, which mimic the songs of *L. rubricata* in Cameroon and Sierra Leone (Payne 1976, 1996, Payne & Payne 1994, 1995). *Vidua maryae* in breeding plumage are large and green, whereas *V. camerunensis* are smaller and blue. The wings of *V. maryae* are brown, not black as in *Vidua chalybeata*. The feet are pale purplish, as in the other West African indigobirds except *V. chalybeata*, in which they are bright orange red. Weights ($n = 4$) were 12.0–14.5 g. Two non-breeding males in female-like plumage were taken at the site of the Panshanu males in 1968; one sang the descending trill treeeee.

Female *V. maryae* are known from one specimen (UMMZ 217008) taken with a breeding male at Panshanu on 30 August 1968. Its wing-length is 66 mm, the tail 37 mm, the bill 6.8 mm measured from the base and the tarsus 14 mm. The bill is grey horn above, whitish below; the feet are pinky flesh grey. The skull is 80% unpneumatized and the bird was not laying. Other females were seen to visit singing males at Panshanu and Taboru, and they appeared indistinguishable from females of other West African indigobirds, with pale purplish feet, horn-coloured bill, dark streaks along the side of the crown and dark streak through the eye and the back indistinctly streaked (Payne 1982, 1996). Juvenile *V. maryae* and mouth mimicry of the young firefinches are unknown.

Behaviour of *V. maryae* is similar to that of the other indigobirds. Males at Taboru and Panshanu each sang on its own tree or call site. Males shared the details of songs at Taboru, where four males were tape-recorded, and at Panshanu in 1968, where four males were tape-recorded. Males differed in the details of songs between Taboru and Panshanu in 1995 and at the single site of Panshanu between 1968 and 1995 (Fig. 4), much as the songs differ among local neighbourhoods and change in detail from year to year

in other indigobird species (Payne 1973, 1985). Long-term use of a call site was apparent both in a replacement series of males taken in a tree at Panshanu in 1968 and in the use of the same tree as a call site in 1995. Females visited the singing males at their call sites, where the males courted in a hovering flight display as the females perched, then copulated with them on the perch and, after a courtship display, flew to the grass and sang mimicry songs. Males sometimes were joined by the female, and the pair fed together, all as in *V. chalybeata* (Payne 1973).

Distribution

The Jos Plateau Indigobird *V. maryae* is known from Panshanu, Taboru near Jos and Kagoro (Figs. 5–7). All these sites are known localities of the firefinch *L. sanguinodorsalis* in northern Nigeria (Fig. 8).

Other indigobirds and indigobird hosts occur in the same localities. *Vidua chalybeata* and Bar-breasted Firefinch Indigobirds *Vidua wilsoni* (and their hosts, *L. senegala* and Bar-breasted Firefinch *L. rufopicta*, respectively, and also *L. rara*) are at Taboru; *V. chalybeata*, *V. camerunensis* and *V. larvaticola* (and their hosts *L. senegala*, *L. rara* and Black-faced Firefinch *Lagonosticta larvata*, respectively) are at Panshanu and *L. senegala* were at Rano. Dybowski's Twinspots *Euschistospiza dybowskii*, which are also at Kagoro (Wilkinson *et al.* 1987), are associated with a population of *V. camerunensis* in Sierra Leone (Payne & Payne 1995).

JOS PLATEAU PHYSICAL FEATURES AND ECOLOGY

The Jos Plateau extends over about 8800 km² from its westernmost point at the Kagoro Hills at 8°30'E, south to nearly

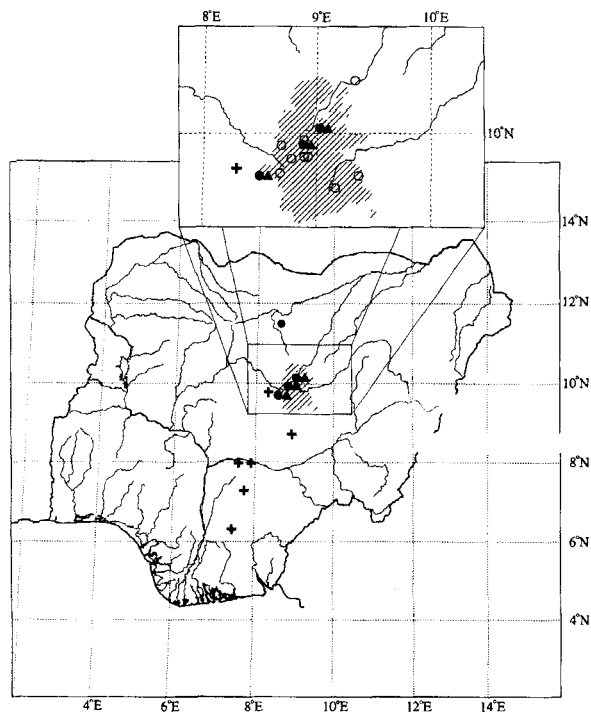


Figure 8. Map of Nigeria, with localities of firefinches *Lagonosticta sanguinodorsalis* (solid circles, observed and tape-recorded; open circles, observed only, M.T.E. Hopkins), *Lagonosticta rubricata polionota* (crosses, specimens or observations) and *Vidua maryae* (triangles, specimens with tape-recordings). The shaded area indicates the Jos Plateau over 3000 feet. Inset, Jos Plateau and environs.

9°N, east to 9°30'E and north to Jos and 10°N. It rises abruptly along an escarpment on the west and south, while on the northeast, it slopes more gradually to the lowlands. The altitude ranges from 1220 to 1450 m, with hills rising to 1781 m; the relief is mainly flat or rolling with isolated granite outcrops and inselbergs. The area is the largest land mass above 1000 m in Nigeria. The vegetation is scattered bush and grass, grazed by cattle, goats and sheep, and cultivated, with forests limited to the southern and western escarpments, river edges and the base of rocky outcrops. Rains fall from late April to early October. Streams flow northeast to Kano and Lake Chad, east to the Gongola River, which enters the Benue River, south to the Benue River and west to the Kaduna River, then the Niger River. West and south of the plateau, the vegetation is southern Guinea woodland; north and east, it is drier northern Guinea woodland (Keay 1959, Elgood *et al.* 1994). Jos has a mean annual rainfall of 1411 mm (Elgood *et al.* 1994). Heavier rains fall south and west of the plateau due to moisture-bearing winds meeting the escarpment (Federal Surveys, Nigeria 1967, Dyer *et al.* 1986, Happold 1987).

The Jos Plateau is not a centre of bird endemism; only one subspecies was recognized as unique in Mackworth-Praed and Grant (1973), a pipit *Anthus similis josensis*, and one endemic mammal is known (Happold 1987). The pla-

teau lacks a montane flora, and its vegetation intergrades with the drier lowlands to the north and east of it (Elgood *et al.* 1994). In contrast, the larger Adamawa Plateau 500 km to the east in Cameroon has several endemic birds (Louette 1981). Some endemic birds and mammals extend west from Adamawa to Jos Plateau, notably Adamawa Turtle Dove *Streptopelia hypopyrrha*, which occurs north to Falgore near Rano (Elgood *et al.* 1994). Rano has outcropping inselbergs along the Kano River rising to 746 m (Federal Surveys, Nigeria 1961).

Early ornithologists visited the plateau but collected few birds. In August 1904, Boyd Alexander passed west of the plateau through Dororo and Kagoro, then north of the plateau to Bauchi (Alexander 1907a,b). His field register ("The Naturalist's Diary" for April 1904–December 1905) and the Tring Museum specimen register for 1911 indicate no firefinches taken in the area other than *L. rara* at Dororo (BMNH BA no. 3266, 4 August 1904). Bates collected around Jos in 1922 but had no firefinches (Bannerman & Bates 1924, Bates 1924). Bannerman (*in* Young 1931, p. 635) commented on the plateau as an "ornithologically little-known part of Nigeria". Jos was a mining centre through the 1920s, as noted by Bates, and western agricultural, veterinary, medical and Christian missions have been there for decades. The University of Jos was established only in the early 1970s and has no tradition of natural history (Prof. C.O.E. Onwuliri, pers. comm.). The bird list of Ebbutt *et al.* (1964) included sightings of "*L. rubricata*" but not firefinches that were identified in the hand, and V.W. Smith (1966), who ringed near Vom, did not mention the firefinch.

Now, I find that two species of birds are endemic to the Jos Plateau and its north and eastward extensions, the firefinch *L. sanguinodorsalis* and its brood-parasitic indigobird *V. maryae*. Their breeding season was late in the rains, from August to October, when the indigobirds were in breeding plumage and song; the juvenile firefinch appeared to have hatched in late August or early September, as firefinches moult when about 3 months of age (Morel 1973, Payne 1980).

DISCUSSION

The indigobird *V. maryae* was first found and its songs tape-recorded at Panshanu in 1968, and its distinctive songs eventually led to a search for the firefinch song model in 1995. Although the history of use of this name is not well summarized in a taxonomic synonymy, a historical account describes the steps that were involved in recognition of the indigobird species. The green indigobirds that were tape-recorded and collected in 1968 were first referred to *nigeriae*, and this was considered a form of *V. funerea* (Payne 1968) because it appeared to be the same kind of bird collected farther east in Nigeria at Kiri on the Gongola River and described as *Hypochera nigeriae* (Boyd Alexander 1908) and because the Panshanu birds were thought to mimic the same species of host *L. rubricata* as *V. funerea* in southern

Africa. Nicolai (1968) reported a green *nigeriae* to mimic the songs of *L. larvata* in Ngaoundere, Cameroon. He collected two birds (one green, one blue) at this site but did not determine the songs of the birds that he collected, and plumage colour and size of the birds he heard to mimic *L. larvata* were uncertain (Payne 1976, 1982). Next, *nigeriae* was considered to be a colour form of a broadly conceived *V. wilsoni* (Payne 1973), then to be a colour form of *V. funerea* with *wilsoni* as a subspecies with several distinct colour forms (Payne 1976). Then *nigeriae* was considered a *nomen dubium* because the holotype was not associated with any particular species of firefinch, so that the parasite and its host could not be matched, and *V. funerea maryae* was used as a replacement name for the green indigobirds of Nigeria (Payne 1982). Recently, as here, the Jos Plateau Indigobird was considered a species *V. maryae* (Payne 1994, 1996, Payne & Payne 1994), distinct from *V. nigeriae*. The indigobird *V. nigeriae* mimics the songs of Quail-finch *O. atricollis* and is smaller and more dull green in male breeding plumage than *V. maryae*.

The songs of the hosts also were not well understood previously, and this contributed to the confusion of associations of indigobirds and their host species. As described here, the reported indigobird "*nigeriae*" at Panshanu that mimicked "*L. rubricata*" was a *V. maryae* treeeee mimic of *L. sanguinodorsalis* (Payne 1973:audiospectrogram 14h). Also, the indigobird with a descending trill of "*L. rubricata*" in Zimbabwe (Payne 1973:audiospectrogram 14g) was a mimic of Peters' Twin-spot *H. niveoguttatus*; this is the Peters' Twin-spot Indigobird *V. codringtoni* (Payne *et al.* 1992). The firefinches *L. rubricata* and *L. rhodopareia* and their indigobird song mimics are not known to have a treeeee trill (Immelmann *et al.* 1965, Nicolai 1965, Goodwin 1982, Payne 1982, Payne *et al.* 1992, 1993).

The rationale for considering the indigobird *V. maryae* to be a species (Payne & Payne 1994, Payne 1996) is that it is distinct in size and plumage colour (hence a species; Cra-craft 1983), and it mimics the songs of a distinct species of firefinch *L. sanguinodorsalis*. Its most similar and closest phylogenetic relatives are neither the indigobirds *V. camerunensis*, which mimic *L. rubricata* elsewhere in West Africa (Payne & Payne 1994, 1995), nor *V. funerea*, which mimic *L. rubricata* in east and southern Africa, nor Purple Indigobirds *Vidua purpurascens*, which mimic *L. rhodopareia* in eastern and southern Africa (Payne 1973, Payne *et al.* 1992, 1993); together these are the firefinches most closely related to *L. sanguinodorsalis* which are known to have indigobirds associated with them. The indigobirds which are most similar to *V. maryae* in plumage and colour are *V. raricola* and *V. nigeriae*, and both of these are associated with estrildid hosts other than the firefinches. Preliminary analysis (M.D. Sorenson & R.B. Payne, unpubl.) of mitochondrial DNA sequences indicates the same set of relationships among these indigobirds.

The difference in the songs of the Jos Plateau indigobirds and the indigobirds that mimic *L. rubricata* elsewhere was recognized only after 1992 (Payne & Payne 1994). This rec-

ognition and the lack of any specimens of *L. rubricata* from the locality of *V. maryae* as illustrated in the colour plate in Payne and Payne (1994), led to the search in 1995 for the Jos Plateau firefinch song models. As described here, the firefinches of this area are distinct in morphology and song from the *L. rubricata* that occur elsewhere in Nigeria and West Africa. In this case, the brood parasite was first recognized as a distinct species, and then its host was recognized as a distinct species. At the same time, the species status of *V. maryae* was tested by the distinctiveness and distribution of the indigobirds first tape-recorded and collected at Panshanu in 1968.

The association of the Rock Firefinch and its *Vidua* indigobird is known from their songs and distributions. No observations of brood parasitism are available; their association as host and brood parasite is assumed because in other species in which indigobird brood parasitism has been observed, the indigobird males mimic the song of the host that is known to rear its young. Field evidence of brood parasitism is known in *V. chalybeata*, *V. purpurascens*, *V. funerea*, *V. larvaticola*, *V. wilsoni* and *V. raricola* (G. Morel 1959, M.-Y. Morel 1973, Nicolai 1967, 1972, Payne 1973, 1982, 1996, Macdonald 1980, D.N. Mansfield in Payne *et al.* 1993, Payne & Payne 1994). Additional fieldwork is needed to document brood parasitism in the other indigobirds.

As the only two species of birds known to be endemic to Nigeria, the firefinch and its brood parasitic indigobird are of conservation interest and concern. Their restricted range and the apparent low population numbers suggest that *L. sanguinodorsalis* and *V. maryae* be recognized as near-endangered species (Collar *et al.* 1994) and their habitat be protected. The Panshanu site is within the Magama Forest Reserve, where some indigenous trees that were present in 1968 were still recognizable in 1995 and the vegetation had not changed to a noticeable extent (compare Fig. 6 with Payne 1973, p. 201). Woodland vegetation on rocky hillsides persists well in Africa where remote from intense cultivation (Shantz & Turner 1958). However, intensive wood-cutting was evident, with commercial firewood sales by the roadside in Panshanu village. The Bauchi-Jos road through Panshanu Pass was upgraded in 1976-1978 when rock was removed, though most of the area was little changed by 1995. The Taboru site is within the Jos watershed protection area, but this area is intensely grazed and the remaining wooded vegetation is rapidly being removed for fences and firewood. Where both a firefinch species and its indigobird have been ringed, released and observed, and also counted on transects to estimate population numbers, the population density of a firefinch *L. senegala* was ten times as great as that of its indigobird brood parasite (Payne & Payne 1977) so numbers of *Vidua* are lower than numbers of the firefinch. The numbers of *V. maryae* were not observed to decline during the past 27 years in Nigeria; no long-term observations are available for the firefinch.

Mark T. E. Hopkins introduced me to Taboru and made available his observations on birds of the plateau area. Mary E. Gartshore

made available her song tape-recordings, observations and photographs of birds at Kagoro. N. J. Skinner, K. D. Groschupf, R. E. Sharland, R. Wilkinson, D. Kumbak and L. L. Payne were helpful in the field in Nigeria. The Director of the Federal Ministry of Agriculture and Natural Resources and the Federal Environmental Protection Agency of Nigeria approved research permits, and Profs J. Ajayi and C. O. E. Onwuliri of the Department of Zoology, University of Jos, provided facilities. M. D. Sorenson carried out the molecular genetics comparisons, and J. Megahan drew the map. The American Museum of Natural History (AMNH) in New York, Delaware Museum of Natural History (DMNH), Field Museum of Natural History (FMNH) in Chicago, National Museum of Natural History (USNM) in Washington, D.C., Natural History Museum (BMNH) in Tring, National Museum of Scotland (NMS) in Aberdeen, Koninklijk Museum voor Midden-Afrika (MRAC) in Tervuren, Muséum National d'Histoire Naturelle (MNHN) in Paris, ORSTOM at Mbour in Sénégal, University Museum in Copenhagen (ZMUC), Humboldt University Museum in Berlin (ZMB), Staatliches Museum für Naturkunde in Stuttgart (SMNS) and Museum Alexander Koenig (ZMFK) in Bonn allowed examination of specimens. M. P. Walters made available Boyd Alexander's field records and the Natural History Museum specimen register at Tring, and R. Prýs-Jones mentioned the Serle birds at NMS. C. Chappuis sent a copy of Brunel's 1978 tape-recordings of *L. umbrinodorsalis*. The tape-recordings and specimens are in UMMZ. J. C. Coulson, M. E. Gartshore, M. T. E. Hopkins, D. P. Mindell, M. D. Sorenson and two reviewers commented on the manuscript. Research was supported by a National Science Foundation grant (IBN-9412399).

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