The study and ringing of Palaearctic birds at Ngulia Lodge, Tsavo West National Park, Kenya, 1969–2012: an overview and update

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Summary

Concentrations of Palaearctic passerines were discovered at the lights of Ngulia Lodge, Tsavo West National Park, Kenya, in December 1969. It was established that such 'falls' of southbound migrants occurred regularly each November and December when there was low mist or rain at night under moonless conditions. They involved three main species, Marsh Warbler *Acrocephalus palustris*, Thrush Nightingale *Luscinia luscinia* and Common Whitethroat *Sylvia communis*, as well as several other migrants not known west of the Kenya highlands, but included surprisingly few Afrotropical birds. Thousands of migrants were often grounded at night, but these moved on within one day. Such concentrations were rare in spring because of a lack of night mist, but a few April falls revealed a very different species composition.

From 1972 to 1992 migrants were ringed by small teams each year over November–December new moon periods. Birds were trapped at dawn in mist-nets set in bush south of the Lodge and, from 1976, in one to three nets set below the floodlights at night. In more recent years larger teams have been involved. Dawn operations were moved in 1994 to an area north of the Lodge, beyond the floodlights, resulting in larger catches, often of well over 1000 birds. Experiment at night with playback of recorded song showed some species to be responsive when already brought low by lights and cloud, but overflying migrants did not react and come to ground on clear nights.

[1] The terms 'autumn', 'winter', 'spring' and 'summer' are applied throughout in a northern hemisphere sense.

In autumn (late October to early January) the Lodge has been manned on well over 1100 nights, with mist occurring on over 60% of these and rain on 26%. The incidence of these attractive conditions has been higher later in the season. A total of 499 677 Palaearctic birds ringed to 2012 has given 222 long-distance ringing movements. These comprise 122 to or from Palaearctic breeding areas, 81 to or from Middle East passage sites, 18 from southern African wintering areas and one from a likely Ethiopian stopover area. Only 63 birds ringed have been retrapped at the Lodge in a subsequent season. Catches have involved a mix of first-year and adult birds, in most species in a ratio of about two to one. Racial plumage characteristics and winglengths indicate that most species are from populations breeding in eastern Europe or western/central Asia. Each species has a characteristic seasonality at Ngulia. Marsh Warbler passage picks up only in mid November but continues into January, whereas that of Thrush Nightingale begins earlier but declines in mid December. Species occurring early, mainly in November, include Red-backed Shrike *Lanius collurio*, Olive-tree Warbler *Hippolais olivetorum*, Rufous Scrub Robin *Cercotrichas galactotes*, Spotted Flycatcher *Muscicapa striata* and Eurasian Nightjar *Caprimulgus europaeus*.

Patterns of moult are summarized. Some species reach Ngulia with newish looking flight feathers grown the previous July–August, some with very new feathers grown in northeast Africa in October–November, and some with old worn feathers due for renewal in southern Africa in January–March. Details of weights are discussed. Some species are commonly 20–30% and even 50% above lean weight, with a potential for long onward flights. These include Marsh Warbler, Common Whitethroat, River Warbler *Locustella fluviatilis*, Willow Warbler *Phylloscopus trochilus*, Basra Reed Warbler *Acrocephalus griseldis*, Olive-tree Warbler and Red-backed Shrike. By contrast, others such as Irania *Irania gutturalis*, Common Nightingale *Luscinia megarhynchos*, Rufous Scrub Robin, Upcher's Warbler *Hippolais languida* and Isabelline Shrike *Lanius isabellinus* are rarely more than 20% above lean weight; none of these migrate far south of Ngulia. Species tend to show a small mean weight increase between early November and December. There are significant changes in mean weight from year to year, often by over 5%, suggesting different feeding possibilities and migration strategies. Traces of the annual mean weight of Marsh Warbler and River Warbler correspond closely. At night, weights are lowest between 03:00[2] and 06:00, then increase during the day to a late afternoon peak 8–10% above the late night minimum. Birds caught after heavy rain tend to have higher weights than those on nights of typical mist. Comparison of the composition of catches over four decades shows a recent increase in the percentage of Marsh Warbler and a decrease in Common Whitethroat. Isabelline Shrike and Rufous Scrub Robin feature much less in catches than formerly, and trends would also suggest a recent decrease in Upcher's Warbler and Willow Warbler.

Major outstanding questions concern the location of the autumn stopover areas of the birds which subsequently arrive at Ngulia, and the events by which these are brought down to the lights in such numbers from overhead passage.

Introduction

The seasonal attraction of Palaearctic birds to the lights of Ngulia Safari Lodge, Tsavo West National Park, Kenya, was discovered in 1969, the year that it was opened. Every late autumn since 1972 large numbers of migrant passerines have been trapped here for ringing. These have generated many recoveries, from breeding areas in Europe and Asia, passage sites in the Middle East, and wintering areas in southern Africa. Accounts of the phenomenon and its dependence on mist and moonless conditions, and details of the species composition involved, were given by Pearson & Backhurst (1976) and Backhurst & Pearson (1984). Annual summaries of ringing activity up to 1992 were published in *Scopus* (Backhurst & Pearson 1977–1993, Backhurst *et al.* 1986),

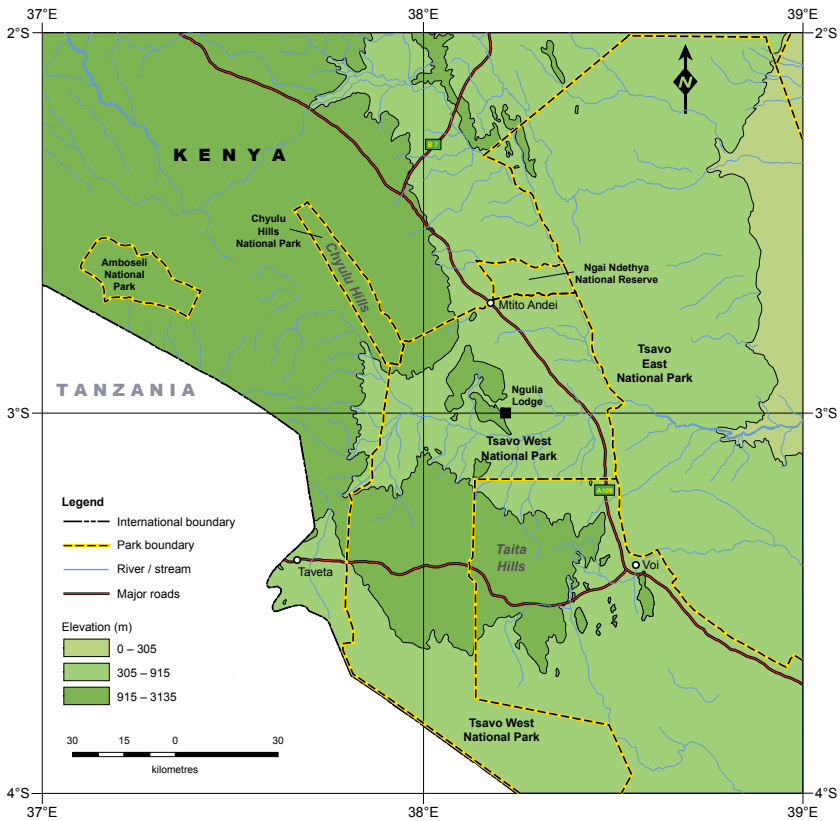
[2] Throughout this paper times of day are given in this form.

and early recoveries were listed (Backhurst 1977, 1981, 1988), but updates since then have been confined to privately circulated annual reports. Since 1993, the scale of ringing operations each November and December has been expanded, and there have been many more recoveries. We have had further opportunities to study the arrival and behaviour of birds at the lights under various conditions, and we have analysed accumulated measurement and moult data. In this report we review the history of operations at the Lodge from 1969 to 2012, and present details of numbers ringed and of all recoveries and controls. We discuss the migrations of the species involved, summarize observations on moult and analyses of winglengths and body weights, and examine the species composition over four decades.

History and review of operations

The earlier years (1969–1992)

Ngulia Lodge (3°00´S, 38°13´E, altitude 920 m) was opened in May 1969, sited above a 300-m escarpment overlooking plains to the east, and backed to the south by the Ngulia ridge (rising to 1821 m). The higher Chyulu Hills formed a visible feature 50 km to the northwest as did the Taita Hills some 40 km to the south (Map 1). Powerful floodlights illuminated drinking pools for game on the northern side of the Lodge, and these immediately attracted immense numbers of insects. Later that same year, on misty December nights, a more remarkable phenomenon was discovered. Alec



Map 1. Ngulia and surrounding regions of southeast Kenya.

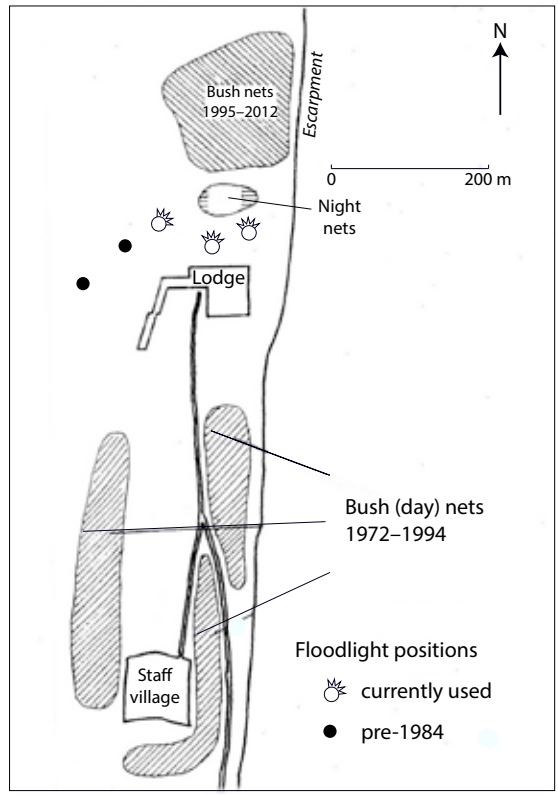
Forbes-Watson found huge numbers of Palaearctic migrant birds attracted to the lights, and brought back a series of interesting specimens to the National Museum, Nairobi. Scores of casualties were picked up beneath an illuminated white wall, and the offending 1.5 kW light had to be removed from the wall to resolve the problem. Over the next three years visits to the Lodge by DP, GB, Daphne Backhurst and Peter and Hazel Britton confirmed that these arrivals of Palaearctic passerines were frequent at night in late autumn, and hundreds of birds were caught and ringed.

From late November 1972 to early January 1973 near-continuous daily manning was achieved. Over 2500 passerine migrants were ringed, and the basic features of these arrivals were established and described (Pearson & Backhurst 1976). The birds involved were predominantly Palaearctic passerines, the three main species being Marsh Warbler *Acrocephalus palustris*, Thrush Nightingale *Luscinia luscinia* and Common Whitethroat *Sylvia communis*. A further 15 or so species occurred frequently although in smaller numbers. Apart from Harlequin Quails *Coturnix delegorguei* and a few Jacobin Cuckoos *Clamator jacobinus* Afrotropical migrants occurred only in very small numbers. Palaearctic migrants landed at any time of night when the cloud level (mist) in the floodlit area in front of the Lodge dropped to bush-top height or below, but only under moonless conditions. Arrivals were greatly reduced by a small partial moon, and abolished by a near full moon. Showers increased the numbers landing and settling in the bushes through the night, and heavy rain without mist could occasionally produce a fall. Many thousands were sometimes grounded close to the Lodge at dawn, but these dispersed quickly during the morning and practically all moved on next night. Clear nights or nights with high cloud were followed by mornings without birds, even when thousands had been present the previous day. When a cloud layer descended to 50 to 100 m above the lights, but no lower, passerines were evidently attracted and were frequently glimpsed overhead, heading south, but very few descended to tree height.

Over the next few years, spells of several days on either side of a new moon were covered by DP, GB, Daphne Backhurst and Anna Forbes-Watson, supported by small groups from Nairobi, and the annual number of birds ringed was sometimes well above 5000. Different seasonal periods were explored, and although mists were uncommon before mid November, it was established that this passerine migration across Ngulia extended from late October to early January with a peak about the end of November (Backhurst & Pearson 1984). Most birds were ringed between mid November and mid December, but information was sometimes gathered from two or even three new moon periods each year. It was found that some species passed through earlier than others. Red-backed Shrikes *Lanius collurio* and Olive-tree Warblers *Hippolais olivetorum*, for example, were caught mainly in November. Routines were established for recording measurements, weights and moult details from the birds handled. Weights gave an indication of potential onward flight range and some interesting wing moult strategies were discovered. Criteria were established in several species for separating first-year from older birds, information not previously available for these birds in late autumn. By the 1980s Ngulia was recognized as a unique site for ringing Palaearctic passerines, with an unbroken run of prolific seasonal catches unmatched anywhere in Africa.

During the first few years, birds were picked up on active nights inside the Lodge, but most were caught from dawn and through the morning in mist-nets sited in the bush between the Lodge and the staff village 300 m to the south, typically six to ten nets of 12 or 18 metres. From 1976, however, most birds were caught during mist

at night in one or two (and occasionally three) nets positioned immediately north (i.e. in front) of the Lodge below the floodlights. This resulted in larger catches, and small Kenya-based teams were sometimes able to handle over 1000 birds per night/day. The main illumination was provided for many years by three to four powerful 1.5 kW halogen lamps. When these were replaced in 1984 by an assortment of weaker (500 W) lamps fewer birds were attracted. But from the following year an efficient mobile 1 kW halogen lamp was employed, which could be conveniently placed for attracting birds and extracting from the nets when catching at night. Two of the Lodge lamps were upgraded to 1 kW in 1988 to light the 'leopard' tree — an artificial 'tree' of dead branches 25 m in front of the dining room baited with a goat leg each evening to attract leopards. This restored illumination to something nearer that of the early years, and since the addition of a second mobile 1 kW lamp in 1995 the lighting regime has remained much the same until the present time. Floodlight positions are shown on the Lodge site map (Map 2).



Map 2. Ngulia Lodge, to show position of floodlights and mist-netting areas.

Origins and migration routes

Ngulia migrants included populations breeding from western and northern Europe to Siberia and central and southwest Asia, but all known to pass south in autumn through the Middle East, Arabia and the Horn of Africa before reaching Kenya (Moreau 1972). Some were bound for northern Tanzania but others for winter quarters as far south as Botswana and South Africa. Early observations stressed the strength of the migration across Tsavo and its distinctive species composition. Marsh Warbler,

Thrush Nightingale and Common Whitethroat were all birds scarce or practically unrecorded in autumn movements through Uganda and western Kenya, and were evidently concentrated within this southeast Kenyan corridor on their way to southern Africa. Other prominent Ngulia species such as River Warbler *Locustella fluviatilis*, Irania *Irania gutturalis*, Basra Reed Warbler *Acrocephalus griseldis* and Olive-tree Warbler *Hippolais olivetorum* were likewise known to be scarce or absent on passage further west. Supporting autumn observations elsewhere in southern Kenya confirmed that the Tsavo flyway was channelled to the east of Mt Kilimanjaro with its eastern edge about 50 km from the coast (Pearson *et al.* 1988).

As regards species composition, these earlier autumn catches at Ngulia are compared in Figure 1 with those at Kampala, southern Uganda (DP, and see Pearson 1972); also with spring catches at Ngulia (discussed further below).

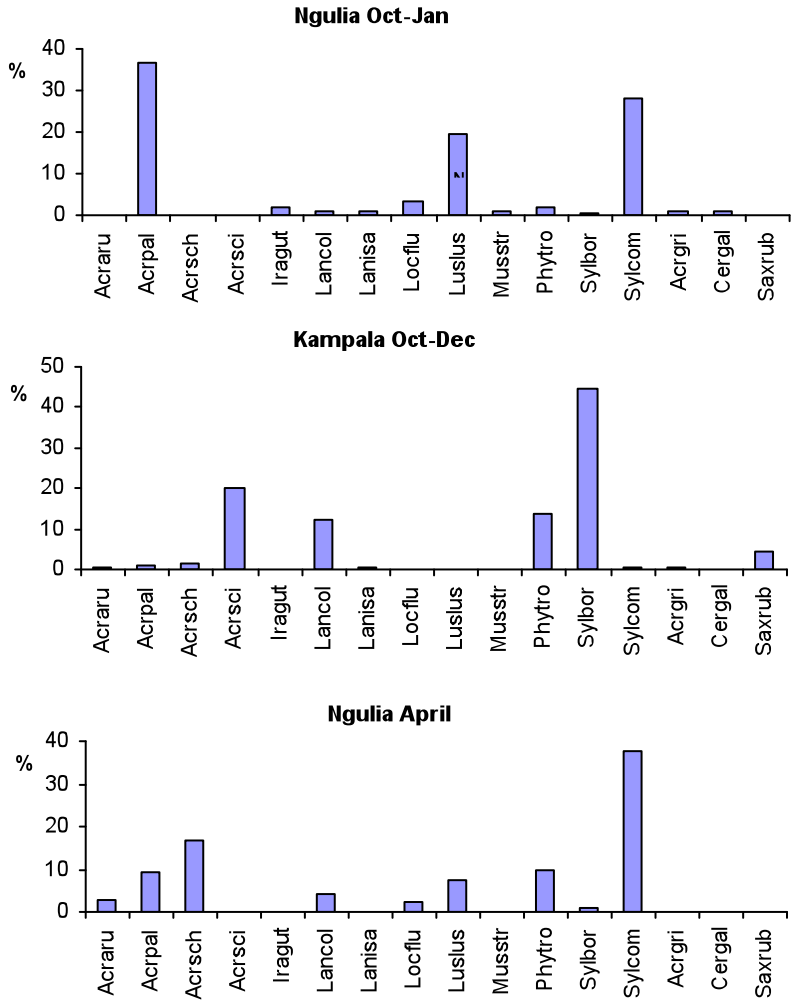


Figure 1. Percentage species composition at Ngulia, autumn 1969–1989 (n = 90 639); Kampala, autumn 1966–67 (n = 541); and Ngulia, spring 1973–1982 (n = 883). Abbreviated systematic species names use the first three letters of the genus followed by the first three of the species.

The main Ngulia movements, between mid November and early December, occurred about two and a half months after arrival of the species concerned in northeast Africa, in late August and September (see Pearson *et al.* 1988, Pearson 1990). They thus indicated the existence of major autumn stopover areas in Ethiopia, supporting virtually the world population of species such as Marsh Warbler and River Warbler for many weeks each year.

Spring observations

The attractive effect of the lights during spring was also investigated. Between 1972 and 1982 the Lodge was visited by ringers on some 40 nights between late March and early May, the period when Palaearctic migrants are returning north through Kenya. But only two large falls and two other substantial arrivals of migrants were encountered. Heavy afternoon and evening rain-storms are common in Tsavo during April, but cloud is high and mist is rare, and a strong southerly breeze typically blows during the latter part of the night.

In late April 1973, many passage migrants were found in the Ngulia bush after some relatively clear nights. These consisted mainly of Common Whitethroats, Willow Warblers *Phylloscopus trochilus*, Marsh Warblers and Sedge Warblers *Acrocephalus schoenobaenus*, the last of these a species rarely seen in autumn. Then in mid April 1977, a thunderstorm with heavy rain before dawn grounded thousands of Common Whitethroats and smaller numbers of Thrush Nightingales, Willow Warblers and Red-backed Shrikes (Britton & Britton 1977). In mid April 1980, a whole night of typical 'autumn-type' mist produced another large and more varied fall. Over 400 birds were ringed, mainly Common Whitethroats, Sedge Warblers and Marsh Warblers, with good numbers of Willow Warblers, River Warblers, Red-backed Shrikes and Great Reed Warblers *Acrocephalus arundinaceus* (Pearson 1980). Finally, in early April 1981, a few hundred birds grounded with some patchy mist comprised mainly Willow Warblers, Thrush Nightingales and Common Whitethroats. These fragmentary observations, taken together with records of falls in April near the lighted township of Mtito Andei, have indicated a strong spring passage over Tsavo, but with birds typically reluctant to come to ground. As well as Sedge Warbler, other species such as Red-backed Shrike and Great Reed Warbler are clearly much more prominent in spring passage movements than in autumn (see Figure 1).

Early ring recoveries

Annual accounts of autumn operations and numbers of birds ringed and recovered were given in *Scopus* up to 1993 (Backhurst & Pearson 1977–1993, Backhurst *et al.* 1986). A few Ngulia-ringed birds, mostly Marsh Warblers, were recovered during the 1970s in Europe, Russia and the Middle East, and a Marsh Warbler was recovered in southern Malawi just five days after being ringed. The first European-ringed birds were caught at the Lodge in 1979, two Marsh Warblers from Czechoslovakia. The flow of recoveries then picked up substantially, and by 1992 a total of 125 000 migrants caught had produced 55 long-distance recoveries, from Belgium east to Russia and Oman, and south to Zimbabwe.

More recent years (1993–2012)

Ringing sessions at Ngulia became more ambitious during the 1990s. An efficient system was used for catching grounded birds at dawn, with more personnel for extracting, handling and ringing them. Teams often now number 12 to 25 during the main

sessions, involving ringers based outside Kenya and with Kenyan ringers represented mainly by CJ and members of the Nairobi Ringing Group based at the Ornithology Section, National Museums of Kenya.

Day and night netting systems

By 1994 a new daytime netting strategy was needed. Following a gradual clearance of bush south of the Lodge few of the traditional net sites remained, and numbers of birds appearing there were distinctly low. Nets were therefore employed at dawn in the bush in front of (north of) the Lodge, about 70 m beyond the area illuminated at night, so that a high proportion of the grounded birds might be caught immediately. An L-shaped arrangement was used, a larger arm of some 60 m north of the lights and a smaller arm of 40 m to the east, along the edge of the escarpment. This system proved highly productive, and was used routinely the following year, while the old netting area was abandoned. Two further net lines were added north of the main arm of the L, so that up to 15 nets were in use north of the Lodge through the early morning hours. With a good series of mists and a strong team a record 29 000 birds was ringed in 1995. Next year the third (back) net line was increased by a further five nets, giving 270 m of net in all. This arrangement has since been used regularly, but sometimes without the back line when teams have been small or when bush falls have been judged particularly heavy. Catching and ringing at night with one, or more usually two, 18-m nets has continued much as before 1993, beginning near or after midnight, as signs of mist appear, and finishing about 04:30 to allow time to deal with all night-caught birds before opening the bush (day) nets at 05:45. Map 2, showing the Lodge surrounds, indicates the position of earlier and more recent netting areas.

Catches in the bush with the new post-dawn system have typically been about five times larger than those possible in the old southern netting area. On active days over 1000 birds are sometimes caught within the first hour and a half. These are ringed and processed at two or preferably three tables, each with three ringers and a recorder (scribe). Whereas before 1995 birds ringed at night typically formed about 70% of the day's catch, proportions are now reversed, and the dawn catch has usually been much higher than that at night. In 2011, during a drought that followed failure of the April rains, elephant damage severely reduced the bush cover in front of the Lodge. The dawn catches have since been noticeably reduced.

Luring with tape-recorded song

It is well established that migrating passerines respond to recordings of the song of their own and other associated species. Overflying birds are attracted to such song when played at night or at dawn at a volume audible to them, some landing and breaking their flight near the speaker source. From 1993, experiments with tape-recorded song were conducted at Ngulia, with amplified sound sources in the bush south of the Lodge.

Table 1. Effect of taped sound on percentage contributions to the combined catches of 1997–2002.

	Total catch	% Marsh Warbler	% Thrush Nightingale	% Common Whitethroat	% River Warbler	% Other species
No sound	52 979	45.7	20.9	20.3	2.9	10.2
Taped sound	56 354	52.2	24.6	15.2	2.7	5.4

Almost no birds were attracted on clear nights or nights with high cloud (conditions when the lights also fail to attract). It was concluded therefore that overhead migration was taking place at high altitude under these conditions. But when nighttime cloud was low, song playback attracted down scores of passerines, and substantial catches resulted at dawn, even after nights when mist failed to descend. This confirmed the effect of low cloud in concentrating migrants above the lights. Sound was then effective in bringing down birds attracted within range by the lights, which would not otherwise have come to ground. Two species which clearly responded to song playback were Marsh Warbler and Thrush Nightingale, but attempts to specifically increase catches of minor species such as Olive-tree Warbler and Basra Reed Warbler were not obviously successful.

From 1999, two 12 V-powered, amplified Sony Walkman tape players were introduced, feeding speakers in front of the Lodge, within and behind the floodlit area. These were regularly used from 02:00 to dawn, whatever the weather, throughout 1999 and much of the 2000 season and on alternate nights during 2001. A 'mixed-species' tape was used with songs of the four main species, Marsh Warbler, Thrush Nightingale, Common Whitethroat and River Warbler, repeated in succession, each burst lasting approximately 45 s. Effects on catch size, species composition, and the weights and ages of grounded birds were noted. Catches were enhanced, both at night and at dawn, and the large numbers brought down in mist were further increased. Species composition was affected, however (see Table 1). The proportion of Marsh Warblers was higher when tapes were played, but that of Common Whitethroat was lower, and both the number and proportional contribution of most of the 'more interesting' minor species were decreased.

The ability to compare results with earlier years is important, and so, since 2002, the use of taped song has been avoided on misty nights when adequate attraction is provided by the lights. The 'mixed-species' tape is still used, however, typically from 02:30, when mist fails to appear, and this substantially increases catches on what would otherwise be poor nights. A careful note is made of when tapes are used so that data can be treated according to the capture regime used.

The amplified Walkman sound sources have also been used to concentrate hirundines feeding by day in front of the Lodge on the moths remaining from the previous night. Using a few fine mist-nets, this has resulted in some large catches of Barn Swallows *Hirundo rustica*, and sometimes significant numbers of Common House Martins *Delichon urbicum*. Annual Barn Swallow catches usually now run into thousands and these have given a small series of exchanges with the Chokpak Pass ringing station in southeast Kazakhstan.

Ageing and sexing

Determining the age and sex of individual birds in the hand is crucial for gaining further understanding of population dynamics as well as migration strategy. Until good numbers had been handled at Ngulia, there was little ageing information for many species in the moult state and plumage condition in which they occurred at the Lodge in late autumn. Most previous ageing studies concerned early autumn in Europe.

Thus it was that criteria for separating first-year and adult birds had to be established early on at Ngulia for most of the common Palaearctic species, and these have now been set out in a guide to Ngulia migrants (Pearson 2012). They depend on the moult strategy and/or amount of wear of wing and tail feather tracts (often subtle in this season), a difference in tail feather shape, and sometimes diagnostic fringing

or spotting on wing or tail feathers. By 1980, most Marsh Warblers, Common Whitethroats, River Warblers, Willow Warblers, Barred Warblers *Sylvia nisoria*, Garden Warblers *Sylvia borin*, Iranias, Spotted Flycatchers *Muscicapa striata*, Thrush Nightingales, Common Nightingales *Luscinia megarhynchos*, Red-backed and Isabelline Shrikes *Lanius isabellinus* could be aged. With careful observation, including the noting of leg and eye colours and tongue spots, this list of ageable species has now been extended to include Basra Reed Warbler, Great Reed Warbler, Olive-tree Warbler, Olivaceous Warbler *Iduna pallida*, Common Rock Thrush *Monticola saxatilis*, Rufous Scrub Robin *Cercotrichas galactotes*, and Eurasian Nightjar *Caprimulgus europaeus*.

In most of the Ngulia migrants, males and females are identical in plumage and inseparable in the hand. The sexes of adult-plumaged birds are distinguishable, however, in Irania, Barred Warbler, Common Whitethroat (sometimes with difficulty), Blackcap *Sylvia atricapilla*, Red-backed and Isabelline Shrikes, Northern Wheatear *Oenanthe oenanthe*, Pied Wheatear *O. pleschanka*, Common Rock Thrush and Eurasian Nightjar.

Further observations on night-time arrival and 'moon-effect'

On some moonless occasions mist has already been present from dusk onwards. The first few birds are typically to be seen flying outside the Lodge from about 19:15, one hour after sunset. Larger numbers—tens or hundreds—are then likely to appear in the floodlit area from 20:00 onwards, mainly passerines, but often also Eurasian Rollers *Coracias garrulus*, nightjars *Caprimulgus* spp. and Harlequin Quails. These tend to increase with light rain so that impressive numbers may already be perched in trees and bushes by 22:00. It appears that the night movement takes an hour or so to build up after dark, but that full numbers are then flying until first light at 05:15. However, since game viewing by tourists usually has to take precedence during the evening, night netting activity has rarely begun before 21:30. Most birds grounded by mist or rain early at night will depart if clouds lift before 02:00, especially if there are clear patches with stars, and the dawn catch may then be small. Huge numbers of birds are sometimes seen in the lights after an early night storm, taking to the air again once clouds begin to lift.

Passerines appear in mist with either a light easterly breeze from the plain or in still conditions. Arrivals cease, however, when a cool breeze blows from the higher ground to the west and south, even when a low mist persists. Birds typically appear from the north or northeast, flying low overhead in the base of the cloud layer and, in the absence of any sound attraction, drop into the bushes around the lights only when this nears the ground as mist. They have occasionally been noted flying in numbers across the escarpment edge from the east as if disorientated over the plain. Birds can be seen to arrive singly but they clearly associate quickly once landed, for individuals of a species are often found grouped together in a net at night.

On the rare occasions when the lights have failed during misty moonless nights and then been restored again, it has been observed that birds take some time to reappear, with few within the first 30 minutes. A similar delay has more often been seen on nights when a large moon is setting after midnight with mist already in place. Again, numbers take 30 to 60 minutes to build up once the moon has disappeared. These observations suggest that birds are not normally flying low, within easy reach of the lights' attraction.

Even a small moon reduces the attraction of the lights. This is often seen at the beginning of a ringing session when a waning moon is rising two to three hours before

dawn. With persistent mist giving a rapid capture rate around midnight this usually tails off markedly within an hour or so of moonrise. Ringers have occasionally been present at the Lodge over full moon nights with mist, and have then usually noted almost no arrival of migrants. However, birds grounded by heavy rain and with a large moon can evidently concentrate at the lights to some extent. Thus, in 1993, seven consecutive misty nights spanning a full moon in late November produced just 307 birds ringed, but 173 of these were after the one night with heavy rain. On 2 December 1998, when mist was accompanied by heavy showers, birds were already appearing in the net rides before the large moon had set at 04:20, and the day's catch was a surprising 305.

Calls at night

The thousands of birds that sometimes pass over the Lodge at night in mist or low cloud do so relatively silently. But the eerie atmosphere is often broken by soft high pitched flight calls, most of these clearly above about 7 kHz. Most frequent is a barely audible '*tseep*' assumed to be attributable to Thrush Nightingale. Tree Pipits *Anthus trivialis* are commonly heard and Yellow Wagtails *Motacilla flava* more rarely, although neither of these usually features among migrants caught in the nets. Spotted Flycatcher calls have been frequently detected during some early season falls, and twittering disorientated flocks of Barn Swallows sometimes arrive in the lighted area. From birds on the ground, Willow Warbler contact calls can be heard, and occasional harsh Irania rattles, and Thrush Nightingales below the lights frequently give snatches of song towards dawn.

Some of the larger birds attracted in the mist tend to be revealed by their calls as they pass overhead or circle the lighted area. These include Little Bitterns *Ixobrychus minutus* and Black-crowned Night Herons *Nycticorax nycticorax*, and sometimes waders such as Wood Sandpipers *Tringa glareola*. Migrating Afrotropical species such as Jacobin Cuckoo, Harlequin Quail, Grey-headed Kingfisher *Halcyon leucocephala* and African Paradise Flycatcher *Terpsiphone viridis* can all be vocal at night.

Update and analysis of autumn ringing data

Coverage, numbers ringed and recovered

From 1972 to 2012 the Lodge was manned by ringers on 1149 nights between late October and early January (the period referred to as 'autumn'). At least one hour of mist occurred on over 60% of these nights. There were showers or heavier rain on 26% of them, usually together with mist. Seasonal details are shown in Table 2. Only 36% of nights were misty up to 15 November, but 64% between 16 November and 15 December and 74% from 16 December. This illustrates the lower incidence of attractive weather conditions during the early part of the season.

Numbers of Palaearctic birds ringed each autumn are shown in Figure 2. Since

Table 2. Summary of coverage and weather, 1972–2012, by half-month periods.

Period	Oct II	Nov I	Nov II	Dec I	Dec II	Jan I
Nights covered	33	152	375	369	181	39
With mist (often also rain)	8	59	235	238	132	31
With rain but no mist	0	2	11	14	4	3

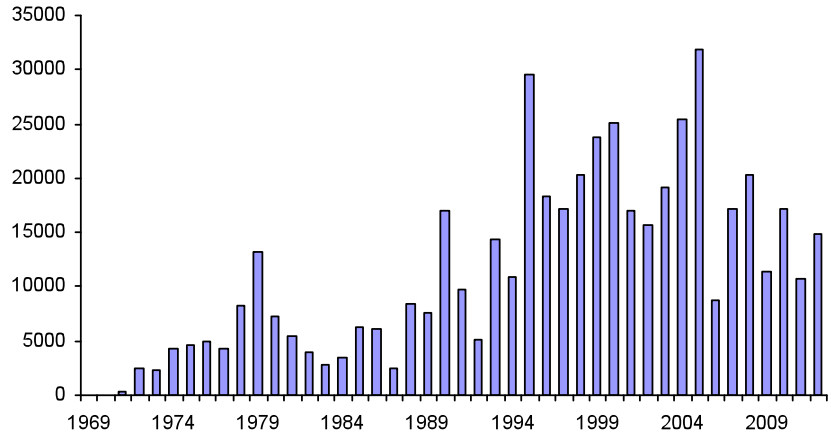


Figure 2. Autumn Palaearctic ringing totals, 1969–2012.

1995, these have averaged almost 20 000, bringing the overall total by 2012 to over 499 000. Totals of individual species ringed, 1969–2012, are given in Appendix 1.

To September 2013 there have been 222 long-distance ringing movements (168 from Ngulia, 54 to Ngulia). These comprise 122 to or from Palaearctic breeding areas ranging from France, Finland and Italy to Siberia and Pakistan; 81 to or from Middle East passage sites; 18 from wintering areas in southern Africa; and just one (an October Thrush Nightingale) from the likely Ethiopian stopover area. Numbers of recoveries per country are listed in Table 3. The majority of these ringing movements involve distances between 3000 and 7000 km.

More than half the birds recovered from Ngulia ringing have been found more

Table 3. Number of recoveries and controls to and from each country to 2012.

Austria	3	Italy	2	Saudi Arabia	37
Belarus	1	Jordon	1	Slovakia	1
Belgium	17	Kazakhstan	7	Slovenia	6
Botswana	1	Kenya	1	Sweden	5
Czech Republic	15	Kuwait	3	Switzerland	1
Denmark	3	Lebanon	5	Syria	5
DR Congo	1	Lithuania	1	Tanzania	3
Egypt	9	Luxembourg	2	Turkey	1
Ethiopia	1	Malawi	4	Ukraine	4
Finland	4	Mozambique	3	United Arab Emirates	1
France	3	Netherlands	3	Yemen	4
Georgia	2	Norway	1	Zambia	4
Germany	17	Oman	10	Zimbabwe	1
Hungary	4	Pakistan	1	Total	222
Iran	2	Poland	1		
Israel	4	Russia	17		

than a year later, and a few of them more than four years later. For the three main species, Table 4 shows numbers found after different yearly intervals. An interval of '1 year' refers to birds recovered during the twelve months from the April following ringing.

Table 4. Numbers found after various intervals from ringing at Ngulia.

Recovered after year	0	1	2	3	4	5	6	7	8	9
Marsh Warbler	6	31	25	21	3	1		1	1	
Common Whitethroat		5	2	1	1					
Thrush Nightingale		18	6	3	3	2	1		1	1

Clearly, few Marsh Warblers or Thrush Nightingales live beyond five years. However, the two oldest Ngulia-ringed Thrush Nightingales were respectively 8 years 10 months old when controlled on spring passage in Israel, and 8 years old when killed by a car in Sweden. The oldest Marsh Warbler was at least 8 years and 2 months old when 'hunted' in Saudi Arabia. These longevity figures are similar to the maxima given for these species by Cramp (1988, 1992). No difference has been found between Marsh Warblers ringed at Ngulia as first-year and adult, with regard to either the percentage of birds recovered or the yearly recovery pattern.

Of 24 Marsh Warblers ringed in Europe and controlled as adults at Ngulia only four were more than three years old.

Full details of all recoveries and controls are given in Appendix 2**,** and they are plotted on Maps 3a–3d. They are also discussed in the next section under individual species on p. 14.

Retraps

The proportion of the birds ringed at Ngulia and retrapped on a later day the same season has been very low, usually less than 1%. This emphasizes an almost complete turnover of birds each day, even after large falls. Of the birds ringed during a night's catching and immediately released in the general direction of the bush netting area very few are retrapped again after dawn. Thus, from a catch of say 500 birds released at night, no more than about ten would typically be expected next morning among a further 500 birds caught in the bush. This gives an idea of the immense numbers often involved, and probably also indicates a continual turnover of birds through the night.

Very occasionally, birds have been retrapped in a season subsequent to that in which they were ringed. Some of these may have recognized the Lodge area as a site to return to and break their passage journey for a few days, especially in the greened up conditions of late December and January. But the great majority were undoubtedly birds briefly attracted down by chance in mid migration in more than one year. It is no surprise therefore that examples of subsequent season retraps have been extremely few, only 63 in all (just one bird per 7600 ringed). These are summarized in Table 5 by species and seasonal interval.

No bird has been retrapped in more than one season. Thirty-two of the subsequent season retraps (51%) had been ringed as adults, 26 (41%) as first winter. Since, overall, only about one third of the birds ringed at Ngulia have been adults, this suggests their subsequent fidelity to the migration route is greater than that of first-winter birds.

Sixteen of the above retraps involve at least one date in late December or January and these could well relate to birds returning to Ngulia as a brief stopover site. Another Whitethroat was a bird ringed in spring (on 5 April) and retrapped the following autumn. The remaining 46 cases, of birds ringed and retrapped during the November–early December period are likely to have involved individuals trapped in both years on the day of their transit across Ngulia. But comparison of the first and second year's capture dates in these cases does not suggest very high timing precision. There

was a mean difference of 9.6 ± s.d. 6.4 days. Twenty-five birds were caught on an earlier date the second year than the first, two on the same date, and 19 on a later date.

Whereas subsequent season retraps have included seven Isabelline Shrikes there have been no Red-backed Shrikes, despite the higher number of the latter species ringed. This must reflect the different passage status of these two. Isabelline Shrike is near or perhaps at its wintering site at Ngulia by late December, whereas Red-backed is passing rapidly through to wintering grounds far to the south.

Table 5. Numbers retrapped at Ngulia in years subsequent to that in which ringed.

	Number retrapped after					
	1 year	2 years	3 years	4 years	5 years	Total
Isabelline Shrike	2	3	2			7
Barn Swallow	4	2				6
River Warbler	1					1
Marsh Warbler	10	9	1	1		21
Olivaceous Warbler	1		1			2
Upcher's Warbler				1		1
Willow Warbler	1					1
Garden Warbler	3					3
Common Whitethroat	7	4		1		12
Thrush Nightingale	3	1	1		1	6
Spotted Flycatcher	2					2
Tree Pipit	1					1

Recoveries, origins and races of individual Palaearctic species

Numerous recoveries of Marsh Warbler and Thrush Nightingale have confirmed the wide breeding range from which Ngulia birds are drawn, helped to define their migration routes and (in Marsh Warbler) indicated a large southern African wintering area. Several other species have given a few recoveries that reveal breeding and/or wintering sites. In geographically variable species, additional information on origin comes from observations of race, plumage colouration and winglength.

A summary of winglengths at Ngulia is given as Appendix 3.

Eurasian Roller *Coracias garrulus*

An Ngulia-ringed bird was found in Oman in May, presumably on passage.

Tsavo migrants are likely to include nominate *garrulus* from southern and eastern Europe as well as *semenowi* from western Asia. It has not been possible to assess the race of the worn autumn birds trapped at the Lodge.

Eurasian Nightjar *Caprimulgus europaeus*

An Ngulia bird was controlled in May at the Chokpak ringing station in southern Kazakhstan. Another was recovered (date unknown) in southern Iran.

A variety of plumage types occurs at Ngulia and birds have been referred to the following races: darkish, grey-brown nominate *europaeus* (breeds Europe to southern Siberia); paler *sarudnyi* (Kazakhstan); pale, grey and finely streaked *unwini* (south-west Asia); and pale, sandy-buff *plumipes* (northern China). The main forms, *europaeus*

and *unwini*, are recorded in about equal numbers, with *sarudnyi* and *plumipes* each making up about 5%. It is unlikely that many birds from western or central Europe occur at Ngulia.

Red-backed Shrike *Lanius collurio*

The two recoveries are from the southeastern part of the breeding range, from northwest Iran (May) and Georgia (July).

The main southward passage of this species through East Africa occurs through Uganda (Britton 1980). Ngulia birds are probably all from eastern populations, nominate *collurio* from Russia and Siberia (including '*pallidifrons*') and *kobylini* from the Caucasus. This would explain the lack of recoveries from Europe. About 30% of adult males examined at the Lodge have been referable to *kobylini*.

Isabelline Shrike *Lanius isabellinus*

Two Ngulia birds have been recovered, both on passage through Kuwait in mid April.

Three forms are recognizable among adult males: *phoenicuroides* from Kazakhstan, with chestnut crown contrasting with brown back, conspicuous whitish supercilium and whitish underparts; *karelini*, a paler greyer version of this pattern; and *isabellinus* from Mongolia, with more uniform greyish isabelline upperparts, pale buffish supercilium and buff-washed underparts. Most adult females are also separable with care. The form *karelini* occurs within the range of *phoenicuroides* and is thought to represent a dry habitat morph. At Ngulia, *phoenicuroides* is the main form which occurs, about five times as numerous as *isabellinus* and 15 times as numerous as *karelini*.

Russian authorities (e.g., Panov 1996, Koblik *et al*. 2006) have long considered *phoenicuroides* and *isabellinus* as representing separate species, and this view is now becoming more generally accepted. But in the tables and analyses here these forms have been treated within a single species.

Barn Swallow *Hirundo rustica*

There are six exchanges of birds between Ngulia and the Chokpak ringing station in southern Kazakhstan, birds being caught at Chokpak in September and (once) April. Two Ngulia birds have also been found wintering in Tanzania and one the next winter in Tsavo East National Park — the only Ngulia-ringed Palaearctic bird recovered elsewhere in Kenya.

The absence of any recoveries in Europe from the 24 000 birds ringed to date suggests that nearly all have an Asian origin.

River Warbler *Locustella fluviatilis*

There are three ringing movements between Ngulia and European breeding grounds, perhaps the only long-distance recoveries of this species. Birds ringed in Slovakia (May) and Slovenia (July) were later controlled at Ngulia, and one ringed at the Lodge was recovered in May near Smolensk, Russia.

This species follows similar migration routes to those of Marsh Warbler, and Ngulia birds are presumably drawn from across a similar west–east breeding range. About 20% of young birds and adults caught at Ngulia are tinged yellowish on face and underparts and are slightly greener above than the more typical olive-brown and buffy white birds. This appears to represent polymorphism rather than any known geographic variation.

Basra Reed Warbler ***Acrocephalus griseldis***
An Ngulia bird was recovered in central Arabia in August, the only ringing movement of this species to date between tropical Africa and the Palaearctic.

Breeding is practically confined to the marshes of Iraq and bordering Kuwait and Iran.

Great Reed Warbler ***Acrocephalus arundinaceus***
Scarce at Ngulia in autumn, and there are no recoveries.

Birds have been referred to nominate *arundinaceus* (breeding east to the Caspian Sea) and paler, more olive-brown *zarudnyi* (typical in Central Asia) in a ratio of approximately 3:1.

Reed Warbler ***Acrocephalus scirpaceus***
Scarce at Ngulia and there are no recoveries.

Birds are referable to the central Asian race *fuscus*. Winglengths at Ngulia average about 2 mm longer than those of *fuscus* caught in Uganda and central Kenya. This suggests that these birds on the eastern edge of the flyway in East Africa have a specific, perhaps far eastern, origin in Asia.

Marsh Warbler ***Acrocephalus palustris***
There are 86 recoveries from the Eurasian breeding range, almost all between late May and early August, from France, Belgium and Scandinavia to Russia east to the Urals, and south to Italy and Slovenia. Birds from both western and eastern parts of the range have thus been confirmed at Ngulia. This species funnels through the Middle East and northeast Africa on both autumn and spring migrations (Dowsett-Lemaire & Dowsett 1987, Kennerley & Pearson 2010).

There have been 24 dated passage recoveries of Ngulia birds in autumn, and 14 in spring. Apart from one from northern Turkey these have all been from the Middle East. The autumn recoveries are from Syria (2), central and western Saudi Arabia (23) and Oman (1), and dated 1 August to 6 September (median 15 August). The spring recoveries are from Yemen (3), Oman (6), central Saudi Arabia (1), eastern Saudi Arabia (1), Dubai (1), Kuwait (1) and Turkey (1), and dated 2 to 18 May. In autumn, passage across Arabia extends over a few weeks but occurs three months before the migration over Ngulia. In spring, the absence of recoveries from western and central Arabia is striking. Migration is more time restricted, and would appear to follow a more easterly route across the Arabian peninsular, with major landfalls in the southeast. There are recoveries of Ngulia-ringed birds in southern Africa between December and February, from Zambia (3), Malawi (2), northern Mozambique (1) and Zimbabwe (1).

One of the Malawi birds, recovered on 1 December 1975 just five days after being ringed at Ngulia, had flown nearly 1500 km. Another interesting bird in East Kasai, Democratic Republic of Congo, on 1 April 1989, had probably begun spring migration but seems unusually far west.

No obvious variation in the tone of fresh plumage has been noted in autumn birds at Ngulia.

Olivaceous Warbler ***Iduna pallida***
There are no recoveries. Ngulia birds are practically all referable to the Eurasian race *elaeica*. A freshly moulted browner bird trapped on 24 November 2003 was considered to be a representative of the Nile Valley nominate race *pallida*.

Upcher's Warbler *Hippolais languida*
There are no recoveries. Ngulia birds are presumably drawn from the whole south-west Asian range.

Olive-tree Warbler *Hippolais olivetorum*
Two birds from Ngulia have been recovered in southern Africa, in northern Mozambique in March and eastern Botswana in January. These appear to be the only ringing recoveries of this species from sites south of the Sahara.

Breeding is restricted to islands and low coastal hinterland in the northeastern Mediterranean area (Kennerley & Pearson 2010).

Willow Warbler *Phylloscopus trochilus*
There are no ring recoveries from Ngulia.

Adults vary in the amount of grey and white as opposed to green and yellow that they show in the plumage. Most fall within the variation of the race *acredula*, and could potentially be derived from Scandinavia as well as Siberia. At least 15% of adults show very grey upperparts and whitish supercilium and underparts, without any yellow. These are referable to the eastern Siberian race *yakutensis*. These birds are more frequent at Ngulia than among populations caught further west in Kenya (authors' unpublished data), suggesting that many birds here are from the eastern end of the range.

Blackcap *Sylvia atricapilla*
Scarce at Ngulia and there are no recoveries.

Nominate *atricapilla* and the paler and greyer *dammholzi* have been noted in about equal numbers.

Garden Warbler *Sylvia borin*
The single recovery was a passage bird found in Jordon in late August. Our birds vary in plumage tone but all are greyer than those of western Europe, and have a slightly longer winglength.

Barred Warbler *Sylvia nisoria*
The single recovery was a passage bird found in Saudi Arabia in mid September. We are unable to detect racial differences at Ngulia, and birds probably originate from throughout the range, from central Europe to central Asia.

Common Whitethroat *Sylvia communis*
There are just 12 recoveries, two of these from within the breeding range in Russia at about 50°E. A bird in northwest Pakistan in late August was perhaps already on passage, and there are autumn passage recoveries from Syria (1, August) and Saudi Arabia (5, late July to early September). There are single passage recoveries in May from Yemen and Oman, and a presumed wintering bird was found (month unknown) in southern Tanzania.

Ngulia birds are from eastern parts of the species' range, showing the winter wing moult strategy characteristic of the eastern races. There has been no convincing evidence of the nominate European race. Mean winglength is longer than that of western European birds. Variation in adult plumage is consistent with the occurrence of three races. Browner *volgensis* (southern Russia, southwest Siberia) account for about 20%, grey-brown *icterops* (Turkey, Levant and Caucasus to northern Iran) make up the majority, and paler and greyer *rubicola* (Central Asia) account for about 10%.

Thrush Nightingale *Luscinia luscinia*
There are 21 recoveries from the breeding range, dated 1 May to 24 August, from Scandinavia (to 60°N in Finland) and European Russia (to 55°E) south to Germany, Czech Republic and Ukraine. A bird ringed in southwest Georgia on 15 August and subsequently controlled at Ngulia was on passage.

There are 18 dated passage recoveries from the Middle East. Those in autumn are from northern Egypt (8), Israel (1) and Lebanon (1), between 20 August and 13 September. Those in spring are all from the Levant, from Israel (3), Lebanon (3) and Syria (2), between 13 April and 2 May. This species clearly crosses or skirts the eastern Mediterranean, with Middle East recoveries west of those obtained from Marsh Warbler. There are two recoveries south of the Sahara, to western Ethiopia on 20 October and to northern Mozambique, a long-dead bird reported in May.

This species is monotypic. However, a range of upperpart colours has been noted at Ngulia, from rather dark rufescent brown to paler greyer brown. This colour variation is not associated with any difference in winglength. The greyer birds are not described from Europe so may perhaps originate from eastern breeding areas where the species ranges to 80°E in southern Siberia. Ngulia birds are thought to be derived from the entire west–east range

Common Nightingale *Luscinia megarhynchos*
There are no recoveries.

Two eastern races occur at Ngulia, *africana* (from the Caucasus to Iran) and the slightly larger, paler and greyer *golzi* [3] (from Central Asia), in a ratio of approximately 3:1. Additionally, some 10% of birds handled have been classed as intergrades. The more rufous nominate *megarhynchos* from Europe has not been noted, and Ngulia winglengths are generally longer than those of European birds.

Irania *Irania gutturalis*
This species breeds in Turkey and southwest Asia and migrates through Arabia. Surprisingly, there have been no recoveries from nearly 9000 birds ringed at Ngulia.

Some 20% of males are pale cinnamon below rather than the usual orange-rufous, and occasional birds have almost white underparts. These are thought to represent morphs rather than different geographical races.

Rufous Scrub Robin *Cercotrichas galactotes*
There are no recoveries.

Birds are from the eastern part of the Palaearctic range, but as most are in worn plumage at Ngulia determination of race is not easy. The main form occurring is the paler *familiaris* from southwest and central Asia, but some birds with new body plumage have been assigned to *syriacus* from southeastern Europe.

Spotted Flycatcher *Muscicapa striata*
There are no recoveries.

Ngulia birds are referable to the greyer, less strongly streaked eastern races *neumanni* and *sarudnyi* from Siberia and central and southwest Asia. It is unlikely that European birds occur.

[3] For the use of *golzi* rather than *hafizi* see Dickinson (2008).

Diurnal changes in species pattern

Night catch vs bush catch

It was noted during the early years that the species composition of night catches differed from that of catches made in the bush during the day. Certain species were particularly well represented at night, others caught mainly in the bush with few at night. This night–day difference is illustrated in Table 6 which gives data for the combined years 1991 to 1998, when no serious sound attraction was employed. The percentage contribution of each species to the total night and the day catches is shown.

Among the main species, Thrush Nightingale makes a greater contribution at night, Marsh Warbler by day. Common Nightingale and Irania are both more prominent at night as also is Willow Warbler. On the other hand, the minor *Sylvia* species, Basra Reed Warbler, Olivaceous Warbler, and in particular Olive-tree Warbler and the shrike species feature more by day. The few wheatears have mainly been caught at night, whereas Rock Thrush has contributed well by day. The great majority of the Eurasian Nightjars and Eurasian Rollers have been caught at night.

Table 6. Percentages in total night and day catches for the combined years 1991–1998.

	% Night	% Day		% Night	% Day
Eurasian Nightjar	0.51	0.05	Garden Warbler	0.18	0.83
Eurasian Roller	0.14	0.01	Barred Warbler	0.38	0.82
Red-backed Shrike	0.67	1.80	Common Whitethroat	23.11	21.56
Isabelline Shrike	0.44	1.25	Thrush Nightingale	27.23	15.20
River Warbler	3.13	3.17	Common Nightingale	0.48	0.33
Basra Reed Warbler	0.50	0.77	Irania	3.30	1.85
Great Reed Warbler	0.02	0.04	Rufous Scrub Robin	0.30	0.34
Sedge Warbler	0.04	0.06	Northern Wheatear	0.10	0.02
Eurasian Reed Warbler	0.01	0.05	Isabelline Wheatear	0.06	0.02
Marsh Warbler	35.18	47.81	Pied Wheatear	0.07	0.01
Olivaceous Warbler	0.21	0.50	Rock Thrush	0.16	0.21
Upcher's Warbler	0.18	0.22	Spotted Flycatcher	1.07	0.95
Olive-tree Warbler	0.24	0.95	Tree Pipit	0.01	0.08
Willow Warbler	1.98	0.89			
Blackcap	0.00	0.06	Total catch*	56 571	66 332

*Hirundines — mainly day-feeders — are here excluded from the total catch figures.

Catching pattern during the morning hours

After a fall of migrants, the bush nets are opened in partial dawn light at about 05:45. Thrush Nightingales are then already dispersing and are usually the first birds to fill the nets. Marsh Warbler dispersal typically peaks some 20 minutes later, and that of Common Whitethroat later still. But some 70% of the daytime catch of all three main species is typically taken and extracted by 07:00 hours. Some of the minor species, however, tend to move later, and are mainly caught after this first dispersive rush. Combining data for 1994 to 1998, percentages caught before 07:00, between 07:00 and 09:00, and between 09:00 and 11:00 are shown for each of the common species in Figure 3 (and see also Appendix 10).

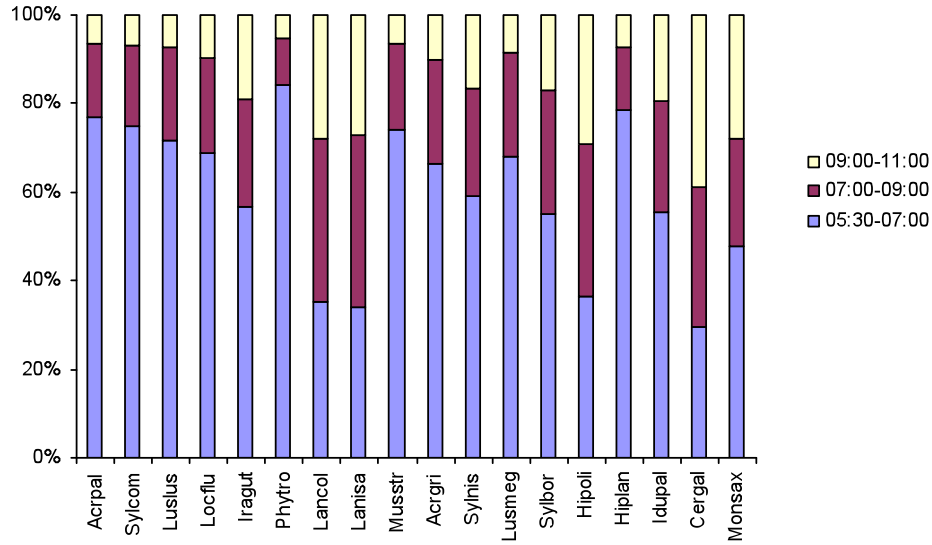


Figure 3. Percentage of day catch taken during three morning periods. Data for 1994 to 1998 are combined. Abbreviated systematic species names use the first three letters of the genus followed by the first three of the species.

Most shrikes, Olive-tree Warblers and Rufous Scrub Robins are caught after 07:00, and many of these after 09:00. Other species typically prominent later in the morning are Irania, Barred Warbler, Garden Warbler, Olivaceous Warbler and Rock Thrush. In contrast to Olive-tree Warblers, most Upcher's Warblers are caught early, and Willow Warblers are particularly restricted to the first hour's catch.

Seasonal timing of migration

The phenology of migration at Ngulia was described earlier (Backhurst & Pearson 1984), but can now be reviewed in the light of data from many more years.

Daily catches from 1972 to 2010 and between 27 October and 9 January have been used, selecting only dates with appropriate weather and moon conditions. Catches have been affected by a number of operational changes, notably the introduction of night netting in the mid 1970s and of more ambitious bush netting in the mid 1990s. But once adopted these changes have applied across the season and introduced little bias. However, mist, essential for attraction to the lights, is much less frequent earlier in the passage period. To reduce the obvious bias towards low catches at this time, only dates with mist have used in calculating mean daily catches. In addition, dates from three days before to seven days after the full moon (i.e., with little moonless window between 22:00 and dawn) have been ignored, as have all dates when tapes were in use at night.

Catches for the selected misty, moonless dates have been grouped into five-day periods (pentads) and mean values calculated for each of these. Figure 4 shows, for each pentad, the mean of the total daily Palaearctic catch, emphasizing a rapid build-up of passage in early November, a peak from mid November to mid December and a tailing off into early January.

Some species cross Ngulia each autumn earlier than others. Passage of some is well spread through the migration period, that of others confined mainly to November.

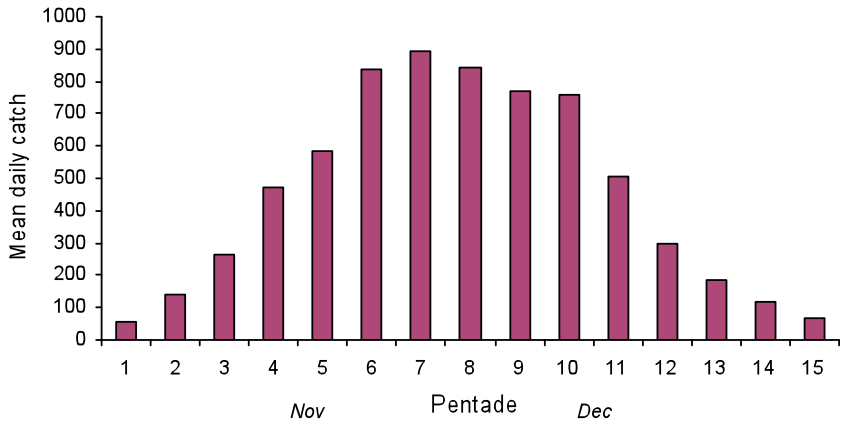


Figure 4. Mean daily Palaearctic catch plotted against pentad, using only dates with misty moonless nights and no tape lure; data for 1972 to 2010 combined. Pentad #1 = 27–31 October, #15 = 5–9 January.

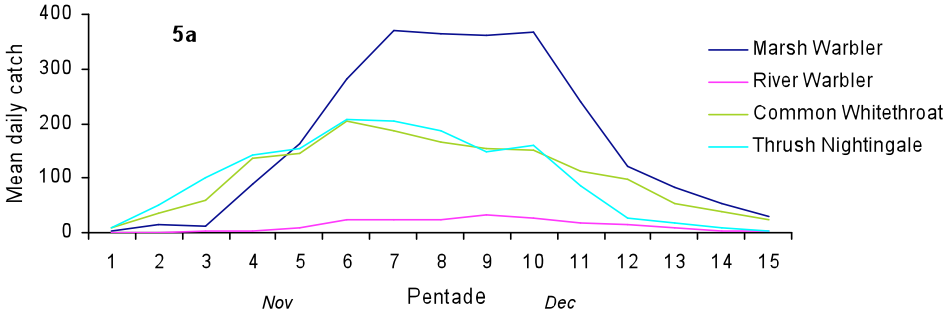
For each of the commoner species, mean daily catches per pentad are plotted through the season in Figure 5 (a–e). They are also given in Appendix 5.

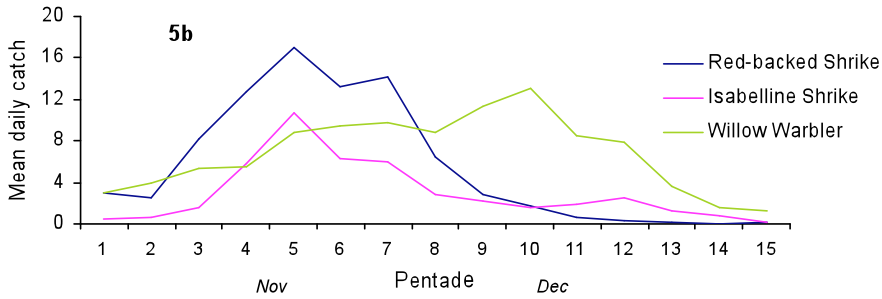
Of the main species (Figure 5a), Common Whitethroat and Thrush Nightingale are prominent at the beginning of the season, their movement well under way in early November. Both pass mainly between mid November and mid December, but while Thrush Nightingale numbers then decline sharply Common Whitethroat movement continues well into January. Marsh Warbler passage picks up only during mid November, peaks to mid December and then tails into early January. River Warbler movement is timed much as in Marsh Warbler.

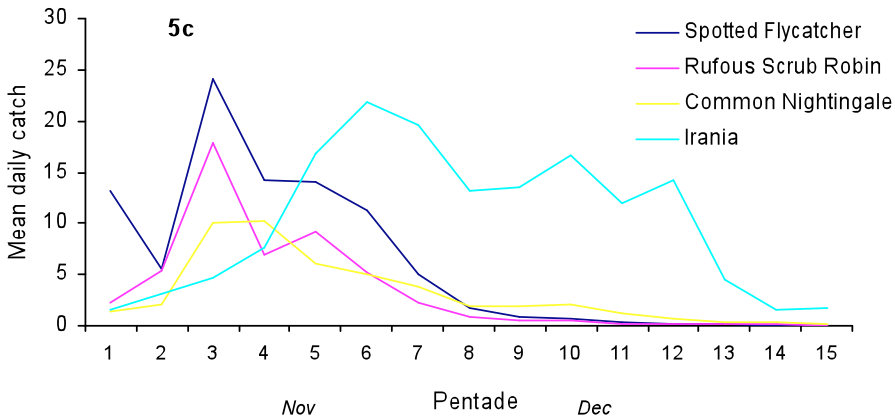
Several species have passage restricted to the earlier part of the season. Thus the shrikes occur mainly in November, with Red-backed in particular scarce after early December (Figure 5b). Three muscicapid species also pass through early: Spotted Flycatcher in late October and November, Rufous Scrub Robin in November, and Common Nightingale mainly in November (tailing off earlier in December than Thrush Nightingale) (see Figure 5c). By contrast, Irania has a later but more protracted passage, mainly from late November to late December. Olive-tree Warbler (Figure 5d) is another November species, with few trapped after early December, and most Olivaceous Warblers have been caught in November. Upcher's Warbler on the other hand, appears from mid November, then occurs up to early January. The remaining warblers (shown on Figures 5b, 5d and 5e) have a broad passage period, Basra Reed Warbler from mid November to late December and Willow, Barred and Garden Warblers throughout November and December, the last prominent in early January.

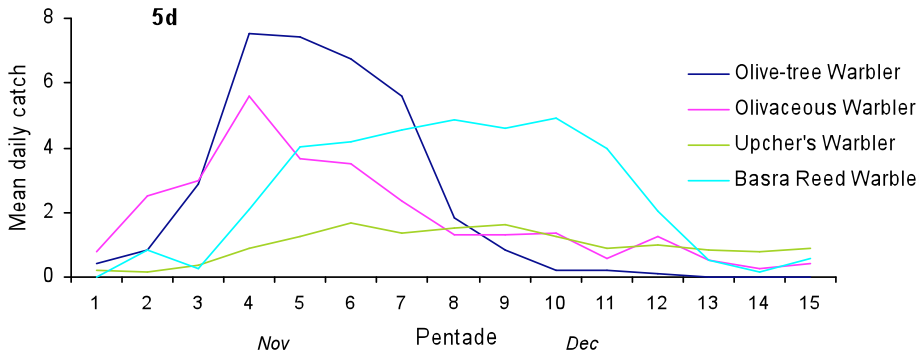
Most Eurasian Nightjars (Figure 5e) occur in early to mid November, before the arrival of Plain *Caprimulgus inornatus* and Dusky *C. fraenatus* Nightjars, the main Afrotropical passage species. Eurasian Roller *Coracias garrulus*, on the other hand, has been caught mainly between mid November and mid December.

The median passage date for each species has been calculated, again using only catch totals for days with misty moonless nights and no tape use. For each date, from late October through to early January, totals were averaged, and these average figures were then summed to give a seasonal total. The date where the cumulative figure (summing from the beginning of the season) reached half the seasonal total was identified as the median date. Results are listed below in Table 7.


5a
Mean daily catch
400
300
200
100
0
Marsh Warbler
River Warbler
Common Whitethroat
Thrush Nightingale
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Nov
Pentade
Dec


5b
Mean daily catch
20
16
12
8
4
0
Red-backed Shrike
Isabelline Shrike
Willow Warbler
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Nov
Pentade
Dec


5c
Mean daily catch
30
25
20
15
10
5
0
Spotted Flycatcher
Rufous Scrub Robin
Common Nightingale
Irania
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Nov
Pentade
Dec


5d
Mean daily catch
8
6
4
2
0
Olive-tree Warbler
Olivaceous Warbler
Upcher's Warbler
Basra Reed Warbler
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Nov
Pentade
Dec

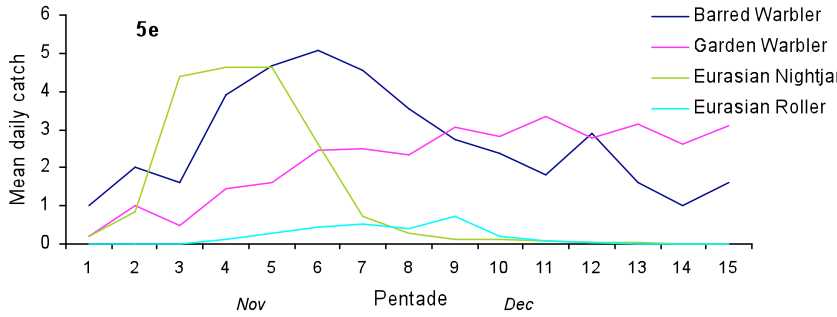


Figure 5 a–e. Mean daily catch plotted against pentad using dates with misty moonless nights and no tape lure; data for 1972 to 2010 combined. Pentad #1 = 27–31 October, #15 = 5–9 January.

Table 7. Median passage dates for the main Ngulia species.

Eurasian Nightjar	15 November
Eurasian Roller	30 November
Red-backed Shrike	20 November
Isabelline Shrike	23 November
Spotted Flycatcher	9 November
Basra Reed Warbler	3 December
Marsh Warbler	6 December
Upcher's Warbler	5 December
Olive-tree Warbler	20 November
Olivaceous Warbler	19 November
River Warbler	8 December
Willow Warbler	2 December
Garden Warbler	13 December
Common Whitethroat	1 December
Barred Warbler	27 November
Rufous Scrub Robin	11 November
Irania	2 December
Thrush Nightingale	28 November
Common Nightingale	15 November
Common Rock Thrush	26 November

Age proportions

Ngulia catches comprise a mix of adult (older than one year) and first-year birds. In most species, first-year birds outnumber adults across the season as a whole by about two to one. However, as shown in Table 8, there are some intriguing species differences. The high percentage of young in Red-backed Shrike (compared to Isabelline Shrike) presumably indicates that adults of the former have mostly passed through by mid-November, before the regular mist season, when catching occurs. The low percentage of young Basra Reed Warblers may reflect the smaller clutch size

in this species than in similar warblers breeding in temperate latitudes (usually three; Kennerley & Pearson 2010). The low percentage of young Iranias is particularly surprising, for the usual clutch size of four is only slightly lower than that of Thrush Nightingale (Cramp 1988). It should be noted that ageing is especially easy in this species.

Table 8. Percentages of first-year birds in Ngulia autumn catches, data from 1974 to 2010.

	Sample size	First-year (%)
Red-backed Shrike	4617	82
Isabelline Shrike	2318	54
River Warbler	11 213	70
Basra Reed Warbler	1341	49
Marsh Warbler	25 279	64
Olive-tree Warbler	1445	55
Willow Warbler	4563	71
Garden Warbler	1581	62
Barred Warbler	1985	52
Whitethroat	8431	58
Thrush Nightingale	7963	71
Common Nightingale	1976	74
Irania	6216	44
Spotted Flycatcher	2199	67

Age proportions may change through the migration period (see Figure 6 and Appendix 6), with adults featuring more strongly up to mid November, and less so during December. But in most species there is broad overlap, with young birds present in early falls and adults still included up to early January. In Red-backed Shrike the

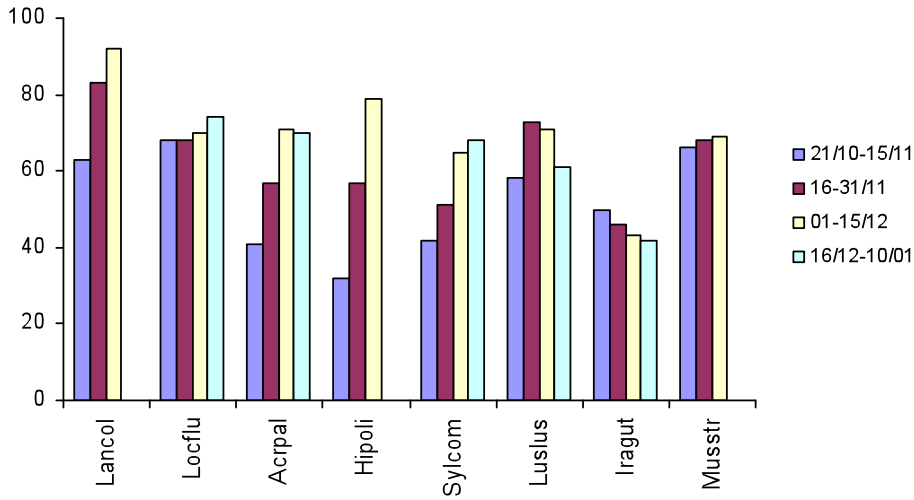


Figure 6. Seasonal change in age proportions. Percentage of first-year birds in samples aged between the dates given.

passage of the two age groups is largely separated, peaking about two weeks later in young birds than in adults. In Marsh Warbler, the median passage date of young birds is about 5 days later than that of adults, and a similar age difference applies in Olive-tree Warbler. But in River Warbler, Thrush Nightingale, Irania and Spotted Flycatcher little or no age difference in passage timing has been found.

Patterns of wing moult

Timing strategy

In Palaearctic passerines that migrate to tropical Africa, adults may complete their annual wing moult on the breeding grounds in late summer, or they may undertake it in Africa after migration, during autumn or winter. In summer moulters, young

Table 9. Primary moult strategy and state of the feathers in Ngulia birds. Timing is shown as S (summer), A (autumn), W (winter) or A–W (divided between autumn and winter). Less common strategies are given in brackets. 'Mixed primaries' implies new inner feathers and old worn outers.

	Moult timing	Adult primaries	First-year primaries (juvenile feathers except where marked*)
Summer moulters			
Blackcap	S	unworn	unworn
Barred Warbler	S	unworn	unworn
Thrush Nightingale	S	unworn	unworn
Nightingale	S	unworn	unworn
Irania	S	unworn	unworn
Northern Wheatear	S	unworn	unworn
Isabelline Wheatear	S	unworn	unworn
Pied Wheatear	S	unworn	unworn
Rock Thrush	S	unworn	unworn
Autumn moulters			
Basra Reed Warbler	A (A–W or W)	new (mixed or very worn)	new* (mixed or worn)
Great Reed Warbler	A	new	new*
Olivaceous Warbler	A or A–W (W)	mixed (all new)	worn or mixed*
Upcher's Warbler	A–W (A)	mixed (all new)	mixed*-new inners
Winter moulters			
Red-backed Shrike	W	worn	unworn
Isabelline Shrike	W (A–W)	worn (mixed)	unworn
River Warbler	W	new outers	unworn
Sedge Warbler	W (A–W or A)	worn (mixed or new)	worn (mixed or new*)
Reed Warbler	W (A–W or A)	worn (mixed or new)	worn (mixed or new*)
Marsh Warbler	W	worn	unworn to worn
Olive-tree Warbler	W	very worn	worn
Willow Warbler	W	slightly worn	slightly worn
Garden Warbler	W	worn	unworn to slightly worn
Common Whitethroat	W (A–W or A)	worn	slightly worn
Rufous Scrub Robin	W or A–W	usually mixed-worn outers	slightly worn
Spotted Flycatcher	W	worn	unworn to slightly worn

birds retain their juvenile flight feathers for a whole year, while in autumn/winter moulters they also moult in Africa, often at the same time as the adults. Because of the two-stage nature of the migration to southern Africa, there is a further choice of wing moult timing. It can take place on the final wintering ground or it can occur earlier, during October–November, in a northeast African stopover area. A further complication is that moult is sometimes divided between two areas, beginning in one and finishing after the next stage of migration.

Birds reaching Ngulia in November–December can have flight feathers (usually newish looking) grown the previous July–August (summer moult), very new feathers grown in northeast Africa in October–November (autumn moult), or old worn feathers still due for renewal (winter moult). Observations at Ngulia have emphasized the importance of the autumn stopover area as a moulting place, for many species arrive with new blackish flight feather tracts fully or partly completed. Some species exhibit a variety of primary moult states, due to different timing in adult and first-year birds, or to different strategies in different populations. Thus, while the majority of adult Common Whitethroats have a full set of old feathers (winter moulters), many show newly grown inner feathers, and a substantial minority show completely new plumage (autumn moulters). Young Common Whitethroats are almost all in unmoulted plumage.

Table 9 shows the wing moult strategy of the main Ngulia passerine species and the state of the flight feathers of adult and first-year birds. The nightingale and chat species are summer moulters, with the sole exception of Rufous Scrub Robin. The shrikes and the majority of warblers are winter moulters which appear at Ngulia with old primaries. Great Reed, most Basra Reed, and some Reed, Sedge and Olivaceous Warblers are autumn moulters, renewing their entire plumage shortly before reaching Ngulia, as do some 15% of the Common Whitethroats (already mentioned above). Other Common Whitethroats and Olivaceous Warblers, some Basra Reed and Reed Warblers, and nearly all Upcher's Warblers arrive partially moulted, with a variable number of new inner primaries.

Willow Warblers uniquely have two complete moults per year, but are treated here as winter moulters as all are approaching moult in November–December. A few other unusual moult behaviours have been revealed at Ngulia. Adult River Warblers renew their outer primaries in the Ethiopian stopover area and appear at Ngulia with new blackish feathers that contrast with the browner inner ones. There is a subsequent complete moult in southern Africa when these outer primaries are renewed again (Pearson & Backhurst 1983). Adult Barred Warblers moult their primaries in summer but this moult is not complete. They retain most of their secondaries and outer tail feathers until after migration, and renew these on the wintering grounds in Kenya and northern Tanzania, a so-called "split flight feather moult" strategy (Lindström *et al.* 1992). Adults at Ngulia thus show some contrasting old secondaries and tail feathers. A similar strategy is seen in many adult Iranias. They renew their primaries and tail during the summer moult, but usually retain most of their secondaries. These may be seen as contrasting faded brown feathers at Ngulia. However, some or all may be replaced in October to November, presumably in northeast Africa, and then appear at Ngulia as very fresh blackish feathers.

Suspension for migration

Among the autumn and winter moulting species, percentages arriving at Ngulia with new, mixed and old primaries are shown in Table 10.

Many of the birds with mixed primaries show no actively growing feathers and have suspended their moult, a sign of their migratory physiological condition. Among moulting warblers, only Upcher's and Olivaceous commonly show actively growing feathers, perhaps reflecting the fact that these two are close to their migratory limit and probably making only short flights across Tsavo.

Table 10. Autumn and winter moulting species. Percentage in November–December with primaries old (O), actively moulting (A), in suspended moult (S) or new (N).

	n	% O	% A	% S	% N
Eurasian Nightjar	625	57.4	41.0	1.6	0
Red-backed Shrike	4463	99.5	0.3	0.2	0
Isabelline Shrike 1	1259	90.4	7.9	0.7	0
Isabelline Shrike 2	556	75.4	17.8	6.1	0.4
Barn Swallow 1	758	40.5	55.1	4.3	0
Barn Swallow 2	267	20.2	71.5	8.2	0
Common House Martin 1	331	6.0	92.1	1.8	0
River Warbler	7188	100.0*	0	0	0
Basra Reed Warbler	1713	19.8	0.8	9.2	70.8
Great Reed Warbler	121	4.1	0	0	95.9
Sedge Warbler	217	83.3	0.5	2.8	12.9
Eurasian Reed Warbler	177	68.4	5.1	11.9	14.6
Marsh Warbler	14 929	99.8	0	0.2	0
Olivaceous Warbler	1133	57.9	11.9	2.7	3.6
Upcher's Warbler	702	5.1	57.0	32.2	5.6
Olive-tree Warbler	1701	96.1	2.8	1.2	0
Willow Warbler	4492	99.3	0.7	0	0
Garden Warbler	1726	95.6	3.8	0.5	0
Common Whitethroat 1	4758	94.5	0.8	4.7	0
Common Whitethroat 2	3400	52.2	2.4	34.0	11.4
Rufous Scrub Robin 1	440	95.5	0.6	3.9	0
Rufous Scrub Robin 2	224	33.9	9.3	56.7	0
Spotted Flycatcher 1	1611	100.0	0	0	0
Spotted Flycatcher 1	663	77.5	19.2†	3.3	0

* All old with respect to the full winter moult; † The primaries moult from the outermost inwards; 1: first-year, 2: adult.

Weights and fat loads

Birds grounded at the Ngulia lights are interrupted in mid migration. The spare fat they carry as fuel is an indication of their potential onward flight range. Fat load can be approximately deduced from body weight, and also assessed by scoring the amount of subcutaneous fat visible beneath the skin of the 'furcular pit' and the abdomen. A simple 1–4 point scoring system employed at Ngulia between 1972 and 1992 was based solely on appearance of the furcular pit (Pearson & Backhurst 1976). But

since 1994, the 0–8 point system of Kaiser (1993) has been used, involving inspection of both the furcular pit and the abdomen. The fat scores reported below are those based on the latter system.

For the main Ngulia species, Table 11 gives weights (range, mean, s.d. and sample size); lean weights (LW — the mean for birds scoring *fat 0*); percentages of birds 20% or more above LW; and percentages of birds scoring *fat 3* (moderately fat) and above and *fat 4* and above. *Fat 4* birds have the furcular pit filled level with fat and the abdomen almost or fully covered.

Table 11. Weights (g), 'lean weights' (LW) and percentages of fat birds, data from 1972 to 2008.

						% with	%	
	Range	Mean	s.d.	n	LW	LW+20%	≥ *f3*	≥ *f4*
Red-backed Shrike	19.4 – 38.5	26.4	2.5	4465	24.7	11	23	9
Isabelline Shrike	19.4 – 32.1	25.0	1.9	2274	24.3	3	8	1
River Warbler	11.9 – 23.5	16.1	1.3	10 564	15.2	7	27	9
Basra Reed Warbler	13.0 – 24.0	16.6	1.7	2200	15.4	14	28	8
Marsh Warbler	8.0 – 18.8	11.2	1.3	15 904	10.4	17	37	19
Olivaceous Warbler	6.6 – 11.8	9.1	0.7	1200	8.9	2	8	0
Upcher's Warbler	9.9 – 15.6	12.0	0.8	740	11.8	0	4	0
Olive-tree Warbler	13.3 – 25.2	17.8	1.9	1769	16.1	22	45	19
Willow Warbler	5.9 – 12.5	8.4	1.0	4819	7.7	16	31	10
Garden Warbler	13.5 – 25.2	18.2	1.6	1688	16.9	11	34	14
Barred Warbler	17.7 – 33.4	22.7	1.9	2022	21.4	7	26	8
Common Whitethroat	10.3 – 21.2	14.5	1.6	7921	13.1	21	44	25
Thrush Nightingale	16.2 – 33.4	22.7	2.0	7397	21.3	9	27	8
Common Nightingale	15.6 – 28.1	20.3	1.8	2031	19.3	7	15	3
Irania	16.2 – 29.9	21.7	1.6	5520	21.2	2	4	1
Rufous Scrub Robin	15.4 – 24.0	19.5	1.4	903	19.0	2	5	1
Spotted Flycatcher	10.8 – 20.2	14.0	1.3	2252	13.3	9	11	3

Certain species have regularly included a substantial proportion of fat birds. The main examples are Marsh Warbler, Thrush Nightingale, Common Whitethroat, River Warbler, Willow Warbler, Basra Reed Warbler, Garden Warbler, Olive-tree Warbler and Red-backed Shrike. Their weights are commonly 20–30% and occasionally 50% above lean weight, and they often score *fat 3* or above. All these species include birds bound for Africa south of 15°S, and many have the potential for onward flights of 1000–2000 km when they cross Ngulia (see, e.g. Pennycuick 1975). Such individuals would presumably normally land, rest quietly by day and resume flight next evening, and would have little need to feed. Other species by contrast are rarely caught at Ngulia more than 20% above lean weight, or with a fat score above *2*. These include Irania, Common Nightingale, Rufous Scrub Robin, Olivaceous Warbler, Upcher's Warbler and Isabelline Shrike. All of these migrate only as far as northern or central Tanzania, and are inevitably near the end of their migration at Ngulia, with little need of reserve fuel. For weights of a full list of Ngulia species see Appendix 4.

Only small changes in weight have been detected over the passage period. The seasonal pattern for five common species is shown in Figure 7, in which mean weights for ten-day periods are plotted, combining data from all years (and see also Appendix 7). Fewer fat birds have been found earlier in November, when species' mean weights

typically average 5–10% lower than in December and early January. Weight peaks earlier in Red-backed Shrike, but most of the passage birds in this species have already moved through by early December.

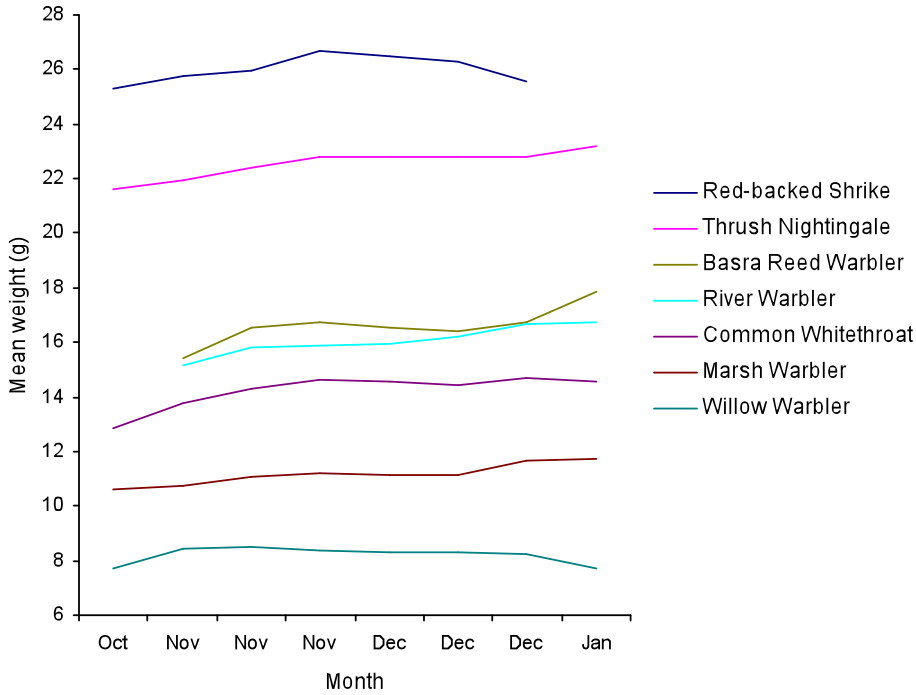


Figure 7. Seasonal variation. Mean weight (g) plotted against 10-day periods, from 22 October to 9 January.

Annual weight fluctuations

There have been marked weight differences between years, suggesting changes in migration strategy, presumably in response to weather patterns and feeding potential further north. Over the last two decades, 1994, 1997, 1999, 2004 and 2009 were years when more high weights than usual were noted in a range of species. Most of the year-to-year changes in mean weight recorded in individual species have been highly significant ($p < 0.001$). Figure 8a traces the yearly mean weights of Marsh Warbler and River Warbler from 1972 to 2011, and shows a remarkable correspondence between these two species. This would support the assumption that they are closely associated in habitat and feeding requirements on passage through eastern Africa. The annual weight trace peaks in both species in 1997, an El Niño year with heavy autumn rains in northeast Africa, and again in 1999 and 2009.

The yearly mean weight traces of four other species from 1991 to 2011 (Figure 8b) show slightly different patterns, three with a pronounced peak in 1994. Those of Irania and Thrush Nightingale mirror one another surprisingly closely, which might reflect a similarity in their food and feeding strategy. (See also Appendices 8a, 8b.)

Hourly weight changes

Mean weights through the night and morning, and for smaller samples through the afternoon, are shown for the four main night migrants in Figure 9 (and see Appendix 9).

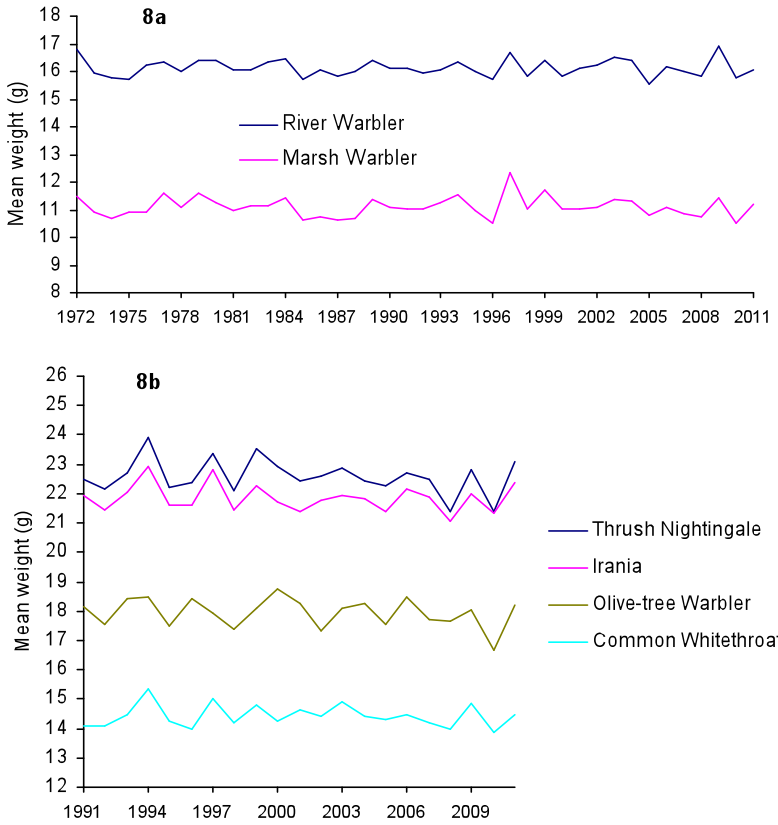


Figure 8. Annual weight variation. Mean weight (g) plotted against year.

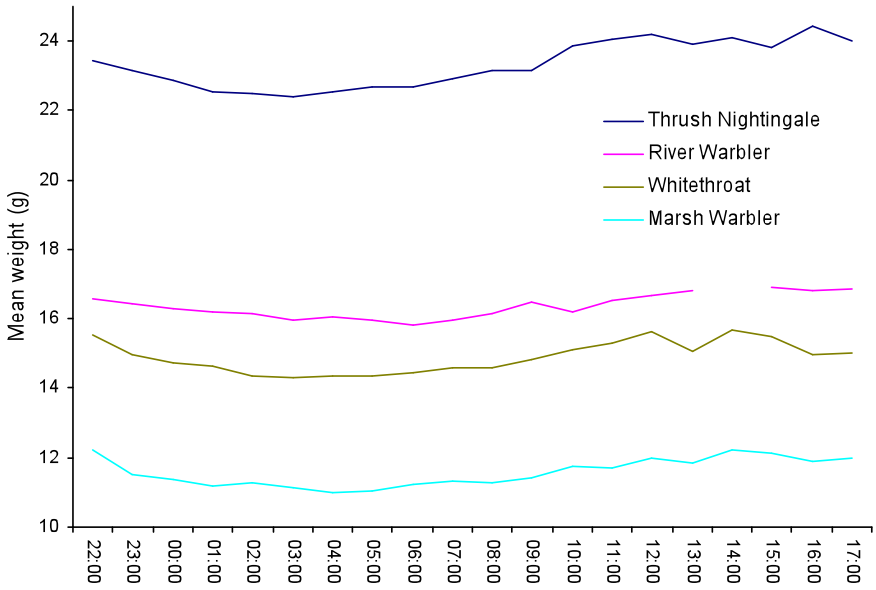


Figure 9. Hourly weight changes. Mean weight (g) plotted against time of night or day.

These decreased through the night, then built up with feeding through the morning. Mean weights decreased most rapidly before 02:00 and reached a minimum in most species an hour or two before dawn. The difference between this minimum and the maximum maintained during the afternoon was 8–10%.

Other factors affecting weights and fuel loads

It was reported earlier (Kelsey *et al.* 1989) that first-year Marsh Warblers tended to be lighter than adults. This is confirmed in Table 12, which shows a similar marked age difference in Olive-tree Warbler, but little or no difference in five other species examined.

Table 12. Weights (g) and percentagte of fat birds: first-years and adults compared.

	First-year				Adult			
	mean	s.d.	n	% ≥ *f4*	mean	s.d.	n	% ≥ *f4*
Red-backed Shrike	26.31	2.44	3607	7	26.61	2.67	814	12
River Warbler	16.03	1.34	7084	9	16.08	1.28	3079	7
Marsh Warbler	11.08	1.19	15 617	15	11.43	1.36	8626	25
Olive-tree Warbler	17.54	1.73	783	12	18.37	1.88	630	27
Willow Warbler	8.32	0.96	2921	10	8.39	0.97	1185	11
Common Whitethroat	14.51	1.54	4597	24	14.55	1.63	3157	26

The weather in which birds are grounded at Ngulia at night has also had a noticeable effect on the weights recorded. Birds arriving in very wet conditions have tended to be heavier and carrying higher fat loads. Table 13 compares weights of Marsh Warblers for combined dates grouped according to the night weather conditions.

Table 13. Weights (g) of Marsh Warblers after various night weather conditions.

Overnight conditions	Mean	s.d.	n	% with LW+20%
Clear	11.01	1.11	628	9.7%
High cloud only	11.07	1.18	886	12.8%
Low cloud	11.15	1.18	1968	12.7%
Mist (± showers)	11.18	1.25	21 422	15.7%

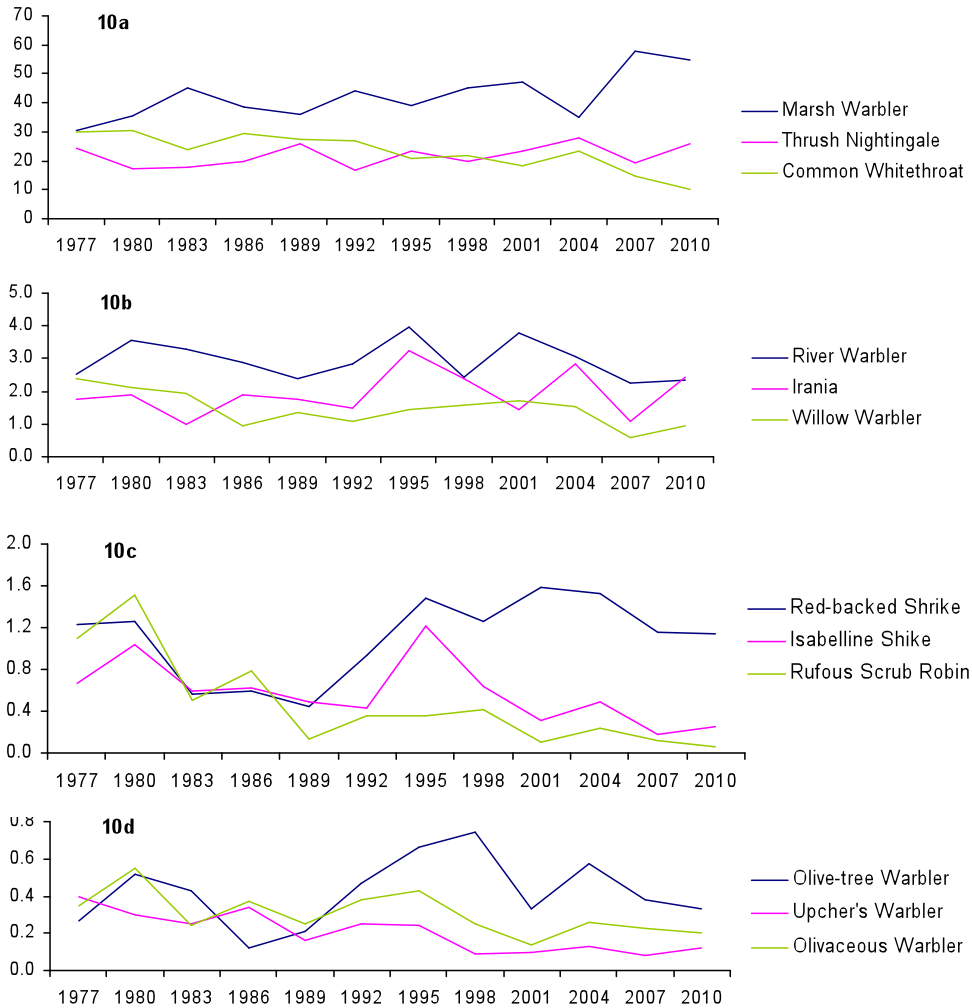
Both mean weight and the proportion of distinctly fat birds (≥20% above lean weight) were significantly higher after heavy rain than in other conditions ($p < 0.001$), which suggests that this brought down birds with potential for longer flights, and which were otherwise resistant to the attraction of the lights. Can it be that heavier birds normally tend to migrate at higher altitude? Higher weights have also been noted in other species on very wet nights, for example in Common Whitethroat, River Warbler and Thrush Nightingale. The use of taped song attraction appeared to have little effect on weights. In 2001, sound was used on alternate nights throughout No-

vember and December ringing sessions, whether or not there was mist. Mean weights of Marsh Warblers were: for 12 nights with taped sound, 11.01 ± s.d. 1.00 g (n = 317); for 17 nights without sound, 11.10 ± s.d. 1.03 g (n = 260). The difference was not significant ($p > 0.05$).

Long-term trends

With experience, and trapping figures from Ngulia over 40 years, we can examine whether there have been any long-term trends. Have there been changes in the magnitude of Palaearctic arrivals at the lights, or in their composition? Have some species become more abundant relative to others?

During the 1970s, falls were often estimated to have grounded tens of thousands of birds, and some of them hundreds of thousands, within a few hundred metres of the Lodge lights. With such numbers involved even a substantial diminution in passage density in more recent times could go unnoticed, especially since the power



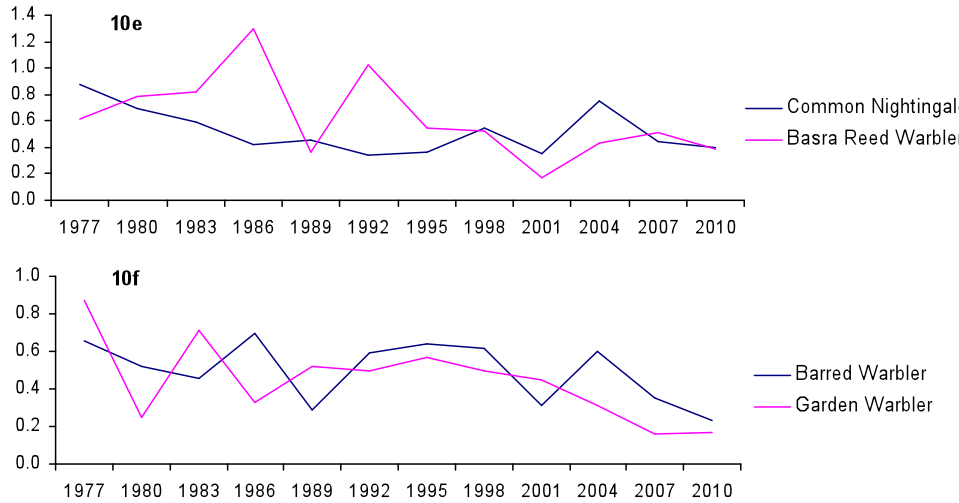


Figure 10 a–f. Percentage contributions to Palaearctic passerine 3-yearly catches.

and positioning of the lights is now different. Certainly, far fewer birds now enter the Lodge during mist, and fewer appear on its southern side, but this could be explained by the focus of the lighting having shifted slightly further out from the north side of the building. Huge falls still occur, involving tens of thousands of birds, when date, moon and mist conditions are right. One arrival after an unusually severe thunder storm with torrential rain on 12 December 2007 had brought down scores of rollers by midnight and filled every bush on the lighted side of the Lodge with small birds, and this was considered the largest fall seen for over 30 years. So the anecdotal indications do not confirm any major decline in the volume of these Tsavo movements.

The raw trapping numbers cannot give comparisons from one decade to another because of changes in the power and positioning of the lights, and mode and scale of the night and daytime ringing operations. However, changes in the species composition of catches over the years, and thus species' relative abundance, do suggest some trends. Ringing totals from 1976 to 2011 have been grouped into three-year periods (this largely offsets the annual shift in peak trapping activity due to change in new moon date). For each period, the catch of each species is expressed as a percentage of the total of all Palaearctic passerines less that of hirundines (as these are mainly day-caught feeding birds). Results for 16 species are plotted in Figure 10 (a–f).

Among the main species, Marsh Warbler has become more dominant over the years, especially recently, when it has formed about 50% of the catch. The contribution of Thrush Nightingale has remained at about 20%, but that of Common Whitethroat has fallen, from about 30% in the 1970s–80s to 15% or less since 2006 (Figure 10a). Among other frequently caught species, River Warbler and Irania show no clear long-term change (Figure 10b), but Willow Warbler contribution does appear to have declined since 2005. An increased emphasis on the dawn catch has resulted in more shrikes from 1995, but whereas the contribution of Red-backed has held up since then at about 1–1.5% (Figure 10c) that of Isabelline has fallen markedly. The ratio of Red-backed to Isabelline, close to 1:1 in earlier years, is usually now about 5:1. Rufous Scrub Robin (see also Figure 10c) is another species that now occurs far less frequently than formerly. The two *Hippolais* species are compared in Figure 10d. Relative to overall

numbers, catches of Olive-tree Warbler have been maintained but those of Upcher's Warbler have clearly declined since 1995. Basra Reed Warbler has attracted concern because of the drainage of some 85% of its breeding marshes in Iraq during the mid to late 1990s, though since 2003 this has been partially reversed (e.g., Richardon & Hussain 2006). Its contribution to Ngulia catches has fluctuated markedly from year to year, but does show a general decline of some 30–50% since the 1970s–80s (figure 10e). A distinct trough around the turn of the century may well reflect events in Iraq.

The Marsh Warblers and Thrush Nightingales occurring at Ngulia are drawn from across their world populations and these would appear to be stable, or perhaps increasing in the case of Marsh Warbler due to expansion to the north and northwest (BirdLife International 2012, Vickery *et al.* 2014). Comparison of catches of other species with those of Marsh Warbler or Thrush Nightingale should therefore give some guide as to any long-term change in their actual numbers crossing Ngulia. On this basis, since the 1980s, Common Whitethroat numbers and probably those of Willow Warbler and Basra Reed Warbler have decreased. Rufous Scrub Robin and Isabelline Shrike have decreased even more obviously, but as these are near their southern migration limit this could reflect a change in wintering pattern rather than of population size. The same rationale could be applied to the evidently lower numbers of Upcher's Warbler and Barred Warbler (Figure 10f), although Vickery *et al.* (*op. cit.*) report a 48% decline for the latter in Europe. For other species in Fig 10 the numbers now crossing Ngulia would seem little changed from the early study years. The steady contribution of River Warbler to Ngulia catches appears to belie the 62% decrease reported for Europe by Vickery *et al.* (*op. cit.*).

Discussion

Migration strategy and stopover questions

The northern tropics of Africa, with rainfall during August to September, provide an important reception area for Palaearctic migrants after their crossing of the Saharan/Arabian desert belt in early autumn. Many of the passerine species ultimately bound for equatorial or southern wintering latitudes linger there for several weeks before continuing migration. In northeast Africa, the main influx across the Red Sea coast is during late August and September, but few species reach Kenya before late October and early November (Pearson *et al.* 1988, Pearson 1990). The intervening period represents much more than a refuelling pause. Northeast Africa is effectively a first wintering ground where some species appear to occupy territories and evidently complete moult processes. But details of movements and behaviour there have been little studied. Do most birds progress slowly south, occupying successive territories, or do they tend to remain for weeks at one site?

Where in northeast Africa do Ngulia migrants spend the months of September and October? The local areas concerned would clearly be strong candidates for protection given the general trend across Africa of land use change and habitat degradation. Two Thrush Nightingales fitted in Sweden with light-level geolocators appeared to be sedentary for over a month in eastern Sudan (Stach *et al.* 2012), but this species also occurs quite widely at this time in west and central Ethiopia (Ash 1980). The single mid October recovery of an Ngulia bird was from western Ethiopia, about 200 km west of Addis Ababa, and this is probably where the main stopover concentrations should be looked for.

The majority of Marsh Warblers enter Africa across the southern part of the Red Sea coast (Nikolaus 1983, Dowsett & Dowsett-Lemaire 1987), thus heading into northern Ethiopia. For two months most of the population remains within an undiscovered stopover area where birds undergo body moult. In Kenya, the preference of this species is for damp valleys at medium altitude with leafy herbaceous and low bush vegetation (Pearson 1982), and it seems likely that October concentrations will be discovered in Ethiopia in similar situations west of the Rift Valley. Relatively few have been trapped in the Rift itself despite extensive ringing there (Ash 1980) and none was found in October searches of river valleys in southeastern Sudan (G. Nikolaus and DP, unpublished). African bird sounds identified in the imitative song of Marsh Warbler indicated time spent in the western part of Ethiopia (Dowsett-Lemaire 1979).

There are still few River Warbler records from Ethiopia (Ash & Atkins 2009), but the bulk of the world's population must spend a long autumn period there, probably in the west, alongside Marsh Warbler. In Kenya, these two species occur together in the same moist herbaceous situations. Stable isotope studies of newly grown feathers of Marsh Warblers and River Warblers caught at Ngulia in November indicated that the two species had grown these feathers in a similar higher rainfall stopover area (Yohannes *et al.* 2007).

Some of the other migrants reaching Ngulia undoubtedly arrive by a different route. In early autumn, Iranias and Basra Reed Warblers are known in Ethiopia mainly from the Rift Valley (Ash & Atkins 2009). Common Whitethroats at Ngulia differ from those that occur on passage on the Sudan coast, for adults of the latter commonly show some inner primaries newly moulted in the Palaearctic (Nikolaus & Pearson 1991). Ngulia birds are presumably of more eastern origin, reaching Kenya via central and perhaps eastern Ethiopia. The stable isotope profile of newly grown feathers collected at Ngulia from Common Whitethroat, Olive-tree Warbler and Irania has indicated a different, more arid stopover area than that used by Marsh Warbler and River Warbler (Yohannes *et al.* 2007). Other drier country species known to occur in early autumn along and east of the Ethiopian Rift include Upcher's Warbler, Spotted Flycatcher and Rufous Scrub Robin.

Onward migration through eastern Africa is largely completed during November and December. Many birds then break their journey in east central and southeast parts of Kenya. The Tsavo bushlands, for example, tend to hold quantities of migrants for about a month from the end of November. Some of these birds may be progressing south in short stages, but others appear to have a lengthy pause, using Kenya as a second African stopover area. Thus the two Thrush Nightingales tracked with geolocators both paused for about a month in November, apparently in northern Kenya (Stach *et al.* 2012).

At Ngulia, each species shows a characteristic passage timing, presumably part of a programmed journey to southern Africa. Most birds grounded by the lights are evidently in a migratory state. All appear to be in good body condition, most show suspension of any moult in the flight feathers and almost all depart next night. Although some may be moving between local transit sites, those carrying higher fat loads are presumably embarked on longer journeys to the south.

Questions regarding attraction to the lights

The few kilowatts of isolated halogen light at Ngulia Lodge can sometimes attract tens of thousands of migrants over a few hours, but only when a covering of low cloud above the building (or sometimes drizzle or rain) is producing a glow of dif-

fused light. Competition from even a small partial moon largely abolishes the effect. Are the attracted birds disorientated below a cloud layer, or 'lost' in cloud over the Lodge, or are they migrating well above the cloud layer until they deliberately descend to the pool of light? On many productive nights the last would seem to be the case, for birds are often seen to arrive through a cloud layer so thin that occasional stars can be glimpsed. Attempts to see birds flying above the Lodge against the face of a large moon have never produced results, and experiments with sound on clear nights have grounded practically no birds. So it would seem that under such conditions migrants are passing south high overhead and well above the Ngulia ridge. The delayed arrival through mist when a large moon sets would then also be explained. Once birds have descended through cloud to near ground level it may be that the local topography, with the north–south escarpment immediately east of the Lodge, is in some way important in channelling them.

If birds are attracted to the Lodge lights from broad overhead migratory traffic then we can attempt to estimate the width of the east–west corridor from which they are derived. Well over 10 000 birds have arrived at Ngulia on some busy nights, and we could take this figure as a minimum estimate of the nightly passerine traffic within attractive range of the lights during the main migration. This would give at least half a million birds (say 200 000 Marsh Warblers) passing along this corridor of attraction during November–December — thus 1% or more of the estimated world population of about 20 million Marsh Warblers (see Schulze-Hagen 1997, BirdLife International 2012). Since most of these Marsh Warblers appear to cross southeast Kenya on a front about 150 km wide (Pearson *et al.* 1988) this gives a conservative crude estimate of the lights' corridor of attraction as 1 to 2 km wide — but more if we assume that only lower flying birds are brought down.

Radar tracking has been an important tool for studying densities, directions and altitudes of bird migration in Europe and the Mediterranean region (see, e.g. Bruderer 1994, 1997) and has been applied to migration across the eastern Sahara (Biebach *et al.* 2000) and Mauritania (Schmaljohann *et al.* 2007). This technique is now in use at Ngulia over the 2013/2014 season, and should provide answers to some unanswered questions. In particular, at what height and in what direction are south-bound migrants travelling over the Lodge in clear conditions, and how are these modified by mist and lights? What is the 'normal' density of migration over the Lodge during November and December, and how is this affected by mist and lights, with and without moon? When concentrated by the lights does movement occur broadly above the Lodge or is it channelled, for instance, along the escarpment edge?

Potential role of Ngulia in population monitoring

Numbers of many passerine breeding species have declined across west and central Europe over the past 40 years, and decreases have been particularly marked in long-distance migrants wintering in sub-Saharan Africa (Berthold *et al.* 1998, Sanderson *et al.* 2006, Heldbjerg & Fox 2008, Vickery *et al.* 2014). The same may well be true of passerines migrating to Africa from eastern Europe and Asia, but relatively little information exists on population trends in these more eastern breeding areas. Ngulia is uniquely placed for sampling Palaearctic migrants that use the southeast Kenyan flyway, and this mainly involves birds breeding in eastern Europe, Siberia, and central and southwest Asia. Any serious wide-ranging population declines should be reflected in a change in the size and/or species composition of Ngulia catches. Already, from trends noted at the Lodge over the past 20 to 30 years, we have strong

indications of a decrease or changed migratory pattern in Common Whitethroat, Rufous Scrub Robin, Isabelline Shrike, Upcher's Warbler, Willow Warbler, Basra Reed Warbler and Barred Warbler. It is important that the ringing programme is continued at the Lodge over new moon periods in late November and/or early December, preferably by both night and day, with the arrangement of lights and nets maintained as constant as possible.

Acknowledgements

For permission to ring birds at Ngulia and for free park entry we are most grateful to the former Director of the Kenya Wildlife Conservation and Management Department Dr Perez Olindo, to senior Tsavo West wardens including Ted Goss, Bill Woodley and James Isiche, and to former KWS directors Dr Richard Leakey, Joe Kioko, Dr David Western and Dr Julius Kipng'etich; more recently, Dr Robert Muasya has been most helpful in facilitating these arrangements.

Past and present managers of Ngulia Safari Lodge have been very helpful, together with their staff, in accommodating us and giving assistance in many different ways. We are most grateful to them all.

From 1990 we have used Stockholm Museum rings for Palaearctic birds and we thank the Swedish Ringing Centre for allowing this, and the late Roland Staav and more recently Thord Fransson, Lina Jonsson and Tuomo Kolehmainen for their speedy service in reporting recoveries and controls to us.

For ongoing financial assistance since 1993, which has enabled young Kenyans to take part, and facilitated the purchase of rings and sundry pieces of equipment, we are most grateful to the Wetland Trust. For financial help in earlier years we thank the Frank M. Chapman Fund, Dr Karl Schulze-Hagen and the Deutsche Ornithologen-Gesellschaft (DO-G). Since 2000, generous contributions have also been received from all the ringing participants from overseas.

Over more than 40 years the ringing operations at Ngulia have been assisted and supported by a great many people. Some key team members have taken part in total for many days, weeks or even months. These are Bernard Amakobe, Susanne Åkesson, Francis Argyle, Daphne Backhurst, Leon Bennun, Herman Bernitz, Zephne Bernitz, Hazel Britton, Peter Britton, Pete Carr, Miles Coverdale, John Cranfield, Dirk De Mesel, June Dirks, Anna Forbes-Watson, David Gitau, Dennis Hasselquist, Marc Hebbelinck, Anders Hedenström, Franziska Hillig, Titus Imboma, Alain Jacot, Pete Jennings, Sylvester Karimi, Ian Kerton, Andrew Kinzer, Kerry Leonard, Adrian Lewis, Jerry Lewis, Åke Lindström, Brian Manton, John Musina, Bob Medland, David Murdoch, Martha Mutiso, Nicodemus Nalianya, Gerhard Nikolaus, Minna Nikolaus, Mercy Njeri, Maggie Pearson, Steve Piotrowski, Lyndon Roberts, Norbert Roothaert, Ludo Roothaert, Richard Seddon, Mary Sinclair, Trevor Squire, Janette Troop, Bennie van den Brink, Patrik Wildjang, Barry Williams, Sergei Yerokhov.

Finally, we thank Edward Khounganian for producing Map 1 and the recovery maps and Andrew Kinzer and A Rocha Kenya for assistance.

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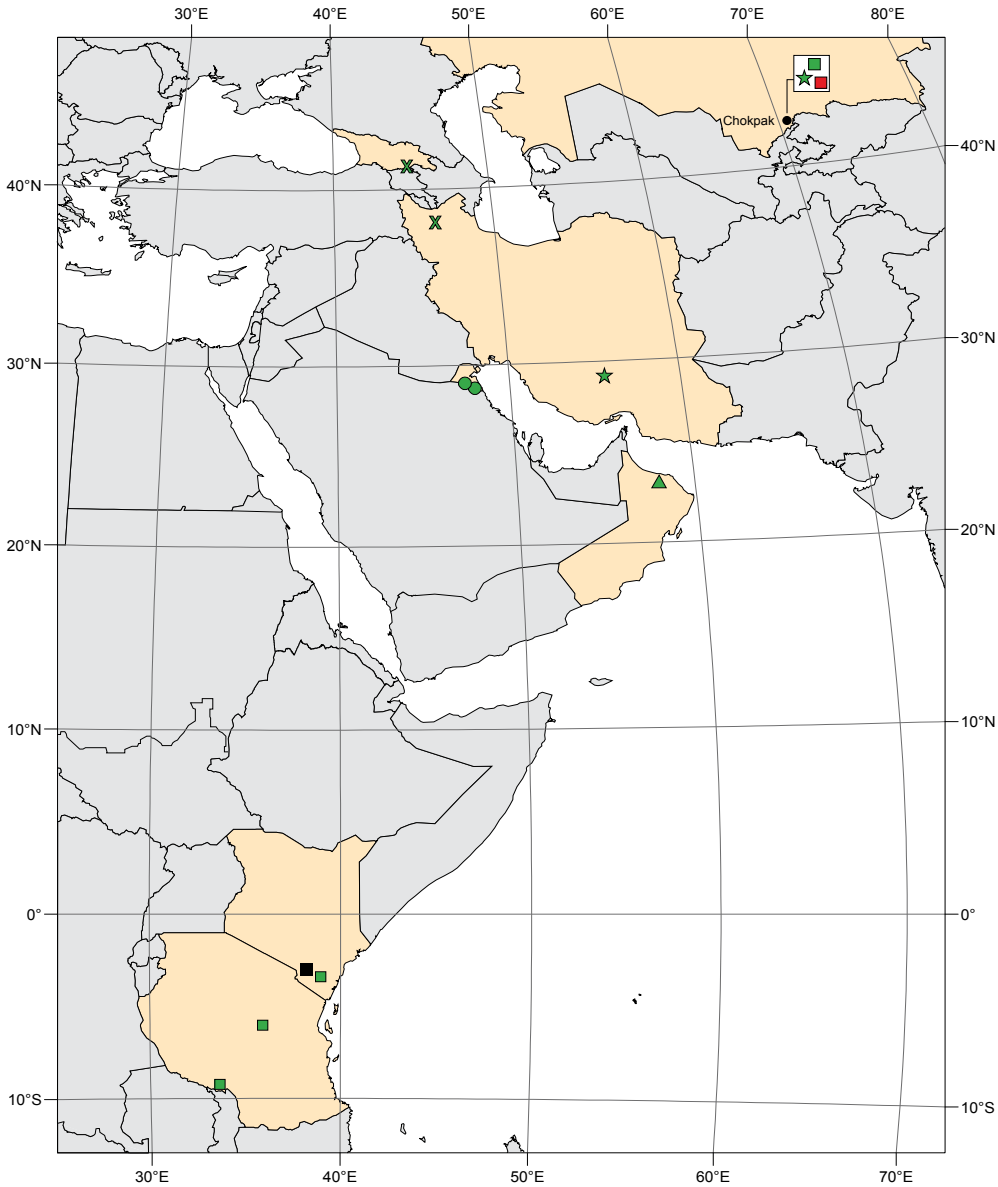
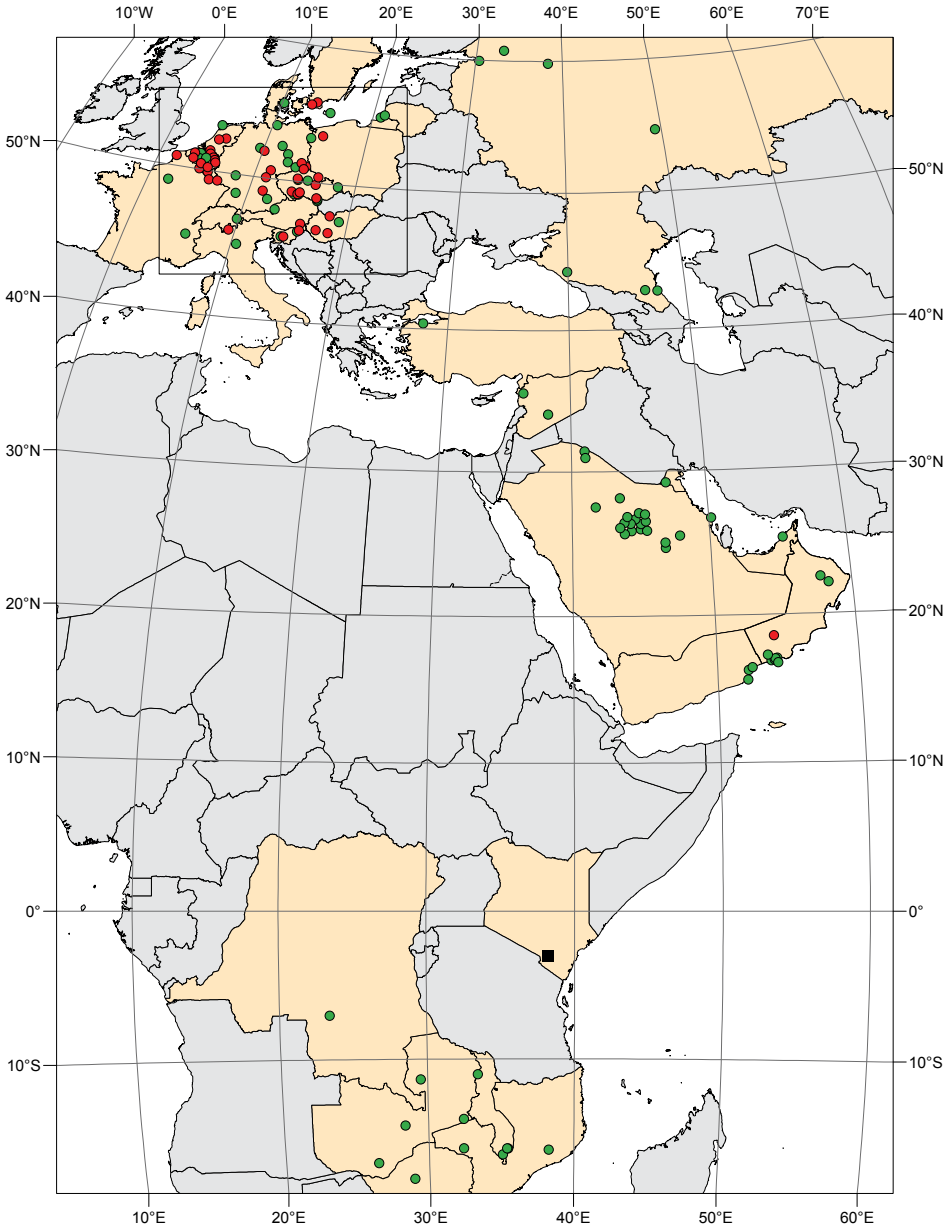
Recovery maps

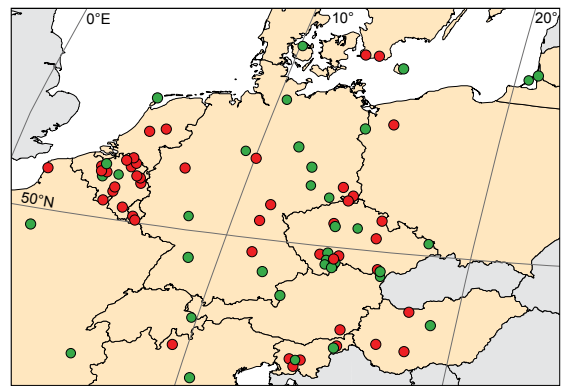
Maps 3a – 3d

Recoveries and controls of Palaearctic birds affecting Ngulia. These conventions are followed on all the maps: Ngulia Lodge is shown as a small black square; green symbols represent the finding sites of birds ringed at Ngulia; red symbols represent the ringing sites of birds found at Ngulia. Countries affected are coloured buff.

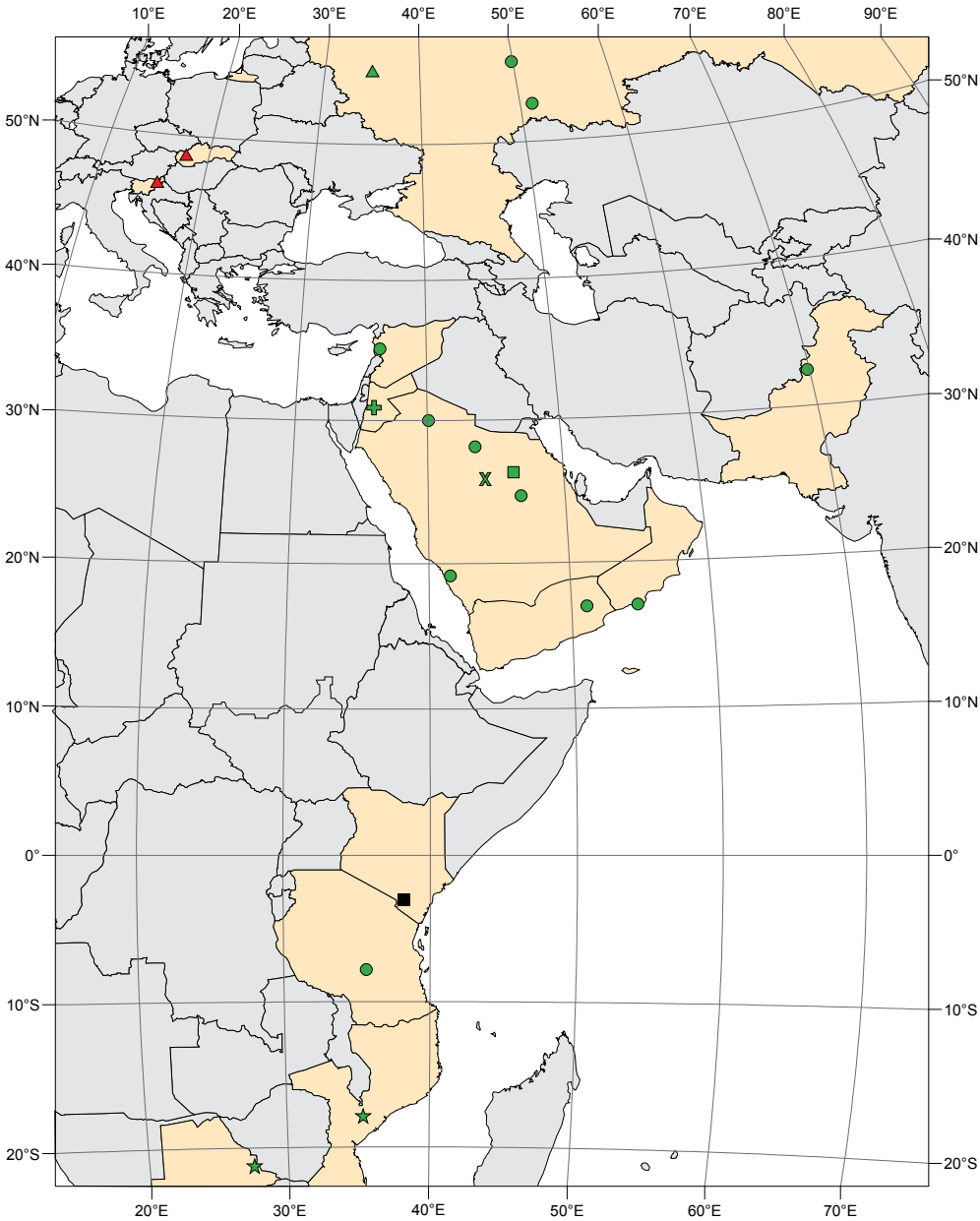


Map 3a. Eurasian Nightjar *Caprimulgus europaeus* star, Eurasian Roller *Coracias garrulus* triangle; each symbol represents one recovery or control. Barn Swallow *Hirundo rustica* squares; at Chokpak, in Kazakhstan, there have been four controls of Ngulia-ringed birds and two Chokpak-ringed birds have been controlled at Ngulia. Red-backed Shrike *Lanius collurio* **X** and Isabelline Shrike *Lanius isabellinus* circle; each symbol represents one recovery or control. Chokpak is shown by a black circle.





Map 3b, above and right, Marsh Warbler *Acrocephalus palustris*. Each circle represents one recovery or control.



Map 3c. Basra Reed Warbler *Acrocephalus griseldis* square, Olive-tree Warbler *Hippolais olivetorum* star, River Warbler *Locustella fluviatilis* triangle, Garden Warbler *Sylvia borin* **+**, Common Whitethroat *Sylvia communis* circle, Barred Warbler *Sylvia nisoria* **X**. Each symbol represents one recovery or control.

Map 3d. Thrush Nightingale *Luscinia luscinia*. Each circle represents one recovery or control.