Annual cycle, timing and speed of migration of a pair of Lesser Spotted Eagles (*Aquila pomarina*) – a study by means of satellite telemetry

Jahreszyklus, Terminierung des Zuges und Zuggeschwindigkeit bei einem Schreiadlerpaar (Aquila pomarina) – *eine satellitentelemetrische Untersuchung*

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1. Introduction

In recent years a great amount of new information had been acquired on the remarkable long-distance migration of the Lesser Spotted Eagle (LSE) *Aquila pomarina* using satellite telemetry (ST) (Meyburg et al. 1993, 1995, 2000, 2001, 2007b, 2008). Much of the early data was collected by tracking nine birds fitted with battery-powered transmitters (platform transmitter terminals, PTTs). Because of their limited life-span, the output from these battery-powered PTTs could be received from only a few locations (circa 100). As a result, the migration routes, especially the homeward ones, were tracked without many specific details.

Since 1996 we have been able to use many solar-powered PTTs. These transmitters can supply much more data than the battery-powered PTTs, thereby allowing a far more detailed study of the migration to be made. Until now, information on the migration and wintering behaviour of only two birds, an adult male from Slovakia and a German juvenile, equipped with this type of transmitter have been published (Meyburg et al. 2004, 2008). Previously it has not been possible to equip both members of a pair with transmitters. This is the first time that a pair of this species has been equipped with PTTs, herby enabling the migration routes of both birds to be monitored with unprecedented precision.

2. Methods

Since 1969, a nest site of LSEs, known since 1961, has been observed continuously by J. Matthes (pers. comm.) This nest site (54°11'N / 12°42' E) is located in north Germany, approximately 36 km east-north-east of Rostock, and on the north-western limit of the species' breeding range.

On 6 July 1997, both adults were caught, ringed and each fitted with a 35 g Argos solar-powered PTT (ID-No. 27999 and 28000) (PTT-100, Microwave Telemetry, Inc. USA). We used the Dho-gaza method to trap the adults (Bloom 2007, Meyburg et al.

2005, 2007a). By this method the eagles attacked a live Sea Eagle *Haliaeetus albicilla*, tethered to a perch in front of a mist net, and became entangled in the net. The transmitter was fitted to each bird as a backpack using Teflon ribbon (Meyburg & Fuller 2007, Meyburg & Meyburg 2007).

On 18 July 1998, the male was re-captured at the nest site and fitted with a new identical transmitter (ID number 06970) because the original PTT had become detached from the bird and lost. The transmitters were programmed for continuous operation, provided that there was sufficient light to generate the required power.

Because the departure date from and the duration of stay at the breeding territory, and possibly, the duration of the autumn migration depend on whether the adult birds successfully raise a young eagle until its independence, breeding success was also controlled each subsequent year. In addition to direct observation at the nest site we also observed LSEs during February 1999 at the male's wintering grounds in Zambia.

2.1 Data analysis

We used the Argos satellite system to radio track the birds. Argos is a polar orbiting-based system that collects and processes environmental data, including location estimates, from autonomous PTTs and distributes the data to users (Argos 2008, http://www.argos-system.org/manuel/).

All location data were analysed individually and entered into databases when considered appropriate. For many calculations, e. g. cross-country speed, we only used standard locations (LC 3, 2 and 1) with an estimated accuracy of 150, 350 and 1000 m, respectively. Sometimes we also used LC 0 locations with an accuracy of less than 1000 m, depending on the purpose of the calculations.

We used the ArcView 3.3 Geographical Information System (ESRI, Redlands, CA, USA) (GIS) to manage and analyze geographical data after importing locations into ArcView. We also used Mapit (Allison 1997) to plot Argos locations, measure distances between the locations and trace the migration routes. Mapit is an integrated global mapping and digital display system that computes the great-circle distance from one point to another while dynamically displaying both great-circle and rhumb lines. Great-circle distances are the physically shortest distances on a globe.

Distances between the wintering and summering areas and their segments were calculated as the sum of the great circle distances between all adjacent Argos locations.

3. Results

The male's first PTT provided information in its locations for almost six months (6 July – 30 December 1997) and its second transmitter provided information for 16 months (18 July 1998 – 14 November 1999). The transmitter attached to the female provided information for 18 months (1 July 1997 – 27 January 1999). Overall all three transmitters supplied information to 3,641 locations.

In 1997, 1998 and 1999 a nestling was reared to fledging. In 1999 we observed the transmitter-carrying male eagle at the nest site. Its female had no transmitter. We

could not establish whether this bird was the female that had been equipped with the PTT. In 2000 as many as four birds were present simultaneously at this nest site. No breeding took place and we could not establish whether the two birds, that had originally been equipped with transmitters, were among them.

During the female's spring migration in 1998, all her overnight roosting locations could be identified accurately, with the result that the daily flight distances flown could be calculated for the whole journey (Meyburg et al. 2007b). This was also possible, but not as exact, for the autumn migrations of both birds in 1997. The recordings of the autumn migration of both birds in 1998 and the male's spring migration in 1999 were less precise. The male's autumn migration in 1999 was tracked until contact discontinued while the bird was in Uganda.

The pair migrated separately and wintered each time approximately 1000 km apart.

Fig. 1: Annual cycle of the male. *Der Jahreszyklus des Männchens.*

Fig. 2: Annual cycle of the female. *Der Jahreszyklus des Weibchens.*

3.1 Annual Cycle

The annual cycles of both birds (Figs. 1 and 2) clearly differed, the difference being the result of the 2000 km greater distance flown by the female. The amount of time spent by each partners at the nest site was almost identical. In 1998, the female spent almost half of the year (48 %) on migration, 43 % at the nest site and only 9 % in its winter quarters (Table 2 and Fig. 2). In the course of a year (from 29 September 1998 to 29 September 1999), the male spent most of his time at the nest site (44 %), 35 % on migration and 21 % at his wintering grounds (Table 1 and Fig. 1).

3.2 Migration Routes

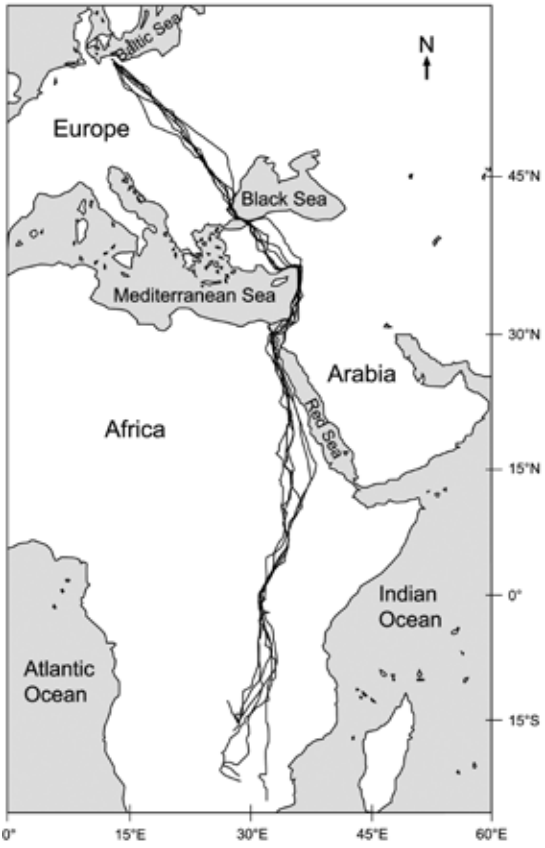
Figure 3 shows all the recorded routes used by the birds in both directions. Both birds reached Suez by flying around the Eastern Mediterranean and on-to the African continent by almost identical routes. Thereafter they flew almost directly to their wintering grounds. In Africa, as far as Zambia, their flight paths ran within a relatively narrow corridor. At different stages of the journey, the width of the corridor, measured by

Table 1: Time period and duration of different phases in the annual life cycle of the male Lesser Spotted Eagle. *Zeitraum und Dauer verschiedener Phasen im Jahreszyklus des Männchens.*

Phase of the year	Time period	No. of days
Autumn migration1997	20.9.1997 – 3.12.1997	75
Autumn migration1998	29.9.1998 – 11.12.1998	74
Overwintering	11.12.1998 – 26.2.1999	77
Spring migration1999	26.2.1999 – 21.4.1999	54
Stay in breeding territory 1999	21.4.1999 – 28.9.1999	160

Table 2: Time period and duration of different phases in the annual life cycle of the female Lesser Spotted Eagle. Zeitraum und Dauer verschiedener Phasen im Jahreszyklus des Weibchens.

Phase of the year	Time period	No. of days
Autumn migration1997	21.9.1997 – 17.1.1998	119
Overwintering	17.1.1998 – 21.2.1998	34
Spring migration 1998	21.2.1998 – 25.4.1998	64
Stay in breeding territory 1998	25.4.1998 – 30.9.1998	157
Autumn migration1998	30.9.1998 – 10.1.1999	103



the distance between the most eastern and western flight paths, varied. For example, over Lebanon and Israel, the width of the corridor was between 45-50 km, 70 km over Uganda, 280 km over Rumania and 450 km over Sudan and Eritrea. Because only the female went to Zimbabwe, the distance between the most western and eastern routes was 600 km.

3.3 Distances covered during migration and annual journeys

The distances flown by the male between the breeding territory and wintering grounds were 9,354 km (spring 1999) and 9,941 km (autumn 1997). For the female the distances were 10,753 km (spring 1998) and 11,351 km (autumn 1997) (Table 3). In 1997,

Fig. 3: All migration routes of both birds combined. *Alle Zugrouten beider Vögel kombiniert.*

Table 3: Migration times, duration, total flight distance, daily flight distance and migration and rest days of the pair of Lesser Spotted Eagles. *Zugzeiten, Zugdauer, gesamte Zugstrecken, Tagesstrecken sowie Zug- und Rasttage der Schreiadlerpaares.*

	Time period	Duration in days	Total km	Average speed across the whole migration in km/day	No. of days with recorded flight distance	Recorded migration days (rest days)	Average daily flight distance when migrating in km (min. & max.)
Autumn migration male 1997	20.9.1997 – 3.12.1997	75	9941	132.5	72	47 (25)	204 (55 – 373)
Autumn migration male 1998	29.9.1998 – 11.12.98	74	9378	126.7	27	26 (1)	172 (40-311)
Autumn migration male 1999	(29.9.1999-13.11.1999) [1)]	(46)	(7344)	(159.6)	15	13 (2)	(298) (154-400)
Spring migration male 1999	26.2.1999 – 21.4.1999	52	9354	179.9	1	1	–
Autumn migration female 1997	21.9.1997 – 17.1.1998	119	11351	95.4	114	63 (51)	173 (15-391)
Autumn migration female 1998	30.9.1998 – 10.1.1999	103	11373	110.4	76	54 (22)	172 (25-521)
Spring migration female 1998	21.2.1998 – 25.4.1998	64	10753	168.0	64	51 (13)	211 (18-406)

[1)] Autumn migration incomplete (only recorded as far as Uganda)

the male made a detour on its autumn journey over Zambia, so that the total distance covered was over 500 km longer than in the following year.

The main differences between the distances flown by the male and the female were the respective winter destinations reached in the autumn, as well as the starting points in spring. The final place of destination (starting-point of wintering) was defined as that from which the bird did not proceed further south. The starting point of the return migration in spring (point of departure) was defined as the location in the wintering area from which the bird suddenly began to migrate north after having rested there for some time. The final place of destination of the outward (southward) journey and starting-point of the homeward (northward) journey were quite distant from each other, due to the female's large wintering area.

The overall yearly distance flown by the female, including her movements while at her wintering grounds, was at least 23,484 km in 1997/98. The overall distance flown by the male in 1998/99 was at least 18,732 km.

3.4 Wintering grounds

We defined the wintering grounds as the southernmost points reached, and where the birds lingered for any length of time. Lingering areas located further north were defined as resting places.

At the end of the autumn migration in 1997 the female spent the winter roving round southern Zimbabwe, the Kruger National Park in South Africa, and neigh-

Table 4: Recorded dates at certain points along the autumn migration route of the pair of Lesser Spotted Eagles. *Die Durchzugstermine an bestimmten Punkten auf der Herbstzugroute des Schreiadlerpaares.*

	Autumn 1997 male	Autumn 1998 male	Autumn 1999 male	Autumn 1997 female	Autumn 1998 female
lat 52°N	22.9.1997 (early)	approx. 4.10. 1998	1.10.1999	22.9. 1997	7.10.1998 (afternoon)
Burgas	1.10.1997 (midday)	20.10.1998	17.10.1999	4.10.1997 (midday)	22.10.1998 (midday)
Bosphorus	2.10.1997 (midday/ afternoon)	21.10.1998	18.10.1999 (midday)	5.10.1997 (morning)	25.10.1998 (midday)
Iskenderun	7.10.1997 (afternoon)	29.10.1998	27.10.1999 (afternoon)	8.10.1997 (afternoon)	4.11.1998
Israel: N.Valley	9.10.1997 (morning)	31.10.1998	30.10.1999 (morning)	12.10.1997	6.11.1998 (midday)
Suez	11.10.1997 (morning)	2.11.1998	31.10.1999	15.10. (afternoon)	12.11.1998
Equator	26.10. 997	17.11.1998	11.11.1999	31.10. (afternoon)	30.11.1998 (morning)
lat 15°S	21.11.1997 (morning)	10.12.1998 (midday)	–	1.1.98 (morning)	13.12.1998 (midday)

bouring Mozambique, within an area of about 26,000 km², that measured 380 km (21°44' – 24°54' S 31°- 32°30' E) on a north/south axis and 150 km on an east/west axis. Within this area, she flew at least 1,380 km.

At the end of the autumn migration in 1998 the southernmost point reached by the female was in Mozambique. Thereafter, up to the cessation of locations, she wintered in an area 120 km north-east of this in Mozambican location that extended 35 km north/south and 50 km east/west, with its centre at 24° 01' S/ 33°13' E.

The male wintered twice at the same place in Zambia (16°15'S / 27°35'E), near the small town of Monze, which is approximately 115 km south-west of Lusaka. The winter home ranges were relatively small: 180 km² (1997/98) and 200 km² (1998/99). In February 1999, between 100-200 wintering LSEs were observed at the same location in a comparatively confined area, whereas we saw only a few passing migrants in other parts of Zambia. The transmitter-fitted male was not observed. This area, in which the birds spent the nights in February, was a wet grassland, rich in food, and with a scattering of trees that the eagles used for perch-hunting and roosting.

3.5 Timing of Migration

Both the male and the female left the breeding site almost simultaneously. In 1997, the migration began at the normal time, i.e. around 20 September. However, in 1998 and 1999 the migration began seven to ten days later (Table 3). As a result, their journey around the Mediterranean was distinctly later than for the majority of birds recorded at numerous locations (e. g. Burgas, the Bosphorus, Iskenderun, Northern Valley in Israel, Suez) in other years (Shirihai et al. 2000) (Table 4).

The spring migration and arrival at the breeding site of the male was late in 1999, and late for the female in 1998 (Tables 1, 2, 3 and 5); they normally arrive between 10 and 15 April. Nevertheless, the birds bred successfully in both years. Arrival after 25 April – 1 May may result in a failure to lay eggs.

Table 5: Passage dates of the Lesser Spotted Eagle pair at certain points along the spring migration route. *Die Durchzugstermine an bestimmten Punkten auf der Frühjahrszugroute des Schreiadlerpaares.*

	Spring 1998 female	Spring 1999 male
lat 15°S	6.3.1998	2.3.1999
Equator	14.3.1998	17.3.1999
Suez	3.4. 1998	30.3.1999
N Valley (Israel)	5.4. 1998	1.4.1999
Iskenderun	7.4. 1998	3.4.1999
Bosphorus	13.4.1998	9.4.1999
Burgas	14.4. 998	10.4.1999
lat 52°N	24.4.1998	19.4.1999

3.6 Duration of migration

The duration of the migration varied between 52 and 119 days (mean 81 days). There were noticeable differences in duration between the male (52-75 days) and female (64-119 days). In addition, for each bird, the duration of the autumn migration (74-119 days) was markedly longer than its spring migration (52-64 days). The two fully tracked autumn journeys of the male differed only by one day. Overall, the female travelled much more slowly than the male during both autumn and spring migrations, which resulted in her autumn migration of 1997 taking more than twice as long as the male's spring migration in 1998.

3.7 Speed of migration and daily distances flown

The speed during migration varied widely between stages and years (Figs. 4-8 and Table 3). Generally speaking, the female travelled more slowly than the male, and travelled about 2,000 km further on each journey. The difference between the duration of the spring and autumn migrations of the male was three weeks (Table 3).

Both birds clearly flew much faster in spring than in autumn (Table 3). In spring 1999, the male's speed averaged approximately 180 km/day whereas the female's speed was 168 km/day. By contrast, in autumn, the average speeds of the male and female in 1997 and 1998 were approximately 130 km/day and 100 km/day, respectively.

Of the male's three autumn journeys, the one in 1999 was the fastest, even though only the section as far as Uganda was recorded. As far as Lebanon, his speed was relatively slow, approximately 100 km/day. Thereafter, the daily flight distance lengthened, reaching up to 400 km/day while crossing the Sahara desert. On twelve days, he covered over 250 km/day.

3.8 Autumn migration

The greatest daily flight distances recorded every year occurred during the autumn migration while crossing the Sahara desert in Egypt and northern Sudan where journeys over 300 km/day and often extending to 350 or 400 km/day were recorded (Figs. 4-7). The highest recorded daily flight distance for both birds on all routes was achieved by the female on 16 November 1998, when she covered 521 km in northern Sudan. On the four days 14-17 November 1998, the bird flew 1,687 km, averaging 422 km/day over Egypt and

the Sudan (Fig. 7). Only in the autumn of 1997 was the speed of the male slower across the Sahara than those recorded for other segments, as far as Zambia (Fig. 4).

3.9 Spring migration

In the spring of 1998, when each individual daily flight distance could be recorded accurately throughout the entire journey, the female flew over 200 km all except two days between 4 and 15 March over Zimbabwe up to Uganda (Fig. 8). On 14 March 1998, the bird flew 406 km across Tanzania and Uganda, making it the longest segment of the spring migration. The crossing of the Sahara desert was not noticeably any faster than for other regions. Overall, the speed from the beginning of March until her arrival at the breeding territory was fairly constant (Fig. 8).

The male's spring migration in 1999 began comparatively slowly across Zambia and Tanzania, with the bird covering only 80 to 170 km each day. From Uganda onwards, the bird increased its speed markedly, regularly travelling over 250 km daily while crossing the desert regions en route to Israel. On six days, more than 300 km were flown on each day. The highest recorded daily flight distance for the male during spring migration occurred on 20 March 1999, 392 km were flown over Sudan. After reaching Israel, his daily flight distances decreased to between 65 and 240 km.

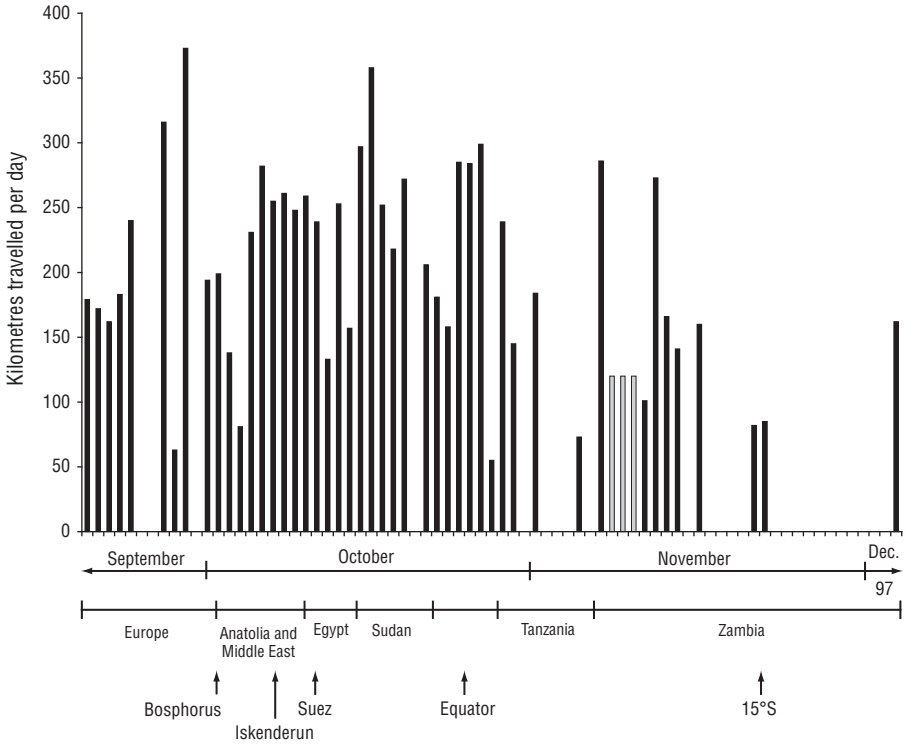


Fig. 4: Daily flight distances of the male during the 1997 autumn migration. *Die Tagesstrecken des Männchens während des Herbstzuges 1997.*

Table 6: Recorded cross country speeds of the male Lesser Spotted Eagle during his autumn migration in 1997 and 1998. *Zuggeschwindigkeiten des Männchens auf dem Herbstzug 1997 und 1998.*

Date	From (time)	To (time)	km covered	Speed in km/h	Country
24.9.1997	11.28	13.09	85.5	50.8	Poland
06.10.1997	9.25	11.03	40.8	25	Turkey
06.10.1997	11.03	12.48	53.8	30.7	Turkey
06.10.1997	12.48	13.45	28.5	30	Turkey
08.10.1997	10.30	14.16	128	34	Turkey
13.10.1997	11.12	12.53	85.4	50.7	Egypt
14.10.1997	11.05	12.40	40	25.3	Egypt
15.10.1997	10.51	12.29	92	56.3	Egypt/Sudan
15.10.1997	12.29	14.58	101	40.7	Egypt/ Sudan
16.10.1997	10.38	14.38	218	54.5	Sudan
17.10.1997	10.31	12.10	41	24.8	Sudan
28.10.1997	11.44	13.26	94	55.3	Uganda/Tanzania
29.10.1997	11.32	13.12	28	16.8	Tanzania
23.11.1998	11.45	13.26	86.5	51.4	Tanzania

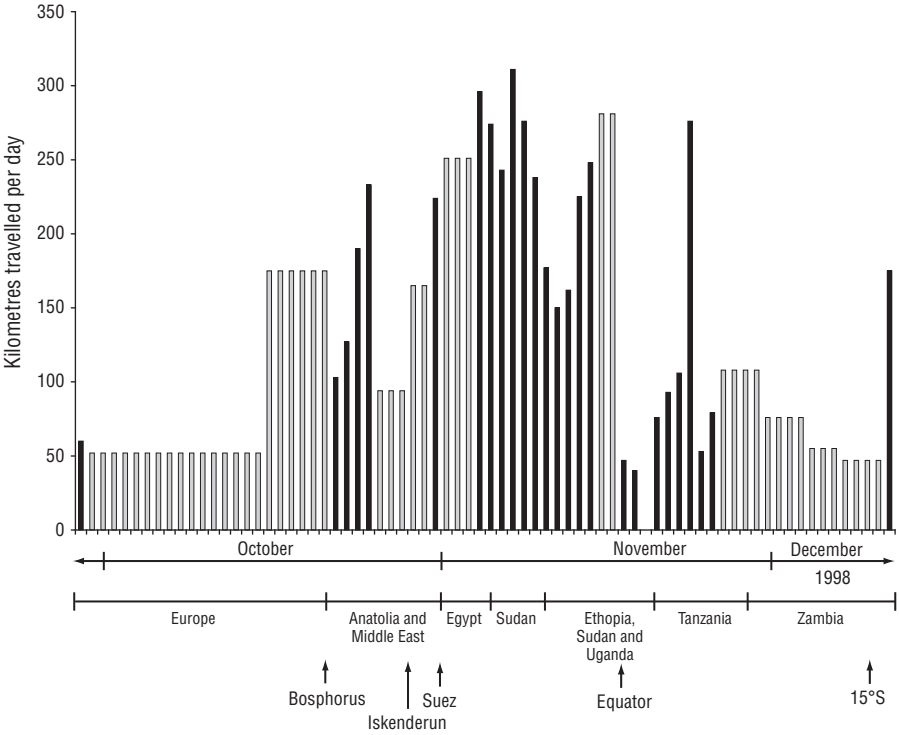


Fig. 5: Daily flight distances of the male during the 1998 autumn migration. *Die Tagesstrecken des Männchens während des Herbstzuges 1998.*

3.10 Cross country speeds

On 33 occasions, because of precise determination of location for brief intervals during the migrations, we were able to calculate the cross-country flight speeds (Tables 6 and 7). We calculated speeds between 20 and 30 km/h on nine occasions, 30 and 40 km/h on seven occasions, 40 and 50 km/h on six occasions and 50 and 60 km/h on eight occasions. Only once were speeds of 16.8 and 66.8 km/h calculated. It is not possible to know whether the whole time was spent on the wing. In cases with low values, the birds may well have interrupted their flight, for example, to search for food.

3.11 Number of days spent flying and resting

During the female's spring migration of 1998, all overnight stopping places were located without exception. This enabled us to calculate all daily flight distances. The bird spent 51 out of 64 days on the move (Table 3 and Fig. 7). With only a few exceptions, the daily flight distances of both birds could also be determined during the autumn 1997 migration. The male flew no fewer than 47 days out of 75, whereas the female migrated at least 63 days out of 119 (Table 3 and Figs. 4 and 6).

Those days on which no movement was detected were defined as resting days. All other days on which the birds covered a certain distance were regarded as spent on migration even though, part of the time must have been spent resting.

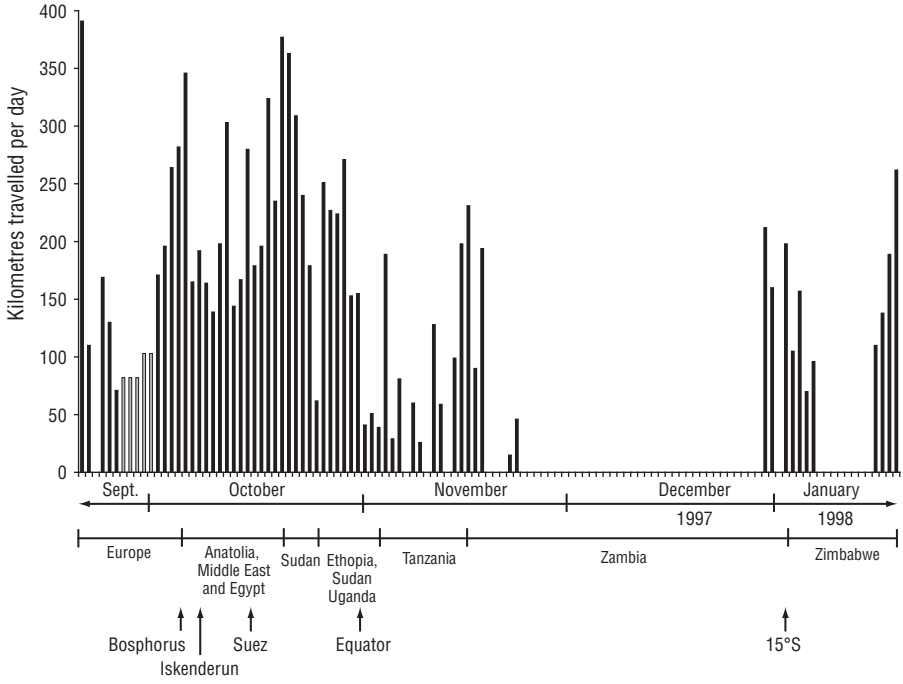


Fig. 6: Daily flight distances of the female during the 1997 autumn migration. *Die Tagesstrecken des Weibchens während des Herbstzuges 1997.*

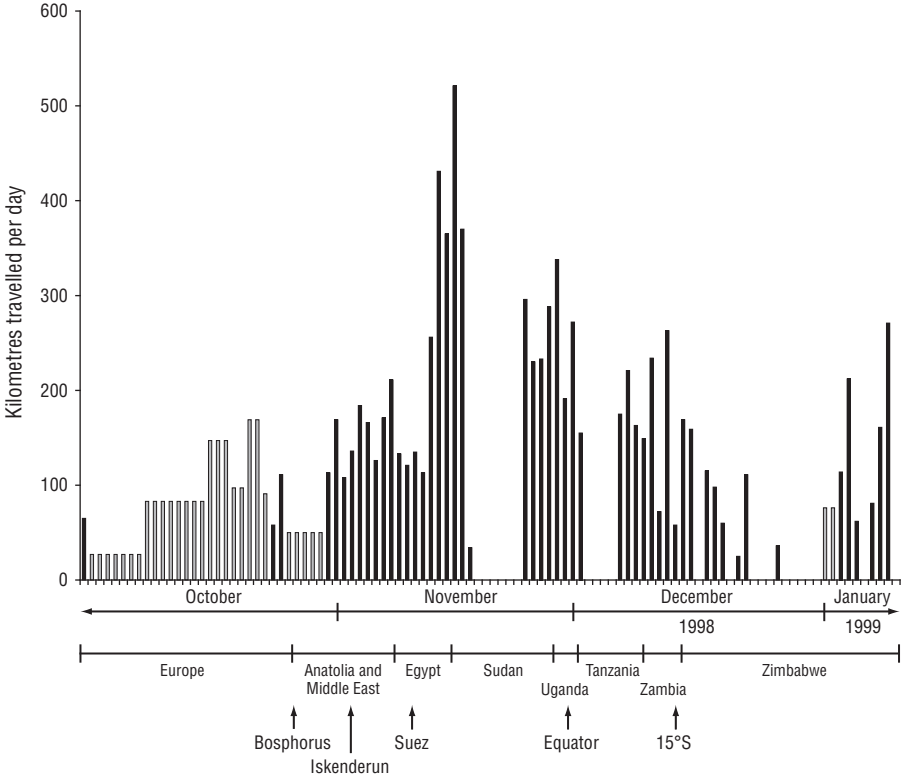


Fig. 7: Daily flight distances of the female during the 1998 autumn migration. *Die Tagesstrecken des Weibchens während des Herbstzuges 1998.*

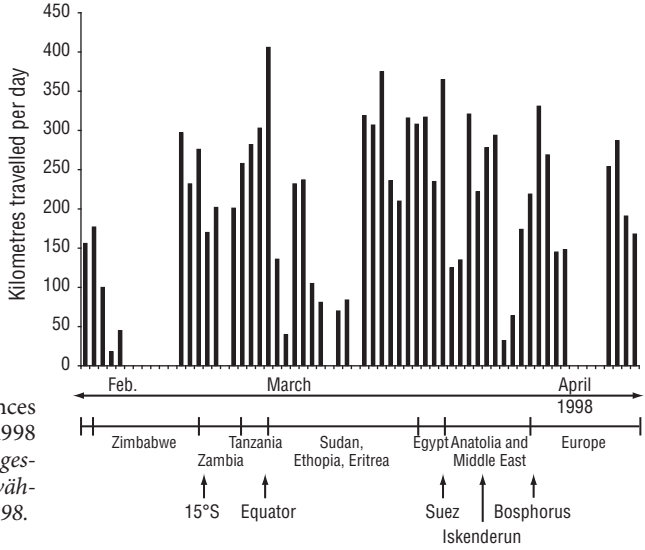


Fig. 8: Daily flight distances of the female during the 1998 spring migration. *Die Tagesstrecken des Weibchens während des Frühjahrsszuges 1998.*

Table 7: Recorded migration speed of the female Lesser Spotted Eagle during her autumn migration in 1998. *Zuggeschwindigkeiten des Schreiadler-Weibchens auf dem Herbstzug 1998.*

Date	From (time)	To (time)	km covered	Speed in km/h
06.11.1998	11.45	13.06	38	28.2
14.11.1998	6.37	11.51	251	48.0
14.11.1998	11.51	13.28	108	66.8
14.11.1998	13.28	14.54 Overnight stop	59	41.2
15.11.1998	11.41	13.21	80.6	59.7
15.11.1998	13.21	14.40	65,3	49.6
16.11.1998	6.11	11.28	277	52.4
17.11.1998	7.43	12.57	200	38.2
17.11.1998	12.57	13.56	52,5	53.4
25.11.1998	11.28	13.10	62,8	36.9
26.11.1998	11.15	12.59	46	26,5
27.11.1998	7.19	12.45	173	31.8
29.11.1998	8.34	12.19	185	49.3
30.11.1998	8.22	12.09	99,4	26.3
01.12.1998	11.59	15.22	160	47.3
07.12.1998	6.58	12.30	132	23.9
08.12.1998	6.06	12.18	156	25.2
11.12.1998	7.50	11.44	78	20.0
11.12.1998	11.44	13.26	51	30.0

Table 8: The most important stop-over areas and rest periods of the pair of Lesser Spotted Eagles. *Die wichtigsten Rastplätze und Rastperioden des Schreiadlerpaares.*

	Rest period	Coordinates	Location
Male	1.-3.11.1997	5°30 S / 31°05' E	30 km north of Ugalla,Tanzania
Male	16.-19.11.1997	14°4'S / 27°40' E	near Shampula, Zambia
Male	22.11.-2.12.1997	15°04' S / 28°36' E	near Chisamba , approx. 48 km NE from Lusaka, Zambia
Female	19.-21.11.97	12°32' S / 32° 18' E	near Mwanya Zambia
Female	25.11.-28.12.1997	12°44' S / 32°05' E	between Chitungulu and Kakumbi Zambia
Female	6.-13.1.1998	19°44' S / 26°49 E	between Pelendaba and Maitengwe in western Zimbabwe, near the border with Botswana
Female	19.-24.11.1998	12°21' N / 3°57' E	Sudan
Female	3.-6.12.1998	4°27' S / 31°20' E	Tanzania
Female	24.12.1998-1.1.1999	19°48' S / 27°17' E	Zimbabwe
Female	26.2-3.3.98	21°21' S / 32°20' E	Zimbabwe
Female	18.-21.4.98	48°30' N / 20°44' E	Unganda

During the autumn migration of 1997, the female spent more days resting then the male (51 days versus 25 days) (Table 3). The male rested on approximately one third of all days, the female rested on nearly half of the days. During the autumn migration of 1998 both birds rested to a far lesser extent than on other migrations.

3.12 Resting places and time spent

The birds rested occasionally during all stages, except while flying over the desert regions between Israel and Sudan. However, far more time was spent resting in southern Sudan, Uganda, Tanzania, Zambia and Zimbabwe than in the Near East, Anatolia and Europe (Table 8 and Figs. 4-8).

During the autumn migration of 1997, the male rested on only five days in Tanzania and 16 days in Zambia. During the same migration, the female rested for longer periods both in Zambia and in Zimbabwe. The longest time spent resting in Zambia exceeded the length of her subsequent stay at her wintering grounds. In Uganda and Tanzania, between 1 and 14 November, she flew fewer than 100 km on all but two days. The small distance travelled indicates that the bird had spent most of these days resting.

4. Discussion

In recent years, many papers have been published about the migration of raptors using satellite telemetry. However, in most cases only the autumn migration routes could be described because the transmitters did not function all year round, as typified by the studies on the Osprey *Pandion haliaetus* by Kjellen et al. (1999) and Martell et al. (2001). Furthermore, these studies often relied on recordings from comparatively few locations for each bird. As a result, data on, daily flight distances, cross-country speed, resting periods, and so forth, could not be collected.

Complete annual migration routes have been described previously for only a few raptors: Steller's *Haliaeetus pelagicus* and White-tailed Sea Eagles *H. albicilla* (Ueta et al. 1998, 2000), several Golden Eagles *Aquila chrysaetos* in North America (Brodeur et al. 1996), two Bald Eagles *H. leucocephalus* (Grubb et al. 1994), one LSE from Germany (Meyburg et al. 1995a), another from Slovakia (Meyburg et al. 2004), a Wahlberg's Eagle *A. wahlbergi* from Namibia (Meyburg et al. 1995b), one Steppe Eagle *A. nipalensis* from Mongolia (Ellis 2001) and one from Kazakhstan (Meyburg et al. 2003).

Published information on periods longer than a year for the same bird has, to date, been scarce, e. g. on one Slovakian LSE (Meyburg et al. 2004). As a result, issues regarding the way in which the routes taken and time spent on migration may differ between years have hitherto hardly been addressed, except for one study that deals with the Osprey (Alerstam et al. 2006).

We compare here the information on our breeding pair mainly with that on the Slovakian and German male LSEs (Meyburg et al. 1995a, 2004). Other raptors have been similarly tracked and their complete routes described, but they are unsuitable for comparison because they travelled considerably shorter distances than, and have a different lifestyle from, our breeding pair.

4.1 Method

In our older studies (Meyburg et al. 1993, 1995, 2001) migration routes of LSEs could be tracked but not very precisely with battery-powered PTTs because battery power is limited and thus locations were obtained only every few days, whereas solar-powered transmitters used in this study led to a huge boost in the number of locations from each transmitter and thereby substantially more detailed information. Present studies can use transmitters with GPS locations (Meyburg et al. 2006, 2007a, 2009) thus with much bigger precision than the Doppler or Argos locations only available at the time of this study.

4.2 Annual time budget

For the three successful breeding seasons, the pair spent the same amount of time in the nesting area (43-44 % of the year). For the German LSE male, tracked in 1994/95, the time was substantially less and he left the area early, because he had no young to rear, unlike the other two male eagles. The duration of the autumn migration varied greatly between birds and also from year to year. In 2001, the autumn migration of the Slovakian eagle took only 40 days (11 % of the year) whereas the other two autumn journeys of this bird lasted 48 days and 61 days. The time spent in their winter quarters by the Slovakian and the first German male eagles was almost exactly four months, a period much longer than the period of the pair of this study. There was a striking congruity in the times (49-52 days, 13-15 % of the year) spent on the spring migration of all three males, which travelled over more or less similar distances, whereas the female took rather longer (64 days, 18 % of the year).

4.3 Migration routes, distances covered and annual journeys

The outward and homeward journeys of the German male eagle, tracked in 1994/95, seemed to be almost identical, almost certainly due to the fact that the locations from its battery-powered transmitter were relatively widely spaced and permitted the route to be followed only imprecisely.

By contrast, the distance between the westernmost and easternmost migration routes was 155 km in Uganda and 645 km in Zambia for the Slovakian eagle. From these results, we concluded that the birds have developed a sufficient sense of orientation to be able to find their way back without the need to retrace the outward route.

The distances of the annual routes of the female (23,484 km) were over 3,000 km longer than those of the three males (18,732-20,396 km).

To a great extent, the routes taken by the pair described (Fig. 3) here were almost identical to those taken by the LSEs who were previously tracked using ST (Meyburg et al. 1995a, 2001. 2004). Only in the region of the Sinai Peninsula did the female make an interesting deviation, already described (Meyburg et al. 2002). In both 1997 and 1998 she was tracked to the southern tip of the Sinai Peninsula, and from there flew north again to Suez.

4.4 Winter quarters

The overwintering behaviour of the four birds widely differed. Both German males confined themselves to a restricted area in Zambia, whereas the male of the pair de-

scribed in this report not only had the smallest winter home range, but also returned to this area in the following winter. The female and Slovakian male eagle, by contrast, roved over a wide area.

4.5 Timing of migration

LSEs normally feed their offspring until the young eagle leaves the breeding territory and shortly after, they also leave. Accordingly, their departure date depends on whether they have bred successfully and when the young are ready to leave. In 1998, the pair's outward journey was delayed and very slow, because of bad weather in central and south-east Europe, whereas in 1997 they departed at the normal time and their passage, e. g. through Israel, was only slightly later than usual. In 1999, the male's outward journey also began later and the journey was very slow as far as Lebanon (Tables 3 and 5).

Most (90 %) LSEs pass through Israel between 21 September and 5 October. Between 6 and 17 October, only 5 % of the birds can be observed and very few thereafter. In 1997, the peak observation day was 2 October and occurred in 1998 on 30 September (Shirihai et al. 2000). In the three years of studying this pair of eagles, and particularly in 1998 and 1999, the pair of eagles tracked in this study must have been among the last stragglers to pass through Israel. Perhaps as a result, both birds arrived in central and southern Africa a month later than the male eagle tracked in 1994/95. As a result, the spring migration of the pair was also delayed. In 1999, the male left the wintering area on the 26 February, the same date as the male tracked in 1995 and arrived about 10 days after the usual arrival time (12-15 April) at the breeding ground in Germany. On these dates, the pair, under observation in this paper had only reached the Bosphorus and Burgas, respectively. In 1998, the female arrived 10-12 days late. Because the female arrived on 25 April 1998, a date when many pairs are already breeding, the male had already paired up with another female, which was driven off by the late-arriving female.

Punctual arrival at the nest site clearly determines an adult's ability to reproduce. The cut off date in Germany is around 25 April till 1 May. In recent years, it has been repeatedly recorded in different countries that the majority of adults arrived so late that egg laying did not take place, e. g. in Latvia in 2007 (Meyburg et al. 2008). It may be assumed that in many cases, as described for this tracked pair of eagles, departure from the wintering grounds was already long overdue. One can only speculate as to the reasons for this delayed departure from the winter quarters. One possible explanation is the low rainfall for many years on the upper reaches of the Zambezi River in the principal overwintering countries of Zambia and Zimbabwe. This must have led, in turn, to a scarcity of prey for the LSEs (Meyburg et al. 2007b). Accordingly, the birds perhaps needed to stay longer at their wintering grounds in order to augment their energy reserves for the northward migration. The impact of this phenomenon on breeding success requires further investigation.

4.6 Duration of migration

The durations of autumn migration of the Slovakian male for years 1994, 2000 and 2001 were substantially longer (1994 – 48 days; 2000 – 61 days; 2001 – 40 days) than

those of the breeding pair and that of the first German male (1994 – 52 days). By contrast, the duration of the spring migrations of all three males were about the same length (49-52 days). The duration of the spring migration 1998 for the female eagle was considerably longer, taking 64 days.

4.7 Speed of migration and daily distances flown

The first eagles tracked by ST had already provided preliminary information on flying speeds during the different segments of the autumn migration (Meyburg et al. 1995a). The information obtained from the present study confirmed the earlier finding. Moreover, the information was more precise in that the flying speeds were relatively slow as far as the Near East, after which the speed increased to reach the greatest daily distance flown during the crossing of the Sahara desert. From southern Sudan to the wintering grounds, a fairly leisurely pace was resumed. In spring, on the return journey, this pattern was less obvious, but still recognizable.

For two out of three autumn migrations, the daily distance covered of the Slovakian male was noticeably longer (1994 – 178 km/day; 2000 – 144 km/day; 2001 – 2l3.5 km/day) than those of the breeding pair. The first-tracked German male also flew faster in his autumn migration (166 km/day) than the pair described in this study. These four birds travelled at similar speeds (166-190 km/day) during the spring migration (Meyburg et al. 1995a, 2004, this study).

4.8 Cross country speed and feeding on migration

Studies in Israel indicate that the LSE is the fastest of migrating soaring birds. Using a motorized glider to follow the birds, Leshem & Yom Tov (1996) found that LSEs flew at an average velocity of 50.9 ± 6.7 km/h, at 567 – 871 m above ground level. The average speed of the female LSE studied here was calculated at an exceptional 66.8 km/h in one case, which was attributed to a strong tailwind. Fourteen cases in which speeds on migration of between 40 and 60 km/h were determined in this study (Table 6 & 7) corroborated findings in Israel. In 1998, using ST, Meyburg et al. (1998) reported that a Short-toed Eagle (*Circaetus gallicus*), approximately the same size as the LSE, attained a cross-country speed of up to 51 km/h.

Except on those days on which they flew long distances, the eagles set off around 0800 hrs and stopped flying at around l600 hrs. It may be assumed that, on such normal days, the birds had sufficient time to search for food if they covered less than about 300 km during the day. Hence, it may be concluded that the birds take no food only when crossing desert regions, and particularly the Sahara desert. Therefore, the eagles must have hunted for food as far as Syria and after reaching the southern part of the Sudan. Our own observations in Northern Valley in Israel tend to confirm that by the time they reach this location, the birds have already ceased to hunt.

5. Summary

A breeding pair of Lesser Spotted Eagles *Aquila pomarina* in Germany was each fitted with satellite transmitters and the information obtained from 3,641 locations was

analysed. Four autumn and two spring migrations were recorded in their entirety and one further autumn migration in part only. The pair, which travelled separately, wintered in Zambia (the male), Zimbabwe, South Africa and Mozambique (the female), approximately 9,350 and 11,350 km distant from their nesting territory. The annual cycles of the two birds differed considerably. In 1998 the female spent 48 % of the year on migration, 43 % at the nest site and only 9 % in her winter quarters. The male spent 44 % in the breeding territory, 35 % on migration and 21 % at his wintering grounds. The length of time spent on migration varied between 52 and 119 days (mean 81 days). For both birds the autumn migration was longer (74-119 days) than the spring migration (52-64 days). The speed while migrating varied during a single journey and from year to year. The fastest flying speed was achieved while crossing the Sahara desert. On average, the female always travelled more slowly than the male. For both birds, the greatest daily distance flown on all migrations was 521 km over northern Sudan. Cross-country speed was ranging between 50 and 60 km/h were calculated to be reached on eight out of 33 determinations. On one occasion, the cross-country speed was as great as 66.8 km/h.

Delayed spring migration, which in recent years has frequently led to the failure of many pairs to breed, also occurred with this pair. This phenomenon warrants further research because of its obvious impact upon breeding.

Zusammenfassung

Über den Zug und die Überwinterung des Schreiadlers, eines ausgesprochenen Weitstreckenziehers, konnten in den letzten Jahren mit Hilfe der Satelliten-Telemetrie (ST) viele neue Erkenntnisse gewonnen werden (Meyburg et al. 1993, 1995, 2000, 2001, 2007b, 2008). Beide Partner eines Paares zu besendern und über längere Zeit mittels ST zu untersuchen gelang erstmals 1997, worüber hier berichtet wird. Die Zugwege dieser beiden Vögel konnten mit bisher nicht erreichter Präzision untersucht werden. Vier Herbst- und zwei Frühjahrszüge wurden vollständig erfasst, ein weiterer Herbstzug nur zum Teil. Am 6. Juli 1997 wurden im Rahmen des Langzeitprojekts „Satellitentelemetrische Untersuchungen am Schreiadler“ der Weltarbeitsgruppe für Greifvögel die beiden Altvögel eines an der nordwestlichen Verbreitungsgrenze der Art in Mecklenburg-Vorpommern brütenden Schreiadlerpaares gefangen, beringt und mit ca. 30 g schweren Satelliten-Sendern (PTTs) mit Solarbetrieb (ID-Nummern 27999 und 28000) markiert. Im darauffolgenden Jahr wurde das Männchen am 18. Juli am Brutplatz wiedergefangen und mit einem neuen Sender (ID-Nr. 06970) ausgerüstet. Den alten Sender hatte der Vogel entfernt bzw. verloren. Alle drei Sender übermittelten zusammen 3641 verwertete Ortungen.

Auf dem Frühjahrszug des Weibchens 1998 gelang es die jeweiligen Übernachtungsplätze ohne Ausnahme zu orten, so dass sämtliche Tagesstrecken für den gesamten Zug angegeben werden können. Fast lückenlos gelang dies auch für den Herbstzug beider Vögel 1997. Weniger genau wurde der Herbstzug 1998 beider Vögel erfasst, ebenso der Frühjahrszug des Männchens 1999. Der Herbstzug des Männchens 1999 konnte nur bis zum Abbruch des Kontakts in Uganda verfolgt werden.

Das Paar zog getrennt und überwinterte 1997/98 und 1998/99 jeweils ca. 1.000 km voneinander entfernt, das Männchen in Sambia, das Weibchen in Simbabwe, Südafrika und Mosambik ca. 9.350 bzw. 11.350 km vom Brutplatz entfernt. Die zwischen Brutplatz und Überwinterungsgebiet jeweils zurückgelegten Strecken betrugen beim Männchen zwischen 9.354 und 9.941 km und beim Weibchen zwischen 10.753 und 11.351 km (siehe Tab. 3). 1997 machte das Männchen innerhalb Sambias auf dem Herbstzug einen Umweg, so dass die Gesamtstrecke über 500 km länger war als im darauffolgenden Jahr. Verspäteter Frühjahrszug, der bei vielen Paaren in den letzten Jahren oft zum Nichtbrüten führte, wurde auch bei diesem Paar festgestellt, ein Phänomen, welches wegen seiner Bedeutung für den Bruterfolg weiter untersucht werden sollte.

Da der Abzugstermin vom Brutplatz, die Aufenthaltsdauer im Brutgebiet und die Dauer des Herbstzugs möglicherweise davon abhängen, ob die Vögel ein Junges aufziehen und bis zum Selbständigwerden versorgen oder aber keinen Bruterfolg haben, wurde auch dieser von vier verschiedenen Beobachtern in den einzelnen Jahren kontrolliert. Zusätzlich zu den direkten Feststellungen am Brutplatz suchten zwei Beobachter (B.-U. Meyburg und J. Matthes) im Februar 1999 den Überwinterungsplatz des Männchens in Sambia auf.

1997, 1998 und 1999 wurde jeweils ein Junges aufgezogen und bis zum Beginn des Herbstzuges gefüttert. 1999 wurde das Männchen mit Sender am Brutplatz beobachtet, das anwesende Weibchen hatte keinen Sender. Ob es sich um das ursprünglich besenderte Weibchen handelte, konnte nicht festgestellt werden. Im Jahre 2000 hielten sich bis zu vier Vögel gleichzeitig an diesem Brutplatz auf, keiner von ihnen trug einen Sender. Eine Brut kam nicht zustande. Es gelang nicht festzustellen, ob die ursprünglich besenderten beiden Vögel darunter waren.

Der Jahreszyklus

Der Jahreszyklus der beiden Vögel wich deutlich voneinander ab, wohl bedingt durch die um 2.000 km größere Zugstrecke des Weibchens. Lediglich die Aufenthaltsdauer am Brutplatz war bei beiden Partnern fast gleich. Im Jahre 1998 verbrachte das Weibchen die meiste Zeit, fast die Hälfte des Jahres (48 %), auf dem Zug, 43 % der Zeit am Brutplatz und nur 9 % des Jahres im Überwinterungsgebiet (Tab. 2 und Abb. 1). Das Männchen verbrachte im Verlaufe eines Jahres (zwischen dem 29.09.1998 und 29.09.1999) die meiste Zeit am Brutplatz (44 %), 35 % der Zeit auf dem Zug, und 21 % am Überwinterungsplatz (Tab. 3 und Abb. 2).

Die Zugrouten

Beide Vögel erreichten auf weitgehend identischen Routen das östliche Mittelmeer umfliegend Suez und den afrikanischen Kontinent. Von dort aus zogen sie fast geradlinig nach Süden bis in die Überwinterungsgebiete. Der Zug in Afrika erfolgte bis nach Sambia innerhalb eines relativ schmalen Korridors. Die jeweils östlichste und westlichste Route lagen an verschiedenen Stellen der Zugstrecke unterschiedlich weit auseinander, z. B. im Libanon und in Israel nur 45-50 km, in Uganda 70 km, in Rumänien 280 km und im Sudan und Eritrea 450 km. Durch Simbabwe zog nur noch das Weibchen. Hier lagen 600 km zwischen der westlichsten und östlichsten Route.

Aus Abb. 3 sind alle erfassten Zugrouten der Vögel in beiden Richtungen ersichtlich. Sie zogen somit weitgehend auf der gleichen Route wie alle bisher mit Hilfe der ST untersuchten ad. Schreiadler (Meyburg et al. 1995a, 2001, 2004). Lediglich im Bereich der Sinai-Halbinsel gab es beim Weibchen in beiden Jahren eine interessante Abweichung, über die bereits berichtet wurde (Meyburg et al. 2002).

Die Zugdauer und die Zuggeschwindigkeit

Die Zugdauer schwankte zwischen 52 und 119 Tagen (Mittel 81 Tage) und war sowohl zwischen Männchen (52 – 75 Tage) und Weibchen (64 – 119 Tage) wie auch zwischen Frühjahrs- und Herbstzug bei jeweils ein und demselben Vogel recht unterschiedlich (Abb. 4-8, Tab. 3). Der Herbstzug (74 – 119 Tage) dauerte bei beiden Vögeln deutlich länger als der Frühjahrszug (52 – 64 Tage). Die beiden vollständig erfassten Herbstzüge des Männchens nahmen bis auf einen Tag gleich viel Zeit in Anspruch. Das Weibchen zog im Durchschnitt langsamer als das Männchen, obwohl es bei jedem Zug jeweils ca. 2.000 km mehr zurückzulegen hatte. Der Unterschied zum Männchen war dabei auf dem Frühjahrszug geringer als im Herbst (Tab. 3). Dementsprechend benötigte das Weibchen für den Zug stets deutlich mehr Zeit als das Männchen (Fig. 1 und 2). So dauerte der Herbstzug des Weibchens 1997 mehr als doppelt so lange wie der Frühjahrszug des Männchens 1999.

Die Zuggeschwindigkeit war sowohl auf den verschiedenen Streckenabschnitten wie auch von Jahr zu Jahr sehr unterschiedlich (Fig. 4-8 und Tab. 3). Am schnellsten wurde beim Durchqueren der Sahara gezogen. Verspäteter Heimzug, der bei vielen anderen Paaren in den letzten Jahren zum Nichtbrüten führte, wurde auch bei diesem Paar festgestellt, ein Phänomen, welches wegen seiner Auswirkungen auf den Bruterfolg weiter untersucht werden sollte.

Beide Vögel zogen auf dem Frühjahrszug deutlich schneller als auf dem Herbstzug (Tab. 3). Das Männchen legte im Frühjahr 1999 im Durchschnitt knapp 180 km, das Weibchen 168 km pro Tag zurück. Im Herbst zog das Männchen hingegen in den Jahren 1997 und 1998 durchschnittlich pro Tag nur etwa 130 km, das Weibchen etwa 100 km (Tab. 3).

Von den drei Herbstzügen des Männchens verlief derjenige im Jahre 1999 am schnellsten, allerdings wurde nur der Teil bis nach Uganda erfasst. Bis in den Libanon wurde relativ langsam gezogen, ca. 100 km pro Tag. Danach erhöhten sich die Tagesstrecken beim Durchqueren der Sahara bis auf 400 km. An 12 Tagen wurden jeweils über 250 km zurückgelegt.

Die Terminierung des Zuges

Beide Vögel zogen jeweils fast gleichzeitig ab. 1997 erfolgte der Abzug zum normalen Zeitpunkt, für den ca. der 16.-20. September angegeben werden kann, 1998 und 1999 leicht, um ca. 1-1½ Wochen verspätet (Tab. 3). Dementsprechend erfolgte der Durchzug an Beobachtungspunkten im östlichen Mittelmeerraum (Burgas, Bosphorus, Iskenderun, Northern Valley in Israel, Suez) auch deutlich später als bei der Mehrzahl der dort festgestellten Vögel (Tab. 4).

Die Frühjahrs-Ankunft am Brutplatz sowohl des Männchens 1999 wie auch des Weibchens 1998 waren deutlich verspätet (Tab. 3). Sie fällt üblicherweise auf den Zeit-

raum 10.-15. April. Dennoch brüteten die Vögel in beiden Jahren erfolgreich. Bei Ankunft ca. nach dem 25. April kommt es oftmals nicht mehr zur Eiablage.

Der Herbstzug
Eindeutig am schnellsten zogen beide Vögel während des Herbstzuges in fast allen Jahren beim Durchqueren der Sahara in Ägypten und im nördlichen Sudan (Abb. 4 – 7). Hier wurden fast stets über 300 km pro Tag zurückgelegt, manchmal auch 350 oder 400 km. Die höchste Tagesleistung beider Vögel auf allen Zugrouten wurde beim Weibchen am 16. November 1998 festgestellt. Es legte an diesem Tage 521 km im nördlichen Sudan zurück. An vier Tagen (14.-17.11.98) bewältigte der Vogel in Ägypten und im Sudan 1.687 km, also durchschnittlich 421,75 km pro Tag (Abb. 7).

Lediglich im Herbst 1997 ließ sich beim Männchen nicht erkennen, dass der Zug in der Sahara deutlich schneller verlief als auf den anderen Streckenabschnitten bis nach Sambia (Abb. 4).

Der Frühjahrszug
Auf dem Frühjahrszug 1998, wo beim Weibchen jede einzelne Tagesstrecke während des gesamten Zuges genau berechnet werden konnte (Abb. 8), legte das Weibchen vom 4.-15. März von Simbabwe bis Uganda an allen ausser zwei Tagen jeweils über 200 km zurück. Am 14. März bewältigte der Vogel 406 km beim Zug in Tansania und Uganda, die höchste Tagesstrecke auf dem Frühjahrszug. Der Zug war beim Durchqueren der Sahara nicht eindeutig schneller als in den übrigen Bereichen. Insgesamt blieb die Zuggeschwindigkeit ab Anfang März bis zur Ankunft am Brutplatz relativ gleichmäßig (Abb. 8).

Der Frühjahrszug 1999 des Männchens verlief in Sambia und Tansania zunächst relativ langsam. Es wurden nur zwischen 80 und 170 km täglich zurückgelegt. Ab Uganda zog der Vogel dann deutlich schneller und bewältigte beim Durchqueren der Wüstengebiete bis nach Israel täglich stets über 250 km, an sechs Tagen 300 km oder mehr. An einem weiteren Tag, am 20. März wurden im Sudan 392 km zurückgelegt, die höchste festgestellte Tagesleistung des Männchens auf dem Frühjahrszug. Ab Israel wurde dann wieder etwas langsamer gezogen, zwischen 65 und 240 km täglich.

Die durchschnittlichen Zuggeschwindigkeiten
In 33 Fällen kam es im Verlaufe von Zugtagen zu genauen Ortungen in relativ kurzen zeitlichen Abständen, so dass die durchschnittlichen Zuggeschwindigkeiten auf längeren Strecken berechnet werden konnten (Tab. 6 und 7). Etwa gleich häufig ließen sich Geschwindigkeiten zwischen 20 und 30 (9 mal), 30 und 40 (7 mal), 40 und 50 (6 mal) sowie 50 und 60 km/h (8 mal) berechnen. Je ein Mal betrug die Geschwindigkeit 16,8 bzw. 66,8 km/h. Natürlich lässt sich nicht sagen, ob jeweils die ganze Zeit über gezogen wurde. Bei niedrigen Werten haben die Vögel möglicherweise Unterbrechungen eingelegt, z. B. zum Nahrungserwerb.

Die Zahl der Zug- und Rasttage
Als Rasttage werden diejenigen Tage betrachtet, an denen kein Zug festgestellt werden konnte. Alle übrigen Tage, an denen die Vögel eine gewisse Strecke zurückgelegt

haben, werden als Zugtage angesehen, auch wenn an vielen Zugtagen mit geringer Tagesstrecke zeitweilig gerastet worden sein dürfte.

Beim Weibchen ließen sich während des Frühjahrszuges 1998 ausnahmslos alle Übernachtungsplätze orten, so dass alle Tagesstrecken berechnet werden konnten. Der Vogel zog an 51 von insgesamt 64 Tagen (Tab. 3 und Abb. 7). Bis auf wenige Ausnahmen konnten auch die Tagesstrecken beider Vögel während des Herbstzuges 1997 festgestellt werden. Das Männchen zog an mindestens 47 von 75 Tagen, das Weibchen an mindestens 63 von 119 Tagen (Tab. 3 und Abb. 4 und 6).

Auf dem Herbstzug 1997 legte das Weibchen mehr Rasttage (mindestens 51) ein als das Männchen (mindestens 25) (Tab. 3). Letzteres rastete an etwa einem Drittel aller Tage, das Weibchen fast während der Hälfte der Tage. Während des Herbstzugs 1998 rasteten beide Vögel offenbar sehr viel weniger.

Die Rastgebiete und die Rastdauer

Die Vögel rasteten gelegentlich in allen Durchzugsgebieten außer in den Wüstengebieten zwischen Israel und dem Sudan. Im südlichen Sudan, Uganda, Tansania, Sambia und Simbabwe wurde jedoch viel mehr gerastet als im Nahen Osten, in Anatolien und Europa (Tab. 8 und Abb. 4 – 8).

Das Männchen rastete 1997 auf dem Herbstzug lediglich fünf Tage in Tansania und 16 Tage in Sambia. Das Weibchen rastete auf dem Herbstzug 1997 sowohl in Sambia wie auch in Simbabwe jeweils längere Zeit. Die längste Rastzeit in Sambia dauerte länger als der darauffolgende Aufenthalt im Überwinterungsgebiet. In Uganda und Tansania wurden vom Weibchen zwischen dem 1. und 14. November bis auf zwei Tage jeweils weniger als 100 km pro Tag zurückgelegt. Der Vogel hat somit auch hier an den meisten Tagen ganz überwiegend gerastet.

Die Überwinterungsgebiete

Als Überwinterungsgebiete betrachten wir hier diejenigen südlichsten Gebiete, die auf dem Zug erreicht wurden und in denen sich die Vögel eine gewisse Zeit lang aufhielten. Aufenthaltsgebiete nördlich davon werden als Rastgebiete betrachtet.

Das Weibchen überwinterte am Ende des Herbstzuges 1997 nomadisierend im südlichen Zimbabwe, in Südafrika im Krüger-Nationalpark und im benachbarten Mozambique in einem Gebiet (Fläche ca. 26.000 km²), welches eine Nord-Süd-Ausdehnung von 380 km und eine Ost-West-Ausdehnung von 150 km hatte (21°44' – 24°54' S und 31° – 32°30' E). Innerhalb dieses Gebietes legte das Weibchen mindestens 1.380 km zurück.

Das Männchen überwinterte zwei Mal in Sambia im selben Gebiet (16°15'S/27°35'E) nahe der Ortschaft Monze ca. 115 km südwestlich von Lusaka. Es hatte hier ein relativ kleines winter home range von 180 km² (1997) bzw. 200 km² (1998/99). Im Februar 1999 konnten hier ca. 100 bis 200 überwinternde Schreiadler auf relativ engem Raum beobachtet werden, während wir in anderen Gegenden Sambias nur wenige Durchzügler sahen. Das markierte Männchen selbst kam nicht zur Beobachtung. Der Bereich, in dem die Vögel übernachteten, bestand aus feuchtem, nahrungsreichem Grasland mit einzelnen, verstreut stehenden Bäumen, die die Adler als Sitzwarten und Übernachtungsplätze nutzten.

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