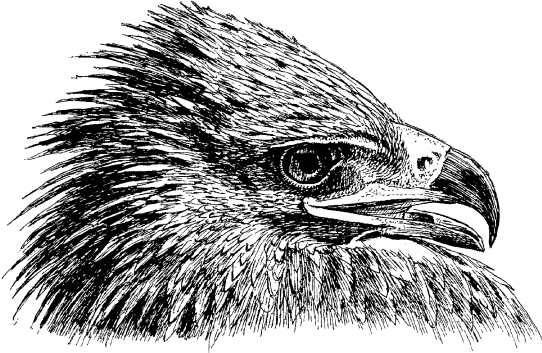


Migrations of an adult Spotted Eagle tracked by satellite



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The Spotted Eagle *Aquila clanga* breeds from eastern Poland to the Pacific Ocean, in southeast Siberia and Manchuria. Despite this extensive breeding range, the biology of this rare species has been very little studied (Glutz von Blotzheim *et al.* 1971; Cramp & Simmons 1980; Meyburg 1994). This applies especially to the eagle's migrations. Ringing has so far revealed very little (Mikhelson & Viksne 1982).

True, there are numerous overwintering areas known in southern Europe, southern Asia, the Middle East, including Egypt, and elsewhere, but hardly anything is known about the migration routes, the migration speed, and the length of time spent at stop-over sites, at resting areas and in the winter quarters.

Within the framework of a research programme on Steppe Eagles *A. nipalensis* by means of satellite telemetry, we captured an adult Spotted Eagle in Arabia which we also equipped with a transmitter. Since an adult specimen of this species had never before been captured and fitted with either a conventional or a satellite transmitter, our findings are given here in detail.

Satellite telemetry has been developing since its first experimental application in 1970 to track the movements of animals. Most early efforts were necessarily associated with large terrestrial and marine mammals because of the size of transmitter units. It was not until the mid 1980s that technology permitted effective deployment on large avian species, and it was only as recently as 1992 that a 48-50 g satellite transmitter, technically called platform transmitter terminal (PTT), became available, small and light enough to be used for birds of the size of Spotted Eagle and Lesser Spotted Eagle *A. pomarina* (Meyburg *et al.* 1993).

Procedure

Satellite telemetry currently uses the Argos Data Collection and Location System,

which is a co-operative international project of the Centre National d'Etudes Spatiales of France (CNES), the National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA). Details are given in Appendix 1.

On 24th October 1993, we caught an adult Spotted Eagle north of Taif¹ in Saudi Arabia. Its weight was 1,900 g and its wing-length 53 cm. A 48-g PTT was attached as a backpack with teflon ribbon and sewn with biodegradable cotton thread (plate 98). Transmitter life can be varied with timer set-up. The unit was set on an 8-hours-on/96-hours-off schedule.

For the computer calculations of distances covered between Argos locations, we used an integrated global mapping system displaying a true Mercator projection. For plotting the breeding area in western Siberia and the stop-over areas in Saudi Arabia, coloured maps of the Russian ordnance survey with a scale of 1:200,000 were used, and for the winter quarters in the Yemen a map with a scale of 1:250,000.



Plate 98. Spotted Eagle *Aquila clanga* fitted with platform transmitter terminal, Saudi Arabia, October 1993 (B.-U. Meyburg)

Results

Between 24th October 1993 (day of capture and release of the bird) and 8th June 1994 (last day when a location was received and when the battery voltage became too low), 96 locations of different quality were obtained through Argos and the bird was tracked over a total distance of 6,390 km excluding local movements in the winter quarters and stop-over sites (see fig. 1).

¹ The geographical co-ordinates of locations mentioned in the text are given in Appendix 2.

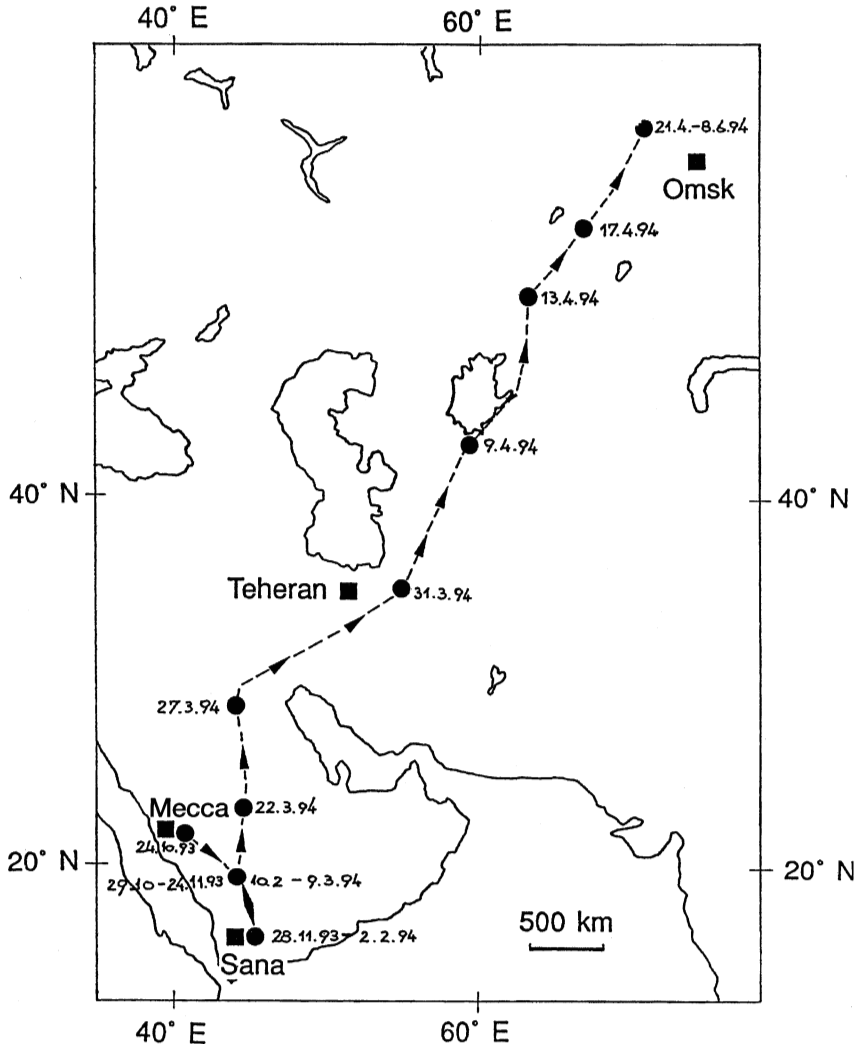


Fig. 1. Migration route of an individual (Spotted Eagle *Aquila clanga*). This bird was tracked by satellite during the last part of its outward migration and during its return migration from the Yemen to western Siberia, 24th October 1993 to 8th June 1994.

After its release, the bird flew a further 385 km southeastwards to the vicinity of the small village of Al Subaikhah² in southwestern Saudi Arabia. There, from 29th October to 24th November, it exploited a home range of about 65 square kilometres. It then moved a further 465 km south into the Yemen, where it remained from 28th November 1993 to 2nd February 1994, in an area around Wadi Adhanah³ 30 km southwest of Marib (104 km east of Sana) in the south of the Sirwan district north of Jebel Suhayfah (2,610 m above sea level). There,

² & ³ See Appendix 2.

its home range, taking only the best locations into consideration, encompassed about 50 square kilometres.

Following this stay of little more than two months at the southernmost point of its migration, the bird moved back to its former stop-over site near Al Subaikhah in Saudi Arabia, where it remained between 11th and 28th February.

Further return migration then continued in a leisurely fashion. Up to 22nd March, it had progressed only another 545 km northwards, but it covered the next 593 km within the space of four days, and at a location⁴ close to the Saudi Arabian-Iraqi border west of Kuwait it swung northeastwards. From there, it crossed over the 4,000-m-high Zagros Mountains and the highlands of Iran. It then journeyed along the southern slopes of the Elburz Mountains, where⁵ on 31st March another change of direction occurred, taking it more to the north. From this point, it crossed the nearly 3,000-m-high Koppet Dagh Mountains to the border of Turkmenistan and made in a straight line for the southern shore of the Aral Sea, where it arrived on 9th April. It then followed the southeastern shore of the Sea, after which it flew more or less northeast to its probable breeding area in the southern part of the West Siberian lowlands⁶, about 196 km northwest of Omsk, arriving there on 21st April. It remained in this area until the last location on 8th June. Unfortunately, the locations were not precise enough to enable us to calculate its home range.

Discussion

Of all the eagles in the genus *Aquila*, the Spotted Eagle is the most strongly attached to water and wetlands. This is equally true of both its breeding and its wintering areas. It is therefore surprising to find this bird spending the winter in the completely arid landscape of the southwest of the Arabian peninsula. The Spotted Eagle was known to be a winter visitor to Arabia, but only in areas of wetland. Further examples need to be tracked in order to establish whether the species is more adaptable in its winter quarters than was hitherto supposed.

The return migration followed almost the shortest possible route. Only the Arabian Gulf near Kuwait was by-passed in a rather circuitous manner, as was the southeastern end of the Caspian Sea, as would appear to be necessary if the shortest possible flightpath was to be followed. The by-passing of the Caspian Sea was probably in order to avoid flying over the Elburz Mountains.

It took the bird a full seven weeks to cover the first 1,010 km from the wintering grounds in the Yemen. It was not until 22nd March that the bird actually appeared to be 'on the move', and the remaining part of the return migration, amounting to 4,516 km, was accomplished within barely a month, with an average of about 150 km being covered daily. The highest average rate of 280 km per day was reached at the end of March, during the crossing of Iraq and Iran.

Acknowledgments

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^{4, 5 & 6} See Appendix 2.

arranged logistic support. Dr Mark R. Fuller was very helpful when we started satellite telemetry. Dr Stephane Ostrowski and Philippe Gaucher of the National Wildlife Research Center in Saudi Arabia helped us in the field. We also thank R. D. Chancellor for linguistic help. Prof K. Graszynski read a first draft of the manuscript and was helpful in various other ways. Friedhelm Weick kindly made the heading drawing and the map.

Summary

The migration and wintering grounds of an adult Spotted Eagle *Aquila clanga* were studied for the first time by means of satellite telemetry. During the 228 days following equipment of the eagle, 96 locations were procured and the bird could be tracked over a stretch of 6,390 km. The eagle spent little more than two months, from the end of November to the beginning of February, in its winter quarters in north Yemen. A stop-over site in southwestern Saudi Arabia was occupied for several weeks on both outward and return migration. Surprisingly, this eagle spent several months in arid desert regions. The total distance between winter quarters and breeding area in western Siberia was 5,526 km, of which 4,516 km were covered on the return migration in scarcely a month.

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Appendix 1. Explanation of Argos Data Collection and Location System

This system includes equipment in Tiros-N satellites and a network of satellite tracking stations and communications links that transfer satellite data to processing centres in Toulouse (France) and Landover, MD (USA). The near-polar, sun-synchronous orbits of Tiros-N satellites permit coverage of a specific geographic area at approximately the same time each day. Locations of transmitters are estimated from the Doppler shift in its carrier frequency (410.650 MHz).

For normal processing, Argos requires four transmissions, or messages, during an overpass of the satellite to calculate location, but special processing for wildlife research estimates locations from as few as two Doppler measurements. Up to 15th June 1994, Argos graded locations according to precision (i.e. 68% of a series of locations expected within the given distance) with location quality indices (LQ): LQ3 = 150 m, LQ2 = 350 m, LQ1 = 1 km, and LQ0 = undetermined. Within LQ0, Argos also provided an interpretative index, which helped in assessing estimated locations by explaining why normal processing failed.

Appendix 2. Geographical co-ordinates of locations mentioned in the text

¹ Taif, Saudi Arabia 21° 31' N 40° 49' E

² Al Subaikhah, Saud Arabia 19° 07' N 43° 21' E

³ Wadi Adhanah, Yemen 15° 19' N 45° 07' E

⁴ Location near Saud Arabian-Iraqi border 29° 23' N 44° 13' E

⁵ Location along Elburz Mountains 35° 50' N 55° 44' E

⁶ Probable breeding area in West Siberian lowlands 56° 14' N 71° 24' E