THE MIGRATION OF THE WHITE STORK IN EGYPT AND ADJACENT AREAS

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Observations on the spring migration of the White Stork (*Ciconia ciconia*) were undertaken in 1962 by the authors as part of the research of the Yale University Prehistoric Expedition to Nubia (Reed 1966), at the suggestion of S. Dillon Ripley, then director of the Peabody Museum at Yale University. Data continued to be assembled during 1964 and 1965 by the senior author and by various other Expedition personnel: Heinz Walter, Chris Maser, Jorg Biel, Eric Wendt, Ingo Gabriel, Ibrahim Helmy, Maxine Kleindienst, Robert Orlins, Peter Banks, and Robert Giegengack, to all of whom we are indebted for numerous observations and suggestions.

In 1962–1963, Expedition members were in Upper Egypt between Aswan and Kom Ombo from October through December, and subsequently in March, and the first two weeks of April; in Egyptian Nubia (between Aswan and the southern border of Egypt) in January and February; on the coast of the Red Sea at Mursah 'Alam (the spelling of this and other place names is variable) a number of times from December through mid-April; and between Mursah 'Alam and Suez from 16 to 18 April. In 1964 the Expedition was in Egyptian Nubia from January into April, and again in November and December, staying through the winter of 1965 and returning to Aswan early in April 1965. During these intermittent periods covering almost three years, we observed storks only during the time of the spring migration.

SUMMARY OF PREVIOUS OBSERVATIONS

Ornithologists have long known from multiple studies in Lower Egypt, Sinai, and the area of the Gulf of Suez that the major migration route of the White Stork between northeastern Africa and southwestern Asia passes across the narrow Straits of Jubal, at the southern end of the Gulf of Suez. Numerous observations, particularly from passing ships, of the mass, low-level fights of *C. ciconia* across this strip of water during both late summer and spring migrations have been summarized by Schüz (1955, 1959b).

During the spring migration, large numbers of storks have been observed flying north along the Nile at Khartoum, Sudan (Mathiasson 1963). However, little has previously been recorded of their route between this point and Aswan. Meinertzhagen (1930) postulated that autumn migrants did not reach the Nile in large numbers north of Wadi Halfa. However this assumption has been proved to be in error, primarily by the observations of G. W. Murray (Moreau 1928) and in more detail by those of Tragenza (1955, 1958) who determined that the main crossing of the Red Sea Hills for both the spring and autumn migrations was between the Nile at Qena and the Red Sea at Hurghada, the birds following the Wadi Qena insofar as possible.

The evidence accumulated to date indicates that storks are rare along the African coast of the Red Sea between Hurghada and Eritrea, the latter area being within their winter range. Storks which winter in Eritrea presumably follow the main inland route between Hurghada and Sudan. There is one curious record (Rosenberg, *in* Schüz 1959b) of a flock of storks met on 13 April 1959 in the middle of the southern part of the Red Sea, crossing toward Arabia. This flock was at 17°20′ N, 40°40′ E, approximately 120 sea-miles NNE of Massaua, Eritrea. The flock was observed near sunset and the birds seemed confused, circling considerably before heading back

southwest toward the African coast. One stork settled aboard the vessel from which the observation was made.

Occasional flocks may cross the Red Sea at places other than the Straits of Jubal or may perish in the attempts. At Massaua, however, the greatest water-gap is only 40 miles, due to numerous islands off both shores, but the birds would have to fly straight across from west to east to use the islands effectively. South of this region the Red Sea narrows to the Bab el Mandeb, hardly wider than the Straits of Jubal, and could be easily crossed by storks, but we know of no such recorded crossing.

In the spring, a few birds do not leave the Nile at Qena but follow the river north to the Delta. These stragglers are said to increase in number toward the end of the spring migration (Greaves 1944), and such individuals leaving the main migratory groups are often stated to be sick or young, but seemingly without real evidence as to their health or age.

Occasionally individuals or small groups of these birds may stay the winter or even the summer in Lower Egypt (Adams 1864; Flower and Nicoll 1908; Nicoll 1912; White 1949). In Nubia, in contrast, von Heuglin (1869–74, Vol. 2, p. 1102) listed storks as present only in April, May, June, July, and September. Dorst (1962:54) included Nubia within the wintering range but Schüz (1959a) has placed the northern limit of the main wintering area farther south at approximately 14° N.

No breeding stork has been recorded from northeastern Africa. In the nineteenth century small numbers of birds were breeding in scattered places in Palestine (Tristram 1884: 111), in Jerash and Amman, and elsewhere in what is now the Kingdom of Jordan, east of the Jordan River (Tristram 1868, 1897). Now, however, no nesting storks are found in these regions and the statement by Howells (1957: 133) that storks breed near Gaza, southwestern Palestine, is seemingly erroneous. No nesting storks are now found in Lebanon (Kumerloeve 1962), where seemingly favorable environments are present. Indeed, the southern boundary of their breeding area, although certainly somewhere in northern Syria, is not known. Farther east, the birds breed over most of Iraq except the western and southern deserts and the southern marshes (Allouse 1953; Johnson 1958), so the single factor of spring heat is no deterrent to successful breeding. In northwestern Africa the White Stork breeds from northern Tunisia westward into the Atlas Mountains of Morocco, but that population migrates across the western Sahara, and is not involved in migrations through Egypt. It is not known whether the few storks which summer in Cyrenaica, Libya (Stanford 1954), are breeding birds.

Some storks stray from the main line of migration and seemingly try to cross the full breadth of the Libyan Desert (the eastern Sahara). Their remains are occasionally found by desert explorers (several such records were summarized by Moreau 1934), and considerable numbers may attempt this crossing. Indeed, one whole "flight" of storks was observed by Clayton (quoted by Moreau 1928) headed NNW across the Gilf Kebir, a plateau in southwestern Egypt. Extremely few storks have been observed on the Egyptian coast west of Alexandria, and we must assume that many of those attempting a direct crossing of the Libyan desert perish on the way. Some storks, however, do reach oases in eastern Libya, and some have been observed in Cyrenaica, but all such records west of the Nile would seem to be incidental to the main group of migrants known to follow the Aswan–Qena–Hurghada route to and from the Straits of Jubal.

The "autumn" migration, which really occurs through Egypt almost entirely in late summer, seemingly has not been observed south of Qena, at which point Tragenza (1955) saw the storks coming to the Nile, flying south down the Wadi Qena. More than a century ago, Taylor (1859) stated that White Storks were "common" between Alexandria and the First Cataract in November and December 1853 and January 1854. Perhaps the pattern of their local distribution has changed in the intervening years, for Mackintosh (1941) could list only a very few recoveries of ringed birds for the Nile Valley in autumn in contrast to numerous such records for the period of the spring migration. Accordingly, our list for storks observed in the "autumn" migration is short (table 2) in contrast to the published records for spring (table 1). One important factor is that few observers are out during the heat of late summer in the Near East, while spring is still part of the tourist season.

DISTRIBUTIONAL OBSERVATIONS OF THE EXPEDITION

Our observations on the spring migrations occurred between Qena and the northern border of Sudan, an area for which little prior information was available (Moreau 1967). Only an article by Marchant (1941) and a note by Ripley (1963), recording storks in early March at Luxor, at and near Aswan, and in small

TABLE 1. Dates of spring migration of the White Stork in Egypt and adjacent areas.

Location	Early date	Late date	Reference
100 miles north of Juba, Sudan		14 April 1943	Vincent 1948
El Fasher, north and central Darfar, Sudan	1 February 1922	2 March 1922	Lynes 1925
Blue Nile, Sudan		18–22 June 1901 (present in considerable numbers although usually gone by end of April)	Butler 1905
White Nile, Sudan, south of Khartoum		Last week in March 1900	Witherby 1901
Shendi, Sudan	16 February 1901		Rothschild and Wollaston 1902
Eritrea		Stragglers departing in early May	Smith 1957
Korosko, Egyptian Nubia		9 April 1964	Reed and Lovejoy 1969
Aswan, Upper Egypt	2 March 1962		Ripley 1963
Upper Egypt	7 March 1940		Marchant 1941
Upper Egypt	14 March 1963		Reed and Lovejoy 1969
"Egypt"	First week in April	First week in May	Hutson 1944a
Qena, Egypt	12 March 1943		Hutson 1944b
Hurghada, Egypt		17 April 1963	Reed and Lovejoy 1969
Gulf of Suez	11 March (year?)	19 April (year?)	Marchant 1941
Gulf of Suez		12 April 1926 (Vast majority had already passed through)	Borman 1929
Suez		29 April (year?)	Boyd 1917
Canal Zone, Suez		28 April (year?)	Bodenham 1945
Sinai	6 March (year?)	(peak 15–30 April) (year?)	Bodenheimer 1935
Sinai	5 March (year?)		Wyatt 1870
Sinai		1 May (1911?)	Anonymous 1912
Wadi el Ain, Sinai	13 March (year?)		Malcolm (*in* Moreau 1928)
Elath, Palestine		9 April (year?)	Meinertzhagen 1954a
Palestine		24 April, after which birds occasionally seen into early June (year?)	Meinertzhagen 1920a
Bersheeba, Palestine	20 March 1923		Meinertzhagen 1925
Palestine coastal area	4 February 1918	2 June 1918	Sladen 1919
West-central Palestine	4 February 1919; "many hundreds"		Meinertzhagen 1920a
Latrun, Palestine	26 February earliest, 1900–1909	22 March latest, 1900–1909	Victor 1909
Lake Galilee, Palestine	6 March (year?)		Meinertzhagen 1920b
Lake Hule, Palestine	11 March 1942		Hutson 1944b
Jordan, east of Dead Sea		First week in May 1955	Hollom 1959
Jordan Valley		1 April (year?)	Bodenheimer 1935
Syrian coast	7 March 1942	Reduced flights in May, "loiterers" into June	Hutson 1944b
Syrian coast	11 April 1943		Note by Greaves (*in* Newcombe 1944)
Northern Syria		13 June 1943; last storks seen in northern Syria	Newcombe 1944
Smyrna, western Turkey	First week in March 1942		Hutson 1944b
Istanbul, Turkey	1 March 1901	16 May (year?)	Kumerloeve 1961

TABLE. 2. Dates of autumn migration of the White Stork in Egypt and adjacent areas.

Location	Early date	Late date	Reference
Taurus Mountains, Turkey	27 July 1956		Kumerloeve 1961
Northern Syria	24 August 1942		Hutson 1944b
Al Mafraq, Jordan		16 September 1942	Hutson 1944b
Amman, Jordan		8–9 September 1921	Meinertzhagen 1925
Azraq, Jordan	20 August 1922		Meinertzhagen 1924
Sinai	Last week in August (some possibly two weeks earlier)	First week in September (some possibly two weeks later)	Meinertzhagen 1954b
Straits of Jubal	1 August 1931		Meinertzhagen 1954b
Gulf of Suez	26 August 1926		P. A. Clayton (*in* Moreau 1928)
Gulf of Suez		9 September 1947	Elliott and Monk 1952
Hurghada, Egypt	No storks had arrived before 22 July 1937		Al-Hussaini 1938
Hurghada, Egypt	August 1938 (storks everywhere)		Al-Hussaini 1939
Hurghada, Egypt	17 August 1949		Tragenza 1955
Qena, middle Egypt		October 1914	G. W. Murray (*in* Moreau 1928)
Darfar (Sudan)	Mid-October 1921	28 November 1921	Lynes 1925
Eritrea	8 August (usually arrive in November)		Smith 1957

flocks and individually as far south as Abu Simbel, present modern evidence to suggest that north-bound storks follow the Nile out of Sudan.

In 1963, the spring migration was observed between Aswan and Edfu, where it closely followed the Nile Valley. We presumed that it continued on a narrow river-valley front north to Qena. No storks were seen in January, February, or March 1964 as we moved slowly north (downriver) from the Sudanese border toward Korosko. This latter point was reached 1 April, several weeks after the beginning of the migratory period for storks through Egypt, and at Korosko the first storks seen that year were observed to be emerging from the mouth of the Wadi Korosko. Nine days later, when the Expedition moved north from Korosko, flocks of storks were still coming down the Wadi Korosko to meet the Nile.

The following year, 1965, the first storks (two only) were seen 31 January at Toshka (not far from Abu Simbel), after which an occasional stork was seen between that point and Amada, where on 4 March the first definite flock was observed. During the first two weeks of March (after which time we moved further north) flocks were seen daily, except in periods of high winds, moving out of the mouth of the Wadi Korosko. Some of the birds followed the Nile directly downstream, but some followed the river in a northwesterly direction (upriver, due to the presence of a bend in the Nile at this point) for variable distances before turning more directly north again to cross a part of the desert and rejoin the river. In either case, the birds, insofar as we were able to observe, then followed the Nile toward Aswan and Qena.

On the basis of these observations, we suggest that the storks do not follow the Nile continuously north from Khartoum, all the way to Qena, but instead shorten their route considerably by leaving the Nile in the northern Sudan (the region of Abu Hamed would be a logical point), rejoining it at Korosko, and avoiding the lengthy Dongola bend (fig. 1). Schüz (1959a), prior to our observations and unknown to us at the time, had already guessed that storks would shortcut across the Dongola bend. We must emphasize, however, that we have found no evidence of observers from the Dongola bend who have stated that they did or did not see storks during periods of migration.

As indicated by the evidence presented above, and by Ripley's observations (1963) of "smaller flocks and individual birds . . ." being present on the river south to Abu Simbel, some White Storks may on occasion be seen upriver from Korosko. Additionally Robert Fernea, an anthropologist who worked in southern Egyptian Nubia for several years, told Reed that on one occasion a Nubian shot a stork near Abu Simbel. Such incidental distribution, away from the main migratory path,

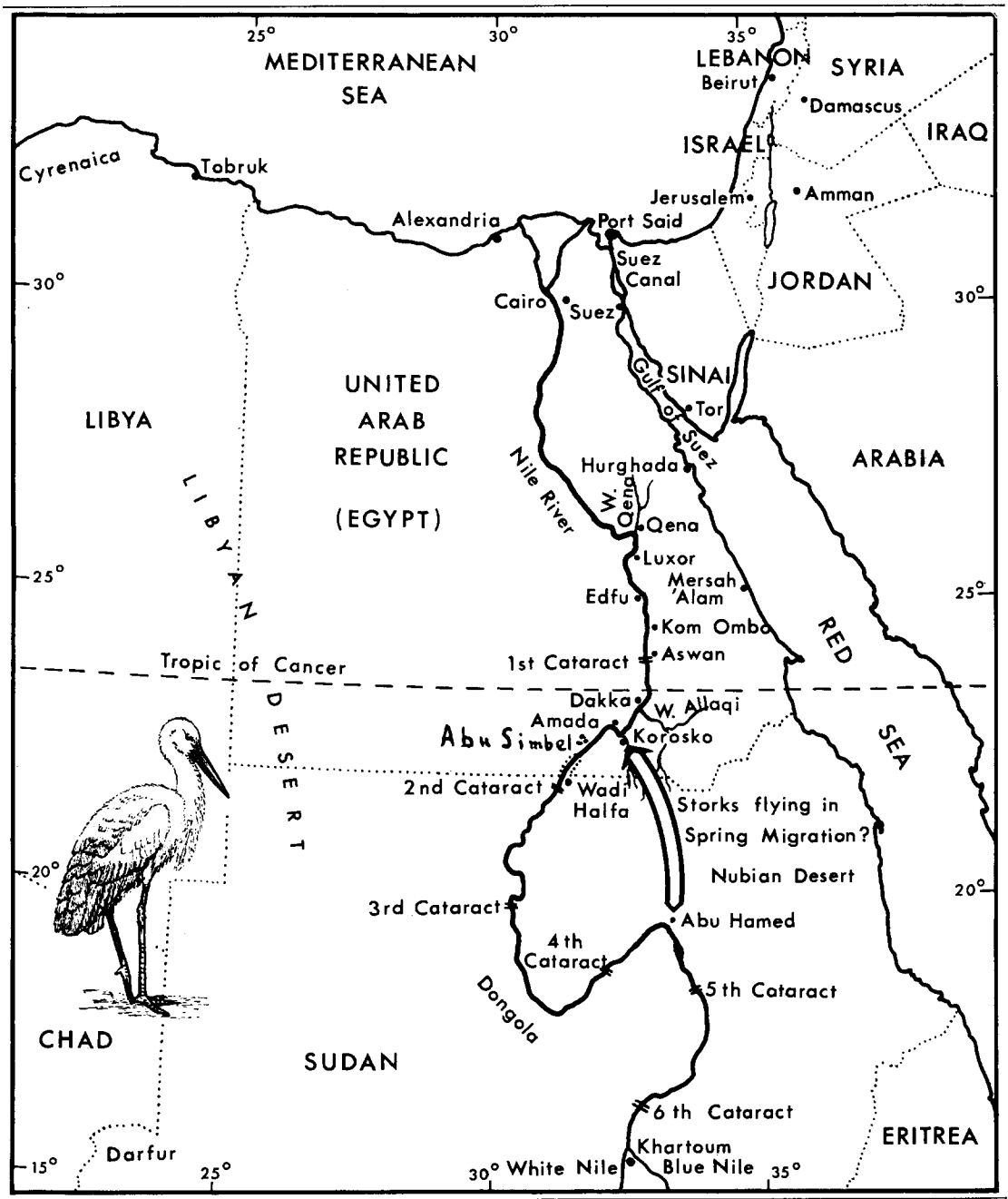

FIGURE 1. Map of Egypt and adjacent areas.

is similar to that of some storks following the Nile north of Qena, of some storks following the Gulf of Suez northward (as seen by Reed in 1963) instead of crossing at the Straits of Jubal, and of some striking directly across the Libyan Desert. Such individualistic behavior should not, however, obscure our knowledge of the main movements.

The birds sighted in January and February 1965 near Abu Simbel are probably best interpreted in terms of this individualistic behavior, for, as has been mentioned, during January, February, and March of the previous year the Expedition moved slowly along the Nile from the southern border of Egypt to Korosko without seeing a stork. Thus the northern edge of the wintering range must now lie south of Egyptian Nubia, perhaps at approximately 14° N where Schüz (1959a) placed it.

We suspect that much of the spring migration may proceed north from Sudan down the Wadi Allaqi, the main branch of which has

its beginnings deep in the Red Sea Hills of northern Sudan. One would, however, have to go a considerable distance up the Wadi Allaqi to prove its share, if any, as a route of spring migration, for its lower parts are broad and one cannot in those regions distinguish between flocks which might have come down the Wadi Allaqi and those moving north along the Nile from the Wadi Korosko.

From Korosko north to Aswan, in March and into early April 1964 and 1965, storks were seen almost continuously along the Nile and on occasion several miles inland. Considering the period of some two months during which they move through this part of Egypt, the problem remains of determining if there exists a chronologic order to this migration. Do birds which migrate farther south into South Africa return earlier or later than those which winter farther north, and what is the corresponding order, if one exists, in which they settle down to breed in Asia and Europe?

BEHAVIOR AND ECOLOGY

FLIGHT

Ciconia ciconia is highly adapted for migration by its behavioral and anatomical specializations for long distance soaring. Flapping flight is a slow and probably exhausting process which they avoid whenever possible; instead they save energy by soaring. They circle upward, wings outstretched, on any rising current of air and then soar off in the direction wanted, to seek another rising current. This practice, called "riding the thermals," has been discussed in detail for the White Stork by Mackintosh (1949). It has been noted by many authors before and since that article, for accipitrine birds as well as storks, and described in poetic language for storks in Syria and Palestine by Hutson (1944b). The sight of a group of storks soaring upward in a whirling spiral appears to be a stimulus to every stork at low altitude to join the group. As each reaches the top of the ascending air column, it levels off, following the one before, and, while a constant stream of storks from all directions may thus be entering such an inverted vortex at the bottom, a single stream emerges at the top, often so high that from the ground each stork appears to be only a dot in the sky.

The altitude of the tops of these ascending spirals of birds has been variously estimated to be 4000 to 5000 ft (Meinertzhagen 1920, 1954a), but in western Sudan (Vincent 1948) the storks have been seen from an airplane to be flying as high as 10,800 ft.

Over water there are no thermals and the storks must flap their way across. They generally avoid water-crossings, limiting intercontinental passages to the Straits of Gibraltar, the Dardanelles and the Bosporus, and the Strait of Jubal. Why the majority of the eastern population elects this latter passage of about 19 miles is not known. They could as easily cross overland from Asia and Africa or back anywhere between Suez and Port Said, as indeed some few hundred storks and many accipitrines seem to do each year.

Thermals, being initiated by differential ground temperatures, occur only on warm to hot sunny days, and generally (at least in our experience) not before 09:00–10:00. At night the storks stand in groups on the ground, generally on an open plain in the desert. Early in the morning, they may fly to cultivated fields to look for food, or may remain where they are until the earth warms sufficiently to provide the rising air columns they need. Before such warming is sufficient, however, the birds become restless and, at first by twos or threes and then by the hundreds, flap off laboriously, seeking the incipient thermals which are not yet strong enough to support their weight. They try to circle upward, flapping for awhile and then soaring experimentally, only to desert that thermal in search of a better one. All is confusion with milling birds crossing in temporary quests, but slowly the thermals strengthen, the birds spread their wings and soar, and across the desert, often on both sides of the Nile, one can see numerous spirals of upward soaring storks. 'Tis at such a moment a delight to be alive in the morning.

No thermals form on cloudy days, which are not uncommon in Nubia and upper Egypt in the spring. In such conditions the storks will not remain on the ground, but fly steadily northward in continuous flapping flight. Under these conditions, they do not reach such great heights as when they soar. Sometimes on calm, overcast days they fly no more than 200 ft above the Nile.

INABILITY TO FLY IN WIND

Difficult periods for White Storks are those of the *khamsins,* overcast periods of several days each with falling temperatures, strong winds, and blowing dust. Such winds, which continue night and day and may last 72 to 96 hr, hold the storks earth-bound. One such group of 600 (estimated) was seen 18 March 1965 in Nubia near the Wadi Allaqi, and another was observed in more detail on 17 April

1963, 17 miles north of Hurghada on the coastal plain near the Red Sea. For a description of this latter group we quote from Reed's notes, made at the time:

"At 8:40 A.M., on near-flat stony desert, saw several groups of *C. ciconia* so immobile they looked like the two-dimensional carved figures in a shooting gallery. The birds were in small groups, each of 30 or fewer, a few isolated, and all facing north directly into a 20-mile-per-hour wind. The wind had been much stronger in the night, tearing awnings from buildings in Hurghada, and some gusts were still strong. When undisturbed, an occasional stork might take a solitary step, or stretch its neck, but even this activity was relatively rare. Most stood on both their legs, although a few managed on only one (the preferred position when on the ground). When disturbed by my close approach, one or a few storks would finally flap into the air, but would not fly higher than 15 feet or more than 50 feet horizontally. The storks stretched along parallel with the road, but at some distance from it and on both sides of it for more than a mile. The greater number of them, some 250, were bunched at the southern end of the group, in sub-groups of 15–30, but with scattered isolated storks between such concentrations. The only observable pattern to the distribution was due to their avoidance of all slight elevations in the gently rolling plain."

Similar behavior of storks in a *khamsin* was noted by Meinertzhagen (1954a) in March 1953 in the Negev of southern Palestine.

Storks immobilized on the ground for several days and nights, unwilling to move and incapable of sustained flight, are obviously subject to hunger, thirst, and predators. At present possible predators in Egypt are man (Nubians and Bedouins for food, others for target practice), hyenas, jackals, and foxes. The latter would probably function as scavengers, but hyenas and jackals, in a land providing a minimum of protein, might well make nocturnal attacks on such immobilized storks, although we have no evidence on this point.

FOOD AND WATER DURING SPRING MIGRATION

Our first observations on the stork were along the cultivated sides of the Nile between Aswan and Kom Ombo. Here many of the birds were feeding each morning in the fields, as Tragenza (1958) described some of them doing at Qena. We assumed, perhaps erroneously, that such daily feeding behavior would be standard to all, while waiting each morning for the thermals to form. Obviously the birds cannot feed or drink when crossing desert, nor do any of them come to the water in uncultivated areas, such as existed for the most part between Korosko and Aswan during the years of our investigations. In such regions the storks settle each night on the open desert, possibly several miles from the Nile, and continue on as soon as possible without necessarily approaching the river. What proportion of them do feed or drink, even in areas where green fields are available, is unknown. Also undetermined is the distance they do or can travel without food or water.

The overland trip from Abu Hamad to Korosko is approximately 250 miles, but to this must be added another 100 miles to Aswan and the nearest cultivated fields. We are not now certain that all storks, or even a majority, eat or drink along the Aswan–Qena stretch of their journey. Tragenza (1958) stated that most of the birds arriving there remain in flocks and do not forage in the fields. Leaving Qena, little fresh water and less food is available until they reach Palestine, where, by all accounts they do assemble at watering places and then scatter to forage. If, however, the majority of them arrive in Asia without having eaten or drunk since leaving the central Sudan, the mass deaths reported for arrivals in Palestine (Sladen 1919) and southern Syria (Meinertzhagen 1935) are not surprising.

FATALITIES ON MIGRATION

Deaths of storks in Egypt would seem to be few; at least few carcasses are seen or have been reported, in relation to the tens of thousands of birds passing through. However, as mentioned above, mass deaths of storks arriving in the spring in Palestine and Syria have been reported, and further north the birds sometimes are caught by late snows in Anatolia or Europe and killed by the hundreds.

The late summer passage through the Levant, Egypt, and Sudan would seem to be a time of great environmental stress, as the daily temperatures are extremely high and available food and water even more restricted than in the spring. Even so, no noteworthy fatalities have been reported along this route, although few natural scientists have made studies in these areas during the late summer months. Southward flight from the western Mediterranean coastlands into the summer heat of the Sahara may, however, be more difficult for the western population of storks than for the birds following the eastern migratory route. Hartert (1913) reported several hundred storks, half-dead from thirst, arriving at a Saharan oasis in southern Algeria through the week preceeding 19 August 1912 during a period of heat and drought extreme even for that area. To these natural rigors was then added the hunger of the local people, who killed at least 500 of the birds for food.

Examples of birds flying south into killing heat or north into potentially destructive snow storms indicate that probably the White Stork

has its biological clock set by changing day-length. To date however little basic physiological study has been attempted on *Ciconia ciconia.*

POPULATION

A near approximation of the number of storks passing through Egypt could be determined by a team of students making annual censuses at the Straits of Jubal and/or at the Wadis Korosko and Allaqi. At present no such estimates are possible, although the torrent of storks moving north some 60 years ago may be judged by the estimate of 30,000 crossing the Straits of Jubal within 1½ hours on the afternoon of 19 April ?1910 (Mackenzie 1910). Although such a mass crossing may have been exceptional, many observations (particularly those from shipboard since the Suez Canal was opened) are testimony to the great numbers of White Storks which twice annually funnel through the narrow region of the Straits of Jubal.

Population estimates of flocks seen along the Nile Valley are relatively meaningless, as the birds are often extremely high and also are spread over the desert on both sides of the river. We did attempt estimates of the sizes of the flocks observed, but these ranged widely for the same flock seen by several people at the same time. However, Ingo Gabriel photographed four successive flocks as they emerged within an hour from the Wadi Korosko, then counted the dots (storks) as projected on a cross-lined screen. The flocks had 260, 260, 260, and 275 birds, with a few peripheral stragglers missing from each group. The largest flock ever seen by us was estimated to consist of approximately 1000 birds in a single thermal several miles south of Aswan on the morning of 30 March 1965.

A flock of storks is not a stable group. Individuals are constantly changing from one group to another, particularly in the morning when they are trying to get airborne. The general principle seems to be that the other group's incipient thermal is a better one, so many storks are to be seen flapping back and forth.

TIME OF SPRING AND AUTUMN MIGRATIONS IN THE NEAR EAST

In tables 1 and 2 we have organized, insofar as possible from a scattered and often indefinite literature, the observed dates of migration of the White Stork through Egypt and adjacent parts of the Near East. Some particularly early or late dates may represent only a few early birds or late stragglers. The authors quoted are not always as informative as we would wish, and often the observations were made, as were our own sometimes, by persons passing through an area, thus not seeing the beginning or the end of a particular migratory episode. Still, the data here assembled may furnish the basis for more detailed research, planned in advance to answer the numerous questions we must leave unsolved.

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