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The Behaviour of White Storks *(Ciconia ciconia)* hatched in South Africa

1. Migratory urge

By G. J. Broekhuysen

Introduction

Migratory urge and certain features of migratory behaviour are inherited and in nearly all cases the first migratory journey undertaken by a migratory bird is from the breeding (summering) area to the non-breeding (wintering) area. Although first year birds mostly do occupy the same wintering area as the older birds, there is evidence that at least in some migratory species, the young birds on average arrive after the adults (Broekhuysen et al. 1963, Schüz 1971) and that young birds are the last ones to leave and departure in the direction of the summering quarters (Broekhuysen et al. 1963). Schüz (1971) and Hornberger (1967) mention that in several species first year birds migrate further south during the northern autumn and during the following northern spring do not quite return to the area where they hatched. In many of the migratory palearctic species considerable numbers remain in the wintering quarters and these numbers seem to be on the increase. One gets the impression that the migratory urge is waning (Broekyhusen 1967, 1971). It would be interesting to establish whether the majority of overwintering birds are young and immature, or whether all ages are represented. It usually is not possible to age the birds unless one has them in the hand.

It seems that in some cases individuals of otherwise rather typical migratory species have not only lost the urge to migrate, remaining in the wintering quarters, but also have started to breed there. There are several of these cases in South Africa and the White or European Stork (*C. ciconia*) is such an example. It is a common bird in South Africa during the southern summer from December to March and considerable numbers stay and fail to migrate north in March and April.

Prior to 1961 there was only one reliable record of the White Stork breeding in Southern Africa. The nest was on the farm „Welbedacht" between Calitzdorp and Oudshoorn in the Cape Province. It was first recorded in 1940 (Roberts 1941). On November the 26th in 1961 a nest containing three large nestlings was recorded in the Bredasdorp District, the most southern tip of the African Continent (Martin et al. 1962, Schüz 1963). This was the beginning of a small „colony" which development has been closely watched up to date and has been reported on by G. J. Broekhuysen (1965, 1971).

In addition to the Bredasdorp breeding birds another pair of storks were found to breed on the farm „Arum Valley" about 20 km from Mosselbay. This nest was located in the southern spring of 1966 and the birds have been breeding there ever since (Uys 1966, 1968).

During 11 years it became quite clear that the Bredasdorp „colony" is not increasing but just holding its own. Adverse influences must be at work which are limiting the development and the success of these breeding birds. It was found that periods of drought, causing lack of food during the period when nestlings are developing and have to be fed, resulted in a high mortality among these young birds. Further occasional very strong gales and the little protection provided by the large flat open nests, cause half grown chicks to be blown out of the nest (BROEKHUYSEN 1971, 1973). But there could be another even more important factor. Could the young storks hatched in these nests from parents which ceased to migrate still have the migratory urge as this urge is an inherited one? In fact there was already evidence of this. The three large nestlings found in the first nest in 1961 were ringed at the time; this was in December. Two of these were subsequently recovered, one four months later near the northern boundary of Zambia (MCLACHLAN 1963) and the other was found dead in the Orange Free State a few years later.

E. H. BALLOT on whose farm ROBERTS (1941) recorded the breeding pair of storks in 1940, near Oudshoorn, mentioned at the time that in the seven years the birds had been breeding on his farm, the young had always left in the autumn, except in 1939 when they stayed during the winter.

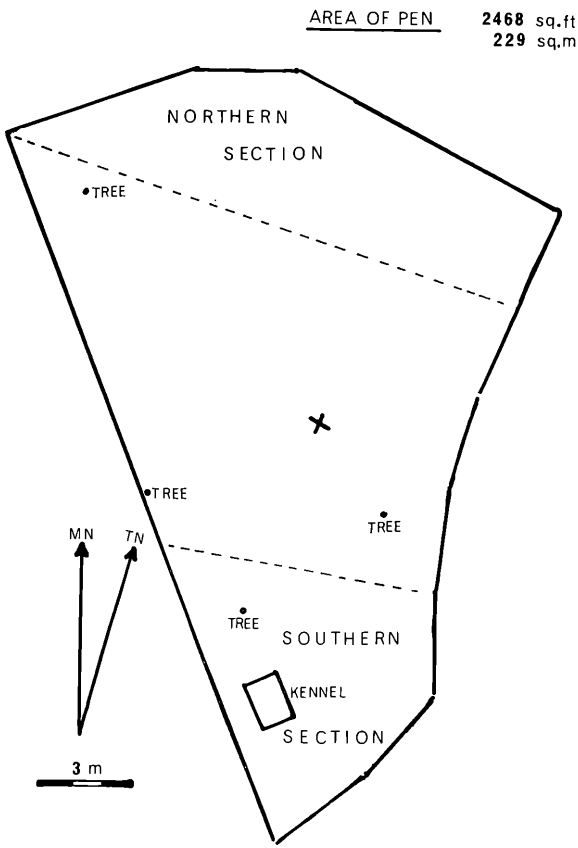


Fig. 1: Diagram of the enclosure at the Tygerberg Zoo where the storks were kept during the investigations. – Diagramm des Storchgeheges im Zoo Tygerberg.

It seemed that here was an unique opportunity to find out whether the South African born storks still had a migratory urge by keeping some of them in captivity and watching their behaviour closely.

Methods and material

The birds were kept in the Tygerberg Zoo near Durbanville in an open pen of 229 m². The pen had an elongated, somewhat irregular shape, with its main axis pointing towards the magnetic north (fig. 1). A more regularly shaped and even better, circular pen, would have been preferred but was not available. One of the storks kept had dislocated one of its wings at an early stage of its development and could not fly. The others were clipped. While the storks were kept in the enclosure, they had the company of some other animals at one stage or another, such as: an immature Black-headed Heron (*Ardea melanocephala*), Cape Grysbok (*Raphicerus melanonotis*), Grimm's Duiker (*Sylvicapra grimnia*) and Steenbok (*Raphicerus campestris*). On the whole there was little interference and usually the storks dominated the others.

During the four years of this investigation a total of four different storks were observed. The maximum number observed together in any one year was two. The storks were:

Stork 1. taken out of a nest in 1967 and kept until its death on the 29th of July 1972. The sex could not be determined.

Stork 2. taken out of a nest in 1968 and kept until its death in November 1970. This was a male.

Stork 3. taken out of a nest in 1970 and still alive at the end of November 1972 when the investigation was terminated.

Stork 4. taken out of a nest in 1971, still alive at the end of November 1972.

Storks 1, 2 and 3 came out of the same nest (Prinskraal I nest) and stork 4 came from Prinskraal II nest. The birds were observed throughout the year, nearly always during the morning for a continuous period of three hours, seven to ten times each month.

Observations in 1968, although regularly and frequently carried out, were rather incomplete and mainly served for learning the types of behaviour which could prove to be indicative for the presence of a migratory urge if such an urge did exist. After this first year's experience several types of behaviour were found to be possibly indicative and these were concentrated on in the following years. They were:

(a) „Looking up" (fig. 3). This consists of the bird looking up into the sky by tilting the head. It was thought that if the bird was keen to fly off as it would be if an urge to migrate was felt, it would keenly watch and be attracted to anything passing overhead and thus look at it. It was amazing how these storks would detect a minute speck like for instance a Steppe Buzzard (*Buteo buteo*) soaring very high up often hardly visible to the observer. There was no evidence that the number of birds flying over the zoo differed very much in the different months of the year. The number of times the storks were looking up during the observation periods was recorded.

(b) „Defecation" (fig. 6). Defecation is stimulated by restlessness and agitation. Schüz (1943) states: „Bei alten wie jungen Störchen kann die Entleerung auch als nervöser Ausdruck der Erregung in das reizsammelnde Warten vor dem Abflug eingebaut sein."

It was, therefore, likely that the rate of defecation could be indicative of the intensity of migratory restlessness. However, it was realised that high temperatures as frequently prevailed during the summer months also made birds restless and influenced the defecation rate. There are two different ways of defecation in storks. The normal way is to go a few steps back or just to stop for a fraction, and then defecate vertically down (fig. 6). In the other variation the hind part of the body makes a quick movement forwards prior and during defecation, and the legs get covered in faeces (Schüz 1942, Kahl 1963). There is strong evidence that the defecation towards the legs is motivated by a high intensity of stress. Schüz (1943) in mentioning this type of defecation suggests that it can take place as an intention movement whereby no actual faeces are produced.

These two variations of defecation behaviour will be discussed in a separate paper dealing with comfort and reproductive behaviour. In the present paper only the rate of defecation and not the variation will be considered. It has been expressed in number of defecations per observation period.

(c) „Restlessness wing-flaps" (fig. 5). As the birds were pinioned they could not take off but only flap with their wings. It was likely that if the birds would be restless because of an active migratory urge, they would flap frequently. However, it soon appeared that flapping could also be motivated by sexual and reproductive drives and also could occur as comfort flapping, for instance after preening. It was eventually possible to differentiate between these differently motivated flaps, and only the number of sessions of flaps motivated by restlessness during each period of observation was recorded.

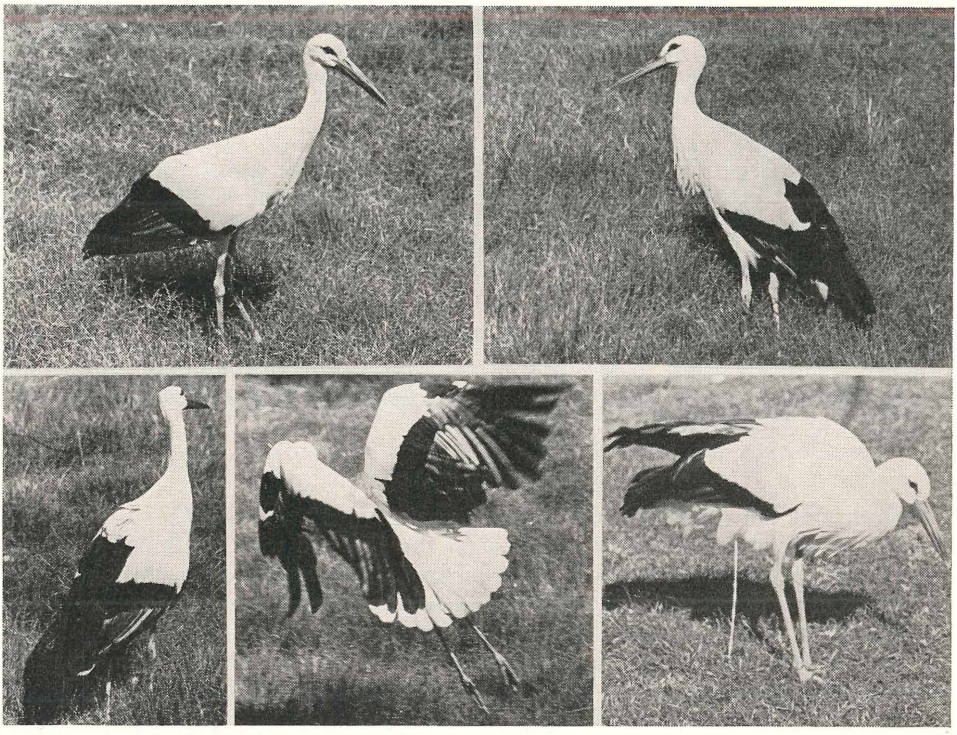


Fig. 2–6: Various stages of „restlessness":
2 Body slightly upwards, neck somewhat stretched.
3 Body tilted upwards, neck stretched, bird looking up.
4 Facing the wind, neck stretched, slightly looking up.
5 Flapping against wind.
6 Bird defecating vertically down.

Abb. 2–6: Verschiedene Stadien von Unruhe:
2 Körper leicht erhoben, Hals etwas gestreckt.
3 Körper steil erhoben, Hals gestreckt, Blick nach oben.
4 Front gegen den Wind, Hals gestreckt, Blick etwas nach oben.
5 Gegen den Wind rudernd.
6 Senkrecht nach unten sich lösend.

(d) „Restlessness" (fig. 2–5). In its most complete form this consisted of a sequence of the following events: It usually started with the bird taking on a sleek posture with the body somewhat tilted upwards and the neck somewhat stretched (fig. 2). The bird remaining in this posture would turn around, look up (fig. 3) and then walk to a part of the enclosure which was down wind (fig. 4). It would look up frequently and also defecate, often in a rather hurried way, being more of an intention defecation than anything else. In this last case the defecation would be the „towards the legs" variety. Having arrived at the down wind section, the bird would then start to run against the breeze with parted or flapping wings (fig. 5) as if trying to take off.

The behaviour was not always complete and sometimes the bird would not flap but only spread the wings while running. There were instances where a bird would, in a rather agitated way, pace up and down along part of the fence of the pen. This was also considered to be „restlessness". The total time of these restlessness periods was expressed as percentage of the total time of observation which was usually 180 minutes.

(e) Direction which the bird faced when not engaged in feeding activities. It was thought possible that a bird which had a strong urge to migrate in a special direction would, if not engaged in other activities, be inclined to face the direction in which it would have flown, if it could have done so. This tendency is well

known in passerine migrants and has been first made use of in KRAMER's (1951, 1952) classical experiments on the importance of navigation by the position of the sun in, for instance, the European Starling (*Sturnus vulgaris*). The direction the stork faced was recorded each time the bird stood motionless, was lying on the ground or was preening itself. The total time that the bird spent facing a particular direction, was not recorded, only the times it occurred. During the few times that the wind was so strong that it clearly influenced the bird, no observations were made.

(f) The time spent by birds in the most northern and most southern sector of the enclosure. It was thought feasible that a bird with a strong urge to migrate north, would show a preference for the northern sector of its enclosure. A bird which had the urge to move south, would then prefer the most southern part. The time the birds spent in the northern and southern sectors of the pen (Fig. 1) during the observation period was recorded and expressed as percentage of the total observation period time.

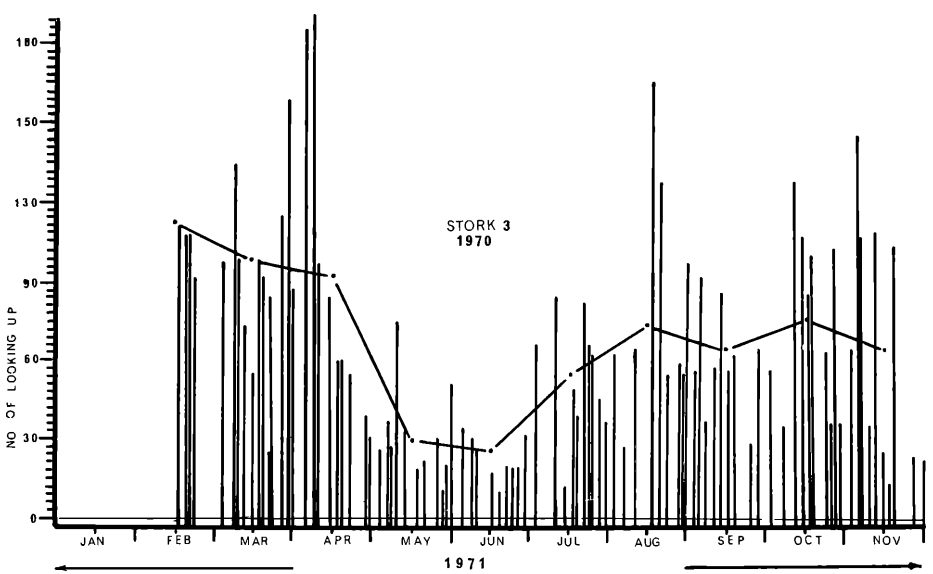
Results

The results are given in the form of histograms. The detailed observations and figures have been deposited in the Percy FitzPatrick Institute of African Ornithology, University of Cape Town.

Looking up

Stork 3. A full record for two consecutive years — 1971 and 1972 — is available. In 1971 the observations started on February the 17th and were continued until the end of November. The results are given in fig. 7a. The length of the histogram columns indicates how many times the bird had been „looking up" during the period of observation at this particular day. The graph shows a high frequency of „looking up" in February, March and the first part of April. It then decreased and reached a low in May and June, rising again in July. The results obtained in the following year (1972) are given in fig. 7b. There is a definite peak for March with a mean of 49. Then there is a gradual decline reaching means of 7, 5 and 8 for May, June and July. This is followed by an increase until September, when a mean of 40 was reached.

Stork 4. Records for one year only — 1972 — are available and these are given in fig. 7c. The graph also shows a peak for March with a mean of 61. April was some-



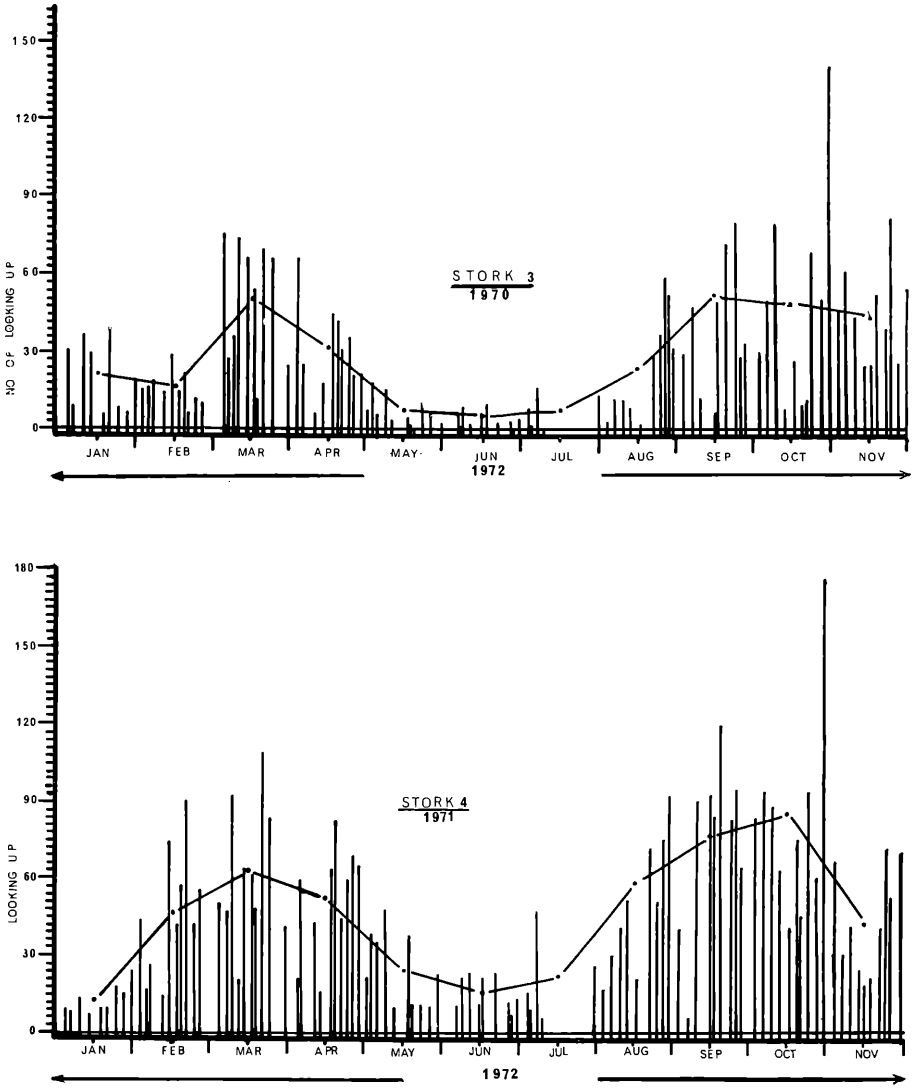
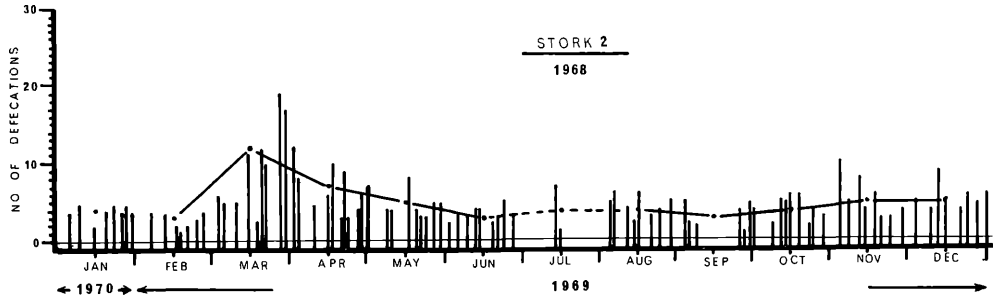


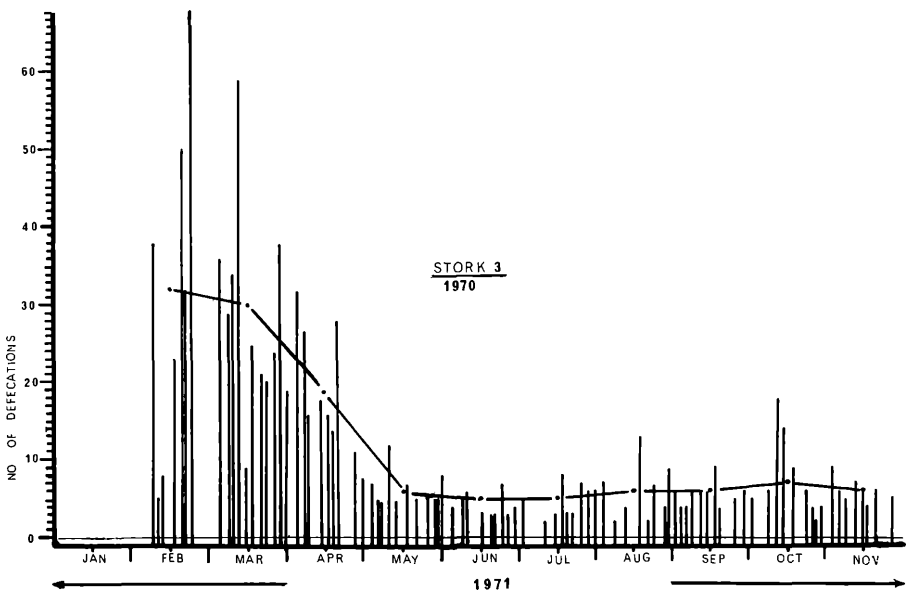
Fig. 7 (a links, b, c oben): Number of times the storks „looked up" during the observations. – Zahl der Fälle von „Nach-oben-zielen" während der Beobachtungszeit.

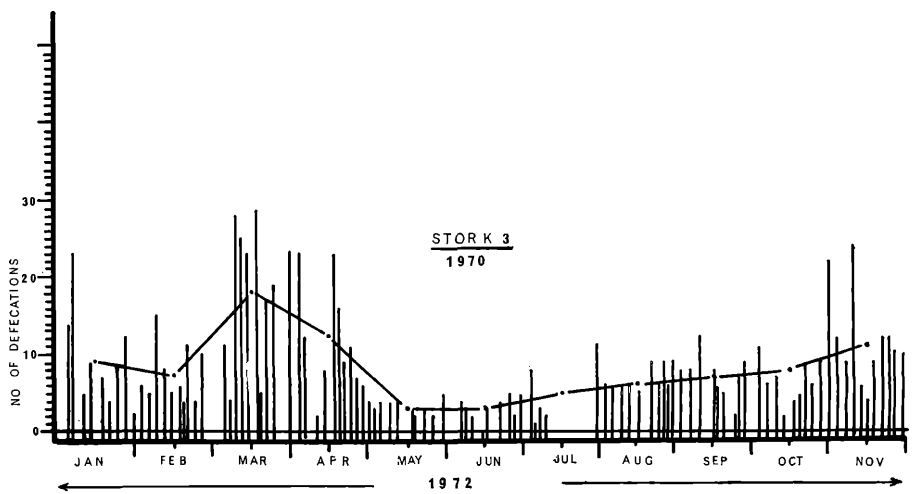
what lower with a mean of 51 but still relatively high. The monthly mean then goes down to 24 for May and reached a low in June of 16. July, with 21 was still low, but then there was an increase to 57 in August, 76 in September and 85 in October. In November the mean had decreased to 42.

Comparing the results for stork 3 and 4 (fig. 7a, b, c), it is clear that they are very similar in that there are peaks from February to April and from September onwards. The monthly means were low in May, June and July.

Comparing the results of the consecutive years for stork 3 (figs. 7a, b) it is clear that the figures on the whole and, therefore, consequently also the peaks are considerably higher for 1971 than for 1972.







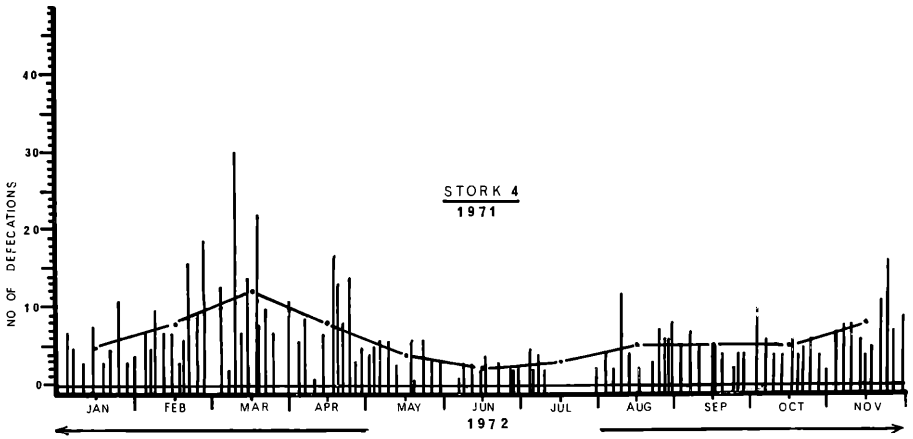


Fig 8 (a, b, c links, d oben): Number of times the storks „defecated" during the observations. – Zahl der Entleerungen während der Beobachtungszeit.

Defecation

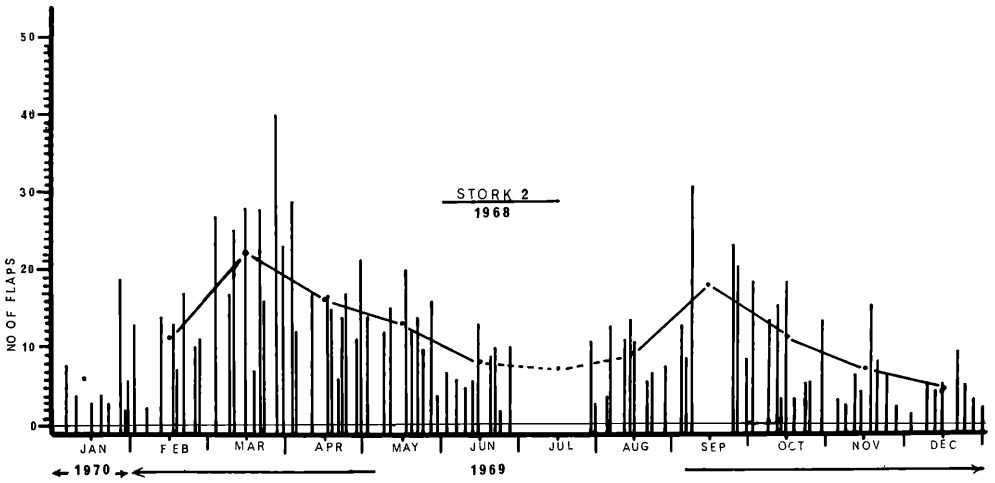
Stork 2. The observations cover only 1969, as the stork which turned out to be a male, died in the beginning of its second year. The results are given in fig. 8a. The lengths of the histogram columns give the number of defecations for the particular day of observation. – The graph shows a monthly mean of defecation rate of 11 for March. It decreased to 7 in April and 5 in May and reached the lowest figure of 3 for June. The position for July is uncertain as only two days of observation are available. August with 4 and September with 3 were still low, after which there was a small and gradual increase to 4 in October and 5 in November and December.

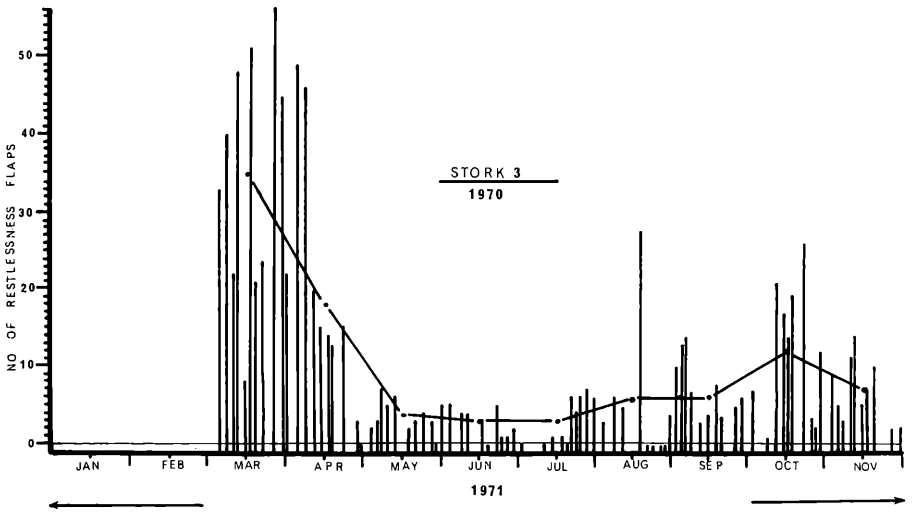
Stork 3. Observations for two consecutive years – 1971 and 1972 – are available. In 1971 observations started on February the 8th and are given in figure 8b. The mean defecation rate for February was 32 and the highest for all months. In March it was still high at 30. It then fell steeply to 19 for April and reached the near minimum at 6 in May and the lowest figure of 5 in June. It never got higher than 7 in the following months. – The results for 1972 are given in fig. 8c. The graph shows a distinct increase in defecation rate from February with a mean of 7 to March with a mean of 18. Then follows a fairly steep decline to 12 in April and 3 in May and June. From then on there was a slow and gradual incline which reached a peak for November with a mean of 11.

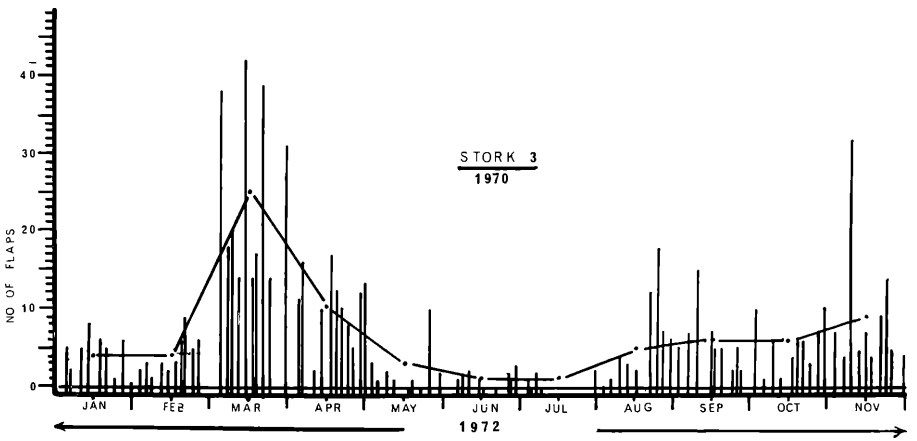
If the two years are compared, it is clear that there is a similar general tendency. However, the March peak in 1971 was considerably higher than in 1972, although the lower values for May, June and August are of the same order, for both years.

Stork 4. Only one year of observations covering 1972 are available and the results are given in fig. 8d. The graph shows a gradual rise from a mean defecation rate of 5 in January to 8 in February to a maximum of 12 in March. It then decreased to a mean of 8 for April, 4 in May and a minimum of 2 in June. In July the mean was 3, and still very low. In August, September and October it was 5 and in November it had gone up to 8.

In comparing the defecation rate of the three storks studied and only considering the first year for each (figs. 8a, b, d), it seems clear that storks 2 and 4 had a rate of defecation of the same order. The defecation rate of 3, especially during the peak period, was much higher.







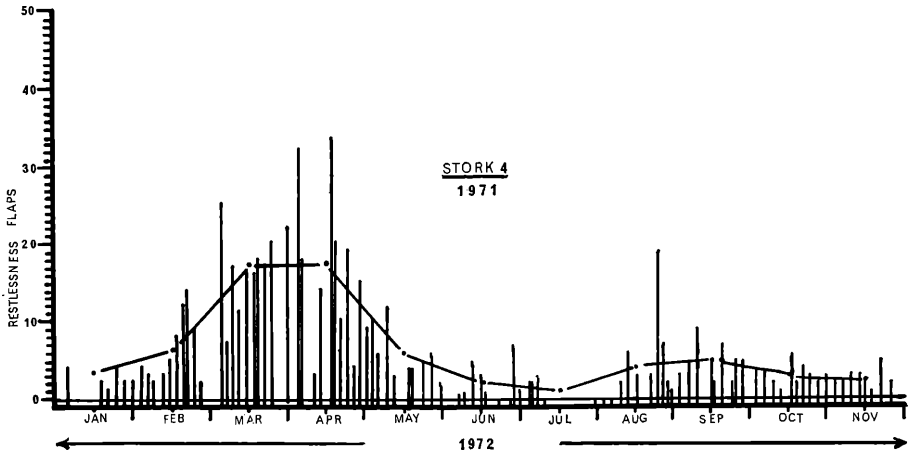


Fig. 9 (a, b, c links, d oben): Number of bouts of „restlessness flaps" during the observations. – Zahl der Flatterversuche der (durch Flügelklammern behinderten) Störche während der Beobachtungszeit.

If we compare the results for the two consecutive years for stork 3 (figs. 8b, c) it appears that the autumn and winter figures were higher in 1971 than in 1972. The figures for the spring were very similar but the monthly mean for November was higher in 1972.

Restlessness wingflap

Stork 2. Observations are available for 1969 and the results are given in fig. 9a. At that time the difference between wingflaps motivated by restlessness and the sexually motivated flaps was not fully appreciated yet. Some of the flaps included in the graph of fig. 9a may have been sexually motivated or were comfort-flaps. The graph shows that there was a distinct peak of a monthly mean of 22 wingflaps for March against 11 in the preceding month. The number decreased to 16 in April and 13 in May. It reached a minimum of 8 in June. Due to absence of the observer, no observations are available for July. In August the mean was 9, very similar to the June figure. It then rose to a mean of 18 for September, with high day figures of 31 for the 8th, 24 for the 25th and 21 for the 27th of September. After September a gradual decrease started with a mean of 14 for October, 7 for November and 5 for December.

Stork 3. Two consecutive years of observation (1971 and 1972) are available. – The results for 1971 are given in fig. 9b. The observations were started on March the 4th. There was a distinct peak in March with a monthly mean of 35 and with six daily figures between 33 and 56. There was a steep decrease to 18 for April and 4 in May. A minimum of 3 was reached in June and July. There was an increase to a mean of 6 for August and September with a daily figure of 33 on the 18th. In October the mean was 12 with three daily observations of between 19 and 26 flaps. In November the mean had fallen to 7. – The results for 1972 are given in fig. 9c. The graph has a marked peak with a mean of 25 for March and with daily figures of 38 for the 4th, 42 for the 14th, 39 for the 21st and 33 for the 31st. Then there was a steep decrease to a mean of 10 for April and 3 for May. The minimum of 1 was reached in June and July. The mean then gradually increased to 5 in August, 6 in September and October and 9 in November.

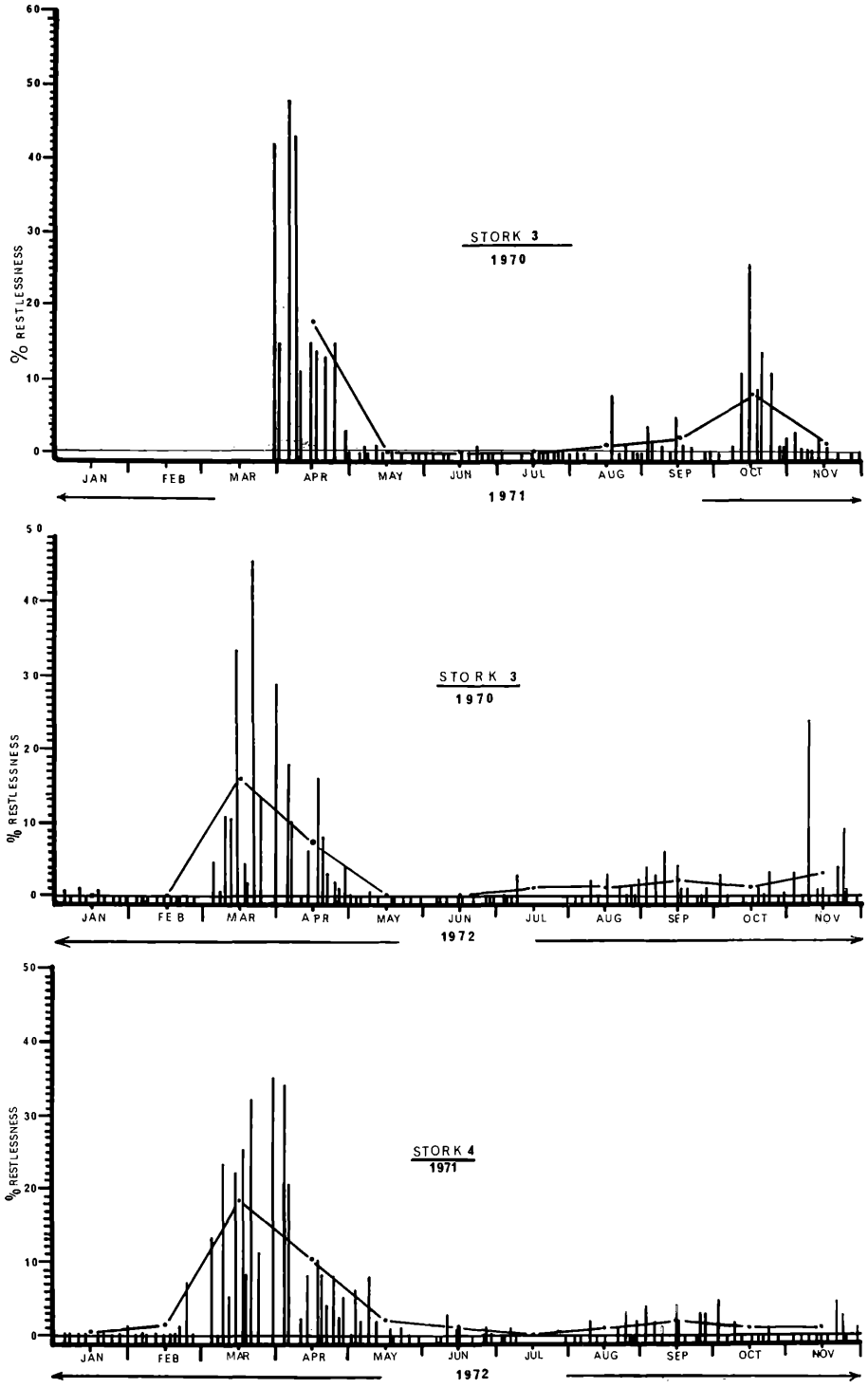


Fig. 10 (a, b, c): Percentage time of „restlessness" of total time of observations. – Prozentanteil der Unruhezeit an der gesamten Beobachtungszeit.

Stork 4. One year of observations (1972) is available and the results are given in fig. 9d. The graph shows that the highest monthly means of restlessness wingflaps both of 16, occurred in March and April with high daily figures of 25 on March the 4th, 20 on the 24th, 22 on the 31st, 32 on April the 4th and 34 on the 17th. There was a steep decrease to 6 for May and a further decrease to 2 for June and 1 for July. In August the mean was 4, but a high daily figure of 19 on the 24th occurred. In September the mean was 5 and fell to 3 for October and 2 in November.

If we compare the amount of restlessness flapping of the three storks observed, only considering the first year of observation for each (figs. 9a, b, d), storks 2 and 4 are rather similar. As the figures in the case of stork 2 are probably somewhat too high, due to wingflaps other than only motivated by restlessness having been included, the similarity between storks 2 and 4 may even be more pronounced than indicated by the graphs.

Stork 3 showed a considerably higher rate of restlessness flapping than the other two. This was especially so during the peak period in autumn.

If we compare 1971 (fig. 9b) and 1972 (fig. 9c) of stork 3, it appears that on the whole the rate of flapping was somewhat higher in the first year compared with the following year.

Restlessness:

Stork 3: Observations are available for the two consecutive years 1971 and 1972. – The results for 1971 are given in fig. 10a. The observations started late, on March the 26th, and no reliable monthly mean for this month can, therefore, be given. However, from the trend of the graph it is likely that the mean for March was higher than the mean of 18 % restlessness for April. No restlessness was recorded in May, June and July. In August the mean was 1 %, mainly due to 8 % restlessness on August the 18th. There was a slight rise to 2 % for September and a considerable rise to 8 % for October, with daily observations of 26 % on October the 14th and 14 % on the 18th. The mean for November was 1 %.

The results for 1972 are given in fig. 10b. The figure shows that there was virtually no restlessness in January and February. In March it shot up to a mean of 16 % with some daily figures being as high as 34 % on March the 14th, 46 % on the 21st and 29 % on the 31st. This was followed by a relatively steep decrease to a mean of 7 % in April falling to zero for May and June. In July and August the mean was 1 % and in September 2 %. In October it was 1 % and in November 4 % with one daily observation of 24 %.

Stork 4. The results for 1972 are given in fig. 10c. The graph shows that there was virtually no restlessness in January. The mean for February was 1 % mainly due to a 7 % restlessness on February the 24th. In March there was a sudden increase to a mean of 18 % with daily observations as high as 23 % on the 9th, 22 % on the 14th, 25 % on the 17th, 32 % on the 21st and 36 % on the 31st. After March there was a sharp decrease in restlessness to a mean of 10 % in April, 2 % in May, 1 % in June, and zero in July. The mean for August was 1 %, for September 2 % and for October and November 1 %.

If the restlessness of storks 3 and 4 in the first year (figs. 10a, c) are compared, it seems that there is quite a degree of similarity between the two but that stork 3 showed a somewhat higher percentage of restlessness in March and April and especially in the spring.

If the results obtained for stork 3 in 1971 (fig. 10a) are compared with those in 1972 (fig. 10b) the percentage restlessness in 1972 (second year) is perhaps somewhat less than for 1971 (first year). This especially applied for the spring figures.

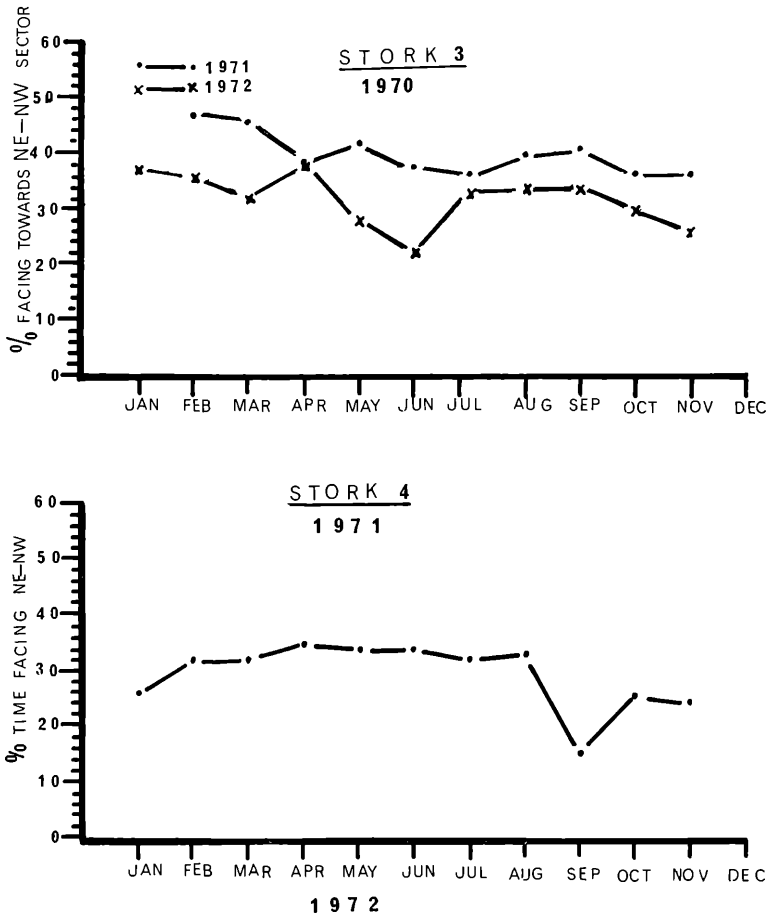


Fig. 11 (a, b): Number of times expressed in percentage the storks were facing the NE-NW sector during the observations. – Nord-Ausrichtung der Gehegestörche in Prozenten der Beobachtungszeit.

The number of times that birds were facing the true NE–NW direction:

Observations covering the two consecutive years 1971 and 1972 are available for stork 3. For stork 4 there are observations for 1972. – The results for stork 3 are given in fig. 11a. It is clear that in both years there was no distinct peak. – The results for stork 4 are given in fig. 11b. Most of the time the graph runs horizontally, but for the month September there is a distinct drop.

The percentage time birds spent in the northern/southern sector of the enclosure:

Stork 1. Observations are available for 1968 (fig. 12a) and part of 1972 (fig. 12b). – The graphs concerning 1968 show that little time was spent in the northern sector during April, May and June, but relatively more in March and the period after July, especially during November and December. The graph referring to the time spent in the southern sector is very irregular from March to September, but from September onwards there is a regular decrease reaching a very low figure in December. The graph referring to the first half of 1972 shows that the bird spent a lot of time in the northern sector during Fabruary and March, and little time in the south in January, February and March.

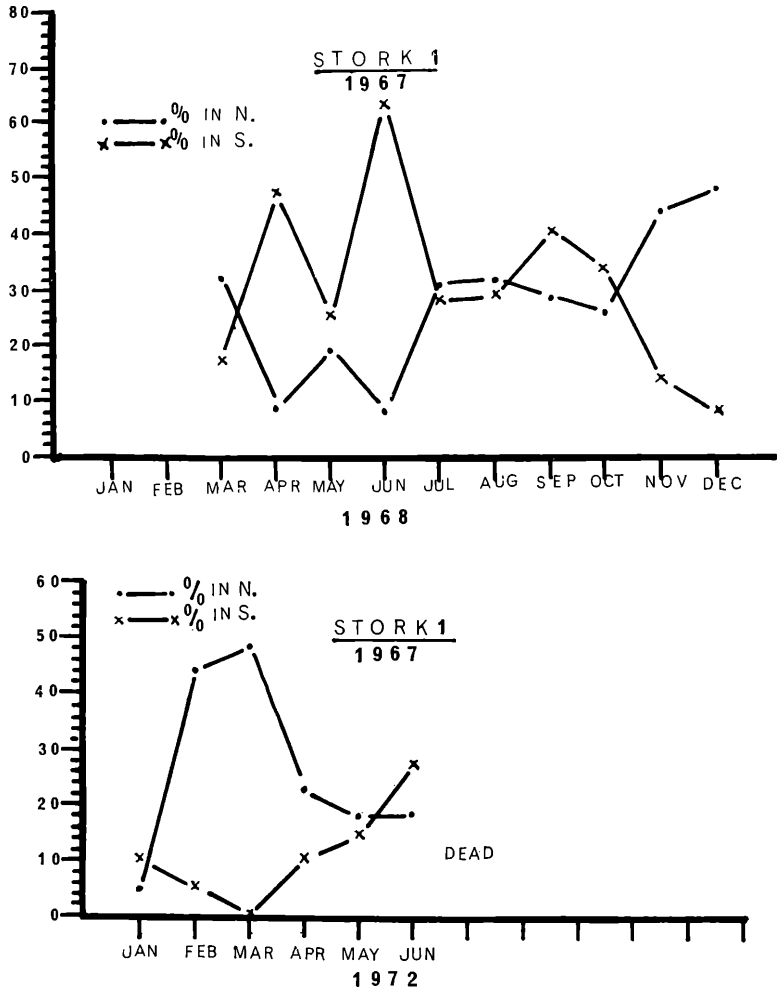
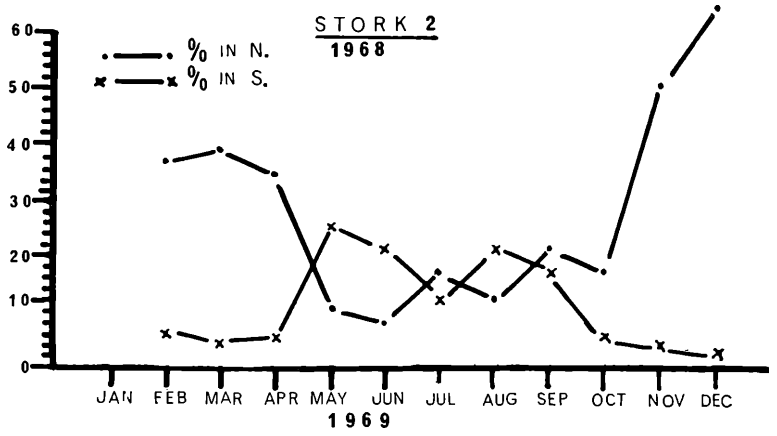


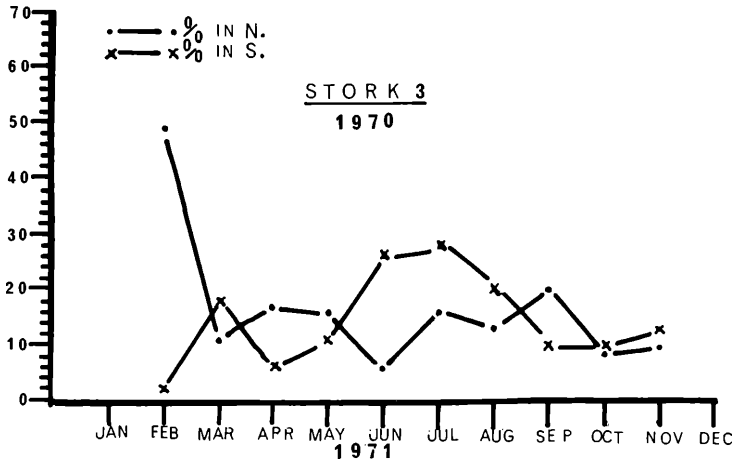
Fig. 12 (a, b): Percentage of time the stork spent in the northern/southern section during observations. – Verweilen im N- und S-Teil des Geheges in Prozenten der Beobachtungszeit (Storch 1).

Stork 2. There are observations for 1969 and these are given in fig. 13a. The graph referring to the percentage of time spent in the northern sector shows a rather regular pattern. The monthly means for February, March and April was relatively high. There was a steep decrease in May, and the lowest level was reached in June, after which there was a slight increase, followed by a decrease, then an increase and then again a decrease. After October there is a steep increase, reaching a high figure in December. – The graph referring to the percentage of the time spent in the southern sector, gives low figures in February, March and April. May to September showed higher figures, with another decrease following.

Stork 3. Observations are available for 1971 and 1972. – The results for 1971 are given in fig. 13b. The graph concerning the percentage of time spent in the northern sector shows a high figure for February with a steep drop in March after which the figure remained low, though somewhat irregular. The graph concerning the percentage of time spent in the southern sector shows that the bird spent relatively a lot of time in the south in June and July. There was, therefore, a peak during the wintermonths.

The results for 1972 are given in fig. 13c. The graph referring to the time spent in the north shows a definite pattern. The percentage of time spent in the northern sector was





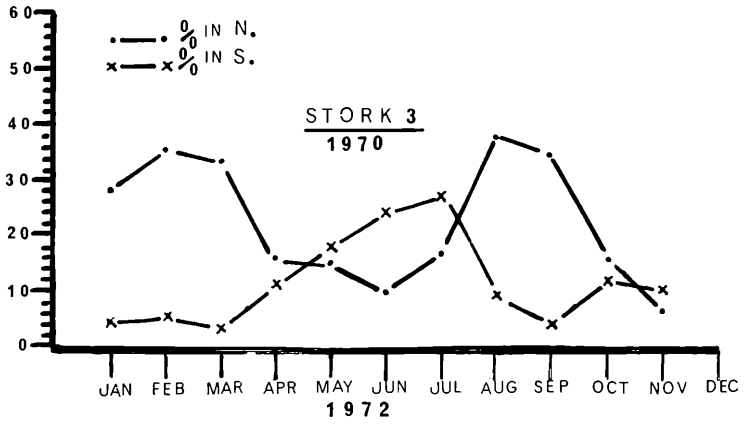


Fig. 13 (a, b, c): Percentage of time storks spent in the northern/southern section during observations. – Wie Abb. 12, Störche 2 und 3.

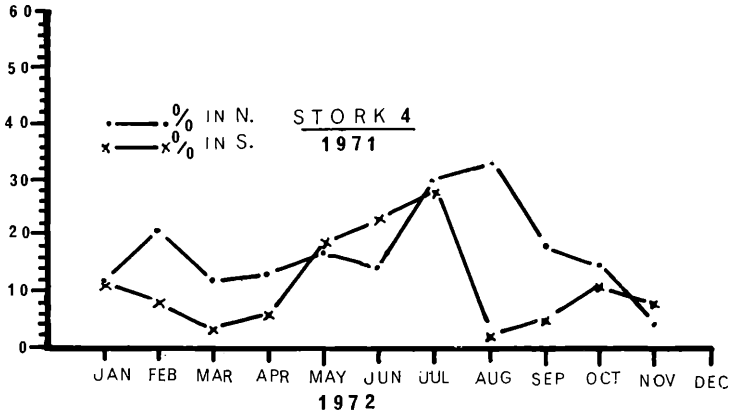


Fig. 14: Percentage of time stork spent in the northern/southern section during observations. – Wie Abb. 12, Storch 4.

relatively high in January, February and March. It decreased sharply towards April and remained rather low until July, when in August, there was a steep increase. The monthly mean remained fairly high in September, after which it decreased steeply.

The graph referring to the time spent in the south shows a long and fairly steep, though gradual increase until July, followed by steep decrease in August. After August the monthly mean varied, but remained low. The peak figures, therefore, occurred during the winter months.

Stork 4. The results for 1972 are given in fig. 14. The graph, referring to the % time spent in the northern sector only indicates a slow, somewhat irregular, increase to a peak figure in August. After that there was a sharp drop. The graph referring to the time spent in the southern sector shows that the lowest monthly means occurred in March and August and the highest during the winter in May, June and July.

If we compare the results for storks 1, 2, 3 and 4, only considering the first year of observation (figs. 12a, 13a, b, 14) we find that there is a considerable variation. However, as regards the time spent in the southern sector, storks 2, 3 and 4 spent more time in the southern sector during the winter months than during the other months of the year. The results for stork 1 are very different, and irregular.

If we compare the results obtained for two consecutive years for stork 3 (figs. 13b, c) we find that for both years the highest percentage of time spent in the north occurred in February. During 1971 the monthly mean remained low from March to November. During 1972 there were peaks more or less coinciding with the changing of the seasons. – When we consider the time spent in the south, the results obtained during the two years show the same general tendency, that is a period of highest percentage in the south in June and July.

In the case of stork 1 there are observations for 1968 which was the first year (fig. 12a) and the first half of 1972 (fig. 12b) when the bird was in its fifth year. If we compare the results it is clear that they are very different.

Discussion

The results obtained show quite clearly that in all four storks, originally taken from nests in the Bredasdorp District, a strong migratory urge developed during the southern autumn (March/April). This is indicated by the number of times the birds „looked up" (figs. 7a, b, c), rate of „defecation" (figs. 8a, b, c), number of „restlessness flaps" (figs. 9a, b, c) and percentage of time of „restlessness" (figs. 10a, b, c).

The indication was clearest in the case where restlessness was recorded. This could be expected as this type of behaviour is most, if not exclusively, linked with an active migratory urge. The other types of behaviour were no doubt somewhat influenced by factors other than only migratory urge. High temperature in the summer

caused a certain amount of stress and consequently a higher defecation rate, also probably more frequent flapping and perhaps induced more frequent looking up. It is significant that nevertheless these types of behaviour also showed a pattern which clearly indicated the presence of migratory urge.

The time at which the increase in the different behaviour patterns occurred coincided with the time when the White Storks normally migrate north from their southern wintering quarters, that is from late February to the beginning of April (SCHÜZ et al. 1950, HORNBERGER 1961). If the migratory urge is present then one could also expect an indication of it during the southern spring (northern autumn) when normally storks would be migrating south from their northern breeding quarters. This southern migration usually takes place during August, September and October (HAVERSCHMIDT 1949, BROEKHUYSEN 1971) and one could expect a second peak in the various types of migratory urge indicative behaviour actions around that time of the year. The results show that in several cases such a peak was present (figs. 7a, b, c; 9a, b, c; 10a, b). However, where a spring peak (Aug./Oct.) was present it was much less pronounced than the autumn peak (Febr./Apr.).

This to a certain extend is in accordance with the migratory pattern of palaearctic migrants observed in their northern breeding quarters. It has been known for some time that the northern autumn migration is much more spectacular and more condensed than the northern spring migration when the birds return from their southern wintering quarters. The reasons may be more uniformity in the urge during the autumn and the large numbers due to all the young birds of the year. During the spring migration when birds return to their northern breeding quarters, the urge to migrate may vary due to the different age classes involved. Numbers participating will be smaller due to casualties during the previous migration south and while staying in the southern wintering quarters.

The observations on the captive storks show a relatively strong autumn migratory urge during mainly two months (Febr./Apr.) and a weaker spring migratory urge spread over a longer period (Aug./Oct.). The difference between the intensity of the migratory urge during the two different periods may very well have been accentuated by the following. January, February, March and April are months when wild storks are in their southern wintering quarters. The captive storks being observed in the south were, therefore, in similar circumstances and conditions to the free storks. Climatical changes, like decrease in average daylight, decrease in temperature, etc. were the same for both categories.

The position during the southern spring and early summer was very different. At that time the majority of wild birds and especially adults would be in their northern summering quarters and would come under northern autumn climatical conditions. The captive birds being observed in the southern wintering quarters would at that time come under southern spring conditions. Instead of the average daylight decreasing it would be increasing and so would the average day temperature. In other words, while conditions for the birds north of the equator would be deteriorating, those for the captive birds in the south would be improving. These improving conditions may have an inhibiting effect on migratory urge developping. This may be one of the factors causing the autumn migratory urge (March/April) to be so much more pronounced than the spring migratory urge (Aug./Oct.). In addition the fact that birds observed were mostly immature may also have caused less urge to move north.

If there would be a tendency in the captive birds to spend relatively more time in that part of the enclosure which was facing the direction in which normally the birds would have departed and migrated if they had been free to do so, one would have expected the following: During the southern autumn (March/April) a bias

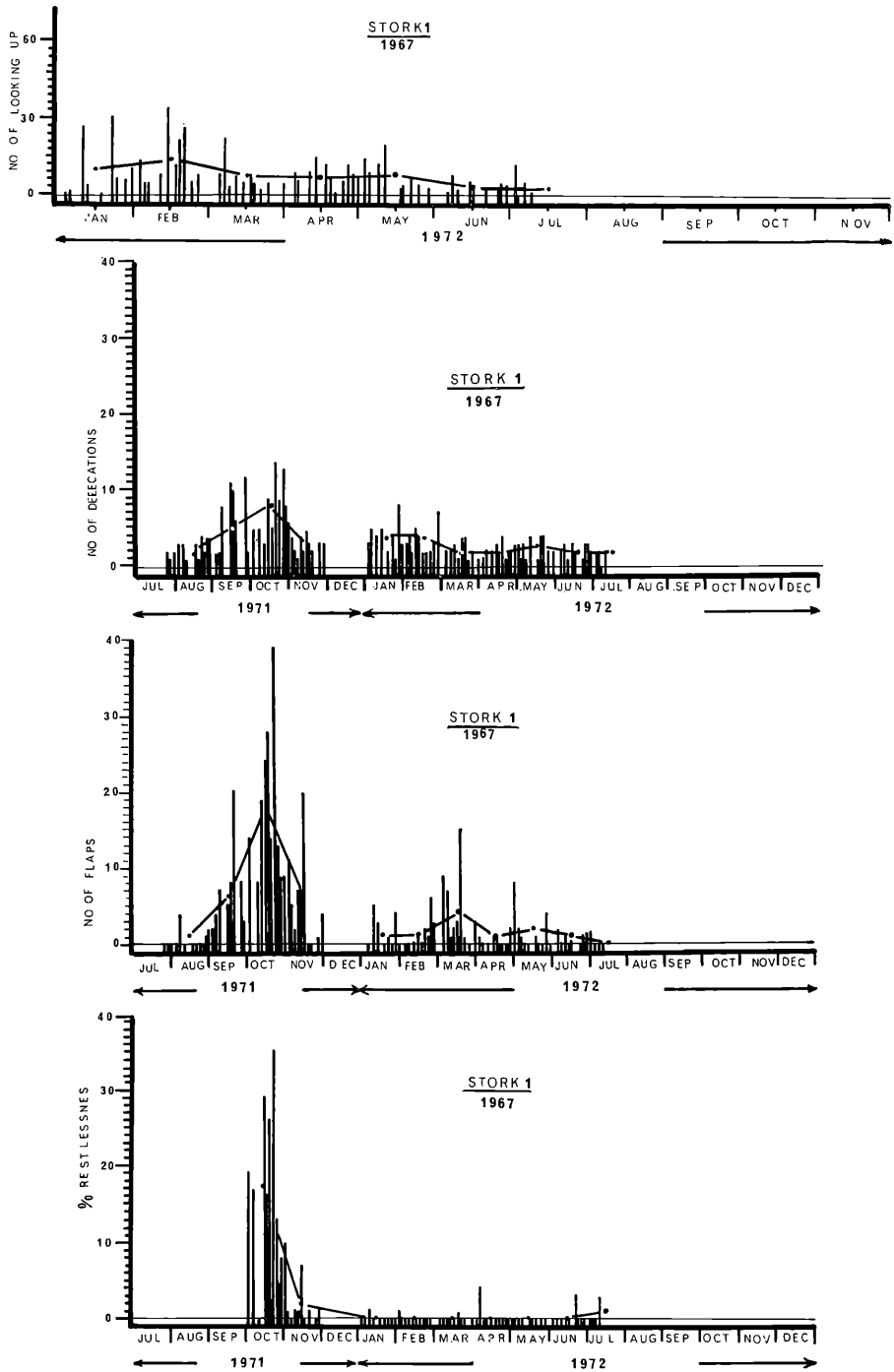


Fig. 15 (a, b, c, d): Number of „looking up" (a), „defecation " (b), bouts of „restlessness flaps" (c) and percentage of „restlessness" (d) of stork 1 during the last half of 1971 and the first half of 1972. – Fälle von Nach-oben-zielen (a), Defäkation (b), Flatterversuchen (c) und prozentualer Zeitanteil von Unruhe des Storchs 1 von Mitte 1971 bis Mitte 1972.

towards the northern section of the enclosure. During the southern spring (Aug./Oct.) a bias towards the southern section.

The results obtained show that in the case of Stork 1 (fig. 12a), Stork 2 (fig. 13a) and the second year of observation for Stork 3 (fig. 13c) there was a bias towards the north in the southern autumn. However, there appeared to be no such bias in the case of Stork 3 during the first year of observation (fig. 13b) and also Stork 4 (fig. 14).

The observations show no indication favouring a bias towards the south in the southern spring. However, there seems to have been a bias towards the south during the winter months. This rather unexpected result must go unexplained for the time being. It may be that the fact that the birds being observed were already in the southern wintering quarters at the time the urge to depart for the southern wintering quarters became active had something to do with.

An important point intimately linked up with the question of some storks losing their migratory urge completely and starting to breed in what normally is their southern wintering quarter, is how long it will take for the migratory urge to disappear if the birds are kept in their wintering quarter and prevented from migrating north. The observations available cannot settle this point completely but there are indications.

Stork 3 was observed during two consecutive years. If we compare the relevant graphs for these two years (figs. 7a, b, 8b, c, 9b, c, 10a, b) it is clear that there was a certain amount of decrease in the second year in all the different behaviour patterns indicative for an active „migratory urge"

For stork 1 observations are available for when the bird was in its fifth year. They only cover the period October – July as the bird then died.

The number of times of „looking up" (fig. 15a), number of „defecations" (fig. 15b) and percentage „restlessness" (fig. 15c) all show no indication of any substantial increase in their monthly mean during March and April. There is a small increase in the monthly mean for March in the number of „restlessness flaps" (fig. 15d). One is tempted to conclude that in this stork 1 the migratory urge was not present any longer when the bird had been kept in captivity for four years. Surprisingly, however, this stork showed very strong migratory restlessness in the spring (October) (fig. 15b, c, d). This was the more surprising as all the first and second year observations in the other storks showed no prominent spring migratory urge.

It is clear that more investigation is needed to establish after how many years storks which are prevented to migrate lose the migratory urge. BLOESCH (1968) reports that nine pairs kept in captivity for at least five years had lost the urge to migrate and stayed at Altreu in Switserland during the northern winter.

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Summary

1. All together four White Storks *Ciconia ciconia* taken as nestlings from nests in the Bredasdorp District on the southern tip of Africa, were kept in captivity. Regular observations on their behaviour throughout the year were carried out in an attempt to establish whether these birds had a migratory urge.
2. In all closely observed birds there was a distinct, fairly sudden, increase in number of times of „looking up", rate of „defecation", number of „restlessness wing-flaps" and

amount of „restlessness" in March and the first part of April, after which there was a sharp decrease in all these parameters. In several cases there was a less obvious, and spread over a longer period, increase after August. From this it was clear that the birds showed a strong migratory urge in the autumn (March/April), limited to a fairly short period. There seemed to be a rather weak migratory urge, spread over a rather long period, in spring (Aug./Oct.).

3. Observations carried out on the same bird in consecutive years showed identical patterns but indicated a small decrease in the migratory urge in the second year of captivity in comparison with the first year.
4. Rather incomplete observations on a bird kept for four years in captivity, suggests ceasing of the migratory urge in the fourth year.

Zusammenfassung

Im südlichsten Südafrika hat sich vor rund 35 Jahren als paläarktischer Gast der Weißstorch angesiedelt. Diese Kolonie blieb jedoch sehr klein; es muß Gründe geben, die ein weiteres Aufblühen verhindern. Da erhebt sich vor allem die Frage, wie es mit dem Zugtrieb dieser Störche bestellt ist. Daß sie wenigstens teilweise bis in tropische Bezirke wandern, ist erwiesen. Die Untersuchung prüft 4 jung aus der südafrikanischen Kolonie entnommene Störche auf Anzeichen eines Zugtriebs: (a) Nach-oben-zielen, (b) Erregungs-Defäkation, (c) Flatterversuche der durch Flügelklammern am Wegfliegen behinderten Vögel, (d) Unruheverhalten, (e) Ausrichtung in Ruhehaltung und (f) Streben zum nördlichen bzw. südlichen Sektor des Geheges. Die einzelnen Punkte werden auf ihren Deutungswert geprüft. Die Verhalten (a) bis (d) ergaben im Herbst, also im März, eine plötzliche Entfaltung und Mitte April einen starken Abfall. Weniger auffällig und länger verzögert zeigte sich im August wieder eine Zunahme. So ist im März-April ein kurzer, aber starker Trieb zum Wegzug deutlich, während der Heimzug-Trieb im Frühjahr (August bis Oktober) ziemlich schwach und zeitlich ausgedehnt auftritt. Die Faktoren (e) und (f) erwiesen sich als viel weniger überzeugende Indikatoren. Vergleiche am selben Vogel in aufeinanderfolgenden Jahren ergaben Übereinstimmung, jedoch geringe Abschwächung des Zugtriebs im zweiten gegenüber dem ersten Jahr. Noch unzulängliche Beobachtungen an einem Storch über vier Jahre hinweg legen – mit allem Vorbehalt – nahe, daß im 4. Jahr der Zugtrieb verloren geht.

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