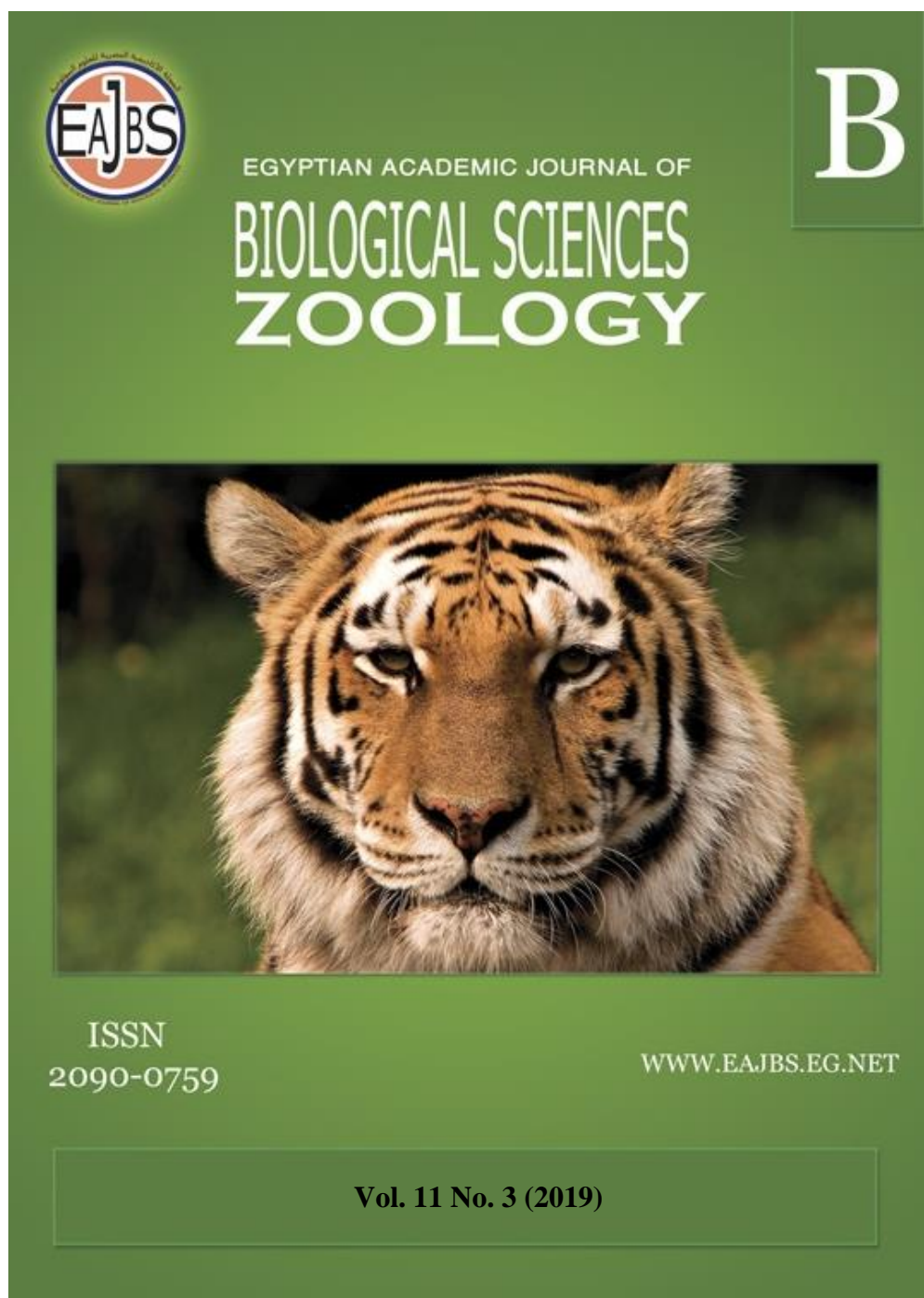


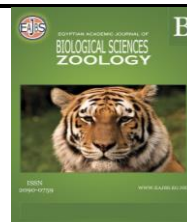
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Movement Patterns of the Black Kite (*Milvus migrans*) During Spring Migration over Rift Valley/Red Sea Flyway, Gulf of Suez, Egypt

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ABSTRACT

The aim of this study to follow up on the spring migration of the black kite (*Milvus migrans*) before crossing from the west bank of the Gulf of Suez opposite the South Sinai region, Egypt. Daily observations were carried out over the period 22 February - 12 May 2019, where 7,004 individuals (968 records) of BK were recorded. Most BK flight direction observed (46% NW and 17% SE) had a reversed direction of spring migration, which need to soar to gain height, and then return over and around the study area at higher altitudes to be able to cross the water barrier easily. The observed behavior of black kites is regularly shown in the study area despite long-term irregular weather conditions during the Spring, most of BK 66% were recorded during the prevailing northwardly wind. whereas, more than 43% of BK were recorded in low wind speeds, representing about 43% of all records, while less than 3% of birds recorded in high wind speeds, representing less than 6% of records.

INTRODUCTION

Egypt occupies the northeastern part of the African continent (Riad, 2019), it is of critical importance for the bird migration as it is located on the only land bridge between the Eurasian and African landmasses that links breeding grounds in Europe and Asia with wintering areas in Africa (Bergen 2007; Bergen 2013; CarlBro 2010).

The Gulf of Suez area lies at the heart of the Rift Valley / Red Sea Flyway and at its narrowest points that include several bottlenecks, which are internationally recognized as Important Bird and Biodiversity Areas (IBAs). These are Gebel El Zeit, Suez, Ain Sukhna and the Qaa' plain. The Important Bird Areas of Egypt, (Baha El Din, 1999), where each year millions of birds belonging to almost 200 species migrate from their breeding grounds in Eurasia to sub-Saharan Africa, where they spend the winter, returning in the following spring (Moreau 1972). These migrants face very harsh conditions as they cross large areas of unfavorable habitats, such as deserts and open seas, without the possibility of feeding or drinking. Most of the species, particularly smaller ones, perform direct and active flights, selecting the most direct route between the breeding and the wintering grounds.

The black kite has a wide distribution in all the Palaearctic, Afro Malagasy, Indomalaya, and Australasian regions, but is absent in the New World (Nearctic and Neotropic). At least six subspecies are known (Cramp and Simmons, 1980). Among them, two live in Africa and are mostly residents or short-distance migrants. *Milvus migrans aegyptius* is found in the Nile Valley and on both coasts of the Red Sea with some individuals wintering in Sudan and coastal Kenya. *Milvus migrans parasitus* is widely distributed in sub-Saharan Africa, Comoros, and Madagascar and has strong intra-continental movements (Cramp and Simmons, 1980; Ferguson-Lees and Christie, 2001). The nominal subspecies is almost entirely migratory and is distributed in the Western Palaearctic and in some areas of Central Asia. *Milvus migrans migrans* (hereafter called black kite) is a widespread summer visitor in Europe, with a breeding population counting less than 100,000 pairs (Birdlife international, 2004). Its wintering grounds are located mostly in Africa, south of the Sahara Desert, but also in the Middle East (Shirihai *et al.*, 2000; Ferguson-Lees and Christie, 2001); birds breeding in central-western Europe mostly overwinter in Western Africa (Cramp and Simmons, 1980; Meyburg and Meyburg, 2009).

Black kites are opportunistic predators; they can feed on “live animals from the size of a mosquito to a 1-kg adult rabbit and use all sources of carrion when available” (Tanferna *et al.*, 2013; 2012) exploiting concentrations of food that are spatially and temporally unpredictable (Viñuela 2000; Sergio 2003a; Cortés-Avizanda *et al.*, 2011). This species often breeds in loose colonies (Cramp and Simmons 1980), and it has been observed that juvenile and adult survival is higher for individuals born or living in high-density areas, at least in some populations (Forero *et al.*, 2002).

The flight behavior of this species during migration is halfway between broad-winged raptors like buzzards, eagles and vultures and relatively long-winged raptors like *Circus* species. For this reason, black kites tend to use soaring flight over land during migration to minimize energetic costs and concentrate at straits and isthmuses, but they are also able to cross large bodies of water using long powered flights (Zalles and Bildstein, 2000). Some research showed phenotypic plasticity of the species in response to climate change: climate warming seems to trigger earlier egg laying and a northward shift of the breeding and wintering ranges (Burton 1995; Sunyer and Viñuela 1996; Moss 1998; Sarà 2003a; Sergio 2003b; Sergio *et al.*, 2007). Thus, several studies are available, but knowledge about the migratory routes and the connectivity with African wintering grounds is still incomplete (Panuccio *et al.*, 2013). During the movements from Africa to Europe towards the breeding territories, an important flyway is located between the Nile Valley and the Red Sea in Egypt, and two watch sites are known along this route: Bûr Sâfaga, on the Red Sea Mountains, and Zait Bay, (Zalles and Bildstein, 2000; Hilgerloh, 2009). Numbers recorded at Suez are larger in spring than in autumn (Meininger and De Roder 1992; Zalles and Bildstein 2000). In the Middle East, the migration takes place mostly between the second half of March and the first days of April, with few birds observed outside this period. In some years, a second, smaller wave of migration has been observed at Eilat in late April. Until the end of March, aged Black Kites were mostly adults, but in late April and May 2nd calendar-year birds predominated (Shirihai *et al.*, 2000).

In general, the black kite (*Milvus migrans*) uses three principal routes to the Mediterranean basin on the migration to Africa. The most important of which is across the Strait of Gibraltar, much less important is the eastern route across the Bosphorus throughout of Sinai and Egypt, the third principal migratory route crosses the Sicilian Channel, about 150 km wide, in the central Mediterranean, between Italy and Tunisia (Cramp and Simmons, 1980).

Observation Techniques:

Visual observations were conducted during daylight hours daily between February 22th and May 12th, 2019 covering all spring migration season. The standard methodology for bird census according to Scottish Natural Heritage guidance (SNH, 2010), and by following the methodology described in Scutherland (2006), bird monitoring was conducted through three fixed vantage points, observation posts strategically positioned to provide the best visual coverage of the bird movements, each vantage point almost complete coverage within 2500m view scope within the selected study area (Fig. 1). The survey covered all points watches for 8 hours/day, 7 days/weekly, from 7:30, am to 4:00 pm, with 30 minutes break between morning and evening sessions (11:30 – 12:00). Bird heights were recorded at time intervals with 15-seconds, weather conditions (wind direction & speed, temperature, cloud/mist, precipitation, and visibility) were recorded on hourly bases by one member of the team using IQS weather software. Professional birdwatching binocular, camera, bird identification filed guide, clipboards, recording (sheets & maps), compass and cell phone were providing the whole survey team.

Data Analysis:

A total of 576 survey hours per each observation point (1728 observation hour for the whole study area) were conducted in the field during the survey period, generally 4 hours morning session and 4 in the evening. Usually, when the time allows, average counts from the closest observation point were recorded. The double-checking process was also conducted for the row data to exclude double counts from the data set for large and obvious double-counted flocks. Individual and small flocks of bird's double-counting proved to be difficult to eliminate, however, they form a small proportion of the dataset and does not substantially affect the main conclusion of the survey results. To simplify weather data, wind direction measurements were converted into eight main directions, and wind speed measurements were also converted into four main categories, Table 1.

Table 1: Wind direction and speed categories used in the data analysis.

Wind direction (Degrees)	Wind direction (Category)	Wind speed (m/s)	Wind speed (Category)
337.5-22.5	N (North)	Less than 5	C – Calm
22.5-67.5	NE (Northeast)	5 -10	L – Low
67.5-112.5	E (East)	10 – 15	M – Medium
112.5-157.5	SE (Southeast)	More than 15	H – High
157.5-202.5	S (South)		
202.5-247.5	SW (Southwest)		
247.5-292.5	W (West)		
292.5-337.5	NW (Northwest)		

RESULTS

During the field observation from February 22th to May 12th, 2019, a total of 7006 individuals (968 records) of the black kite (*Melvus migrans*) were recorded. Considering the maximum count birds recorded through the study area during 10 weeks of study (absolute minimum without duplication with the other observation points), the ninth week was the highest in individuals and records of BK (37%, 26%),

respectively (Fig. 2). In this study, most individuals were recorded for flock more than 11 individuals (56%) however, they comprise less than 16% of all records. On the other hand, the observations composed of 2-10 birds were recorded 26% form 48% of all records, and the individual observations only 5% of birds but were forming 43% of all records (Fig. 3). Migration activity was higher during morning hours for all the numbers of birds and records (Fig. 4).

The flight altitude of all recorded BK in the study area were classified into five classes (0-100, 100-200, 200 -300, 300-500 and < 500), the majority of the most BK was recorded in the altitudes above 100m and less than 500m, while was recorded less than 25% from records and 15% of bird numbers under 100m altitude (Fig. 5).

Fight direction of most BK revealed an expected northerly pattern (between northwest and the northeast quadrant). Interestingly, most records showed a north-western direction which is probably adopted to avoid direct headwinds, since the prevailing wind direction is straight from the north (Fig. 6).

Flight Behavior and Weather Conditions:

Most of BK 66% were recorded during the prevailing northwardly wind. The difference between the number of records 74% and the number of birds 66% recorded during north wind is attributed to the recording of large flocks of birds. In contrast, the number of birds recorded southwest was 20% (Fig. 7). More than 43% of BK were recorded in low wind speeds, representing more than 43% of all records, while less than 3% of birds recorded in high wind speeds, representing less than 6% of records (Fig. 8). The proportion of recorded birds in different wind directions and speed classes to the overall recorded birds are presented in Figure (9), hence, to compare the proportion of birds recorded in different wind speeds to the overall birds recorded for each wind direction. The total field observation hours for each wind direction and speed class were considered, reveals that northwest low winds had the highest migration rate accounting for 25% of all recorded birds during the study period (Fig.10). When relating the wind direction to a bird's flight direction, the relationships become more complicated and dependent on other environmental factors. Only one case showed about 10% of BK flying southeast opposite to north wind direction (Fig. 11). For the BK flying at the different altitudes, more than 30% of birds recorded during northward low winds, while, more than 10% of bird observation recorded during northward calm winds, on the other hand, more than 15% of bird observation recorded during southward calm winds (Figs. 12 &13).

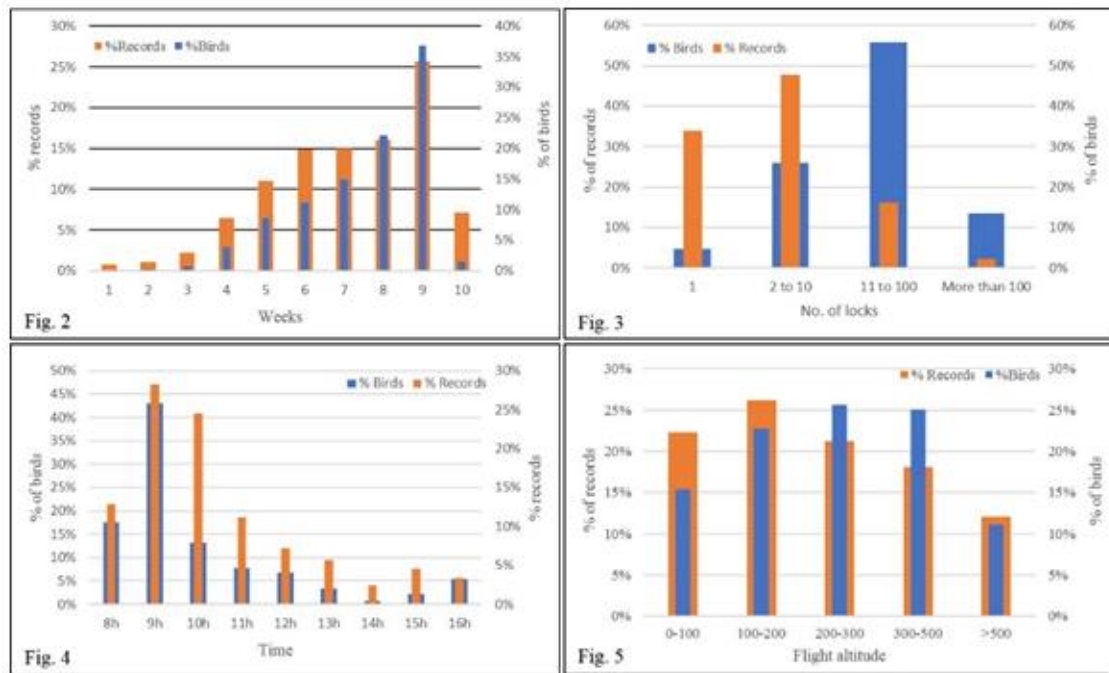


Plate 1: **Fig. 2,** Relative seasonal distribution of individuals/records for all observation; **Fig. 3,** Relative frequency of individuals/records for numbers of flocks; **Fig. 4,** Relative daily distribution of individuals/records for all observation; **Fig. 5,** Percentage of flight altitudes of individuals/records for BK recorded in the study area

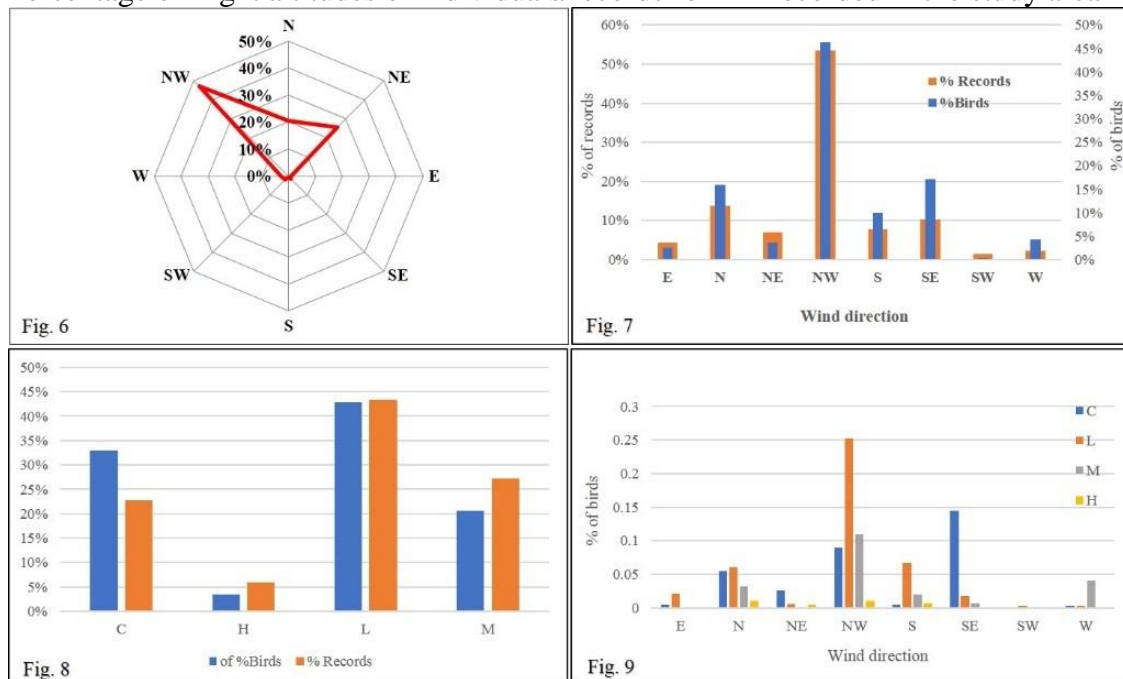


Plate 2: **Fig. 6,** Distribution of flight directions for all observation of BK; **Fig. 7,** Percentage of flight direction of individuals/ records for all observation; **Fig. 8,** Percentage of individuals/records of each wind speed; **Fig. 9,** Percentage flight at each wind direction at different wind speed classes for all observation.

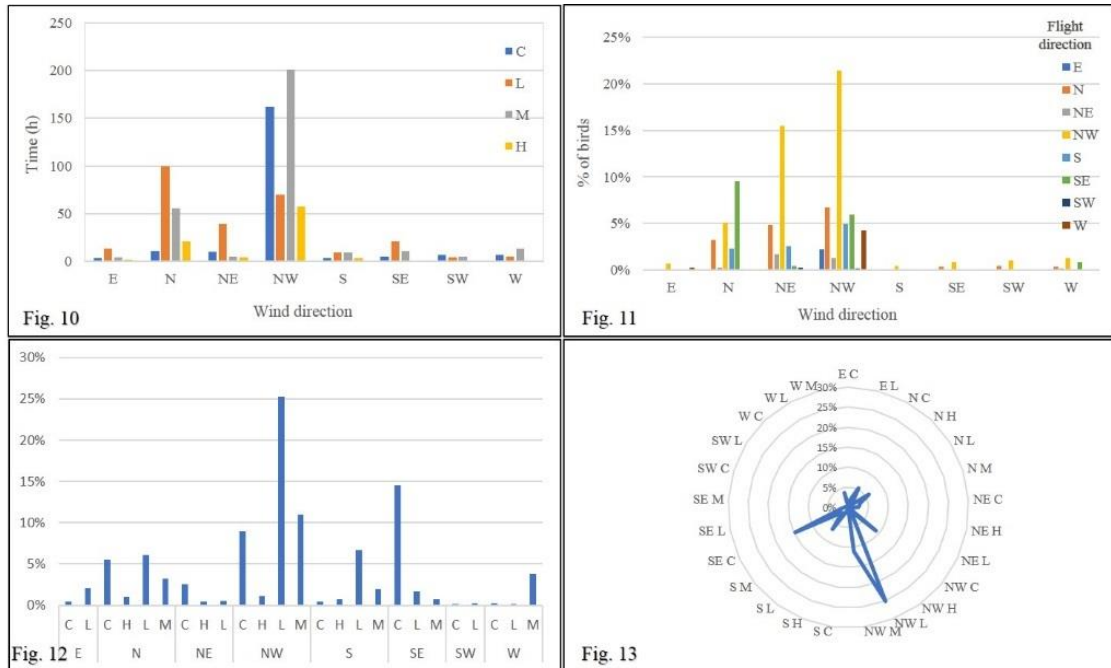


Plate 3: Fig. 10, Migration rate for different wind directions and speed classes; **Fig. 11**, Percentage of BK recorded in each wind/flight direction; **Fig. 12**, Percentage of BK recorded flying in different wind conditions; **Fig. 13**, Distribution of BK flight in different wind conditions.

DISCUSSION

The Black Kite is listed as Least Concern by the IUCN at the global level. Its population at the Rift Valley/Red Sea flyway is estimated to range between 164,788 and 221,206 individuals (STRIX, 2019). The number of birds recorded in the study area was 7,004 individuals, representing between 4.3% to 3.1% of the flyway. The study area is thus a site of international importance for this species, Nevertheless, it appears that the largest number of black kites across the Gulf of Suez by heading north and northwest along the corridor between the mountains and the Red Sea to cross into the Sinai is closer to Suez. Black kites are highly gregarious during migration and often formed flocks of several hundred birds and that reached up in the current study to 300 birds.

The number of birds recorded during the first three weeks and the last week of the monitoring season was very low, indicating that the migratory passage of this species was fully covered by the monitoring program. The number of birds started raising in mid-March, peaked from late March to late April and then decreased in the first week of May. As with most raptors, the daily passage of black kites was more intense during the morning, with peak passage from 9h to 11h, and decreased sharply during the afternoon, this phenology and hourly pattern of black kite migration was an agreement with (Shirihai *et al.*, 2000; Panuccio *et al.*, 2004).

The black kite was mostly recorded in the height classes above 100 m. The proportion of records at these altitudes totaled 25%. Nonetheless, there was a significant number of records at 0-100 m about 20%. Black kites tend to start passing in the study area early in the morning, and usually earlier than other raptors, when hot thermals are still weak and birds fly lower (STRIX, 2018; 2019).

The majority of black kites recorded in the early morning with NW & W winds (above 5m/s) were drafting with the wind toward the SE/S, soar to gain height, and then return over and around the study area at higher altitudes, generally heading to northwardly, in the less common southern winds, most of the black kites were observed flying very fast and at high altitudes when having medium winds, when having low winds they fly slower but with higher maneuverability.

The general flight pattern started to change in the last week of April, where black kites started to actively fly off earlier in the morning, especially in the hot days with low and calm winds, and migration activity started to decrease steeply in the evening session. Many black kites flying at altitudes less than 100 meters in groups indicate that it shows opportunistic feeding behaviour when they meet significant food resources during their migratory journey (Bahat, 1985; Giordano *et al.*, 1995; Shirihihi *et al.*, 2000; Panuccio & Agostini, 2010 and Panuccio *et al.*, 2013).

Future studies should clarify the areas that the black kites fly near the current study area and that they use to cross the Suez Canal to South Sinai, as well as to explore the complex migration patterns of black kites that migrate through the Rift Valley/Red Sea Flyway.

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ARABIC SUMMARY

نمط الحركة للحدأة السوداء (مليفيس ميجرانس) أثناء هجرة الربيع عبر ممر البحر الأحمر/ الوادي المتصدع،
خليج السويس، مصر

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تهدف هذه الدراسة إلى متابعة هجرة الربيع للحدأة السوداء (مليفيس ميجرانس) قبل العبور من الضفة الغربية لخليج السويس في المنطقة المواجهة لجنوب سيناء ، مصر. تم إجراء رصد يومي على مدار الفترة من 22 فبراير إلى 12 مايو 2019 ، حيث تم تسجيل 7,004 طائر (968 تسجيل) من الحدأة السوداء. معظم الإتجاهات المرصودة كان لها اتجاه عكسي لهجرة الربيع (46% شمالاً و 17% جنوباً) والتي تحتاج إليها لتحوم لزيادة الارتفاع، ثم تعود فوق منطقة الدراسة وحولها على ارتفاعات أعلى لتتمكن من عبور حاجز المياه بسهولة. يظهر السلوك المرصود للحدأة السوداء بانتظام في منطقة الدراسة على الرغم من الظروف الجوية غير المنتظمة طويلة المدى خلال فصل الربيع، قد تم تسجيل معظم الأعداد 66 ٪ خلال الرياح الشمالية السائدة. بينما تم تسجيل أكثر من 43 ٪ من أعداد الحدأة عندما كانت سرعات الرياح منخفضة، وهو ما يمثل حوالي 43 ٪ من جميع التسجيلات، في حين أن أقل من 3 ٪ من أعداد الحدأة السوداء كانت عند سرعات رياح عالية، ومثلت أقل من 6 ٪ من التسجيلات.