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Far from the Palaearctic realm: First breeding record of the Blue-cheeked Bee-eater *Merops persicus* in Peninsular India with notes on its breeding ecology

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Abstract The first breeding site of Blue-cheeked Bee-eater *(Merops persicus)* in Peninsular India was observed in the Andivillai saltpans of Kanniyakumari district, Tamil Nadu. We found a total of 28 breeding burrows distributed into three subsets in the stretch of 30 m. Among 28 nests, 16 were active and 12 were inactive/unused. The active nest-tunnels have a mean tunnel length of 1.53±0.53 m and nest-mouth diameter of 9.93±1.48 cm. While the females excavated tunnels and started brooding males were guarding the colony. The male very often fed the female brooding inside the nest till the hatchlings appeared, and later both parents were observed feeding their chicks during the day. The chicks were first observed peeping out of the tunnels on 22 August 2023. At the end of September few juvenile birds were seen flying along with the adults foraging in the open sky. The Blue-cheeked Bee-eater is considered a passage migrant and winter visitor to the north-western part of India and vagrant in Southern India, but this study confirmed its breeding in Southern India. Additionally, the study provides baseline information on the breeding ecology of the species in India.

Keywords: Blue-cheeked Bee-eater, *Merops persicus*, Meropidae, Peninsular India, breeding ecology

Összefoglalás A zöld gyurgyalag *(Merops persicus)* fészkelését először dokumentáltuk az indiai szubkontinensen az Andivillai sólepárló tavaknál a Kanniyakumari járásban, Tamil Nadu tartományban. Összesen 3 kisebb csoportba rendezett 28 fészket találtunk egy 30 méteres partfal szakaszon. A 28 fészekből 16 bizonyult használtnak, 12 lakatlan volt. A fészeküreghez vezető alagutak átlagos hossza 1,53±0,53 méter, a bejárati nyílás átmérője 9,93±1,48 cm. Míg a tojók a fészkelő üregeket mélyítették és költeni kezdtek, a hímek a kolóniát és a párjukat őrizték. A kotlótojókat gyakran a hímek etették a fiókák kikelésig. Ezután mindkét szülő etette a fiókákat. A fiókákat először 2023 augusztus 22-én figyeltük meg a fészkek bejáratánál. Szeptember végén pár fióka már a szüleivel repült, és a levegőben repülő rovarokat kaptak el. A zöld gyurgyalagot eddig vonuló, illetve telelő madárfajként tartották számon India északnyugati részén, és ritka kóborlóként India déli részén. Azonban tanulmányunk bizonyítja a faj költését Dél-Indiában. Emellett cikkünk ismerteti a faj költésbiológiájának alapelemeit.

Kulcsszavak: zöld gyurgyalag, *Merops persicus*, Meropidae, Indiai szubkontinens, fészkelés biológia

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Introduction

Bee-eaters (Meropidae) are specialised aerial insectivores inhabiting the palaeotropical region with 31 species in three genera. The Blue-cheeked Bee-eater *(Merops persicus)* has two recognized subspecies, the first *Merops persicus chrysocercus* breeds in the periphery of Western Sahara and winters in West Africa, and the second *Merops persicus persicus* breeds along Nile Delta and in Asia and winters in tropical Eastern Africa (Fry *et al.* 1988, Fry 1992, Gunnarsson & Ekblom 2019, Fry & Kirwan 2020). The Blue-cheeked Bee-eater and European Bee-eater *(Merops apiaster)* are the two species that mostly breeds in assorted colonies in the Palaearctic region. They often migrate in mixed groups to their common wintering grounds in Africa (Kossenko & Fry 1998) *(Figure 1)*. They mainly feed on various flying insects such as odonates, lepidopterans, hymenopterans (Kossenko & Fry 1998, Gunnarsson & Ekblom 2019).

In India, the Blue-cheeked Bee-eater is a widely known passage migrant to the north-western Indian Subcontinent (Ali & Ripley 1987, Rasmussen & Anderton 2012, Grimmett *et al.* 2016). The breeding of Blue-cheeked Bee-eater was once vaguely recorded by Dharmakumarsinhji (1947) in Gujarat, but Ali (1945) and Marien (1950) stated that the species was not found breeding in Kutch, but just to south in Kathiawar Blue-cheeked

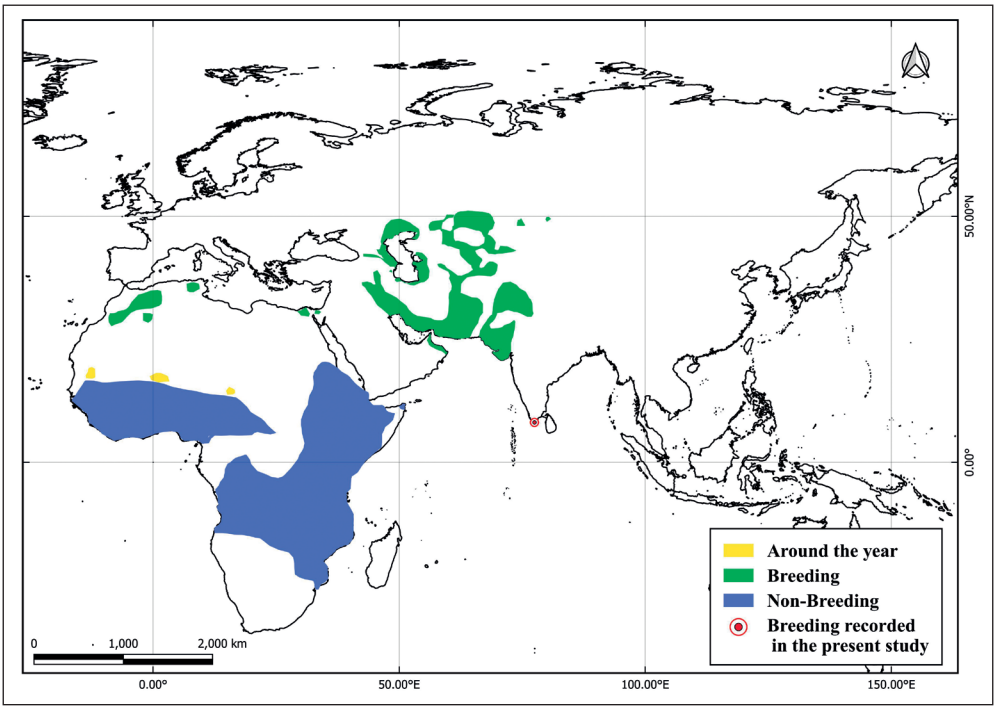

Figure 1. Global distribution map of Blue-cheeked Bee-eater with the breeding site in Kanniyakumari, Tamil Nadu, India (present study) (Source: Fry & Kirwan 2020)

1. ábra A zöld gyurgyalag elterjedési térképe, és az új fészektelep helye az indiai Kanniyakumari járásban, Tamil Nadu tartományban (Forrás: Fry & Kirwan 2020)

Bee-eater reaches its southernmost limit in India. Baker (1934) ascribes all the breeding birds of Punjab and Rajputana to Blue-cheeked Bee-eater, but that is not entirely accurate (Baker 1934, Ali 1945, Marien 1950). After 2007, they have been sparsely recorded along the south-western coast from Goa to Kerala as a passage migrant and monsoon visitor (Holt 2009, Sashikumar *et al.* 2011, Sreenivasan 2013, George 2014, Mannar & Sumesh 2015, Gosavi *et al.* 2019). They have been sighted year around in the Changaram wetland and once observed to attempt breeding, but failed before nesting due to rain and there were no further breeding evidences found in the consecutive years (Mannar & Sumesh 2015).

The breeding biology of the Blue-cheeked Bee-eater are so far studied in mixed colonies with the European Bee-eater and are very scanty in monospecific colonies (Kossenko 1994, Kossenko & Fry 1998). Until now, there are no studies on the breeding of the Blue-cheeked Bee-eater in India, and only sightings during seasonal migration have been reported. Therefore, the breeding report of the species in India is of great significance.

The study was carried out to document the breeding behaviour of the Blue-cheeked Bee-eater in Southern India and to impart the baseline details on the nesting parameters and requirements for the effective conservation of these birds in their acute habitat.

Material and Methods

Study area

The Pazhayar river, one of the prime rivers of the Kanniyakumari district originates from the slopes of Mahendragiri hills and flows southwest and reaches Arabian Sea near Manakudy mangroves. The river serves as one of the main sources of water for the Suchindram Theroor Wetland Complex, a Ramsar site and Important Bird Area (IBA) that lies at the southern tip of the Central Asian flyway of migratory birds (Ramsar 2022). The total length of the river from the origin to its outfall into Arabian Sea is 40 km.

Along the Pazhayar river basin, Periyakulam, Manakudy mangroves, Puthalam and Andivillai were frequently visited and studied from January 2022 to October 2023. These areas are mostly covered by saltpans and a few mangrove patches, and coconut coir factories have been established in their peripheries. The vegetation comprises open thorny scrubland, coconut plantations and mangroves *(Figure 2)*.

Data collection

During one of our field surveys, we sighted a flock of Blue-cheeked Bee-eaters. As the birds indulged in courtship and mounting behaviour, we tried to find their nesting site. A keen observation was made over the river beds, loess banks of abandoned saltpans and all possible suitable places around the area following Look and See method (Bibby *et al.* 1992). We found some breeding burrows of Blue-cheeked Bee-eaters along the saltpans of Pazhayar river basin. We decided to observe and document the breeding of Blue-cheeked Bee-eater regularly further using Nest and Roost count method (Javed & Kaul 2002). The breeding

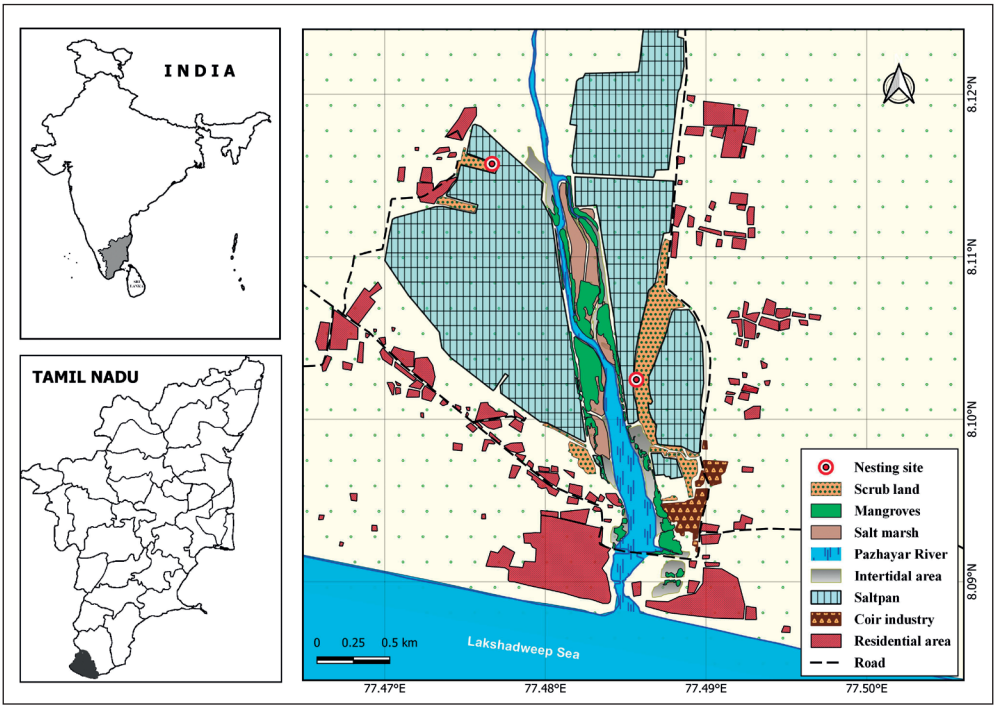

Figure 2. Locations of Blue-cheeked Bee-eater breeding sites in Kanniyakumari, Tamil Nadu, India: Red dots indicate breeding sites

2. ábra A zöld gyurgyalag fészektelepei az indiai Kanniyakumari járásban, Tamil Nadu tartományban. A piros pöttyök jelölik a költőtelepeket

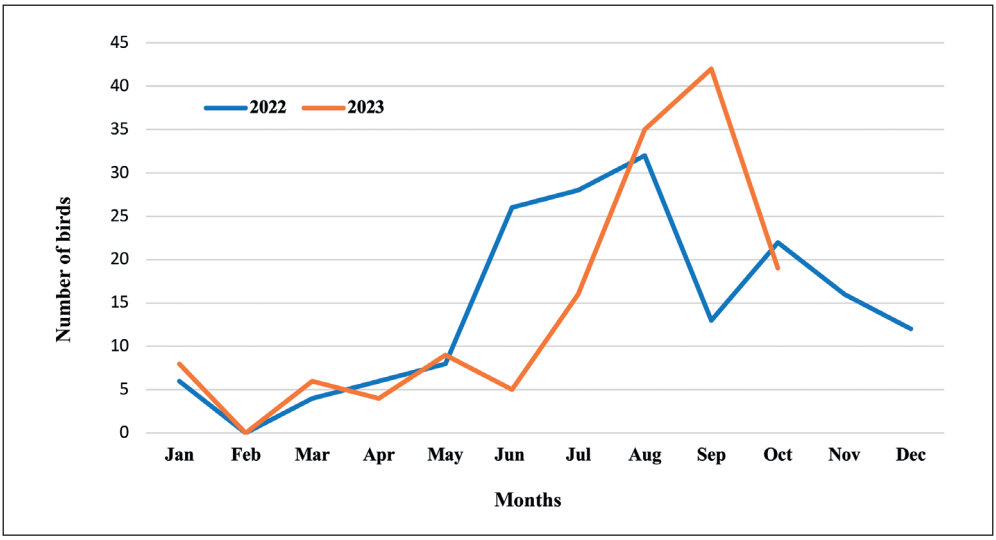

Figure 3. Variation in number of individuals of Blue-cheeked Bee-eaters throughout the year in the study site

3. ábra A zöld gyurgyalag éves állományváltozása a költőtelepen

behaviours were observed with binoculars (Olympus 8x40) and photographic documentation was carried out using a DSLR camera (Canon 200D ii). We used standard field guides and available literature (Ali & Ripley 1983, Grimmett *et al.* 2016). The observations were made on different occasions of the day light hours.

Results

The Blue-cheeked Bee-eaters were seen in the breeding sites throughout the year except February. The population fluctuates every month with a peak during the end of southwest monsoon that indicates the rise in population at the end of breeding season. The breeding season started with 28 birds and at the end we counted 48 individuals, the additional birds being juveniles, which indicates the successful breeding of the colony *(Figure 3)*. The other bee-eater species in the breeding area are Blue-tailed Bee-eater *(Merops philippinus)* and Green Bee-eater *(Merops orientalis)*. There were no heterospecific breeding colonies around the area. The interspecific competition for food among Blue-tailed Bee-eater and Blue-cheeked Bee-eater was observed several times.

Nesting site complex

We discovered two new nesting colonies of Blue-cheeked Bee-eaters, Puthalam and Andivillai situated on both sides of the Pazhayar river about 2 km far from each other. Puthalam (8.11572°N, 77.47668°E) is situated 350 m west of Pazhayar river, and the area is covered mainly by saltpans surrounded by coconut plantations. Andivillai (8.10243°N, 77.48566°E) is located 105 m east of Pazhayar river, adjacent to the 80 m wide linear saltpans and a small 5 m wide creek between them *(Figure 2)*. The saltpans consist of three distinct pans namely; reservoir pans, evaporator pans and crystallizer pans. Each saltpan has a separate reservoir pan to stock the seawater. The top ground of the dug reservoir pans consists of thorny shrubs and few trees. The reservoir pan being devoid of water and the protruding roots of *Prosopis juliflora* and Azadirachta indica through the vertical surface facilitated the perch of nesting birds *(Figure 4)*.

Puthalam nesting site

During our field visit along the Pazhayar river basin on 26 June 2022 to Puthalam saltpans, we saw about eight individuals catching dragonflies and presenting them to their mates, and four of them were already engaged in digging tunnels. The breeding burrows were excavated along the vertical surface of an abandoned partly dug saltpan pond (pond used for stocking saltwater in saltpans). The nesting site was 50 m and 350 m far from saltpan and Pazhayar river, respectively *(Figure 2)*. There were about 11 breeding burrows among which six were utilised for nesting. Later, on 30 June 2022 the heavy rain destroyed the breeding burrows and the birds disappeared for a week and appeared again from 11 July 2022.

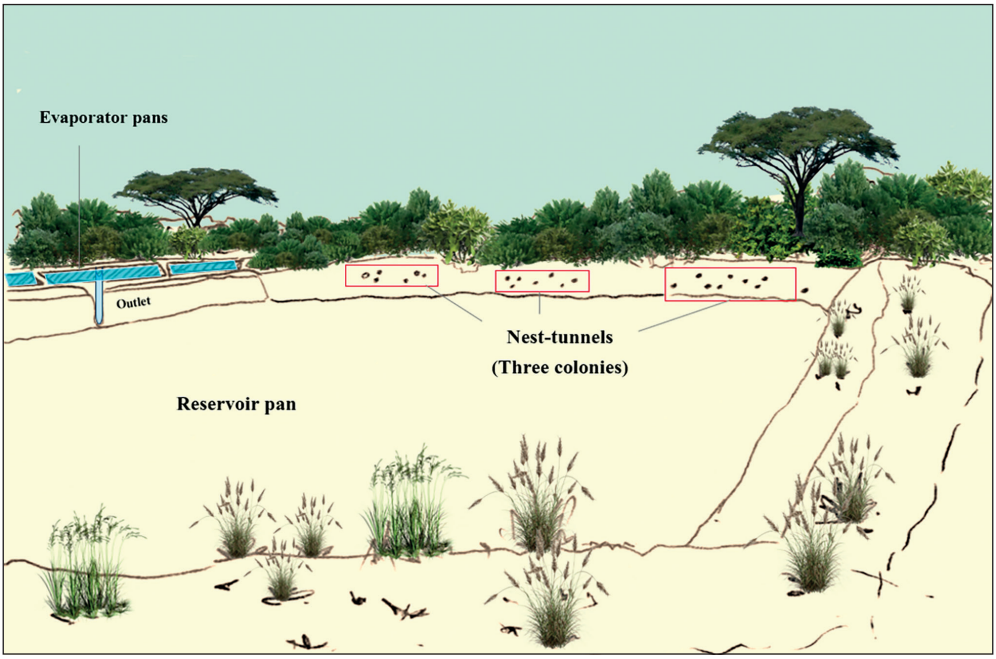

Figure 4. The breeding site of Blue-cheeked Bee-eater in the declivity face of reservoir pan along the saltpans of Andivillai, Kanniyakumari, Tamil Nadu, India

4. ábra A zöld gyurgyalagok fészektelepe a lepárló tó partoldalában az Andivillai sólepárló tavaknál az indiai Kanniyakumari járásban, Tamil Nadu tartományban

Andivillai nesting site

We found another nesting site of Blue-cheeked Bee-eater on 07 August 2023 along the Andivillai saltpans. After the birds vacated the nesting site on 10 October 2023, we examined the breeding burrows. The breeding burrows were excavated along the vertical surface of a newly dug reservoir pan with the dimensions of 40 m length, 35 m breadth and 2.7 m height. In the nesting segment, 28 breeding burrows were counted which spreads over 30 m length *(Figure 4)*. The nest segment strip was about 1.65 m below the top-ground level and 0.53 m above the base ground *(Table 1)*. The 28 nests altogether formed three loose subsets consisting 16 active nests and 12 inactive nests *(Table 2)*. All these tunnels were freshly dug with varying depths and nest-mouth diameter ranging from 0.97 m to 2.78 m and 8 cm to 12.5 cm respectively *(Table 1)*. The active nest-tunnel has a mean tunnel length of 1.53±0.53 m and nest-mouth diameter of 9.93±1.48 cm.

Behaviour observed

The breeding sites in Puthalam and Andivillai saltpans were frequently visited during the study. The observations during the field visits are compiled in *Table 3*.

Table 1. Physical characteristics of active nests of Blue-cheeked Bee-eaters in the colony
1. táblázat Az elfoglalt zöld gyurgyalag fészkek fizikai paraméterei

Nest number	Length (m)	Diameter (cm)	Height from ground (m)
S1N01	1.13	12.2	0.53
S1N02	1.54	9.5	0.78
S1N03	1.23	8.5	0.83
S1N04	1.73	9.2	0.93
S2N05	1.33	11.3	0.55
S2N06	2.01	12.0	0.96
S2N07	0.97	11.5	0.77
S2N08	1.07	12.5	0.93
S2N09	2.32	10.8	0.77
S2N10	2.78	11.5	0.99
S2N11	1.23	9.6	0.66
S3N12	1.20	9.2	0.81
S3N13	1.37	8.0	1.06
S3N14	1.16	8.5	1.09
S3N15	2.27	11.2	1.01
S3N16	1.20	9.8	0.90

Note: The nest number denotes the number of the subset (S1, S2, S3) and number of the nest (N1, N2, N3…)

Table 2. Nest composition of Blue-cheeked Bee-eaters in the nest subsets
2. táblázat A fészkek eloszlása a költőtelep csoportjai között

Breeding colonies	Active nest	Inactive nest	Total nest
Subset A	5	3	8
Subset B	7	4	11
Subset C	4		9
Distance between subset A&B	16 m		
Distance between subset B&C	9 m		

Diet

Throughout the period of observation from March 2022 to October 2023, the Blue-cheeked Bee-eaters were observed to feed on various flying insects in and around the Pazhayar river basin. Their diet mainly constitutes dragonflies, butterflies, hawk moths and bees *(Figure 5)*. The insects captured by the Blue-cheeked Bee-eater around the nesting sites are butterfly species: Common Mormon *(Papilio polytes)*, Lime Butterfly *(Paplilio demoleus)*, Common Emigrant *(Catopsilia pomona)*, Mottled Emigrant *(Catopsilia pyranthe)*, Common Grass Yellow *(Eurema hecabe)*, Plain Tiger *(Danaus chrysippus),* Common Crow *(Eupolea core)*, Tawny Coster *(Acraea violae),* Painted Lady *(Vanessa cardui)*, *Rice Swift (Borbo cinnara)*; dragonfly species: Ditch Jewel *(Brachythemis contaminata)*, Blue-tailed Green Darner *(Anax*

Table 3. Behavioural observations of Blue-cheeked Bee-eater in the breeding site of Andivillai, Kanniyakumari, Tamil Nadu, India

3. táblázat A zöld gyurgyalag viselkedésének megfigyelése az indiai Kanniyakumari járásban talált kolónián, Tamil Nadu tartományban

Date	Time	Duration (Hours)	No. of Birds seen	Observations
07 August 2023	07:20	4.20	26	Aerial display and close perch by mates, mutual preening on nape and breast, alluring and offering treats to mates and few females started excavating nest.
09 August 2023	07:35	5.00	32	Aerial display and close perch by mates, mutual preening, males offering treats to females, mating (one observation) and females started excavating nest.
12 August 2023	08:00	4.40	30	Aerial display and close perch by mates, mutual preening, males offering food to females, frequent mating (12 observed), almost all females started excavating nest (12 individuals) and few females took nesting materials inside breeding burrows.
21 August 2023	07:10	4.30	34	Close perch by mates, mutual preening on nape, males offering food to females, mating (8 observations), several females completed nesting, few females started excavating nest and males fetching food for brooding females in 4 tunnels.
22 August 2023	07:30	4.20	36	Males were frequently fetching food for the female inside the tunnel, mates took turns in brooding (observed in two nests), still two birds were nesting, no mating observed, males involved in watch and guard duty perching along the roots near the tunnel entrance and a chick peeping from a nest.
24 August 2023	07:40	3.40	35	Males were busy fetching food for the females and hatchlings inside the tunnel, no mating and nesting was observed, males involved in watch and guard duty and few chicks peeping from the nests.
05 September 2023	08:00	5.00	38	Parents rapidly feeding the hatchlings inside the tunnel and few chicks fed near the nest entrance. Blue tailed Bee-eaters snatched the food from Blue-cheeked Bee-eaters while approaching back to the nest-tunnel (two times).
14 September 2023	08:10	3.30	36	Parents were rapidly feeding their chicks at the tunnel entrance, two fully grown chicks were seen perching on the roots adjacent to the tunnel entrance and fed by the parents.
28 September 2023	07:40	4.20	42	One chick perched outside the tunnel and fed by parents and three juvenile birds perching on the dry thorns nearby with adults and five juveniles were flying in open air trying to catch insects.
04 October 2023	07:00	5.30	16	Four juveniles were seen flying with adults and catching insects, only two pairs were feeding their chicks near the nest entrance and many nests were vacated.
05 October 2023	07:40	5.00	8	Heavy downpour on the last night damaged the breeding burrows, one male kept insect near the tunnel entrance and was waiting for the mate to retract the food inside but there was no response from inside, rather it tried again and again with different insects till noon and we left the place.

Figure 5. Blue-cheeked Bee-eater feeding on dragonfly (Lesser Green Emperor *Anax guttatus*)
5. ábra Zöld gyurgyalag zöld óriásacsa zsákmánnyal *(Anax guttatus)*

Figure 6. Mating Blue-cheeked Bee-eaters near the breeding site
6. ábra Párosodó zöld gyurgyalagok a fészektelep közelében

guttatus), Green Marsh Hawk *(Orthetrum sabina)*, Coral-tailed Cloudwing *(Tholymis tillarga)*, Ruddy Marsh Skimmer *(Crocothemis servilia)*, Globe Skimmer *(Pantala flavescens)*, Common Picture Wing *(Rhyothemis variegate)*, Ground Skimmer *(Diplacodes trivialis)*, Greater Crimson Glider *(Urothemis signata)*, Yellow-tailed Ashy Skimmer *(Potamarcha congener)*, Long-legged Marsh Glider *(Trithemis pallidinervis)*, Crimson Marsh Glider *(Trithemis aurora)*, Black Marsh Trotter *(Tramea limbata)*; moth species: Coffee Bee Hawkmoth *(Cephonodes hylas)*; bee species: Blue-banded Bee *(Amegilla zonata)*, Honeybee (*Apis* sp.) and dipteran species: Green Colonel Fly (*Odontomyia* sp.), Greenbottle Fly (*Lucilia* sp.).

Courtship and mating

The observed courtship behaviour contained the following elements: flying together in air, aerial display by males, intimate close perching by mates, mutual preening especially on nape, presenting and accepting treats. During copulation the male mounts over the female

Figure 7. Breeding colony of Blue-cheeked Bee-eater: A: female excavating nest-tunnel in the colony; B: male keeping the food for the brooding female at the tunnel entrance and signalling with a mild voice note

7. ábra Zöld gyurgyalag költőtelep: A) Egy tojó fészket ás a telepen a partfalba. B) Egy hím a fészek bejáratánál élelmet tart a csőrében a fiókákat nevelő tojó számára, és közben lágy hangon hívást hallat

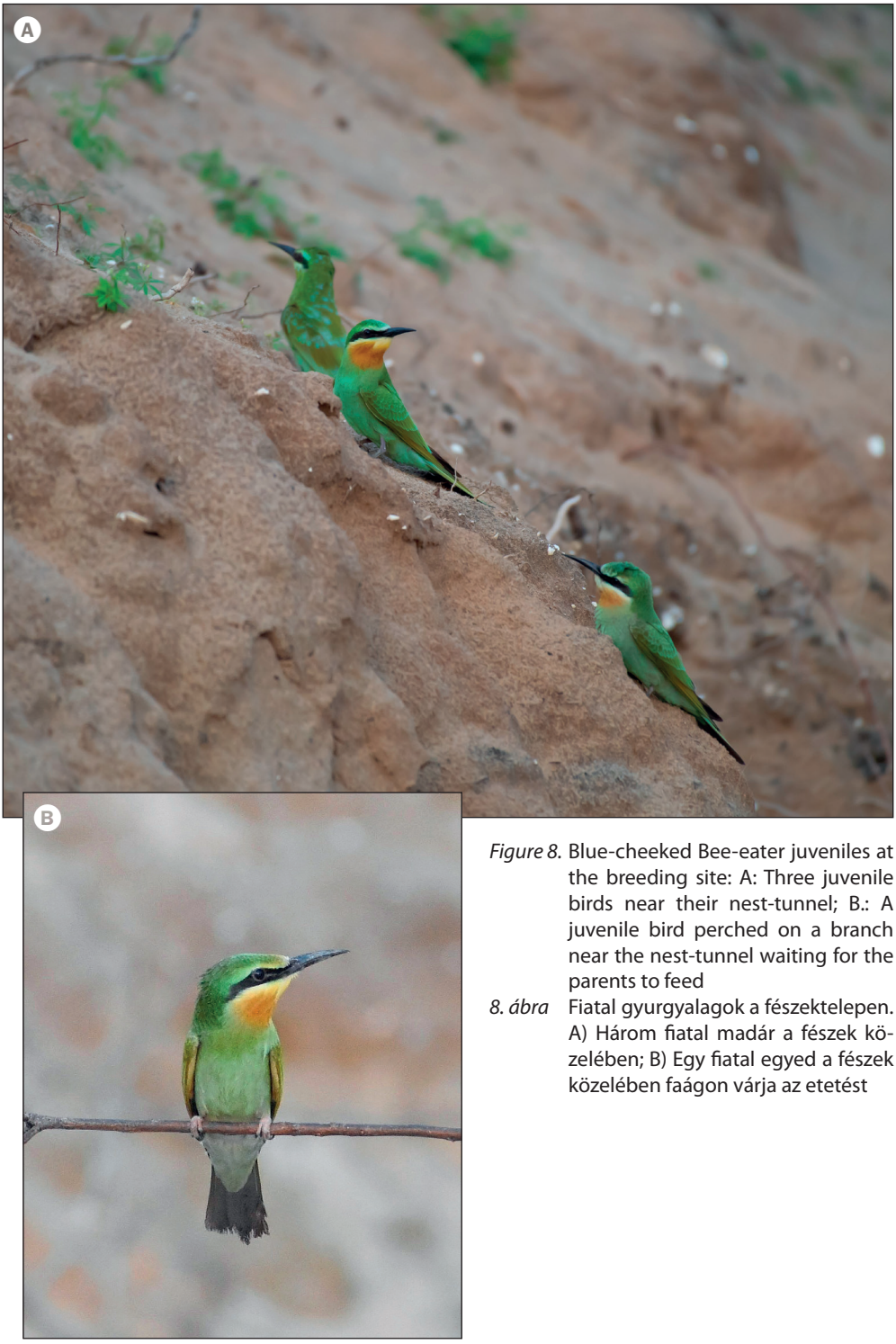

Figure 8. Blue-cheeked Bee-eater juveniles at the breeding site: A: Three juvenile birds near their nest-tunnel; B.: A juvenile bird perched on a branch near the nest-tunnel waiting for the parents to feed

8. ábra Fiatal gyurgyalagok a fészektelepen. A) Három fiatal madár a fészek közelében; B) Egy fiatal egyed a fészek közelében faágon várja az etetést

(Figure 6). After the copulation that lasted for 3–4 seconds, the male flew to the nearby perch and the female stayed in the same posture for a while. This act was repeated consecutively for 4–5 times with an interval of 20–30 minutes. The mating occurred on two substrates, the ground and dried thorny branch in close proximity (<5 m) to the nest.

Breeding burrows and brooding activities

After mating the females started excavating nest tunnels and males rarely assisted them *(Figure 7a)*. The male mostly perched on the exposed *Prosopis juliflora* roots and dry thorns nearby, and performed mate guarding. The male occasionally offered food to the female during nest building. Subsequently, females carried nesting materials like *Prosophis* leaves and grasses inside the nest-tunnel. Males carried the food and perched on the protruding roots from the soil near the opening of the tunnels mouth and made mild call. As a brooding female from the posterior end approached the entrance of the tunnel, the male left the insect at the tunnel entrance and flew to the nearby perch. While brooding, the female accepts the insects left by the male near the entrance of the tunnel and rarely flew out of the tunnel for food *(Figure 7b)*. The male took turns in brooding whenever the female flew out of the tunnel.

Hatchlings and juveniles

The male birds were very busy, feeding the brooding females and chicks inside the tunnel. The female fed the chicks after retracting the food inside the tunnel as it did during brooding. This is done every time when a male carried the food to the tunnel. The chicks were first observed peeping out of the tunnels on 22 August 2023. The females were seen more often outside the tunnel as the chicks grew up. Then both the males and females took turns in provisioning the chicks at the entrance of the tunnel *(Figure 8a)*. The sky was filled with 'tick' sound of the busy parents gliding around to catch insects. The 'tick' sound was produced whenever a bee-eater whacked a prey in mid-air. Later, on 14 September 2023 two juvenile birds were seen outside the nest-tunnel and often perched on the dry thorny branches while the parents fed them *(Figure 8)*. The juvenile birds can be easily identified by their black eyes unlike adults that have red eyes *(Figure 8b)*. Four juvenile birds were seen flying with their parents in open sky above the saltpans on 4 October 2023.

Discussion

The mating and presence of freshly dug active breeding burrows, broken egg shells, and parents feeding the chicks at the nest entrance, confirmed the successful breeding of the species. The breeding population of Blue-cheeked Bee-eater along the Pazhayar river may be resident as they are sighted throughout the year with some fluctuations in the population during different months.

There are several studies on the ecology and breeding biology of the Blue-cheeked Bee-eater from the mixed colonies with European Bee-eater in the Palearctic regions (Kossenko

1994, Kossenko & Fry 1998). Usually, egg laying starts in the first half of May in north-west Africa and Nile Delta, in March in Mesopotamia, from April to June in Iran and in the second half of June in south Pakistan and Oman (Fry 1984). The breeding season of Blue-cheeked Bee-eater in the present study interestingly overlaps with the breeding season of its conspecifics from West Africa in North Senegal from July to September, in Eastern Sahel and Southern Mauretania from July to October (Guichard 1947, Fry 1981, Morel & Roux 1996). Though Blue-cheeked Bee-eaters are summer nesting species in the Palaearctic realm in India the breeding has been observed during the southwest monsoon.

So far, the Blue-cheeked Bee-eater was considered a passage migrant and winter visitor to North-western India, but our study confirmed its breeding in Southern India. The present record of the Blue-cheeked Bee-eater is the first breeding record of the species in Peninsular India and southernmost limit of its occurrence in the Indian Subcontinent. Furthermore, this study significantly contributes a baseline information on the breeding ecology of Blue-cheeked Bee-eater in India.

Conclusion

The Kanniyakumari coast and Pazhayar river basin are increasingly under pressure from developmental activities. The present breeding site of the Blue-cheeked Bee-eater along the Pazhayar river basin is threatened by habitat destruction due to anthropogenic pressure. In addition to anthropogenic pressure, natural events like floods, high tides, erosion and unprecedented rainfall have adverse effects on these birds and the riverine ecosystem. Privately owned lands around these ecologically sensitive areas are prone to rapid unpredictable changes and exploitation.

Though the newly discovered breeding site of Blue-cheeked Bee-eater lies within the Coastal Regulation Zone (CRZ) and No Development Zone (CRZ-III NDZ), the area is highly subjected to developmental activities. Being in close proximity to the Ramsar site and IBA the area requires special protection status for the conservation of wetland birds. Therefore, we have to protect the breeding site and ensure the feeding and nesting requirements are not compromised as this serves as the only hub of breeding population in the country.

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