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## Moult, biometrics, age composition and migration of Terek Sandpipers *Xenus cinereus* wintering at two sites along the southeast coast of India

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This paper provides information on phenology, biometrics, moult and ringing recoveries of Terek Sandpipers *Xenus cinereus* staging and wintering at two sites along the southeast coast of India – Mandapam and the Great Vedaranyam Swamp of Point Calimere. The ringing data were collected from 1985 to 2021. Most of the adults completed their primary moult by the end of November, but birds arrived with more advanced moult in 1985–1988 than in 1998–2021. A few first-year birds were observed to renew some outer primaries (three to six) before leaving for the breeding sites. Individual weights varied from 47 to 89 g, and the average wing chord was 132.7 mm in adults and 128.6 mm in first-year birds. Bimodality in the distribution of wing lengths suggests the possible occurrence of two distinct populations, as was previously reported for Southeast Asia. Recaptures of marked birds in subsequent years confirmed both fidelity to the southeast coast of India and exchange between the two study locations. The sighting in the Seychelles of a colour-flagged Terek Sandpiper marked at Point Calimere is the first recovery for this species in the Southern Hemisphere in winter.

### Keywords

shorebirds  
waders  
Central Asian Flyway  
primary moult

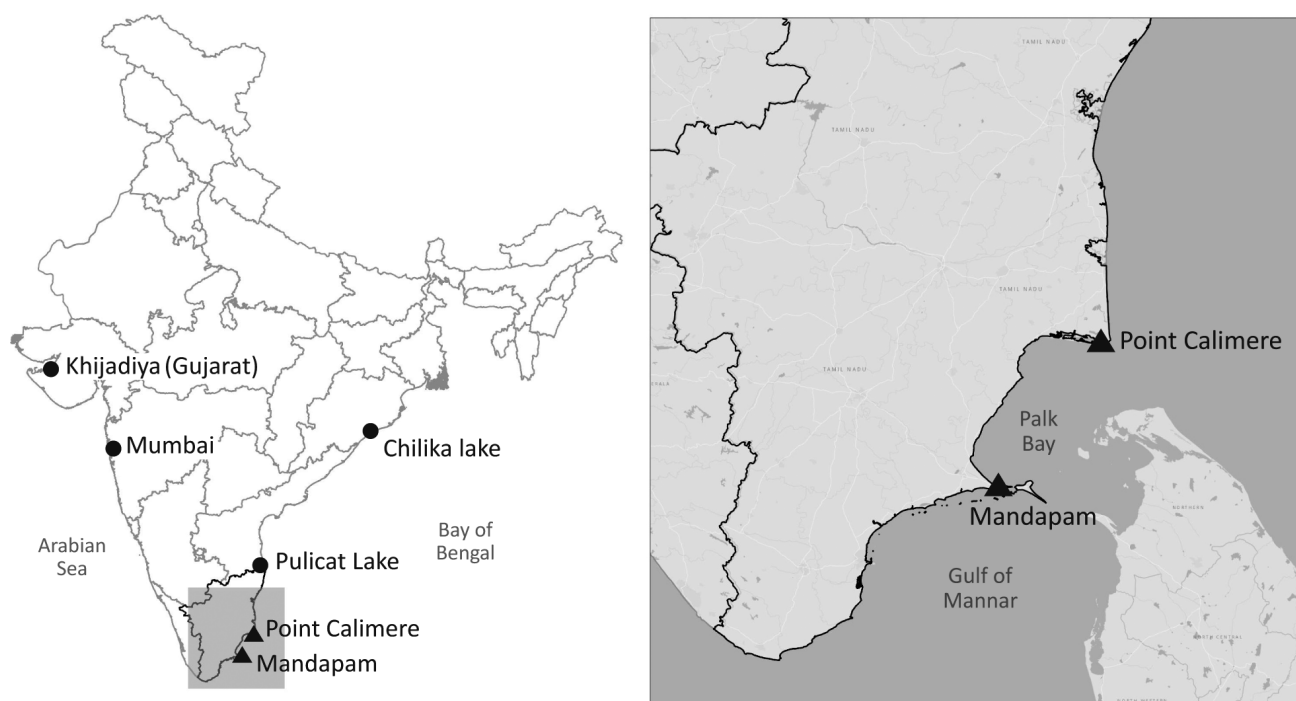
### INTRODUCTION

Terek Sandpipers *Xenus cinereus* breed in the boreal taiga zone, extending north into the subarctic tundra and south to the fringes of steppes (van Gils *et al.* 2017). The breeding range covers southern Finland, northwest Russia, Belarus and Ukraine, East Siberia to the Kolyma River, the southern Urals to Lake Baikal, and central Siberia to northwestern Europe. It migrates through the Arabian Gulf, India, Peninsular Malaysia, and New Guinea (Lane 1987), and is a vagrant to Alaska in spring (Hayman *et al.* 1986). It winters throughout Africa through the Middle East, southern Asia and Indonesia, and as far as Australia (Golovatin *et al.* 2010, van Gils *et al.* 2017). Occasionally it is reported wintering in southern England and Tunisia (Hayman *et al.* 1986), and also in Madagascar, Mauritius, Myanmar, the Malay Archipelago, and Tasmania (Ali & Ripley 1983). The species is listed as of Least Concern based on the estimated global population size of 160,000–1,200,000 individuals (Wetlands International 2015, BirdLife International 2021).

The Terek Sandpiper is one of the least-studied wader species in the Northern Hemisphere. Very little is known about its breeding ecology except for a few recent studies on its distribution, habitat selection, phenology, and biometrics (e.g. Karlionova *et al.* 2006, Golovatin *et al.* 2010,

Meissner *et al.* 2012, 2013, Pakanen 2016). It has also rarely been studied in the Indian Subcontinent, with the exception of a recent description of its migratory pattern (Balachandran *et al.* 2018).

In the Indian Subcontinent, the species is a frequent migrant found on the shore, mudflats, and lagoons of the mainland, the Lakshadweep, Andaman and Nicobar Islands, Sri Lanka, and the Maldives. Terek Sandpipers occurring in India likely belong to the breeding populations from Siberia that winter in huge numbers in Asia, i.e. in India and east to Malaysia, although a significant minority migrates west to winter in Africa (Cramp & Simmons 1983). During winter, the species occurs along the entire seaboard from Kutch and Saurashtra in western India, south to the Peninsula, and from the southeast coast to West Bengal (Ali & Ripley 1983). It also uses inland flyways through northwest Himalaya to Rajasthan, the Gangetic Plains and Nepal (Balachandran *et al.* 2018). Although Ali & Ripley (1983) stated that the species is known to winter along the entire sea coast of India, and Cramp & Simmons (1983) mentioned that the highest numbers winter in India, recently there have been no counts exceeding 2,000 in any of the wetlands that are currently being monitored. Terek Sandpipers occur along the Indian coast in higher numbers during the southward



**Fig. 1.** (a) Wader areas in coastal India mentioned in the text. (b) Inset of southeast India showing the two sites in this study: Mandapam and Point Calimere (PTC).

passage (September–October) than in the winter or during northward passage (Balachandran 1990). Most of the wintering individuals utilize Indian wintering grounds to moult and to gain substantial weight to reach their next stopover site *en route* to the breeding grounds. Their departure occurs from late February onwards and there is no substantial increase in numbers during northward passage (late February–April; Bombay Natural History Society [BNHS] unpubl. ringing data).

Information on biometrics, age composition and moult of Terek Sandpipers is relatively scarce (but see Fry 1989, Karlionova *et al.* 2006). Here, we analyze ringing data generated from two sites along the southeast coast of India – Mandapam, and the Great Vedaranyam Swamp of Point Calimere (hereafter PTC; Fig. 1) – to present new information on biometrics and moult from the Indian wintering grounds.

## METHODS

### Study area

Mandapam (9°16'37.34"N, 79°07'30.78"E) lies on a narrow strip of land projecting from the southeast coast of India, with the Gulf of Mannar (GoM) to the south and Palk Strait to the north (Fig. 1). The inshore region of the Palk Strait is mostly muddy, whereas that of the GoM is rocky with small areas of sandy mud in between. The GoM comprises a chain of islands running parallel to the coast, with waders using Manali and Hare Islands as well as Dhanushkodi lagoon.

Our study site in PTC's Wildlife and Bird Sanctuary (10°17'04.22"N 79°49'26.66"E; Fig. 1) lies parallel to the Palk Strait and includes wide mudflats, lagoons, creeks, and estuaries. Two salt works within the area have large reservoirs and condensers to store and evaporate seawater for salt extraction, providing feeding and roosting grounds for waders and other waterbirds (Balachandran 1998).

Ongoing research on Terek Sandpipers in India also takes place at two other sites along the east coast of the subcontinent – Pulicat Lake and Chilika Lake (Balachandran 1998c) – and in the west along the Mumbai and Gujarat coasts (Fig. 1).

### Field methods

We used trapping data collected from Mandapam (1985–1988) and PTC (in two periods: 1980–1991 and 1998–2021; Table 1). Count data were also collected at Mandapam (1985–1988) to understand the monthly fluctuations in numbers. Due to the inaccessibility and size of the site, we did not attempt to count the birds at PTC. The Total Count Method (Howes & Bakewell 1989) was adopted to count the birds at Mandapam: the birds were counted fortnightly and the maximum count was taken for each month.

Birds were captured using noose-traps (Sanzenbacher & Haig 2002) or 3-inch mesh gillnets made by professional bird trappers (Gartshore 1978), methods traditionally followed by ornithologists of the coastal regions of India (Balachandran 2002). Birds were individually marked with a unique metal ring and a black flag engraved with a

white alphanumeric code, and were aged, measured, weighed and examined for moult before release. We measured: bill length from tip to the start of feathering on the upper mandible, using calipers (mm; Evans 1964); wing chord with flattened and straightened primaries, using a ruler (mm; Branson & Minton 1976); tarsus using calipers (mm; length of tarsal bone); and mass with a Pesola balance (g; Prater *et al.* 1977, Balachandran *et al.* 2000). All measurements throughout the study were taken by a single observer (SB).

Birds were aged as 'first-year' (juvenile) or 'adult' based on the characteristics described in Prater *et al.* (1977); these include presence of retained juvenile plumage, state of primary wear, and leg colour. The term 'first-year' refers to birds in the first 12 months of their life, from hatching to 1 August the next calendar year. The term 'adult' refers to birds older than 12 months and this category included 'second-year' birds from 1 August. Moulting followed Snow (1967); primary moult was scored for each of the ten primaries, from 0 (= old) to 5 (= new), giving a moult score of 0 (all old) to 50 (all new). Terek Sandpipers are not sexually dimorphic and therefore cannot be reliably sexed based on measurements (Prater *et al.* 1977).

### Data analysis

For analyses, the year was classified into four seasons based on migration patterns: southward passage (August–October), winter (November–February), northward passage (March–May), and summer (June–July). As Terek Sandpipers move between our two sites (Balachandran *et al.* 2018), data from both sites were combined for most analyses. Independent-sample *t*-tests were used to look for significant differences in wing, bill and tarsus lengths between adults and juveniles, and Pearson correlations test were conducted in Excel to test for relationships between measurements within age classes.

## RESULTS

### Occurrence

During the 1980s, Terek Sandpipers were regular winter visitors at Mandapam, arriving in late August and staying throughout the non-breeding season (late August–late April). The maximum numbers were recorded during southward passage in September (1985–1986 = 410 birds; 1987–1988 = 540) and October (1986–1987 = 130), and numbers declined to December (Fig. 2). A few individuals,

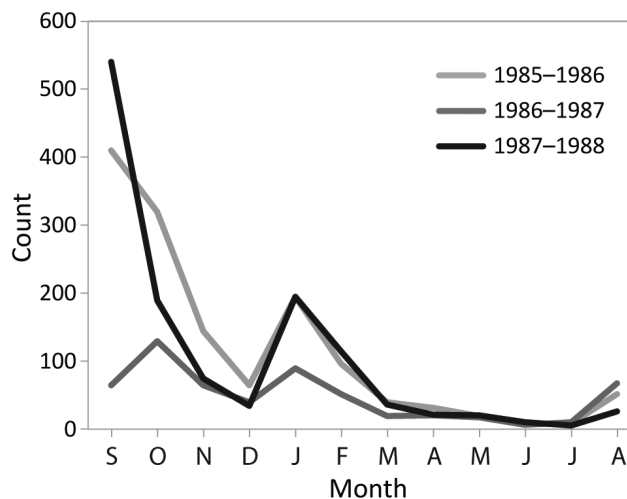


Fig. 2. Monthly (September–August) counts of Terek Sandpipers at Mandapam, southeast India, in three consecutive years (1985–1986 to 1987–1988).

mostly first-year birds, have also been reported during summer. No count data were available for PTC.

### Primary moult

**Adults** – Most birds initiated their primary moult before arriving at our study sites. Adults with complete moult scores of 50 were recorded from mid-September onwards (Fig. 3). Moulting scores recorded in September ranged mostly between 21 and 50. In October, adults had moult scores above 20, except one individual with a moult score of 3 on 9 October 2007 at PTC. Most of the adults completed their moult by the end of November, when birds had advanced scores ranging from 35 to 49, and a very few continued moulting after January (Fig. 3). One adult yet to complete moult in mid-March had suspended moult (nine renewed inner primaries and an old outermost primary). The two lowest scores of 3 (9 October; three growing inner primaries) and 7 (28 August; four growing inner primaries) were recorded in PTC in the 2000s and differed from the pattern observed in the 1980s when the lowest score recorded during post-breeding arrival was 21. This may suggest that in recent years some adults arrive with old primaries and initiate moult after reaching the wintering ground.

**Juveniles** – First-year birds commenced a partial moult in early April, starting primary moult from the 4<sup>th</sup> or 5<sup>th</sup> primary at Mandapam, but mostly from the 8<sup>th</sup> primary

Table 1. Numbers of Terek Sandpipers ringed at each study site in southeast India. The percentage of first-year birds is given in parentheses. \*In Mandapam birds were only ringed during 1985–1988.

Site	1980–1988	1989–1991	1998–2021
Mandapam	138* (46.4%)	–	–
Point Calimere	157 (unknown)	36 (55.5%)	119 (53.8%)

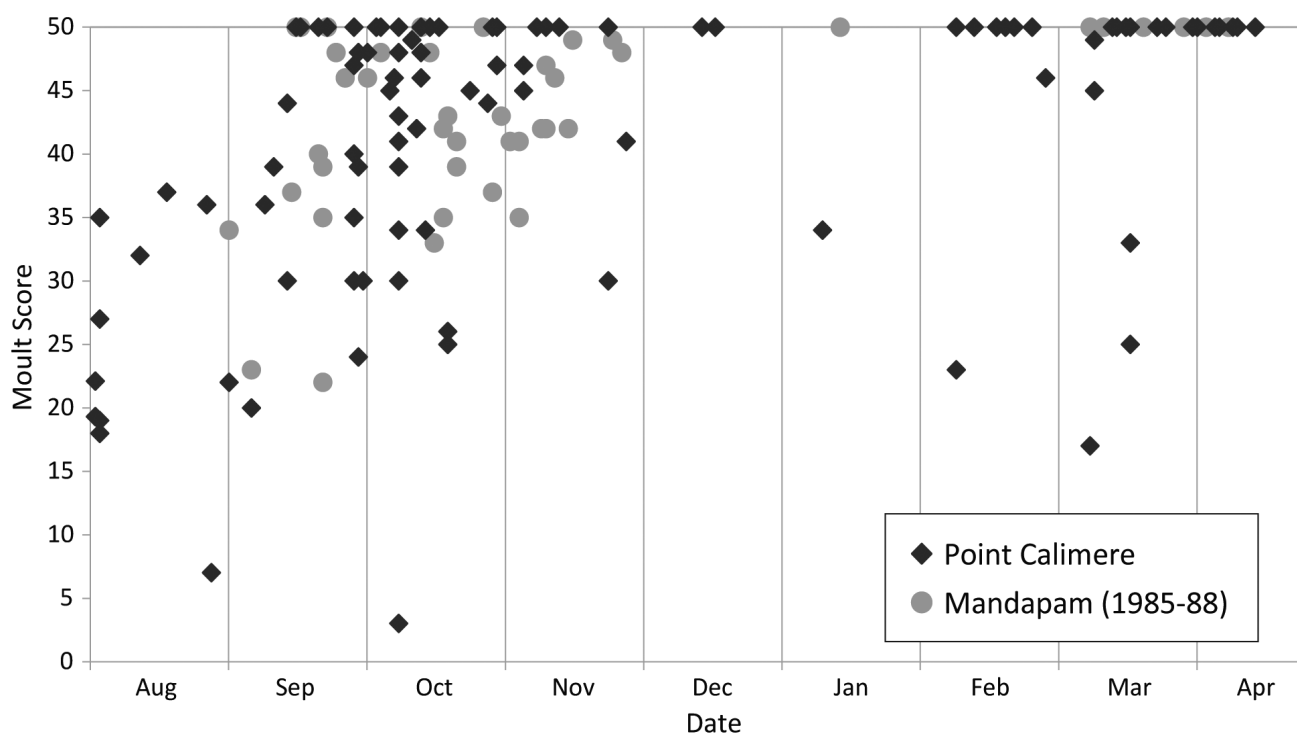


Fig. 3. Progress of primary moult in Terek Sandpipers caught at Mandapam and Point Calimere during 1985–2021 ( $n = 144$ ).

at PTC in later years. Juveniles that had renewed the outer three primaries (see Fig. 4) were observed from April onwards at PTC ( $n = 6$ ). In some years, we continued to record moult scores in May–August and found four over-summering birds with 1–4 renewed outer primaries and 2–4 renewed inner primaries, and intervening primaries with scores of 0–4 (e.g., 5543200555). This moult pattern is indicative of first-year birds that carried out a partial primary moult involving only the outer feathers in earlier months, typically during winter, and are now commencing a complete primary moult. This could be recognized by the colour differences between the slightly faded outer primaries, the faded and worn middle primaries, and the fresh darker inner primaries. These could have been second-year birds that spent the summer at the wintering grounds. However, three other probable over-summering birds caught before 13 August had a similar moult pattern to the adults, commencing from the innermost primary, with scores ranging between 18 and 37.

Of the 37 juveniles examined from early September to mid-July, 31 (84%) had not initiated primary moult. Juveniles from mid-May to early June were observed with a moult score of 0. However, one first-year bird caught on 5 April was observed with P5 to P9 moulted, and two individuals captured on 25 May had three renewed outer primaries. In April 1990, two first-year birds were observed with three renewed outer primaries. Of the two first-year birds caught during July (over-summering individuals), the moult in one was progressing like a normal adult (commencing from the innermost and proceeding outwards). The other was observed with two generations of

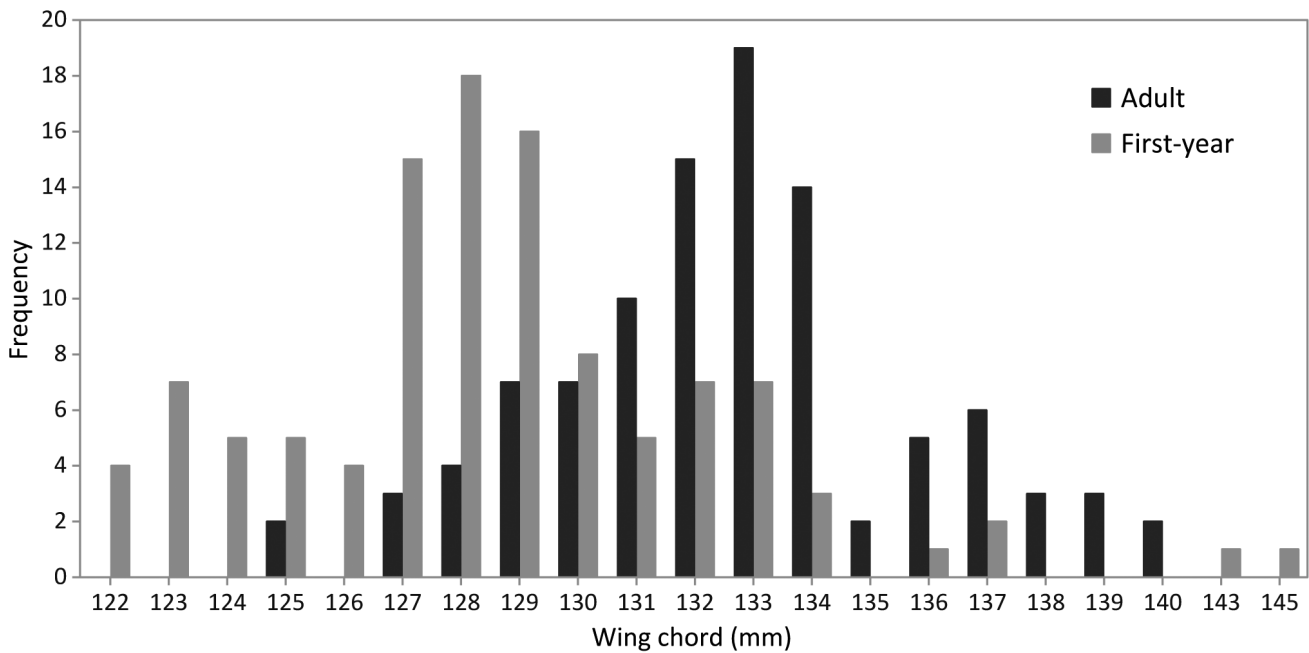
primaries: the outer three and inner three primaries were renewed, whereas the four middle primaries (P4–P7) were old.

#### Age composition

Of the 293 individuals caught during 1985–1988 at Mandapam and 1989–2021 at PTC, 145 were adults and 148 were first-year birds (50.5% juveniles). Separating the sites, 46.4% of birds at Mandapam and 54.2% at PTC were first-year birds (Table 1). At PTC, the percentage of first-year birds was 63.6% in 1989–1991 ( $n = 33$ ), 44.8% in 2001–2010 ( $n = 29$ ), and 49.2% in 2010–2021 ( $n = 61$ ). In only three years did the sum of catches at both sites exceed



Fig. 4. A first-year Terek Sandpiper that has replaced outer primaries (P8–10) before leaving the wintering grounds (photo: S. Balachandran).



**Fig. 5.** Frequency distribution of wing chords of adults ( $n = 102$ ) and juveniles ( $n = 109$ ) caught at Mandapam and Point Calimere during 1985–2021.

20 birds, in 1985–1986 ( $n = 49$ ), 1987–1988 ( $n = 68$ ) and 2013–2014 ( $n = 23$ ). In those years, the percentage of first-year birds was 28, 59 and 42%, respectively.

### Biometrics

Adults had significantly longer wings than juveniles ( $t = 3.554$ ,  $P < 0.0001$ ,  $n = 204$ ), but no significant differences between adults and juveniles were detected in bill or tarsus lengths (bill:  $t = 1.598$ ,  $P = 0.112$ ; tarsus:  $t = 0.330$ ,  $P = 0.196$ ). The mean wing chord was 128.7 mm (range: 122–145 mm) for juveniles and 132.7 mm (range: 124–140 mm) for adults, with a mean difference of 4 mm (Table 2). The frequency distribution of wing chords in both first-years and adults showed bimodality (Fig. 5). Among the adults, bill length was most commonly 48 mm (in 25 individuals), and in juveniles 49 mm (in 17 individuals; Fig. 6). We found similar positive correlations

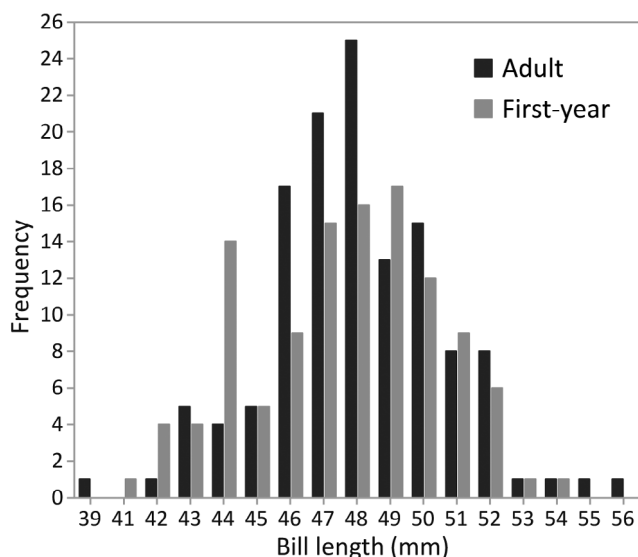
between biometric measurements in both age groups: in adults between wing and bill lengths ( $r = 0.23$ ,  $P = 0.017$ ), and between bill and tarsus lengths ( $r = 0.30$ ,  $P = 0.002$ ); and also in juveniles, between wing and tarsus lengths ( $r = 0.24$ ,  $P = 0.013$ ), and bill and tarsus lengths ( $r = 0.32$ ,  $P = 0.001$ ).

### Weight changes

The mass of 83 individuals captured and weighed during 1998–2021 varied between 47 and 89 g. The minimum mean weight (56.8 g) was observed in February and the maximum mean weight (68.3 g) in May. The mean monthly weight did not vary considerably for the remaining months, ranging from 63.5 to 67.0 g. The lowest individual weight (47 g) was found in a juvenile in April, which was apparently over-summering.

**Table 2.** Measurements of Terek Sandpipers recorded during 1985–2021 at Mandapam and Point Calimere (data combined).

Lengths	Age	Range	Mean	SD	$n$
Bill (mm)	Adult	39–56	47.99	2.65	127
	Juvenile	41–54	47.54	2.81	114
Tarsus (mm)	Adult	26–33	28.67	1.33	121
	Juvenile	21–32	28.42	1.54	111
Wing (mm)	Adult	125–140	132.66	3.14	102
	Juvenile	122–145	128.63	3.91	109



**Fig. 6.** Frequency distribution of bill lengths of adults ( $n = 127$ ) and juveniles ( $n = 114$ ) caught at Mandapam and Point Calimere during 1985–2021.

### Recapture and recoveries

During 1985–1988, four adult birds were re-trapped in the subsequent migratory seasons at the same site. An adult bird ringed at PTC in December 1971 was recovered after one year in December 1972 in Pamban, Ramanathapuram district, Tamil Nadu. Another bird ringed at Sobolkho Lake (55°11'N, 114°46'E) in the Buryatia region of Russia in July 1985 was recovered in the Great Vedaranyam Swamp, Nagapattinam district, Tamil Nadu in March 1986 (Balachandran *et al.* 2018). A first-year bird ringed in Mandapam on 16 December 1985 was recovered at PTC on 25 March 1987. More recently, an adult bird ringed in PTC on 9 October 2019 was recovered from Alphonse Island, Seychelles (7°05'S, 52°44'E) on 13 November 2019. This recovery suggests that Terek Sandpipers utilize PTC as a stopover site during their southward passage to the Southern Hemisphere.

## DISCUSSION

Terek Sandpipers occurred in the 1980s at our study area in modest numbers; the highest number recorded between 1985 and 1988 was 540 individuals (see also Balachandran 1990). In 2020, we recorded fewer than 100 birds in our study area on the east coast (Balachandran *et al.* 2021). Here we explore whether there are indications that Terek Sandpipers may currently occur in higher numbers along the west coast of India than on the east coast. Indeed, most current ringing studies of Terek Sandpipers are carried out along the west coast, and catches exceed the numbers ringed along the east coast in the last four decades. On the Mumbai Coast, 773 individuals were ringed by the Bombay Natural History Society (BNHS) between September 2019 and January 2020 (Mrugank Prabhu pers. comm.). Additionally, at Jamnagar in Gujarat,

78 birds were ringed in 2019–2020 by the BNHS (Madhumita Panigrahi pers. comm.). More recently, in March 2021, flocks consisting of more than 100 Terek Sandpipers were sighted in Gujarat, on the west coast (Sachana/Balachadi; 22°58'20.14"N, 70°19'03.40"E; photographic record by Yashodhan Bhatia). Due to a lack of information on historical abundances and distributions from the west coast of India, it is not known whether these occurrences are new. The increase in observations from the west coast may reflect an increase in birdwatchers and the initiation of intensive wader ringing in recent years. However, Terek Sandpipers may have shifted their wintering grounds. The recoveries of a PTC-marked bird at Mandapam in 1972 and a Mandapam-ringed bird at PTC in 1987 suggest that individuals do shift wintering grounds.

Most adults arrived at our study sites with almost completed wing moult in September and October, showing that they had commenced their moult before reaching the study site, perhaps at the breeding grounds, and progressed further at various stopover sites located both in India and further north. Commencement of moults on stopover sites for renewal of inner primaries in late July and completion of moult on wintering sites between late November and early January has been reported by Cramp & Simmons (1983). The current study confirms that Mandapam and PTC are moulting grounds for adult migratory waders to complete the later part of their primary moult. The primary moult duration for Terek Sandpipers wintering in PTC was estimated as 120 days by Jackson (2017), based on the individual feather growth rate in relation to feather mass. However, Jackson (2017) reported no cases of suspended moult from India; in contrast, in the current study we observed a few individuals with suspended moult at both study sites.

The observation of moulting birds with moult scores varying from 3 to 49 during the arrival time suggests that there may be different arrival strategies between the two age groups and possibly among populations. Remarkably, during the earlier years of our studies (1985–1988), no adults were recorded with low moult scores (<21). The low scores of 3 and 7 recorded on 9 October 2007 and 28 August 2018 lead to the speculation that in recent years some adults arrive with all old primaries before commencing the moult. The moult scores also suggest that adults arrive through October, but the low sample size precludes any definite conclusion. In the 1980s, primary moult in the first-year birds indicated that they may have renewed the outer 5 to 6 feathers either before leaving the wintering ground or elsewhere on transit. However, in recent years, first-year birds mostly renewed the outer three primaries only. Similar changes in juvenile moults have been recorded for other species such as Little Stint (BNHS unpubl. data), which commenced moult in September in recent years, while it was known to commence in December during the 1980s.

The maximum weights recorded for adult (101 g) and juvenile (102.5 g) Terek Sandpipers on the breeding

grounds in Pripyat valley, South Belarus (Karlionova *et al.* 2006) were greater than the highest weight recorded from PTC (89 g). This could reflect seasonal differences in weight between the breeding and wintering period. The measurements of bill, tarsus and wing in this study were consistent with the range of measurements specified by Cramp & Simmons (1983), Ali & Ripley (1983), Hayman *et al.* (1986) and Fry (1989) with a slight variation in wing and bill lengths. We demonstrated a moderate correlation between bill and tarsus lengths of adults and juveniles and wing and bill lengths of adults. Also, there were significant differences in the mean wing lengths of adults and juveniles, and possible evidence of bimodality in size. Although Terek Sandpiper is a monotypic species, this study hints at the possible occurrence of two different populations, one with longer wings than the other, which was also suggested for Southeast Asia by Cramp & Simmons (1983). The minimum (122 mm) and maximum (146 mm) wing chords recorded during our study were 4 mm lower and 2 mm higher, respectively, than the measurements given by other authors (see Cramp & Simmons 1983, Hayman *et al.* 1986), which could also support geographic variation in size.

The breeding origin of Terek Sandpipers wintering at PTC has been predicted to be in northeast Russia, based on the recovery of a Russian-ringed individual from Sobolkho Lake, Buryatia (Balachandran *et al.* 2018). Our study area also seems to be connected to other wintering grounds. A Terek Sandpiper colour-flagged in our study site on 9 October 2019 (during autumn passage) was photographed in the Seychelles on 13 November 2019 (after 35 days), and suggests an autumn movement through PTC to Southern Hemisphere wintering grounds. Furthermore, the maximum weight recorded in our study, 89 g in a juvenile on 8 October 2019, suggests that it might have been fueling for further migration. These observations indicate the presence in our study area of a transient population migrating further south. Further research is needed to clarify the importance of southeast India for Terek Sandpipers on the Central Asian Flyway.

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