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Selected aspects of breeding biology in the Tree Sparrow *Passer montanus saturatus* (STEJNEGER, 1886) in South Korea

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Abstract. The breeding biology of the subspecies of Tree Sparrow living in South Korea, *Passer montanus saturatus,* was compared with that of the subspecies *montanus* inhabiting Poland. Of the two, *P. m. saturatus* was the more closely associated with human settlement in the breeding season. In the monsoon period and during heatwaves, *P. m. saturatus* sought shelter and food within farm buildings in a way that *montanus* individuals do not. *P. m. saturatus* also made greater use of plant food (rice and barley) in the rearing of nestlings. After fledging, the young of both subspecies spend a similar amount of time near their place of birth (40 days in the case of first broods and 25 in the case of second). Subsequently, individuals of subspecies *montanus* join flocks within a radius of c. 5 km, while *saturatus* individuals were not to be found within such a distance after this period of time.

Key words: *Passer montanus saturatus,* breeding ecology, South Korea.

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I. INTRODUCTION

The subspecies of the Tree Sparrow *Passer montanus* (LINNAEUS, 1758) have been researched to differing extents where breeding biology is concerned. The nominate *montanus* (LINNAEUS, 1758), inhabiting Europe and northern Asia, is well-studied, even in its various regions of occurrence, with no fewer than three summary works having been written (PINOWSKI & KENDEIGH 1977, NOSKOV 1981, SUMMERS-SMITH 1995). A series of studies has also addressed the reproductive biology of *P. m. dilutus* RICHMOND, 1896, from central Asia and the greater part of China (FORMOZOV 1944, AKHMEDOV 1957, CHIA et al. 1963, HSIA et al. 1965, KASHKAROV & PUZANKOVA 1974, NOSKOV 1981, RUAN & ZHENG 1991 and others). In contrast, the subspecies *transcaucasicus*, BUTURLIN, 1906, *tibetanus* BAKER, 1925, and *malaccensis* DUBOIS, 1885, are poorly-known, not least from this point of view (WARD & POH 1968, NOSKOV 1981, WONG 1983), while subspecies *saturatus* STEJNEGER, 1886 – of the Kurile Islands, Sakhalin, Japan, South Korea and Taiwan (SUMMERS-SMITH 1988) – has hitherto attracted only one broad study (ABË 1969), based on Hokkaido in the northern part of the range. Research on *saturatus* individuals from South Korea has so far been confined to the dietary components of nestlings (KIM & KIM 1980).

In consequence, the aim of the present study was to describe selected elements of the breeding biology of this subspecies in South Korea, and to compare findings with analogous data for the other subspecies living at various latitudes, especially in Central Europe.

II. STUDY AREA

The work was done at Juseo-ri in the Republic of Korea (South Korea), at 35°15'N, 128°15'E (Fig. 1). This village lies some 56 km from the city of Masan, in Yehang-myon district, Haman-gun county, Kyongsangnam province. It is situated on a hillside separated from the sea by a range of forested mountains 600-750 m a. s. l. The valley has fields with barley, rice, soybeans and garlic, while the slopes have orchards with chestnuts *Castanea crenata* SIEB. et ZUCCO. and persimmons *Diospyros kaki* THUMB. Higher parts of the mountains support mixed forest.

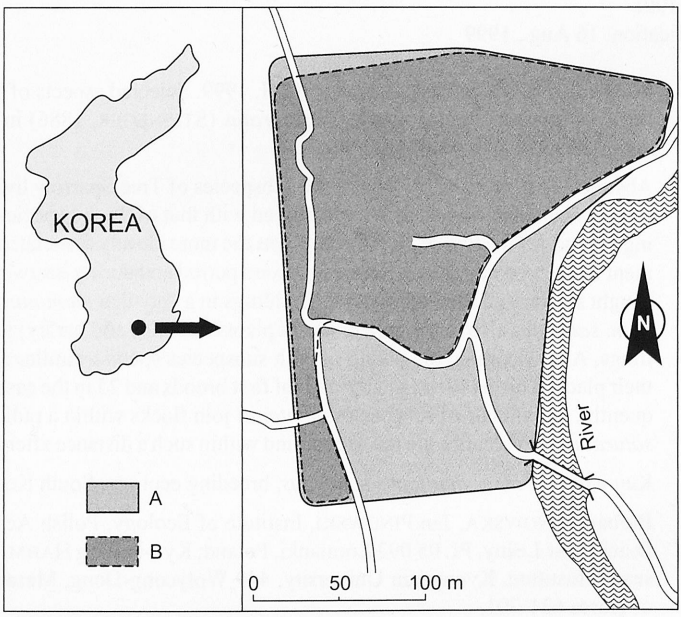

Fig. 1. Situation of Juseo-ri village (black circle) and a schematic map of the study area showing the relation between the Tree Sparrow's feeding (A) and breeding (B) areas.

Villages in the area develop in such a way as to create a labyrinth of narrow streets surrounded by stone walls. Buildings are mainly traditional Korean houses with stone walls plastered with clay and roofed with thick cement tiles or else „eternit". Livestock are fattening cattle – permanently maintained in semi-open sheds, but not put out to pasture – as well as goats. Hens and ducks are only kept in walled or even fully-enclosed areas. Crops are harvested twice – garlic and barley in early June (8-12.06.1996 – cutting of barley), and rice, soybeans and peppers in September-October. Spring is a dry and rather warm season interrupted by the monsoon rains from mid June onwards. Summer is hot (Fig. 2).

The research ran from May 16th to August 4th 1996, with a total of 35 days of fieldwork. Work was done between sunrise (06.00) and sunset (19.00), with a 1-2 hour break in the middle of the day.

Weekend observations of Tree Sparrows were made in Masan, a city of 500,000 inhabitants. In addition, the presence of the species in places visited on longer trips was noted.

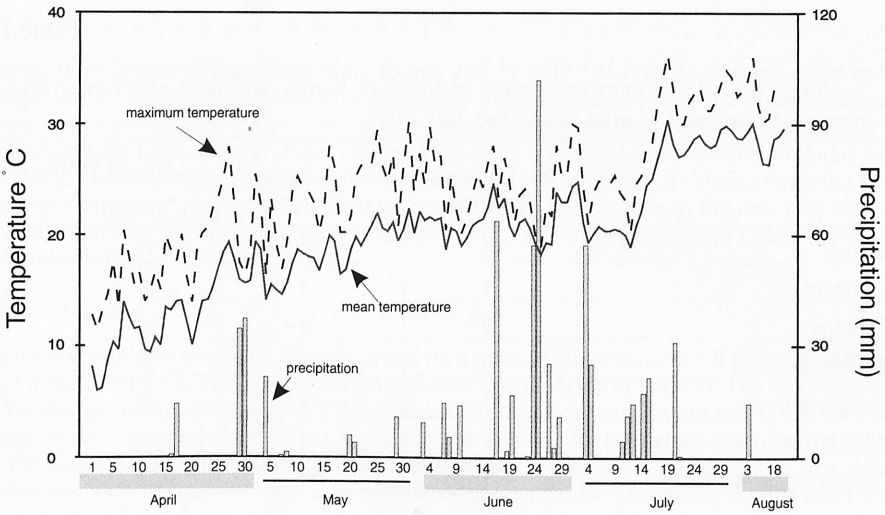

Fig. 2. Maximum and mean temperature and precipitation total in the study period (according to Masan Meteorological Station).

III. METHODS AND MATERIALS

Nesting was confined to the eaves of houses and to electricity pylons. Nestlings were more or less inaccessible, with ringing possible at only two nests, so studies involved fledged birds caught in nets. Birds were weighed to an accuracy of 0.01g on electronic balances, aged and sexed and then ringed with aluminium rings from the Ornithological Station of the Institute of Ecology, Polish Academy of Sciences, as well as colour-rings. The colour rings allowed individuals to be identified using binoculars. Determinations were made of the number and distribution of nests occupied by second and third broods, mainly on the basis of the calls of nestlings and feeding parents. The observations were begun too late to obtain data from the first broods. The frequency with which nestlings were fed by parents was observed, as was the type of food brought in the bill of parent birds – defined as plant food (barley or rice grains) or animal food (invertebrates). Later, feeding birds – especially newly-fledged young – were watched to determine the place of foraging, while parents feeding fledged young were also observed. Additional observations were made in neighbouring villages to determine if birds there had been ringed by us.

A total of 155 Tree Sparrows were ringed (Table I). Of these, 93 (i.e. 60%) were recaptured or observed subsequently, including 28 adult birds (10 females and 18 males) or 73.7% of those ringed, 40 young birds from the first brood or 55.6% of those ringed, and 25 young from the second brood (again 55.6%). Binocular observations to identify individual ringed birds were made over a total of 134 hours.

The frequency with which parent birds brought food was determined in the course of two uninterrupted observation sessions on June 12th and 13th. The first lasted 190 minutes (between 05.40–11.00) and the second 100 (between 09.35–12.22). Nestlings in the two observed nests were about 10 days old, though the numbers were not known. In 90 cases it was possible to determine the nature of the food brought, at least to the extent that it was either of plant or animal origin.

Each day, J. PINOWSKI counted Tree Sparrows at Juseo-ri by traversing the whole village (area of 0.189 km^2) along the same route, most often in the course of 45 minutes between 06.30 and 07.30. Mid-field areas of trees and fields near Juseo-ri (area of 0.317 km^2) were also visited once or twice a week. Similarly, the streets of Masan were walked at least once or twice a week, with note being taken of the places of occurrence, ages and behaviours of Tree Sparrows, as well as the locations of nests. The constant 3km route led through apartment-block housing, a busy street and areas of old buildings. Finally, the occurrence and nesting of Tree Sparrows were also noted away from the main study area.

Table I

Numbers of Tree Sparrows ringed at Juseo-ri, Korea, and then observed subsequently or retrapped in mist-nets, May-July 1996

	No. of adult females	No. of adult males	No. of young birds	
			1st brood	2nd brood
Ringed birds	16	22	72	45
Retrapped birds	1	3	23	11
No. of retraps	2	4	24	11
Ringed birds observed	9	18	28	20
No. of observations	41	58	48	41
Ringed birds observed or retrapped	10	18	40	25
No. of observations and retraps	43	62	72	52

The meteorological data used in the work were from the Masan Meteorological Station. They showed a high degree of concordance with the authors' own qualitative data obtained in the course of the study.

IV. RESULTS

Habitat selection

The Tree Sparrows at Juseo-ri occurred in the built-up part of the village (Fig. 3). Three males performing courtship displays on the pylons in open fields 300, 500 or 600 m from it did not build nests, even though one bird won and copulated with a female. Fields of barley and wheat c. 500 m from the village were not damaged by Tree Sparrows. Similarly, the species was only encountered near human settlements even in the course of trips further afield. In Masan, nests were to be found singly every 200-300 m, while flocks of 30-50 young birds formed after the first fledging, and always kept to patches of green space, shrubberies or squares. These flocks increased in size as young birds from successive broods flew. On July 20th, colonies of tens of nests and flocks hundreds strong were noted at a zoo on the marine island of Totsom, c. 1 km from Masan. The nests here were located under the straw roofs of cages.

The phenology of the breeding period

The majority of nestlings from the first brood had already flown by the time the research commenced, i.e. May 16th 1996. Forty-eight young birds of the first brood were captured between May 20th and 22nd, among which 10 still had large yellow-edged gapes, attesting to recent departure from the nest. The first clutches may thus be presumed to have been laid around April 5th-10th (assuming, after SUMMERS-SMITH 1995, the commencement of incubation with the 4th egg, an incubation time of 11-14 days and a time in the nest for nestlings of 12-17 days, making 27-35 days in total). The last nestlings from first broods had fledged by May 29th. Nestlings of early second broods present in nests on May 29th were already 3-5 days old, while 10-day-olds from a 2nd brood were ringed on June 4th. Nestlings from 6 of the 19 second broods had fledged by June 8th, and by the 14th second-brood nestlings remained in only 4 nests. Most of the third-brood nestlings found in 11 nests fledged between July 13th and 16th, though there were still young nestlings in 3 as late as on August 4th, when the research ceased. It was therefore impossible to state whether or not 4th broods were produced.

The locations of nests

19 nests with 2nd-brood nestlings were found, and 11 with 3rd-brood nestlings. All were within the village, and of the 30 only 5 were on electricity pylons: within transverse metal beams, in the empty interior of the cement pylon itself or in the plastic surround covering cable junctions. The remaining nests were in buildings: under cement roof tiles or in cracks in the stone and clay walls. In parallel, casual observations regarding nesting sites for Tree Sparrows in Masan revealed that birds in the old part of the city most often nested under roof tiles, while those in the new part chose transformers on electricity pylons, even ones near the busiest streets; or else more rarely the cracks and crevices in buildings.

The feeding of nestlings

The food brought to nestlings was observed on a total of 90 occasions. Of these, 69 cases (75%) involved insects, while 22 (25%) concerned grains of cereals (rice or barley). The nestlings were being fed by the parents on average every 12 minutes. During heavy monsoon rains (e.g. on 24th-25th June), old birds remained under barn roofs for the whole time, seeking food for their nestlings among the cattle fodder: insects in the grass brought in for the stock and grains in rice straw. The Tree Sparrows with nests so placed as to permit feeding without the need to fly out from under the roof continued with intensive feeding even during torrential rain. When the monsoon was followed by a heatwave (on and after July 19th), Tree Sparrows fed their nestlings in the morning and evening, with a break in activity in the hours before and after midday.

Foraging by young fledged birds

The main foraging places for the flock of first-brood birds were fields of ripening barley in the immediate vicinity of the village. Tree Sparrows fed there up to June 8th-10th, when the harvest was followed by flooding of the fields in preparation for rice growing. However, fields of barley 500 m from the village were not fed in at all. Birds eating barley sat on the blades and broke them, then removed grain from the husk while perched on the ground. Our estimate is that they ate c. 10% of the yield. They did not consume dry barley grains; only immature ones dehusked directly from the ear or else moistened by rain or dew following the harvest. Harvested grain was dried on the asphalt road running through the village, but Tree Sparrows did not collect the dry grains there. Food for birds of all ages was also provided by the grains of rice to be found in barns in the rice straw brought in as cattle fodder. Further places of frequent foraging were road verges on which the rice straw was laid out to dry. Seeds of the weeds *Echinochloa crus-galli* and *Setaria viridis,* both common in the Juseo-ri fields, are a favourite food of Tree Sparrows (PINOWSKI & WÓJCIK 1969; PINOWSKI, TOMEK & TOMEK 1973), but remained insufficiently ripe up to the time the research ceased and were not therefore taken. Insects and other invertebrates were sought throughout the area: in a field of peonies, on boundary strips cut with a sickle, etc.

Roosts, flocks, dispersion from the place of birth

After fledging, the Tree Sparrows at Juseo-ri formed flocks several tens of birds strong. These sometimes joined together at a rich feeding ground (field of ripening barley) such that c. 200 birds were feeding together. The roost common to all was a grove of bamboo on the edge of the village. At Juseo-ri, the young first-brood birds left the area of their birth around mid June, i.e. an average of 38.2 days after fledging (SD=14.25, n=36). This period ran from May 10th, taken as the day of flight from the nest, to the last capture or observation through binoculars. Second-brood birds left the village around July 20th, i.e. an average of 25.8 days after fledging (SD=9.10, n=20), if the date of the first flight is taken to be June 10th. However, single birds remained in the area up to the end of July. Finally, third-brood birds were still in the natal area at the time when the research was halted. The difference in the length of time for which young first- and second-brood birds remained was statistically significant (Student t test: t=3.41; p.01). We are not able to state where the birds flew, because individuals we had ringed were not to be found either on the fields or in neighbouring villages at distances of 4-5 km from Juseo-ri.

The majority of the adult birds ringed by us remained within the village for the whole time. The mean period from first capture to last capture or binocular observation was 42.1 days for females (n=10, SD=18.8), and 35.9 days for males (n=18, SD=14.3).

The influence of weather conditions

Breeding was not found to be interrupted by the monsoon rains, as claimed by Professor P. O. WON (personal verbal communication). The rainy season coincided with the late second and early third broods. In the rain, Tree Sparrows did not appear in the open, but fed under barn roofs, where they sought food for their nestlings (Fig. 4). When rain stopped, birds moved out into the fields, but their flights were interrupted when rain fell again.

The heatwave following the monsoon (after July 19th, Fig. 2) saw temperatures rise above 35°C. At this time, Tree Sparrows became less active and, as the temperature rose, confined the feeding of nestlings to the early morning and late afternoon. Courtship displays were also restricted to the early morning and early evening. In the heat, birds were most often to be found in barns or other roofed farm buildings, where the thick cement tiles provide effective insulation from the sun's rays. Furthermore, barn roofs covered in „eternit" are also overlain with pine branches by their owners in hot weather. Even in those cooler conditions Tree Sparrows were seen panting and standing tall on their feet. Birds with nests so-located that they could feed young without flying out from under a roof did not interrupt feeding in the middle of the day.

Body weights of young fledglings did not vary greatly through the study period (Table II). Thus the heavy monsoon rains falling between June 16th and July 22nd seem not to have exerted a significant influence on the weights of young birds. However, the cases of repeat capture showed that the variability to the difference between body masses determined the second and first times was greater if the recapture occurred 1-2 days after heavy rain than if it occurred after several dry days. In the first case the range to the differences was between -3.2 and +1.8 g (i.e. 5.0 g), while in the second it was between -1.8 and +0.78 g (i.e. 2.06 g). Second-brood birds (average weight 18.27 g, SD=1.21, n=38) were rather lighter than those from the first brood (mean 18.91, SD=1.24, n=65, t=-2.524, p.01). The difference in the number of birds in relation to Table I reflects the escape of some birds in the course of ringing and prior to weighing.

V. DISCUSSION

Habitat selection

Throughout its range, *Passer montanus saturatus* is an inhabitant of towns, cities and other human settlements (NOSKOV et al. 1981a, FUJIMAKI 1996). In Hokkaido (Japan) the population density of Tree Sparrow in the breeding season correlated best with the number of houses which were used as nesting sites and with human population density. During breeding season the Tree Sparrows feed within a 70 m radius of the houses (SANO 1979). In cities, it occurs at much higher densities where there is more green space than in areas where there is little or none (NOSKOV et al. 1981a).

Table II

Mean gram body masses of young Tree Sparrows trapped with mist-nets at Juseo-ri, Korea, over six 10-day periods

	1st brood			2nd brood		
10-day period	n	mean	SD	n	mean	SD
16-25 May	58	18.95	1.23	0		
26 May-4 June	18	18.90	1.10	0		
5-14 June	6	19.47	1.09	3	18.41	0.82
15-24 June	6	18.81	0.71	35	18.21[1]	1.32
25 June-4 July	0			9	17.33[1]	0.47
5-14 July	0			1	18.29	

[1]Student's t-test: t = 1,92 p ≈ 0,06 (NS)

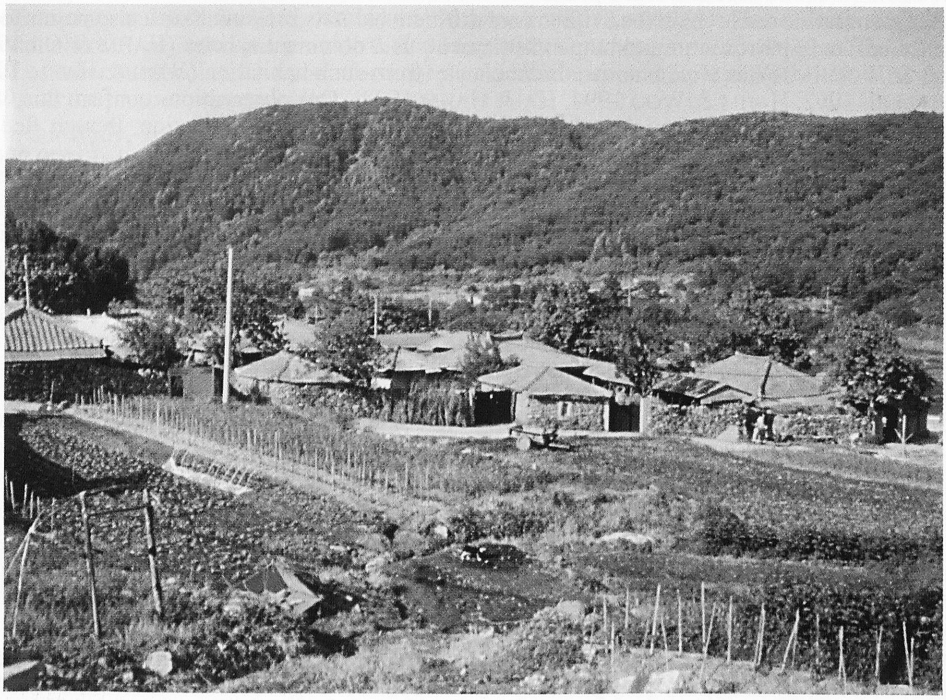

Fig. 3. General view of the Juseo-ri village, showing the character of the environment and countryside architecture.

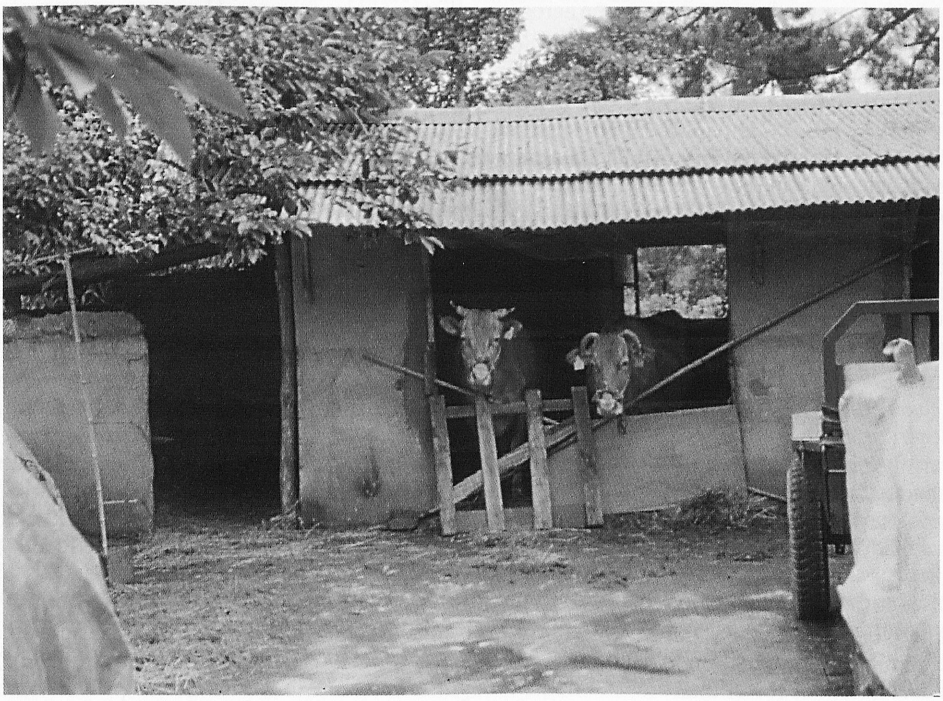

Fig. 4. Typical cattle-shed built at Juseo-ri. Its walls are not complete, so the inside is always accessible for sparrows.

GORE & WON (1971) gave the Tree Sparrow as an abundant inhabitant of urban and village areas in Korea. Quantitative research on the avifaunas of different habitats in South Korea also points to the presence of Tree Sparrows around human settlement, as a dominant species (HAHM & OH 1989, HAHM & WOO 1994), as well as to its absence away from such habitation (WOO & HAHM 1982, HAHM et al. 1992, HAHM & WOO 1994, HA & HAHM 1994). Our observations confirm this, with nests in Masan being on pylons near busy streets with very limited vegetation, though fledged young always remained in greenery: small groups of trees, shrubs, hedges, etc. *P. m. dilutus* and *P. m. malaccensis* – other synanthropic subspecies occurring across most of southern and eastern Asia (NOSKOV et al. 1981a, SUMMERS-SMITH 1995) behave similarly, as does *P. m. dybowskii* (DOMANIEWSKI, 1915). This last subspecies, occurring in North Korea and Russia's Primorye Province (NANKINOV et al. 1981), is a synonym for the nominal subspecies *P. m. montanus*, according to SUMMERS-SMITH (1988), or else of *P.m. saturatus*, according to KIM et al. (1986) on the basis of protein electrophoresis. Support for the latter claim may be drawn from the fact that Tree Sparrows in Primorye inhabit urban areas and settlements (PANOV 1973, NOSKOV et al. 1981b), thereby behaving more like *P. m. saturatus* than *P.m. montanus* (DYER et al. 1977).

The onset of laying and number of broods

Data on the onset of breeding were gathered by PINOWSKI and KENDEIGH (1977), and SUMMERS-SMITH (1995). At our field site, a prediction for the onset of laying of April 10th is obtained when use is made of the empirical formula from DYER, PINOWSKI and PINOWSKA (1977). The formula relates this time to latitude (in this case 35°N), taking the form $D=74.2 + 0.77 \cdot l$ (where D is one of the successive calendar days from January 1st and l the latitude). However, SUMMERS-SMITH's (1995) analogous formula ($D = 32.7 + 1.61 \cdot l$) provides the date April 4th, which is in line with our estimate of April 5th-10th, based on the ages of captured first-brood fledglings.

As throughout the species' range (SUMMERS-SMITH 1995), Tree Sparrows in South Korea produce at least 3 broods. However, in spite of a huge number of studies (see SUMMERS-SMITH 1995), fourth broods have only been noted from Belgium (DE BETHUNE 1961), from the state of Missouri (ANDERSON 1975) and from Poland (WIELOCH & FRYSKA 1975), and then only sporadically rather than as a rule. We had no opportunity to determine whether fourth broods were produced in Korea, as we ended our work too early to come across any that might have arisen. However, as is usual with Tree Sparrows (PINOWSKI 1968, SUMMERS-SMITH 1995), third broods were less common than second ones in our study area (the figures for numbers of nests being 19 and 11 nests respectively).

Nest locations

The nests observed in Juseo-ri and Masan were entirely confined to manmade structures. There were no nestboxes in the study area, though much use has been shown to be made of these by *P. m. saturatus* in Japan (ABË 1969, MINEGISHI 1994,1996). European populations of Tree Sparrows are also very willing to utilise manmade structures as nest sites. So, for example, more than 66% of 1813 nests studied in Bulgaria were in buildings or street lighting, under bridges, etc., while only 9% were in natural tree holes (NANKINOV 1984). Analogous figures obtained in the former Yugoslavia were 33 and 16% (ŠLIVKA 1981-1983). In our study area, the lack of trees with holes made such nesting impossible, hence the lack of significant differences between *P. m. saturatus* and *P. m. montanus* in the choice of nest site.

The food of nestlings

At 12 times per hour, the observed frequency with which c. 10-day-old nestlings were fed corresponded to the range 8.2-11.7 noted for older nestlings in Hopeh Province, China (CHIA et al. 1963), but was markedly different from the mean of 33, recorded by ABË (1969) in Sapporo, Hokkaido Island, Japan; and the 17-29 found by GYURKO et al. (1959) in Hungary. The frequency of feeding depends on many factors, such as the ages of nestlings and their numbers in the nest, the season, weather conditions and the availability of food (GYURKO et al. 1959, SEEL 1969 and others).

The monograph by SUMMERS-SMITH (1995) brings together the results of most of the studies done on dietary composition in nestling Tree Sparrows in various parts of the species' range. Plant food accounted for fewer than 5.5% of items brought to nests in 9 localities in Europe and 1 each in the USA and China. In contrast, our Korean material gave a figure of 25%; and a similar 20.6% was recorded for the Seoul area by KIM & KIM (1980). In turn, the work done in Sapporo revealed that as

many as 38% of the items in birds' stomach contents were of plant origin, with the figures by volume for spring and summer being 33% and 19% respectively (ABË 1969). These results suggest that individuals of *P. m. saturatus* provide their young with a greater proportion of plant food than do those of other subspecies. The main foods of this kind are rice and barley (ABË 1969, KIM & KIM 1980 and the present paper).

In our study, Tree Sparrows confined their foraging to fields near the village. Similarly, KIM & KIM (1980) reported that damage inflicted upon fields of ripening rice was greater near to a village than further away.

The influence of climatic conditions

The literature has made clear the role of rain in reducing rates of increase in the body weights of nestling Tree Sparrows, or even in reducing weights in absolute terms (ABË 1969, GRÜN 1974, and others). However, there were no previous data on the role played by rain once birds had fledged, and the present study suggested no clear trends for body weight for the period May 16th-August 4th (Table II). Likewise, no such trends have been recorded for European populations of the Tree Sparrow. The work by NOSKOV et al. (1981b), in the St. Petersburg area of Russia, showed no systematic changes in the body weights of fledged individuals up to the 55th day of life.

Our study found no significant differences in body weight when periods of particularly heavy rain were compared with dry spells (Table II). The lack of such an influence may have been linked to the birds' use of barns and other buildings in feeding during rainy periods.

Roosts, flocks, dispersion from the birthplace

Tree Sparrows in South Korea resemble those in Poland (PINOWSKI 1965a,b, 1967, 1971) in remaining near the nest site after fledging and forming flocks of between several tens of birds and c. 200. Birds in such flocks feed together and share a roost. In Juseo-ri, the roosts were a bamboo grove at the edge of the village or a clump of shrubs hanging down from the slope, while in Poland examples include areas of birch on the forest edge or village buildings (PINOWSKI 1967).

Young first-brood Tree Sparrows studied in Poland in the years 1961-62 were found to leave the vicinity of the natal area an average of 43.6 days after departure from the nest and the joining of flocks seeking food in fields. Second-brood birds were quicker in leaving the nesting area and joining flocks (doing so after 18.6 days in 1961 and 24.6 days in 1962), and third-brood birds even quicker (PINOWSKI 1965a,b, 1967, 1968, 1971). A similar shortening of the time spent locally by second-brood birds was observed by us in Korea. At the same time, the majority of marked adult birds remained in the village. We are not able to determine the degree to which the disappearance of young from the breeding area reflects mortality, or else emigration from the place of birth by way of dispersion or further migrations. The search for ringed birds among those feeding in neighbouring villages proved fruitless, which may mean that young migrate over longer distances in Korea, in a way that they do not in Poland, but do seem to do in some other countries (VERHEYEN 1957, KURODA 1966, MCCLURE 1974, NOSKOV 1981, Japanese Bird Banding 1985, SUMMERS-SMITH 1995).

In our study area, Tree Sparrows were present in barns day after day in periods of heavy monsoon rain and subsequent summer heat. Such buildings afforded sufficient food, as well as a refuge from both soaking and overheating. Also SUMMERS-SMITH (1963, p. 213) writes: „The Tree Sparrow, in the East, where it behaves as a „House Sparrow", is if anything, more cheeky, regularly coming inside houses and even nesting in occupied rooms". The behaviour described resembles that of the House Sparrow *P. domesticus*, which makes frequent breeding-season and winter use of such utilised premises as market halls, stations, mills, stables, barns, etc., in many places across its temperate-zone range (WEAVER 1939, YOUNG 1962, WILL 1969, NOVOTNY 1970, PINOWSKA et al. 1976). It seems that a House Sparrow may live almost solely within buildings (own observations), but this phenomenon is not known for Tree Sparrows in Europe. In 1971-1972 in 86 barns located in the district of Gdańsk we mist-netted 2303 House Sparrows (PINOWSKA et al. 1976, PINOWSKA 1979) and not one Tree Sparrow (own observations). Over 35 years of the study of a Tree Sparrow population in central Poland we never saw Tree Sparrows entering buildings (own observations).

In Europe Tree Sparrows compete with House Sparrows for nesting sites (PINOWSKI 1967, CORDERO & RODRIGUEZ-TEIJEIRO 1990, CORDERO & SENAR 1990, CORDERO 1993, SUMMERS-SMITH

1995) and food for nestlings (ANDERSON 1978, 1984, SUMMERS-SMITH 1995). After the autumn sexual display and before the onset of spring sexual display Tree Sparrows only roost in nests. In the morning they leave the nest and fly to the foraging site of the flock. They come back to the nest at dusk and immediately roost (PINOWSKI 1966). On the contrary, House Sparrows often stay around the nesting site also in autumn-winter period (own observations). House Sparrows begin spring sexual display and egg laying earlier than Tree Sparrows (MACKOWICZ, PINOWSKI & WIELOCH 1970, ANDERSON 1978). House Sparrows are bigger than Tree Sparrows, so the latter can successfully defend the nest only in special situations, for example by blocking the entrance to the nest with the body (CORDERO & SENAR 1990). The gradients of habitat preference differ for the Tree and House Sparrows (DYER, PINOWSKA and PINOWSKI 1977), nonetheless, in habitats suitable for the House Sparrow, Tree Sparrows are forced to occupy inferior nest sites, e.g. located lower, or more exposed to predators (CORDERO & RODRIGUEZ-TEIJEIRO 1990, CORDERO 1991). In our study area in South Korea, Tree Sparrows occupied habitats that in Europe are most preferred by House Sparrows.

VI. CONCLUSIONS

1. The breeding biology of the Tree Sparrows of subspecies *Passer montanus saturatus* living in South Korea is somewhat different from that of the nominal subspecies *montanus* studied in Central Europe.

2. In its choice of breeding-season habitat, *P. m. saturatus* is more closely-associated with human settlement than *P. m. montanus*.

3. In periods of extreme weather (torrential rain, high temperatures), *P. m. saturatus* resembles House Sparrows *P. domesticus* – but not individuals of *P. m. montanus* in Europe – in taking advantage of the refuge provided by buildings.

4. *saturatus* individuals in Korea differ from those of the subspecies *montanus* in Europe in making greater use of plant food (rice and barley) in the feeding of nestlings.

5. Like those in Europe, the young Tree Sparrows studied in Korea left their place of birth 26-39 days after fledging, depending on the brood. However, while European birds go on to join nearby flocks feeding on fields no more than 5 km from their birthplace, none of the young Tree Sparrows ringed in Korea was later found within such a range, suggesting that movements were made over greater distances.

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