

The changing song patterns of the Great Tit *Parus major*

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Observations on the song of the Great Tit were made in the Helsinki region in the period 1947–81. Until the 1950s the dominant song in Finland and elsewhere in Europe was the 3-syllable phrase, but 2- and 4-syllable phrases were also heard. Later the 2-syllable phrase increased strongly in Helsinki, its present frequency being 75–90 %. The 3-syllable phrase is now rare and the 4-syllable phrase has disappeared entirely. Since the late 1970s, the Great Tit has sung a new one-syllable phrase and intermediate phrases, with 3/2 and 2/1 syllables, in which the final syllable is shortened.

Great individual differences exist in the strength, pitch, tempo and tone of the song, and the song of the same male can vary fairly widely. The difference in pitch between the syllables in a phrase also varies, but this does not greatly affect the audibility of the elements of the songs, and cannot have played a role in the shortening of the phrase.

The shortening of the song phrase can be seen most clearly in sparsely wooded, noisy urbanized areas where the population is denser than in natural habitats. In such areas the daily and annual rhythms of the Great Tit and other birds have also changed; the singing season now starts earlier and amount of singing has increased. It is not yet known why the increasing noisiness of the environment has led to the shortening of the phrase.

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Introduction

The literature on the Great Tit contains little research on the different song patterns (Sasvári 1971, 1973a, b, Hunter & Krebs 1979). Only recently has attention been paid, for example, to the fact that the relative frequencies of the phrases of different lengths have changed sharply in the last few decades. Bergman (1980) has dealt with one aspect of this change, using his own observations and answers to a questionnaire. I have studied the song of the Great Tit since the 1940s and wish to present my views on this question, based on my own observations and the information available in the literature.

Material and methods

Observations on the song patterns of the Great Tit and their relative frequency were made in the Helsinki region from 1947 to 1981. The song pattern of each male was recorded at the time of occurrence by writing phonetic descriptions of the phrases, noting the number of themes and making relative estimates of the pitch, tempo and tone. Systematic research took place in 1947–50 (Lehtonen 1954) and in February–May in 1974, 1975 and 1981, when I mapped the Great Tit population of the Itä-Pakila allotments and the nearby areas.

The rest of the material comprises random observations in different parts of Helsinki, especially in the residential areas and small woods of Lauttasaari, Maunula and Pakila, and records made in 1959–63 in the vicinity of 228 bird boxes put up in the woods of Maunula and

Haltiala. The principles used in collecting the material have been explained earlier (Lehtonen 1954). As the methods have remained almost the same for decades, the observations from different years are comparable, though some parts of the material are rather scanty (Table 2).

The information available for comparison in the literature from the beginning of the century is unfortunately limited. The study of bird song was then in its infancy and even experienced ornithologists did not provide adequate descriptions of the song of the Great Tit.

The song patterns of the Great Tit in different parts of Europe

The Great Tit is one of the few songbirds whose phrases comprise many themes (Seppä 1922, Lehtonen 1954, 1955, Table 1). The number of syllables per phrase varies from one to four and there are great differences in the various features of the song. The same male may sing phrases of different lengths, changing without a pause to a different number of syllables "mixed song" (e.g. ti-ti-tyy → tyyti). Earlier, the syllables of the individual phrases were complete (e.g. ti-ti-tyy), but recently intermediate songs (e.g. ti-ti-t) have been heard, in which the number of syllables is changing from three to two (3/2) and from two to one (2/1) through shortening of the final syllable (Tables 2 and 3). As the syllable is shortened its audibility becomes weaker; after a time it is occasionally left out and eventually it completely disap-

Table 1. The song patterns of the Great Tit in different parts of Europe.

Region	Reference	Typical phrase	Usual phrases	
			3 syllables	2 syllables
Finland	Seppä (1922)			x
	Kivirikko (1926, 1940, 1947)	tsi tsi da, tittifyy	x	
	Hortling (1929—31, 1937)	tittifu	x	
	Lehtonen (1954, 1955)	ti-ti-tyy, tsi-tsi-daa	x	x
	v. Haartman et al. (1967)	tityy, tyyti, titivity	x	x
Sweden	Lönnberg (1924)	tititij		
	Rendahl (1935)	tsitsida		
	Holmström (1942)	tsi-tsi-da, tittify	x	
	Söderberg (1951)	zi-zi-da, zizi dy	x	
	Rosenberg (1953)	sissida, sittuu	x	x
Norway	Løvenskiöld (1947)	si-tsi-da	x	
	Haftorn (1971)	tititu. tuti		x
Denmark	Salomonsen-Rudebeck	zidi	x	x
			x	
Germany	Floericke (1911)	"Spitz die Schar"		
	Niethammer (1936)	zizibäh, titisi		
	Frieling (1951)		x	
	Stadler (1957)	zizibe	x	x
	Fehringer (1958)		x	x
Holland	Kluijver (1951)	"teateacher", "teacher"	x	x
England	Witherby et al. (1938—41)	teechuwee, teechu	x	
Spain	According to the tv-films by de la Fuente (1980—81)	titivity		
Hungary	Sasvári (1971, 1973a, b)		x	x
			x	
			x	x
The Soviet Union	Dementjev ym. (1970)	sisisyu	x	
The Palaearctic region	Hartert (1910)	sitzida, sitti		

pears (e.g. ti-ti-tyy → ti-ti-t → ti-ti or ti-tit). There has been a clear increase in my study area, in the number of birds singing phrases whose weak final syllable can be heard only 10—15 m away (Table 2).

The features of the song vary widely between the individual males. The tempo ranges from calm and slow to agitated and quick. The intensity (= the volume of the sound penetrating a certain area) and the volume and tone vary between individuals and different times of the day and season. There is also great variation in the pitch, and the particular stress on the different syllables of the phrase increases or diminishes the differences in the pitch.

Time	Phrase	Strength	Pitch	Tempo	Tone
18.16—25	ty-ti (— —)	Strong	High	Quick	Melodic
18.36—36	vii-tii (— —)	Very strong	— 1 octave	Very slow	Non-melodic
18.37—38	tii-ti-ti (— — —)	Moderately strong	— 1/2 octave	Slowish	Semi-melodic
18.39—48	ti-ti (— —)	Moderately strong, weakening towards the end	— 1 octave	Slow	Non-melodic
18.49—56	ty-ti (— —)	Strong	— 1/3 octave	Quick	Melodic
18.57—59	ti-ti (— —)	Strong, weakening and becoming broken towards the end	High	Quickish	Semi-melodic

Each male generally has his own characteristic song. Thus a certain individual may sing in a weak, half-pitch, quick, melodic voice, while another will sing in some other way. Males living in neighbouring territories can usually be identified by the voice. However, this is not possible at the liveliest singing time, especially in the mornings and evenings when there may be great variation in all the features of the song.

The male of a pair nesting in my yard in Itä-Pakila in 1981 sang every evening on 9—11 May for long periods, during which I noted 9 different phrase types. On 9 May the following song patterns were recorded (the basic pitch of the voice is estimated as "high").

Table 2. The frequency of different song patterns of the Great Tit in Helsinki in 1947—81. The terms "mixed song" and "intermediate song" (3/2 and 2/1) are explained in the text.

Period	Observations in minutes	Number of syllables per phrase										"Mixed song"					
		4		3		3/2		2		2/1		1		3 2		2 1	
		Min.	%	Min.	%	Min.	%	Min.	%	Min.	%	Min.	%	Min.	%	Min.	%
1947—50	1149	27	2.3	799	69.6			258	22.5					65	5.6		
1951—55	208	5	2.4	157	75.5			30	14.4					16	7.7		
1956—60	190	3	2.0	89	46.8			90	47.4					8	4.2		
1961—65	168	1	0.6	85	50.6			78	46.4					4	2.4		
1966—70	104	—	—	24	23.1			78	75.0					2	1.9		
1971—75	573	2	0.4	61	10.6			510	89.0					—	—		
1976—80	139	—	—	7	5.0	1	0.7	102	73.4	12	8.6	5	3.6	12	8.6		
1981	412	—	—	19	4.6	3	0.7	331	80.3	28	6.8	20	4.9	2	0.5	9	2.2

The phrases of the Great Tit can be roughly grouped into those where the syllables clearly differ in pitch and those where such differences are slight or missing. This was confirmed by recording made using a 50-cm parabolic reflector. The relative pitches of the syllables of the phrase types recorded in my study area are presented in Table 3.

Generally only 3- and 2-syllable songs are mentioned in the literature. It is almost impossible to obtain an exact idea of their prevalence in different parts of Europe, because their relative frequencies are recorded in only a few publications. The material in Table 1 indicates however, that the 3-syllable phrase is the most typical one in at least Fennoscandia. Elsewhere in Europe, 3-syllable and 2-syllable phrases are more or less equally frequent. Thus the published information does not support Bergman's (1980) observation that "the Great Tits in Western Europe have evidently never had the *tittity* theme as their main phrase."

The Great Tit song is not dealt with in the oldest Finnish zoological handbooks (Mela 1882, Mela & Kivirikko 1909, Renvall 1916). What is even stranger is that neither Kivirikko (1926, 1940, 1947) nor Hortling (1929—31, 1937) mention the 2-syllable phrase at all, despite the fact that it had been generally heard from at least the first decade of the century (Seppä 1922).

Table 1 shows, however, that the *tittity* theme was dominant in Europe until at least the 1950s. In Finland and Sweden, and possible elsewhere, other phrases were seldom heard. At present the situation is quite different at least in Northern Europe (Bergman 1980), though in time at which the change took place cannot be exactly determined.

My own material shows that the increase in the

2-syllable song began in the Helsinki region in the mid-1950s and continued for 20 years. In the second half of the 1950s the 2- and 3-syllable songs became equally frequent, and in the second half of the 1960s the 2-syllable song became dominant, reaching its peak, nearly 90 %, in the early 1970s (Table 2). Since then it has become less frequent, as a completely new 1-syllable song and an intermediate 2/1-syllable song have become more common. The advent of the 1-syllable song shows that the change in the song of the Great Tit is still continuing.

Thus during the last 25 years in the Helsinki region, the phrase of the Great Tit song has become increasingly shorter. Bergman (1980) has demonstrated that this trend is extending to the whole distribution area of the species in Finland and Scandinavia.

My field observations confirm Bergman's (1980) conclusion that the change has been slower in sparsely populated than in urbanized areas. In Kullasniemi, Joutsa, the average prevalence of the 3-syllable song was about 53 % in 1978—81 and in Rajakulma-Paippinen, Sipoo, it was about 25 % in 1981.

Reasons for the change in the Great Tit song pattern.

Bergman (1980) considers that the *tittity* phrase predominated in Finland until the 1950s because the Great Tit population was sparse and every individual could hear the details of the phrases of the neighbouring tits. In Western Europe, where, according to him, the population has always been dense, and there are plenty of other birds singing in early spring "it is not so easy for the tits to distinguish, learn and imitate the phrases of their own species. Two- and three-sylla-

ble phrases tend to sound the same. Two consecutive different-pitched notes are more easily distinguished from the background noise, and that is why the two-syllable phrase type is better in a noisy environment than the three-syllable one."

According to Bergman (1980) the change occurred much later in Finland than Western Europe. With growing urbanization, increasing numbers of Great Tits have moved to built-up areas and the population density has risen. These conditions favour a change in the song. Local factors have also contributed to the trend, e.g. migrant tits which have learned the 2-syllable phrase in Sweden and brought the song pattern to Finland.

My own observations support Bergman's (1980) conclusions that the song of the Great Tit has changed most in urban areas, and that the main reason for the change is the sharp increase in environmental noise. However, our points of view differ in many details.

Actually, the change in the Great Tit song cannot have anything to do with either the population density itself, or the fact that the phrase is better distinguished from other birdsong, if the syllables are of different pitch (Bergman 1980). If this were true, the change should have started in Finland several decades earlier. The Great Tit population has been fairly dense in the urbanized areas in Finland, since at least the beginning of the century, nor has the pair density differed greatly from that in Continental Europe. In the Netherlands for instance, "the area of the territory is usually 2 to 3 ha, but in very suitable habitats, it may be as small as 0.5 ha and in less favourable areas with a low population density, it may be larger" (Kluijver 1951). The territory size in my study areas in the Helsinki region, where no changes worth mentioning have taken place since the 1930s, have been about the same as in the Netherlands: generally 2–3 ha, but in favourable areas only about 0.6–1.0 ha. In Mustasaari (5.7 ha) for example, there were 6 nesting pairs in 1937 and in the northern, western and central areas of Korkeasaari (12 ha) the population varied in the 1930s and 40s between 10 and 16 pairs. In both places the song of other birds *Parus caeruleus*, *Carduelis chloris*, *Emberiza citrinella*, *Pyrrhula pyrrhula*, *Passer domesticus* and in Korkeasaari also the calls of zoo animals and other noises were rather noticeable from the beginning of the singing season. In spite of all this, almost all the Great Tits were in clear voice contact with each other: in Korkeasaari this was evident from the chain reaction at the start of the dawn chorus (Lehtonen 1947).

There have probably been similar population densities in other Finnish urbanized areas and yet the *tittity* theme preserved its strong position there

Table 3. The relative pitches of the syllables in the different phrases of the Great Tit.

Number of syllables in the phrase	Phrase	The relative pitches of the syllable
4	tí-tí-tí-tyy	— — — —
	týi-ti-ti-ti	— — — —
3	tíi-tí-tí	— — —
	tí-tí-tyy	— — —
	tsíi-ti-ti	— — —
	ty-týy-tí	— — —
3/2	ti-ti-tí	— — —
	tsi-ti-tí	— — —
2	tíi-tí	— —
	tí-tí (tí-tíi)	— —
	tí-tít	— —
	tít-tít	— —
	tíi-ty	— —
	tí-víts	— —
	tjí-ti	— —
	tsí-tít	— —
	tsi-tíi	— —
	ty-tí	— —
tyt-tíi (tyt-tít)	— —	
2/1	tyy-ti	— —
	vii-tíi	— —
1	tí-tí	— —
	tsíi	— —

until the 1950s. As I see it, the claim that different pitched syllables are more audible among birds is purely hypothetical and cannot be used to explain the change in the song pattern of the Great Tit.

The audibility of the song differs fairly greatly between Great Tit males, but the reasons for this lie not in the differences in the pitch of the syllables but rather in the strength and pitch of the voice (cf. Lind 1979). Strong sounds carry long distances even in densely vegetated areas, where weak voice easily becomes inaudible. High-pitched sounds travel a much shorter distance than low ones. This can be seen in the voice selection of each bird species; for example, the voices of species living in tropical rain forests are strong and low compared with the voices of birds in open areas (Lind 1979).

The audibility factor determines the quality of the acoustic expression in tits as well. Contact and warning calls intended for short distances only are so high that some of them reach the upper limit of the human hearing range, whereas the song

is both stronger and lower-pitched, since it should carry over the territorial limits even in noisy environments.

Bergman (1980) considers that two consecutive notes of a different pitch are separated most clearly from the background noise and that this makes the two-syllable phrase in the Great Tit song more audible in noisy surroundings. In fact in many of the two-syllable phrases of the Great Tit the pitch difference between the syllables can hardly be distinguished in the field, besides which the one-syllable song, which is becoming more common, is even-pitched (Table 3). Only in the phrases of 3–4 syllables does one of the syllables almost always differ clearly in pitch from the others. Altogether, the differences in the audibility of the syllables of the phrase are so subtle that they cannot play an important role in separating the parts of the song.

In theory, a far more important factor is the wide variation in the strength of the song voice and the total pitch between different males. For example, the human ear can detect the song of one Great Tit even twice as far away as that of another. However, the variation in the audibility factors can hardly have any biological meaning in the life of the Great Tit. Field observations, and cage and tape-recorder tests show that the Great Tit, like any other bird, can distinguish even weak calls of its species from the multi-voiced bird chorus and other background noise (Braun 1915, Koehler 1951, my own unpublished observations). The reaction to the calls varies with the season. During the winter months, Great Tit males, even those living together, pay little attention to each other's song, because the territorial control and defence instinct is lacking. But the reaction to the contact, alarm and danger calls is strong, as also noted by Sasvári (1973b).

I cannot believe that the sound of the song of the Coal Tit has served to preserve the 3-syllable phrase of the Great Tit as suggested by Bergman (1980). The Coal Tit generally sings both 2- and 3-syllable phrases (Lehtonen 1955) and the Great Tit seldom learns to imitate the calls of other species (Kühn 1954, my unpublished observations). The latter fact shows that the species' song pattern is inherited. The birds merely combine the inherited calls in different ways, thus obtaining a wide selection of phrases.

Bergman (1980) also considers that migrant tits played a local part in the change in the phrase length of the Great Tit: "The autumn migrations can carry young individuals from Finland to Sweden, where most of them learn the two-syllable phrase, which is prevalent there. When they return to Finland in the spring, they bring this phrase with them". It should be remembered that only a small minority of the tits migrate and only

about 35 % of these are males (Hildén 1979), so that the call pattern of those returning in spring cannot have much influence on the song.

The real reason for the shortening of the phrase length of the Great Tit song is to be found in the physical and acoustic changes in the habitat, a fact also pointed out by Bergman (1980). The original habitat of the Great Tit was closed mixed forest, from which an ever growing part of the population has moved to less wooded surroundings, such as yards and parks. From the start the new environment was noisier than the forests, and the amount of noise pollution has increased many times over, especially during the last few decades. My observations in central Helsinki and along the ring road show that the noise of traffic changes the daily rhythm of several species (e.g. *Parus major*, *Pyrrhula pyrrhula*, *Carduelis chloris*, *Passer domesticus*, *Corvus corone*) so much that they begin their daily activity in winter 0.5–3 hours earlier than the same species in quieter areas. The noise in the urbanized areas — together with the change in illumination caused by the street lamps — makes the singing livelier and earlier, and even slightly affects the seasonal pattern. The winter song of such species as *Parus major*, *P. caeruleus*, *Carduelis chloris*, *Turdus merula* can be heard 1–3 weeks earlier in central Helsinki than in the quieter suburbs. In the peaceful countryside, the singing season begins even later (cf. v. Haartman et al. 1967). The liveliness of the calls of the Great Tit also seems to be proportional to the noise pollution of the environment. Checks made simultaneously on 8 days in February–March 1981 in central Helsinki (K. Raitasuo) and Itä-Pakila (L. Lehtonen) showed that the singing was livelier in the city centre than in the suburbs on each occasion.

This justifies the conclusion that a restless, noise-saturated, sparsely wooded environment, readily penetrated by all sorts of sounds, has played an important part in the changes in the Great Tit song. Since such an environment can cause changes in the Great Tits daily and annual rhythms, and also in the liveliness of the song, it may be assumed to have contributed to the shortening of the song phrase. Why the call has developed in this particular direction is a riddle that remains to be solved.

Selostus: Talitiaisen laulutavoista ja niiden muuttumisesta

Kirjoitus perustuu talitiaisen laulun tutkimiseen Helsingin seudulla vuosina 1947–81. Vallitseva laulu Suomessa ja muualla Euroopassa oli 1950-luvulle saakka 3-tavuinen säe, jonka ohella koiraat lauloivat myös 2- ja 4-tavuisia aiheita. Myöhemmin 2-tavuinen säe on yleistynyt Helsingissä siinä määrin, että sen osuus on tällä hetkellä 75—

90 % laulusta. Vastaavasti 3-tavuinen säe on harvinaistunut 4–5 %:in ja 4-tavuinen hävinnyt kokonaan. 1970-luvun lopulta lähtien talitiainen on laulanut uutta yksitavuista säettä sekä 3/2- ja 2/1-säkeen välimuotolauluja, joiden viimeinen tavu on aivan lyhyt.

Talitiaislaulun voimakkuudessa, sävelkorkeudessa, tempossa ja sointivärisissä esiintyy yksilöiden välillä suuria eroja, mutta myös tietyn koiraan laulu vaihtelee paljon. Säkeiden eri tavujen sävelkorkeus on joko sama tai erilainen, mutta kyseinen seikka ei vaikuta sanottavasti laulun yksityiskohtien kuuluvuuteen. Sillä ei myöskään ole ollut merkitystä laulusäkeen muuttumisessa yhä lyhyemmäksi.

Talitiaisen säkeen tyyppiäminen on selvimmän havaittavissa vähäpuustoisissa ja meluisissa taajamissa, missä kanta myös on voimakkaampi kuin luonnonbiotoopeissa. Säkeen lyheneminen johtuu ilmeisesti elinympäristöjen muuttumisesta entistä rauhattomammiksi. Mainitun tekijän merkitystä lintujen elintavoille osoittavat mm. havainnot, joiden mukaan taajamien meluisimmilla paikoilla talitiaisen ja muidenkin lintujen vuorokausi- ja vuosirytmii on muuttunut, laulukauden alku varhaistunut ja laulu runsastunut. Ilmeisesti meluisia ja puoliavoin asutusmiljöön on päätehtijänä myös säepituuden muuttumisessa. Toistaiseksi on ratkaisematta, miksi kehitys-suunta on johtanut juuri säkeen lyhenemiseen.

References

- Bergman, G. 1980: Die Veränderung der Gesangmelodie der Kohlmeise *Parus major* in Finnland und Schweden. — *Ornis Fennica* 57:97—111.
- Braun, F. 1915: Über die erblichen und individuel erworbenen Bestandteile des Vogelgesanges. — *Orn. Monatsber.* 23:120—124.
- Dementjev, G. P. & Gladkov, N. A. (eds.) 1970: Birds of the Soviet Union. Vol. V. — Israel Program for Scientific Translations, Jerusalem.
- Fehringer, O. 1958: Vogelhochzeit. — Dietrich Reimer Verlag, Berlin.
- Floerické, K. 1911: Taschenbuch zum Vogelstimmen. — Kosmos, Gesellschaft der Naturfreunde, Stuttgart.
- Frieling, H. 1951: Die Kohlmeise. — *Ornithol. Mitt.* 3:54—55.
- v. Haartman, L., Hildén, O., Linkola, P., Suomalainen, P. & Tenovuo, R. 1967: Pohjolan linnut värikuvin. — Otava, Helsinki.
- Haftorn, S. 1970: Norges fugler. — Universitetsforlaget, Oslo-Bergen-Tromsø.
- Hartert, E. 1910: Die Vögel der paläarktischen Fauna I. — Friedländer & Sohn, Berlin.
- Hildén, O. 1979: Vaelluslinnut. — *In* Hildén, O., Tiainen, J. & Valjakka, R. (eds.): Muuttolinnut, pp. 157—180. — Kirjayhtymä, Helsinki.
- Holmström, C. T. 1942: Våra fåglar i Sverige, Del 1. — Natur och Kultur, Stockholm.
- Hortling, I. 1929—31: Ornithologisk handbok. — Helsingfors.
- Hortling, I. 1937: Lintukirja. — Otava, Helsinki.
- Hunter, M. L. & Krebs, J. R. Jr. 1979: Geographical variation in the song of the Great Tit (*Parus major*) in relation to ecological factors. — *J. Anim. Ecol.* 48:759—785.
- Kivirikko, K. E. 1926: Suomen linnut. — WSOY, Porvoo-Helsinki.
- Kivirikko, K. E. 1947: Suomen linnut, 2nd ed. — WSOY, Porvoo-Helsinki.
- Kivirikko, K. E. 1940: Suomen selkärangaiset. — WSOY, Porvoo-Helsinki.
- Kluijver, H. N. 1951: The population ecology of the Great Tit (*Parus major* L.). — *Ardea* 39:1—135.
- Kühn, H.-J. 1954: Kohlmeise (*Parus major*) imitiert Haubenlerchenruf. — *Ornithol. Mitt.* 6:229.
- Koehler, O. 1951: Der Vogelgesang als Vorstufe von Musik und Sprache. — *J. Ornithol.* 93:3—20.
- Lehtonen, L. 1947: Zur Winterbiologie der Kohlmeise, *Parus m. major* L. — *Ornis Fennica* 24:32—47.
- Lehtonen, L. 1954: Talitiaisen, *Parus m. major* L., laulurytmiikasta ja ääntelystä vuoden eri aikoina. — *Ornis Fennica* 31:99—115.
- Lehtonen, L. 1955: Jokamiehen lintukirja. — WSOY, Porvoo.
- Lind, H. 1979: Djurens beteende. — Forums, Borås.
- Lönning, E. 1924: Svenska fåglar 1. — Stockholm.
- Løvenskiold, H. 1947: Handbok over Norges fugler. — Oslo.
- Mela, A. J. 1882: Suomen luurankoiset. — WSOY, Porvoo.
- Mela, A. J. & Kivirikko, K. E. 1909: Suomen luurankoiset. — WSOY, Porvoo.
- Niethammer, G. 1937: Handbuch der deutschen Vogelkunde I. — Leipzig.
- Rendahl, H. 1935: Fågelboken. — Stockholm.
- Renvall, T. 1916: Suomen retkeilyfauna. — Helsinki.
- Rosenberg, E. 1953: Fåglar i Sverige. — Stockholm.
- Salomonsen, F. & Rudebeck, G. 1962: Danmarks Fugle. — Branner og Korch, København.
- Sasvári, L. 1971: Investigations on the form and meaning of the vocalisation of the Great and Blue Tits. — *Acta Zool. Acad. Scient. Hungaricae* 17:107—117.
- Sasvári, L. 1973a: Development of the vocalisations of some tit species. — *Acta Zool. Akad. Scient. Hungaricae* 17:333—347.
- Sasvári, L. 1973b: Responsiveness of the Great Tit to different vocal stimuli. — *Acta Zool. Acad. Scient. Hungaricae* 17:155—166.
- Seppä, J. 1922: Lintujen äännet. — WSOY, Porvoo-Helsinki.
- Stadler, H. 1957: Gesang und Rufe der Kohlmeise (*Parus major*). — *Acta Musei Macedoni Scient. Naturalium* 1—14.
- Söderberg, R. 1951: Alla Nordens fåglar. — Bonniers, Stockholm.
- Witherby, H. F., Jourdain, F. C. R., Ticehurst, N. F. & Tucker, B. F. 1948: The handbook of British Birds. — Witherby, London.

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