A STUDY OF PASSERINE MIGRATION

AT METU (ANKARA, CENTRAL TURKEY) BASED ON THE MIST-NETTING METHOD

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ÖZGE KEŞAPLI CAN

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Prof. Dr. Canan Özgen
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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Prof. Dr. Semra Kocabıyık
Head of Department

This is to certify that we have read the thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

____

Assoc. Prof. C. Can Bilgin
Supervisor

Examining Commitee Members

Prof. Dr. Aykut Kence ______________

Assoc. Prof. Meral Kence ______________

Asst. Prof. Zafer Ayaş ______________

Dr. Ayşe Turak ______________

Assoc. Prof. C. Can Bilgin ______________

ABSTRACT

A STUDY OF PASSERINE MIGRATION AT METU (ANKARA, CENTRAL TURKEY) BASED ON THE MIST-NETTING METHOD

KEŞAPLI CAN, Özge
M.Sc., Department of Biology
Supervisor: Assoc. Prof. Dr. C. Can BİLGİN

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Turkey is on the main migratory route for many bird species although especially passerine migration is little known. The objective of this study is to document and analyze the diversity, abundances, daily and seasonal phenologies of migrating passerines at METU as well as compare seasonal phenologies with those obtained at Manyas Kuşcenneti (Balıkesir) and Cernek (Samsun) stations.

The study covers autumn 2001, spring and autumn 2002 migration seasons. Methodology is based on the capture and ringing of passerines. In the first two seasons, intermittent sampling was the rule, but in autumn 2002 the study was continuous throughout the day and the season.

Totally 1,832 individuals of 60 passerine species were ringed. Blackcap (*Sylvia atricapilla*) and Willow Warbler (*Phylloscopus trochilus*) were the two most common species. Blackcap dominates species composition in autumn seasons with a very high percentage (%33).

Daily captures peaked in the early morning and with a smaller peak one hour before the sunset. Several waves of migrants were detected in autumn 2002, with most peaks in close correlation with those recorded at Cernek station, indicating some connection between migrant populations using both sites for stopover. Fat deposition rates showed that at least Yalıncak is a high quality stopover site for most migrant species since many species gained weight up to around 50% within a period of 10 days.

This is the first study documenting passerine migration in Turkey, and it revealed that small wooded landscapes within less hospitable habitats provide crucial stopover habitat for many migrant passerines.

Keywords: Passerines, migration, ringing, phenology, species composition, fat deposition, METU

ÖZ

AĞLA YAKALAMA YÖNTEMİ İLE ODTÜ'DE (ANKARA, ORTA ANADOLU) ÖTÜCÜ KUŞ GÖÇÜ ÜZERİNE BİR ÇALIŞMA

KEŞAPLI CAN, Özge
Yüksek Lisans, Biyoloji Bölümü
Tez Yöneticisi: Doç.Dr. C. Can BİLGİN

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Çok önemli göç yolları üzerinde yer aldığı halde Türkiye'de özellikle ötücü kuş göçü çok az bilinmektedir. Bu çalışmanın amacı ODTÜ üzerinden göç eden ötücülerin çeşitliliğini, yoğunluğunu, günlük ve mevsimsel fenolojilerini belgelemek ve analiz etmek, aynı zamanda mevsimsel zamanlamayı Manyas Kuşcenneti (Balıkesir) ve Cernek (Samsun) halkalama istasyonunda elde edilenlerle karşılaştırmaktır.

Bu çalışma 2001 sonbahar ile 2002 ilkbahar ve sonbahar dönemlerini kapsamaktadır. Çalışma yöntemi ötücülerin yakalanması ve halkalanmasına dayanmaktadır. İlk iki dönemde aralıklı bir örnekleme yapılmış ancak sonbahar 2002'de çalışma günboyu ve mevsimboyu aralıksız sürmüştür.

Toplam olarak 60 türden 1.832 ötücü halkalanmıştır. Karabaşlı Ötleğen (*Sylvia atricapilla*) ve Söğüt Bülbülü (*Phylloscopus trochilus*) tüm çalışma dönemlerinde en yaygın iki türdür. Sonbahar dönemlerine ait tür kompozisyonlarında Karabaşlı Ötleğen çok yüksek bir yüzdeyle (%33) baskın türdür.

Günlük kuş aktivitesi sabahın erken saatlerinde en yüksektir ve günbatımından bir saat önce de aktivitede artış gözlenmiştir. Sonbahar 2002'de birçok göç dalgası elde edilmiştir. Bu dalgaların Cernek istasyonundakilerle benzerlik göstermesi iki istasyonu da konaklama alanı olarak tercih eden populasyonlar arasında bir ilişki olabileceğine işaret etmektedir. Birçok türde 10 gün içinde % 50'ye varan ağırlık artışı gözlendiğinden en azından Yalıncak'ın ötücü kuşların yağ depolamak için kullandığı nitelikli bir konaklama noktası olduğu anlaşılmıştır.

Türkiye'de ötücü göçünün ilk kez belgelendiği bu çalışma ile, elverişsiz yaşam alanlarıyla çevrili küçük ağaçlıkların birçok tür için çok önemli bir konaklama alanı olduğu ortaya çıkmıştır.

Anahtar kelimeler: Ötücüler, göç, halkalama, fenoloji, tür kompozisyonu, yağ depolama, ODTÜ

To my mom and dad

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INTRODUCTION

1.1. Migration as a phenomenon

Migration can basically be described as a regular seasonal movement between breeding and wintering areas, and it is a common and taxonomically widespread phenomenon in nature. Seasonal long-distance migration can be seen in many arthropod species; for example, marine crustacea may migrate for several hundred kilometres on the bottom of the sea, while the American Monarch Butterfly (*Danaus plexippus*) migrates up to 4000 km between Canada and Mexico. In vertebrates, seasonal long-distance migration is pronounced in all taxa – among fish such as salmon covering thousands of kilometres between rivers and sea, among amphibians such as toads covering several kilometres to and from their spawning grounds, among reptiles such as Green Turtles (*Chelonia mydas*) which cover around 2000 km to reach specific coasts of remote islands to lay its eggs, among marine mammals such as whales and seals carrying out continent-wide migrations, and among terrestrial mammals such as reindeer covering huge distances annually (Berthold 1993).

As for birds, diversity and complexity of migration patterns are much more pronounced than all other taxa. It is estimated that every autumn 5 billion of land birds of 187 species migrate from Europe and Asia to Africa, leaving seasonally inhospitable areas (Moreau 1972). Bird migration routes cover almost the whole earth's surface; they migrate over all oceans, deserts, mountain ranges and ice fields (Berthold 1993, Gill 1994).

1.1.1. Why do birds migrate?

Why some bird species migrate while others are resident is still one of the most difficult questions in ornithology. There are even differences among the populations of the same species, Blackcap (*Sylvia atricapilla*) being one of the extreme examples that the entire range from complete sedentariness to long distance migratoriness can be found (Shirihai *et al*. 2001).

Avian migration is affected by many environmental factors, mainly spatial and temporal variations in food availability, weather conditions, predator abundance and breeding opportunities, relative importance of which is different for any particular species (Alerstam 1990).

In order to understand the different patterns of bird migration, evolution of this fascinating phenomenon should be considered. Since 1960s different hypotheses about ecological factors important in the evolution of bird migration has been proposed. One of the hypotheses mainly stresses the importance of interspecific competition (Cox 1968) and argues that migration evolves if resident birds by moving from an area of high competition to an area of low competition, experience increased survival or reproductive output, when discounting the migration costs. On the other hand, Haartman (1968) suggested that competition for limited nesting opportunities, such as nest holes, is the main ecological factor selecting for residency in a seasonal environment since prior occupancy should give an advantage in relation to late arrivals. This idea is supported by the fact that there are much more migrant species which are open-nesters than hole nesters. In another hypothesis, unpredictability of habitat is thought to be the main factor responsible for the evolution of migration (Alerstam and Enckell 1979). Seasonal fluctuations and an unstable environment with irregular variations in food supply decrease or even cease the advantages of uninterrupted site fidelity. That is why most of the long distant migrants originate from savanna and steppe regions with strong seasonal changes between rainy season and dry season, and with great instability in the environment because of occasional droughts, fires and floods. On the other hand, there are very few migratory birds in the rainforests since the environment is stable and the advantages of site fidelity are very high (Alerstam and Hedenström 1998).

In another hypothesis, it is assumed that there is a latitudinal trade-off between reproductive success (increasing to the north) and non-breeding survival (decreasing to the north) and so optimal time allocation between breeding and survival habitats determine the pattern of migration (Greenberg 1980). Generally, birds wintering in tropical regions have a higher survival chance than the birds resident in temperate regions. On the other hand, residents of temperate regions have higher reproductive success than migrants. Fretwell (1980) proposed a seasonally asymmetric competition model in which non-breeding competition for food (or roosting sites) encourages birds to migrate south, while density-dependent nest predation in the southern areas favours return migration to the north. The combination of the two hypotheses mentioned before is proposed by Cox (1985) as time allocation and competition model in which a species evolves into a migratory species in three stages, namely partial migration, the division of a species into migratory and resident populations, and fully disjunct migration due to gradual elimination of resident populations by diffuse competition from other migratory species (Alerstam & Hedenström 1998, Alerstam 1990, Gill 1994).

It is thought that bird migration probably evolved independently several times over in different taxa and in different places (Farner 1955). It is also known that migratory behaviour can be acquired, lost and altered even in modern times as continual changes in the environment, mainly due to human influence, require new adaptations from contemporary migratory species. For example, the European Serin (*Serinus serinus*) has spread throughout Europe from Mediterranean in the last 100 years and while the ancestral Mediterranean populations are resident the new northern populations are migratory (Mayr 1926). As another example, over the last twenty years Blackcaps formerly migrating towards south-west Europe from breeding sites in Central Europe have changed their migratory behaviour and started wintering in Britain (Berthold 1993, Alerstam 1990, Sutherland 1998, Gill 1994).

1.1.2. Preparation for Migration

A lot of physiological and behavioural adjustments are required for a successful migration. However, birds already have a number of morphological adaptations. Generally migrants have longer and pointed wings. This difference can be observed even between the southern and northern populations of the same species. Migrants have also large flight (pectoral) muscles, making up to 35% of body mass in pronounced migrants (Butler and Woakes 1990). Besides these, birds, especially migrants, have a highly interesting adaptation in the fine structure of their haemoglobin called haemoglobin polymorphism. Having this feature, migrants are well adapted to sudden changes of altitude, as they possess two types of haemoglobin, which differ in their combinations of amino acids and therefore in their oxygen carrying and releasing capacities (Berthold 1993).

The complex behavioural and physiological condition which usually characterizes a migrant that is ready for departure is called migratory disposition. Before the actual migration period sets in, birds suddenly and spontaneously start to ingest considerably larger amount of food and this situation is called hyperphagia (eating to excess). The storage of extensive fat reserves is the main characteristic of migratory disposition and the end result of hyperphagia. Since fat is optimal flight fuel, birds and also many other migratory animals store excess amounts of fat before migration. Fat yields twice more energy than an equal amount of carbohydrate and protein. In addition, it can be stored dry without addition of water, and during its oxidation the use of glucose and muscle protein is economical. Kuroda (1964) showed that enlargement of digestive tract is also observed in thrushes during hyperphagia (Berthold 1993, Gill 1994).

It is known that, resident passerines have fat loads of only 3-5% of their lean body mass. On the other hand, short or medium distance passerine migrants have fat loads of 10-25% and long-distance passerine migrants regularly have fat loads in the range of 30-50% of live body mass (or 60-100 % of fat free body mass) at departure (Berthold 1993).

The migrant's whole physiology is adjusted for fat metabolism. During migratory disposition, carbohydrate reserves are often greatly reduced and in a number of species a decrease in protein content has been also observed. In addition, a reduction in body water has been also seen. It is thought that during fat storage, the migrant reduces its wing load as much as possible with these adaptations in order to save energy. However, the increasing fat percentage still causes an increase in weight and air resistance during flight and both of these factors result in raising the bird's flight power. In order to compensate for the increased flight power demands, the birds also strengthen their flight muscles before migration. It is shown in a number of species that in addition to fluctuations in fat stores during long distance flights, muscles and belly organs also considerably change in size. This situation represents a type of phenotypic plasticity called "phenotypic flexibility" (Berthold 1993, Alerstam 1990, Piersma 1998).

Since the birds have to pay extra energy for the transport of fat stores, too high a fat percentage means poor transport economy. Migrating in short stages with low fat stores and regularly refuelling at suitable stopover places can solve this problem. For example, a migrant with 50% fat percentage consumes approximately 40% more total energy as a result of continuous flight till the fat reserves run out than a migrant which covers the same distance by building up 10% fat content and regularly refuelling at several stopover sites. However, this strategy cannot be used when migrants have to pass large ecological barriers like deserts or oceans. In addition, migrating in short stages have several disadvantages. It is difficult to find many suitable stopover sites on the route and at every new stopover site finding an unoccupied territory to replenish fat reserves takes time and is risky because of competition (Alerstam 1990). Supporting this, a study on New World Catharus thrushes revealed that songbirds spend double the amount of energy during stopovers that they spend on flight during the whole migration period (Wikelski *et al.* 2003)

Migrants have also developed special adaptations with respect to food choice. The most obvious one of these adaptations is widespread switching to fruits and berries in species mainly feeding on invertebrates at other times. This adaptation has an ecological and physiological basis. In the period of migratory disposition when the migrants need to increase energy intake for fat storage insect supplies are known to decrease. As a result, during this critical period fruits and berries are very good food sources since large quantities are often easily accessible; they contain carbohydrates favouring lipogenesis and they are easily digestible (Berthold 1993).

1.1.3. Timing of Migration

One of the most impressive features of migration is the precise arrival and departure dates in some species. For example, it is observed that many pelagic sea birds such as terns, boobies and shearwaters arrive at their breeding islands approximately the same week every year. It was suspected by von Pernau (1702) that especially for species leaving the breeding grounds very early (for example while it is still summer) and individually, endogenous factors play an essential role in the initiation of migration. It was discovered by Gwinner (1967) that Willow Warbler (*Phylloscopus trochilus*) is equipped with endogenous annual cycles, so called "circannual rhythms", controlling the development of migratory restlessness (*zugunruhe*) along with many other aspects of annual cycle. Migratory restlessness which is especially obvious in nocturnal migrants is interpreted as an indication of migratory urge. There is a strong positive correlation between the duration of *zugunruhe* and the length of migratory period and the migration distance (Berthold *et al*. 1990c, Berthold 1993, Gill 1994, Welty and Baptista 1988)..

It is known that increasing day length in winter stimulates early spring restlessness, hyperphagia and fat deposition in many migratory birds. Rowan (1925) had suggested that at least return migration to the breeding grounds is triggered by the gonads, i.e. by sexual hormones. However, it was shown by Putzig (1938) and others that sex hormones do not directly regulate migration since castration did not prevent migratory restlessness in a number of species. The autumn migration towards wintering grounds is indirectly set by spring activities such as breeding time and moulting (Welty and Baptista 1988, Berthold 1993, Gill 1994).

It is thought that once a bird is internally prepared for migration, the beginning of the migratory journey may be triggered by various external stimuli among which weather plays the major role. For many species weather conditions may determine whether the birds will begin their migrations or not. It is found that local weather conditions and existence of tail winds is very important for the initiation and maintenance of migration. But once under way, birds are deterred from migration only by extremely adverse weather. It is generally accepted that in the north temperate zone, migration is intimately related to the eastward advancing high and low barometric pressure centres. Studies by radar also have shown that especially winds are the most important influence in determining the time and direction of migration. As a result of a six year-long radar study it was shown by Hilgerloh (1981) that the heaviest diurnal autumn migration of birds were observed in high pressure zones with tail winds or weak head winds in Switzerland. In addition, a study on Reed Warblers (*Acrocephalus scirpaceus*), at Falsterbo (southwest Sweden) during autumn migration, showed that birds chose to depart on nights with tailwinds and when air pressure was increasing which suggested that Reed Warbles are sensitive to winds and air pressure and select favourable wind conditions for their migratory flights. In another study on Reed Warblers carried out during spring migration at one of the stopover sites in the western Mediterranean, it also appeared that wind direction is a determining factor for stopover decisions and resumption of flight (Welty and Baptista 1988, Elkins 1988, Ǻkesson *et al*. 2002, Barriocanal *et al*. 2002).

Variations in timing and distance of migration can be observed between different populations of the same species or even between age and sex classes of the same species. This phenomenon is called differential migration. Generally males migrate north earlier than females and try to occupy the best territories before females arrive. In many short and medium distance migrants adults generally migrate shorter distances than juveniles and males shorter than females. This separation of sex and age classes at resting grounds may reduce intraspecific competition. In addition, shorter return distance for adults, especially for males, increase the chance of a successful return since wintering rather north make them adapted in adverse weather conditions which can create problems for migrants in spring migration (Berthold 1993, Welty and Baptista 1988).

Migrants should fly at times and at heights where travel is least costly, safest and most rapid. Four basic categories of bird migration with respect to daily rhythm can be classified. The first group has flexible migration times and migrate by day as well as by night, examples for which are ducks, swans, geese, waders and gulls. The second group is soaring and gliding birds which migrate in the middle of the day since they depend on the rising thermals over land. In this group are large winged birds like storks, raptors, and cranes. The third group is principally diurnal migrants but do not migrate by soaring and gliding such as finches, buntings, wagtails, swallows, bee-eaters and starlings. The last group includes primarily nocturnal migrants such as warblers, flycatchers, chats and thrushes. However, members of this group can also fly both day and night during long, non-stop flights while passing over ecological barriers. There are 5 main advantages of migrating nocturnally for these normally diurnal birds. The first advantage is reduced pressure from predators since most birds of prey migrate during day. The second one is gaining time by migrating during night and foraging during day. The other advantage is saving energy since it is less energy consuming to fly in cooler, denser air with lower wind speed, lower range of variable wind directions and less common vertical turbulences. The fourth advantage is increased physical security since the risk of hyperthermia and dehydration is reduced at lower ambient temperatures at night. Finally the use of the star compass is thought to be another advantage of nocturnal migration. (Alerstam 1990, Berthold 1993, Gill 1994).

Long distance migration in passerine birds is composed of flight phases, which are only one night of flying or several consecutive nights, usually landings during the day for resting periods of a few to many hours, and of stopover phases which last one to three weeks. Actually, the total duration of migration is primarily determined by the length of the stopover phase as shown by Fransson (1995) and also by Hedenström and Alerstam (1997) that during the whole migration period in spring or autumn the ratio of time spent in flight to stopover is about 1:7 in several warbler species (Biebach 1998).

1.1.4. Migration Strategies

Most of the migratory species – for at least part of their journey – migrate on a broad front which means that individuals originating from geographically dispersed breeding areas cross all the geomorphological features along their routes, such as lowlands, mountains, rivers without deviating much from the orientation of their initial tracks. However, this pattern does not develop as a result of the individuals of different populations migrating randomly all over the area, but different populations moving parallel to each other (Berthold 1993).

Many migrants on the other hand migrate between breeding and wintering grounds as if on small corridors or migratory pathways without the direct effect of a leading line which is called “small front migration”. “Funnel shaped migration” is a special pattern of small front migration in which converging migratory routes are often funnelled in certain areas. For example, there are two funnels for White Stork migration one of which is at Gibraltar and the other one is at Bosphorus (Berthold 1993).

In some species it is observed that northern populations migrate over more southerly ones and reach to the southernmost winter grounds. This can occur as when resident populations are passed by migrating ones, when those leaving later or migrating slowly are passed by migrants or are overtaken on the way. This type of a migration is called “leap-frog migration” and it is quite a common phenomenon. It is thought to be functioning to reduce intraspecific competition by separating wintering grounds (Alerstam 1990, Berthold 1993).

Many migrants do not use the same migratory routes for outward and return migrations. These birds migrate on a kind of circular route when returning to their breeding grounds, which is a pattern called “loop migration”. Migration pattern of Red-backed Shrikes (*Lanius collurio*) is a typical example for loop migration. In autumn, whole populations in Europe (even the most western ones in Iberian Peninsula) migrates over the eastern Mediterranean and northeast Africa to reach winter grounds in Central and Southern Africa. During return migration, the birds first predominantly migrate to the further east, across the Arabian Peninsula, and then migrate to the north. Migration strategy of Red-backed Shrike is also an example of “historically based detour”. It is assumed that this species colonized Central and Western Europe from eastern refuges after the ice ages and recent populations still follow the traditional and historic immigration routes during their outward migration (Berthold 1993).

Reverse migration is also a common phenomenon in migration. It is generally observed that if birds are hit by adverse weather conditions during return migration or at their breeding grounds upon arrival they fly back for some distance in the direction of wintering grounds. It is also observed in coastal places where land birds meet with a sea crossing. Reverse migrations are observed regularly during outward migration as well but it is more difficult to explain. As a result of a radar study in Israel, it was suggested that apart from adverse weather conditions or ecological barriers, reverse migration might originate from the inaccuracy in the orientation of the individual birds, search for appropriate stop over sites or the bird’s actual physiological condition (Berthold 1993, Alerstam 1990, Komenda-Zehnder *et al*. 2002).

Theoretically, migrants are capable of arranging their movements as fast as possible, or to be cautious as regards of energy or the risk of predators. Alerstam and Lindström (1990) develop 3 basic hypothesis derived from the model of optimal migration as time-minimization, energy minimization and predation risk minimization. According to time-minimization hypothesis, birds should be sensitive to the rate of fuel deposition in order to minimize time (=maximize migration speed) and they should leave a stop-over site for further migration with maximum fuel loads. According to energy minimization hypothesis, birds should travel with as low extra weight as possible in order to minimize cost of transport. As for the predation risk minimization hypothesis, birds should adjust their decisions to stay at or leave a stopover site with respect to predator–load of a particular site. To militate against mortality risks birds should be inclined to depart with smaller fuel reserves than is optimal in time selected migrants.

1.1.5. Orientation and Navigation

One of the biggest questions in bird migration research is how the birds find their way. For birds, proper orientation is not only important during migration but all kind of movements such as daily foraging. It is known that birds have diverse navigational tools that increase in sophistication with experience (Gill 1994).

Two main categories can be differentiated in terms of orientation performances: The first one is orientational migration (compass orientation) in which birds have an innate directional instinct which leads them the right way between breeding and wintering grounds. The second is navigational migration (goal orientation) in which birds can determine their position in relation to the migration goal towards which they navigate all the time. It is mostly probable that birds use these two in combination, as they mostly migrate by orientational navigation and then switch to navigational migration when approaching their final destination which is a familiar place (Alerstam 1990).

Two main hypotheses, namely the clock and compass hypothesis and the goal-area navigation model have been suggested to explain how first year migrants -especially the ones migrating individually- find their migration route. In the first hypothesis, it is thought there are pre-programmed phases of the first autumn migration in which the bird migrates for a fixed length of time by using an internal time sense and an inherited direction according to its different compass capabilities. When the migratory program ends the young should have arrived in the wintering grounds (Baker 1978, Rabøl 1978, Berthold 1991). However, this hypothesis can not explain the long distance migrants which experience repeated wind drift on the way and so may not reach the expected wintering grounds. The second hypothesis, suggests that a complete program of ancestral migration route is inherited and in the first year birds may have an innate map based on geomagnetic and/or celestial cues and use coordinate navigation to reach the wintering area (Rabøl 1978, 1985) (Ǻkesson *et al*. 1995).

Migrants mainly use three compass systems: The solar compass depending on the changing position of the sun during the day, the stellar compass focusing on the constellations close to the North Star, which is the fixed axis of rotation of the night sky, and the magnetic compass. Magnetic compass is especially important when celestial cues are not visible when it is cloudy. A relationship was found between magnetic and stellar compasses that during migration the stellar compass is calibrated by information derived from the magnetic compass. It is also shown that visual memory is also very important in orientation especially for short distance movements and local orientation. In addition to these, it is thought that some species possibly use the moon, polarized light, wind direction, infra-sound and olfactory cues for orientation (Berthold and Terrill 1991, Berthold 1993, Gill 1994).

1.1.6 Genetic Basis of Bird Migration

It is generally accepted that bird migration is, at least in part, determined genetically (Berthold 1993). For example, it is shown with Blackcaps that the urge to migrate can be transmitted from a migratory population to a non-migratory one within the F1 generation. In addition, F1 generation hybrids of different populations having varying migration distances and showing varying amount of *zugunruhe* were phenotypically intermediate in behaviour. Therefore, at least for Blackcaps, endogenous programmes of the migration are innate, inherited and population-specific properties (Berthold 1988a)

An inherited migration programme is especially advantageous for small birds, life spans of which are on average only two years. Inherited programmes and selection processes allow for a continuous integration of all essential environmental influences, which result in optimally adapted migration plans for migrating species. Mainly exogenously controlled migration would be very risky for a short-lived small passerine species since there is little time to collect and make use of immediate experiences (Berthold 1993).

In general, migratory activity and orientation performance are probably population specific, quantitative genetic traits that can rapidly be transmitted even to the descendants of non-migratory individuals. Obligate partial migratory behaviour is also inherited, and has great genetic variability and a very high potential evolutioary speed (Berthold 1993).

1.2. Migration studies

Seasonal appearances and disappearances of birds have attracted many early naturalists including Aristotle. He believed that some birds hibernate, changed to other species (transmutation theory: Mead 1983) or even migrate to the moon (Nachtigall 1987, Berthold 1993).

It was in the XIX. century that intensive studies of bird migration began. Two main periods can be differentiated in bird migration research as the period of observation (1825-1925) and the period of experimental studies introduced by Rowan in 1925 (Farner 1955, Berthold 1993).

1.2.1. Ringing

By the turn of the 20th century, bird-ringing experiments were launched. After being tried by Danish H. D. Mortensen on Starlings in 1899 ringing became one of the most common research methods for bird migration studies (Bairlein 2001).

Scientific bird ringing is based on the individual marking of birds. Any record of a ringed bird, either as a control at any other place or as dead, gives a lot of information about its life, particularly its movements, migratory routes, staging areas and also population parameters such as survival estimates and lifetime reproductive success (Wassenaar 2003).

It is not necessary to wait for mainly accidental recoveries to obtain information from ringing studies. Huge amount of data can be collected when birds are caught, like the age and sex of the bird, a variety of measurements (or biometrics) such as wing and tail length, the amount of fat stored by migratory species, the state of feather moult as well as the habitat preferences. Information about body mass and visible fat reserves at successive stopover sites are of great importance for the study of migration strategies and identification of the important fuelling sites. For many bird species, different breeding populations have different migration routes and wintering grounds. For only a few species there are enough ringing recoveries to identify these patterns. On the other hand, it is possible to use morphological data such as the size and shape of the wing, the length of the tarsus or the bill and plumage coloration, to indicate the origin of the individual (Wassenaar 2003).

However, the disadvantage of this method is that at many stations birds that have landed after their night migration are caught, not the ones actively migrating. This creates some complications for the interpretation of data. For example, a huge number of birds can be caught in poor weather conditions because the birds have broken off their migration and landed. Locally unfavourable conditions for migration are generally the main causes of large morning catches especially on exposed headlands and small islands. In good weather conditions nocturnal migrants keep on migration till they can find the best stopover place inland. Disproportionately large percentage of juvenile catches also proves that morning catches at coastal stations do not reflect the night time passage. Probably more experienced adults chose best stopover sites inland and avoid migration in uncertain weather conditions when they risk being forced to land on exposed headlands and islands (Alerstam 1990).

Bird ringing has been also an invaluable technique for monitoring of bird populations as shown by many studies. For example, the Operation Baltic bird migration study programme was established in 1961 at the southern Baltic coast of Poland. Since a standardized methodology at a network of catching stations was used from the very beginning of the programme, a huge amount of data has been gathered on the timing and scale of autumn migration, and long-term changes in annual catch totals have been used to monitor population changes (Busse 1994). The Mettnau-Reit-Illmitz (MRI) Programme (since 1974) is a long term bird trapping program, in which 37 small bird species were trapped at three central European stations using standardized mistnetting to monitor migrating songbirds during the period of June to November. The netting effort is strictly standardized and the habitat is not allowed to change, so changes in the numbers of birds trapped should reflect changes in the numbers of migrating birds (Berthold *et al.* 1991). Constant Effort Sites (CES) is another such standardized effort to understand long-term trends in abundances and survival (Wassenaar 2003).

1.2.2. Other methods

Visual observation is the most basic method in studying bird migration especially for diurnal migrants. It is a very practical method which requires only an observer with a pair of binoculars. If carried out daily throughout the migration seasons systematically and for several years, it is possible to obtain a lot of information on diurnal and seasonal migration patterns, temporal distribution and density of passage migrants at certain days and/or over the migration season, as well as relationship with weather conditions. This method is mostly applied at bottlenecks like Bosphorus, at guiding lines as mountain ridges, coastlines where visible bird migration is more pronounced since birds tend to be funnelled by weather or topography at such places. The biggest disadvantage of this method is being limited in distance and dependent strongly on light and weather conditions. It is also not possible to study nocturnal migration by this method, although most of the birds, especially small-long distance migrants, migrate at night (Berthold 1993, Bruderer 1997).

Moonwatching, which was introduced by Lowery in 1951, is another method in bird migration research. In this method nocturnal migrants are observed through a telescope as their silhouettes pass across the moon's disc. It is possible to have a continent wide view of relative densities and directions of migration with a network of moonwatchers. On the other hand, this method is restricted to nights around full moon with clear sky and an observer can survey a small space. In addition there are problems with the assumption of even distribution of birds up to an altitude of 1500 m., uncertainty in determining the direction of birds and difficulties in calibration (Alerstam 1990, Bruderer 1997).

As many species have specific calls during migration, acoustic registration is another method in migration research. However, this method is restricted to birds close to the ground and many birds call only when disturbed or not at all (Berthold 1993, Bruderer 1997).

Small transmitters based on electromagnetic impulses are often used for bird migration research. Tracking of migrants, which are fitted with radio transmitters, by car or aeroplane during part of their migration has been tried many times, especially in the USA. In addition, the behaviour of partial migrants, behaviour at communal roosts, and the dispersal of juveniles have also been monitored for a number of species (Kenward 1987). The transmitters are now minimized to such an extent that they can be even fastened on small songbirds. There is also the new method called satellite tracking which uses satellites to receive the signals permanently from birds fitted with transmitters but weight limitations constrain researchers (Berthold 1993, Alerstam 1990).

Since watery tissues and blood in the birds' bodies reflect radio waves, radar has been a very important tool in migration studies since the sixties. Systematic "radar ornithology" developed first in the USA, England and Switzerland (Eastwood 1967). It is possible to study bird migration with radar under various environmental conditions. It covers wide distances, is independent of light and reasonably independent of weather. It can provide detailed information about migration density, altitude of migration, migratory directions, and speed of migration and wing-beat pattern of birds. There are two types of radars used in migration research, which are surveillance radar and tracking radar. It is possible to map the bird's movements over wide areas, sometimes as far as 100 km. or even more from the radar station with surveillance radar. On the other hand, tracking radar tracks individual birds or bird flocks and provides continuous and exact information on position, altitude, flight direction and flight speed in both vertical and horizontal planes. The biggest problem with this method is species identification. It is only possible to roughly classify according to body size and group of birds mainly as passerines, waders or waterfowl (Williams &Williams 1990), so even very exact and complete set of data cannot be analyzed at species level. On the other hand, Alerstam states that "Different species have different characteristic "echo signatures"! It is still a very valuable method in solving the questions of how migrants cross ecological barriers such as deserts, seas and high mountains (Bruderer and Jenni 1990, Bairlein 1985a, Bruderer 1997, Berthold 1993, Alerstam 1990).

The use of stable isotopes offers alternative approaches in migration research which relies on the fact that food web isotopic signatures are reflected in the tissues of organisms and such signatures can differ spatially based on a variety of biogeochemical processes. Organisms can carry information on the location of previous feeding while moving between isotopically distinct food webs. There are some studies showing that stable hydrogen isotope ratios in the tissues of animals often correlate with that of local precipitation. For birds, the isotopic composition of feathers reflects diet only during the period of growth. In a study with neotropical migrant songbirds, it is shown that the hydrogen isotope ratio values for the feathers are largely correlated with that of growing season precipitation at the breeding site, since many species of migrant songbirds grow feathers on or close to the breeding grounds before migration. Therefore this knowledge can be used to link breeding and wintering grounds (Hobson & Wassenaar 1997, Hobson 1999).

Additionally, there are laboratory research programmes including physiology, endocrinology and genetics of bird migration (Berthold 1993).

1.2.3. Orientation studies

Three methods are generally used to study orientation performance of migrants. They are observation of birds in the wild, experiments on free living birds, and experiments on migratory birds in circular orientation cages. In the wild, by ringing and recapturing of migrants it is possible to measure the extent of bird’s site fidelity to breeding, wintering and stopover sites and understand the precision of their orientation. Visual observations and especially radar is also a very valuable method to provide information on directionality of migrants in natural conditions (Berthold 1993).

Among experiments on free living birds, displacement studies provide important evidence. Especially adults are displaced from breeding grounds while still having young in the nest, domestic pigeons from their lofts and migrating birds from their migration route and then their homing rate is measured (Berthold 1993).

Since firstly shown by Kramer (1949) that caged birds show migratory activity in preferred, specific directions, evaluation of migratory restlessness in orientation cages became a standard method in orientation studies. Many cages have been developed from the one with some perches inside where birds hopping were evaluated by means of electric counters (Kramer 1949, Sauer, 1957) or counting of scratches on typewriter correction paper in Emlen's funnel cage (Emlen and Emlen, 1966), to counting dots made by the beak on transparent plastic foil in Busse's flat cage (Busse 1995). Automatic registration was also achieved by circular cages having perches fitted with microswitches. Experiments with the Busse cage can be performed in ordinary field conditions since it is a very simple technique and allows to collect huge amount of data as experiments can be carried out both in the night and day (Busse 1995, Busse and Trocińska 1999, Berthold 1993).

1.3. Bird migration in Turkey

Turkey is a thermal pathway for soaring bird migration between Europe, Asia and Africa. There are 3 important bottlenecks for soaring bird migration in Turkey as Bosphorus, Arhavi/Borçka and the Belen Pass (Bijlsma 1987, Bilgin and Akçakaya 1987). The importance of these bottlenecks has been shown by many studies such as Porter and Willis (1968), Sutherland and Brooks (1981) and references cited in Can (2001). The only systematic bird migration study in Turkey, that covers both spring and autumn, has been carried out by Can (2001) on soaring bird migration at the Belen Pass and Hatay province.

However since 2002, till the start of National Ringing Scheme, there haven't been any systematic studies carried out on passerine migration over Turkey. During the 20th century more than 17,000 birds of 166 bird species have been ringed in Turkey and more than 750 birds, ringed in 43 different foreign countries, have been reported from Turkey during episodic ringing expeditions conducted by visiting foreign ringers which shows the importance of Turkey for bird migration. (Tavares 2002). In March 2002, Turkish Bird Research Society (KAD) in collaboration with General Directorate of National Parks and Wildlife (Ministry of Forestry) and METU Biology Department launched the National Ringing Scheme. In spring 2002, 15,487 birds of 107 species, and in autumn 2002, 12,340 birds of 99 species were ringed at 4 stations, namely METU (this study), Kuşcenneti (Bandırma, Balıkesir), Cernek (Kızılırmak Delta, Samsun) and Titreyengöl (Manavgat, Antalya). In addition, 26 birds from 13 countries were recovered in Turkey while 8 birds ringed in Turkey were reported from 4 countries (Keşaplı Can and Keşaplı Didrickson 2003).

It is shown by Busse (2001) that in particular knowledge about birds that migrate by eastern flyway, where Turkey is also located, is lacking. It is stated that Central and Eastern Europe is larger and richer in passerine populations than the rest of Europe and actually more European passerines migrate over south-eastern flyway than south-western flyway. It is impossible to understand passerine migration system over Europe without detailed research on bird migration through the south-eastern flyway.

1.4. Aims and scope of the study

This is the first systematic study on passerine migration in Turkey covering both spring and autumn seasons being completely continuous in one season.

The aims of this study are;

- To find out the daily and seasonal migration patterns (phenologies) of passerines at METU.
- To find out the importance of METU for migrating passerines.
- To compare the migration patterns with those at Manyas Kuşcenneti station (Balıkesir) and Cernek station (Samsun).

CHAPTER 2

MATERIAL AND METHODS

2.1. Study Area

The study was carried out in METU campus field, Ankara (north-western part of Central Anatolia). The METU campus field is mainly dominated by steppe vegetation and has also afforested sites.

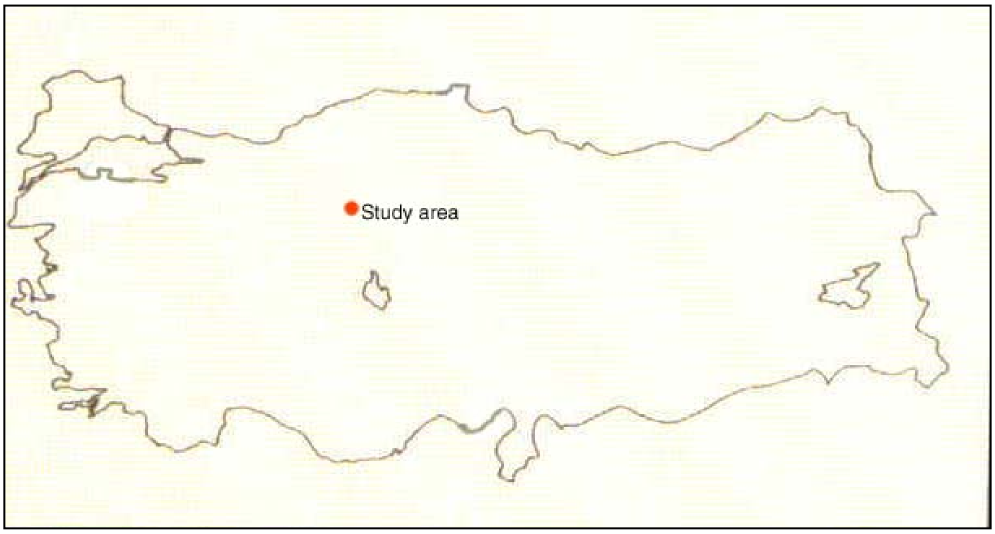

Figure 2.1. Study area on the map of Turkey.

In order to cover different habitats, the study was carried out at 5 different substations within the campus field, namely Yalıncak, Eymir, Fidanlık, Ölüm Vadisi and Sosyal Bina.

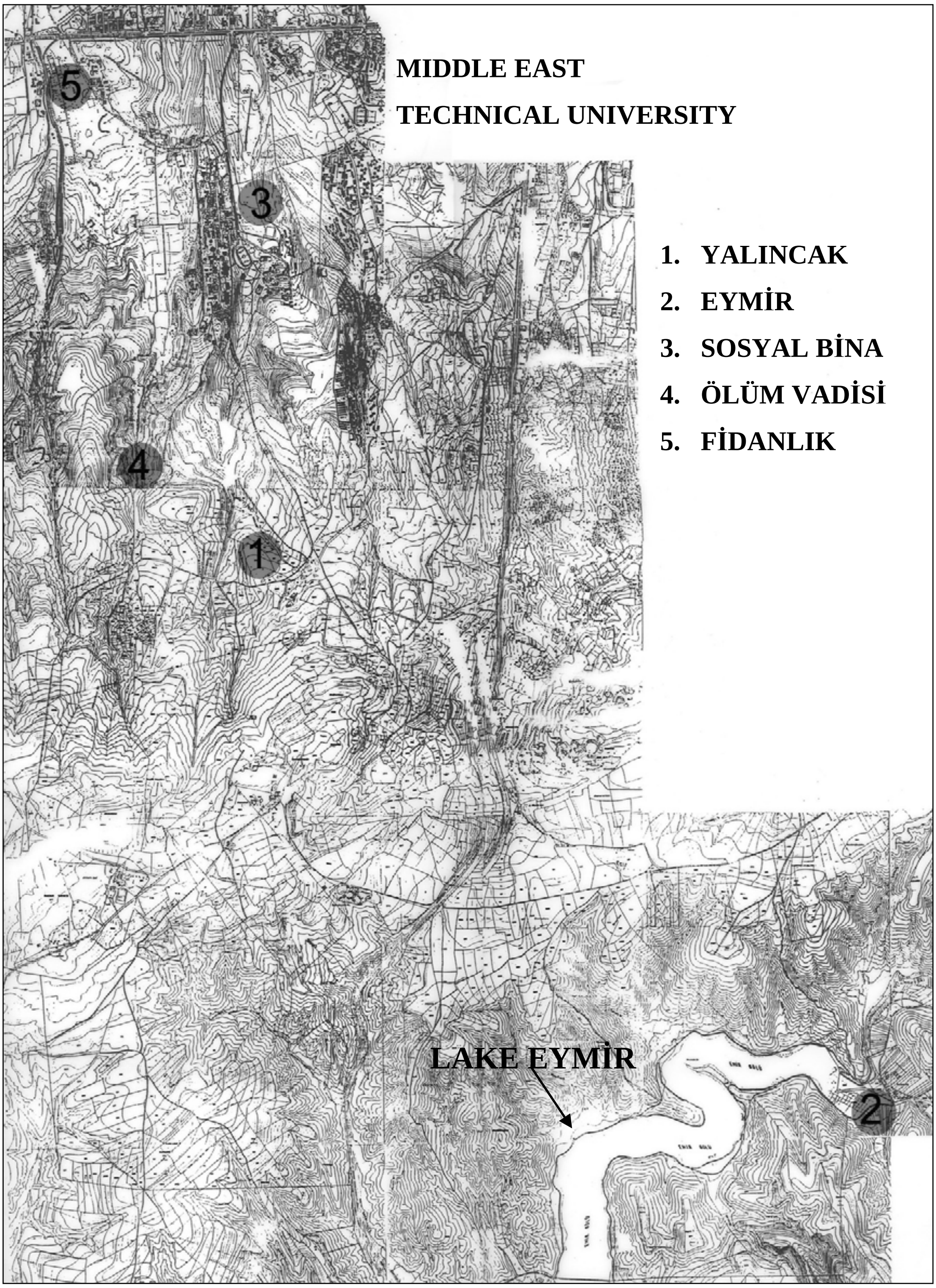

Figure 2.2. All substations on topographic map of METU (scale: 1/80,000)

The habitat of Yalıncak (39º 52.1' N 32º 47.4' E, alt. 1,063 m) which is an old nursery can be described as a willow grove surrounded by shrubland and open land. In the middle of the study site there is a small stream along which there are tall willow (*Salix spp.*) and Black Poplar (*Populus nigra*) trees. Under the trees it is covered by dense shrubs mainly Rosehip (*Rosa canina*) and herbs. At the two sides of the stream, there is open land covered by herbs like Dock (*Rumex patientia*), *Graminea spp*., scattered Rosehip shrubs, Wild Pear (*Pyrus eleagrifolia*) and Common Hawthorn (*Crataegus monogyna*) trees shorter than 6 m. Besides the open land there is a grove formed by Wild Almond (*Prunus dulcis*) and Common Hawthorn trees shorter than 6m.

Figure 2.3. Yalıncak substation (red circle shows the study area)

The second substation, is located in a nursery at the north edge of lake Eymir (39º 49.6' N 32º 50.6' E, 975 m.) which is relatively large (125 ha), shallow (max. 6 m, av. 3.1 m deep), eutrophic lake. The habitat in the nursery is more or less uniform with tall poplar and willow trees, and shrubs and herbs under them. A stream which is the only outflow of Lake Eymir runs through it. One side of the nursery has border with a large reedbed.

Figure 2.4. Eymir substation (red circle shows the study area)

The third substation, Fidanlık (39° 54.1' N 32° 46.1' E, 870 m.), is also a nursery with a variety of medium to tall trees, shrubs, bushes and some small openings. The nursery is covered by a reedbed at one side and open land with shrubs, herbs and scattered reedbeds on the other sides.

The third substation, Ölüm Vadisi (39° 52.4' N 32° 46.5' E, 972 m.), was a valley through which a small seasonal stream runs through and along the stream there were a couple of tall Poplar trees and Rosehip shrubs. The slopes of the valley on each side and the open field at the mouth of it were covered either by planted mature pines (*Pinus spp*.) or by spiny cushion plants such as *Astragalus spp*., various grasses and scattered Wild Almond & Common Hawthorn shrubs.

The fifth substation, Sosyal Bina (39° 53.7' N 32° 47.1' E, 905 m.), is similar to Yalıncak (although at a lower altitude) as there is a small stream running in the middle and along the stream there are tall willow, poplar and sycamore (*Platanus orientalis*) trees, shrubs and additionally some reeds. One side of the stream is a Black Pine (*Pinus nigra*) forest and the other site is open field covered by grasses and scattered short pine trees.

Figure 2.5. Sosyal Bina substation

2.2 Studied species

In this study passerines (Passeriformes) which are common and regular during spring and autumn migration at METU are studied.

Additionally, several predominantly non migratory passerine species such as Great Tit (*Parus major*), House Sparrow (*Passer domesticus*) as well as some non-passerine species such as Wryneck (*Jynx torquilla*), Syrian Woodpecker (*Dendrocopos syriacus*) were also caught & ringed but not analyzed here (see Appendix A).

2.2.1 Passeriformes

The perching birds, known as passerines, form the largest order of class Aves with approximately 5700 species of 1161 genera (Sibley and Monroe 1990). This order includes a diverse group of tiny to fairly large land birds of many adaptive types, mainly arboreal but also terrestrial and aerial. The main characteristics of passerines are a syrinx, which is a resonating chamber at the lower end of trachea, and perching feet with an enlarged flexible hind toe called hallux. Their metabolism is higher than that of other birds of comparable size and they have relatively larger brains and superior learning abilities, especially with respect to vocalizations. They are also known as songbirds (Gill, 1994, Snow and Perrins,1998).

2.2.2 Blackcap (*Sylvia atricapilla*)

Blackcap is a highly arboreal species that breeds in shady woodland with dense shrubby undergrowth, and also in parks and gardens. It has a wide variety of migration strategies with populations from different parts of range varying from resident to migratory. In the northern and eastern regions it is wholly migratory while in the southern regions it is partially migratory, with most of the birds north of the Mediterranean region leaving breeding area. It is a leap front migrant (see section 1.1.4). It winters within and south of its breeding range, south to sub-Saharan Africa and north to Britain and south-west Norway. It is a summer visitor in Turkey and also winters in the Aegean and Mediterranean coasts (Mullarney *et al.* 1999, Snow and Perrins 1998).

2.2.3 Willow Warbler (*Phylloscopus trochilus*)

Willow Warbler breeds in the upland birch and willow zone, in all types of woodland and in copses and wooded parks and gardens. All populations are migratory, wintering extensively in sub-Saharan Africa from southern Senegal east to Ethiopia, south to South Africa. It is a passage migrant in Turkey, where no evidence of breeding exists (Mullarney *et al.* 1999, Snow and Perrins1998, Kasparek and Bilgin 1996).

2.2.4 Chiffchaff (*Phylloscopus collybita*)

Chiffchaff breeds in woodland, normally open and with tall deciduous trees and a moderate shrub layer. It can also locally breed in conifer forest with some deciduous trees. Most populations are migratory except the ones in Canary Islands, where it is resident. Populations in western regions winter within and south of breeding areas, while eastern populations leave breeding areas entirely. It winters south to northern Afrotropics, Arabia, and northern India. In Turkey, it breeds especially in northern parts but also in the Aegean, central and eastern regions; it is also a winter visitor (Mullarney *et al.* 1999, Snow and Perrins 1998, Kasparek and Bilgin 1996).

2.2.5 Robin (*Erithacus rubecula*)

Robin breeds in woodland, gardens, parks, forest edge, generally with some dense vegetation and open areas. Most populations are partially migratory with males being more sedentary than females, totally migratory in the north-east of range, and probably largely sedentary in the extreme south. It winters south to Saharan oases and the Middle East. It is a resident species in northern parts of Turkey and a winter visitor in other regions (Snow and Perrins 1998).

Apart from these species, all long distance migrants ringed in this study winter in sub-Saharan Africa, except for Black-headed Bunting (*Emberiza melanocephala*) and Common Rosefinch (*Carpodacus erythrinus*) which winter in southern Asia.

2.3 Methods

This study was carried out during autumn 2001 and spring-autumn 2002. Totally 151 days of fieldwork were carried out. Previously, preliminary fieldwork was carried out on 15 and 29 May 2001 at Yalıncak.

Methodology was based on the capture and ringing of passerines at various substations in the campus field throughout the spring and autumn migration periods. The beginning and end of the study period were determined according to previous records in the study area and literature data. For catching birds, 6 m., 7 m. and 12 m. long. and 2 m high mist nets with 4 shelves specially produced for bird catching were used. 7 m. and 12 m. nets were made up of thick nylon thread but 6 m. long nets were made up of thinner nylon thread. All nets have 16 mm mesh size (knot to knot).

Daily total net length was 12-30 m. in autumn 2001 (in autumn 2001 only 6 m. long nets were used), 42-71 m. in spring 2002, and fixed as 123 m. in autumn 2002 except first 5 days during which it was 97 m.-109 m. Nets were placed among bushes, trees, borders of different habitats as perpendicular to the expected bird movement mainly as north-south direction along the guiding lines such as streams, valleys, stripes of bushes. Except for the first few days, net positions and net sizes were kept constant within the season and between the seasons but when it is possible nets were added to the new suitable spots in autumn 2001 and spring 2002.

In autumn 2001, 39 days of fieldwork were carried out between 8 August and 11 November at 4 different points; 21 days at Yalıncak, 9 days at Eymir, 5 days at Fidanlık, and 4 days at Ölüm Vadisi. In spring 2002, 39 days of fieldwork were carried out between 22 March and 26 May at 4 different points; 18 days at Yalıncak, 10 days at Eymir, 9 days at Sosyal Bina and 2 days at Ölüm Vadisi (see Appendix B for the distribution of field work during the study period).

In autumn 2001 and spring 2002 the study was not continuous throughout the period. On average, ringing was carried out 2.9 days a week (1-5 days per week) in autumn 2001, and 4.1 days a week (1- 6 days per week) in spring 2002. The only exception was between 4-12 October 2001 when no ringing was carried out. In addition, nets were open half day from sunrise (half an hour before to half an hour after sunrise) to midday (11:00-13:00). However, starting from end April 2002, nets were open the whole day on 27 and 30 April, 02, 10, 11, 15, 17 and 19 May, following SEEN methodology (Busse 2000).

In autumn 2002, fieldwork was carried out only at Yalıncak continuously (73 days totally) between 18 August and 29 October. Nets were open everyday for 24 hours except on 16.09, 29.09, 07.10, 15.10, and 25.10 on which nets were closed around midday because of strong wind or heavy rain. The day after such cases the nets were opened before sunrise.

The net controls were done every half an hour in autumn 2001 and till 27 April in spring 2002 and at the beginning of every full clock hour after 27 April in spring 2002 and in autumn 2002. The first control in the morning was done between 15 minutes to half an hour after sunrise and the last control was done when it got complete dark. During the controls every net was visited in an order as a loop and birds were removed from the nets gently and put in bird bags for transport. At the ringing table bird bags were hung by species on tree branches or hooks on the table. Afterwards they were taken form the bags one by one for the standard ringing procedure. Firstly, species and if possible subspecies identification was done with the help of guide books including “Identification Guide to European Passerines” (Svensson, 1992), Collins Pocket Guide Birds of Britain & Europe with North

Africa and the Middle East (Mullarney *et al.* 1999), “Songbirds of Turkey” (Roselaar, 1995), and “Non-Passerines Identification Guide” (Baker, 1993). Then each bird was fitted with an aluminium ring of 2 mm, 2.3mm, 2.5 mm, 2.8mm, 3.5mm, 4.2mm, 5.5mm, 7 mm diameter according to international standard lists of ring sizes for species. Rings were put on the bird’s left tarsus by specially made pliers. On each ring there was a unique serial number so it was possible to identify individuals when they were caught again in this study or somewhere else. In addition to the special code, the standard national address was also written on the rings as KAD PK 311 06443 TR on all rings and in autumn 2002 ODTÜ-KAD ANK-TURKEY address on 2.5 mm rings.

After ringing, age and sex determination was made with the help of the guide book “Identification Guide to European Passerines” (Svensson, 1992) and based on personal training by Prof. Przemyslaw Busse. In autumn 2002, for all individuals of every species, the wing formula (feather tips distances method), wing length (maximum chord), tail length (to the back method after Busse 1983, 1990) measurements were done except for individuals with moulting or very worn wing and tail feathers. For the measurement techniques “Bird Station Manual” (Busse, 2000) was used. A 30 cm. long ruler (1 mm precision) cut off at the zero was used for these measurements.

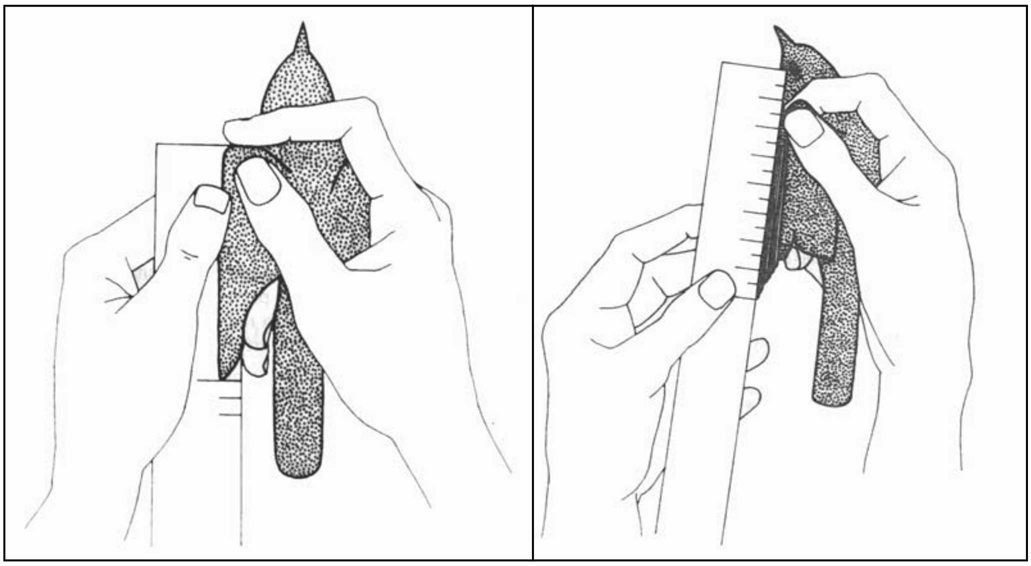

Figure 2.6 Wing length (left) and wing formula (right) measurements (Busse 2000)

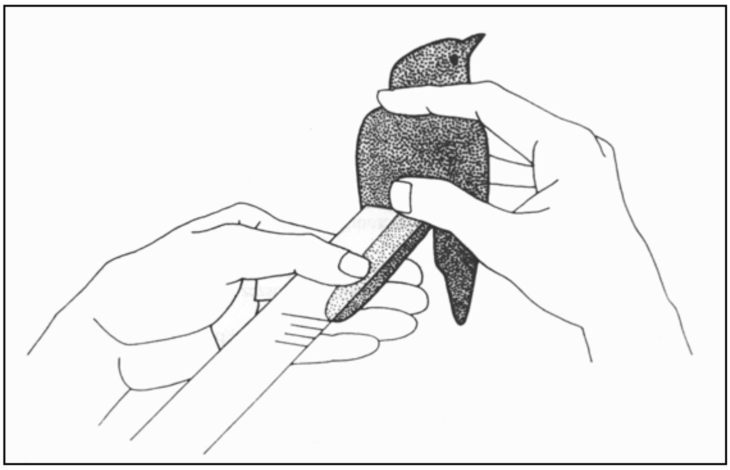

Figure 2.7 Tail measurement (Busse 2000).

For some species identification and age & sex determination, additional measurements like bill length to the feathering, bill length to the skull, bill depth, bill width, toe length, tarsus length were also taken by a calliper.

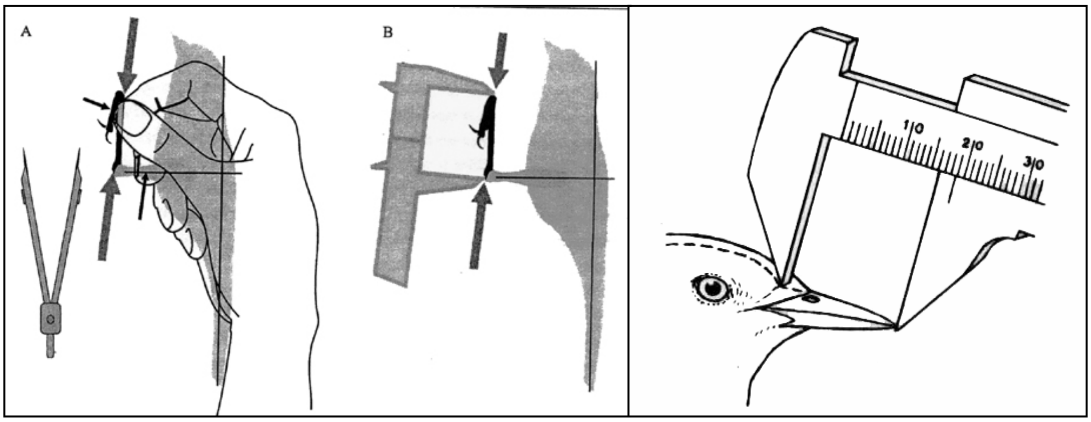

Figure 2.8 Tarsus (left) and bill length to the skull measurements (Busse 2000)

Then, fat score was estimated visually with the help of 3 level - belly, furculum and pectoral muscles- key system according to 9 (0-8) graded scale (after Busse 1983 and Kaiser 1993, combined) (See Appendix C for key to fat determination). Finally birds were weighed with 50 g. and 100 g. capacity Pesola spring balances to the nearest 0.25 g. Since experience with fat determination and wing formula was not gained until late April 2002, these measurements were not carried out before that. In autumn 2001 and till 27 April in spring 2002 only wing length and weight were measured for every individual and tail, tarsus, bill measurements were carried out only for some special cases. Wing length (maximum chord) is measured with a 30 cm ruler with a stop and tail length is measured from below the tail method with a 30 cm. ruler without a stop (Svennson, 1992, Redfern and Clark, 2001). After changing the measurement method for wing and tail length, the results of these two separate methods were compared on a sample of 11 birds of different sizes from Olivaceous Warbler *Hippolais pallida* to Blackbird *Turdus merula* in order to see size-dependent differences. No difference was found for wing measurements while a slight difference of 5% for tail measurements were noted.

In autumn 2001 and till 27 April in spring 2002 the birds were hold in reverse grip (bill to the wrist) by left hand and after 27 April in spring 2002 and autumn 2002 birds were held by right hand as standard ringer’s grip during all of the procedures.

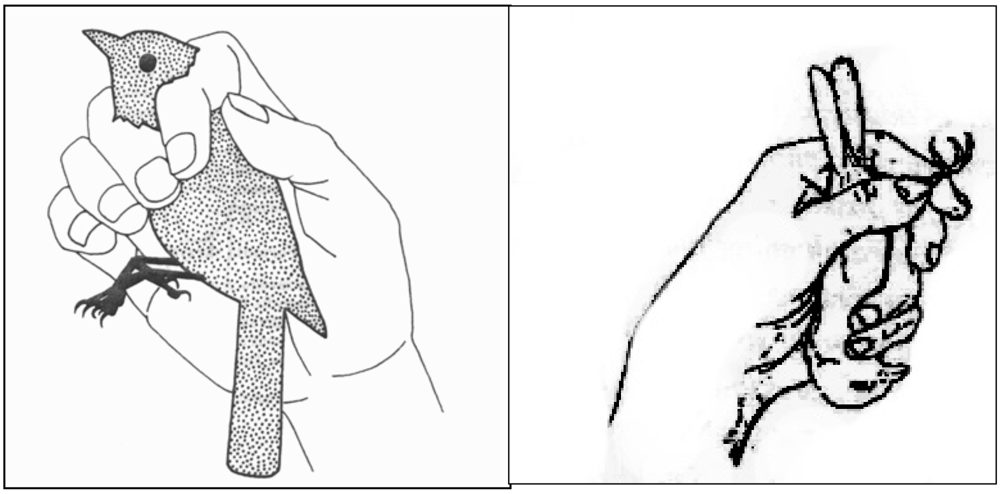

Figure 2.9 Standard ringers grip (left) (Busse 2000) and reverse grip (right) (Redfern and Clark 2001)

When ringed birds of the same season were retrapped, fat score and weight were remeasured and recorded into the logbooks with their ring number and status as retrap (R). When ringed birds of previous seasons were retrapped all measurements were done again and recorded into the logbooks with their ring number and status as control (C) (see Appendix A for retraps and controls).

Standard logbooks were used in this study, and date, hour (all times reported in hours are based on Daylight Saving Time), ring number, status (retrap, control or dead), substation (in autumn 2001 and spring 2002), species code (as 5 letter code of Latin name like SY ATR for *Sylvia atricapilla*, ER RUB for *Erithacus rubecula* with some exceptions of 6 letter code like PH TROU for *Phylloscopus trochilus*. See Appendix A for the list of species codes), age, sex, fat score and all biometric measurements, name of the ringer, and if necessary any comments were recorded. In a separate notebook, net length, time of putting up the nets and time of closing the nets (for autumn 2001 and spring 2002), weather conditions and other casual bird observations were also recorded.

As a whole, the M.Sc. candidate was in the field for 146 days (96.6%) and did 88.5% of all ringing and measurements. At a time 1-3 helpers joined to the study.

2.4 Data Analysis

Results were analyzed in Microsoft Excel mainly by graphing the daily totals against time (days) for all species, and also separately for Blackcap, Willow Warbler, Chiffchaff and Robin for autumn 2002. For autumn 2002, data smoothing was carried out as four times repeated 5-day running average with the formula:

$$D_x = 0.06*(d_x-2)+ 0.24*(d_x-1)+0.40*(d_x) +0.24*(d_x+1)+0.06*(d_x+2)$$

where d_x is the number of birds ringed on the x^{th} day (Busse, 2000).

Comparisons of seasonal dynamics for the four species mentioned above were made between METU, Cernek and Manyas stations for autumn 2002 with respect to smoothed phenologies.

A migration volume index was computed by 10 days periods for each season through standardizing by effort in terms of net length and the time nets were open.

Fat scores were analysed by graphing against weights, by averaging over pentads (five-day periods), and for retraps by connecting values recorded from each retrapped individuals through time.

A characterization of different substations was attempted through Bray-Curtis ordination of these sites on species compositions using PC-ORD for Windows (version 4.24, MjM Software, Oregon, USA). In addition, an effort index for each substation was calculated by multiplying total time and average net length in order to compare different substations and seasons.

CHAPTER 3

RESULTS & DISCUSSION

3.1 Critique of the methodology

This is the first systematic study documenting passerine migration in Turkey covering both spring and autumn.

As mentioned by Alerstam (1990) with catching and ringing method the birds that have landed after their night migration, i.e resting or foraging birds, but not the ones that are actively migrating can be caught and this may cause complications in interpreting the results.

According to Busse (2000) to study seasonal dynamics of bird migration:

1. Time and period of work should be standardized and within the season work should be carried out continuously or at least regular and frequent sampling should be done. It is even possible to miss 20% of the annual catch of one species as a result of one day miss.
2. Equal number and equal quality of nets should be used from year to year since any changes affect comparatibility.
3. The number of nets should be stable within a season.
4. The catching should be continuous all through the day without closing the nets for night.

With this knowledge the critique of the methodology can be made as following.

3.1.1 Catching effort

In autumn 2001 and spring 2002 the study was not continuous throughout the period due to logistical difficulties and other duties. In addition, during these seasons the study was carried out at different substations with different efforts and at different dates. Sampling for every substation was not equal. As a result, analysis of phenology data collectively for all substations without any standardization is probably somewhat biased.

Additionally, the study was not carried out continuously throughout the day during the seasons mentioned above. The nets were collected at midday (even the closing time of the nets were not standard) and every morning they were erected again. The time of putting up the nets in the morning varied since the team was not very experienced. Consequently, operation time of the nets was different for every workday. In addition the total net length was low and not standard within the season.

The places of nets may not be very good because of lack of experience in selecting the best places for effective catching.

3.1.2 Species bias

It is mentioned in Busse (2000) that registered number of birds can be lower than those corresponding with the actual intensity of bird passage since some birds might be out of catching equipment range. This can be also valid for species compositions. In this study it was not possible to catch every species with equal effectiveness since only 16 mm mesh size nets, effective for small passerine species, were used. These nets have lower catching ability when bigger passerine species like thrushes (*Turdus spp.*) are involved. Even if they are caught, the possibility of getting out of the net is higher for these species. In addition, very few nets were put at open places and as a result species like Wheatears (*Oenanthe spp*.), and larks (*Alaudidae spp.*) could not be caught and, very few individuals of some species like Whinchat (*Saxicola rubetra*), Tree Pipit (*Anthus trivialis*) and Black-headed Bunting *(Emberiza melanocephala*) were caught. In addition, aerial passerines which are very common during migration at METU like swifts and swallows and Lesser Grey Shrike (*Lanius* *minor*) which prefers mostly the top of tall trees were also out of the range of the nets and any individual of any species were not caught.

The study period did not cover migration period of all species. For example Marsh Warbler (*Acrocephalus palustris*) migration had already started in mid August, Black-headed Bunting had already migrated in autumn, and in spring only the tail end of Chiffchaff (*Phyloscopus collybia*) and Robin (*Erithacus rubecula*) migration was caught.

3.1.3 Efficiency of mist nets

In spring and autumn 2002 thick nets were used and especially at open places birds can see these nets and hence avoid easily.

Busse (2000) mentions that weather conditions may also prevent some birds from being caught even if the birds are within the range of catching equipment - bird activity changes and visibility of nets increase with wind, rain- and quality of catching equipment – catching capacity of damaged nets with holes decreases. Some of the 6 m. long thin nets were much damaged and it was not possible to change them in autumn 2001.

3.1.4 Catching effort, among sites and seasons

Throughout the study mist netting was carried out for a total of 151 days at up to 4 substations in one season. Daily total length of nets used ranged between 12 m. and 123 m.

Substation	**Total time (min)**	**Average net length (m)**	**Effort index**
Eymir	2055	27.8	57,026
Yalıncak	5385	24.6	132,317
Fidanlık	1350	30	40,500
Ölüm V.	1005	28.5	28,642

Table 3.1 Catching effort at different substations in autumn 2001

Substation	Total time (min)	Average net length (m)	Effort index
Eymir	4530	58	262,740
Yalıncak	8535	60.4	515,855
Sosyal	4395	62.6	275,258
Ölüm V.	1200	71	85,200

Table 3.2 Catching effort at different substations in spring 2002

Season	Total time (min)	Average net length (m)	Effort index
Autumn 2001	10062	26.4	265,636
Spring 2002	18213	61.5	1,120,100
Autumn 2002	81000	121.4	9,833,400

Table 3.3 Catching effort among seasons

According to Alerstam (1991*a*), for long distance migrants autumn migration lasts 88 days which is the median value for 13 species. This is 42 days for medium distance migrants and 32 days for partial and short distance migrants. However, according to Berthold *et al.* (1990*b*) and Pearson (1990) spring migration lasts one third to one half shorter time since birds are in hurry to exploit breeding territories and get as much benefit as possible of the short breeding season in the north (Berthold 1993). As a result, fieldwork was distributed through two months between end of March to end of May in spring but it is distributed through almost three months between mid August to early November in autumn.

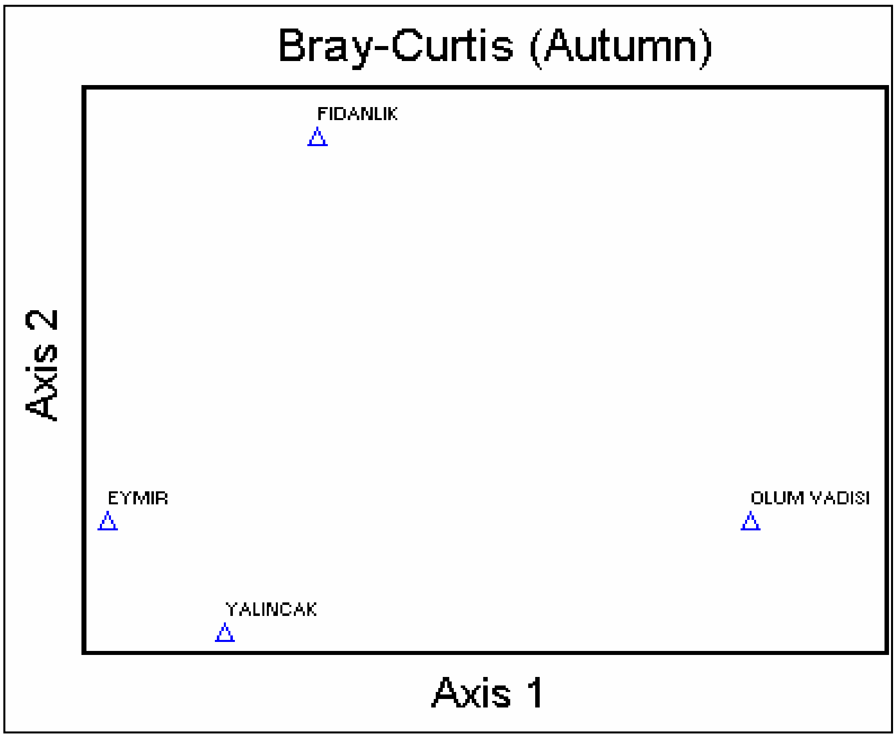

Figure 3.1 Ordination graph showing relationships among sites based on species composition for autumn seasons

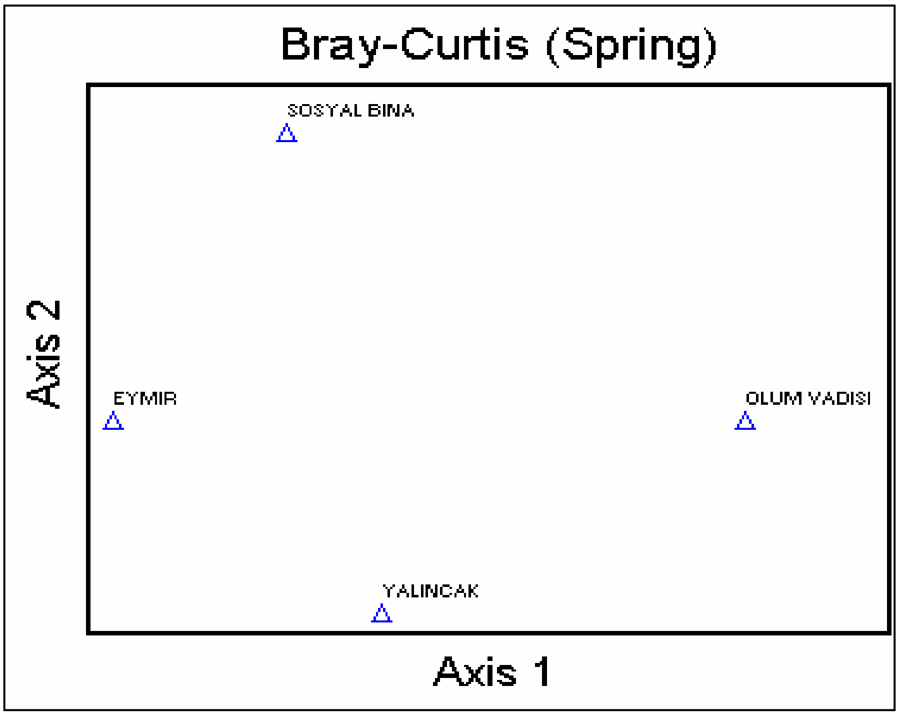

Figure 3.2 Ordination graph showing relationships among substations based on species composition for spring season

Comparison of all substations based on species composition in autumn and spring shows that Yalıncak is not an outlier (figure 3.1 and 3.2). Actually this comparison is somewhat biased since the effort is not equal for all substations and the dates are different which might affect the results a lot when migrating birds are considered.

Yalıncak was chosen as the only study site for a continuous and more standardized field work in autumn 2002 since the number of suitable places for putting up nets was higher, and because it was logistically more convenient. More importantly Yalıncak reflects METU habitat better than all other substations since it offers a balanced combination of woodland, shrubland and open areas.

3.2 The species and numbers caught

In this study totally 1,832 individuals of 60 passerine species were caught and ringed during 3 seasons. One species which is River Warbler (*Locustella fluviatilis*) was caught as dead because of raptor attack in the net.

3.2.1 Autumn 2001

In autumn 2001, totally 344 individuals of 39 passerine species were caught and ringed. Among those birds 95 individuals of 12 species namely Wren (*Troglodytes troglodytes*), Stonechat (*Saxicola torquata*), Blackbird (*Turdus merula*), Mistle Thrush (*Turdus viscivorus*), Cetti’s Warbler (*Cettia cetti*), Starling (*Sturnus vulgaris*), Great Tit (*Parus major*), Blue Tit (*Parus caeruleus*), House Sparrow (*Passer domesticus*), Tree Sparrow (*Passer montanus*), European Jay (*Garrulus glandarius*) and Rock Bunting (*Emberiza cia*) were excluded from the analysis since they are predominantly non-migratory passerine species in this region.

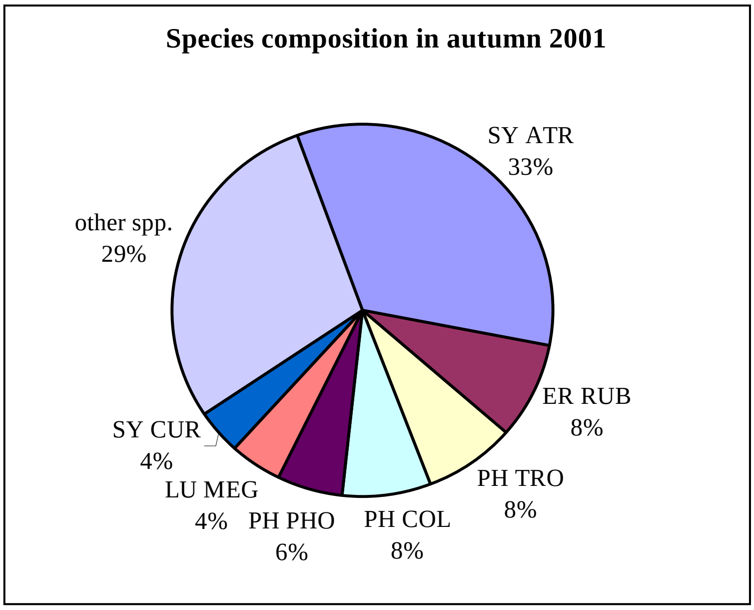

Figure3.3 Species composition in autumn 2001

In autumn 2001, the most common six species were Blackcap (*Sylvia atricapilla*) with 84 individuals, European Robin with 21 individuals, Willow Warbler (*Phylloscopus trochilus*) and Chiffchaff with 19 individuals, Redstart (*Phoenicurus phoenicurus*) with 14 individuals and Nightingale (*Luscinia megarhynchos*) with 11 individuals. Long distance migrants constitute 78% of all birds and the rest are either short distance migrants or winter visitors. (See Appendix D for details)

6 individuals of 5 species were retraped and 2 Nightingale individuals which were ringed during the experimental field work on 29 May were controlled (ring numbers A00004 and A00005). These were probably breeding individuals (see Apendix A for details).

Thrush Nightingale (*Luscinia luscinia*), Garden Warbler (*Sylvia borin*) and Olive-tree Warbler (*Hippolais olivetorum*) were recorded in METU campus field for the first time (C.Bilgin pers.comm.). It is quite normal that these species were not recorded during irregular observations in the campus field before. Thrush Nightingale is a passage migrant in Turkey. Especially during migration, when birds do not sing, it is very difficult to distinguish it from Nightingale only by observation. Garden Warbler is a summer visitor and breeds in northern and eastern regions in

Turkey. It is also difficult to identify this species by observation since it has not any obvious features. As to the Olive-tree Warbler, it is a breeding species mainly along Aegean and Mediterranean coast and Sea of Marmara. It is thought to be irregularly breeding at some other isolated localities north of Ankara like Kızılcahamam (Barış *et al.* 1984, Roselaar 1995, Mullarney *et al*. 1999). The two individuals caught in this study might belong to the population of Kızılcahamam.

3.2.2 Spring 2002

In spring 2002, 423 individuals of 42 passerine species were caught and ringed. Among these, 88 individuals of 16 species namely House Sparrow, Tree Sparrow, Great Tit, Blue Tit, Long-tailed Tit (*Aegithalos caudatus*), Penduline Tit (*Remiz pendulinus*), Blackbird, Mistle Thrush, Cetti's Warbler, Western Rock Nuthatch (*Sitta neumayer*), Magpie (*Pica pica*), European Jay, Starling, Goldfinch (*Carduelis carduelis*), Greenfinch (*Carduelis chloris*) and Corn Bunting (*Miliaria calandra*) were excluded from the analysis since they are predominantly non-migratory species in this region.

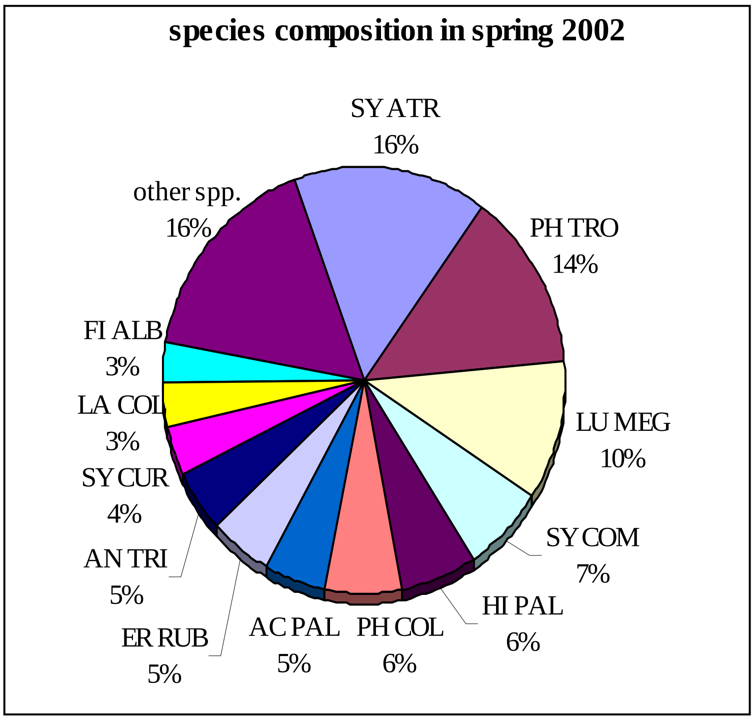

Figure 3.4 Species composition in spring 2002

The most numerous 6 species were Blackcap with 52 individuals, Willow Warbler with 46 individuals, Nightingale with 35 individuals, Common Whitethroat (*Sylvia communis*) with 22 individuals, Olivaceous Warbler (*Hippolais pallida*) with 21 individuals and Chiffchaff with 20 individuals. Long distance migrants constitute 87.8% of all birds and the rest are either short distance migrants or winter visitors (see Appendix D for details).

42 birds of 9 species were retraped and 3 Nightingale individuals ringed in autumn 2001 with ring numbers A00005, A00011 and A00019 were controlled. Nightingale is a long distance migrant wintering in Africa (south of Sahara) and it is a breeding species of METU. It is understood that these controlled birds went to Africa for winter season and then returned to the same spot for breeding as a result showed some site fidelity to breeding grounds. It is mentioned in Berthold (1993) that fidelity to breeding areas or even to the nest sites have been established as normal behaviour for many species and the increased using of ringing and the increase in recoveries and other observations verify more and more cases of fidelity to stop over and wintering areas as well.

3.2.3. Autumn 2002

In autumn 2002, 1,064 individuals of 47 passerine species were caught and ringed. Among these, 110 birds of 12 species namely Wren, Stonechat, Blackbird, Mistle Thrush, Cetti's Warbler, Great Tit, Blue Tit, Long-tailed Tit, Coal Tit (*Parus ater*), Western Rock Nuthatch, Starling and European Jay were excluded from the analysis since they are predominantly non-migratory passerine species in this region.

In this season, Eastern Bonelli's Warbler (*Phylloscopus orientalis*) and River Warbler were recorded in the METU Campus field for the first time (C. Bilgin pers.comm). Eastern Bonelli's Warbler is a summer visitor in Turkey and breeds in western Black Sea region, northern parts of Central Anatolia, Marmara, Aegean and Mediterranean regions. River Warbler is a passage migrant in Turkey. Since these species are rare and also difficult to identify other than breeding seasons it is quite normal that they were not observed in the METU campus field before during irregular observations.

The species composition was very similar to autumn 2001 with Blackcap being the dominant species with the same percentage (38%, 308 individuals) followed by Willow Warbler with 145 individuals, Chiffchaff with 98 individuals, Robin with 79 individuals, Common Redstart with 42 individuals and Spotted Flycatcher (*Muscicapa striata*) with 36 individuals. Being very similar to autumn 2001 the long distance migrants constitute 74.3% of all birds and the rest are either short distance migrants or winter visitors (see Appendix D for details).

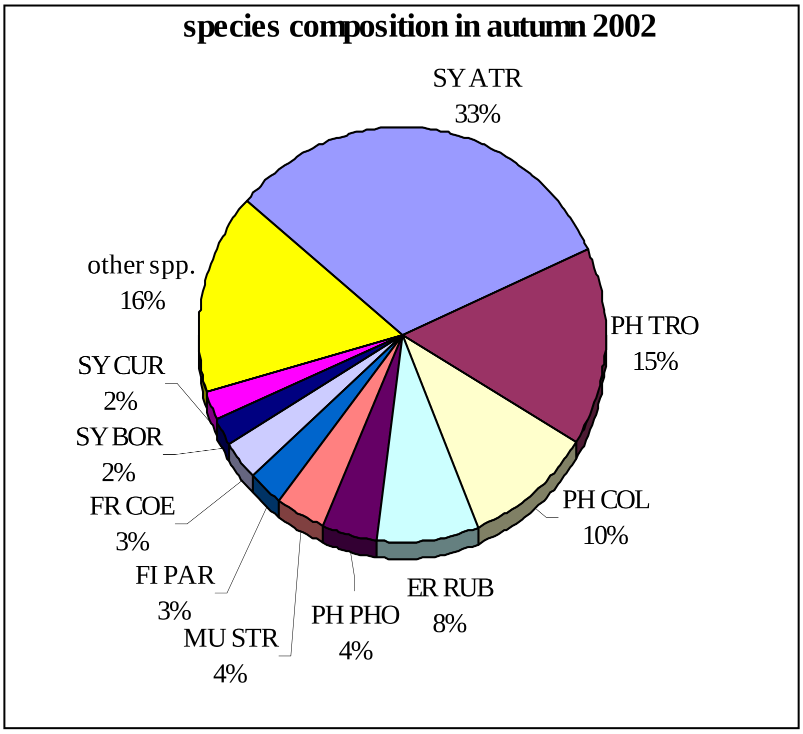

Figure 3.5 Species composition in autumn 2002

116 individuals of 14 species were retraped and 5 individuals of Nightingale were controlled, two of which were ringed in autumn 2001 (ring numbers A00019 and A00023) and three of which were ringed in spring 2002 (ring numbers A00311, A00400 and A00429). A00019 was also controlled in spring.

3.3 Daily phenology

In spring 2002, daily activity of migrating birds was highest at early morning especially between 6 and 7 am, which is roughly the first hour after sunrise (Figure 3.6). This activity gradually decreases till midday when ringing was stopped.

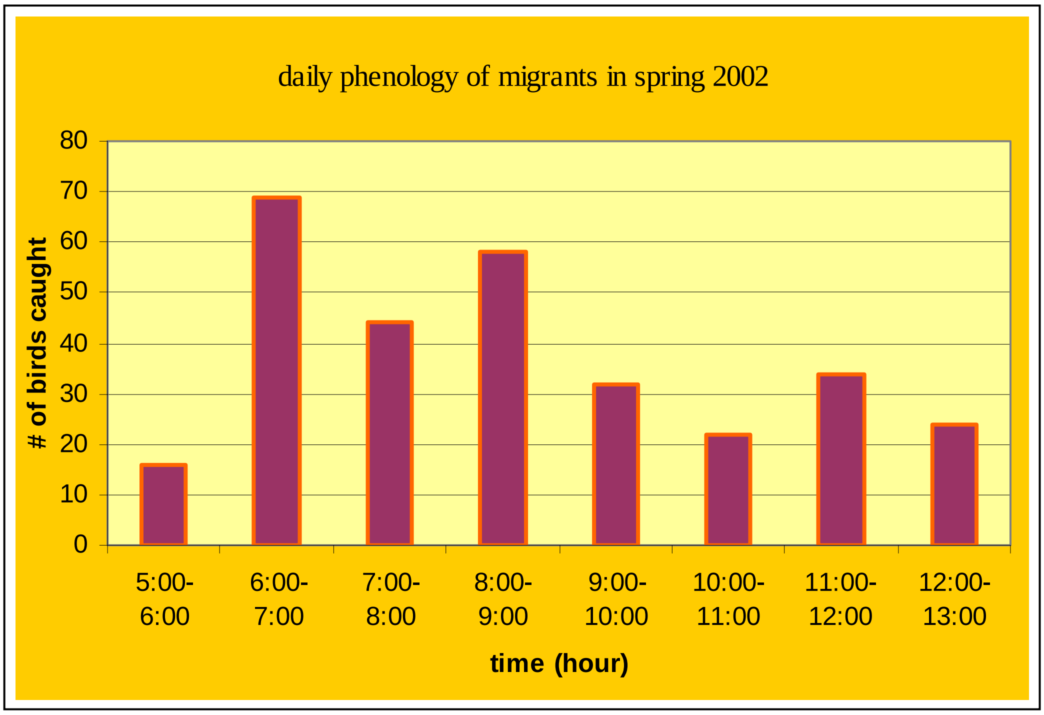

Figure 3.6 Daily phenology of migrants in spring 2002

Similarly in autumn 2002 bird activity was highest between 7 and 8 am, decreased till midday and increased again in the evening (especially between 6 and 7 pm) (Figure 3.7). When the daily activity of the two most common species, Blackcap and Willow Warbler, was checked the same pattern was observed. This activity pattern is expected since nocturnal migrants are generally start feeding immediately after the day has broken and their migration begins suddenly on average 30 minutes after sunset (Alerstam 1990).

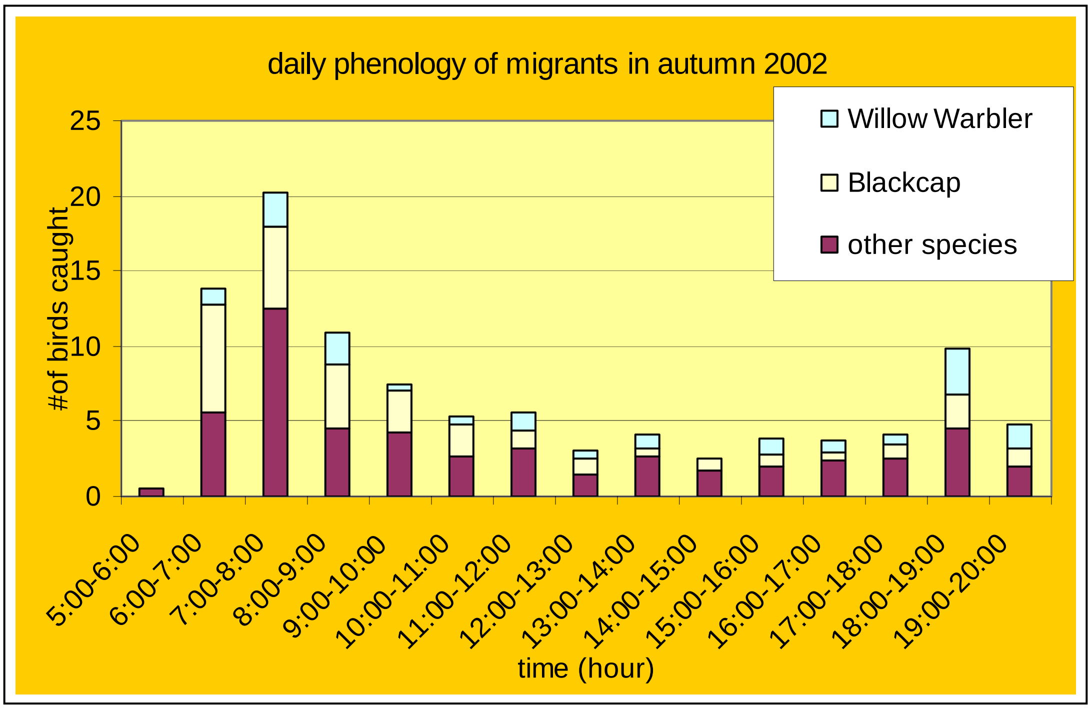

Figure 3.7 Daily phenology of migrants in autumn 2002

3.4 Seasonal phenology

3.4.1 Autumn2001

In autumn 2001, the highest daily catch was obtained on 9 September at Eymir with 29 birds, the second highest catch on 27 September at Yalıncak with 21 birds and the third highest catch on 15 September at Ölüm Vadisi with 19 birds. It is not possible to identify individual migration waves since the study was not continuous.

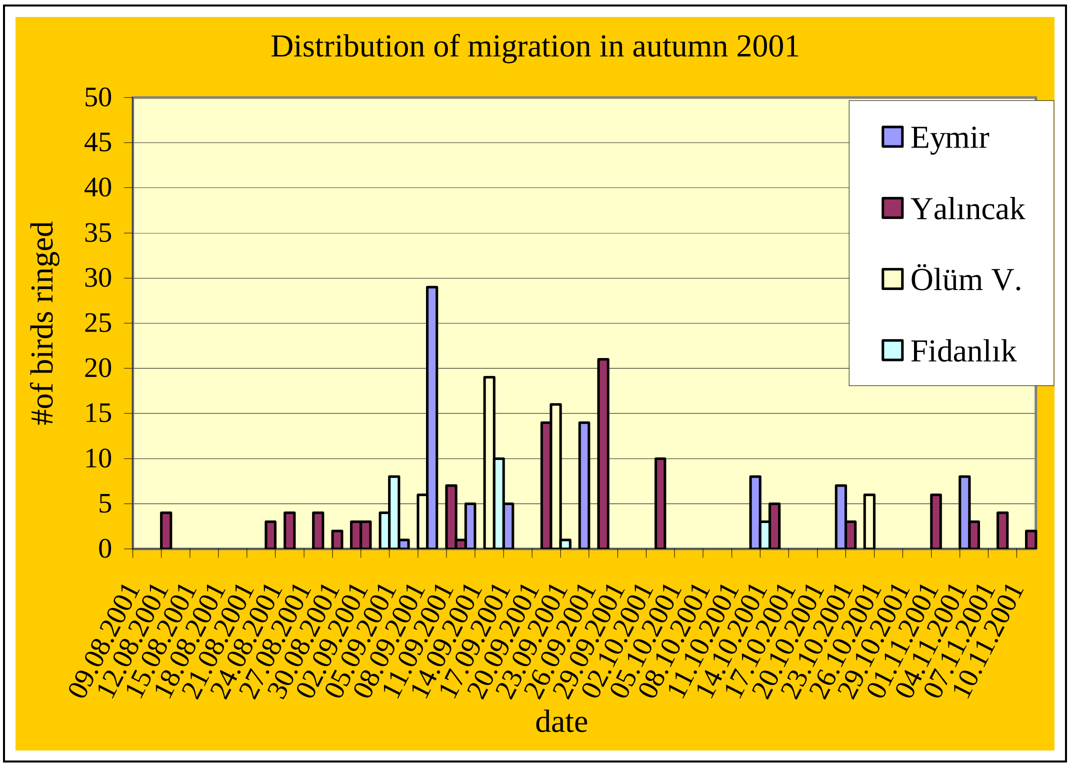

Figure 3.8 Migration phenology of all species in autumn 2001

It can be seen in figure 3.9 that bird migration intensity is highest from last third of September end of October; more than 60% of the migrants were caught during these 6 weeks. This is expected since the main migration period of long distance migrants is September and October (Snow and Perrins 1998).

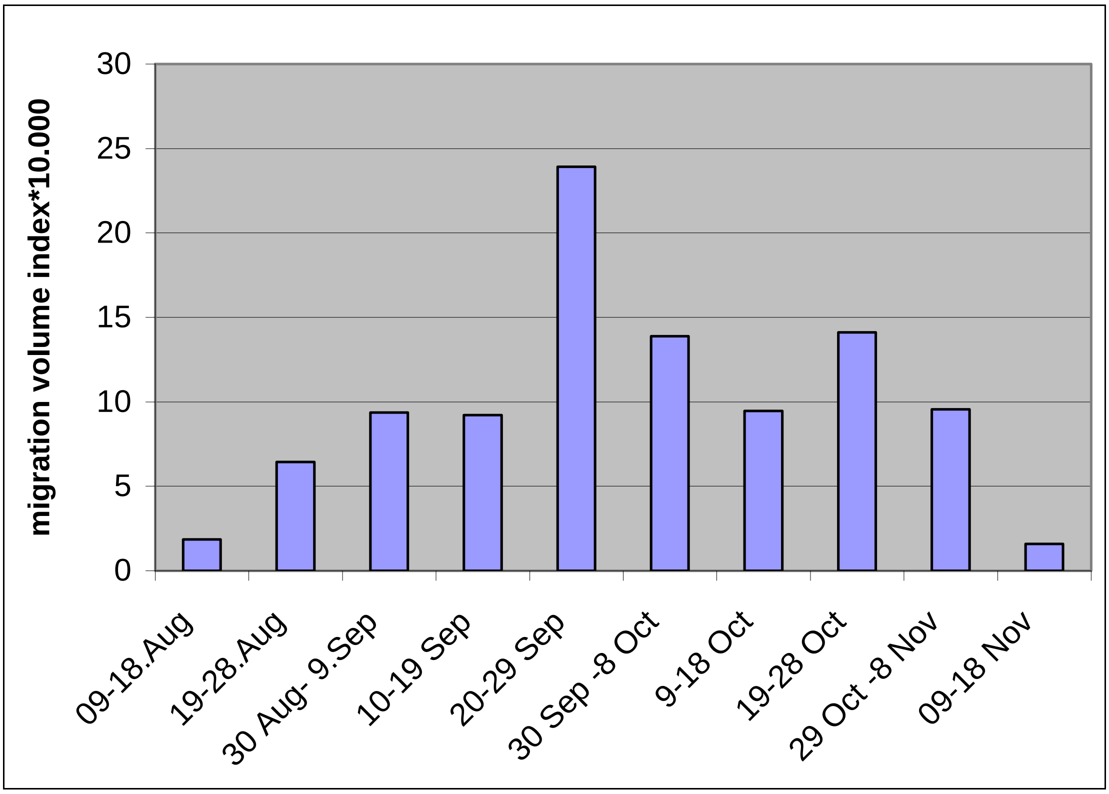

Figure 3.9 Migration intensity by 10 days periods in autumn 2001

3.4.2Spring 2002

In spring 2002, the highest number of birds caught on 20 April at Sosyal Bina with 43 individuals, the second highest on 17 May at Eymir with 22 individuals, the third highest on 16 April at Sosyal Bina with 21 individuals. It is not possible to identify migration waves since the study was not continuous.

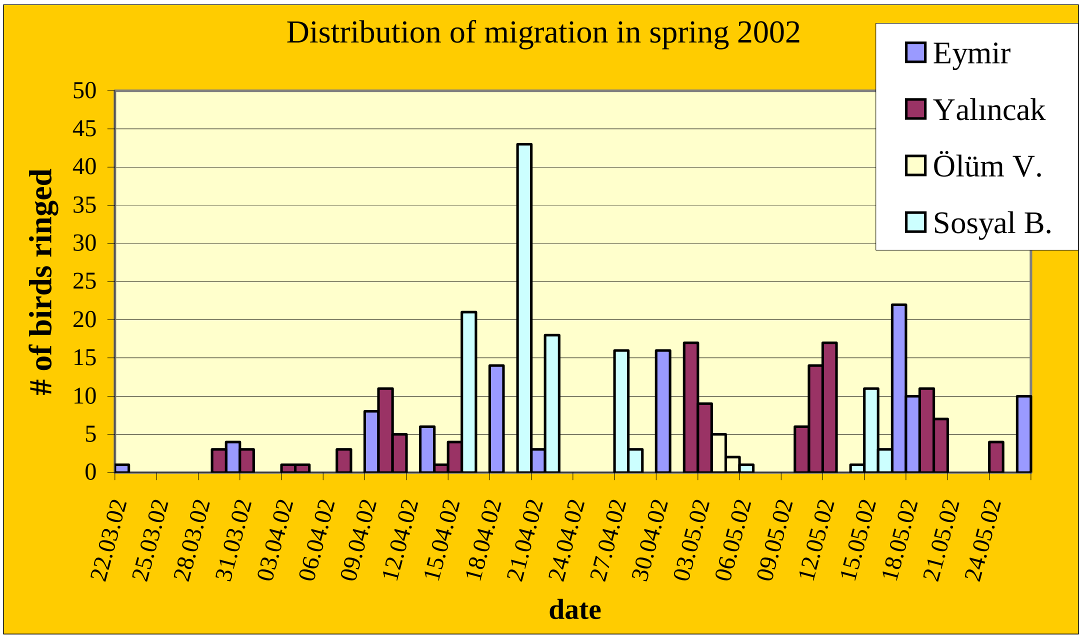

Figure 3.10 Migration phenology of all species in spring 2002

It can be seen in figure 3.11 that migration is almost twice as intense in April than in May. If the last ten day period (22 May-1 June) is left out (since numbers probably reflect newly fledged birds of the year), the third week of April makes up almost half of the captured migrants. This is expected since several migrant species are reported to start breeding in May in most of the northern hemisphere (Snow and Perrins 1998).

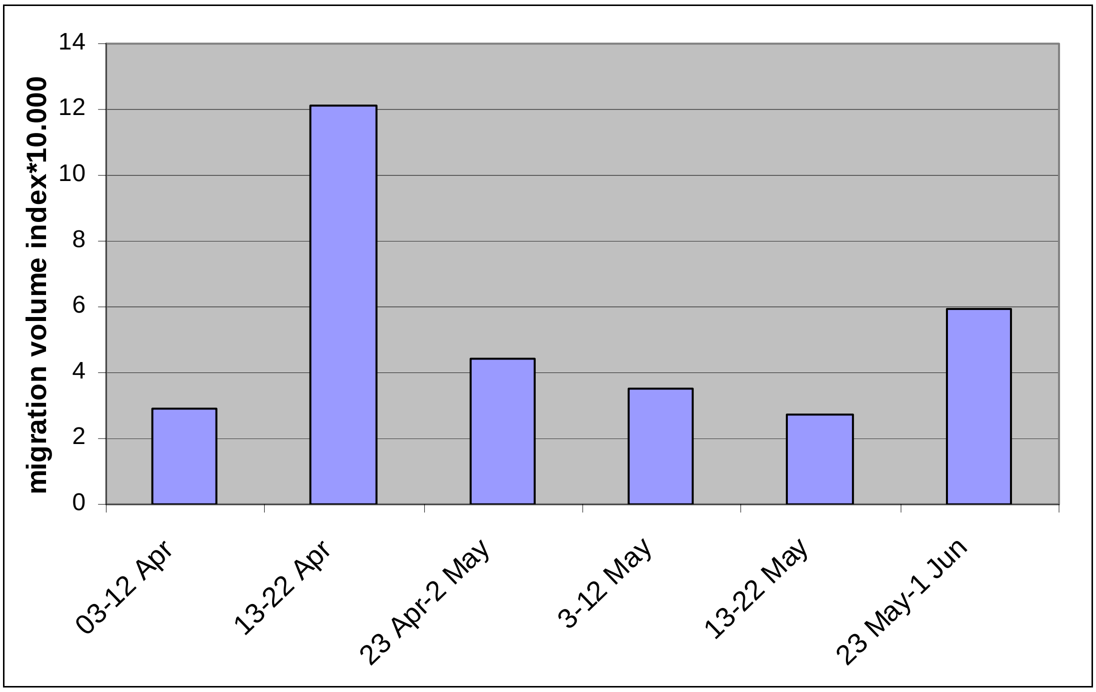

Figure 3.11 Migration intensity by 10 days periods in spring 2002

3.4.3 Autumn 2002

In autumn 2002, the highest daily catch was obtained on 5 September with 34 individuals, the second on 10 October with 30 individuals and the third on 4 September with 28 individuals. 7 migration waves are observed at periods 18- 29 August, 30 August to 10 September, 11-17 September, 18-26 September, 27 September to 3 October, 4-15 October and 16-27 October. The division of 2nd -3rd and 5th-6th waves are not very clear, there might be overlapping waves of different species in these periods. As it can be seen in figure 3.13 first 4 waves are formed mainly by Blackcap which is the most numerous species, 5th one is mostly formed by Willow Warbler, 7th is formed by Robin and Chiffchaff waves. It is very well seen that 6th wave which is the second strongest one coincides with waves of 4 common species. Other species contribute only minimally to the formation of wave peaks.

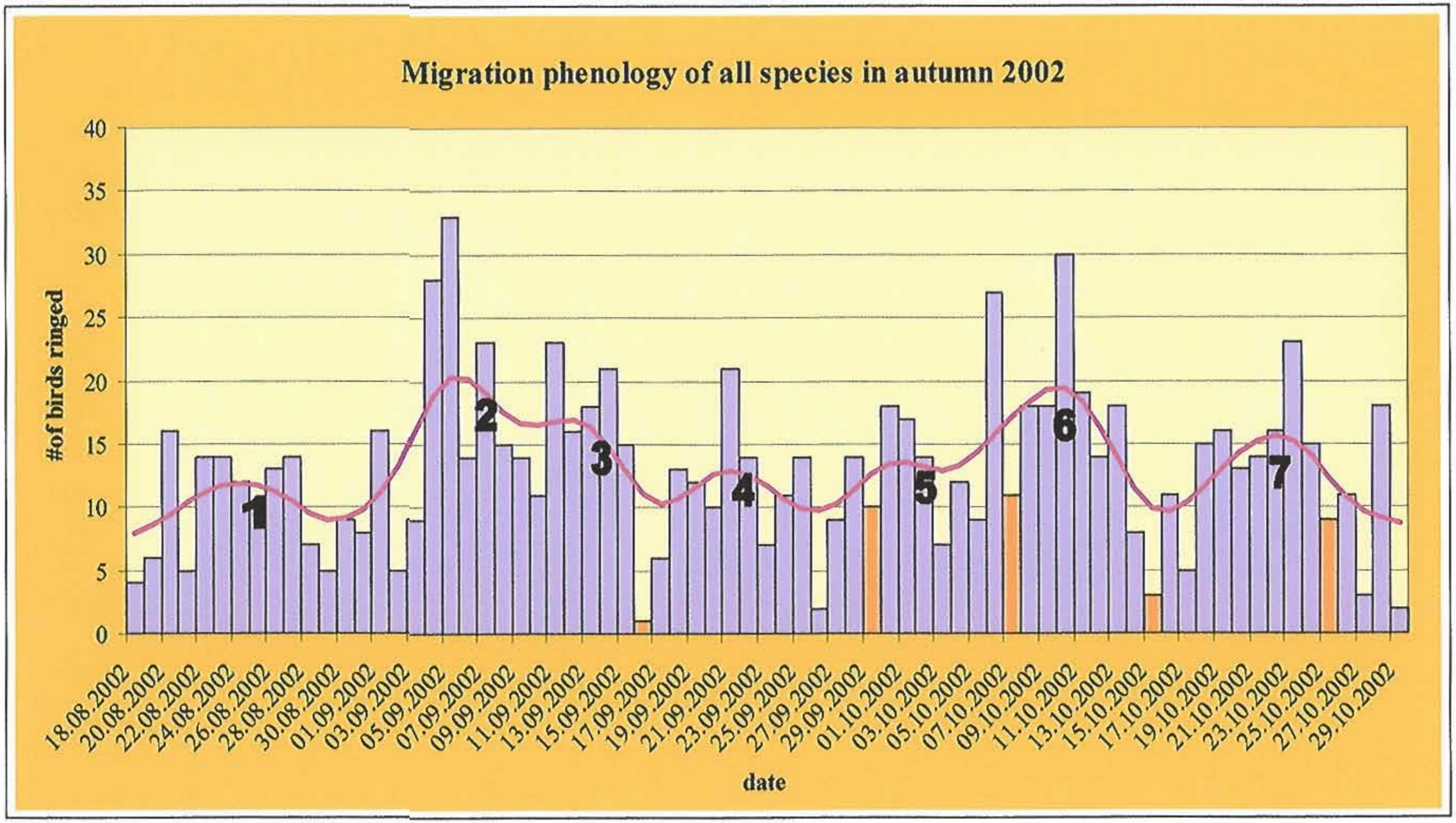

Figure 3.12 Migration phenology of all species in autumn 2002 (orange bars show incomplete work days because of bad weather conditions).

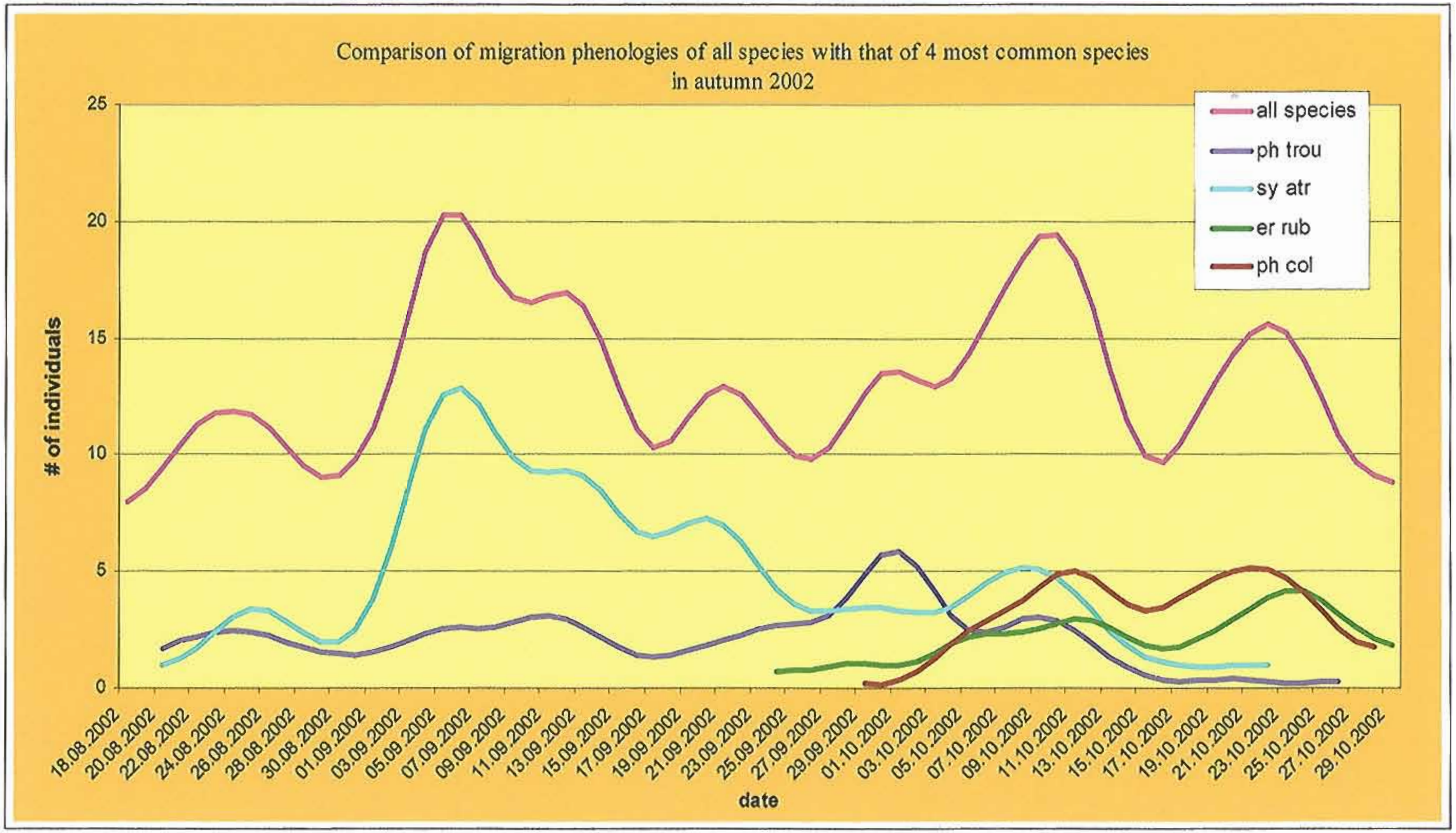

Figure 3.13 Comparison of migration phenology of all species with that of Blackcap, Willow Warbler, Chiffchaff and Robin in autumn 2002

Figure 3.14 shows high levels of migration intensity in September and October and lower intensity in late August like in autumn 2001, although in 2002 the captured migrants are distributed more evenly over time.

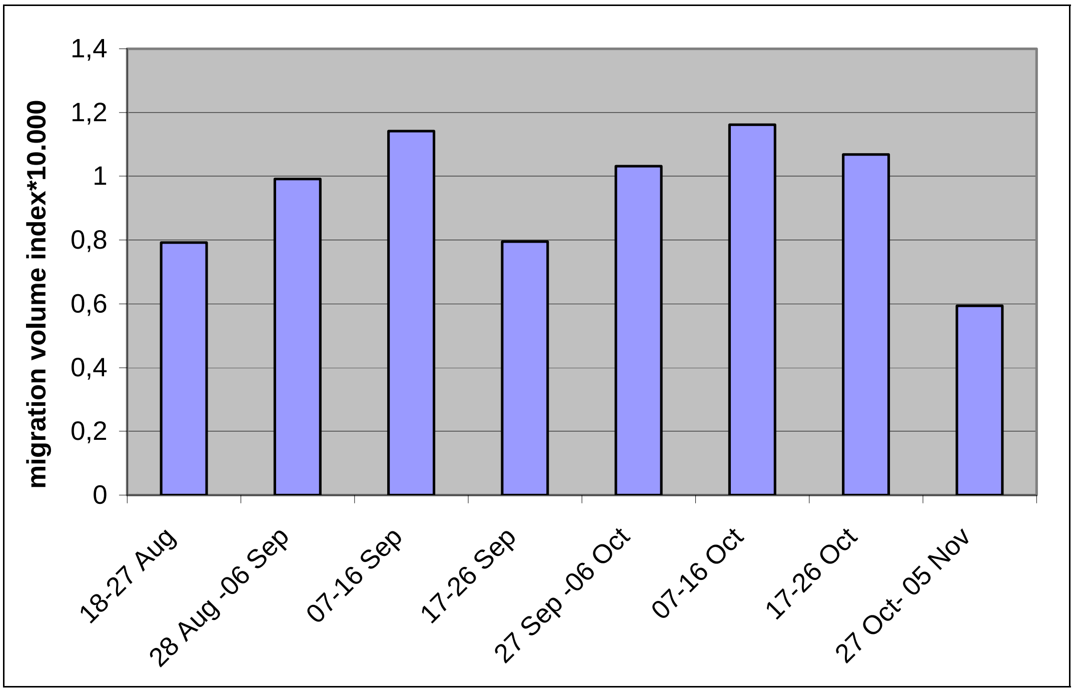

Figure 3.14 Migration intensity by 10 days periods in autumn 2002

3.4.3.1 Blackcap Phenology

The species is a passage migrant in METU. Its migration has occurred between 20 August to 22 October. Totally 308 individuals were ringed and the highest daily catches were obtained on 4, 5 and 7 September with 19 individuals per day. 6 migration waves are observed at periods 20-29 August, 30 August to 9 September, 10-16 September, 17-26 September, 27 September to 3 October and 4-17 October (Figure 3.15). Separating 2nd and 3rd waves are not easy because they probably overlapped. 5th wave is very weak.

3.4.3.2 Willow Warbler Phenology

It is a passage migrant in METU. Very similarly with Blackcap phenology, Willow Warbler migration has occurred between 22 August to 26 October. Totally 145 individuals were ringed and the highest daily catch was on 1 October with 11 individuals. 5 migration waves are observed but it is difficult to determine the boundaries of each except the 4th wave which starts on 27 September and ends on 5 October (figure 3.16)

3.4.3.3 Chiffchaff Phenology

It is a passage migrant and opportunistic winter visitor in METU. Chiffchaff migration started on 29 September and kept on till the end of the study with last individuals ringed on 28 October. 2 migration waves can be identified at periods 29 September to 14 October and 16 to 26 October (figure 3.17). Totally 98 individuals were ringed and the highest daily catch was obtained on 10 October with 8 individuals. Most probably the migration of this species continued till mid November and possibly even further on. For example, in autumn 2001, a few Chiffchaff had been caught and many individuals observed in November.

3.4.3.4 Robin Phenology

It is a passage migrant and winter visitor in METU. Similar to Chiffhaff phenology, Robins were caught between 24 September and 29 October. Totally 79 individuals were ringed and the highest daily catch was obtained on 23 October with 8 individuals. 2 migration waves can be identified at periods 2-15 and 16-29 October (Figure 3.18). Most probably the migration of this species continued till mid November and possibly even further on.

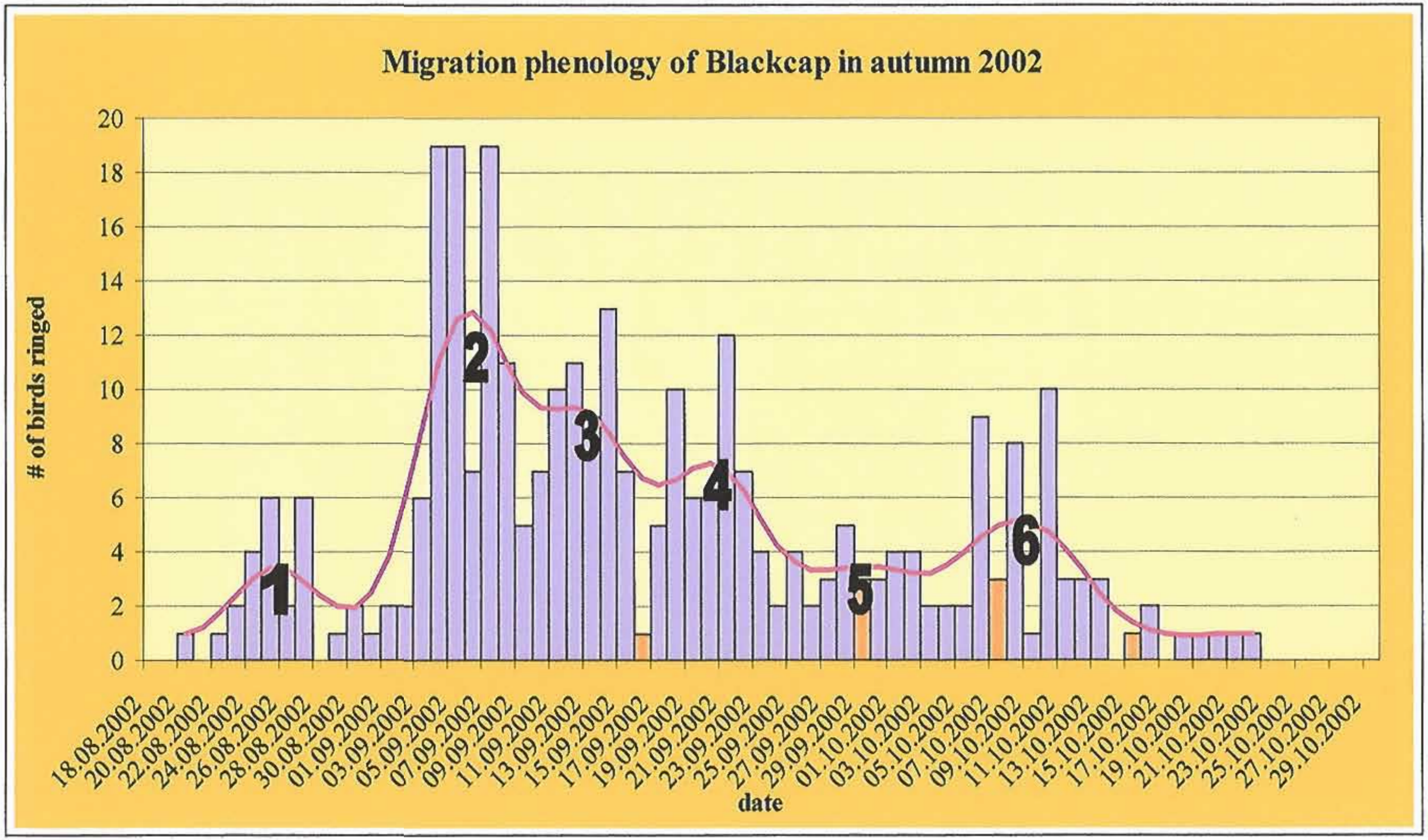

Figure 3.15 Migration phenology of Blackcap in autumn 2002 (orange bars show incomplete days work beacuse of bad weather conditions)

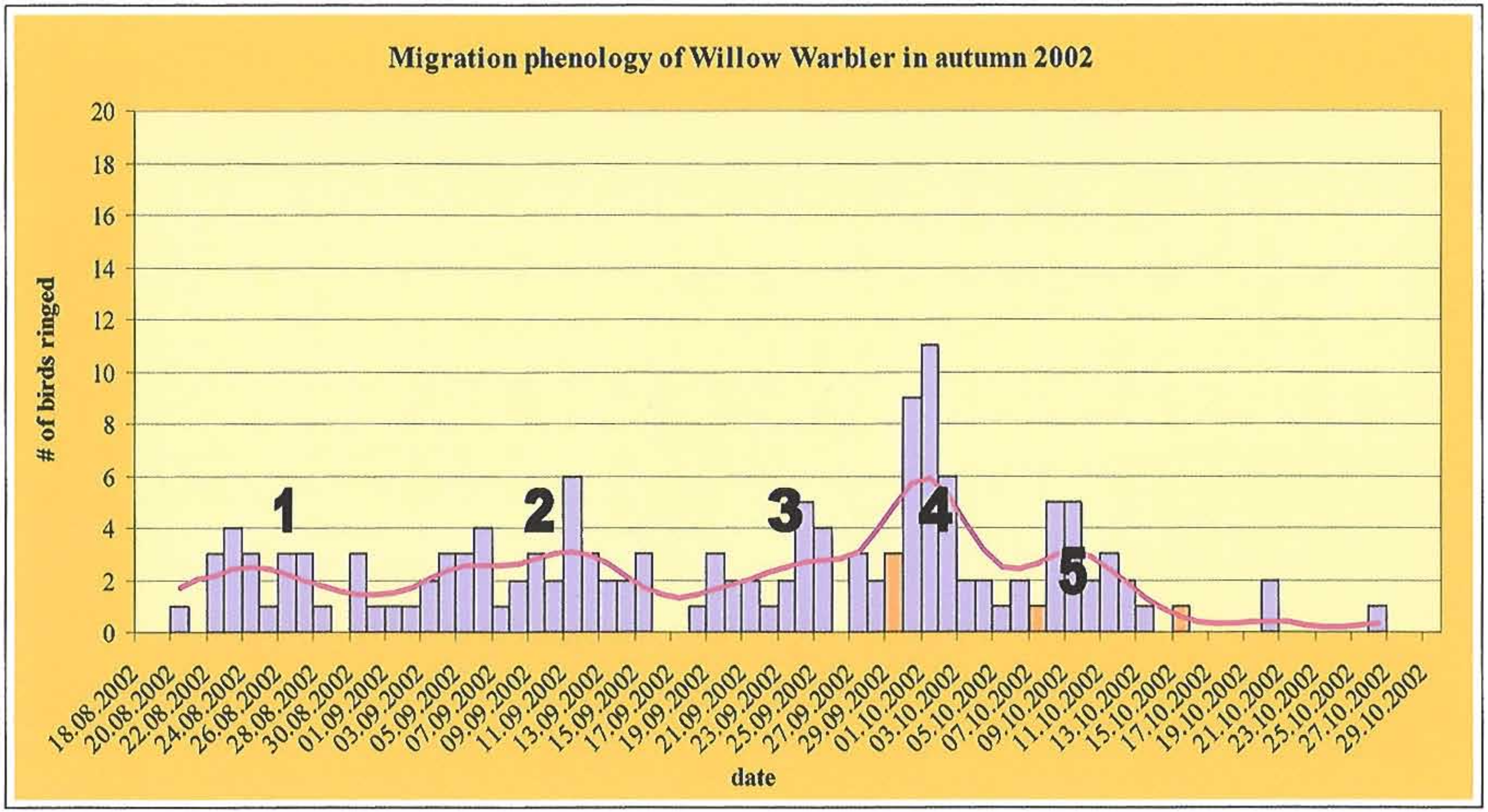

Figure 3.16 Migration phenology of Willow Warbler in autumn 2002 (orange bars show incomplete work days because of bad weather condition).

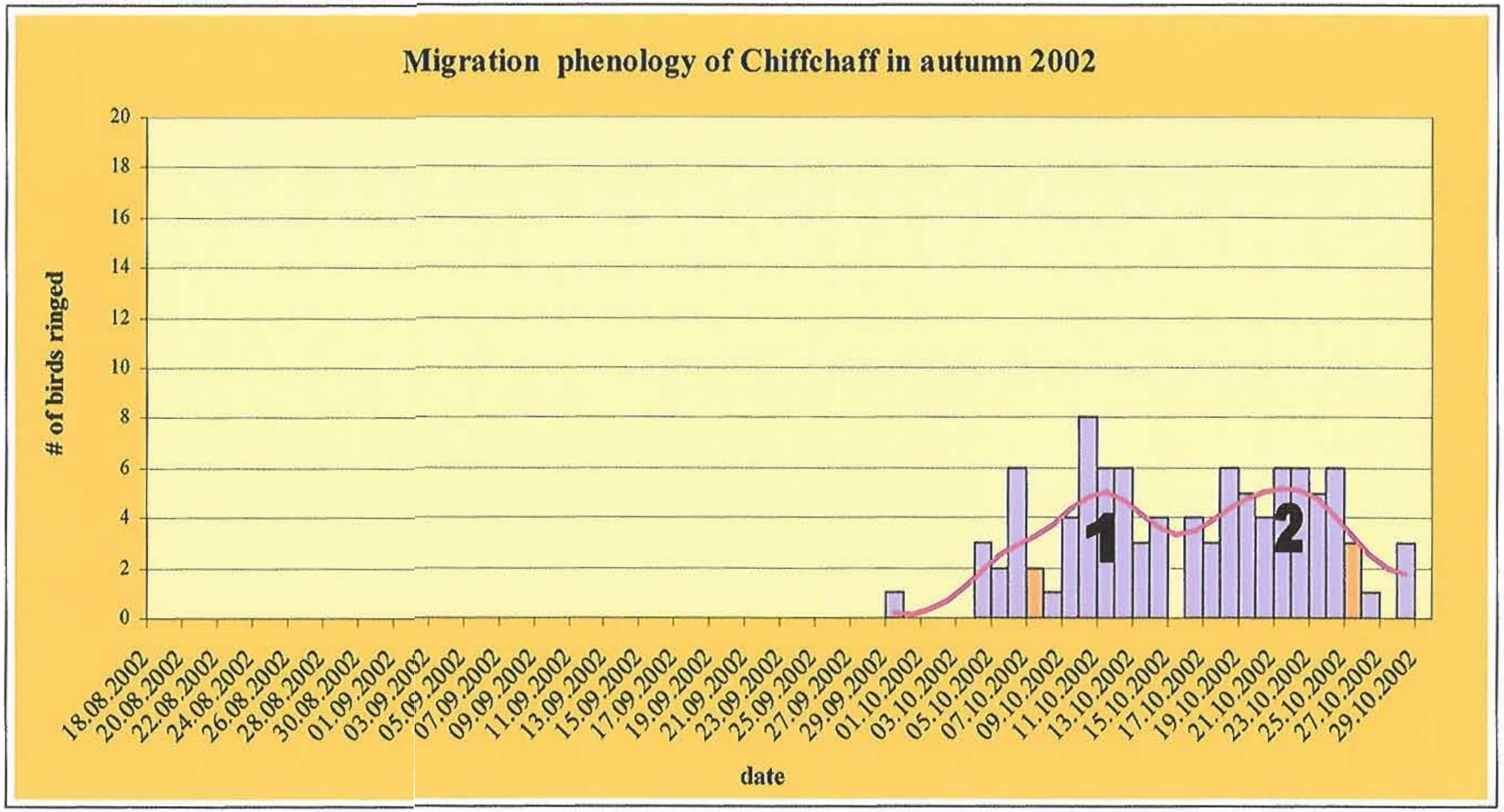

Figure 3.17 Migration phenology of Chiffchaff in autumn 2002 (orange bars show incomplete work days because of bad weather conditions)

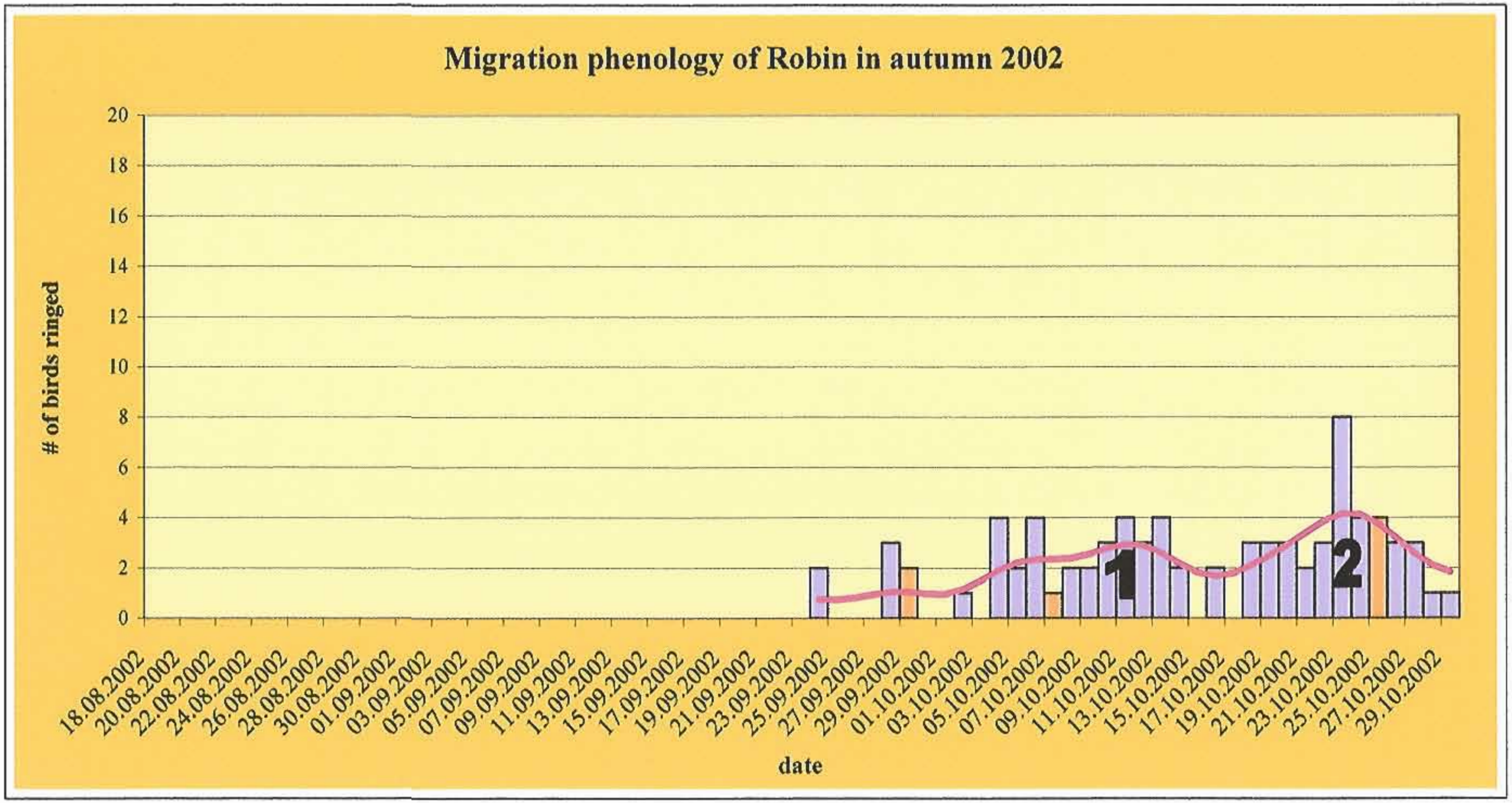

Figure 3.18 Migration phenology of Robin in autumn 2002(orange bars show incomplete work days because of bad weather conditions).

3.5 Comparison with Manyas and Cernek stations

In autumn 2002 a similar study, following the same standards, was carried out at Cernek station (Samsun) during the same period and at Manyas Kuşcenneti station (Balıkesir) between 14 September to 21 October. Comparison of Blackcap and Willow Warbler phenologies among these 3 stations and comparison of Robin and Chiffchaff phenologies between Manyas and METU was carried out.

Several Blackcap waves (at least four of them) seem to coincide quite well at Cernek and METU. However, there is little matching with the waves observed at Manyas although there is a possibility that the migration front of a particular population can reach different stations with a several days lag (figure 3.19). As to Willow Warbler, compared with other stations daily numbers are very low at METU therefore making meaningful comparisons impossible (figure 3.20). The only obvious correlation involves the 4^{th} wave at METU and corresponding waves at the other two stations. For Chiffchaff and Robin, a lag of 5-9 days separates the first respective waves at METU and Manyas while the second waves seem to coincide well (Figures 3.21, 3.22).

Limited recovery data (unpublished data) and observations of subspecific variations indicate that populations from different geographic regions migrate over Turkey, even at the same station. For Blackcap, there are recoveries that indicate at least two routes, one from north of the Black Sea straight to south, and the other from Central Europe/Balkans southeast to Middle East. This may explain the closer correlation between Cernek and METU while most Manyas migrants seem to continue south of these other stations.

Regarding species compositions at each station both Blackcap and Willow Warbler are among the 3 most common species ringed. However, Cernek station has Garden Warbler as the most common species (16% of the total), Manyas station has Reed Warbler (*Acrocephalus scirpaceus*) as the third most common species (14% of the total), while METU is dominated by Blackcap (33% of the total). Although a high correlation in phenology seems to exist between Cernek and METU, the very low numbers of Garden Warblers ringed at METU (2% of the total) was unexpected. This may have to do with the habitat requirements of the species. Unlike its name suggests, Garden Warbler is put off by disturbance and do not prefer parks and gardens like Blackcap. Either due to higher disturbance levels or lack of a large, contiguous suitable habitat, METU may not be very attractive for Garden Warblers (Snow and Perrins,1998).

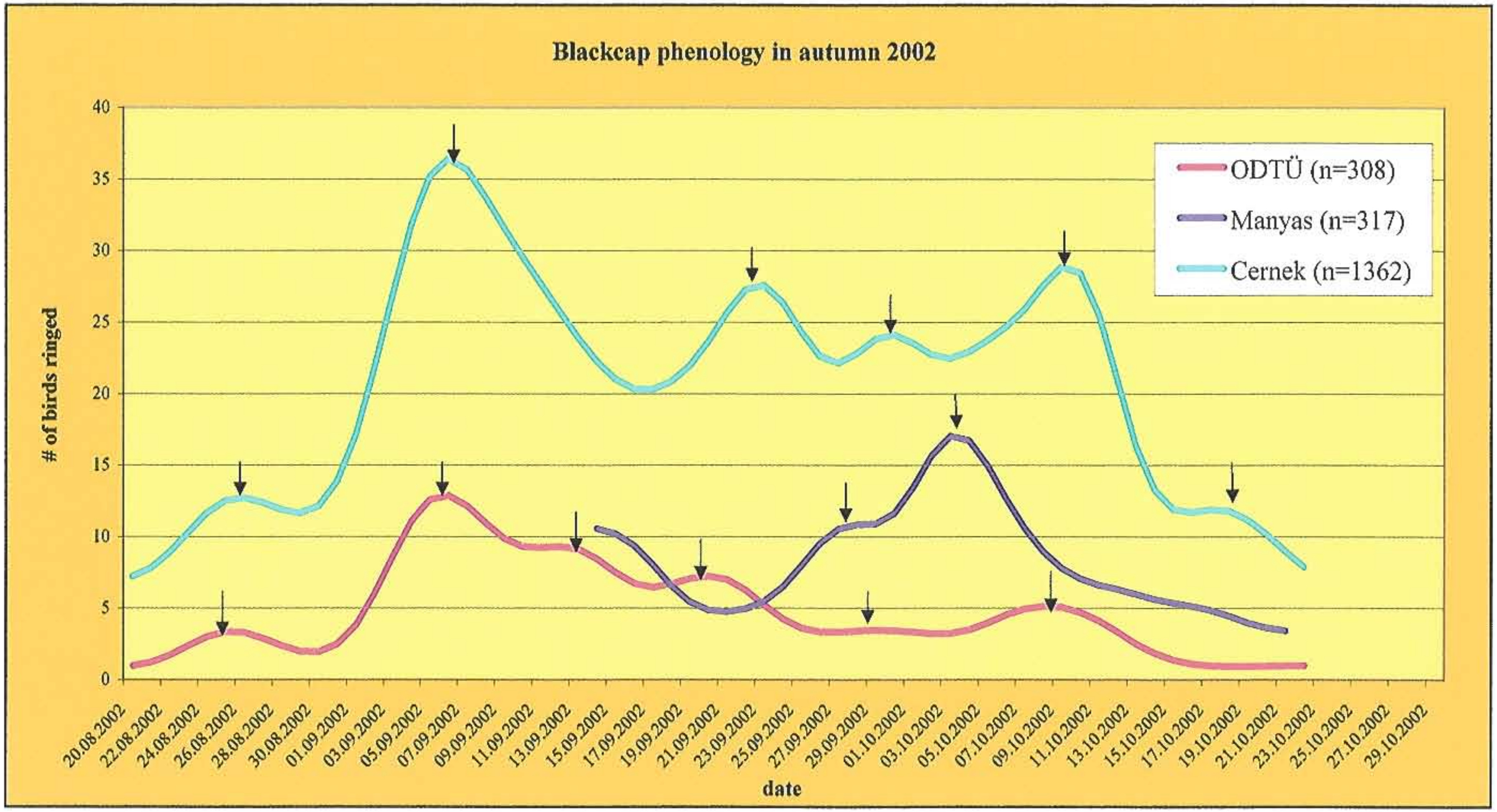

Figure 3.19 Comparison of Blackcap migration phenology with Manyas and Cernek stations in autumn 2002

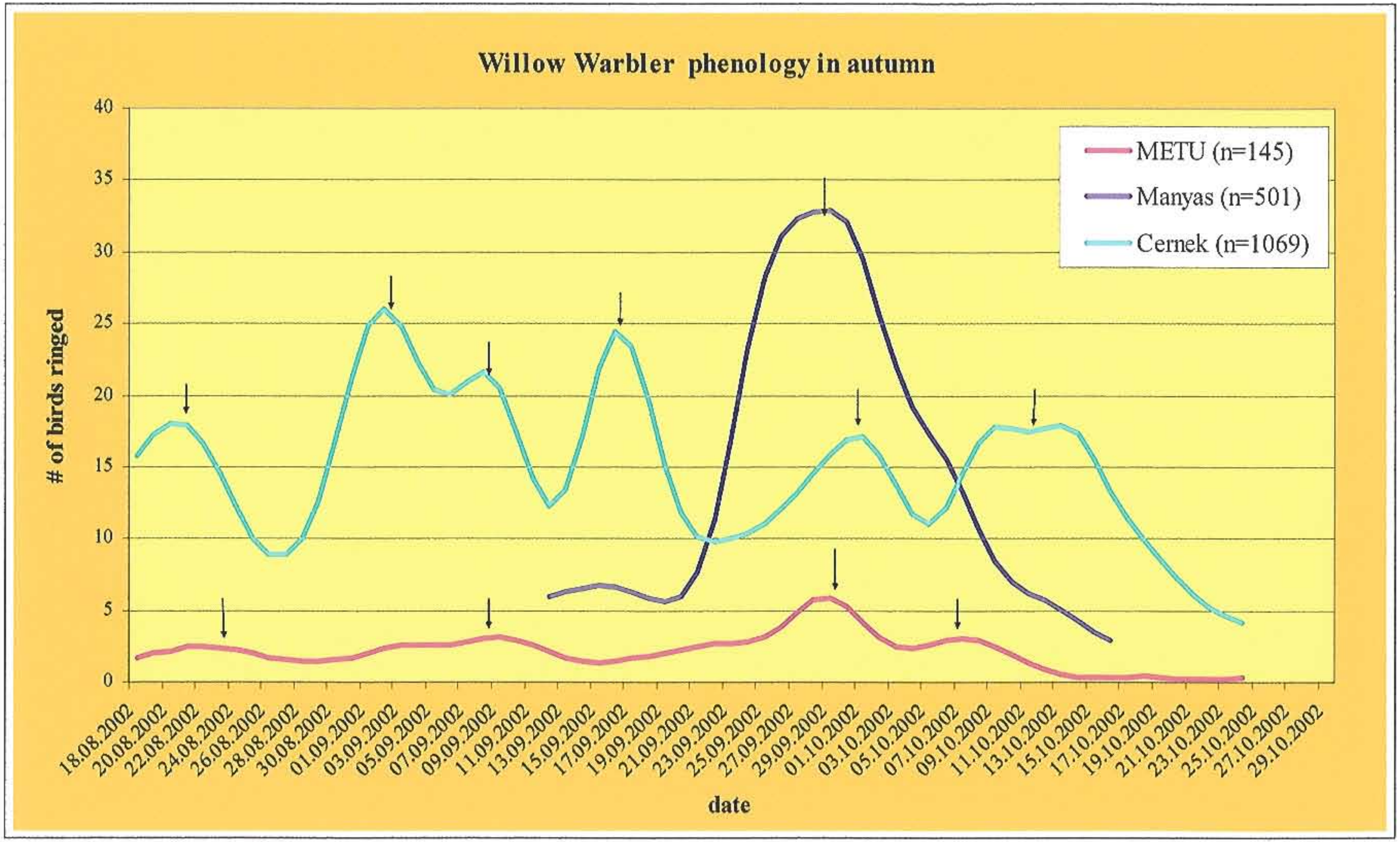

Figure 3.20 Comparison of Willow Warbler migration phenology with Manyas and Cernek stations in autumn 2002

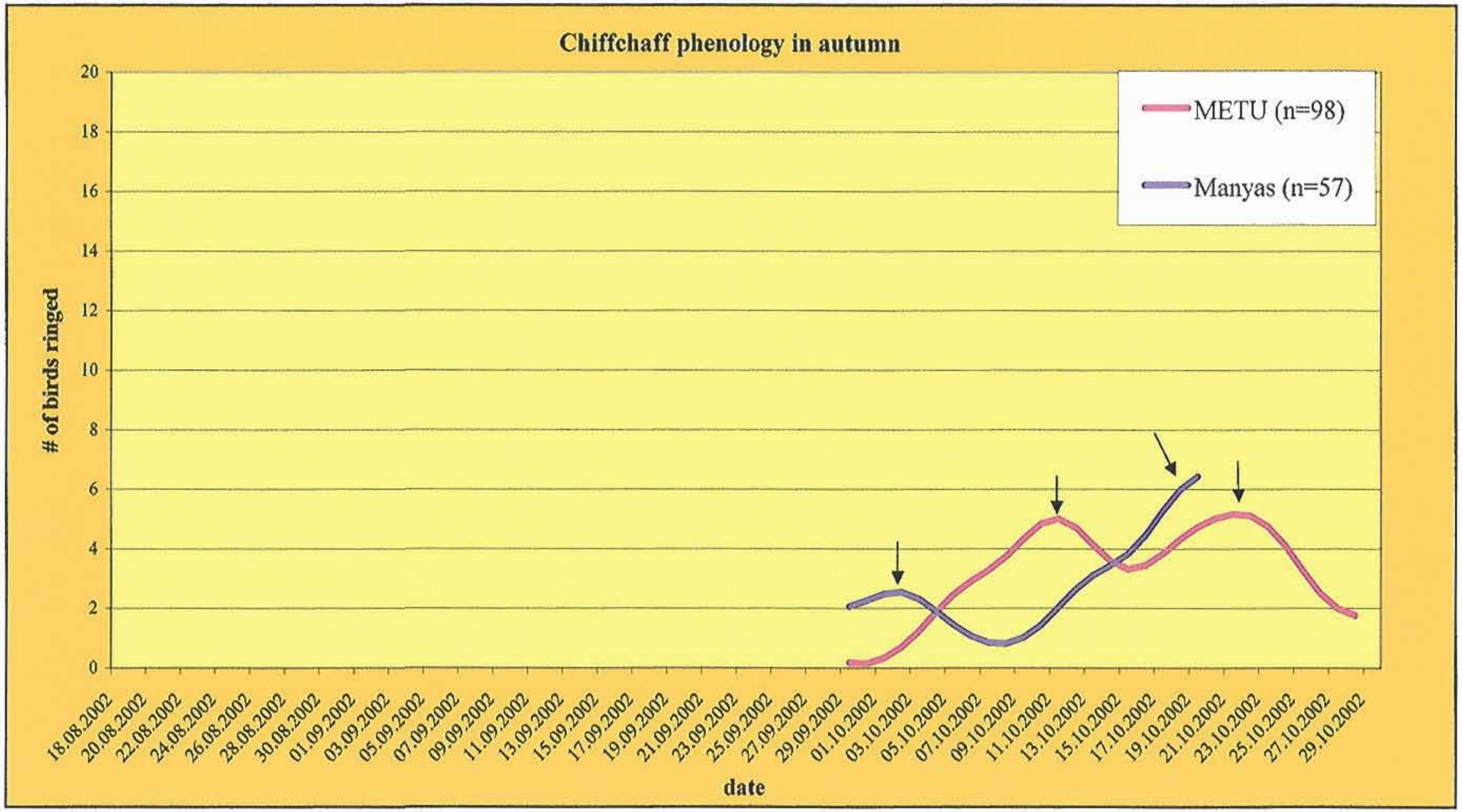

Figure 3.21 Comparison of Chiffchaff migration phenology with Manyas station in autumn 2002

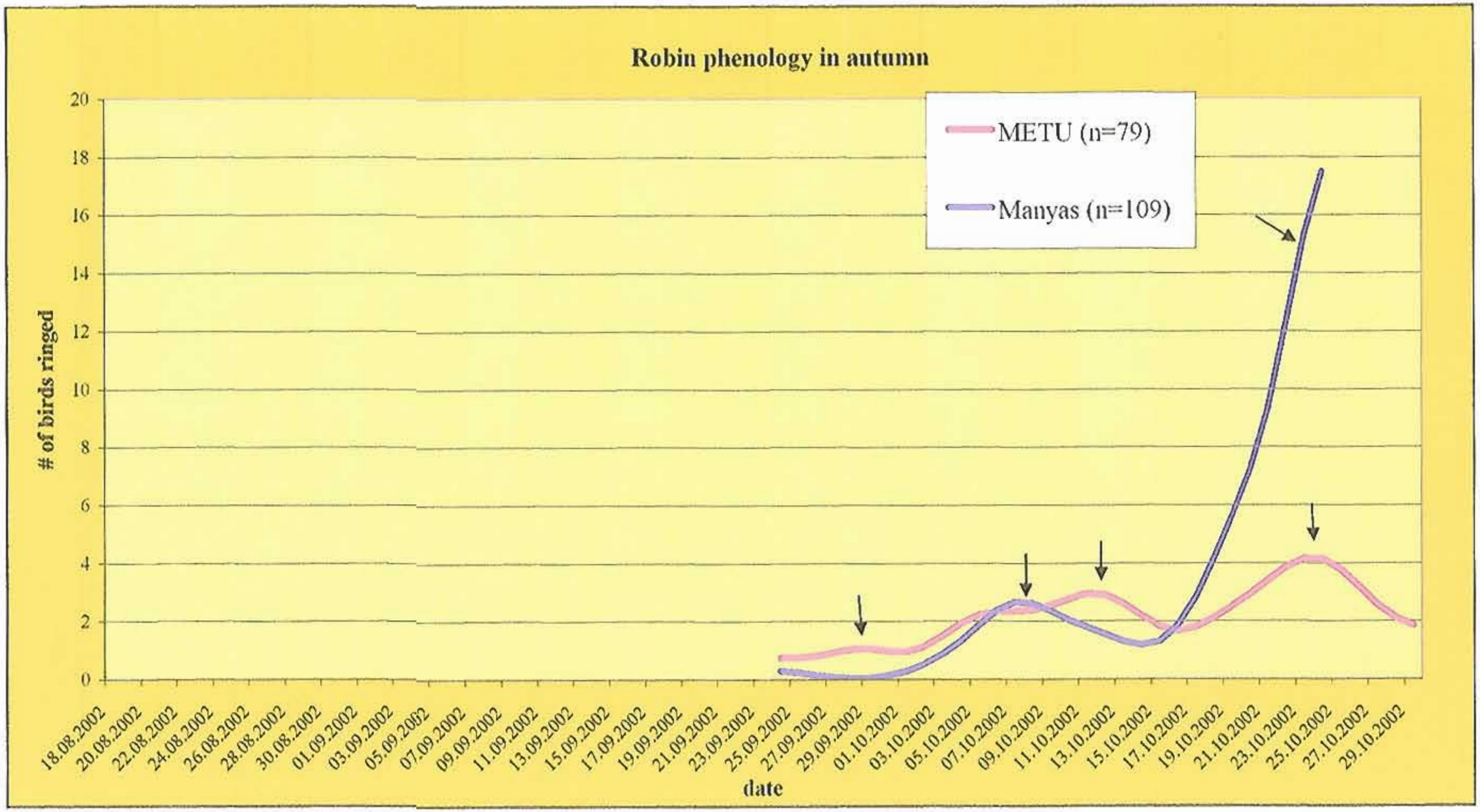

Figure 3.22 Comparison of Robin migration phenology with Manyas station in autumn 2002

3.6 Fat scores

Fat scores were recorded for the majority of individuals captured during the study. However, sample sizes were sufficient only for two species, Blackcap and Willow Warbler. Therefore, relevant analyses only for those two species during autumn 2002 are presented.

3.6.1 Blackcap

Since significant barriers like the Mediterranean and the Sahara are still some considerable distance away, and since it is costly to accumulate excess levels of fat (see section 1.1.2), it is expected that Blackcaps on average should not deposit high levels of fat. Moreover, some populations of this species do not cross the Sahara and may even winter in southern Turkey. Individuals from such populations should have low to medium levels of fat compared to trans-Saharan migrants. This is indeed reflected in the low proportion of individuals (11.5%) with fat scores of 6 and above (Figure 3.23).

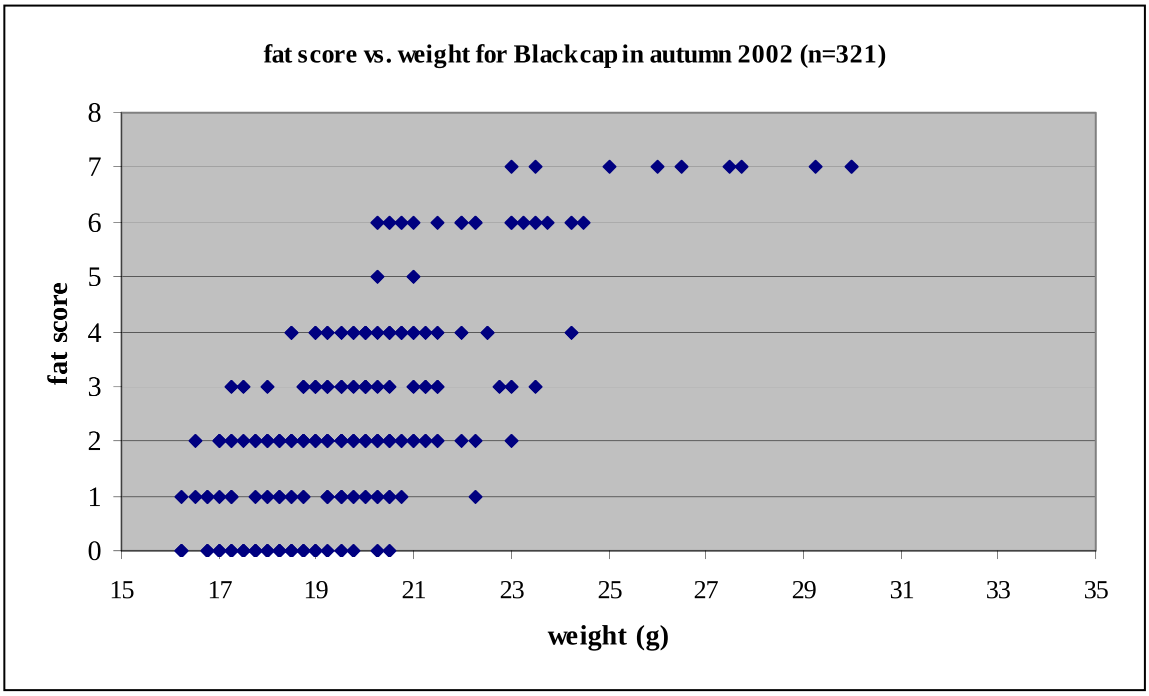

Figure 3.23 Relationship of fat score with weight for all Blackcaps in autumn 2002

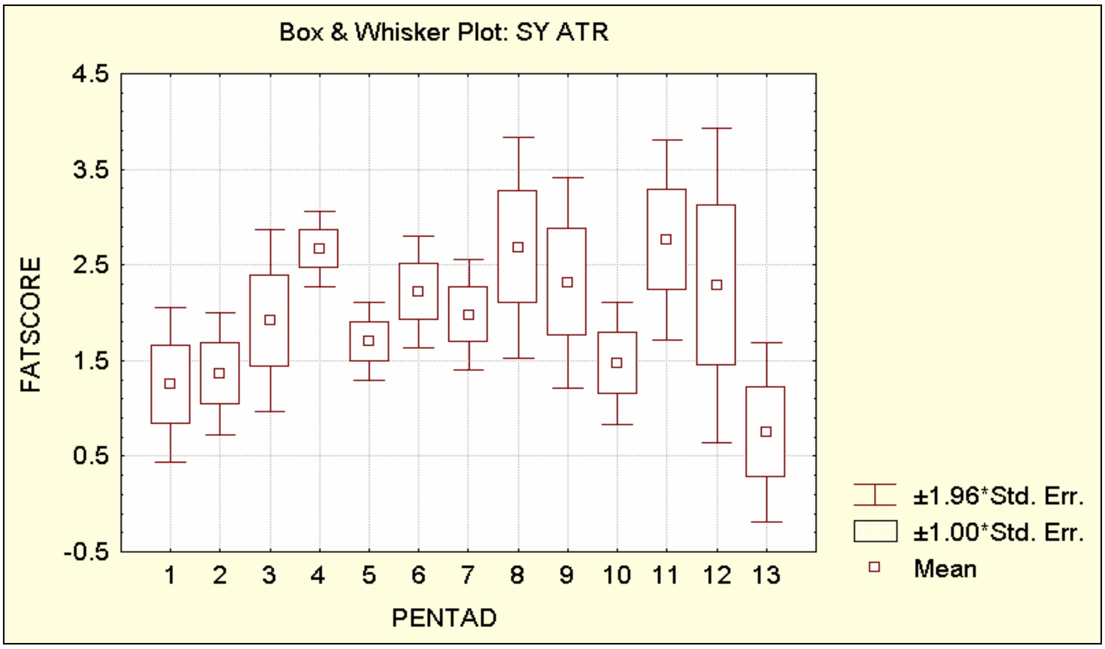

Figure 3.24 Fat scores of all Blackcaps in autumn 2002 by pentads

Average fat scores of caught individuals by pentad (five-day period) show a gradual increase from below 1.5 up to 2.5 within the first 20 days (late August to mid September), followed by fluctations around the latter value, and finally a steep drop down to an average fat score of about 1.0 in the final week (late October) (Figure 3.24).

Statistically, only the difference between the consecutive pentads 4 and 5 are significant. This (and perhaps other such fluctations) may perhaps be explained in that they actually represent separate populations with different strategies, and therefore, fat levels. An examination of the phenology of Blackcap migration for the same period (Figure 3.15) reveals that the boundary between pentads 4 and 5 also separates the waves labelled 2 and 3. Similarly the pentad 10-11 boundary separates waves 5 and 6. Since the origins of those waves (i.e. populations) are not known further elaboration of this finding is not possible.

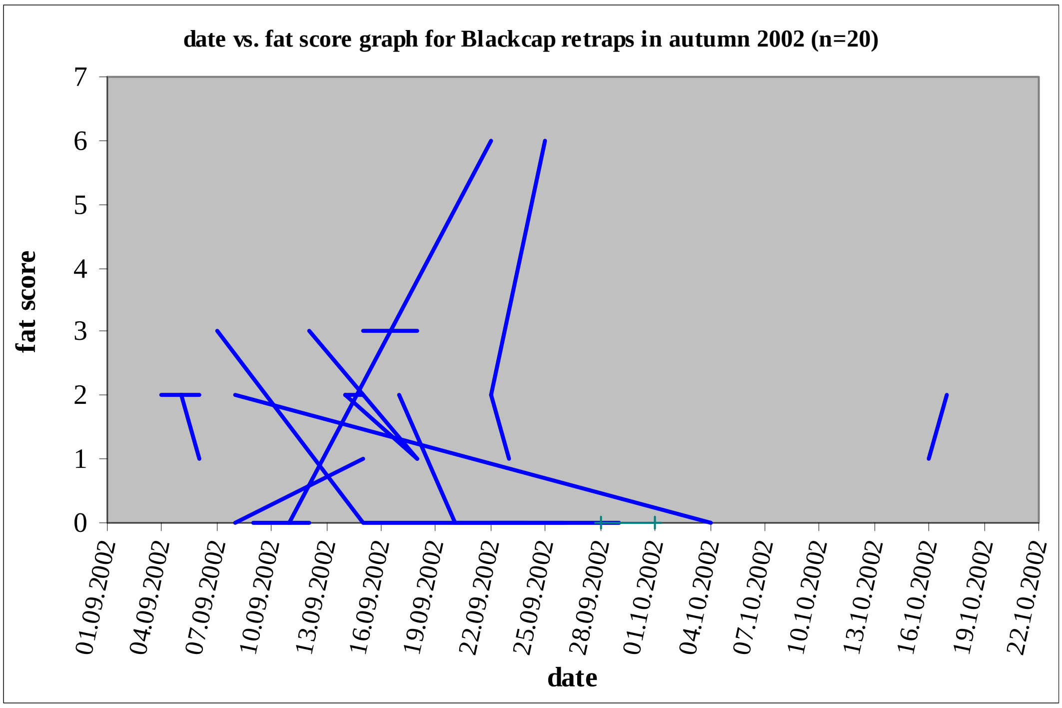

Figure 3.25 Changes in fat scores of retraped Blackcaps in autumn 2002

As can be seen in figure 3.25 among 20 Blackcap retraps, only 2 of them gained considerable amounts of fat (from 0 to 6 in 3 days and from 2 to 6 in 11 days -which put on 5.75 g. (0.53 g/day). All other retraps lost fat, increased only 1-2 scores or stayed at the same level. The former might belong to long distance migrant populations although there is no data to support this. Another explanation is that such birds might occupy and defend higher quality habitat patches compared to others (Alerstam, 1990). Blackcaps consume large amounts of fruits (mainly berries) for fat deposition during migration (Snow and Perrins 1998). There are only very localized source of berry shrubs (Wild Jasmine, *Jasminum fruticans*) at Yalıncak, supporting the second explanation.

3.6.2 Willow Warbler

Willow Warbler is a true trans-Saharan migrant with no populations wintering north of it. Therefore, one should predict higher average fat score levels compared to those of Blackcap. Figure 3.26 shows a much higher proportion of individuals (46%) with fat scores of 6 and above.

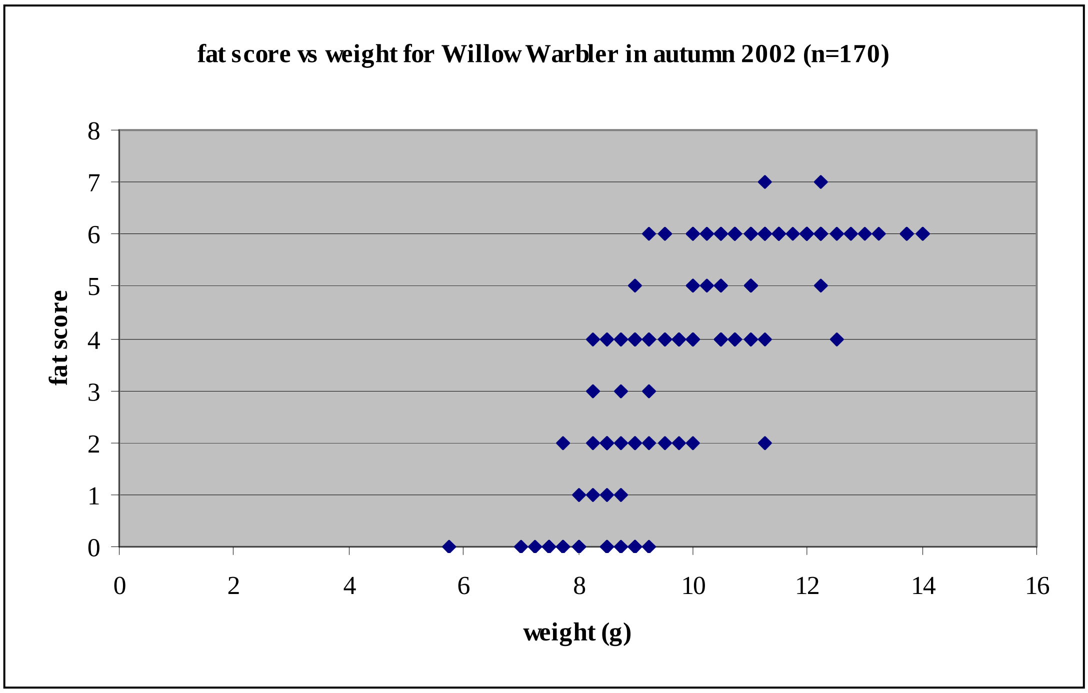

Figure 3.26 Relationship of fat score with weight for all Willow Warblers in autumn 2002

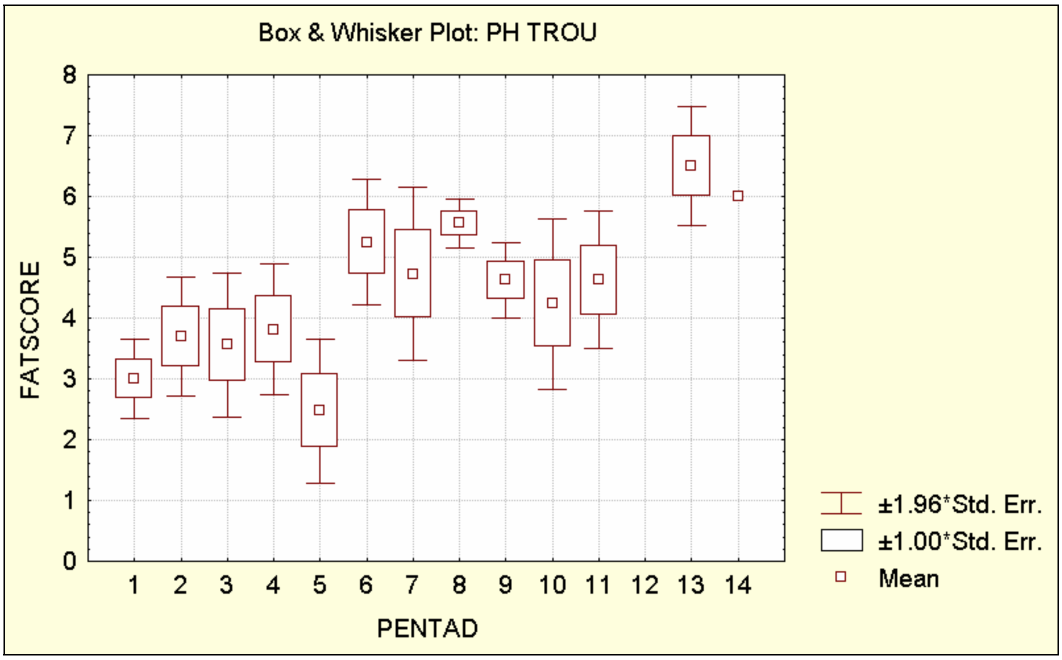

Figure 3.27 Fat scores of all Willow Warblers in autumn 2002 by pentads

Average fat scores of caught individuals by pentad (five-day period) show a significant jump from an average value of about 3.5 during the first month (late August to mid September) to an average value of about 5.0 in the latter part (Figure 3.27).These periods correspond to the first two and the latter two waves, respectively, as shown in Figure 3.16. Again, since the origin of those waves (i.e. populations) are not known further elaboration of this finding is not possible.

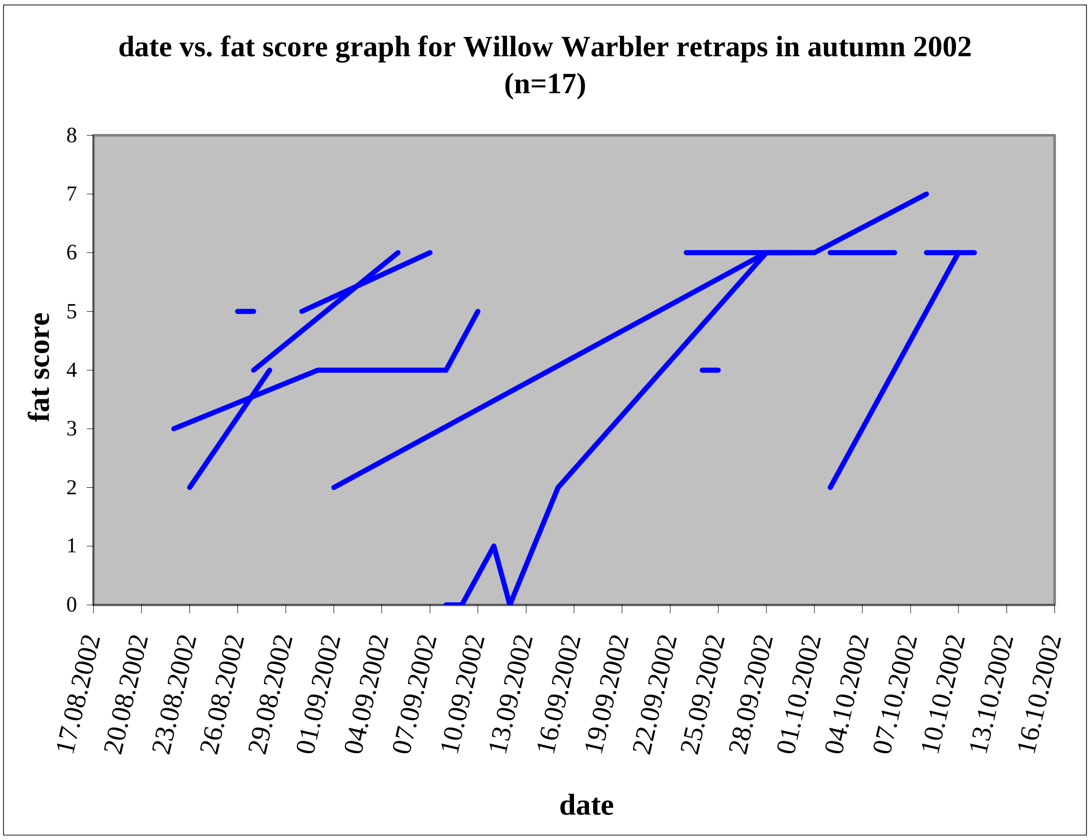

Figure 3.28 Changes in fat scores of retraped Willow Warblers in autumn 2002

It can be seen in figure 3.28 that as a long distance migrant most retraped Willow Warblers gained fat (from 0-6, from 2-7, from 2-6). None of them lost fat but some stayed at the same level but they already had high level of fat.

3.6.3 Other species

The numbers of individuals retraped for other species are too low to permit an analysis similar to that performed for Blackcap and Willow Warbler. However, examining how fat scores of selected individuals of other migrant species changed over time could be carried out (Figure 3.25).

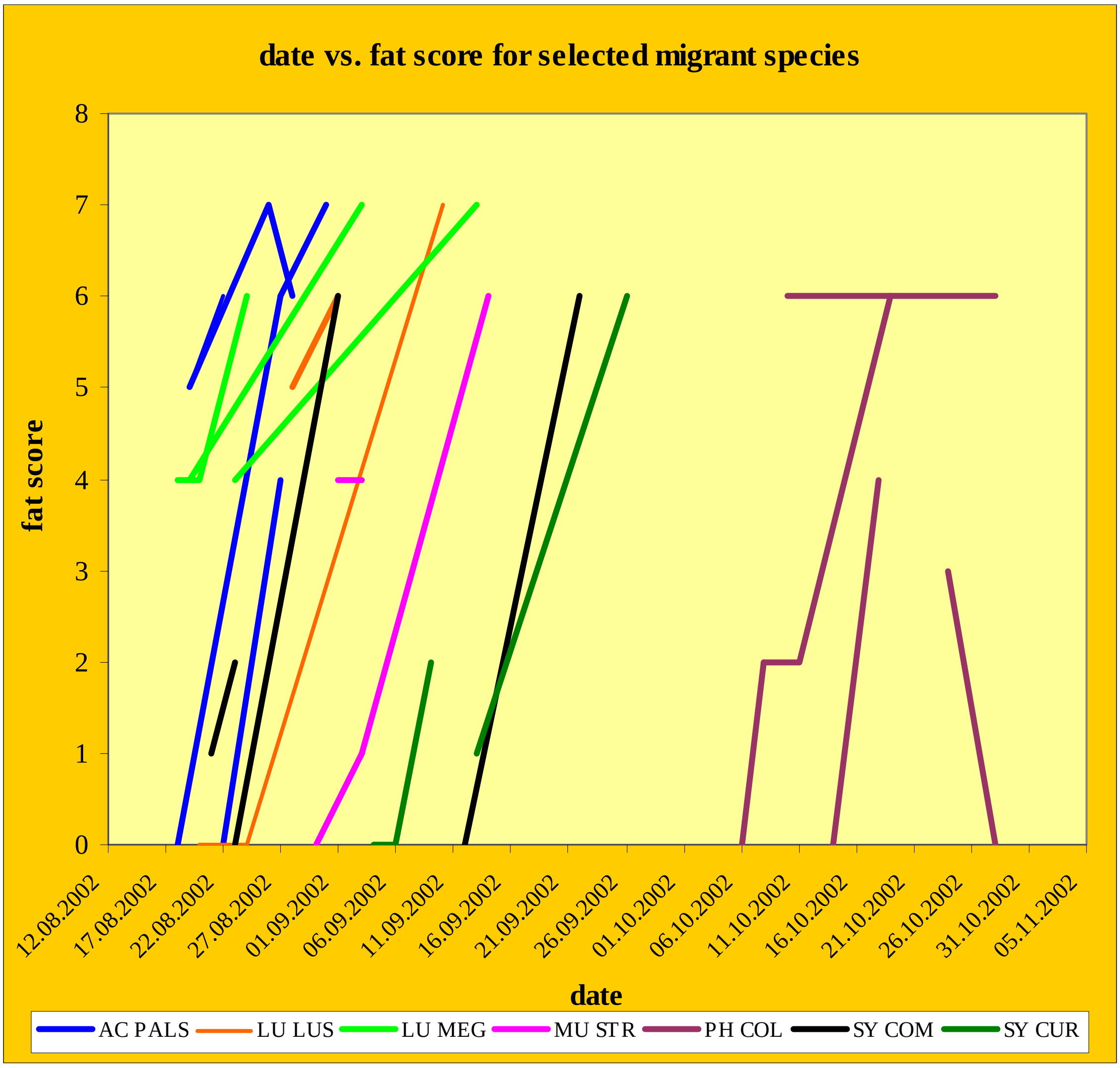

Figure 3.29 Increase of fat score in some selected migrant species through time

Species	Date	Fat score	Weight	Rate of weight increase
LU LUS	20/8/2002 23/8/2002 24/8/2002 10/9/2002	0 0 0 7	22.50 22.25 23.25 32.50	0.57 g./day
SY COM	23/8/2002 01/9/2002	0 6	12.5 19.5	0.78 g./day
AC PALS	18.08.2002 27.08.2002 31.08.2002	0 6 7	11.75 14.50 17.50	0.44 g./day
MU STR	30.08.2002 03.09.2002 14.09.2002	0 1 6	15.00 16.00 21.50	0.43 g./day
LU MEG	23.08.2002 13.09.2002	4 7	23.75 31.00	0.35 g./day

Table 3.4 Increase in fat score and weight for some selected migrant species

3.7. Importance of METU habitats as stopover sites

In Central Anatolia, which is dominated by steppe habitats and agricultural fields, suitable habitats as stopover sites for long distance migrants are scarce. Therefore, even small patches with trees or tall shrubs should be crucial to wide variety of migrant passerines. The diverse number of such species ringed at METU shows that these habitats are indeed utilized by a variety of migrants.

On the other hand, a rough calculation of average daily number of birds caught (after standardization for effort) shows that this number at METU is only half of that in Manyas and less than one third of that in Cernek.

Fat deposition rates show that at least Yalıncak is a high quality stopover site for most migrant species. Many individuals have gained up to around 50% of body weight within a period of a week to 10 days.

CHAPTER 4

CONCLUSION

Ringing is an effective way to study migrants that prefer wooded or shrubby habitats. Although the intensity, location and continuity of the field work varied throughout this study, a diverse and significant passage of passerines over METU was revealed. Moreover, five new species were discovered at this relatively well studied site, which proved the effectiveness of this method in sampling birds, especially those species difficult to identify by sight or sound.

Blackcap and Willow Warbler were the two most common species during spring and autumn migrations at METU. Blackcap was especially dominant in the autumn. In spring, migration intensity was higher in April, and in autumn it was highest during September and October. The start and end dates of the migration period for studied species were not different from that reported in the literature.

Although not as many birds were caught compared to Cernek or Manyas stations, it was shown that a diverse number of species utilize METU habitats as stopover site during their migration. Analysis of fat deposition rates showed that at least Yalıncak serves as a good stopover site for many species to replenish fat reserves. Long distance migrants with still a long way ahead to fly had higher average fat scores compared to those wintering in nearby regions.

As was expected, birds migrate over METU in a series of consecutive, sometimes overlapping, waves. Such waves probably represent populations with different geographical origins and/or migratory strategies. Long-term standardized ringing research is required in order to understand the real nature of these waves and migration strategies of different species and populations.

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APPENDIX A

List of species ringed during the study

Table A.1 Species list in autumn 2001

Species code	Species name (in English)	Species name (in Latin)	# of birds ringed
SY ATR	Blackcap	*Sylvia atricapilla*	84
PA MAJ	Great Tit**	*Parus major*	34
TU MER	Blackbird**	*Turdus merula*	24
ER RUB	European Robin	*Erithacus rubecula*	21
PH TROU	Willow Warbler	*Phylloscopus trochilus*	19
PH COL	Chiffchaff	*Phylloscopus collybita*	19
PH PHO	Common Redstart	*Phoenicurus phoenicurus*	14
CE CET	Cetti's Warbler**	*Cettia cetti*	14
LU MEG	Common Nightingale	*Luscinia megarhynchos*	11
SY CUR	Lesser Whitethroat	*Sylvia curruca*	10
SY COM	Common Whitethroat	*Sylvia communis*	9
FI PAR	Red-breasted Flycatcher	*Ficedula parva*	9
PA CAE	Blue Tit**	*Parus caeruleus*	9
MU STR	Spotted Flycatcher	*Muscicapa striata*	9
LA COL	Red-backed Shrike	*Lanius collurio*	5
FI ALB	Collared Flycatcher	*Ficedula albicollis*	4
JY TOR	Wryneck*	*Jynx torquilla*	4
AC SCI	Reed Warbler	*Acrocephalus scirpaceus*	4
FR COE	Common Chaffinch	*Fringilla coelebs*	4
PR MOD	Dunnock	*Prunella modularis*	4
SA RUB	Whinchat	*Saxicola rubetra*	3
GA GLA	Eurasian Jay**	*Garrulus glandarius*	3
TU PHI	Song Thrush	*Turdus philomelos*	3
PA MON	Eurasian Tree Sparrow**	*Passer montanus*	3
LU LUS	Thrush Nightingale***	*Luscinia luscinia*	3
DE SYR	Syrian Woodpecker*	*Dendrocopos syriacus*	2
SA TOR	Stonechat**	*Saxicola torquata*	2
SY MEL	Sardinian Warbler	*Sylvia melanocephala*	2
HI OLI	Olive-tree Warbler***	*Hippolais olivetorum*	2
EM CIA	Rock Bunting**	*Emberiza cia*	2
PH SIB	Wood Warbler	*Phylloscopus sibilatrix*	2
AC PALS	Marsh Warbler	*Acrocephalus palustris*	2
SY BOR	Garden Warbler***	*Sylvia borin*	2
LA NUB	Masked Shrike	*Lanius nubicus*	1
HI ICT	Icterine Warbler	*Hippolais icterina*	1
TU VIS	Mistle Thrush**	*Turdus viscivorus*	1
TU TOR	Ring Quzel	*Turdus torquatus*	1
ST VUL	Common Starling**	*Sturnus vulgaris*	1
HI PAL	Olivaceous Warbler	*Hippolais pallida*	1
TR TRO	Winter Wren**	*Troglodytes troglodytes*	1
UP EPO	Hoopoe*	*Upupa epops*	1
PA DOM	House Sparrow**	*Passer domesticus*	1
	Total	**42 species**	**351**

Table A.2 Retraps in autumn 2001

Species name	Latin name	Number of birds
Cetti's Warbler**	***Cettia cetti***	5
Common Nightingale	*Luscinia megarhynchos*	1
Great Tit**	*Parus major*	1
Blackbird**	*Turdus merula*	2
Red-backed Shrike	*Lanius collurio*	1
Thrush Nightingale	*Luscinia luscinia*	1
Blackcap	*Sylvia atricapilla*	1
Blue Tit**	*Parus caeruleus*	1
Chiffchaff	*Phylloscopus colybita*	1
Collared Flycatcher	*Ficedula albicollis*	1
Total	**9 species**	**15**

Table A.3 Controls in autumn 2001

Species name	Latin name	Number of birds
Common Nightingale	***Luscinia megarhynchos***	2
Great Tit**	*Parus major*	1
Total	**2 species**	**3**

Table A.4 Birds recovered dead in autumn 2001****

Species name	Latin name	Number of birds
Blackcap	*Sylvia atricapilla*	1
Lesser Whitethroat	*Sylvia curruca*	1
Total	**2 species**	**2**

*non-passerine species
**predominantly non-migratory passerine species excluded from the analysis
***new species for METU

Table A.5 Species list in spring 2002

Species code	Species name (in English)	Species name (in Latin)	# of birds ringed
SY ATR	Blackcap	*Sylvia atricapilla*	52
PH TROU	Willow Warbler	*Phylloscopus trochilus*	46
LU MEG	Common Nightingale	*Luscinia megarhynchos*	35
SY COM	Common Whitethroat	*Sylvia communis*	22
HI PAL	Olivaceous Warbler	*Hippolais pallida*	21
PH COL	Chiffchaff	*Phylloscopus colybita*	20
CE CET	Cetti's Warbler**	*Cettia cetti*	18
AC PALS	Marsh Warbler	*Acrocephalus palustris*	17
ER RUB	European Robin	*Erithacus rubecula*	17
PA MAJ	Great Tit**	*Parus major*	16
AN TRI	Tree Pipit	*Anthus trivialis*	16
TU MER	Blackbird**	*Turdus merula*	14
SY CUR	Lesser Whitethroat	*Sylvia curruca*	12
LA COL	Red-backed Shrike	*Lanius collurio*	11
FI ALB	Collared Flycatcher	*Ficedula albicollis*	10
PA DOM	House Sparrow**	*Passer domesticus*	9
SY NIS	Barred Warbler	*Sylvia nisoria*	8
JY TOR	Wryneck*	*Jynx torquilla*	8
PH SIB	Wood Warbler	*Phylloscopus sibilatrix*	8
EM MEL	Black-headed Bunting	*Emberiza melanocephala*	7
AC SCI	Reed Warbler	*Acrocephalus scirpaceus*	7
LU LUS	Thrush Nightingale	*Luscinia luscinia*	7
DE SYR	Syrian Woodpecker*	*Dendrocopos syriacus*	6
AE CAU	Long-tailed Tit**	*Aegithalos caudatus*	6
AC ARU	Great Reed Warbler	*Acrocephalus arundinaceus*	4
ST VUL	Starling**	*Sturnus vulgaris*	5
GA GLA	European Jay**	*Garrulus glandarius*	3
CA CAR	Goldfinch**	*Carduelis carduelis*	3
RE PEN	European Penduline Tit**	*Remiz pendulinus*	3
MI CAL	Corn Bunting **	*Miliaria calandra*	3
FR COE	Chaffinch	*Fringilla coelebs*	3
EM HOR	Ortolan Bunting	*Emberiza hortulana*	3
SY BOR	Garden Warbler	*Sylvia borin*	2
PA MON	Eurasian Tree Sparrow**	*Passer montanus*	2
CA ERY	Common Rosefinch	*Carpodacus erythrinus*	2
FI PAR	Red-breasted Flycatcher	*Ficedula parva*	2
PI PIC	Magpie**	*Pica pica*	2
OT SCO	Scops Owl*	*Otus scops*	2
SY MEL	Sardinian Warbler	*Sylvia melanocephala*	1
CA CHL	Greenfinch**	*Carduelis chloris*	1
SI NEU	Western Rock Nuthatch**	*Sitta neumayer*	1
CA EUR	European Nightjar*	*Caprimulgus europaeus*	1
CU CAN	Common Cuckoo*	*Cuculus canorus*	1
PA CAE	Blue Tit**	*Parus caeruleus*	1
FI HYP	Pied Flycatcher	*Ficedula hypoleuca*	1
TU VIS	Mistle Thrush**	*Turdus viscivorus*	1
OR ORI	Golden Oriole	*Oriolus oriolus*	1
	Total	**47 species**	**441**

Table A.6 Retraps in spring 2002

Species name	**Latin name**	**Number of birds**
Common Nightingale	*Luscinia megarhynchos*	23
Cetti's Warbler**	*Cettia cetti*	13
Blackcap	*Sylvia atricapilla*	4
Great Tit**	*Parus major*	3
Red-backed Shrike	*Lanius collurio*	3
European Robin	*Erithacus rubecula*	3
Barred Warbler	*Sylvia nisoria*	2
Olivaceous Warbler	*Hippolais pallida*	2
Black-headed Bunting	*Emberiza melanocephala*	2
Chiffchaff	*Phylloscopus colybita*	2
Syrian Woodpecker*	*Dendrocopos syriacus*	1
Western Rock Nuthatch**	*Sitta neumayer*	1
Wryneck*	*Jynx torquilla*	1
Willow Warbler	*Phylloscopus trochilus*	1
Total	**14 species**	**61**

Table A. 7 Controls in spring 2002

Species name	**Latin name**	**Number of birds**
Cetti's Warbler**	*Cettia cetti*	5
Common Nightingale	*Luscinia megarhynchos*	3
Total	**2 species**	**8**

Table A.8 Birds recovered dead in spring 2002****

Species name	**Latin name**	**Number of birds**
Blackbird **	*Turdus merula*	1
Willow Warbler	*Phylloscopus trochilus*	1
Blackcap (both R and D)	*Sylvia atricapilla*	1
Total	**3 species**	**3**

*Non-passerines
** Predominantly non-migratory species excluded from the analysis

Table A.9 Species list in autumn 2002

Species code	Species name (in English)	Species name (in Latin)	Number of birds
SY ATR	Blackcap	*Sylvia atricapilla*	308
PH TROU	Willow Warbler	*Phylloscopus trochilus*	145
PH COL	Chiffchaff	*Phylloscopus colybita*	98
ER RUB	European Robin	*Erithacus rubecula*	79
PH PHO	Common Redstart	*Phoenicurus phoenicurus*	42
PA MAJ	Great Tit**	*Parus major*	37
MU STR	Spotted Flycatcher	*Muscicapa striata*	36
FI PAR	Red-breasted Flycatcher	*Ficedula parva*	28
FR COE	Chaffinch	*Fringilla coelebs*	28
SY BOR	Garden Warbler	*Sylvia borin*	22
SY CUR	Lesser Whitethroat	*Sylvia curruca*	20
AC PALS	Marsh Warbler	*Acrocephalus palustris*	19
CA SPI	Eurasian Siskin	*Carduelis spinus*	19
AN TRI	Tree Pipit	*Anthus trivialis*	16
CE CET	Cetti's Warbler**	*Cettia cetti*	15
SY COM	Common Whitethroat	*Sylvia communis*	13
TU MER	Blackbird**	*Turdus merula*	13
FI ALB	Collared Flycatcher	*Ficedula albicollis*	12
AE CAU	Long-tailed Tit**	*Aegithalos caudatus*	12
TU PHI	Song Thrush	*Turdus philomelos*	11
GA GLA	European Jay**	*Garrulus glandarius*	10
PH SIB	Wood Warbler	*Phylloscopus sibilatrix*	9
PA CAE	Blue Tit**	*Parus caeruleus*	9
LA NUB	Masked Shrike	*Lanius nubicus*	8
LA COL	Red-backed Shrike	*Lanius collurio*	8
LU LUS	Thrush Nightingale	*Luscinia luscinia*	7
SA TOR	Stonechat**	*Saxicola torquata*	7
LU MEG	Common Nightingale	*Luscinia megarhynchos*	6
DE SYR	Syrian Woodpecker*	*Dendrocopos syriacus*	5
PR MOD	Dunnock	*Prunella modularis*	4
ST VUL	Starling**	*Sturnus vulgaris*	3
OT SCO	Scops Owl*	*Otus scops*	3
HI ICT	Icterine Warbler	*Hippolais icterina*	2
RE REG	Firecrest	*Regulus ignicapillus*	2
SY MEL	Sardinian Warbler	*Sylvia melanocephala*	2
JY TOR	Wryneck*	*Jynx torquilla*	2
CA EUR	European Nightjar*	*Caprimulgus europaeus*	2
SA RUB	Whinchat	*Saxicola rubetra*	1
EM MEL	Black-headed Bunting	*Emberiza melanocephala*	1
OR ORI	Golden Oriole	*Oriolus oriolus*	1
EM HOR	Ortolan Bunting	*Emberiza hortulana*	1
PH ORI	Eastern Bonelli’s Warbler***	*Phylloscopus orientalis*	1
PA ATE	Coal Tit**	*Parus ater*	1
AC BRE	Levant Sparrowhawk*	*Accipiter brevipes*	1
HI PAL	Olivaceous Warbler	*Hippolais pallida*	1
HI OLI	Olive-tree Warbler	*Hippolais olivetorum*	1
CA ERY	Common Rosefinch	*Carpodacus erythrinus*	1
SI NEU	Western Rock Nuthatch**	*Sitta neumayer*	1
AC SCI	Reed Warbler	*Acrocephalus scirpaceus*	1
SE SER	European Serin	*Serinus serinus*	1
ME API	European Bee-eater*	*Merops apiaster*	1
TU VIS	Mistle Thrush**	*Turdus viscivorus*	1
TR TRO	Winter Wren**	*Troglodytes troglodytes*	1
	Total	**53 species**	**1,078**

Table A.10 Retraps in autumn 2002

Species name	Latin name	Number of birds
Cetti's Warbler**	*Cettia cetti*	44
Willow Warbler	*Phylloscopus trochilus*	32
Blackcap	*Sylvia atricapilla*	27
European Robin	*Erithacus rubecula*	15
Great Tit**	*Parus major*	12
Common Nightingale	*Luscinia megarhynchos*	7
Marsh Warbler	*Acrocephalus palustris*	7
Chiffchaff	*Phylloscopus collybita*	7
Blackbird**	*Turdus merula*	5
Thrush Nightingale	*Luscinia luscinia*	4
Long-tailed Tit**	*Aegithalos caudatus*	4
Blue Tit**	*Parus caeruleus*	4
Red-backed Shrike	*Lanius collurio*	3
Spotted Flycatcher	*Muscicapa striata*	3
Common Whitethroat	*Sylvia communis*	3
Lesser Whitethroat	*Sylvia curruca*	3
Common Redstart	*Phoenicurus phoenicurus*	2
Masked Shrike	*Lanius nubicus*	2
Collared Flycatcher	*Ficedula albicollis*	1
Total	**19 species**	**185**

Table A.11 Controls in autumn 2002

Species name	Latin name	Number of birds
Great Tit**	*Parus major*	9
Cetti's Warbler**	*Cettia cetti*	6
Common Nightingale	*Luscinia megarhynchos*	5
Long-tailed Tit**	*Aegithalos caudatus*	2
Blackbird**	*Turdus merula*	2
Total	**5 species**	**24**

Table A.12 Birds recovered dead in autumn 2002****

Species name	Latin name	Number of birds
Common Redstart	*Phoenicurus phoenicurus*	2
Chiffchaff	*Phylloscopus colybita*	2
River Warbler***	*Locustella fluviatilis*	1
Spotted Flycatcher	*Muscicapa striata*	1
Blackcap	*Sylvia atricapilla*	1
Total	**5 species**	**7**

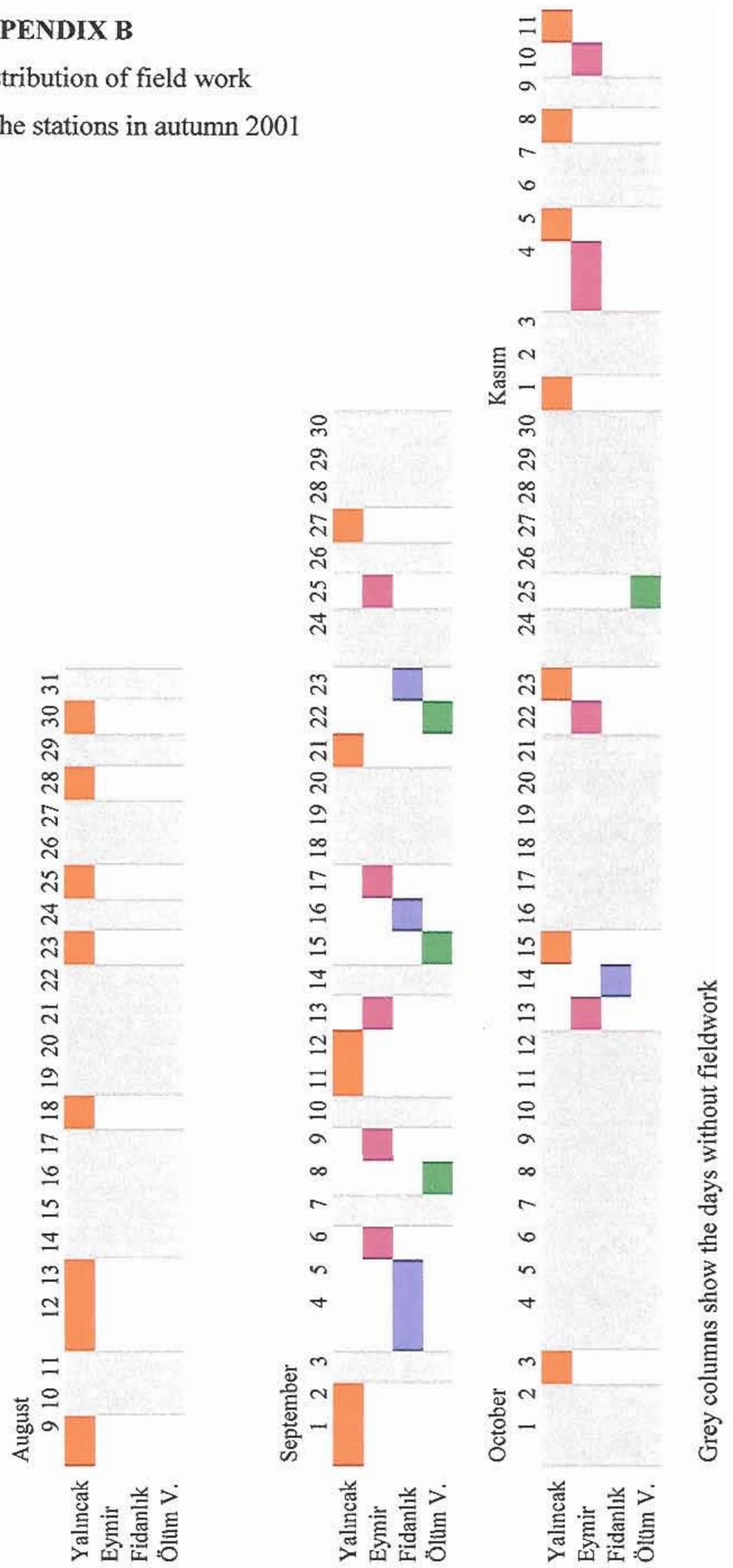
* non-passerines (Levant Sparrowhawk is also a new species for METU)
** predominatly non-migratory passerine species excluded from the analysis
*** new species for METU

****These birds died because of predation (domestic cat or birds). Domestic cat was caught and removed from the area.

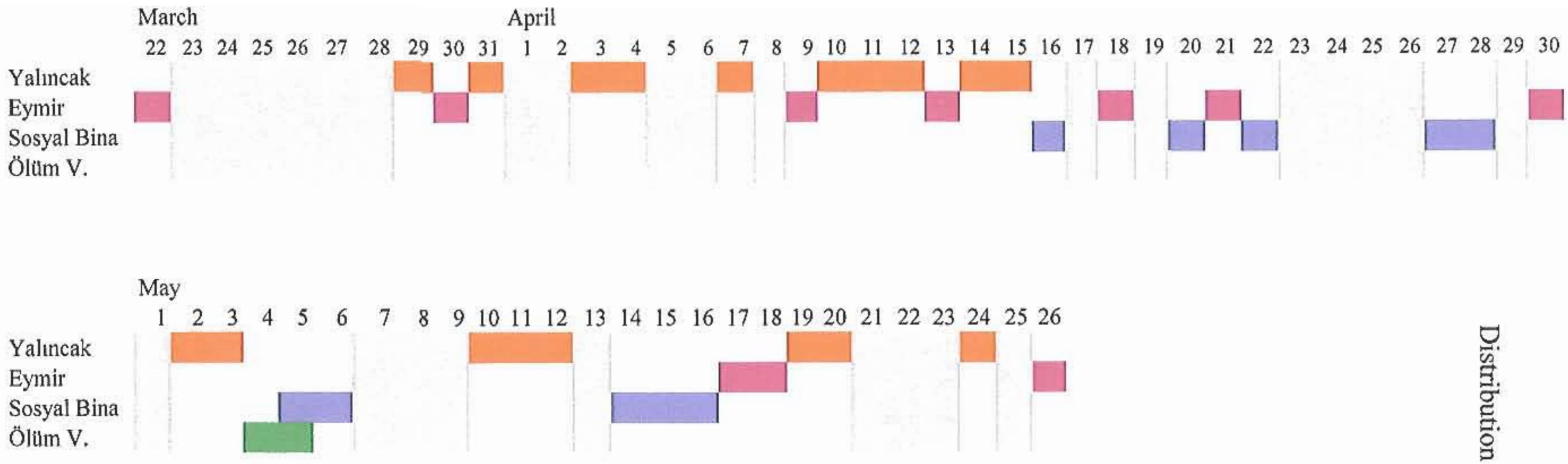
APPENDIX B

Distribution of field work

to the stations in autumn 2001



Distribution of fieldwork to the station in spring 2002



Grey columns show the days without fieldwork

APPENDIX C

Key to the fat determination

(afterBusse 1983 and Kaiser 1993, combined) (Busse, 2000)

Determination of fat goes through three levels;
Level I- belly
Level II- furculum
Level III- pectoral muscles

I. 1) Belly is without visible fat or with reddish traces only- **IIA**

2) Belly with infused bands of fat (intestinum is visible)…………………...........**2**

3) Belly has a fused cover of fat; intestinum is not but the liver is visible……….**3**

4) Belly is completely covered with fat, a very narrow band of the liver may be visible but, if this is so, the roll of fat is just above it- **II B**

II A. 1)Air-sack is visible within furculum (some fat may ocur)…………………..…**0**

2) All the interior of furculum is covered with fat…………………………...**1**

II B. 1) Fat in furculum flat or concave……………………………………...........**4**

2) Fat in furculum forms a convex cushion- **III**

III. 1) Sides of pectoral muscles without stripes of fat……………………….........**5**

2) Sides of pectoral muscles with stripes of fat………………………………..**6**

3) Pectoral muscles partly covered with fat………………………………........**7**

4) Pectoral muscles completely covered with fat…………………….................**8**

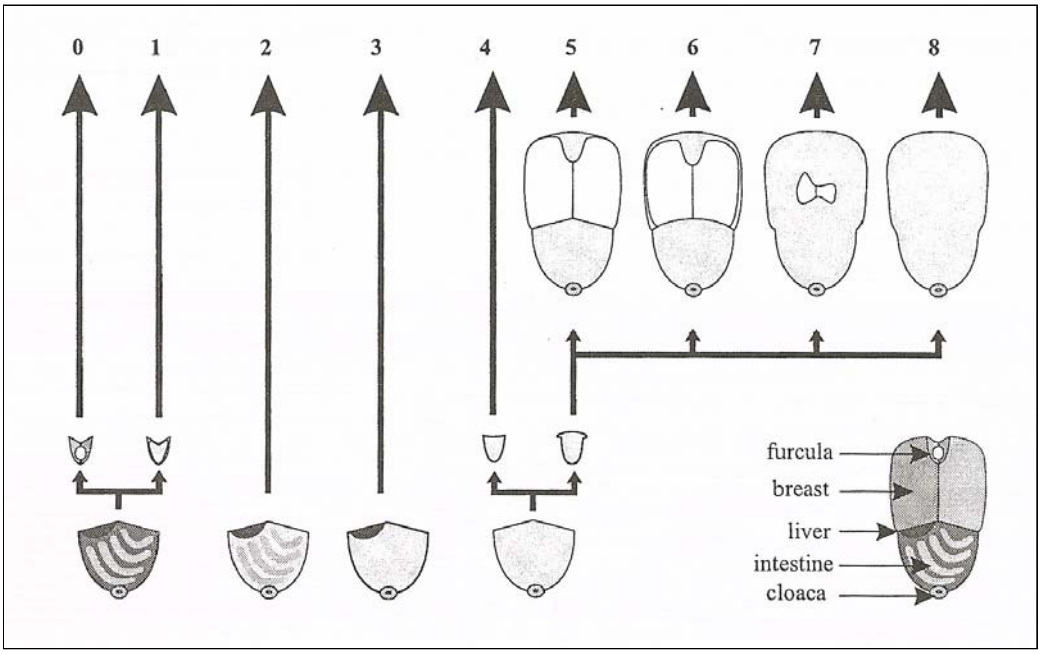


Figure C.1 Key to the fat determination

APPENDIX D

Passerine bird numbers ringed by species in all seasons

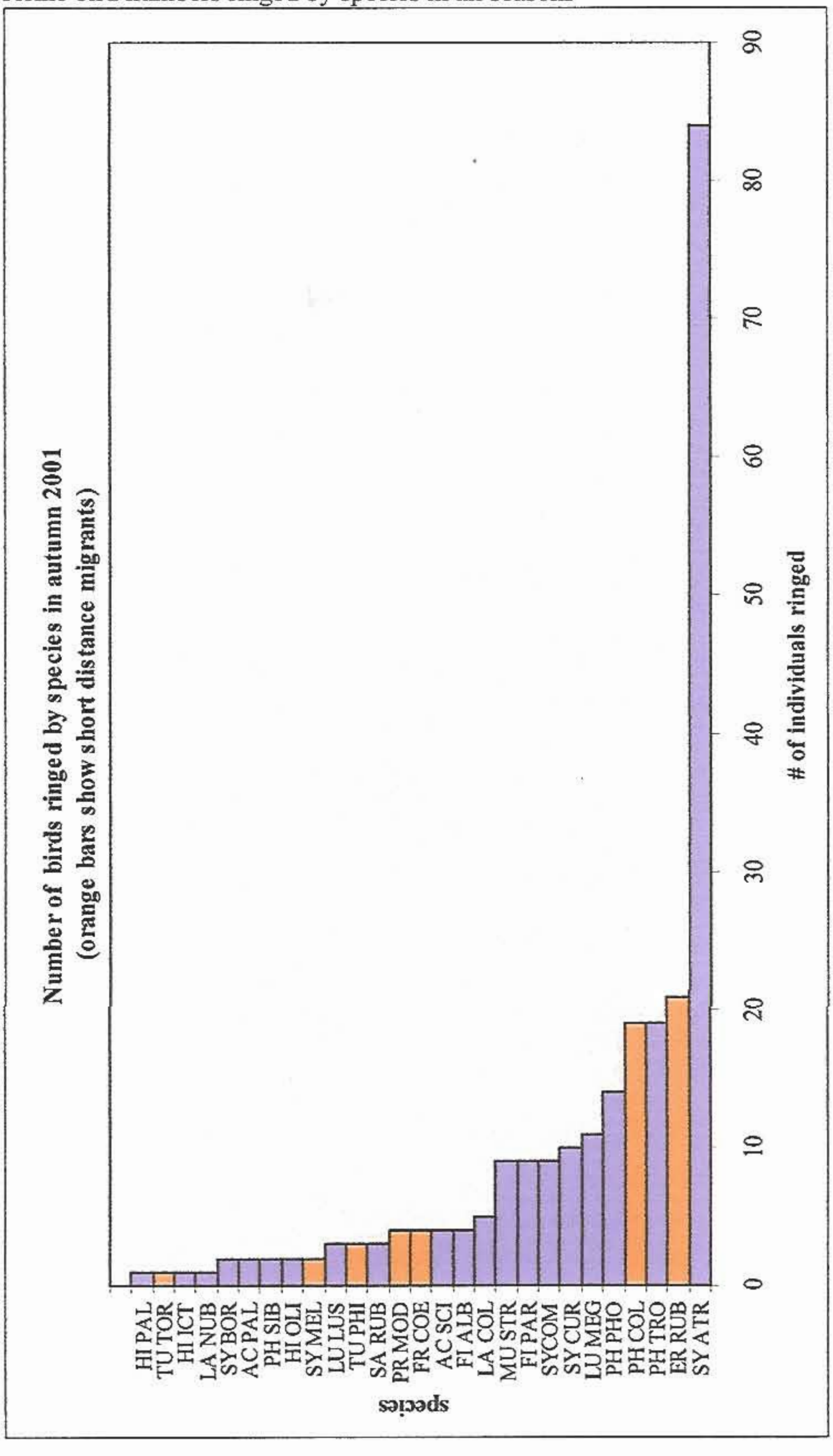


Figure D.1 Passerine bird numbers ringed by species in autumn 2001

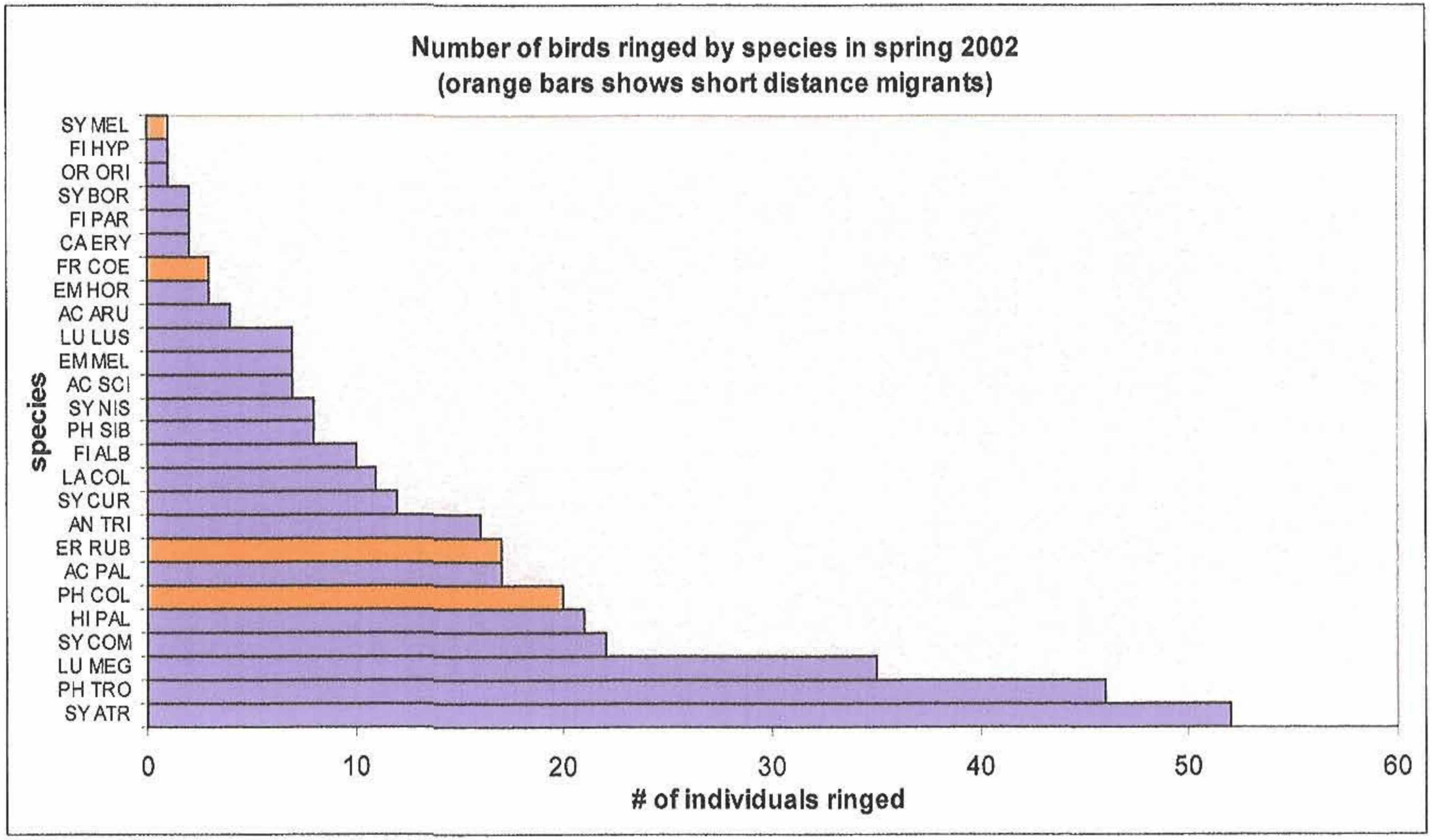


Figure D.2 Passerine bird numbers ringed by species in spring 2002

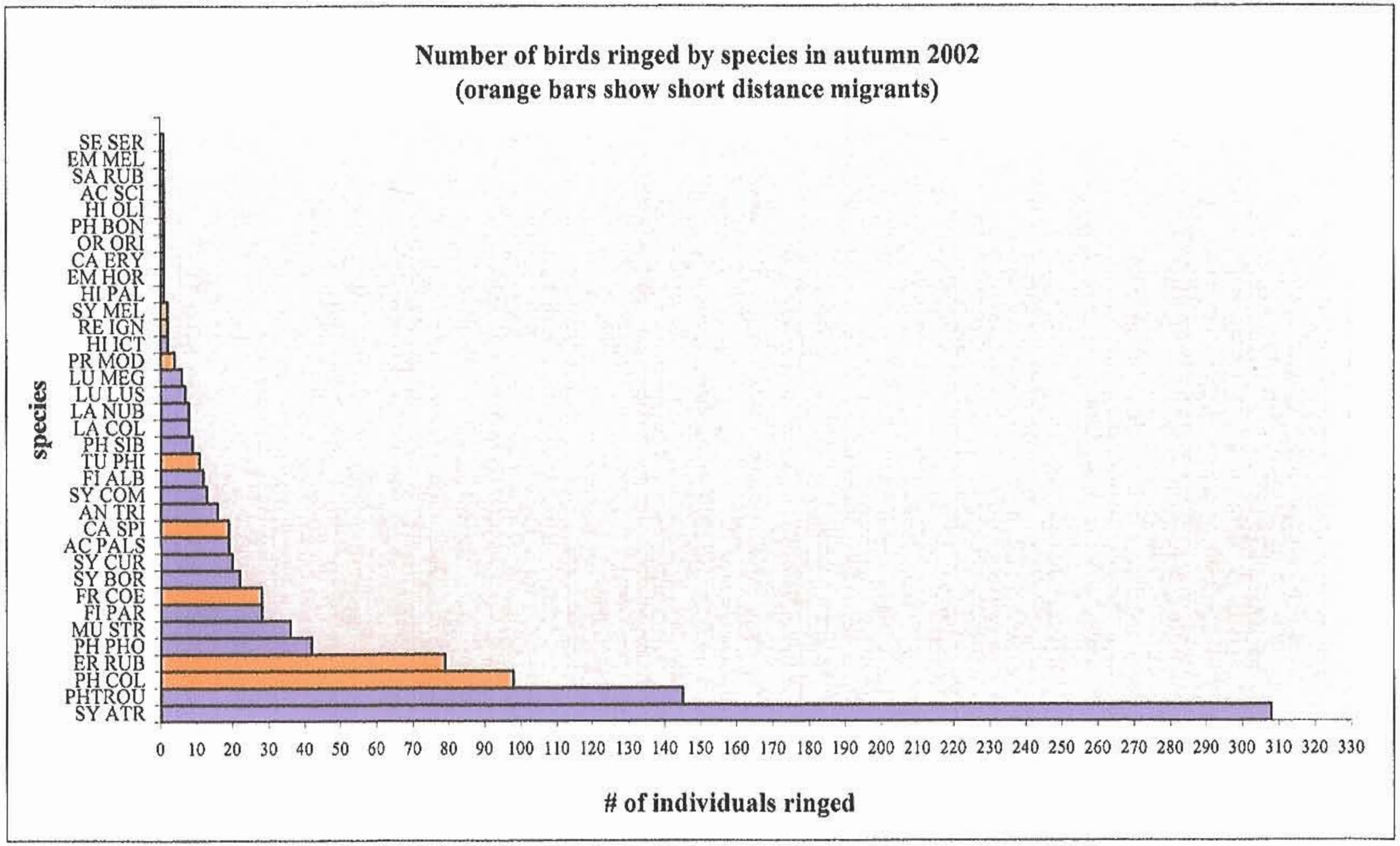


Figure D.3 Passerine bird numbers ringed by species in autumn 2002

APPENDIX E
Photographs

Willow Warbler & Chiffchaff
Phylloscopus trochilus &
Phylloscopus collybita

Robin
Erithacus rubecula

Olive-tree Warbler
Hippolais olivetorum

Thrush Nightingale
Luscinia luscinia

Blackcap
Sylvia atricapilla

Garden Warbler
Sylvia borin

Whitethroat
Sylvia communis

Red-backed Shrike
Lanius collurio

Olivaceous Warbler
Hippolais pallida

Reed Warbler
Acrocephalus scirpaceus

Great Tit
Parus major

Nightingale
Luscinia megarhynchos

Non-Passerines

Levant Sparrowhawk
Accipiter brevipes

Cuckoo
Cuculus canorus

Bee-eater
Merops apiaster

Scops Owl
Otus scops

Measurements