

## Inter-annual variation in clutch size and laying date of Rufous Bush Chats *Cercotrichas galactotes* inhabiting an Algerian oasis



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### ABSTRACT

We studied clutch size and timing of breeding of Rufous Bush Chats *Cercotrichas galactotes* inhabiting Date Palm plantations in an oasis in NE Algeria with respect to interannual variation. Although oases may be assumed to provide relatively stable ecological conditions favourable for some insectivorous birds, including Rufous Bush Chats, we found relatively high year-to-year variation in the life history traits analysed. In general, clutch size was negatively related to the egg-laying date, with this relation differing between years. This suggests that clutch size was probably determined by a combination of within-year and between-year factors partly operating through the timing of reproduction. The most important of these factors were probably the amount of rainfall and year-to-year growth of palm trees.

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## 1. Introduction

Natural selection favors organisms that produce the largest number of offspring which survive to breed. Life history traits mainly result from the way in which energy intake of animals is allocated into growth, survival and reproduction (Williams, 1966; Stearns, 1992). In birds, clutch size is considered to reflect the number of young that the parents can properly nourish in current conditions. Therefore clutch size may be influenced by a variety of factors (Kluijver, 1951; Lack, 1954; Högstedt, 1980; Slagsvold, 1982, 1989; Williams, 2012). Main factors could be abiotic (temperature, precipitation, solar activity, pollution) or biotic (predation, parasitism, competition, genetics of parents).

The decision about when to start laying eggs during the breeding season is very important for the purpose of achieving success in reproduction. A general feature of many passerines that breed in seasonally-changing environments is a seasonal decline in clutch size as breeding season progresses (Perrins and McCleery,

1989; Nilsson and Svensson, 1993; Visser et al., 2010). Two groups of hypotheses have been proposed to explain this pattern. Firstly, higher quality parents (breeding on good quality territories) can produce larger clutch size and are able to breed early in the season. Secondly, some characteristics of the environment change with the progress of the breeding season (e.g. abundance of food) (Svensson, 1997; Nilsson, 2000; Jankowiak et al., 2014). Especially, weather conditions are important because variable precipitation levels and temperature characteristics affect the availability and phenology of invertebrate prey for insectivorous passerines (Mellanby, 1939; Lack, 1954). Cavity nesters (like tits) use environmental cues to synchronise their breeding cycle with caterpillar abundance (Perrins and McCleery, 1989), but breeding parameters of the open nesters (like thrushes), may be also explained to some degree by the availability of different prey that may be shifting within and between seasons (Cramp et al., 1998).

In this study we make an attempt to identify the main factors which determine variation in clutch size and laying date in a population of the Rufous Bush Chat (*Cercotrichas galactotes*), an insectivorous species inhabiting a north-east Algerian oasis. In most of its area of distribution, Rufous Bush Chats inhabit bushy habitats

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(Cramp et al., 1998), while our study population breeds in intensely cultivated palm tree plantations that are arguably a secondary habitat for this species (Tabib et al., 2016). Oases are isolated plantations usually surrounded by an inhospitable desert matrix, but they provide many birds with habitat islands useful for breeding. Fruit trees and associated vegetation of plantations produce a microclimate that contrasts with the harsh conditions of the desert environment (Selmi et al., 2002). Therefore, those vegetation islands may be inhabited by non-desert species, mainly by birds from the forest or bushy environments (Selmi et al., 2003). North African oases may offer important opportunities to conserve biodiversity in arid and semi-arid areas where fragmented natural habitats are unlikely to be restored (Selmi et al., 2002; López-Pomares et al., 2015). Additionally, knowledge on the breeding ecology of the Rufous Bush Chat is still far from complete (Palomino et al., 1999). There are only a few studies lasting several breeding seasons (also the numbers of breeding pairs are usually low, López and Gil-Delgado, 1988) and their main focus is often on nest parasitism. The Rufous Bush Chat is a host of the Common Cuckoo (*Cuculus canorus*) in the Mediterranean area (Alvarez, 2000), but not in the central part of North Africa (Cramp et al., 1998; Tabib et al., 2016).

The desert surroundings of oases are harsh environments but are also thought to be climatically and ecologically stable (Shachak et al., 2005; Nicholson, 2011). Therefore, it seemed justified to presume that the environmental conditions of oases should be relatively stable too. The main aim of this study is 1) to test inter-annual differences and 2) to examine intra-seasonal differences in clutch size. As a consequence, we hypothesized that the timing of breeding and clutch size of Rufous Bush Chats should not markedly differ between years. On the other hand, we predicted that clutch size of these insectivorous birds should decrease with the progress of the breeding season because weather becomes more and more hot and dry in spring, which should limit the availability of prey.

## 2. Methods

This study was carried out during 5 breeding seasons (2008–2009 and 2011–2013) in Al Amri Oasis (34°41' N; 5°15' E, altitude about 150 m a.s.l.), north Algeria. In the study area Date Palm (*Phoenix dactylifera*) is the dominating species with smaller numbers of Common Fig (*Ficus carica*) and Pomegranate (*Punica granatum*) also occurring (Adamou et al., 2014). The climate is arid (mean yearly temperatures of 23.3 °C and rainfall about 130 mm per year), therefore all the plantations are watered all year around by artificial irrigation systems. The efficiency of orchards in achieving high productivity requires keeping a specific age/size and spatial structure (individual trees being spaced 8 m apart from one another) of trees within plantations. That is why the whole area consists of a mosaic of plots differing in the age of palm trees, with palm trees growing in height about 40 cm per year (Tabib et al., 2016). For the present study we sampled 11 orchards with Date Palm trees up to 10 m high. Predators occurring in the study area and occasionally seen to depredate avian nests include: the Common Genet (*Genetta genetta*), Viperine Snake (*Natrix maura*) and Horseshoe Whip Snake (*Hemorrhois hippocrepis*). There were no active avian predators in the area (Adamou et al., 2014). We used precipitation sums between February and May each year as simple indicator of rainfall conditions. The respective values were as follows, for 2008: 10.17 mm, 2009: 44.46 mm, 2011: 131.31 mm, 2012: 12.14 mm, 2013: 46.22 mm. The local temperatures for the study area were obtained from TuTiempo.net database (<http://en.tutiempo.net/>).

A random sample of Date Palm trees from the same plantation was measured at different age (2, 6, 10 and 14 year old). The plantation was expanded by a new planted area of 1 ha every 4

years. The soil, the irrigation, the tree spacing (light), and Date Palm variety remained the same in the whole area of plantation. The age (height) of the palms was the only changing structural characteristic of the plantation. The height was correlated with the age of Palm trees (Fig. 1;  $r = 0.94$ ,  $N = 75$ ,  $p < 0.0001$ ). The height of the palms was measured as a distance between the soil level and the inflorescence (location of the Rufous Bush Chat nests).

The study area was systematically tree-by-tree searched for nests once a week, starting in late February and finishing in late July each year. The Rufous Bush Chat is a migratory species and arrives at Al Amri Oasis in early April. Females produce only one clutch per year in the study population (Tabib et al., 2016). Once found, the active nests were inspected twice a week to record basic breeding characteristics, including the date of the first egg laying, clutch size and brood size at different stages. When the appearance of the first egg was not directly recorded, the date was calculated assuming that one egg is laid per day (Cramp et al., 1998). In this paper we included the data on 93 complete clutches. Because adult Rufous Bush Chats were not individually marked in this study, bird-age effects were not considered. No annual mortality estimations are available either, but it seems likely that mortality is at least as high as in other migrating passerines, 60–70% (Lack, 1954; Perrins and Birkhead, 1983; Mead, 1985). Therefore we assume that an influence of records of clutches of the same individual birds on our analyses is rather weak.

Separate general linear models were first computed to test for between-year variation in the laying date and clutch size. To examine a relationship between clutch size and laying date, both these variables were centered within year and, then, analysed using another general linear model (Crawley, 2002; Heck et al., 2010). The most important purpose of this analysis was to examine an effect of the year-laying date interaction on clutch size. The centered laying dates and clutch sizes were also used to calculate a linear mixed model of the relation between clutch size and laying date, with year treated as a random effect and the Satterthwaite method used to estimate degrees of freedom (Crawley, 2002; Heck et al., 2010). All statistical analyses were performed using the IBM SPSS software (Heck et al., 2010).

## 3. Results

Based on 93 complete clutches recorded in 2008–2013, the grand mean laying date was 24 May (day number starting from 1 April:  $53.73 \pm 1.98$  (SE)). Mean laying dates ranged from 18 May (2011) to 6 June (2013) and were significantly variable among years

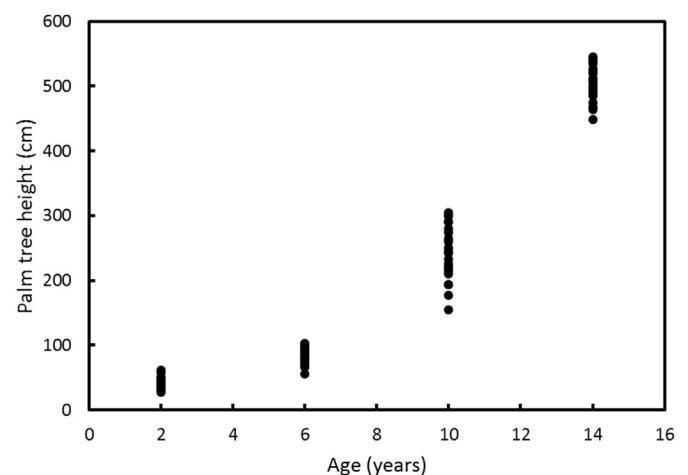


Fig. 1. Relationship between height and age of palm trees in Al Amri Oasis.

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