The Behavioural Ecology, Local Population Dynamics and Conservation of the Bearded Reedling *Panurus Biarmicus* in “El Hondo Natural Park” (SE Spain)

Ignacio García Peiró

Department of Ecology and Hidrology, Faculty of Biology, University of Murcia, Espinardo, Murcia, Spain

Email address: ignacio.peiro@yahoo.es

To cite this article:
Ignacio García Peiró. The Behavioural Ecology, Local Population Dynamics and Conservation of the Bearded Reedling *Panurus Biarmicus* in “El Hondo Natural Park” (SE Spain). *Ecology and Evolutionary Biology*. Vol. 2, No. 2, 2017, pp. 25-33. doi: 10.11648/j.eeb.20170202.12

Received: February 28, 2017; Accepted: March 9, 2017; Published: March 28, 2017

Abstract: The behavioural ecology of the Bearded Reedling *Panurus biarmicus* in wild using data available from mist-netting has received little attention. One of such aspects is to evaluate if flock composition and structure vary among reed successional stages and facilities dispersal among near wetlands in small and semi-isolated populations by analysing mist-netting capture events. This study shows that mist-netting events comprised catches of solitary birds or small groups in samples from small to moderate size. Overall mean frequency of each flock result in a population of low aggregation at low densities and being lower than reported from bigger central Spanish populations. A majority of birds of these flocks are "transients", characterized by have shorter wing lengths and smaller body masses compared to "residents", which attain higher body masses and longer wing lengths. Residents have the ability to settle in unmanaged sparse habitats in the periphery of the wetlands and the possibility to undertake longer flights outside wetlands is greater due to a higher condition and performance. Since a high overnight mass loss of birds has been verified in this study, I hypothesize that Bearded Reedlings move in short-times elapsed from sunset (before arriving at the roosts) to sunrise, so earlier surveys carried out in wetlands might give inadequate results to monitoring Bearded Reedling’s populations, demanding alternative methods to survey them properly. Due to the occurrence of such residents, the importance of saltmarshes with reed sparse-patches in the periphery of wetlands results in a key factor for the dispersal of this species.

Keywords: Bearded Reedling, Dispersal, Reed Succession, SE Spain, Social Structure

1. Introduction

It is broadly assumed that social status may be determined by sex, age [1] body size and body condition [2]. In social birds matching a group-system in some part of the year it has been proved that some species have a double diet: seed-based [3-5] and invertebrate-based [6]. Some birds are termed "resident", staying at the site for long-periods and being recaptured on some occasions. By contrast, the majority of social birds are "transients", staying for short periods and often only being caught once. Transients are more mobile than residents which make only short-range [3, 6]. Residents are consistently heavier than transients in absence of predators [7] and prey and its abundance in the proximity of predators [8].

Is generally probed that social behaviour strongly depends on the environment where birds can develop its vital cycles [9]. Since body mass is affected by age and moult and decreases to improve manoeuvrability (see review in [10]) and further flight is traditionally related to longer wings [11, 12] is generally assumed that birds that have good manoeuvrability are agile in clumped habitats, such as reeds, and abilities dispersal [13]. Also is found that birds in better condition and size (expressed as body mass and wing-length) stay for short periods at given site than those that habits sparse habitats [11, 14], probably due to the variability in the food availability [15] or due to changes in the microclimatic conditions of the habitat [16].

The Bearded Reedling *Panurus biarmicus* is a socially monogamous reed-dwelling passerine with a strong sexual dimorphism and a fragmented distribution across reed patches of Western Palearctic [17, 18]. In the breeding season, they often breed in groups [19]. These groups usually consist of several breeding pairs and group size is usually
determined by available nest sites. In these groups, females pursue extra-pair fertilizations on which some morphological traits, as body size and condition are enhanced [19]. Pairs are formed in juvenile flocks and usually remain stable for life [20]. Studies in wild based in observations show that its behaviour is nomadic-named eruptive- after breeding which reflects large high flying multi-age flocks of different size related to its complete moult [4, 21-22]. Habitat preferences differ on breeding and on wintering [23, 24]. These are based in tail length which influences how Bearded Reedlings move and make use of their habitat [25]. The social behaviour indicates that the level of influence that males exert on social cohesion is not related to ornamental traits so Bearded Reedlings are likely to have a consistent social position within their flocks. Pioneer works on the behavioural ecology of the Bearded Reedling are based primarily in observations [21, 24, 26-27]. However, few studies in wild using data inferred from mist-netting have been performed [28-30]. Its social system inferred from mist-net captures indicates a basic unity of two [28] or more individuals [29] however observations give higher sizes [21]. This is due mainly to biases in the captures since part of the Bearded Reedling's flock stay near from mist nets once that some individuals have been already trapped.

Some internationally protected habitats such as reed-mash habitats immerse in fragmented, semi-isolated wetlands, support important populations of endangered birds [31-33, 24]. They are adequate to the management of these habitats that play a key role in the success and survival of these birds (see [34] for a review). The behaviour of these endangered or uncommon marshland small birds might aid to define strategies to the conservation of their habitats [24] or mechanisms for the conservation of this species [35-37].

In this paper, I analyse some capture data from this social bird which conform flocks of different size and composition in a so-called eruptive behaviour [21] as part of its vital cycle. I use a dataset of measures and events of mist-nets in Bearded Reedlings captured and after ringed at “El Hondo” Natural Park (SE Spain). On doing so I try to analyse the flock structure and dynamics is related with successional stages of the reed where the effect of management actions remains nowadays unclear. In view of this, we aim to hypothetize that habitat structure influences flock variability and not intra-specific factors such as age and sex composition, often assumed in social structure studies [7]. Since wing length is related with wing shape [38] is understandable that transient birds have greater wing shapes than residents [39] so larger measures of body size, highly related to wing length [40] and weight, highly related to condition [41, 42]. We should be expect that birds in poorer condition and size, behave as transients, behave in worse ability for movement and dispersal in managed dense reed patches in the core of wetlands, than birds often retrapped in better condition and size, termed as residents, which stay at the earlier stages of succession at totally or partly unmanaged habitats acting as corridors that abilities its dispersal and survival.

2. Material and Methods

2.1. Study Area

The subspecific status and distribution in Eurasia of the Bearded Reedling remained controversial on early [43, 44] but today is currently assumed as polytypic species in the Western Palearctic [17] and corresponding to the Paradoxornithidae Family. Since late 1960’s [45] the species expanded in some European countries (England and the Netherlands: [44, 46], France: [47]; Sweden: [48]; Switzerland: [49]. Apparently, its expansion in Europa is followed to the expansion of the Groundsel Senecio spp, a pioneer saltmarsh seed plant strongly linked to the first successional steps of reed Phragmites australis invasion [50]. The species is of not conservation concern in Europe [51] but its status in Spain passed from Near Threatened [52] to Critically Endangered [53] so population studies linked to conservation management are of highly priority in Spain.

Breeding population in Spain is spread in three nucleus of centre (Castilla-La Mancha), North (Navarra and Ebro Valley) and East (Comunidad Valenciana and Cataula) and it has been estimated in almost 1000 pairs (1998-2002: [54]) and with similar estimates in winter (2007-2010: [55]). The southern Alicante population comprises two main internationally protected wetlands [56, 57]: El Hondo Natural Park, Elche-Crevillente, 38°10'N 00°44'W monitored from 1980’s [58-60] and Santa Pola’s saltpans Natural Park, 38°12'N 00°37'W, surveyed recently [61] and distant among them 10.9 km as remnants of a great saltmarsh swamp in the past centuries [59]. They kept the most important populations of the Spanish Levant in 2005-2006 (70 and 25 pairs respectively [62] ) and with absence of recaptures of ringing birds among them [63] although is not discarded movements among near wetlands [58, 64, 65] so both populations appear to have a semi-isolated status.

Inside El Hondo Natural Park, a trapping site was chosen from 1991 so-called Bearded Reedling’s edge line [59]. Reedbed edge lines are probes to be the sites of wetlands concentrating the most densities of marshland passerine birds [66, 101] and these sites are usually preferred as roosting sites because they receive much more sun radiation [67]. This line conform three units of reed succession from the outermost (cleared-reed) towards the innermost of one of the two reservoirs (dense reed) (Table 1). Sites are distant 100 meters among them. Some areas of reed were submitted to management actions from 1992 onwards (Table 1) and measures of density of reed stems [68] and height of reed (cm) after each management action were taken for research purposes [22, 69].
2.2. Local Population Dynamics

Populations of Southern Alicante are currently of about 40 pairs (2005-2006: [62]) shorter than estimated in earlier years (75 pp; 1998-2002:[54]) and showing a decreasing trend of about 90% [62] higher than decreasing trend of 10% estimated by ringing schemes (1992-1999: [70]). Population models [62] prevent a short term quasi-extinction process of this populations in these areas. By contrast, population models based in ringing abundances covering a broader time scale (1991-2007:[60]) offer a contrasting line, depending on the habitat surveyed. The separation line, depending on the habitat surveyed. The

| Description | CLEARED | SALTMARSH | DENSE REED |
|-------------|---------|-----------|------------|
| Reed height (cm) | 101.1 ± 6.2 (14) | 133.7 ± 5.7 (7) | 32.6 ± 0.7 (7) |
| Density (stems/m2) | 31.5 ± 4.6 (4) | 47.9 ± 2.9 (7) | 1992-2002 1992-2007 |
| Year of samples | 1992-1993 | 1998-2002 | 0.864 Ha |
| Mist-nets home range | 5.18 Ha | 1.72 Ha | 70% |
| Bush cover | 60% | 80% | 0% |
| Water regime | Shallow water | Shallow/Deep water | Deep water |
| Main management actions | control (never managed) | medium managed | heavily managed. |
| Study years | 1992-1993 | 1998-2002 | 2002-2007 |
| Mist-Netting effort (m2 x hour) | 4793 | 25367 | 2042 |
| Mean flock size | 2.2 ± 0.6 (11) | 1.8 ± 0.5 (84) | 1.6 ± 2.0 (49) |
| Bearded Reedling's abundance | 0.0050 | 0.0057 | 0.0039 |
| Bearded Reedling's body mass (gr) | 13.2 ± 0.2 (24) | 12.7 ± 0.1 (133) | 13.2 ± 0.1 (76) |
| Bearded Reedling's wing-length (mm) | 58.4 ± 0.4 (24) | 57.3 ± 0.2 (135) | 59.9 ± 0.2 (77) |

2.3. Mist-Netting Protocols

Between 1991- 2007, a variable number of units of mist-nets (each unit 12 m length, 2.5 m high, 30 mm mesh size) placed in groups varying between one and ten and during variable hours and days were used in the Bearded Reedling's edge line. Birds were captured between sunrise and sunset. Mist-netting has found to provide reliable data on the sex and age structure of flocks in a minimum radius of more than 10 km in passeresines [74]. In order to minimize effects of weather and predator disturbance on mist-netting efficiency [75-78], mist-nets groups were placed at the same height from the ground in sunny days and checked every 10 minutes. Particularly mesh size diameter used in this study (15-20 mm) was adequate to capture birds of less than 16 gr [79] and hence to assure that the most number Bearded Reedlings present in a given flock was trapped. Some authors find that mist-netting show differences in spacing system, flight distance, and flight frequency of birds that exert strong effects on capture rates but mist-netting that assumes similar frequency of captures of adult and juvenile birds, is shown to be a reliable estimator of ages and sexes [80] although mist-netting can offer some biases in productivity [81]. I also calculated the home range of mist nets (Table 1) as the imaginary surface of a T-polygon of 5 mist nets in the central line (12 meters each standard length) and 1-3 mist nets of diameter at each one of the separation line, depending on the habitat surveyed. The home ranges resulted on average similar those of other marshland passerines [82, 83].

2.4. Capture Data Recording

Individual Bearded Reedlings were ringed with adequate numbered aluminium rings (Spanish Ministry of Environment-MMA remit) and checked for date and hour of capture. According [2] intra-specific factors usually is considered to determine the social status are tarsus length, body mass, age and sex. For this reason birds were also noted for wing length (left, maximum chord, to the nearest 0.5mm, according [84]) and weight (to the nearest 0.1gr). Wing-length instead of tarsus-length was used to assess body size and weight (to the nearest 0.1gr). Weight was assessed again for wing length (left, maximum chord, to the nearest 0.5mm, according [84]) and weight (to the nearest 0.1gr).
habitat distinction of this species [23] and also appropriate to the diet turnover of this species [26]. For the analyses of daytime activity of the flocks, morning sampling alone does not give an accurate estimate of relative abundance and age structure of reed passerines in mist-netting [86], so sampling included evening birds and all of them were grouped in morning-catches (7-10 hours GMT) and evening-catches (11-21 hours GMT). I calculated the group size as the number of individuals trapped in the same capture event (hour and day). Therefore each group size was given as solitary (if only one bird was trapped at the same event); pairs (if two birds were trapped at the same event) and flocks (if more than two birds were trapped at the same event). Under this classification it was calculated: 1) the frequency of items, as the number of times which each event was given and 2) the number of individuals implicated in each item.

2.5. Statistical Analysis

Observed flock frequencies were not normally distributed (Kolmogorov-Smirnov-Test, Z = 3.934, P < 0.001, N = 143) and were adjusted to Poisson equation [87] to obtain expected frequencies. I used Chi-squared-tests by contingency tables to test observed captures against expected/similar frequencies in each case (SPSS 2001). Body masses did meet criteria for normality (Kolmogorov-Smirnov Test: Z = 0.990, P = 0.280, N = 268) but not wing-lengths (Z = 2.334, P < 0.001, n = 236).

Due to this, I used overall non-parametric tests (Mann–U–Whitney and Kruskall-Wallis) to compare differences among means (± SE) in the samples. All data were analysed using the SPSS v. 11 statistical package [87]. Significant values (P < 0.05) were two-tailed.

3. Results

3.1. Flock Structure

A total sample of 246 Bearded Reedlings ringed was obtained. The overall dataset was composed of 144 samples of 1 to 8 individuals each and contained 109 adult males/61 adult females; 42 juvenile males/34 juvenile females. Mean flock size was composed by 1.72 ± 0.11 individuals (range 1-8). The frequency of solitarys and pairs (90/34) did not meet the expected frequencies (44/38 obtained from the Poisson equation (X₁² = 7.77, P > 0.05). Flocks were more frequent in summer (Mean: 1.73 ± 0.14, range 1-8) than in winter (Mean = 1.71 ± 0.18, range 1-5) but not significantly (Mann-Witney Test U-Test = 2165.5, N₁ = 98, N₂ = 45, P = 0.922). Groups were significantly bigger during evening (3.24 ± 0.26, range 1-8) than during morning (2.52 ± 0.15, range 1-8) (U = 5715.8, N₁ = 82, N₂ = 164, P = 0.047). Males were predominantly more abundant in groups than females and adults were more abundant than juveniles in pairs. Analysis of recaptures were surprisingly low (N = 38) and shows a significant probability of males to be more often recaptured than females (29/9, X₁² = 10.52; P < 0.001) and adults more recaptured than juveniles (30/8, X₁² = 12.73, P < 0.001).

3.2. Flock Dynamics

Body masses of solitaires, pairs and flocks did not differ among them, although solitaires were in better condition (solitaries: 12.92 ± 0.12, pairs: 12.84 ± 0.13, flocks: 12.87 ± 0.11; Kruskal-Wallis: X₁² = 0.092, N₁ = 83, N₂ = 62, N₃ = 88, P = 0.955). Wing-lengths did not also differ among groups (solitaries: 58.25 ± 0.25, pairs: 58.10 ± 0.34, flocks: 57.65 ± 0.25; Kruskal-Wallis: X₁² = 3.43, N₁ = 88, N₂ = 62, N₃ = 86, P = 0.134). Birds were significantly lighter in the morning than in the evening (morning: 12.65 ± 0.08, evening: 13.37 ± 0.11; U = 3489.5 N₁ = 159, N₂ = 74, P < 0.001) experiencing an overnight loss of 6 % of their body mass. It was found that the majority of birds (87%, N = 246) were "transients", staying for short periods and never being recaptured but only 13% (N = 38) of birds captured at the study sites became "resident", being caught on more than one (N = 36) or two (N = 2) occasions after ringing. Residents attained higher body masses (13.26 ± 0.27) than transients (12.84 ± 0.07), (U = 1442, N₁ = 20, N₂ = 214, P = 0.016). Wing-length for residents (58.98 ± 0.43) was also significantly longer than transients (57.89 ± 0.17) (U = 1599.5, N₁ = 20, N₂ = 214, P < 0.05).

3.3. Habitat Preferences

Frequency of individuals tended to decrease not significantly as the reedbed grows in density and management perturbation, from cleared (2.18 ± 0.60) to dense reed (1.61 ± 0.16) (Kruskal-Wallis; X₁² = 0.929, N₁ = 11, N₂ = 84, N₃ = 49, P = 0.628 ) in similar form that individual’s abundance (Table 1). Body masses were greater in the heavily managed plot in summer (Summer; dense:13.08 ± 0.08, cleared reed: 12.60. ± 0.27, saltmarsh reed: 12.51. ± 0.009, Kruskall-Wallis; X₁² = 7.63, N₁ = 38, N₂ = 12, N₃ = 110, P = 0.022). In winter, control areas supported birds in better condition (cleared-reed: 13.70. ± 0.22, dense:13.36 ± 0.15, saltmarsh-reed: 13.19. ± 0.19, Kruskall-Wallis; X₁² = 4.24, N₁ = 12, N₂ = 38, N₃ = 23, P = 0.180). Larger wing-lengths were found in dense habitat (dense:59.16 ± 0.21, cleared-reed: 58.42 ± 0.43, saltmarsh-reed: 57.24 ± 0.22, Kruskall-Wallis; X₁² = 27.95 N₁ =77, N₂ = 24, N₃ =135, P = 0.180). The percentage of resident Bearded Reedling’s was not significantly higher in the cleared reed areas (26/12/16, X₁² = 5.02, N = 38, P = 0.081). Recaptures among habitats occurred in 9% (N = 2) of birds.

4. Discussion

This study reveals that Bearded Reedling at El Hondo, as an example of a semi-isolated wetland complex, is basically a solitary and nomadic bird or conform small flocks of small to moderate size similar to another findings [28]. Overall mean frequency of individuals is lower than reported for central Spanish localities [88] which reflect strong differences among Iberian populations and the use of different methodological
approaches, but flock numbers seem comparable to the observations found in winter in Poland [89]. This study confirms the not significant differences in body condition among those forming small groups (colonial) and solitary [19]. Social status seems not to be determined by age and sex or body condition but the habitat preferences and management actions show major importance on flock dynamics. I found that the habitat heterogeneity and frequency of management actions are seasonally dependent and might account for social dynamics. Individuals in better condition and size stay at heavily managed reed habitats that might improve invertebrate quality and diversity because are wetter areas [24, 103]. The frequency of trips between reedbed sites is low (9%) as ringing recaptures among ringing places show, proving that Bearded Reedlings are mobile inside the succession line, depending on the Arthropods density [104] and seed availability, expressing similar social characteristics of Bearded Reedlings in The Netherlands [24] and England [4] with short trips of 100-800 m between nesting and foraging areas. This variability in dispersal occurs in other marshland passerines [13, 15] and illustrates the importance of not manage earlier successional stages of reed to improve passerines movements. It is found that, on average, overnight weight loss was high and is lower than reported in other Tits of related size and mass [89]. Such loss weight might aid to explain why Bearded Reedling’s movements are nocturnal from nesting to roosting areas starting during sunset and stopping on arriving at the roosts, probably associated to the advancement of high flying flights peaks at the sunrise pointed by [4, 21]. This period of the day is when researchers are rarely active or not monitoring mist-nets and it is highly recommended when surveying populations of marsh passerines, because greater numbers are found in the morning [86]. Birds of longer age, transients (in this study, adults) move over bigger areas and are in poorer condition than residents (in this study, birds of the year or juveniles) [90]. Transients benefit from residents for finding food by “local enhancement” (i.e. differential use of foragers for residents of previous knowledge for other area than make transients) and suffer more mortality [91]. This might help to explain why some scarce observations in Alicante and Murcia have been obtained [64, 65, 106]. Due to overnight mass losses is considered that methodology used on earlier surveys [62] can result inadequate because they to offer low estimates of individuals sampled at unappropriated times of day. The absence of observations of Bearded Reedlings in surveys at reed corridors [92] supports the use of alternative methodologies as telemetry, geolocators [93, 94] and use of sunset times at roosts to survey more properly its populations.

Bearded Reedlings population dissimilarities between South-east and Central-Spain and similarities with small isolated populations placed at similar latitude in Turkey [95] and Italy [96, 97] indicates that distant study populations from the same species are exposed to similar regional climates and they may have different characteristics in social organisation due to the populations sizes involved in each site and that seasonal cycle of climatic regimes could exert a major importance on them [69, 98]. Also, some populations may have a higher tendency to disperse than others [99] or different populations may vary in composition and behaviour, perhaps reflected in age-specific or sex-specific avoidance behaviour [7, 8]. At difference of other cohabiting reedbed passerines in El Hondo of similar moult patterns and wing shapes like Moustached warbler (Acrocephalus melanopogon) with longer movements [94] the Bearded Reedling’s possess shorter movements [100] related to different age-related wing shapes [101] and long-tail, that in spite to be an ornament implied in sexual and natural selected processes [102], has an important role for habitat choice as balancing organ among reed-stems [25].

The management actions carried out in El Hondo seem to have a differential effect on the dispersal and the survival of this species. First, wet managed reeds in the core of the wetland have proved to be helpful for the development of the Bearded Reedling because birds staying at these areas are composed mostly by transients in poorer condition and size. The saltmarsh areas surrounding the belts of reed are used mostly by resident Bearded Reedlings in good condition so maybe are using these sites as foraging sites, and these sites remain as unmanaged control areas with a good reed seed production, with young reeds seeds, that are preferred by Bearded Reedlings [24]. For this reason the settlement of residents in the periphery of reeds might favour dispersal towards another wetlands favouring by reed corridors with similar characteristics of unmanaged reeds.

5. Conclusions

Conservation measures should offer added nesting sites by nest-box provision at dense wet reeds in the core of wetlands to favour the recruitment rates and the reinforcement of the population. Dry sparse-reed sites should be supplied as gittering tray areas. This should to favour the seasonal changes in the diet of this species enhancing a higher condition of the bird residents situated at periphery areas. Also management purposes should keep in mind the maintenance of saltmarsh plots in the periphery of wetlands to favour rich areas with Groundsel Senecio spp, a pioneer saltmarsh seed plant strongly linked to the first successional steps of reed Phragmites australis invasion and following expansion of Bearded Reedling. This implies that more study is need with this species in similar wetlands with low population sizes to understand the underlying behavioural demography-related mechanisms such as nestling survival, fledgling productivity, dispersal and demographic rates by using mist nets as a highly recommendable research tool.

Acknowledgements

I thank the Spanish national authorities for providing to me the rings and national licenses. Regional and private
references

[1] Carpenter FL, Hixon MA, Russell RW, Paton DC and Temeles EJ. (1993) Interference asymmetries among age-sex classes of rufous hummingbirds during migratory stopovers. Behavioral Ecology and Sociobiology 33: 297–304.

[2] Arizaga J and Bairlein F. (2011) The role of age, sex, subspecies, body size and fuel load in determining the social status of a migratory passerine during the non-breeding period. Ornis Fennica 88:154–160.

[3] Senar JC, Burton, JKF, and Metcalfe NB. (1992) Variation in the nomadic tendency of a wintering finch Carduelis spinus and its relationship with body condition. Ornis Scandinavica 23: 63-72.

[4] Bibby CJ. (1981a) Studies of west Palearctic birds. 186. Bearded Tit. British Birds 76:549-563.

[5] Bibby CJ. (1981b) Food supply and diet of the Bearded Tit. Bird Study 28:201-210.

[6] Belda EJ, Barba E. and Monrós JS. (2007) Resident and transient dynamics, site fidelity and survival in wintering Blackcaps Sylvia atricapilla: evidence from capture-recapture analyses. Ibis 149: 396–404.

[7] Pascual J, Senar JC. (2015) Resident but non transient Eurasian Siskins reduce body mass in response to increasing predation risk: a natural experiment. Journal of Ornithology 156: 451–456.

[8] Møller AP, Kwiecinski Z. and Tryjanowski P. (2017) Prey reduction and abundance in the proximity of predators. Current Zoology 63: 1–8.

[9] Senar JC, and Borrás A. (2004) Sobrevivir al invierno: estrategias de las aves invernales en la Península Ibérica. Ardeola 51:133-168.

[10] Telleria JL, de la Hera I. and Pérez-Tris J. (2013) Morphological variation as a tool for monitoring bird populations: a review. Ardeola 60: 191-224.

[11] Kennerley P. and Pearson D. (2010) Reed and Bush Warblers. Christopher Helm, London.

[12] Nowakowski JK, Szulc J. and Remisiewic M. (2016) The further flight, the longer wing: relationship between wing length and migratory distance in Old World reed and bush Warblers (Acrocephalidae and Locustellidae). Ornis Fennica 91: 178-186.

[13] Poulin B, Lefebvre G. and Metref S. (2000b) Spatial distribution of nesting and foraging sites of two Acrocephalus warblers in a Mediterranean reedbed. Acta Ornithologica 35: 117-121.

[14] Leisler B, Schulze-Hagen K. (2011) The reed warblers. Diversity in a uniform bird family. KNNV Publishing, Zeist.

[15] Bibby CJ. and Thomas D. (1985) Breeding diets of the Reed Warbler at a rich and a poor site. Bird Study 32:19-31.

[16] Mezquida ET, Villarán A, Pascual-Parra J (2005) Microhabitat use and social structure in Linnet Carduelis cannabina and Corn Bunting Miliaria calandra at a winter roost in Central-Spain. Bird Study 52: 323-329.

[17] Cramp S. and Perrins CM. (1993) The Birds of the Western Palearctic. Vol VII. Oxford University Press, Oxford.

[18] Gosler A. and Mogyorósi D. (1997) Bearded Tit. In Hagenmeijer EJ. and Blair MJ. (eds), The EBCC Atlas of European Breeding Birds: Their Distribution and Abundance. TAD Poyser, London. pp 628–629.

[19] Hoi H. and Hoi-Łeitner M. (1997) An alternative route to coloniality in the Bearded Tit: females pursue extra-pair fertilizations. Behavioural Ecology 8:113-119.

[20] Griggo M. and Hoi H. (2011) An experiment on the function of the long-term pair bond period in the socially monogamous bearded reedling. Animal Behaviour 82: 1329-1335.

[21] Pearson DJ. (1975) Moult and its relation to eruptive activity in the Bearded Reedling. Bird Study 22: 205-227.

[22] Peiró IG. (2006) Ecologia y gestión del hábitat de los passeriformes palustres: passeriformes palustres (Cl. Aves). Starbrücken.

[23] Hoi H. and Hoi Ch. (2001) Habitat selection and habitat use of the Bearded Tit (Panurus biarmicus). In Hoi, H. (ed) The ecology of reed birds. Biostemetics and Ecology Series 18: 73-85. Austrian Academy Science Press, Vienna.

[24] Beemster N, Troost E. and Plateau M. (2015) Early successional stages of Reed Phragmites australis vegetation and its importance for the Bearded Reedling Panurus biarmicus in Oostvaardersplassen, The Netherlands. Ardea 98: 339-354.

[25] Romero-Pujante MD, Hoi H and Blomqvist D. (2005) The importante of tail length for habitat use in the Bearded Tit Panurus biarmicus: an experimental study. Ibis 147: 464-470.

[26] Spitzer G. (1972) Jahreszeitliche aspekte der biologie der Bartmeise (Panurus biarmicus). J. Orn. 113: 241–275.

[27] Hoi, H. 1989. Ökologie und Paarungssystem der Bartmeise (Panurus biarmicus). PhD Thesis. University of Vienna.

[28] Brocchier L, Matessi C. and Marin G. (1992) Influence of pair bonds from capture data based on low variation in the sex ratio among catches. American Naturalist 140: 492-508.

[29] Bártol I. and Csérgo T. (2000) Dynamics of pair formation of the Bearded Reedling (Panurus biarmicus) on the basis of capture-recapture data. Ornis Hungarica 10:71-77.

[30] Poulin B, Lefebvre G. and Piland P. (2000a) Quantifying the breeding assemblage of reedbed passerines with mist-net and point-count surveys. J. Field Ornithol 71: 443-454.

[31] Poulin B, Duborper E, Lefèbre G. (2010) Spring stopover of the globally threatened aquatic warbler Acrocephalus paludicola in Mediterranean France. Ardea 57:167-173.

[32] Vera P, Belda EJ, Kvist L, Encabo I. and Monró JS. (2011) Habitat preference of endangered Eastern Iberian Reed Buntings Emberiza schoeniclus witherby. Bird Study 58: 238–247.
[33] Pasinell G. and Schiegg K. (2012) Die Bedeutung kleiner Feuchtgebiete für den Artenschutz: Synthese einer Populationsstudie an der Rohrammer Emberiza schoeniclus. Ornithol. Beob 109:201-220.

[34] Valkama E, Lytinen S. and Koricheva, J. (2008) The impact of reed management on wildlife: a meta-analytical review of European studies. Biological Conservation 141:364-374.

[35] Wilson J. (2005) Nestbox provision to provide additional nesting sites for bearded tits Panurus biarmicus at Leighton Moss RSPB Reserve, Lancashire, England. Conservation Evidence 2: 30-32.

[36] Wilson J. (2013) The gritting behaviour of Bearded Tits Panurus biarmicus. Ringing and Migration 28: 1-4.

[37] Wilson, J. 2013 A. nest-box and colour-ringing study of Bearded Tits Panurus biarmicus at Leighton Moss, Lancashire. Ringing and Migration 30: 75–80.

[38] Mönkkönen M. (1995) Do migrant birds have more pointed wings? a comparative study. Evolutionary Ecology 9: 520-528

[39] Senar JC, Lleonart J. and Metcalfe NB. (1994) Wing shape variation between resident and transient wintering Siskins Carduelis spinus. J. Avian Biol. 25: 50-54.

[40] Senar JC and Pascual J (1997) Keel and tarsus length may provide a good predictor of avian body size. Ardea 85: 269–274.

[41] Schamber JL, Esler D. and Flint P. (2009). Evaluating the effect in reedbed design: a 12-year study on five bird species. Wetlands Ecology and Management 17: 69-82.

[42] Barberá GG, Calvo JF, Esteve MA, Gil. VH. and Robledano F. (1990) Importance of small man-made wetlands for breeding waders in south-eastern Spain. Wader Study Group Bulletin 60:24-26.

[43] Green AJ. (1993) The status and conservation of the Marbled Teal Marmaronetta angustirostris. IWRB Special Publication No. 23.International Waterfowl and Wetlands Research Bureau, Slimbridge.

[44] Navarro JD. and Navarro J. (1984) La avifauna de los embalses de «El Hondo» (Alicante). Mediterránea 7: 117-137.

[45] Navarro JD. (1988) Estudio ornitológico de "El Hondo". Caja de Ahorros del Mediterráneo. Alicante.

[46] Pérez IG. (2010) Estudios sobre el Bigotudo (Panurus biarmicus), un superspecialista de carril. In Hernández, VJ (ed). Estudios de campo sobre Passeriformes palustres: ecología, evolución, comunidades y conservación. Técnicas en Biología de la Conservación 3: 63-76. Tundra, Valencia.

[47] López G, Belenguer R, Castany J. and Dies JI. (2007) El declive del bigotudo en la Comunidad Valenciana. Quercus 262:14-18.

[48] Belenguer R, López G, Dies JI. and Castany J. (2016) Dramatic decline of the bearded reedling Panurus biarmicus in Spanish Mediterranean wetlands. Animal Biodiversity and Conservation 39: 17-27.

[49] Frías O, Serradilla AI. and Escudero E. (2007) Informe de las actividades de la central de anillamiento de aves ICONA. Año 2006. Apéndice 11. Ecología 21:301.

[50] Alcaraz LR. and Gil-Delgado JA. (1986) Aves nidificantes de la provincia de Alicante. Instituto de Cultura Juan Gil-Albert. Alicante.

[51] Pérez IG. 1992. Bigotudo (Panurus biarmicus). Anuario Ornitológico Comunidad Valenciana 1992: 107.

[52] Báldi A. (2005) The importance of temporal dynamics of edge effect in reedbed design: a 12-year study on five bird species. Wetlands Ecology and Management 13: 183–189.

[53] Vil-lén-Pérez S, Carrascal LM. and Gordo O. (2014) Wintering forest birds roost in areas of higher sun radiation. Eur J Wildl Res 60:59–67.

[54] Montes C. and Ramírez L. (1978) Descripción y muestreo de poblaciones y. comunidades vegetales y animales. University of Sevilla.
[99] Fortuna MA (2003) Dependencia hídrica de la comunidad ornítica acuática de la laguna de Manjavacas: la importancia de la desecación estival. Oxyura 11: 85-98.

[100] Greenwood PJ and Harvey PH (1982) The natal and breeding dispersal of birds. Ann Rev Ecol. Syst. 13:1-21.
[101] Peiró IG (2013) Movements, sex-ratios, recovery rates and longevity of the Bearded Reedling Panurus biarmicus in Iberia. *Ringing and Migration* 28:50–52.

[102] Peiró IG, Robledano F and Esteve MA (2006). The effect of age and sex on wing morphology and body size of the Bearded Tit Panurus biarmicus in relation to complete moult. *Ringing and Migration* 23: 101-106.

[103] Romero-Pujante, M. D. (2000) La importancia de los procesos de selección sexual y selección natural en el Bigotudo Panurus biarmicus. PhD thesis. University of Granada.

[104] Poulin B, Lefèbvre G. and Mauchamp A. (2002). Habitat requirements of passerines and reedbed management in southern France. *Biological Conservation* 107: 315-325.

[105] Schmidt MH, Lefèbvre G, Poulin B, Tscharntke T. (2005) Reed cutting affects arthropod communities, potentially reducing food for passerine birds. *Biological Conservation* 121: 157–166.

[106] Calvo, JF et al. (2017) Catálogo de las aves de la Región de Murcia (España). *Anales de Biología* 39: 7-33.