

Contribution to the study of pair formation strategy of the Bearded Reedling (*Panurus biarmicus*)

Lilla LOVÁSZ^{1*}, László FENYVES² and József GYURÁ CZ¹

1. Institute of Biology, Faculty of Natural and Technical Sciences,
University of West Hungary, Károlyi Gáspár tér 4., H-9700 Szombathely, Hungary
2. Duna-Ipoly National Park Directorate, Költő u. 21., H-1121 Budapest, Hungary
*Corresponding author, L. Lovász, E-mail: lovasz.lilla@yahoo.com

Received: 21. March 2016 / Accepted: 29. August 2016 / Available online: 13. October 2016 / Printed: December 2017

Abstract. The aim of this study based on personal field observations and capture (8407 individuals) and recapture (2691 individuals) data was to broaden the knowledge about the pair formation strategy of the Bearded Reedling *Panurus biarmicus*. A male and a female bird were considered a pair if they were not further than 1 meter from each other in the net; or if they were further than 1 meter, but they have behaved as pairs before the capture. Our results partially confirm the previous knowledge about the pair formation of juveniles; furthermore, we proved that 63% of those pairs that were recaptured once consisted of juvenile males and females even before the summer complete moult. 30% of all the pairs were formed of adult males and adult females and only 7% were of juvenile-adult combination. 78% of the birds captured as pairs and recaptured at least once kept the pair bond from the time before the moult until the time of roaming, while 22% changed their pairs during the same period.

Key words: *Panurus biarmicus*, pair formation, pair association.

Introduction

The Bearded Reedling *Panurus biarmicus* (Linnaeus, 1758) is a socially monogamous species (Birkhead & Møller 1996, Cramp 1998, Griggio, Hoi 2011, Romero-Pujante 2002). The pair-formation in this species occurs very early, namely in the same year when the nestlings had hatched, between June and September; Surmacki et al. (2015) suggest that females may already use juvenile plumage to select males. At the same time, Griggio & Hoi (2011) state that the pair bond lasts for life.

There are various reports regarding mate preference polymorphisms among adult female individuals, some of them showing the preference for the trait of the moustache, while others the tail length of adult males (Hoi & Griggio, 2012; Griggio et al. 2016). During a few months after pair-forming, which lasts from 2 weeks to 6.5 months (Griggio & Hoi 2011), the birds pursue the strengthening of the pair bond. Copulations and moving together were also observed during this time (Griggio & Hoi 2011). Even egg laying can occur in the autumnal period of the year of the hatching (Griggio & Hoi 2011). This corresponds with Koenig's (1951) assumption according to which young pairs stay together during winter-time, and thus in the next year they can straightaway start nest building in March, instead of the

long ceremony of mate choice. Although this long time pair bond was not clearly confirmed for decades (Wawrzyniak & Sohns 1986), several subsequent studies gave some evidence (Hoi & Hoi-Leinter 1997, Bártol & Csörgő 2000, Mogyorósi 2009) for the long-term pair bond of the Bearded Reedling despite the high rate of extra pair copulations. However, the permanence of pair bonds has not been clarified yet: we do not know for sure if the pairs formed of young birds would stay together as nesting pairs next year (Cramp & Perrins 1993), and we do not know either how tight the association of the pairs is. A study (Bártol & Csörgő 2000) targeted revealing the latter: the authors examined the case of 36 pairs and they managed to give some evidence to the association. However, that study could not prove certain statements about long-term pair bond (Bártol & Csörgő 2000). Furthermore, only a few studies have been dealing with the composition of the age groups of these birds so far (Cramp 1998, Bártol & Csörgő 2000). All the above-mentioned facts raise the necessity of further research.

The aim of our study was therefore to broaden the knowledge about the pair formation strategy of the Bearded Reedling. We searched answers for the following questions: (i) When do the pairs form? (ii) How frequent is the pair-formation of the young birds? (iii) How are the age-groups composed? (iv) How long do pairs stay together?

Materials and methods

Data collection was carried out within an expansive (200 m × 340 m) reed bed (*Phragmitetum communis*) of the Marshes of Dinnyés, in the area of Lake Velence, Hungary. The study area is under the administration of the Duna-Ipoly National Park Directorate (Fig. 1).



Figure 1. The study area at the marshes of Dinnyés, Hungary.

The data collection took place between 2001 and 2013. Bird-ringing was carried out from mid-July to early August and from mid-September until the end of October (depending on the weather), but ad hoc ringing also took place at other periods of the year as well.

For capturing the birds mist nets were used. We pulled 17 nets of 12 meters length and 2.5 meters width each across a trodden path in the reed (N47° 8' 45.42"; E18° 33' 55.76" and N47° 8' 46.84"; E18° 33' 47.75"). The documentation of the birds captured was carried out according to the methods used in the Actio Hungarica bird ringing network of the BirdLife Hungary (Szentendrey et al. 1979), while we determined the age and sex with Svensson's (1992) method.

For marking the pairs, we used the capture-recapture data and birds' behaviour before the capture, a method developed by L. Fenyvesi instead of the technique of Bártol & Csörgő (2000) that uses merely the capture-recapture data. We classified the single males and females captured together as pairs, based on personal observation and the results of a previous study (Brocchieri et al. 1991). Similarly, several individuals captured together were classified as groups. The following cases were treated as "captured together":

In the case of pairs:

1. A male and a female caught in the mist net (considering the neighbouring net as well) not further than 1 meter from each other, in the same controlling occasion. This occurred when both the male and the female of the pair were caught in the net at once.

2. In case they were not caught at the same moment, but we noticed that a bird of the opposite sex appeared near the one caught in the net, we observed the behaviour of the birds even between the net-controls. If the one that has not been caught behaved as "pair" (eg: jumping on the reed right next to the other individual that was caught; trying to help the one in the net with flying around; mak-

ing "desperate" calls etc.), and after a while this individual was also caught in the net, we treated these two as pairs, even if there was more than 1 meter between them.

In the case of groups:

Several individuals caught in one distinguishable area of the same or neighbouring mist-net. In the case of groups, depending on their size, the extent of the spreading area of the birds in the net was different, but those individuals belonging to the same flock were clearly separated. This study does not deal with the examination of the groups but the data collected gives possibility for further research.

In case of pairs, the implementation of the method was the following: during the most intensive activity time of Bearded Reedlings, between 9 and 12 AM (Trnka et al., 2006), we observed the nets through telescopes. This facilitated waiting the mate of an already captured bird to be also caught in the net. According to our observations, in most cases, the mates come and try to rescue each other: the call of the one which is caught generally makes the other bird – that might have already flown away – turn back. The latter bird would then even try to rescue its mate. This, most often, results in the latter bird being caught in the net as well, usually right next to the one caught first. In many controlling occasions, we faced the fact that the male/female is so "desperate" to free its mate that it completely ignores the presence of men and moves, flies, jumps around the one in the net while the mist nets are under control. Thus, we did not specify the time of picking the birds out in every full hour, but in every hour counted from the time when the first bird of the pair is caught in the net. We did not wait for the supposed mate to get into the net after one hour passed, even if it was in sight, in order to secure the one in the net. The pair-classification was done at the time of picking the birds: these pairs were put into the same bag, got rings with consecutive numbers, and were marked with particular pair-sign in the ringing notebook.

In case a larger flock came to the net and the pairs were not clearly separated in space (eg: two males and two females or two males and one female was caught about the same distance from each other), we did not count them as pairs but as groups. We put group members into a bigger bird-bag. When ringing, the flock-members got consecutive numbers and were also marked in the ringing notebook.

We have documented 8407 captures and 2691 recaptures in all. Out of them, 1163 pairs were captured at least once and 273 pairs were captured twice or more. In order to examine formation, permanence and association of the pairs we used only the data of pairs recaptured together at least once. The strength of association between the males and the females specified as pairs and recaptured at least once have been tested with Fischer's exact test (χ^2). The distribution of "faithful" and mate-changing birds, as well as that of pairs according to sex and age groups and time have been tested with goodness-of-fit test (χ^2) (Reiczigel et al., 2007). The Past computer program was used for statistical analysis (Hammer et al. 2006).

Results

Number of definite pairs

From those recaptured once, 157 pairs were caught with the same mate at the time of recapture as at the time of the first capture, while there were 77 cases where the bird was recaptured with a different mate than when captured at first (Fischer's exact test, $\chi^2 = 14,09$, $p < 0.001$). In 43 of the 77 cases, the male changed mate, while there were 34 cases when we documented the female with another mate. From those recaptured more than once, we documented 27 "faithful" and 3 "mate-changer" (one female, two males) cases ($\chi^2 = 11,43$, $p < 0.001$) while in the case of those pairs of which at least one year has passed between the capture and recapture, we documented one mate-changing bird (a female) out of 9 cases ($\chi^2 = 3,08$, $p = 0.13$). The rates of "faithful" and "mate-changer" pairs were 70.3% (192 pairs) and 29.7% (81 pairs), ($\chi^2 = 23.541$, $p < 0.0001$).

Associatedness of pairs

In the case of recaptured pairs, there were 234 cases when the male and female was captured once more beside the first capture, together or separately, in the year of ringing (recaptured once). There were 30 cases when we recaptured the pairs at least twice, also in the year of ringing (recaptured multiple times); and there were nine cases when the recapture(s) were made in the calendar year(s) following the ringing year (recaptured after at least one year). Those males and females that were specified as pairs at the first capture and were then recaptured once or more than once showed significant associatedness.

Composition of pairs according to sex and age groups

Figure 2 (left) shows how pair formations are developed in the case of pairs recaptured once: the pair composition of a female with juvenile plumages and a male with juvenile plumages was of the largest rate (Chi-square test, $\chi^2 = 1712.4$, $p < 0,0001$).

The case of pairs recaptured multiple times shows similar distribution (Fig. 2, right): most pairs are consisted of a juvenile female and a juvenile male. The adult-adult pair construction (birds with adult plumages) shows much smaller percentage; while the rate of pairs formed from different age groups (juvenile-adult relationships) was minimal in the case of those recaptured once

and multiple times). The result of the goodness-of-fit test in the case of those recaptured multiple times is $\chi^2 = 78.007$ and $p < 0.001$. In the average of the pair formations of birds recaptured once or more than once, a relationship of a male and a female of the same age was dominant (97.2%), while the pair formation of a bird with first plumages and one with adult plumages was minimal (2.8%).

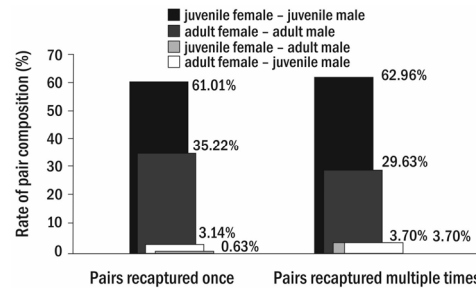


Figure 2. Rate of pair composition according to age groups.

Permanence of pairs

In the instance of birds recaptured once (Fig. 3.), being found together with the same pair as at the first capture was the most frequent in the case of juvenile-juvenile pairs: they kept together for even 31-70 days, or more than 71 days after the first capture ($\chi^2 = 51.53$, $p < 0.001$). Most of the recaptures of adult-adult pair-formations was detected 1-5 days after the first capture. In the case of birds recaptured multiple times (Fig. 4.) the juvenile-juvenile pairs are dominant also both in the cases

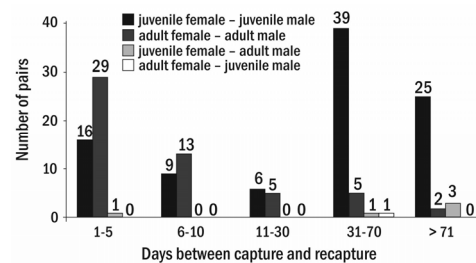


Figure 3. Permanence of pairs in the case of birds recaptured once.

when 31-70 days and when more than 71 days have elapsed between the first and last capture. Adult-adult combinations were mostly recaptured only 11-30 days after the first capture. Averaging the cases recaptured once and multiple times: the time elapsed between capture and recapture of

72.3% of juvenile–juvenile pairs is more than one month, while in the case of adult–adult pairs an average of 84.2% was recaptured less than 30 days after the capture, and only 15.8% of them were together with the same mate after one month.

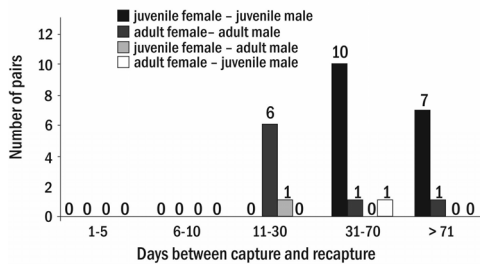


Figure 4. Permanence of pairs in the case of birds recaptured multiple times.

Discussion

More than 70% of the 273 recaptured pairs was caught with the same pair at recapture as it was caught at capture. This result showed a high significance deviation of random variable suggesting that mate fidelity is general in the Bearded Reedling. This confirms, on a wider item scale, the results of a previous study about the permanence of pairs: Bártol & Csörgő (2000). Such mate fidelity can be an advantageous adaptation to colonization of new breeding territories (Hořák et al. 2003).

According to Birkhead & Møller (1996), "social monogamy is defined as partners remaining together", while sexual monogamy means "the absence of extra-pair paternity, but not necessarily the absence of extra-pair copulations" (Birkhead & Møller 1996). In the case of the Bearded Reedling, the system of social monogamy works aright, mostly because, being colonial birds, the possibility of extra pair copulations is given within the flocks (Hoi & Hoi-Leitner 1997). The statistical analysis of the relation of pairs also showed a remarkably high associatedness, which again confirms Bártol & Csörgő's results (2000). Our further research (Lovász 2015) also approves the tight relation, since the coexistence of the pairs and the fact of roaming together is apparent in the comparison of yearly and daily captures as well.

We demonstrated that a relationship of a male and a female of the same age is characteristic (97.2%), while the relation between birds of different age (juvenile and adult) is minimal (2.8% on the average). Similarly, 86.1% of the 36 pairs exam-

ined by Bártol & Csörgő (2000) were composed of birds of homogenous age. The above outcome implies a characteristic of continuous monogamy (Black 1996; Csányi 2002). In the case of this type of monogamy, after losing their social pair, birds can typically form only short term relationships, mostly with younger mates (Csányi 2002). In spite of the phenomenon of extra-pair copulations of the Bearded Reedlings known from earlier studies (Hoi & Hoi-Leitner 1997), these birds live in long term, continuous partnership, which means social monogamy at the same time. This can also be seen from the fact that the pair formation takes place in the birds' young age (Cramp 1998), for which our and Bártol & Csörgő's (2000) results also gave evidence: about 2/3 of the pairs caught together in our study (61% of recaptured once and 63% of recaptured more than once) consisted of juvenile individuals and 75% of the pairs in the study of Bártol & Csörgő (2000) were made up of two young birds.

Our research also shows that the pairs consisting of two juvenile birds remain together for a long time, which approves the presumption of Koenig (1951), Cramp (1998) and Mogyorósi (2009) regarding long-term relationship of the Bearded Reedling. Young aged pair formation and permanent relationship are advantageous since these strategies mean no need to search for a new partner every springtime (Mogyorósi 2009). Thus, Bearded Reedlings are ready to start nesting remarkably early (in March) and as a result, are able to raise even four clutches per one breeding season (Griggio & Hoi 2011).

The time elapsed between the capture and recapture of pairs consisting of young birds was one to two, or even more than two months in the vast majority of the cases (on the whole, an average of 72.3%), which supports the assumption that the pairs certainly stay together from their young age through the time of reaching maturity until the late autumn roaming period. It can be supposed that these pairs leave together for finding new territories (Mogyorósi 2009), though, there is no evidence yet that these pairs would become nesting pairs in the following breeding season (Cramp 1998).

The maintained mate-fidelity during movements is suggested by a research of Czech and Slovak habitats, but it is based on the same rate of males and females (Hořák et al. 2003). This might mean that the pairs stay together, but does not prove it, since the males and females coming from

different areas may mix at the new site without changing the original male-female rate. Similarly, Dürri et al. (1999) draw up only presumptions that the data of recaptured birds outside the breeding sites may show that these birds consisted mostly of a male and a female, supposedly pairs. The observations mentioned above raise the necessity of additional research: the behaviour of the pairs could be followed with a ringing and pair-signing activity carried out in the surrounding sites.

The rate of pairs being in their adult feathers was about 1/3 of all. The smaller number of recaptured adult-adult pairs can be explained with the fact that during breeding time the male and the female do not move together, they stay with the eggs alternately (Kovács 2000), because of the shared sex roles in nesting duties (Bibby 1983), and after the last clutch, they usually join the youngsters and start roaming. Our results showed that in the average of 84.2% of these pairs, the time elapsed between capture and recapture was less than 30 days, and only 15.8% of them were recaptured as pairs after one month. The smaller number of adult pairs may however result from the huge crowd we captured during roaming-time (October), out of which we could mostly identify only groups. Pairs had not always been caught separately in the net.

The number of cases when we managed to recapture the same mates together after one year was rare. It happened only eight times during the research. This shows the slight surviving chance of the birds in their first year, which is in accordance with the findings of Mogyorósi (2009). It can also be supposed that not all the birds die, but they do not go back to their original breeding site after the winter. However, the latter has considerably low probability since previous researches showed the high rate of site fidelity (Hořák 2003).

We can therefore state that these birds form pairs at an early age, even before the moult. Our results show that the pair formation of Bearded Reedlings with juvenile plumages is frequent (more than 60%). This is congruent with a recent study (Surmacki et al. 2015) that assumes the capability of the Bearded Reedling females to select a more ornamented male already in the juvenile plumage, despite the differences between the sexes being very low at young age. As for the age-group composition, it turned out that pairs are overwhelmingly formed of birds of the same age and the juvenile-adult pair construction is very rare (2.8%). We verified the permanence of the

pairs: the pairs formed out of juvenile-juvenile birds stay together from the time before the moult until the autumn roaming at least. Although we think that recapturing the same males and females together after several weeks or even recapturing the same pairs more than once gives evidence for our method of signing the pairs being appropriate, an even better method would be to follow the birds through satellite tracking. Unfortunately, at the time of this study the GPS devices were not light enough for birds lighter than 100 grams (BTO, 2016).

The cases of pairs recaptured not in the same year of the capture suggest that the pairs might roam together, and, if they survive the winter, might be nesting pairs in the following season. However, a further long-term study would be needed to demonstrate this. In addition, an analysis of those pairs that changed mate could be the topic of a further research.

Acknowledgements. We greatly appreciate the assistance of all the members of the Hungarian Ornithological and Nature Conservation Society who participated in the data collection. Special thanks to Valentin Amrhein for the valuable discussions, and to Tibor Tomán and Veronika Gyurácz for the English language improvement of this manuscript.

References

- Bártol, I., Csörgő, T. (2000): Dynamics of pair formation of the Bearded Tit (*Panurus biarmicus*) on the basis of capture-recapture data. *Ornis Hungarica* 10: 71-77.
- Bibby, C. J. (1983): Studies of West Palearctic birds. 186. Bearded tit. *British Birds* 76(12): 549-563.
- Birkhead, T.R., Møller, A.P. (1996): Monogamy and sperm competition in birds. *Oxford Ornithology Series* 6: 323-343.
- Black, J.M. (ed). (1996): Partnerships in Birds: The Study of Monogamy: The Study of Monogamy. Oxford University Press. Oxford.
- Brocchieri, L., Matessi, C., Marin, G. (1992): Inference of pair bonds from capture data based on low variation of the sex ratio among catches. *American Naturalist* 140: 492-508.
- BTO - British Trust for Ornithology: "Tracking studies at BTO" - Topic Overview." British Trust for Ornithology, Downloaded: 4 August, 2016, <<https://www.bto.org/science/migration/tracking-studies>>
- Cramp, P. (1998): The Birds of the Western Palearctic. Oxford CD-ROM. Oxford University Press, Oxford.
- Cramp, S., Perrins, C.M. (eds.) (1993): Birds of the Western Palearctic. Vol 7. Oxford University Press, Oxford. p. 88-101.
- Csányi, V. (2002): Etológia [*Ethology*]. University textbook. Nemzeti Tankönyvkiadó. Budapest. [in Hungarian]
- Dansk Ornitologisk Forenings Fagregistrerings Gruppe. (1989): Yunglefuglerapport 1-46.

- Dürr, T., Sohns, G., Wawrzyniak, H. (1999): Ringfundauserwertung in Ostdeutschland beringter bzw. kontrollierter Bartmeisen (*Panurus biarmicus*). *Vogelwarte* 40: 117-129.
- Griggio, M., Hoi, H. (2011): An experiment on the function of the long-term pair bond period in the socially monogamous bearded reedling. *Animal Behaviour* 82(6): 1329-1335.
- Griggio, M., Hoi, H., Lukasch, B., Pilastro, A. (2016): Context dependent female preference for multiple ornaments in the bearded reedling. *Ecology and Evolution* 6(2): 493-501.
- Hammer, O., Harper, D.A.T., Ryan, P.D. (2006): PAST (Paleontological Statistics Version 1.38), Oslo.
- Hoi, H., Griggio, M. (2012): Bearded Reedlings adjust their pair-bond behaviour in relation to the sex and attractiveness of unpaired conspecifics. *PLoS ONE* 7(2): e32806.
- Hoi, H., Hoi-Leitner, M. (1997): An alternative route to coloniality in the bearded tit: females pursue extra-pair fertilizations. *Behavioral Ecology* 8(2): 113-119.
- Hořák, D., Procházka, P., Cepák, J., Zárbynický, J. (2003): Movements of bearded tits (*Panurus biarmicus*) in the Czech Republic and Slovakia. *Sylvia* 39: 79-94.
- Kovács, G. (2000): Barkóscinege *Panurus biarmicus* (Linnaeus, 1758) [Bearded Reedling *Panurus biarmicus* (Linnaeus, 1758)]. In: Haraszthy, L. (ed.) *Magyarország madarai. [Birds of Hungary]* Mezőgazda Kiadó, Budapest. [in Hungarian]
- Koenig, O. (1951): Das Aktionssystem der Bartmeise. *Österr. Z. Zool.* 3(1-82): 247-325.
- Lovász, L. (2015): A barkóscinege (*Panurus biarmicus*) párképzési stratégiája és kóborlási dinamikája. [Pairbond strategies and population dynamics of the Bearded Reedling (*Panurus biarmicus*)] B.Sc. thesis. University of West Hungary. [in Hungarian with English Summary]
- Mogyorósi, S. (2009): Barkóscinege *Panurus biarmicus* (Linnaeus, 1758) [Bearded Reedling *Panurus biarmicus* (Linnaeus, 1758)]. In: Csörgő, T., Karcza, Zs., Halmos, G., Magyar G., Gyurác, J., Szép, T., Schmidt E. & Schmidt A. (eds.) *Magyar madárvonulási atlasz. [Hungarian Bird Migration Atlas]* Kossuth Kiadó, Budapest. p. 539-541. [in Hungarian with English Summary]
- Reiczigel, J., Harnos, A., Solymosi, N. (2007): Biostatistika - nem statisztikusoknak. [Biostatistics]. Pars Kiadó, Nagykovácsi, Hungary. [in Hungarian]
- Romero-Pujante, M., Hoi, H., Blomqvist, D., Valera, F. (2002): Tail length and mutual mate choice in bearded tits (*Panurus biarmicus*). *Ethology* 108(10): 885-895.
- Surmacki, A., Stepniewski, J., Stepniewska, M. (2015): Juvenile sexual dimorphism, dichromatism and condition dependent signaling in a bird species with early pair bonds. *Journal of Ornithology* 156:65-73.
- Svensson, L. (1992): Identification guide to European Passerines. 4th ed. Ugg. Stockholm.
- Szentendrey, G., Lövei, G., Kállay, Gy. (1979): Az „Actio Hungarica” mérési módszerei [The „Actio Hungarica” bird ringing network]. *Állattani Közlemények* 66: 161-166. [in Hungarian]
- Trnka, A., Szinai, P., Hošek, V. (2006): Daytime activity of reed passerine birds based on mist-netting. *Acta Zoologica Academiae Scientiarum Hungaricae* 52(4): 417-425.
- Wawrzyniak, H., Sohns, G. (1986): Die Bartmeise *Panurus biarmicus*. Die Neue Brehm-Bücherei 553. Ziemsen, Wittenberg Lutherstadt.