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Impact of weather on partial loss of nestlings in the Red-backed Shrike *Lanius collurio* in eastern Poland

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Abstract. The influence of ambient temperature and rainfall on the size of partial losses in broods of the Red-backed Shrike was studied in the extensive agricultural landscape of eastern Poland in 1999–2003. Nestlings were divided into two age classes: up to the 5^{th} day after hatching and the 6–10^{th} day of life. The entire period of the nestlings' stay in the nest (1–10^{th} day of life) was also considered. The ambient temperature did not influence the size of losses at either stage of the nestling life. Rainfall affected the size of nestling losses in the periods when they were 6–10 and 1–10 days old. The influence of rainfall explained only 11% of nestling losses. Thus, one should expect some factors other than weather conditions to cause partial losses in Red-backed Shrike broods in the study area, at least in seasons with an average pattern of air temperature and rainfall. Among such factors, the structure of territories variation in food abundance should undoubtedly be considered.

Key words: Red-backed Shrike, *Lanius collurio*, weather conditions, rainfall, partial losses, fledging success

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INTRODUCTION

Many different factors, including weather conditions, influence the breeding success of birds (Newton 1989). The weather affects avian reproduction in several ways, for example it modifies the availability of food (Bryant 1978, Rodenhouse & Holmes 1992, Siikamäki 1996), changes the costs of thermoregulation (Tinbergen & Dietz 1994), and can be the direct cause of brood losses e.g. even by flooding them (Wesołowski et al. 2002). In species that feed their nestlings with insects, the influence of inclement weather on broods is particularly evident (Turner 1984, Acquarone et al. 2003). This is important also for many species of shrikes, as unfavourable weather reduces the activity of their potential prey, which, as a consequence, affects their reproductive success (Hornman et al. 1998, Kopij 1999, Kuper et al. 2000, Yosef 2000). Weather conditions are sometimes the main reason for complete and partial losses in broods of the Red-backed Shrike (review in: Kuźniak & Tryjanowski 2003), and of other species of shrikes (Takagi 2001, Antczak et al. 2004). Among weather factors, the influence of ambient temperature and rainfall on shrike broods was studied most often, and the parameters of reproduction were usually analysed based on differences between years or months (e.g. Diehl 1977, Lefranc 1979, Horvath et al. 1998). However, weather conditions can change remarkably from day to day even during one breeding season. By considering an additional division according to the advancement of the broods (egg laying, incubation, feeding of nestlings), weather conditions during these several or over ten-day intervals can differ distinctly between broods in one season.

The Red-backed Shrike arrives in Poland usually in the first ten days of May. Females start laying eggs within several to over ten days after arrival. Incubation lasts for 15 days and the first nestlings hatch at the end of May and the beginning of June. They stay in the nest for about 15 days with the first fledglings leaving the nests in mid-June. If the first brood is lost, the birds undertake a second breeding attempt. Thus, the breeding season of this species can extend from May to even August (Kuźniak & Tryjanowski 2003).

The aim of this paper is to determine the influence of selected weather conditions on the number of partial brood losses in the Red-backed Shrike. I expected that nestlings would have different survival rates in various weather conditions. I investigated the influence of temperature and rainfall, as they are most often quoted as factors causing brood losses in birds.

STUDY AREA

The study was carried out in eastern Poland, near Siedlce (52°12′N, 22°17′E) in 1999–2003. The study area consisted of 855 ha of extensive agriculture landscape. Arable fields predominated in this area (53.5%), mainly with crops of rye and potatoes. Overly dry meadows and pastures covered 21.1%. The proportion of set-asides was 2.2%. Woodlands and apple tree orchards were also present in addition to these open habitats. The structure of land use did not change during study period. Red-backed Shrikes occupied open habitats at the edges of woodlands and orchards. More details on the studied population, including aspects of breeding ecology and densities, were published elsewhere (Goławski in press).

METHODS

Red-backed Shrike nests were searched for between mid-May and the end of July, by checking all possible locations favourable for nesting. In analyses, I considered only those broods for which I collected the data listed below, describing the breeding parameters of the Red-backed Shrike. I determined the number of hatched nestlings on the date of hatching or the next day. I calculated the hatching date (the first day of a nestling's life) based on the time the first egg was laid and the number of eggs in the brood. I assumed that Red-backed Shrikes lay one egg per day, begin incubating from the day of laying the penultimate egg and continue incubation for 15 days (Cramp & Perrins 1993). I determined the number of nestlings at the 9th or 10th day of their life, as later they can escape from the nest (Kuźniak 1991). I excluded broods with complete losses from the analysis, assuming that they were caused by predation. Following Simons & Martin (1990), and Whittingham et al. (2001), I assumed that partial losses were not due to predation but to the amount of food provided by the parents to the nestlings.

I calculated the level of losses as the difference between the number of hatched nestlings and the number of nestlings in their 9–10th day of life. I determined weather conditions for two ranges of the age of nestlings. These were the first 5 days from the date of hatching, and between 6 and 9 (or 10) days of nestlings` life. I also analysed weather conditions for the entire nestling period, i.e. from the date of hatching to the 9th or 10th day of nestling life. Such a division into time intervals was imposed by differences in the metabolism of nestlings in the period of their development. During studies on Red-backed Shrike nestlings in captivity, food requirements were the highest between the 6th and 10th day of nestling life (Diehl & Myrcha 1973). I reduced the number of visits to a Red-backed Shrike nest to the necessary minimum, as this species is especially vulnerable to disturbance and it often abandons broods (Tryjanowski & Kuźniak 1999).

I analysed the influence of the ambient temperature and the level of rainfall on the extent of losses in broods. I calculated the mean daily temperature based on three measurements of the ambient temperature taken at: 7:00, 13:00, 19:00 h, accurate to 0.1°C. I also used data on the 24-hour total amount of rainfall (with an accuracy of 1 mm). The weather data were provided by the weather stations in the village of Zawady (ca. 20 km to the south of the study area). In 1999–2003, the yearly mean temperature measured at this station was 9.0°C, and the mean precipitation was 396.1 mm. The studied seasons did not differ in the mean ambient temperature during the breeding period of the Red-backed Shrike — i.e. from May to June (ANOVA, $F_{4,40} = 0.64$, $p = 0.99$, calculations based on decade means). The sum of rainfall did not differ in consecutive seasons as well (Kruskal-Wallis test, $H_{4,40} = 0.47$, $p = 0.98$, calculations based on decade means).

Influence of weather conditions was analysed on the level of brood losses by using the multiple regression method with a stepwise selection of variables (Sokal & Rohlf 2001). In this model, the dependent variable was the number reflecting the size of losses in a brood, and independent variables were the mean daily temperature in specific periods of nestling stay in the nest and the total amount of rainfall in this period. I also added the number of hatched nestlings to the independent variables, as their number could affect the size of brood losses associated with food provision to nestlings (Hegner & Wingfield 1987, Olsen & Tucker 2003). I used Statistica 6.0 (StatSoft 2003) software for the statistical calculations.

RESULTS

An average of 5.1 nestlings hatched in broods, and an average of 4.6 nestling survived until the 9–10th day of life. Partial losses in the number of nestlings occurred in 26.9% of 78 analysed broods and were on average 0.5 nestling/brood (Table 1). The differences in the range of losses between seasons were not statistically significant (ANOVA, $F_{4, 73}$ = 2.33, ns).

During the longer period analysed, the range of weather conditions varied (Table 1). Despite these great fluctuations, mean temperatures were similar, but the amount of rainfall differed threefold between the distinguished periods of nestling age (Table 1).

In the first analysed period of nestling life (1–5 days) the brood losses were dependent only on the number of hatched nestlings (ANOVA, $F_{1,76}$ = 4.23, p = 0.043), which explained only 4% of variation in the range of losses. In the period between the 6th and 9 (10)th day of nestling life, the extent of losses was affected by two factors (ANOVA, $F_{2,75}$ = 6.97, p = 0.002), which jointly explained 13.4% of variation in the losses (Table 2). The determination coefficient of partial correlations was 11.0% for the amount of rainfall, and 6.7% for the number of hatched nestlings. When considering the entire period of nestling stay in the nest, the range of brood losses was also affected by the same two factors (ANOVA, $F_{2,75}$ = 4.58, p = 0.013), which jointly explained 8.5% of variation in brood losses. The determination coefficient of partial correlations was 5.9% for rainfall, and 6.4% for the number of hatched nestlings.

Table 2. Results of a multiple regression analysis of the size of losses in broods of the Red-backed Shrike against the ambient temperature, rainfall and number of hatched nestlings in two periods of nestlings` life (n = 78). Only statistically significant variables are presented.

Variable	B	SE	t	p
1–5 days of life				
N of hatched nestlings	0.19	0.09	2.06	0.043
Constant	-0.49	0.48	-1.02	0.310
6–9 (10) days of life				
Rainfall	0.03	0.01	3.04	0.003
N of hatched nestlings	0.20	0.09	2.32	0.023
Constant	-0.70	0.46	-1.51	0.135
1–9 (10) days of life				
Rainfall	0.01	0.01	2.17	0.033
N of hatched nestlings	0.20	0.09	2.27	0.026
Constant	-0.74	0.48	-1.52	0.132

DISCUSSION

I found that the losses in Red-backed Shrike broods were affected by the number of hatched nestlings in all the distinguished periods of the nestling life. Nevertheless, this factor was most important for brood losses (maximum of 6.7% cases). Among the two analysed weather variables, the ambient temperature did not influence the size of brood losses at all. Rainfall influenced the range of losses when the nestlings were over 6 days old and in the entire period of their stay in the nest. However, this influence was weak and could explain only 11% of partial brood losses. This shows that with inclement weather, the period when nestlings are 6–9 (10) days old is especially difficult for the Red-backed Shrike. This may be due to their food requirements, which are the highest during this period of nestling life. Laboratory studies showed that Red-backed Shrikes at the age of 6–10 days had food requirements at a level of 17–20 Kcal/24 h, while in the preceding period it was up to 11.5 Kcal/24 h (Diehl & Myrcha 1973). The difference between these values is not

Table 1. Parameters of reproduction of the Red-backed Shrike and mean ambient temperatures and mean rainfall in two periods of nestling life in eastern Poland (n = 78).

Variable	Mean	SD	Min.	Max.
N of hatched nestlings	5.1	1.11	1.0	7.0
N of nestlings in 9–10 days of life	4.6	1.27	1.0	7.0
Size of losses	0.5	0.92	0.0	4.0
Mean temperature — 1–5 days of life	19.6	3.50	12.5	26.3
Mean temperature — 6–9 (10) days of life	20.1	3.29	12.9	25.8
Mean temperature — 1–9 (10) days of life	19.8	2.91	14.0	25.7
Sum of rainfall — 1–5 days of life	9.1	11.88	0.0	62.4
Sum of rainfall — 6–9 (10) days of life	4.5	10.02	0.0	62.4
Sum of rainfall — 1–9 (10) days of life	13.6	18.55	0.0	93.8

less than 33%. Moreover, dietary requirements can be even higher under natural conditions, as the ambient temperature rarely reaches the same level as in captivity (25–26°C). Thus, under natural conditions, nestlings have to spend a remarkable amount of energy on maintaining a constant body temperature. Red-backed Shrikes reach the ability of effective thermoregulation in their 7–8th day of life (Diehl & Myrcha 1973). The number of nestlings in broods can influence the amount of food provided to each nestling. During a period of inclement weather, with a reduction of parents' ability to find food, some of the nestlings in a brood can die (Takagi 2001).

Weather conditions probably influence the losses in Red-backed Shrike broods indirectly by reducing the availability of food for nestlings. The activity of the Red-backed Shrike prey strongly depends on the weather (Hornman et al. 1998, Kuper et al. 2000). The increase in the population size of this shrike in some regions of Europe was even explained by high temperatures during their breeding period (Jacob 1999, Kowalski 1999, Van Dijk & Hustings 1999). Under particularly inclement weather, which impeded the feeding of adult Red-backed Shrikes, nests were even abandoned in some cases (Jakober & Stauber 1980). The influence of rainfall is most evident, which has been reported from a remarkable part of the species breeding range and has been identified as the factor causing a high number of losses in broods (Lefranc 1979, Rudin 1990, Olsson 1995, Farkas et al. 1997, Horvath et al. 1998, 2000). In northern Italy, the negative influence of rainfall on the number of breeding pairs and survival of broods of the Red-backed Shrikes was reported. However, the influence of ambient temperature was not confirmed (Fornasari & Massa 2000). In contrast, a positive correlation was found between an increase of temperature and greater survival of broods in central Poland (Diehl 1977). The negative influence of low temperatures and precipitation on broods was also found in other species of shrikes (Kopij 1999, Lovászi et al. 2000, Yosef 2000, Takagi 2001).

In the present study, the influence of rainfall on the extent of losses in broods of the Red-backed Shrike was relatively weak. Perhaps, despite remarkable differences in the level of rainfall between broods, the weather conditions were good enough for birds to find a sufficient amount of food to feed the nestlings. During the study period, days when rainfall was heavy and lasted for a long time were very rare. During inclement weather and the consequent decreased activity of insects, Red-backed Shrikes may catch more vertebrates (Hornman et al. 1998, Tryjanowski et al. 2003). In this area, vertebrates were remarkably below 1% of the number of prey items (Goławski 2005). This can be indirect evidence of the presence of generally favourable conditions during the breeding period of this species. However, the level of losses may be a partial reflection of individual quality or age experience (Nur 1984, Pärt 2001). In Bull-headed Shrikes, it was found that female age significantly affected the maximum mass of nestlings in a brood (Takagi 2003). With limited access to food during periods of worse weather conditions, this factor may be more important and become a cause of partial brood losses. I found in the study area that the number of fledglings in a brood was positively correlated with the amount and biomass of the potential food base on a given territory (Goławski 2005).

Thus, in the study area, one should expect some factors other than weather conditions to cause partial losses in Red-backed Shrike broods, at least in seasons with an average pattern of air temperature and rainfall. The structure of territories and their food abundance should undoubtedly be among the factors considered (Goławski 2005).

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REFERENCES

Acquarone C., Cucco M., Malacarne G. 2003. Reproduction of the Crag Martin (*Ptyonoprogne rupestris*) in relation to weather and colony size. Ornis Fennica 80: 79–85.

Antczak M., Hromada M., Grzybek J., Tryjanowski P. 2004. Breeding biology of the Great Grey Shrike *Lanius excubitor* in W Poland. Acta Ornithol. 39: 9–14.

Bryant D. M. 1978. Environmental influences on growth and survival of nestling House Martins *Delichon urbica*. Ibis 120: 271–283.

Cramp S., Perrins C. M. (eds). 1993. Red-backed Shrike, *Lanius collurio*. The birds of Europe, the Middle East and North Africa. Vol. VII. Oxford-New York.

Diehl B. 1977. The effect of ambient temperature on density-dependent processes in a population of the Red-backed Shrike, *Lanius collurio* L. Bull. Acad. Pol. Sci. 24: 711–718.

Diehl B., Myrcha A. 1973. Bioenergetics of nestling Red-backed Shrikes (*Lanius collurio*). Condor 75: 259–264.

Farkas R., Horváth R., Pásztor L. 1997. Nesting success of Red-backed Shrike (*Lanius collurio*) in a cultivated area. Ornis Hungarica 7: 27–37.

Fornasari L., Massa R. 2000. Habitat or climate? Influences of environmental factors on the breeding success of the Red-backed Shrike (*Lanius collurio*). Ring 22: 147–156.
Goławski A. 2005. [Ecological conditions of the breeding success of the Red-backed Shrike *Lanius collurio* in the agricultural landscape on the North Podlasie Lowland]. PhD. Thesis. Univ. Podlasie, Siedlce, Poland.
Goławski, A. (in press.). [Breeding biology of the Red-backed Shrike *Lanius collurio* in the landscape of extensive agriculture in eastern Poland.] Notatki Ornitol.
Hegner R. E., Wingfield J. C. 1987. Effects of brood-size manipulations on parental investment, breeding success, and reproductive endocrinology of House Sparrows. Auk 104: 470–480.
Hornman M., Nijssen M., Geertsma M., Kuper J., Esselink H. 1998. Temporal effects on diet composition in nestling Red-backed Shrike (*Lanius collurio*) in Bargerveen, the Netherlands. IBCE Tech. Publ. 7: 83–87.
Horvath R., Farkas R., Yosef R. 2000. Nesting ecology of the Red-backed Shrike (*Lanius collurio*) in northeastern Hungary. Ring 22: 127–132.
Horvath R., Kovacs K., Farkas R. 1998. Reproductive biology of the Red-backed Shrike (*Lanius collurio*) in the Aggteleki Nemzeti Park, Hungary. IBCE Tech Publ. 7: 49–50.
Jacob J.-P. 1999. La situation des Pies-grièches écorcheur (*Lanius collurio*) et grise (*Lanius excubitor*) en Wallonie (Belgique). Aves 36: 7–30.
Jakober H., Stauber W. 1980. Flügellängen und Gewichte einer südwestdeutschen Population des Neuntöters (*Lanius collurio*) unter Berücksichtigung der geschlechtsspezifischen Arbeitsteilung während der Brutperiode. Vogelwarte 30: 198–208.
Kopij G. 1999. Breeding ecology of the Fiscal Shrike *Lanius collaris* in a peri-urban environment in Bloemfontein, South Africa. Navors. nas. Mus., Bloemfontein 15: 45–63.
Kowalski H. 1999. Les effectifs de la Pie-grièche écorcheur (*Lanius collurio*) augmentent à nouveau en Allemagne. Aves 36: 137–140.
Kuper J., Van Duinen G.-J., Nijssen M., Geertsma M., Esselink H. 2000. Is the decline of the Red-backed Shrike (*Lanius collurio*) in the Dutch coastal dune area caused by a decrease in insect diversity? Ring 22: 11–25.
Kuźniak S. 1991. Breeding ecology of the Red-backed Shrike *Lanius collurio* in the Wielkopolska region (Western Poland). Acta Ornithol. 26: 67–84.
Kuźniak S., Tryjanowski P. 2003. [Red-backed Shrike]. Wydawnictwo Klubu Przyrodników, Świebodzin.
Lefranc N. 1979. Contribution à l`écologie de la Pie-grièche écorcheur *Lanius collurio* L. dans les Vosges moyennes. Oiseau 49: 245–298.
Lovászi P., Bártol I., Moskát C. 2000. Nest-site selection and breeding success of the Lesser Grey Shrike (*Lanius minor*) in Hungary. Ring 22: 157–164.
Newton I. 1989. Lifetime Reproduction in Birds. Academic Press, London.
Nur N. 1984. Increased reproductive success with age in the California Gull: Due to increased effort or improvement of skill? Oikos 43: 407–408.
Olsen J., Tucker A. D. 2003. A brood size manipulation experiment with Peregrine Falcons, *Falco peregrinus*, near Canberra. Emu 103: 127–132.
Olsson V. 1995. The Red-backed Shrike *Lanius collurio* in southeastern Sweden: Breeding biology. Ornis Svecica 5: 101–110.
Pärt T. 2001. Experimental evidence of environmental effects on age-specific reproductive success: The importance of resource quality. Proc. Royal Soc. London, Series B, 268: 2267–2271.
Rodenhouse N. L., Holmes R. T. 1992. Results of experimental and natural food reductions for breeding Black-throated Blue Warblers. Ecology 73: 357–372.
Rudin M. 1990. Bruterfolg und Fütterungsverhalten des Neuntőters *Lanius collurio* in der Nordwestschweiz. Orn. Beob. 87: 243–252.
Siikamäki P. 1996. Habitat quality and reproductive traits in the Pied Flycatcher — an experiment. Ecology 76: 308–312.
Simons L. S., Martin T. E. 1990. Food limitation of avian reproduction: an experiment with the Cactus Wren. Ecology 71: 869–876.
Sokal R. R., Rohlf F. J. 2001. Biometry. 3rd ed. New York.
StatSoft, Inc. 2003. STATISTICA (data analysis software system), version 6.
Takagi M. 2001. Some effects of inclement weather conditions on the survival and condition of bull-headed shrike nestlings. Ecol. Res. 16: 55–63.
Takagi M. 2003. Different effects of age on reproductive performance in relation to breeding stage in Bull-headed Shrikes. J. Ethol. 21: 9–14.
Tinbergen J. M., Dietz M. W. 1994. Parental energy expenditure during brood rearing in the great Tit (*Parus major*) in relation to body mass, temperature, food availability and clutch size. Funct. Ecol. 8: 563–572.
Tryjanowski P., Karg M. K., Karg J. 2003. Diet composition and prey choice by the red-backed shrike *Lanius collurio* in western Poland. Belg. J. Zool. 133: 157–162.
Tryjanowski P., Kuźniak S. 1999. Effect of research activity on the success of Red-backed Shrike *Lanius collurio* nests. Ornis Fennica 76: 41–43.
Turner A. K. 1984. Nesting and feeding habits of Brown-chested Martins in relation to weather conditions. Condor 86: 30–35.
Van Dijk A. J., Hustings F. 1999. La Pie-grièche écorcheur (*Lanius collurio*) aux Pays-Bas: un équilibre ou une situation précaire? Aves 36: 113–126.
Wesołowski T., Czeszczewik D., Rowiński P., Walankiewicz W. 2002. Nest soaking in natural holes — a serious cause of breeding failure? Ornis Fennica 79: 132–138.
Whittingham M. J., Bradbury R. B., Wilson J. D., Morris A. J., Perkins A. J., Siriwardena G. M. 2001. Chaffinch *Fringilla coelebs* foraging patterns, nestling survival and territory distribution on lowland farmland. Bird Study 48: 257–270.
Yosef R. 2000. Nesting ecology of the Loggerhead Shrike (*Lanius ludovicianus*) in southcentral Florida. Ring 22: 111–121.

STRESZCZENIE

[Wpływ warunków atmosferycznych na straty częściowe piskląt gąsiorka we wschodniej Polsce]

Wpływ temperatury powietrza i opadów deszczu na wielkość strat częściowych piskląt w lęgach gąsiorka badałem w latach 1999–2003 w ekstensywnym krajobrazie rolniczym wschodniej Polski. Wielkość strat obliczyłem jako różnice pomiędzy liczbą wyklutych piskląt, a liczbą piskląt w 9–10 dniu ich życia. Natomiast warunki meteorologiczne ustaliłem dla dwóch przedziałów czasowych wieku piskląt. Było to dla pierwszych 5 dni od daty wyklucia oraz pomiędzy 6–9

(lub 10) dniem życia piskląt. Taki podział czasowy był podyktowany różnicami w metabolizmie piskląt w okresie ich rozwoju podawanymi w literaturze. Przeanalizowałem również warunki meteorologiczne dla całego okresu przebywania piskląt w gnieździe tj. od daty wyklucia do 9 lub 10 dnia ich życia (Tab. 1).

Temperatura powietrza nie wpływała na wielkość start na żadnym etapie życia piskląt. Opady deszczu wpływały na wielkość strat w okresie, kiedy pisklęta miały 6–10 dni i 1–10 dni (Tab. 2). Wpływ opadów deszczu wyjaśnił jedynie 11% strat w lęgach. Warunki atmosferyczne prawdopodobnie pośrednio wpływały na wielkość strat w lęgach gąsiorka poprzez zmniejszenie dostępności pokarmu do karmienia młodych, bowiem aktywność zwierząt stanowiących pokarm gąsiorka, zarówno piskląt jak i dorosłych ptaków, jest silnie uzależniona od pogody.

Na badanym przeze mnie terenie należałoby więc szukać innych, ważniejszych od warunków atmosferycznych, przyczyn wywołujących straty częściowe w lęgach gąsiorka, przynajmniej w sezonach o przeciętnym przebiegu temperatury i opadów. Do przyczyn tych należy z pewnością struktura terytoriów i ich zasobność w pokarm.