Biota

Vol. 1, No. 2, 2000

Revija za biologijo in ekologijo
Journal of biology and ecology

Društvo za proučevanje ptic in varstvo narave
Society of Bird Research and Nature Protection

Društvo varuhov okolja Radoživ
Environmental Society Radoživ

Vsebina/Contents

Članki/Articles

Nove knjige/Book reviews

The presence of West Mediterranean tenebrionid beetles in Greece

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Abstract
The presence of the West Mediterranean tenebrionid beetle *Scaurus striatus* in Greece is confirmed. As *S. striatus* is an anthropophilic species, dispersal by man could be the reason for this disjunct distribution. In particular, the occurrence of *S. striatus* in Greece fits very well with the Venetian presence in this country. Dispersal by man may also explain the occurrence of *S. tristis* on Crete.

Key words:
Coleoptera Tenebrionidae, *Scaurus striatus*, island biogeography, dispersal, introduced species.

Received 10 July 2000; accepted 10 August 2000

Some species of tenebrionids (Coleoptera, Tenebrionidae) are anthropophilic beetles commonly found in grain products or in man made habitats. These beetles can be easily transported with food stores or other goods, becoming widely distributed or even cosmopolitan.

Human dispersal can be an important factor in explaining anomalous distribution patterns, and importation by ships may be a dispersal route for anthropophilic species. In particular, human dispersal could be involved in two West Mediterranean tenebrionid beetles, *Scaurus striatus* Fabricius 1792 and *S. tristis* Olivier 1795.

S. striatus is predominantly West Mediterranean in distribution, occurring in Catalonia, the eastern Balearic Islands, southern France, Corsica, the Italian Peninsula (south of the Po River basin), the Tuscan Archipelago, the Pontine Islands, Ischia and Capri, Sardinia, Sicily, the Pelagie, Egadi and Eolie Islands and the Maltese Islands (e. g. Canzoneri 1972, Gardini 1976, Grimm 1986, Mifsud & Scupola 1998). However, this species has also been sighted on some Greek islands (Kérkira, Zákinthos, Naxos and Milos) (Kühnelt 1965), the Peloponnese and in the Balkans without any specified localities (cf. Peyerimoff 1948, Kaszab 1967).

In Greece, the species was collected on Zákinthos for the first time by Doria and Beccari in 1880 (Gardini 1976) and recently by Kühnelt (Kühnelt 1965). Records from Kérkira are based on collections made in the 1920's, while those for Naxos and Milos are based on older records which were never confirmed (Kühnelt 1965). Finally, the citation from the Peloponnese was regarded as very unlikely (Peyerimoff 1948) and rejected by later authors.

Although many Greek islands and surroundings are faunistically well known (e. g. Kühnelt 1965, Dajoz 1987, Schawaller 1996 and references therein), recent collections (e. g. Liebegott 1982, Fattorini et al. 1999) suggest that additional records are expected.

During an expedition recently undertaken by "Roma Tre" University, a female specimen of *S. striatus* was collected in an archaeological site near Loutráki (nomos Etolía Akarnanía, 15 km east of Vonitsa, 3.VI.1999, M. Bologna, P. De Salvo, F. Turco and M. Zapparoli leg.; Zoological Museum, Universit_ di Roma "La Sapienza"). This is the first known locality for this species in the Balkan Peninsula, confirming its presence in the East Mediterranean.

Compared to the species range and the overall distribution of the genus (South West Europe and North Africa; e. g. Peyerimoff 1948), the occurrence of *S. striatus* in the above mentioned Greek localities appears to be difficult to explain.

Whitehead (1997) cited on Zákinthos two other beetles with West Mediterranean distributions: Brindalus porcicollis (Illiger 1803) (Scarabaeidae) and Halammobia pellucida (Herbst 1799) (Tenebrionidae). As both B. porcicollis and H. pellucida are strictly psammophilic species restricted to beaches and dunes, their presence on Zákinthos is probably relictual. By contrast, as *S. striatus* is an euryoecious thermophilic species

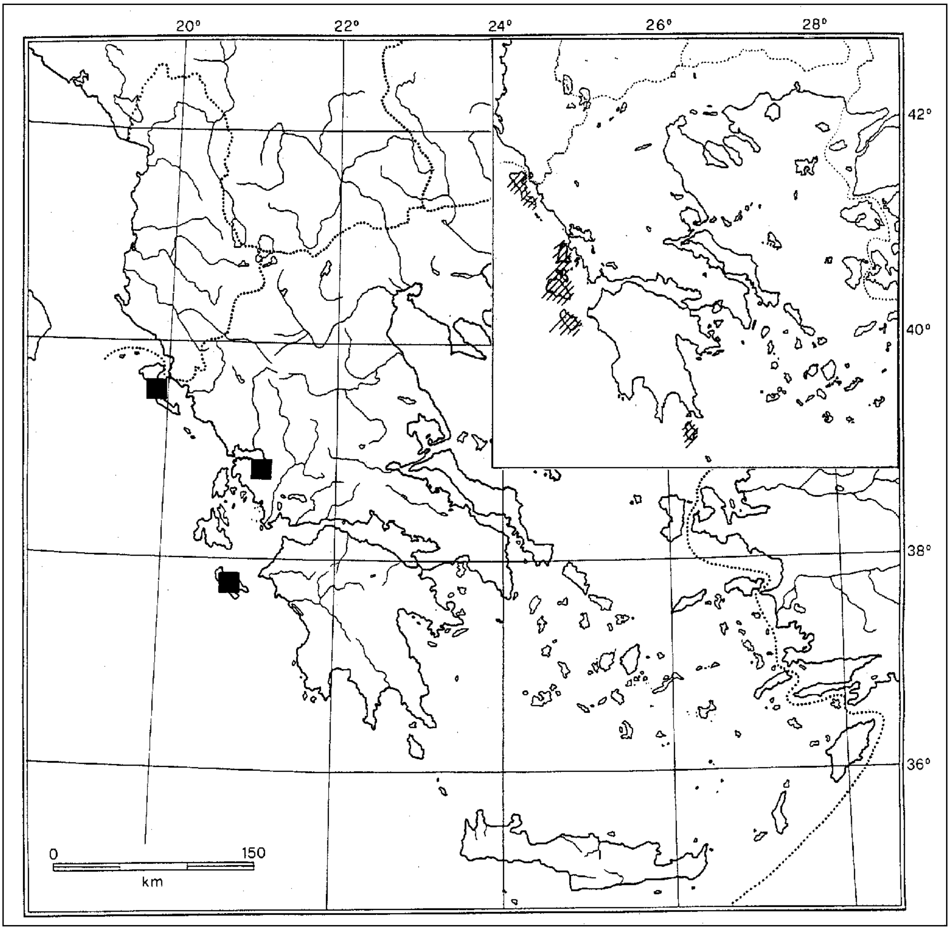

Figure 1. Distribution of Scaurus striatus in Greece (black squares) compared to the ancient Venetian territories during the eighteenth century (hatched areas).
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which could easily find suitable habitats throughout coastal areas of the Balkan Peninsula, no relict models seem to be involved in explaining such a distribution. On the contrary, dispersal by man could be a more realistic explanation for the disjunct distribution of this species.

S. striatus is an anthropophilic beetle, especially linked to ruderal, archaeological and rubble sites where it has many suitable hiding places, such as rock holes and caves. Interestingly, the distribution of *S. striatus* in Greece fits very well with the Venetian presence in this country in the eighteenth century (Figure 1). Zákinthos, as well as Kérkira and other territories, was under Venetian rule from the thirteenth to the eighteenth century, representing fortresses of dramatic importance for foreign trade between the Venetian Republic and the East Mediterranean countries (Lane 1978, Papadia Lala 1998).

S. tristis may have been introduced to the East Mediterranean by Venetian ships. It is a typically West Mediterranean species, distributed in Tunisia, Algeria, Morocco, Portugal, Spain, the Balearic Islands, southern France and southern Italy, Sardinia, Sicily, the Lipari, Egadi and Pelagie Islands, Pantelleria and the Maltese Islands (e. g., Grimm 1985, Mifsud & Scupola 1998). However, the species was also collected on Crete in the nineteenth and twentieth centuries (Kühnelt 1965). As Crete was under Venetian rule during the sixteenth and seventeenth centuries, this species was probably introduced to the island by ship.

However, since both *S. striatus* and *S. tristis* are absent from the Italian territories of the Venetian Republic, they could have been introduced by Venetian vessels with goods coming from other regions. Indeed, Venetian merchants traded with Sicily, Naples, Valencia, Barcelona, and Majorca, calling at Cartagena, Cadiz, Lisbon and various North African cities (Lane 1978, Contamine 1983).

Alternatively, these species could have been imported by the Romans in the second century A. D., when many sea lanes between Rome and the East Mediterranean areas crossed the area around the Greek Islands (cf. Barraclough 1997).

In any case, commerce between Italy and the Greek islands could be the reason for the introduction of *S. striatus* and *S. tristis* with building materials and commercial products into the islands from areas where the species are known. The new locality record of *S. striatus* in Greece, which is the only currently known inland location, is very near the Ionian Islands, from which the species has probably reached the mainland.

Acknowledgements

I would like to thank Prof. M. A. Bologna, Dr. P. De Salvo, Ms. F. Turco (all at Universita degli Studi "Roma Tre") and Dr. M. Zapparoli (Universita della Tuscia, Viterbo) for collecting many tenebrionids, including the specimen of *S. striatus*, during their entomological researches in Greece. Prof. M. A. Bologna, Dr. G. M. Carpaneto (Universita degli Studi "Roma Tre"), Dr. D. Mifsud (Naturhistorisches Museum, Basel) and Dr. L. Salvati made helpful suggestions on the manuscript. Thanks are also due to Prof. A. Biagini (Universita di Roma "La Sapienza") for historical discussions. This research was supported by a grant from the Italian Ministero della Ricerca Scientifica e Tecnologica ("Variazione geografica e diversit_ a livello di specie, faune e zoocenosi: cause storiche ed ecologiche").

REFERENCES

BARRACLOUGH, G. B. 1997: I percorsi della storia - Atlante. Istituto geografico De Agostini, Novara. Corriere della Sera, Milano (original title: The Times Atlas of World History, Times Books Limited, London).

CANZONERI, S. 1972: Nuovi dati sui Tenebrionidae di "piccole isole" italiane, con descrizione di Alphasida tirellii moltonii n. ssp. Atti della Societ_

Italiana di Scienze Naturali e del Museo Civico di Storia Naturale 113: 288-296.

CONTAMINE, P. 1983: Trasformazioni economiche e sociali. In: Livet, G. & Mousnier, R. (eds.). Storia d'Europa - Il Rinascimento. Laterza, Bari - Euroclub: 87-123 (original title: Histoire générale de l'Europe, 1980, Presses Universitaires de France, Paris).

DAJOZ, R. 1987: Les peuplements de Coléopt_res Tenebrionidae des îles grecques. Bulletin de la Societe Zoologique de France 112: 221-231.

FATTORINI, S., LEO, P. & SALVATI, L. 1999: Biogeographical observations on the Darkling beetles of the Aegean Islands (Coleoptera, Tenebrionidae). Fragmenta entomologica 31: 339-375.canzoneri

GARDINI, G. 1976: Materiali per lo studio dei tenebrionidi dell'Arcipelago toscano (Col. Heteromera). Lavori della Societ_ Italiana di Biogeografia 5: 1-87.

GRIMM, R. 1985: Zur Kenntnis der Tenebrioniden aus Süditalien (Insecta: Coleoptera). Stuttgarter Beiträge zur Naturkunde, Ser. A (Biologie) 379: 1-32.

GRIMM, R. 1986: Tenebrionidae vom Maltesischen Archipel. Stuttgarter Beiträge zur Naturkunde, Ser. A (Biologie) 392: 1-17.

KASZAB, Z. 1967: Ergebnisse der Albanien-Expedition 1961 des Deutschen Entomologischen Institutes. 70. Coleoptera Tenebrionidae. Beitrage zur Entomologie 17 : 547-571.

KÜHNELT, W. 1965: Catalogus Faunae Graeciae. Pars I. Tenebrionidae, To Wuno.

LANE, F. C. 1978: Storia di Venezia. Giulio Einaudi, Torino (original title: Venice. A Maritime Republic, 1973, The Johns Hopkins University Press).

LIEBEGOTT, D. 1982: Bemerkenswerte Funde von Tenebrioniden auf Inseln der Ägäis (Coleoptera). Mitteilungen des Internationalen Entomologischen Vereins e. V. Frankfurt 7: 14-19.

MIFSUD D. & SCUPOLA A. 1998: The Tenebrionidae (Coleoptera) of the Maltese Islands (Central Mediterranean). Annali del Museo Civico Storia Naturale "G. Doria" 92: 191-229.

PAPADIA LALA, A. 1998: I Greci fra Venezia e i Turchi nell'arco della lunga durata. In: Motta G. (ed.) I Turchi, il Mediterraneo e l'Europa. Franco Angeli, Milano: 185-196.

PEYERIMHOFF, P. DE 1948: Études sur la systématique des Coléopt_res du Nord Africain. II. Les Scaurus. Revue françoise d'Entomologie 14: 157-193.

SCHAWALLER, W. 1996: Tenebrionidae (Coleoptera) aus Nord-Griechenland: Habitate, Artengesellschaften und Verbreitung. Entomologische Blätter 92: 3-18.

WHITEHEAD, P. F. 1997: The Coleoptera of Zakynthos, Greece. In: Studies in Quaternary Entomology - An Inordinate Fondness for Insects. Quaternary Proceedings 5: 277-291.

Dispersal as a mechanism limiting diversity of high latitudes

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Abstract

The pervasiveness across taxa, space, and time of the latitudinal gradient in species diversity is conventionally thought to suggest a common cause that is not yet identified. Conventionally, the cause of the gradient is thought to originate in the tropics where diversity is high, although recently causes originating at high latitudes or attributable to random patterns have been proposed. Most discussions of causes relative to the diversity gradient are elaborate and burdened with assumptions. A parsimonious causal mechanism that accounts for the accumulation of relatively high amounts of genetic homogeneity within populations at high latitudes could result in suppressed speciation rates. Suppressed speciation rates would, in turn, eventually lead to accumulation of fewer species at high latitudes and the appearance of a latitudinal diversity gradient. Dispersal ability could be a parsimonious cause for the diversity gradient, and species adapted to high latitudes should disperse widely. Therefore, adjacent local populations at high latitudes should be more genetically similar than adjacent local populations in the tropics - when the same longitudinal distance separates local populations. Ultimately, detailed genetic investigations and analyses of extant collections and data will be needed to test this proposed mechanism. Already, however, some genetic evidence supports this idea: low latitude populations of the Eastern Woodrat *Neotoma floridana* show more mtDNA variability than high latitude populations. Also, some behavioral data are supportive: Red Fox *Vulpes vulpes* displays a notable northward bias in their dispersal direction. The uncovering of a parsimonious mechanism that accounts for the latitudinal diversity gradient would resolve decades of discussion and provide valuable insights into the topic of biodiversity. It may be that a parsimonious mechanism for dispersal ability is supported by some data, and awaits more detailed investigations.

Key words: latitudinal gradient, diversity, parsimonious mechanism, dispersal ability, speciation, Red Fox, *Vulpes vulpes*

Received 25 July 2000; accepted 1 October 2000

INTRODUCTION

The latitudinal gradient in species diversity has been widely discussed. Rohde (1992) reviewed explanations for the gradient, and found them lacking. However, most researchers accept that the gradient exists (see Rosenzweig 1995) and the pervasiveness, across taxa, space, and time, of the gradient strongly suggests common cause (Pianka 1966, Ricklefs 1973, Rohde 1978, Brown & Gibson 1983, Rohde 1992). Notably, the mechanism(s) causing the gradient has resisted identification (Blackburn & Gaston 1996).

Conventionally, the cause of the gradient is thought to originate in the tropics (Blackburn & Gaston 1996). This has led to a search for an explanation of high tropical diversity in preference to an explanation for low high latitude diversity. I concur with Pielou (1979) and Blackburn & Gaston (1996) that this reflects a mental predisposition. Objectively, there is no a priori reason to suspect that the diversity gradient is caused by high tropical diversity instead of lower high latitude diversity. Stehli et al. (1969) identified this point but it is only recently that Tilman & Pacala (1993) and Blackburn & Gaston (1996) have suggested that it merits more attention. Colwell & Hurtt (1994) have shown that a gradient will result randomly if diversity at high latitudes is low. Importantly, their hypothesis lacks a mechanism (offered here) allowing attribution of low diversity to high latitudes.

In this paper, I present discussion and data to support the case that differences among populations and or individuals in intra-specific dispersal ability can be expected to reduce speciation rates differentially at high latitudes. Further, I present the case that the latitudinal gradient in species diversity results from expression of this mechanism.

The mechanism is based at the primary levels (Pianka 1988) of natural selection and speciation, affects that directly contribute to species diversity as opposed to affects that require additional assumptions (e.g. refugia and habitat heterogeneity hypotheses for the latitudinal gradient [MacArthur 1965, Whittaker 1969, Haffer 1969, Lynch 1988, Levin, 1974]). Many aspects of the mechanism are testable by existing collections of biogeographical, ecological, genetic, histological, and behavioral information. I focus my attention upon terrestrial non-migratory taxa, although the phenomena described are not limited to these groups (e.g., Bohonak 1999).

STATEMENT OF THE MECHANISM

Glaciation imposed strong selective forces on species at high latitudes, including forces favoring exceptional dispersal ability that allowed species to adapt during relatively short periods of time to spatially and climatically changing environments (Thiery 1982, Brown & Gibson 1983, Begon et al. 1990, Abbott et al. 2000). Dispersal ability is among the characteristics evident among extant high latitude fauna that makes them resistant to extinction (Marshall 1988). High latitude fauna are also wide-ranging generalists (Marshall 1988, Pagel et al. 1991). Thus, empirical evidence suggests that extinction rates are low at high latitudes. Exceptional dispersal ability causes relatively high amounts of genetic homogeneity to develop across local populations (e.g., Coope 1979, Bohonak 1999). Genetic homogeneity reduces the evolutionary potential (Fischer 1960) of species, denying them the opportunity to develop genotypic variation across local populations.

The mechanism causes the latitudinal species diversity gradient by depressing speciation rates at high latitudes relative to rates at low latitudes. A gradient per se is probably not formed but develops randomly by processes described by Colwell & Hurtt (1994) following development of low high-latitude diversity. Lowered speciation rates result in decreased diversity.

The mechanism is parsimonious in its assumptions. They are 1) ice ages eliminated all species which were unable to disperse and colonize new areas, and 2) following assumption 1, ice ages

imposed strong selective forces favoring species and genotypes with exceptional high dispersal abilities.

The critical component of both assumptions is that species dispersed over ecological time from high latitudes because of glacial advance (Davis 1981, 1986). Also, species had to make the return journey upon glacial retreat. Selection was reinforced by multiple episodes of glaciation. Sedentary species and genotypes would be eliminated (Tilman 1994). The assumption that these glacial processes have had no effect on present species distributions (implicit in presentations to the effect that the gradient is a statistical artifact, Colwell & Hurtt 1994) appears improbable.

PREDICTIONS AND EVIDENCE

The mechanism predicts three types of phenomena. First, species in high latitudes will be comprised of local populations that are genetically homogeneous relative to those of lower latitudes (e.g., Bohonak 1999). Second, this homogeneity has resulted in depressed speciation at high latitudes relative to low latitudes. Third, because the mechanism is presumably still operative today, it is expected that intra-specific dispersal distance or number of dispersals should display a northward bias, tending to maintain genetic homogeneity at high latitudes (e.g., Coope 1979).

Red fox *Vulpes vulpes* provide an illuminating example. Red fox display a notable tendency favoring northward dispersal (Figure 1). Other researchers (i.e., Arnold & Schofield 1956, Phillips et al. 1972, Storm et al. 1976, Pils & Martin 1978) have noted this strong tendency but provide no explanations for its cause or consequences.

Rapoport's rule, where species range increases at high latitudes (Rapoport 1975, 1982, Stevens 1989, Lawton et al. 1994, Letcher & Harvey 1994), supports these predictions. Species have greater ranges because they are adapted to a wider array of environmental variation (Stevens 1989) but importantly for this manuscript, they are also more dispersal prone (Marshall 1988, Bohonak 1999).

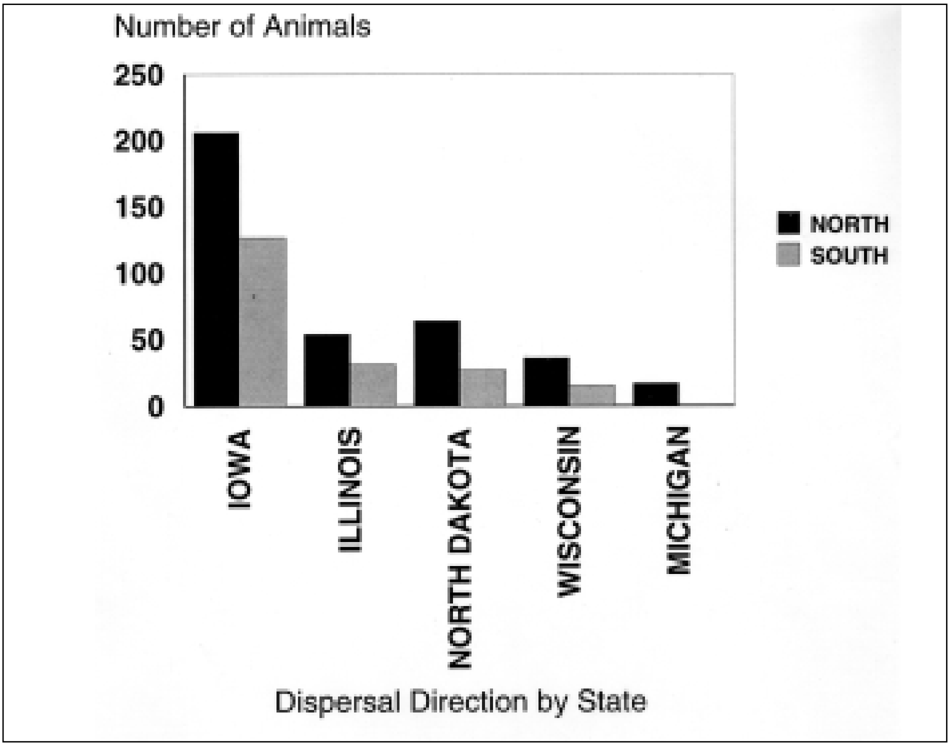

Figure 1. Red fox Vulpes vulpes *displays a consistent northward bias in dispersal direction. Data are from Arnold & Schofield (1956), Phillips et al. (1972), Storm et al. (1976), Pils & Martin (1978), and Allen & Sargeant (1993).*

Genetic evidence also supports the predictions. Low latitude populations of the Eastern Woodrat *Neotoma floridana* show more mtDNA variability than high latitude populations (Hayes & Harrison 1992). Dispersal is widely implicated in measurements of genetic structure for many species (Bohonak 1999).

DISCUSSION

There appears to be every reason to presume that in the history of biota on Earth, and over the many millennia of the Pleistocene, ample opportunity has been presented for evolution to have filled high latitude climates with an assemblage of cold adapted organisms equivalent in diversity to those found at low latitudes. This does not appear to be the case. The latitudinal diversity pattern has been expressed for at least 270 million years (Stehli et al. 1969). Patterns in vegetation attributable to latitude (Timms & Chambers 1984, Raymond et al. 1985, DiMichele & Hook 1992), and warm and cold climatic cycles have been in existence since the dawn of terrestrial life (Fischer 1981). Further, richness limits appear to be met in northern latitudes rapidly following glacial retreat (Currie 1991), suggesting a limiting factor. So, why doesn't diversity increase at high latitudes to the extent found at low latitudes?

A number of authors (e.g., Loucks 1970, Dayton 1971, Grime 1973, Koch 1974, Horn 1975, Connell 1978, Huston 1979) have suggested population mechanisms that may be affecting diversity. These mechanisms can be summarized by the logistic equation;

$\frac{\Delta D}{\Delta t}=\frac{S}{E}D\frac{(K-S)}{K}$ where $\Delta D/\Delta t$ is change in diversity over time, D is diversity at time$_0$, K is maximum diversity, S is speciation rate, and E is extinction rate. The equation suggests that the observed pattern (low high latitude diversity and high tropical diversity) can result only from three phenomena. First, there has not been adequate ecological or evolutionary time since the last glaciation for new diversity to develop at high latitudes (Pianka 1966, 1988). Second, the ratio of speciation to extinction is relatively high at low latitudes. Third, the ratio of speciation to extinction is relatively low at high latitudes.

The first explanation, insufficient ecological or evolutionary time, is a necessary possibility. However, for this to be so an ad hoc argument must be invoked to the effect that our era marks a special point in time. The hypothesis is essentially untestable and such arguments are not persuasive until other explanations have been rejected.

The second and third explanations require an exploration of the factors influencing the speciation/extinction ratio at both high and low latitudes. It has long been considered that high speciation rates at low latitudes are the cause of their high diversity (see Rensch 1959, Stehli et al. 1969, Thiery 1982, Rohde 1992). High speciation rates would cause a high speciation/extinction ratio, but is there good evidence for this? Theories supporting high speciation rates at low latitudes have tended to be elaborate, reaching full expression in hypotheses based on refugia (e.g., Haffer 1969, Lynch 1988) and habitat heterogeneity (e.g., MacArthur 1965, Whittaker 1969, Levin 1974). These explanations tend to be tautological (Huston 1979, Rohde, 1992) and at least come close to violating the expectation that any explanation for the gradient be based upon "primary-level mechanisms" Pianka (1988). Enhanced speciation would be at a primary level, but I concur with Huston (1979) and Rohde (1992) regarding shortcomings and excessive assumptions implicit in these explanations. Rohde (1992) suggests a parsimonious hypothesis, that temperature enhances speciation rates at low latitudes, but offers no mechanism for the effect.

The third explanation, low speciation/extinction ratio at high latitudes, has historically focused upon high extinction rates resulting from glacial advance (Thiery 1982, Brown & Gibson 1983, Begon et al. 1990). However, extant high latitude faunas have many characteristics that make them resistant to extinction (Marshall 1988): species of such faunas are generalists (Pagel et al. 1991), widespread, and have excellent dispersal abilities. Thus, empirical evidence suggests that extinction rates are low at high latitudes. Therefore, on the basis of expected extinction rates alone (assuming equal speciation rates), we should expect the ratio of speciation to extinction to be greater at high latitudes, leading to rapidly accumulating diversity. This is not the observed case, and strongly suggests that something unusual is occurring with high latitude speciation rates; they are unusually low.

Either speciation rates are very high at low latitudes or very low at high latitudes. Any mechanism that can influence these rates differentially (McPeek 1996) across a species' range could account for the gradient. I previously discussed the non-parsimonious theories for high speciation rates at low latitudes. I believe that the dispersal-regulated mechanism I have described in this paper is a parsimonious explanation for low speciation rates at high latitudes, a possibility largely discounted by past treatments.

Dispersal can influence speciation (Balkau and Feldman 1973, McPeek & Holt 1992, McPeek 1996, Bohonak 1999) and can alter the selective environment (McPeek & Holt 1992). Recently, Hewitt (1996) suggested that during glacial advance, long range dispersants within populations from high latitudes set up new local populations first along the expanding glacial front, causing them to dominate the genome. Briefly, subsequent population dynamics favor these founders (Nichols & Hewitt 1994) and the genomes of these local populations tend toward homozygosity (Nei et al. 1975) favoring dispersal tendency. This tendency is further reinforced following glacial retreat.

High latitude diversity may be limited by low speciation rates caused by the exceptional dispersal characteristics evident in high latitude fauna. Further genetic investigations will best be able to investigate this phenomenon (Hewitt 1996). Conspecifics, collected at the same latitude, but at different longitude, at high latitudes should be genetically more related than conspecifics collected in the same way at lower latitudes. This data could be best collected for widely distributed species with substantial high and low latitude distributions. Red fox appears to be a species where genotypic patterns will correlate with dispersal tendency (Figure 1); Bohonak (1999) found equivalent empirical evidence correlating genetic structure to dispersal tendency for many taxa.

Widespread discussion concerning the latitudinal gradient in species diversity continues (e.g. Rhode 1997, Rosenzweig 1997). Empirical data indicate that there must be a mechanism correlated with adaptations to high latitude environments that acts to limit diversity. I propose that the mechanism is dispersal-regulated speciation that depresses speciation rate at high latitudes. I've suggested means for testing the mechanism with extant data and histological samples that have been collected by many researchers. I look forward to seeing investigations concerning correlation of intra-specific genetic relationships with distance across various latitudes and expect that these investigations will be consistent with the dispersal-regulated speciation hypothesis.

Acknowledgments

The views expressed in this manuscript are those of the author and do not necessarily reflect the views and policies of the U.S. Environmental Protection Agency (EPA). I thank M.A McGinley, M.R. Willig, and R.S. Lutz for their advice. I acknowledge S.J. Gould, whose writings have inspired my thinking in this specialty.

REFERENCES

ABBOTT, R. J., SMITH, L. C., MILNE, R. J., CRAWFORD, R. M. M,. WOLFF, K. & BALFOUR, J. 2000: Molecular analysis of plant migration and refugia in the Arctic. Science 289: 1343-1346.

ALLEN, S. H. & SARGEANT, A. B. 1993: Dispersal patterns of red foxes relative to population density. Journal of Wildlife Management 57:526-533.

ARNOLD, D. A. & SCHOFIELD, R. D. 1956: Home range and dispersal of Michigan red foxes. Papers of the Michigan Academy of Science, Arts, and Letters 41:91-97.

BALKAU, B. J. & FELDMAN, M. W. 1973: Selection for migration modification. Genetics 74:171-174.

BEGON, M., HARPER, J. L., & TOWNSEND, C. R. 1990: Ecology. Individuals, populations, communities. Blackwell, London.

BLACKBURN, T. M. & GASTON, K. J. 1996: A sideways look at patterns in species richness, or why there are so few species outside the tropics. Biodiversity Letters 3:44-53.

BOHONAK, A. J. 1999: Dispersal, gene flow, and population structure. The Quarterly Review of Biology 74:21-45.

BROWN, J. H. & GIBSON, A. C. 1983: Biogeography. Mosby, St. Louis, MO.

COLWELL, R. K. & HURTT, G. C. 1994: Nonbiological gradients in species richness and a spurious Rapoport effect. American Naturalist 144: 570-595.

CONNELL, J. H. 1978: Diversity in tropical rainforests and coral reefs. Science 199:1302-1310.

COOPE, G.R. 1979: Late Cenozoic fossil Coleoptera: evolution, biogeography, and ecology. Annual Review of Ecology and Systematics. 10:247-267.

CURRIE, D. J. 1991: Energy and large-scale patterns of animal and plant-species richness. American Naturalist 137:27-49.

DAVIS, M. B. 1981: Quaternary history and the stability of forest communities. In: West, D. C., Shugart, H. H. & Botkin, D. B. (eds.). Forest succession. Springer-Verlag, Berlin: 132-153.

DAVIS, M. B. 1986: Climatic instability, time lags, and community disequilibrium. In: J. Diamond & T. Case (eds.). Community ecology. Harper and Row, New York: 269-284.

DAYTON, P. K. 1971: Competition, disturbance, and community organization: the provision and subsequent utilization of space in a rocky intertidal community. Ecological Monographs 41:351-389.

DiMICHELE, W. A. & HOOK, R. W. 1992: Paleozoic terrestrial ecosystems. In: Behrensmeyer, A. K., Damuth, J. D., DiMichele, W. A., Potts, R., Sues, H., & Wing, S. L. (eds.). Terrestrial ecosystems through time, evolutionary paleoecology of terrestrial plants and animals. Univ. Chicago Press: 205-325.

FISCHER, A. G. 1960: Latitudinal variations in organic diversity. Evolution 14:64-81.

FISCHER, A. G. 1981: Climatic oscillations in the biosphere. In: M. H. Nitecki (ed). Biotic crises in ecological and evolutionary time. Academic Press, New York: 103-131.

GRIME, J. P. 1973: Control of species density in herbaceous vegetation. Journal of Environmental Management 1:151-167.

HAFFER, J. 1969: Speciation in Amazonian forest birds. Science 165:131-137.

HAYES, J. P. & HARRISON, R. G. 1992: Variation in mitochondrial DNA and the biogeographic history of woodrats Neotoma of the eastern United States. Systematic Biology 41:331-344.

HEWITT, G. M. 1996: Some genetic consequences of the ice ages, and their role in divergence and speciation. Biological Journal of the Linnaean Society 58:247-276.

HUSTON, M. 1979: A general hypothesis of species diversity.
American Naturalist 113:81-101.

KOCH, A. L. 1974: Coexistence resulting from an alteration of density dependent and density independent growth. Journal of Theoretical Biology 44:373-386.

LAWTON, J. H., NEE, S., LETCHER, A. J., & HARVEY, P. H. 1994: Animal distributions: patterns and process. In: P. J. Edwards, R. M. May, & N. R. Webb (eds.). Large-scale ecology and conservation biology. Blackwell Scientific Publications, London: 41-58.

LETCHER, A. J. & HARVEY, P. H. 1994: Variation in geographical range size among mammals of the Palearctic. American Naturalist 144:30-42.

LEVIN, S. A. 1974: Dispersion and population interactions. American Naturalist 108:207-228.

LOUCKS, O. L. 1970: Evolution of diversity, efficiency, and community stability. American Zoologist 10:17-25.

LYNCH, J. D. 1988: Refugia. In: A. A. Myers & P. S. Giller (eds.). Analytical Biogeography, an integrated approach to the study of animal and plant distributions. Chapman and Hall, London: 311-342.

MACARTHUR, R. H. 1965: Patterns of species diversity. Cambridge Philosophical Society Biological Reviews 40:510-533.

MACARTHUR, R. H. 1969: Patterns of communities in the tropics. Biological Journal of the Linnaean Society 1:19-30.

MARSHALL, L. G. 1988: Extinction. In: Myers, A. A. & Giller, P. S. (eds.). Analytical Biogeography, an integrated approach to the study of animal and plant distributions. Chapman and Hall, London: 219-254.

McPEEK, M. A. 1996: Linking local species interactions to rates of speciation in communities. Ecology 77:1355-1366.

McPEEK, M. A. & HOLT, R. D. 1992: The evolution of dispersal in spatially and temporally varying environments. American Naturalist 140:1010-1027.

NEI, M., MARUYAMA, T. & CHAKRABORTY, R. 1975: The bottleneck effect and genetic variability in populations. Evolution 29:1-10.

NICHOLS, R. A. & HEWITT, G. M. 1994: The genetic consequences of long distance dispersal during colonisation. Heredity 72:312-317.

PAGEL, M. D., MAY, R. M. & COLLIE, A. 1991: Ecological aspects of the geographic distribution and diversity of mammal species. American Naturalist 137:791-815.

PHILLIPS, R. L., R. D. ANDREWS, G. L. STORM, & R. A. BISHOP. 1972: Dispersal and mortality of red foxes. Journal of Wildlife Management 36:237-248.

PIANKA, E. R. 1966: Latitudinal gradients in species diversity: a review of concepts. American Naturalist 100:33-46.

PIANKA, E. R. 1988: Evolutionary ecology, 4th ed. Harper and Row, New York.

PIELOU, E. C. 1979: Biogeography. Wiley, New York.

PILS, C. M. & MARTIN, M. A. 1978: Population dynamics, predator-prey relationships and management of the red fox in Wisconsin. Tech. Bull. No. 105, Dept. Nat. Res., Madison, WI.

RAPOPORT, E. H. 1975: Areografia: estrategias geograficas de las especies. Fondo de Cultura Economica, Mexico City.

RAPOPORT, E. H. 1982: Areography: geographical strategies of species. 1st English ed. B. Drausal, transl. Publ. Fundacion Bariloche. Vol. 1. Pergamon, New York.

RAYMOND, A., PARKER, W. C., & BARRETT, S. F. 1985: Early Devonian phytogeography. In: Tiffany, B. H. (ed.). Geological factors and the evolution of plants. Yale Univ. Press, New Haven: 129-167.

RENSCH, B. 1959: Evolution above the species level. Methuen, London.

RICKLEFS, R. E. 1973: Ecology. Nelson and Sons, London.

ROHDE, K. 1978: Latitudinal gradients in species diversity and their causes. I. A review of the hypotheses explaining gradients. Biologisches Zentralblatt 97: 393-403.

ROHDE, K. 1992: Latitudinal gradients in species diversity: the search for the primary cause. Oikos 65:514-527.

ROHDE, K. 1997: The larger area of the tropics does not explain latitudinal gradients in species diversity. Oikos 79:169-172.

ROSENZWEIG, M. L. 1995: Species diversity in space and time. Cambridge Univ. Press, Cambridge.

ROSENZWEIG, M. L. 1997: Species diversity and latitudes: listening to area's signal. Oikos 80:172-176.

STEHLI, F. G., DOUGLAS, D. G., & NEWELL, N. D. 1969: Generation and maintenance of gradients in taxonomic diversity. Science 164:947-949.

STEVENS, G. C. 1989: The latitudinal gradient in geographical range: how so many species coexist in the tropics. American Naturalist 133:240-256.

STORM, G. L., R. D. ANDREWS, R. L. PHILLIPS, R. A. BISHOP, D. B. SINIFF, & J. R. TESTER. 1976: Morphology, reproduction, dispersal, and mortality of midwestern red fox populations. Wildlife Monographs 49:1-82.

THIERY, R. G. 1982: Environmental instability and community diversity. Biological Review 57:691-710.

TILMAN, D. 1994: Competition and biodiversity in spatially structured habitats. Ecology 75:2-16.

TILMAN, D. & PACALA, S. 1993: The maintenance of species richness in plant communities. In: Ricklefs, R. E. & Schluter, D. (eds.). Species diversity in ecological communities, historical and geographical perspectives. Univ. Chicago Press: 13-25.

TIMMS, J. D. & CHAMBERS, T. C. 1984: Rhyniophytina and Trimerophytina from the early land floras of Victoria, Australia. Paleontology 27:265-279.

WHITTACKER, R. H. 1969: Evolution of diversity in plant communities. In: Woodwell, G. M. and Smith, H. H. (eds.). Diversity and stability in ecological systems. Brookhaven Nat. Lab., Upton, NY: 178-196.

The topography of the lateral line organs on the skull of *Utegenia shpinari*

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Abstract
The topography of lateral line organs is reevaluated for *Utegenia shpinari* (Discosauriscidae). Ecology and evolutionary trends of the family Discosauriscidae are discussed.

Key words: *Utegenia shpinari*, lateral line canals, pit-organs, pit-lines.

Received 13 September 2000; accepted 11 January 2001

INTRODUCTION

Nearly 500 skeletons of *Utegenia shpinari* are now known from the Kurty locality, South - Eastern Kazakhstan in deposits of the Late Carboniferous (?) - Early Permian age (Radchenko 1959). First described by Kuznetsov & Ivakhnenko (1981), the material was revised by Laurin (1996a). Using all the data available at that time, Ivakhnenko (1987) proposed a scheme of the lateral line system (LLS) in the skull of *Utegenia*. However, the topography of the LLS in *Utegenia* has never been a subject of special study and Ivakhnenko's (1987) reconstruction seems to be incomplete.

I have attempted a new evaluation of the LLS based on material collected in 1998. Because of the small size of the skull of *Utegenia shpinari* (up to 4 cm), detailed study of the LLS requires microscopic analysis. Chemical etching with hydrochloric acid permits removal of individual bones and subsequent examination of their imprints on the exposed matrix reveals fine detail in the LLS. However, this procedure inverts the original bosses and ridges on the surfaces of the bones into pits and grooves in the matrix. Extending a technique employed by Laurin (1996a), I prepared scanned images (Paragon 600 II N, 450 dpi). These were then digitally rotated by 180 degrees to remove the inversions. Pictures of specimens were further processed in Adobe Photoshop 5.5 to make outlined diagrams.

SYSTEMATIC PALEONTOLOGY
BATRACHOSAURIA Efremov 1946
SEYMOURIAMORPHA Watson 1917
DISCOSAURISCIDAE Romer 1947
UTEGENIA Kuznetsov & Ivakhnenko 1981
UTEGENIA SHPINARI Kuznetsov & Ivakhnenko 1981

DESCRIPTION

Previous reports of the presence of lateral line canals (LLC) on nasals, prefrontals, frontals, postfrontals, supra- and intertemporals, jugals and squamosals (Kuznetsov & Ivakhnenko 1981, Ivakhnenko 1987, Laurin 1996) are confirmed. Although canal traces are discernible in all these bones, their clarity varies. Large specimens are not all equally well preserved, and in small specimens LLC may be more or less readily recognizable depending on the growth stage of the specimen.

LLC are also discernible on postparietals (specimens ## 41/K-1988, 92/K-1988, 125/K-1988, 134/K-1988, 185/K-1988), tabulars (specimens ## 92/K-1988, 125/K-1988, 164/K-1988), and lower jaws (specimens ## 26/K-1988, 40/K-1988, 105/K-1988, 156/K-1988, 164/K-1988, 186/K-1988). Pits and faint grooves which correspond topographically to pit-organs and pit-lines (Klembara 1992) are found in *Utegenia* skulls. Pit-organs are found on frontal (specimen # 105/K-1988), supratemporal (specimen # 134/K-1988) and postfrontal (specimen # 164/K-1988) bones (Figure 1). Pit-lines are visible on frontals and temporals of specimen # 41/K-1988 (Figure 1).

On postparietals LLC occupy the postero-dorsal surface near the posterior margin where the bone is oriented

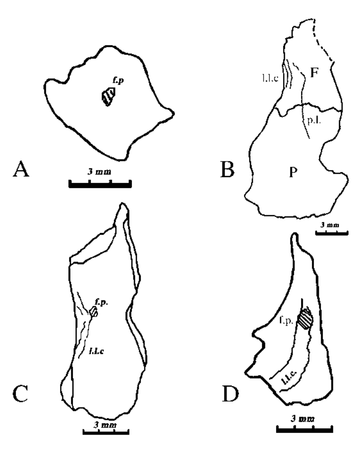

Figure 1: *A distribution of sensory structures within the skull roof bones of* Utegenia shpinari *(Kuznetsov and Ivakhnenko 1981).*
A. 134\K-1988, right supratemporal, dorsal view; B. 105\K-1988, left frontal and parietal, dorsal view; C. 105\K-1988, left frontal, dorsal view; D. 164\K-1988, left postfrontal, dorsal view. Abbreviations: P-parietal, F-frontal, l.l.c.- lateral line canal, f.p. - foraminate pit, p.l. - pit line.

vertically. LLC are similarly placed on the surface of tabulars. Lower jaws have LLC running along their ventral border. LLC may be traced across the angular, splenial and postsplenial bones. Pit-organs, which are solitary, round or oval impressions in the bone surface, are located close to (specimen # 105/K-1988) or inside of the LLC (specimen # 164/K-1988). An apparent pit-line found in a single specimen (# 41/K-1988) had the form of a narrow groove about 6mm long. Arising from the centers of ossification on each bone, this groove crossed the suture between frontalia and parietalia. However, it is possible that this groove is an artifact resulting from damage to the bone that occurred during life or during preservation, and further confirming evidence of pit-lines should be sought. Although the quality of preservation of our material does not permit such detailed evaluation as that given for Discosauriscus by Klembara (1992), both the size and placement of possible pit-organs and pit-lines in Utegenia correlate well to those in Discosauriscus. The topography of lateral line organs in the skull of *Utegenia shpinari* is shown in Figure 2.

COMPARISON

In documenting the presence of pit-lines and "foraminate pits" (= pit-organs of the present study) on the exocranial bones of the Lower Permian Discosauriscus austriacus, Klemabara (1992) provided the first evidence of such structures in true tetrapods. Indicating the identical topography of Discosauriscus and Osteolepis macrolepidotus, this author interpreted their presence as further evidence of tetrapod origins from osteolepiforms. The topography of sensory organs in Utegenia is well correlated to that described previously for Discosauriscus (Klembara 1992, 1994, 1996) and is undoubtedly inherited from their piscine ancestors. Ivakhnenko (1981, 1987) described LLC on nasals, pre- and postfrontals, supra- and intertemporals, postorbitals, postparietals and tabulars in Ariekanerpeton. Although the system seems somewhat reduced in Ariekanerpeton, the pits in its bones may correspond to the pit-organs of Discosauriscus (Laurin 1996b). However, in contrast to our findings in Utegenia, Laurin (1996b) described a complete disappearance of LLS in Ariekanerpeton soon after metamorphosis. One of the largest specimens in our collection (# 164/?-1988, skull length 36 mm (P+F+Na) or 41 mm by prominent points of skull) has both LLC and pit-organs on the bones of the skull roof and lower jaw.

Apart from a single case of possible LLC preservation described for Seymouria baylorensis (Laurin, 1996c), there are no signs of LLS in this genus (Berman et al. 1987, Laurin 1995, 1996c). It may be inferred that Seymouria was aquatic only in the larval stage while the postmetamorphic animal was more or less terrestrial (Laurin 1996a). There are no data available on LLS of Urumqia (Fakui et al. 1984).

DISCUSSION

Data from various authors (Sinitsin 1962, 1967, Ushakov & Yasamanov 1984, Schegolev 1964, Zalessky 1938, Berman et al. 1997) permit the conclusion that Utegenia inhabited a tropical or subtropical environment with increasing aridity. Both sedimentology and taphonomy of the fossil locality support the suggestion that bodies of water in which Utegenia lived occasionally dried up. Alternating layers of light brown and dark gray coloration characterize the limestone containing Utegenia's remains. It is supposed that the light colored, more crumbly, sedimentary layers could represent the dry stage while the dark, denser layer represents the wet stage (Kuznetsov & Ivakhnenko 1981). Because the thickness of either layer nowhere exceeds 2-3 mm, conditions must have changed quite frequently. The absence of other aquatic vertebrates, especially fishes, from the deposits supports the interpretation that the locality derived from temporally unstable, fresh water ponds.

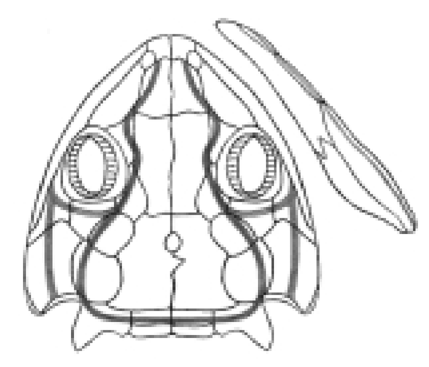

Figure 2: *A diagram of lateral line organ topography within the skull of* Utegenia shpinari*. Skull reconstruction based mainly on specimen 164/K-1988.*

The presence of lateral line organs in the largest specimens of Utegenia along with other paedomorphic characters (Laurin 1996a, Malakhov 1999) may imply that the immaturity of known discosauriscids, as interpreted by previous authors [e.g. Klembara (1995) and Laurin (1996a)], has been overestimated. The presence of LLS, pit-organs and possibly pit-lines in these large specimens of Utegenia suggests that the oldest known growth stages of the animal were fully aquatic. Laurin (1996a) thought that LLC in Utegenia were not functional. Because he studied only latex peels, not the original specimens, it is possible that he was unable to discern some fine details on the bone surface. It is likely that discosauriscids represent a paedomorphic trend in reptiliomorph evolution (Kuznetsov & Ivakhnenko 1981, Malakhov in press). Some peculiarities of dermal armor (pers. obs..) and LLS development imply that Utegenia is the least specialized discosauriscid genus known. The possibility that Discosauriscus and Urumqia were adapted to more humid conditions is supported by the presence of fish and invertebrate remains found together with discosauriscid material from Boskovice Furrow (Klembara & Meszároš 1992) and from Liudaowan (Fakui et al. 1984). By contrast, Ariekanerpeton obviously inhabited a mostly arid environment.

Acknowledgments

I am deeply indebted to Prof. P.F.A. Maderson (Brooklyn College, NY) for English correction of the manuscript and to Dr. J. Klembara (Comenius University, Bratislava) for reading the manuscript and providing critical comments.

REFERENCES

Berman, D.S., Reisz, R.R. &Eberth, D.A. 1987: Seymouria sanjuanensis (Amphibia: Batrachosauria) from the Lower Permian Culter Formation of north-central New Mexico and the occurrence of sexual dimorphism in that genus questioned. Canadian Journal of Earth Science 24: 1769-1784.

Berman, D.S., Sumida, S.S., Lombard, R.E. 1997: Biogeography of Primitive Amniotes. In: Amniote Origins. Academic Press: 85-139.

Fakui, Z, Li Yaozeng, Wang Xungang 1984: A new occurrence of Permian Seymouriamorphs in Xinjiang, China. Vertebrata Palasiatica 22: 294-305

Ivakhnenko, M.F. 1981: Discosauriscids from Permian of Tajikistan. Paleontologichesky Zhurnal 1:114-127 (In Russian).

Ivakhnenko, M.F. 1987: Permian Parareptilia of USSR. Trudy PIN, 223. (In Russian)

Klembara, J. 1992: The first record of pit-lines and foraminate pits in tetrapods and the problem of the skull roof bones homology between tetrapods and fishes. Geologica Carpathica 42: 249-252

Klembara, J. 1994: Electroreceptors in the Lower Permian tetrapod Discosauriscus austriacus. Palaeontology 37. part 3: 609-626

Klembara, J. 1995: The external gills and ornamentation of the skull roof bones of the Lower Permian tetrapod Discosauriscus with remarks to its ontogeny. Paläont. Z. 69: 265-281.

Klembara, J. 1996: The lateral line system of Discosauriscus austriacus (Makowsky 1876) and the homologization of skull roof bones between tetrapods and fishes. Palaeontographica. Abt. A, 240.

Klembara, J. & Meszŕroš, S. 1992: New finds of Discosauriscus austriacus (Makowsky, 1876) from the Lower Permian of Boskovice Furrow (Czecho-Slovakia). Geologica Carpathica 43: 305-312

Kuznetsov, V.V & Ivakhnenko, M.F. 1981: Discosauriscids from Upper Paleozoic of Southern Kazakhstan. Paleontologychesky Zhurnal 3:102-110. (In Russian).

Laurin, M. 1995: Comparative Cranial Anatomy of Seymouria sanjuanensis (Tetrapoda: Batrachosauria) from the Lower Permian of Utah and New Mexico. GeoBios 16: 1-8.

Laurin, M. 1996a: A reappraisal of Utegenia, a permo-carboniferous seymouriamorph (Tetrapoda: Batrachosauria) from Kazakhstan. Journal of Vertebrate Paleontology 16: 374 - 383.

Laurin, M. 1996b: A reevaluation of Ariekanerpeton, a Low Permian seymouriamorph (Vertebrata: Seymouriamoprha) from Tajikistan. Journal of Vertebrate Paleontology 16: 653-665.

Laurin, M. 1996c: A Redescription of the Cranial Anatomy of Seymouria baylorensis, the best known Seymouriamorph (Vertebrata: Seymouriamorpha). PaleoBios 17: 1-16.

Malakhov, D.V. 1999: Some paedomorphic characters in *Utegenia shpinari* (Discosauriscidae, Seymouriamorpha) ontogenesis and lifestyle of discosauriscs. In: Problems of Conservation and Sustainable Use of Animal Biodiversity in Kazakhstan: Proceedings of International Scientific Conference, April 6-8: 32.

Radchenko, I.I. 1959: The first finding of fossil amphibians in Southern Kazakhstan. Vestnik Akademii Nauk Kazakhskoy. SSR 6 (In Russian).

Schegolev, A.K. 1964: Flora differentiation in Late Carboniferous of Westphalian province. In: Problems of organic development regularities and forms. Moscow: 158-170. (In Russian).

Sinitsin, V.M. 1962: Paleogeography of Asia. Moscow. (In Russian).

Sinitsin, V.M. 1967: An Introduction to Paleoclimatology. Leningrad. (In Russian).

Ushakov, S.A. & Yasamanov, N.A. 1984: Continental drift and climates of Earth. Moscow. (In Russian).

Zalessky, M.D. 1938: On climatic zones of Earth at Carboniferous and Permian In: Problems of paleontology. v. IV: 333-362. (In Russian).

Woodland cover and Tawny Owl *Strix aluco* density in a Mediterranean urban area

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Abstract

We studied the distribution of the Tawny Owl *Strix aluco* by assessing territory density in 22 census plots along the urbanisation gradient in urban Rome (central Italy). During the 1998-1999 breeding seasons, a total of 194 territories was censused. Population density was low in farmlands (mean ± SD = 1.0±0.5 territories km^{-2}, n = 6 census plots) and developed areas (= 1.4±0.6 territories km^{-2}, n = 7), but increased in urban parks (= 3.3±1.0 territories km^{-2}, n = 5) and suburban woodlands (= 5.7±1.5 territories km-2, n = 4), being unaffected by the distance from the city-centre. Conversely, density variations are mainly due to the availability of suitable habitats (i.e. woodlands). Wooded area per territory was high in farmlands, where territories are scattered owing to the fragmentation of habitat resources, slightly decreasing in suburban woods, where the whole area is occupied. Hence, wood size is a good predictor of the number of territories occupied, as the dependence of the number of territories on wooded area was strictly linear ($Y = 0.06X + 3.38$, $r = 0.80$, $P < 0.0001$, df = 20). Maintaining natural vegetation and old trees in large urban parks, preventing summer fires in termophilous suburban woods, and providing nest-boxes in small gardens where suitable natural cavities are not available, are recommended as management tools in order to encourage the continued breeding of Tawny Owls in urban habitats.

Key words: Tawny Owl, Strix aluco, territory density, wood cover, urban area, Rome.

Received 26 August 2000; accepted 30 November 2000

INTRODUCTION

Distribution and size of patches of suitable habitats have been considered key variables that affect occurrence (e.g. Opdam & Schotman 1987, Bellamy et al. 1996, Hinsley et al. 1996), territory persistence (e.g. Galeotti 1994, Bellamy et al. 1996), population density (e.g. Stout et al. 1998, Matthysen 1999), territory size (e.g. Galeotti 1994, Redpath 1995), breeding success (e.g. Newton 1991, Matthysen & Adriaensen 1998), feeding habits (e.g. Manganaro et al. 1999), survival (e.g. Matthysen 1999), and dispersal (e.g. Matthysen et al. 1995) of many bird species. Although urban landscape is generally composed of a mosaic of different habitats, little is known about how fragmentation affects population dynamics of city birds (Blair 1996). Birds of prey are extremely sensitive to fragmentation of suitable habitats and represent key species in understanding new strategies to exploit different resources in urban areas (e.g. Galeotti 1994, Blair 1996, Gehlbach 1996, Stout et al. 1998).

Comparatively few raptors are common in cities. The Tawny Owl *Strix aluco* is widespread in many urban green areas and also in European city centres (e.g., Wendland 1984, Galeotti 1990, Jablonski 1991), but its urban ecology is poorly known, especially in the Mediterranean basin. In the town of Pavia, Galeotti (1990, 1994) described population features and habitat selection, and tested how population and habitat variables influenced territory occupancy and defence level of urban and farmland Tawny Owls.

The aim of this work is to provide additional data on Tawny Owl urban ecology, assessing territory density along the urbanisation gradient of the Mediterranean city of Rome, central Italy, in relation to the distribution of different habitats. Assessing distribution patterns and habitat preferences of a large-sized predator in cities may represent an useful tool in understanding its population biology in response to environmental stress. Clarification of raptor habitat needs suggests conservation measures that may allow the continued breeding of their populations in sub-optimal habitats (e.g. Squires & Ruggiero 1996).

STUDY AREA AND Methods

Study area. The fieldwork was carried out in urban Rome (41°53′N, 12°28′E) inside the external ring road. In urban Rome, the highest elevation is the hill of Monte Mario at 139 m. The climate, typically dry, is characterised by two-three months of summer drought for an annual precipitation of 700-800 mm (Attorre et al. 1998).

To calculate population density, we chose 22 census plots (Fig. 1) along the urbanisation gradient from suburban woods and open farmlands to urban parks and the historic city centre (Cf. Attorre et al. 1998, Salvati et al. 1999, Ranazzi et al. 2000). Twelve census plots were investigated from 1984 to 2000, including five developed areas, five urban parks, and two suburban woods; the remaining 10 areas, including two developed areas, six farmland, and two suburban areas, were investigated from 1993 to 2000. Vegetation of gardens and

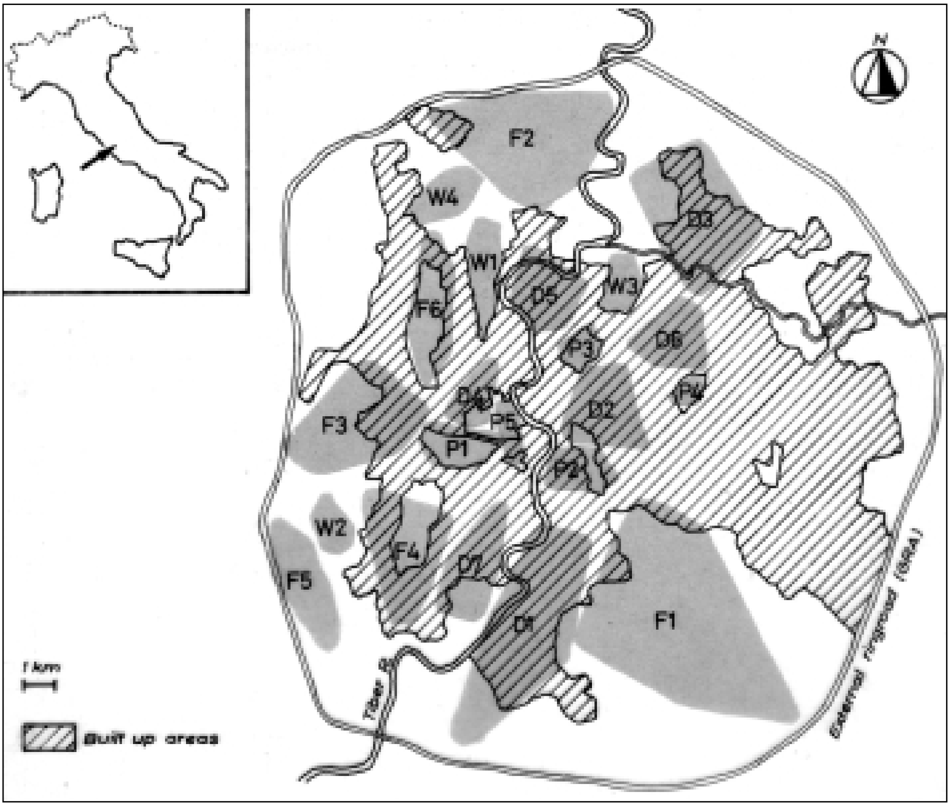

Figure 1. Map of the study area showing 22 census plots in Rome (for abbreviations, see Table 1).

urban parks includes pines *Pinus pinea*, cypresses *Cupressus sempervirens*, cedars *Cedrus* sp., and isolated oaks *Quercus* spp.. Vegetation of suburban woodlands is generally composed of stands of mixed deciduous wood, predominantly oaks e.g. *Quercus ilex*. Owl nests were generally located in natural cavities of old oaks and pines.

Census methodology. A preliminary census of all woodland patches (up to 0.2 hectares) and other potential breeding sites (e.g. ruderal areas, vegetable gardens and arboreal courtyards in the city centre, as well as street trees in residential areas) was made using aerial photographs. The field census was conducted by means of the male territorial 'hoot' playback stimulation performed in each potential site from November to August of each year (Redpath 1994, Zuberogoitia & Campos 1998). During playbacks, all individuals calling were located using 1:1.000 and 1:10.000 maps. The "centre" of each territory (Petty 1989) was determined as the nesting site or, in a few cases, as the diurnal roost site. Diurnal visits in many territories, searching for pellets and prey remains, feathers, droppings, and other traces, were performed each year. During the postfledging period (June-July in Rome) fledglings uttering the typical "begging call" often allowed us to locate the nesting area (e.g. Wendland 1984, Redpath 1995, Ranazzi et al. 2000). Non-breeding territories (e.g. no fledglings heard during breeding period and no other traces detected) with males and, eventually, females actively hooting or calling were however considered. Playbacks were not performed in autumn (Sept-Oct) because the occurrence of fledglings able to hoot in the parent's territory may result in an overestimation of defended territories. All neighbouring territorial pairs or single males were stimulated when an unknown Tawny Owl territory was located. According to Redpath (1995), the overall rapid response by males to playbacks may substantially reduce the likelihood that any territorial owls were missed. Note also that a similar census protocol was followed by Penteriani & Pinchera (1990) in censusing Tawny Owls in a mountain beech forest in central Italy.

In two census plots where the highest densities were recorded (Acquatraversa and Villa Ada, see Table 1), the individual recognition of 8 and 9 neighbour males respectively made on the field was confirmed by comparing spectrograms of owl hooting (see Galeotti & Pavan 1993 for further details). Recordings were made with SHURE unidirectional microphones and SONY TCD-7 Digital Audio Tape and TCS-580 cassette recorder. Note that the subjective assessment of Tawny Owl voice characteristics on the field has been widely used for several purposes, including territory mapping (see Southern 1970).

Population density. Territory density, referring to 1998 and 1999 breeding seasons, was calculated for each census-plot by the nearest neighbour distance (n.n.d.) method (see Salvati et al. 1999 for details). Briefly, the delineation of the surface of each census plot was made by drawing a line on the map around the outermost nesting territories, at a distance from their centres equal to half the mean interterritory distance in continuous nesting habitat. Spacing among territories was computed using the "centre" of each territory (Petty 1989). The total area so obtained was called 'n.n.d. area'. The available area per territory was calculated as the 'n.n.d. area' divided by the number of territories. We chose this method to achieve comparable estimates of density and habitat proportions in each census plot, as woods suitable for nesting are generally separated by tracts of unsuitable woodlands or farmlands (see also Petty 1989).

Habitat variables. Surfaces of developed, farmland and wooded areas were measured across the whole 'n.n.d. area' using aerial photographs and the VIDEOPLAN KONTRON PC package. Developed, farmland and wooded areas per territory were further calculated by dividing the total surface of each habitat type by the number of territories occupied across the whole 'n.n.d. area'. Finally, the size of the greater wood patch and the mean distance from the city-centre of Rome (i.e. Piazza Barberini) were measured for each census plot.

Statistics. Differences in density and habitat proportions in each census plot were compared by Kruskal-Wallis non parametric ANOVAs. Correlations between territory density and percentages of developed, farmland, and wooded areas were assessed using Spearman rank correlation tests. A pairwise non parametric correlation analysis was preferred to a multiple regression analysis because of the deviation of habitat variables from the normal distribution. Statistical analyses were performed with the STATISTICA 4.5 (Statsoft Inc. 1993) PC package.

Results

A total of 194 territories was censused in 22 census plots (see Table 1), 53 territories being located in developed areas, 30 in large urban parks, 61 in farmlands, and 50 in woodlands. The dependence of the number of territories on wooded area was strictly linear ($Y = 0.06X + 3.38$, $r = 0.80$, $P < 0.0001$, df = 20). Territory density varied significantly at the habitat-level ($H = 15.43$, $P < 0.002$, $n = 22$), and increased from farmlands (mean ± SD = 1.0±0.5 territories/km^2, n = 6 census plots) and developed areas (= 1.4±0.6 territories/km2, n = 7) to urban parks (= 3.3±1.0 territories/km^2, n = 5) and suburban woods (= 5.7±1.5 territories/km^2, n = 4). The amount of developed and farmland areas per territory showed significant variations at the habitat level ($H = 13.62$, $P < 0.003$, $n= 22$, and $H = 13.06$, $P < 0.004$, $n = 22$, respectively). Conversely, wooded area per territory was remarkably stable among habitats ($H = 2.21$, $P > 0.05$, $n = 22$). Territory density was positively correlated to the percentage of woodlands ($rs = 0.94$, $P < 0.0001$, $n = 22$) and the size of the greater wood patch in each census plot ($rs = 0.77$, $P < 0.0001$, $n = 22$), negatively to the percentage of developed areas ($rs = -0.62$, $P = 0.001$, $n = 22$), and not correlated to the percentage of farmlands ($rs = -0.02$, $P > 0.05$, $n = 22$), and the distance from the city-centre ($rs = -0.31$, $P > 0.05$, $n = 22$).

Discussion

Tawny Owls are widespread in our study area, but generally avoid areas lacking trees. The estimation of the total number of territories occurring in urban Rome (350 km^2) ranged between 210 and 230 territories, for a breeding density of 0.6-0.7 territories km^{-2}. This value is slightly higher than those recorded in other European cities (Table 2). Note that data from these cities were generally obtained from atlas works, not by specific surveys, and that habitat composition of urban areas differs among cities. However, this comparison suggests that urban areas generally provide sub-optimal habitats and that population density increases from inner cities to neighbour woodlands (e.g. Southern 1970, Delmeé et al. 1978, Wendland 1984, Hirons 1985, Galeotti 1990, Zuberogoitia & Campos 1997, Sánchez-Zapata & Calvo 1999); therefore, Tawny Owls do not follow the pattern of density increase along the urbanisation gradient suggested by Gehlbach (1996) in his model of raptor urbanisation and observed for some birds of prey (e.g. Parker 1996, Stout et al. 1998, Salvati et al. 1999). In Rome, breeding density was affected by the proportion of different habitats in each census plot. Although Tawny owls regularly use strictly-urban areas for catching rats, birds, and other prey (e.g. Wendland 1984, Galeotti 1990, 1994, Manganaro et al. 1999), this raptor always requires small woods to establish a breeding territory. The stability of wooded area per territory, ranging from 9.9 ha in urban areas and woodlands to 11.5 ha in farmlands, confirms this view. Furthermore, the slightly higher value of wooded area per territory recorded in farmland plots suggests that highly fragmented woods in open lands surrounding the city are generally low-quality for Tawny Owls.

The total available area per territory is high (range, 46.7 ha - 183.4 ha) in both developed and farmland areas as compared to the mean territory size respectively measured in an urban area (= 17.6 ± 12.1 ha, n = 22 territories, Galeotti 1994) and in rural habitats (= 46.1±7.1 ha, n = 17, Hirons 1985). This confirms that in inner Rome and in surrounding openlands Tawny Owls do not occupy the whole available area, with territory spacing being affected by the distribution of wood patches and the availability of nest-sites (Petty 1989). By contrast, the available area per territory in urban parks and suburban woods (range, 13.8 ha - 50.9 ha) is comparable to the mean territory size (= 18.2 ± 2.1 ha, n = 31) measured in close woodlands by Hirons (1985), thus suggesting that Tawny Owl territories occupied the whole available area, as suggested by Southern (1970) and Redpath (1995).

In conclusion, the occurrence of Tawny Owls in cities could be encouraged by maintaining natural vegetation and old trees in large urban parks. Also, urban and suburban woods should be protected from excessive human disturbance, and, in Mediterranean areas, from summer fires. Finally, the installation of suitable nest-boxes may allow owls to breed in small gardens where the lack of natural nest-sites appears the main limiting factor for the species.

Acknowledgements

We are extremely grateful to R. Yosef for comments on an early draft and linguistic suggestions, and to an anonymous referee who provided useful advice that greatly improved the manuscript.

References

Attorre, F., Rossetti, A., Sbrega, B. & Bruno, F. 1998: Landscape changes in Rome, Italy. Coenosis 13: 57-64.

Bellamy, P.E., Hinsley, S.A. & Newton, I. 1996: Local extinction and recolonisations of passerine bird populations in small woods. Oecologia 108: 64-71.

Blair, R.B. 1996: Land use and avian species diversity along an urban gradient. Ecol. Appl. 6: 506-519.

DELMEE, E., Dachy, P. & SIMON, p. 1978: Quinze années d'observations sur la reproduction d'une population forestičre de Chouette hulotte (Strix aluco). Le Gerfaut 68: 590-650.

Galeotti, P. 1990: Territorial behaviour and habitat selection in an urban population of the tawny owl *Strix aluco* L. Bollettino di Zoologia 57: 59-66.

Galeotti, P. 1994: Patterns of territory size and defence level in rural and urban Tawny Owl (Strix aluco) populations. Journal of Zoology, London 234: 641-658.

Galeotti, P. & Pavan, G. 1993: Individual recognition of male Tawny Owls (Strix aluco) using spectrograms of their territorial calls. Ethology Ecology & Evolution 3: 113-126.

Gehlbach, F.R. 1996: Eastern Schreech Owls in Suburbia: A model of Raptor Urbanization. In: Bird, D., Varland, D. & Negro, J.J. (eds.) Raptors in human landscapes. Academic Press, London: 69-74.

Jablonski, P. 1991: Distribution of Tawny Owl *Strix aluco* in Warsaw. Acta Ornithologica 26: 31-38 (In Polish, with English summary).

Hinsley, S.A., Bellamy, P.E., Newton, I. & Sparks, T.H. 1996: Influences of population size and woodland area on bird species distributions in small woods. Oecologia 105: 100-106.

Hirons, G.J.M. 1985: The effects of territorial behaviour on the stability and dispersion of Tawny owl (Strix aluco) populations. Journal of Zoology, London (B) 1: 21-48.

Laske, V., Nottmeyer-Linden, K. & Conrads, K. 1991: Die vogel Bielefelds. Ilex-Bucker Natur, Bielefeld.

Luniak, M. 1996: Inventory of the avifauna of Warsaw - species composition, abundance, and habitat distribution. Acta Ornithologica 31: 67-80.

Manganaro, A., Salvati, L., Ranazzi, L. & Fattorini, S. 1999: Predation on geckos by urban Tawny Owls (Strix aluco). Avocetta 23: 73-75.

Matthysen, E. & Adriaensen, F. 1998: Forest size and isolation have no effect on reproductive success of Eurasian Nuthatches (Sitta europaea). The Auk 115: 955-963.

Matthysen, E. 1999: Nuthatches (Sitta europaea: Aves) in forest fragments: demography of a patchy population. Oecologia 119: 501-509.

Matthysen, E., Adriaensen, F. & Dhondt, A.A. 1995: Dispersal distances of nuthatches, Sitta europaea, in a highly fragmented forest habitat. Oikos 72: 375-381.

Newton, I. 1991: Habitat variation and population regulation in Sparrowhawks. Ibis 133, Suppl.: 76-88.

OAG Berlin (West), 1984: Brutvogelatlas Berlin (West), Ornithol. Ber. f. Berlin (West) 9, Sonderheft.

Opdam, P. & Schotman, A. 1987: Small woods in rural landscape as habitat islands for woodland birds. Acta Oecologica 8: 269-274.

Parker, J.W. 1996: Urban ecology of the Mississippi Kite. In: Bird, D., Varland, D. & Negro, J.J. (eds.): Raptors in human landscape. Academic Press, London: 45-52.

PENTERIANI, V. & PINCHERA, F. 1990: Censimento di una popolazione di allocco, Strix aluco, in un massiccio montuoso dell'Appennino Centrale (Abruzzo). Rivista Italiana di Ornitologia 60: 20-28.

Petty, S.J. 1989: Productivity and density of Tawny Owls *Strix aluco* in relation to the structure of a spruce forest in Britain. Annales Zoologici Fennici 26: 227-233.

Raboseé, D., De Wavrin, H., Tricot, J. & Van Der Elst, D. 1995: Atlas des oiseaux nicheurs de Bruxelles 1989-1991. Aves, Liege.

Ranazzi, L., Manganaro, A. & Salvati, L. 2000: The breeding success of Tawny Owls (Strix aluco) in a Mediterranean area: a long-term study in urban Rome (central Italy). Journal of Raptor Research 34, in press.

Redpath, S.M. 1994: Censusing Tawny Owls *Strix aluco* by the use of imitation calls. Bird Study 41: 192-198.

Redpath, S.M. 1995: Habitat fragmentation and the individual: tawny owls *Strix aluco* in woodland patches. Journal of Animal Ecology 64: 652-661.

Salvati, L., Manganaro, A., Fattorini, S. & Piattella, E. 1999: Population features of Kestrels Falco tinnunculus in urban, suburban and rural areas in central Italy. Acta Ornithologica 34: 53-58.

SANCHEZ-ZAPATA, J.A. & J.F. CALVO 1999: Rocks and trees: habitat response of Tawny Owls *Strix aluco* in semiarid landscapes. Ornis Fennica 76: 79-87.

Southern, H.N. 1970: The natural control of a population of Tawny Owls (Strix aluco). Journal of Zoology, London 162: 197-285.

SQUIRES, J.R. & RUGGIERO, L.F. 1996: Nest-site preference of northern Goshawks in southcentral Wyoming. Journal of Wildlife Management 60: 170-177.

Stout, W.E., Anderson, R.K. & Papp, J.M. 1998: Urban, suburban and rural Red-tailed Hawk nesting habitat and populations in Southeast Wisconsin. Journal of Raptor Research 32: 221-228.

Wendland, V. 1984: The influence of prey fluctuations on the breeding success of the Tawny Owl Strix aluco. Ibis 126: 284-295.

ZUBEROGOITIA, I. & CAMPOS, L.F. 1997: Intensive census of nocturnal raptors in Biscay. Munibe 49: 117-127.

ZUBEROGOITIA, I. & CAMPOS, L.F. 1998: Censusing owls in large areas: a comparison between methods. Ardeola 45: 47-53.

The ichtyofauna of Cerknica polje

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Abstract
Between 1999 and 2000, data on the occurrence of fish at Cerknica polje (Slovenia) were collected. Most fish were observed by sight, while occasionally juvenile fish were caught for identification. In these two years twelve fish species were recorded. Of these, Chub *Leuciscus cephalus*, Miller's thumb *Cottus gobio* and Burbot *Lota lota* have a widespread occurrence. Pike *Esox lucius*, Rudd *Scardinius erythrophthalmus*, Carp *Cyprinus carpio*, Tench *Tinca tinca* and Perch *Perca fluviatilis* are restricted to areas with slow-flowing water and flooded parts of the polje. Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta*, Minnow *Phoxinus phoxinus* and Stone Loach *Barbatula barbatula* are restricted to fast flowing streams. Besides these twelve species, at least one unintended introduction took place in the year 2000, believed to be Charr *Salvelinus* spp. Of the twelve species observed during my research, at least four are known to have been introduced.

Key words: ichtyofauna, Cerknica polje, floodplain, introduced species

Received 2 December 2000; accepted 15 January 2001

Introduction

Karst "polje" form unique isolated habitats for fish. Basically a "kraško polje" is a valley with a water system that is connected to other polje through underground streams. These underground streams act as natural barriers against fish dispersal. This results in a low number of species inhabiting each polje naturally. However, throughout historical time man has introduced fish to the polje. In recent years the number of introductions (both deliberate and accidental) has increased (Povž & Ocvirk 1990, Ribiška družina Cerknica 1996).

During 1999 and 2000 multiple visits to Cerknica polje were made to investigate the herpetofauna (Veenvliet in prep.). Although collecting data on fish was not the main objective of this research, notes were made whenever fish were observed. These data collected on the ichtyofauna of Cerknica polje are summarised in this article. While this article does not discuss the number of individual fish species present at any particular locality, it does provide an overview of species occurrence at Cerknica polje.

Since historical times the occurrence of several fish species in Cerknica polje has been known and supports an extensive sports fishery. The most complete survey of the ichtyofauna of Cerknica polje was undertaken by Vovk (1978). However, he provided data only from a part of the area. There have been some important changes in the fish fauna since then, mainly because of introductions. Some data have been compiled by the fisheries society of Cerknica (Ribiška družina Cerknica). These include reports on the management of the fish fauna as well as species lists (Ribiška družina Cerknica 1996). However, these are not widely available and, again, cover only part of Cerknica polje.

Methods

In 1999 and 2000 about five months were spent at the Cerknica polje. During these months, daily trips were made into the area. Every part of the polje was surveyed several times. Most often fish were observed by sight and could be identified without being caught. Occasionally small fish (YOY = young of the year) were caught in a small dip net for identification. Much time was spent turning stones in shallow water, and this made it possible to see and identify species hiding there. No fish were collected, but photographs of most species were made.

STUDY AREA

Cerknica polje is the largest karstic polje in Slovenia (see Figure 1), measuring 35 km^2 (Gospodarič & Habič 1978). Stržen is the main stream, emerging as a karstic spring in the southeast part of the polje, and running though the whole polje. Several smaller streams, Lipsenjščica Žerovniščica, Martinjščica and Cerkniščica, join Stržen from the east. (In Table 1 only Lipsenjščica is mentioned because this is the only small stream where a considerable number of fish were observed). All streams except Cerkniščica have karstic springs. At a karstic spring, large quantities of water emerge from

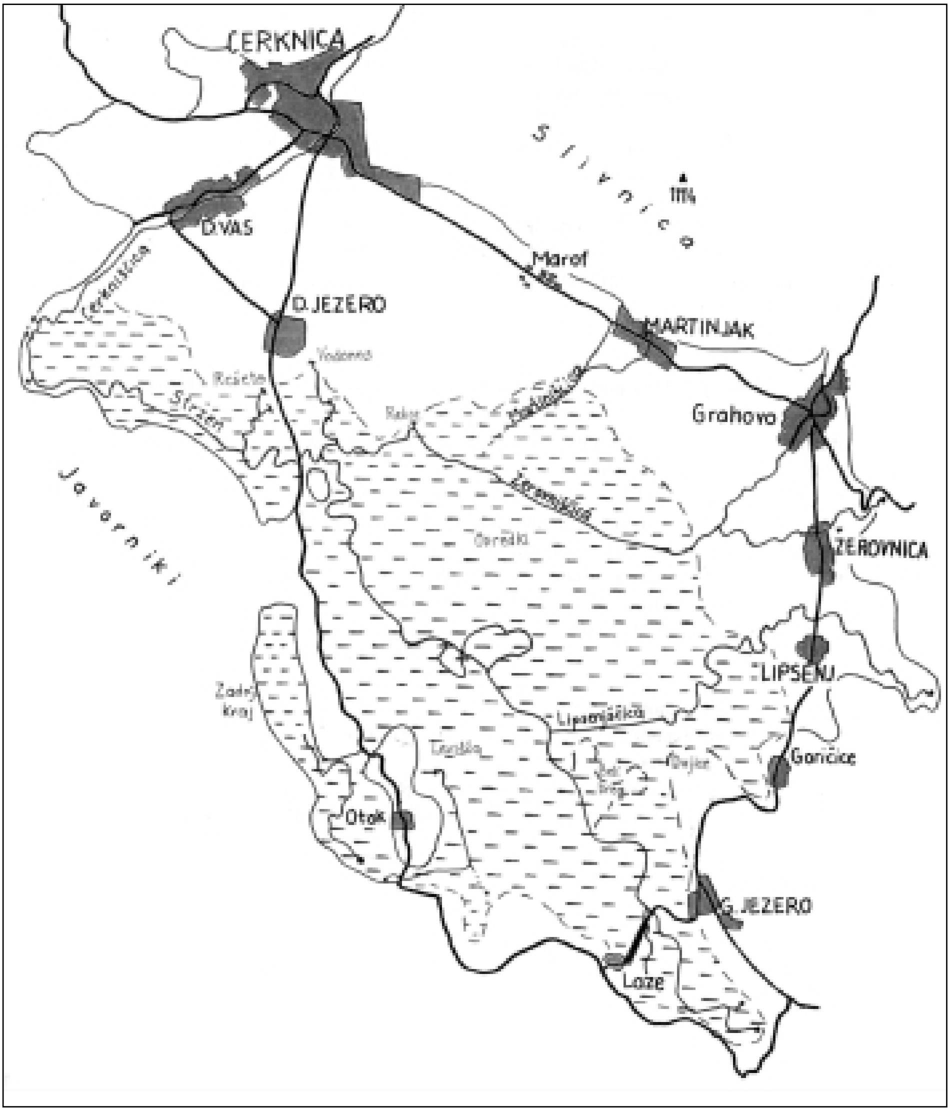

Figure 1: Study area, Map of Cerknica polje (adapted after Ilijanič 1978). Legend: ▭ settlement, — road, 〰 stream, _ˋ spring, ‾_‾_ periodically flooded part. (Illustr. J. Kus)

underground streams and this influences the temperature of the downstream sections.

In all poljes the water level fluctuates dramatically. Several times per year the central part of Cerknica polje is flooded and forms Cerknica "lake". Therefore, the polje can be regarded as an isolated floodplain area. During summer, water stays only in permanent streams and at Rešeto where a dam has been made.

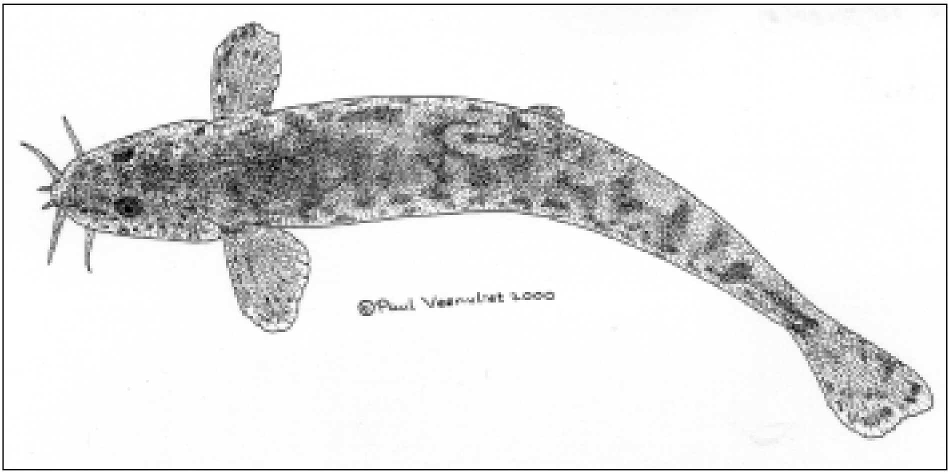

***Figure 2**. Stone Loach Barbatula barbatula from Cerknica polje. Illustration after a photograph taken on 28th July 1999 in the village of Dolenja vas.(Illustr. P. Veenvliet)*

Results

At Cerknica polje twelve fish species were recorded in the years 1999 and 2000 (Table 1). Of these, Chub *Leuciscus cephalus*, Miller's Thumb *Cottus gobio* and Burbot *Lota lota* are widespread. Pike *Esox lucius*, Rudd *Scardinius erythrophthalmus*, Carp *Cyprinus carpio*, Tench *Tinca tinca* and Perch *Perca fluviatilis* are restricted to areas of slow-flowing water and flooded parts of the polje. Brown Trout *Salmo trutta* occurs in Lipsenjščica, Cerkniščica and Žerovniščica, although in Žerovniščica only one juvenile Trout was observed. Rainbow Trout Onchorhychus mykiss, Minnow *Phoxinus phoxinus* and Stone Loach *Barbatula barbatula* (Figure 2) were observed only in Cerkniščica. In most species, juveniles were seen much more often than adults, but of Tench and Carp, only adults were observed.

Discussion

The research of Vovk (1978) showed the presence of seven species at Cerknica lake. This includes the Minnow, which I only observed in the Cerkniščica stream. However, downstream parts of Cerkniščica can be considered part of the 'lake' as well as part of the 'stream', depending on the water level. When this is taken into account, two more species, Carp and Perch, were observed in the lake compared to those observed by Vovk (1978). However, Vovk (1978) noted that Carp had been introduced for the purpose of sports fishing. Estimating from the numbers of fish seen, in 1999 and 2000, Perch was the second most numerous species after Rudd. Perch was not present during Vovk's (1978) research (see below). A species list from the Ribiška družina Cerknica (1996) does not differ much from my research and includes 11 species. However, in the list from the Ribiška družina Cerknica the occurrence of Gudgeon Gobio gobio in Cerkniščica is mentioned. While it is possible that the Gudgeon was overlooked in my research, it is remarkable that the Ribiška družina Cerknica does not mention its occurrence at the nearby Bloščica stream, where it was found to be particularly numerous in 1999 and 2000 (Veenvliet, unpublished data). On the list of the Ribiška družina Cerknica several species are mentioned in Cerkniščica which were found only in Cerknica lake in my research. However, it is likely that all species occurring at Cerknica lake occasionally enter Cerkniščica and can be found there in small numbers.

Only adult Tench were seen in 1999 and 2000. Juvenile Tench are not particularly difficult to find with a dip net. At nearby Planina polje, juvenile Tench were caught within the first few minutes of sampling with a dip net. Because of this, I assume that the absence of juvenile Tench at Cerknica polje in the years 1999 and 2000 is real and not biased by research methods. The cause of the absence of juvenile Tench is unclear, but might be connected with the abundance of Perch as a newly introduced predator. A decline of Tench was also noted by the Ribiška družina Cerknica. Therefore it was decided to lower the number of Tench that one person is allowed to take in one day from 3 to 2 (Ribiška družina Cerknica 1996). Tench is regarded as a rare and endangered species in Slovenia (Mastnak 1999) where it approaches the southern border of its distribution (M. Povž, pers. comm).

Of the twelve fish species observed at Cerknica Polje, at least four, Rudd, Perch, Carp and Rainbow Trout, are known to be introduced. Rudd was introduced in 1969 (Povž & Ocvirk, 1990) and Perch around 1990 (Ribiška drušina Cerknica 1996). Rudd and Perch were the most numerous fish at Cerknica polje in 1999 and 2000. Rudd is held responsible for a decline of Pike (Povz & Ocvirk 1990). Only two adult individuals of Carp (> 40 cm) were seen during my research. Carp is released for sports fishing (Ribiška družina Cerknica 1996). Since no juveniles were seen, they might not reproduce at Cerknica polje. Rainbow Trout are also introduced for sports fishing (Ribiška družina Cerknica 1996). As Cerknica polje is designated as a specially protected area within a future "Regional Park Snežnik", further introductions of allochtonous fish should be discouraged while management of sustainable populations of native species should be the main goal (Povž 1999).

In recent years there has been an increasing awareness that a small species, the Topmouth Minnow Pseudorasbora parva, is being accidentally introduced to many European countries with the stocking of young Carp (Veenvliet, unpublished data). Topmouth Minnows are also recorded in Slovenia (Povž & Ocvirk 1990). While the Topmouth Minnow is not known from Cerknica polje, any Carp meant for stocking should be thoroughly checked for the presence of this potentially hazardous species among them.

In addition to intentional introductions, fish are kept in "semi-captive" conditions at three sites at Cerknica polje. These are: Rainbow Trout in an enlarged part of the small Grahovščica stream in the village of Grahovo, Rudd in a concrete pond in the town of Martinjak, and possibly Charr *Salvelinus* sp. in an enlarged karstic spring under the village of Goričice. The latter escaped soon after their introduction in 2000 because of an insufficient barrier (J. Kus, pers. comm.). In the autumn of the same year, the water level increased to an exceptionally high level and flooded this karstic spring. Because of the unpredictable changes of the water level in the polje, these semi-captive fish are a potential source of accidental introductions. Therefore, fish keeping in parts of the polje water system should be discouraged.

At low water levels, people gather to 'save' fish from getting stranded in shallow ponds. Fish saving is a traditional event which continues today (Vovk 1978, Ribiška družina Cerknica 1996). While individual fish are temporarily saved, extra mortality might occur later when 'saved' fish become overcrowded in certain small areas of streams. Besides, some of the 'saved' fish are released at the nearby Rak and Bloščica streams (Ribiška družina Cerknica 1996). This release of fish from Cerknica polje leads to undesired introductions of species, as well as mixing of genetic stocks from the naturally isolated stream sections. Independent research into the consequences of this saving of fish should be carried out.

While periods of low water are usually regarded as negative for fish abundance, they might well be beneficial for fish. Flooded grasslands are an important breeding area for species that reproduce early in the year, such as Pike and especially Burbot (Crombaghs et. al. 2000). If the flooding continues for a long enough period, these areas become an important habitat for juvenile fish because of the relatively high temperature and high primary production. The availability of nutrients leads to a rapid increase of aquatic invertebrates, which in turn are food for juvenile fish (Crombaghs et. al. 2000). While most species use the flooded areas in this way, it might be especially important for Burbot. In Western Europe the Burbot has declined strongly; nowadays, it is rare, for example, in Holland (de Nie 1996) and extinct in Great Britain (Wheeler 1998). This decline is thought to be connected with the restructuring of shores of streams and lakes, which has prevented temporary flooding of those areas. (Crombaghs et al. 2000). Burbot is also declining in Central Europe. In many localities only single individuals were caught in the past years. The situation is similar in the Drava and Mura rivers in Slovenia. Also in Slovenia this decline is thought to be caused by river regulation, in combination with pollution. In Slovenia Burbot remains widespread only in Bohinj lake, Unica river (Planina polje) and Cerknica lake (Povž & Sket 1990).

Acknowledgments

Most of this research has been a one-person action. However, it would not have been possible without the help of various people: Katja Poboljšaj assisted in obtaining permission for catching protected fish species for identification purposes; Meta Povž sent the valuable report of the Ribiška družina Cerknica; Milan Vogrin commented on earlier versions of this article; Julia Wycherley suggested corrections of the English language. Last, but by no means least, Jana Kus made this research possible by showing me Cerknica polje, discussing concepts and ideas throughout this research, providing a map of the area and suggesting changes to the article.

References

Crombaghs, B.H.J.M., Akkermans R.W., Gubbels, R.E.M.B. & Hoogerwerf, G. 2000: Vissen in Limburgse beken; de verspreiding en ecologie van vissen in stromende wateren in Limburg. Stichting natuurpublicaties Limburg, Maastricht.

De Nie, H. W. 1996: Atlas van de Nederlandse zoetwatervissen. Media publishing int. Doetinchem.

Gospodarič, R. & Habič, P. 1978: Kraski pojavi Cerkniskega polja. Acta Crasologica 8: 7-162.

Iljanič, L. 1978: Vegetacijske Razmere Cerkniškega Jezera. Močvirna, Barjanska in Traviščna vegetacija. Acta Crasologia 8: 163-200.

Mastnak, M. 1999: Sneznik Regional Park - Fundaments for Management Plan; summary. Nature Conservation Authority of Republika Slovenija, Ljubljana.

Povž, M., 1999: Ribe in ribištvo. In: Ogorelec, B., & M. Mastnak eds. Regijski Park Snežnik - izhodisca za nacrt upravljanja. Ministrstvo za okolje in postor uprava RS za varstvo narave, Ljubljana; Royal Dutch Society for Nature Conservation (KNNV), Soest: 92-98.

Povž, M. & Ocvirk, A. 1990: Freshwater fish introductions and transplantations in Slovenia. Ichthyos 9: 1-9

Ribiška družina Cerknica 1996: Ribiško-gojitveni načrt 1996-2000. Cerknica.

Vovk, J. 1978. Ihtioloske raziskave Cerkniskega Jezera (Ichtyological Researches of the Cerknisko Jezero (Cerknica Lake). Acta Carsologia 8: 276-299.

Wheeler, A. 1998: Field key to the freshwater fishes and lampreys of the British Isles. Field Studies 9: 355-394.

Table 1. Occurrence of fish species in various parts of Cerknica polje. A species has been indicated as 'present' when only a few individuals have been seen. When many (> 25) individuals have been seen at every visit, a species has been indicated as 'numerous'. Empty cells in the table mean that the species has not been observed there. For a description of localities mentioned, see main text.

Species	Rešeto	Floodplain	Stržen & Žerovniščica	Lipsenjščica	Cerkniščica
Salmo trutta Brown Trout				numerous	numerous
Oncorhynchus mykiss Rainbow Trout				present	
Esox lucius Pike	numerous	numerous	numerous		
Leuciscus cephalus Chub	numerous	numerous	numerous		present
Phoxinus phoxinus Minnow					numerous
Scardinius erythrophthalmus Rudd	numerous	numerous	numerous		
Tinca tinca Tench	present		present		
Cyprinius carpio Carp	present				
Barbatula barbatula Stone Loach					present
Lota lota Burbot	present		present		
Perca fluviatilis Perch	numerous	numerous	numerous		
Cottus gobio Millers Thumb			present	present	present

Winter bird assemblages on two different urbanization plots in town Žalec: flock size, temperature and snow cover effects on bird assemblages

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Abstract
Studies were conducted in two plots (suburbs 12.4 ha; town centre 9.5 ha) in the small town of Žalec in the Lower Savinja valley (Slovenia) between November 1998 and February 1999. I documented flock size by means of transect-type and mapping methods. I found that absolute minimum air temperature had a significant effect on pooled bird density in the suburbs and on the density of the House Sparrow *Passer domesticus* in the same plot, but not in the centre. Moreover, I found a positive relationship between the density of birds, including House Sparrows, and maximum snow cover in suburban areas but not in the centre. In all species, except Greenfinch *Carduelis chloris*, flock size differed significantly between months. The Great tit Parus major foraged throughout the study period mainly in pairs, probably as a result of the lack of predators and high food availability.

Key words: bird assemblages, winter, town Žalec (Slovenia), flock size, temperature, snow cover

Received 15 August.2000; accepted 5 September 2000

Introduction

Data from research on urban bird assemblages are scarce and scattered (Bezzel 19985). Most of the urban studies describe breeding bird assemblages in parks, periphery and city centers, or compare bird assemblages among them (Suhonen & Jokimaki 1988, Antikainen 1992, Jokimaki & Suhonen 1993, Biadun 1994a and references therein), or researchers choose to work on pre-selected single species (Luniak et al. 1990, Horak 1993). Wintering bird assemblages in urban areas are even less studied. To date, winter bird assemblages in urban areas in Central Europe have been described only by e.g. Luniak (1980, 1981), Luniak et al. (1986), Biadun (1994b), Lentner & Landmann (1994), and Witt (1995).

Here I present winter bird assemblages on two different urbanized plots in the town of Žalec. I also investigated how the size of flocks of the most common species varied between months. Since temperature affects birds in various ways (Bilcke et al. 1986, Newton 1998) I also investigated whether temperature has any effect on composition of bird assemblage and density of any particular species (Elkins 1983, Newton 1998). Since winter temperatures in towns are higher than in surrounding areas (Bezzel 1985, Gilbert 1991, Žiberna 1991, 1996), I predicted that densities of bird assemblages during periods of lower temperatures should be higher than during higher temperatures. Furthermore, I investigated how, if at all, snow cover affects species composition and density.

Study area

The Town of Žalec is located in the Lower Savinja valley about two kilometres north of the river Savinja and is 257 metres above sea level. It has a population of approximately 5400 inhabitants and is one of the smallest towns in Slovenia. The surrounding

Figure 1. *The second plot in the town of Žalec in December 1998. Photo: Milan Vogrin*

landscape is predominantly agricultural, the main crop being hops, *Humulus lupulus*.

My first study plot was situated in the town centre, where blocks of flats predominated. Green areas were small. The small park of about 0.4 ha was managed and human interference was high throughout the centre. The plot was bordered by the streets of Ivanjke Uranjek, Šlander square, Prešeren street, the roadway of Žalski tabor and the railway. The whole study plot measured 9.5 ha.

The second plot was located in the suburbs, where small houses with gardens predominated, along with a few small blocks of flats (Figure 1). Deciduous and coniferous trees (mainly fruit) were mostly young and the undergrowth with some bushes was managed. The plot was bordered by the Savinjska road, Vrbje road, Prešernova street and railway. The area measured 12.4 ha. See also Vogrin (1998a).

On both plots birds were sporadically fed by the public in one or two areas.

Weather

Data about temperatures and snowfall were taken from the nearest weather station in Celje, which is situated about 10 km from Žalec (Hidrometeorološki zavod Slovenije 1998a, b, 1999a, b) - Table 1. The coldest months were December and January, the most snowy month was February. Daily temperature data were measured by the author. Absolute minimum air temperature at a height of 2 m was taken for the decade when the survey was conducted.

Methods

Field methods

The study was conducted from early November 1998 till late February 1999. A count of all birds was made three times each month in each plot at 10 day intervals throughout the study. Birds were censused by means of a transect-type method and by a mapping method. All counts were made with binoculars and the observer walked over all parts of the plot to make a count of all birds present. The sizes of flocks were registered, and for the Blackbird Turdus merula I noted also the sex of observed individuals, further divided into three categories: adult males, subadult males and females.

One disadvantage was the increased possibility of double counting errors when birds were flushed from one part of the area to another part. This source of error could not be eliminated, but was minimized by taking into account birds flushed to parts to be counted. Moreover, I also took into account human disturbance, although I could not know to what degree this might be present. Counts were not made during periods of heavy snow, strong wind or poor visibility. Census routes were changed at each visit to minimize errors in an effort to randomize the sample set and to remove any effects of weather or time of day on the presence and detectability of birds. Both plots were censused on the same day in random sequence to avoid effects of time and temperature on the conspicuousness of the birds. All counts were made between 8:00 a.m. and noon. Birds which overflew the area were ignored. Feral Pigeons *Columba livia domestica*, which were present on both plots (according to my estimate about 30 individuals in the centre and about 10 individuals in the suburbs), were ignored. On each survey I also counted domestic cats, which could be important predators in towns (Svensson 1996).

Flocks were identified either as a cluster of birds which called to each other, or when a bird clearly followed another (Berner & Grubb 1985).

Analysis

Each count acted as an independent datum in the analysis, so I calculated density of particular species separately for each survey. For the most common species, such as House Sparrow *Passer domesticus* in the town centre and Great Tit *Parus major*, House Sparrow, Chaffinch Fringilla coelebs and Greenfinch *Carduelis chloris* in suburban areas, I calculated also the flock size. Outside the breeding season, most birds do not maintain territories and are likely to be relatively mobile, so numbers recorded in an area may fluctuate considerably. To take into account possible seasonal variations, I also calculated flock size separately for each month. Flocks were divided into five categories (Vogrin 1998b, c): 1 individual, two individuals, 3-5 individuals, 6-10 individuals and > 10 individuals.

For comparisons of similarities between bird communities in the two plots I used the formulae given by Southwood (1978) and Tomialojć et al. (1984) to calculate Sorensen index; $QS = 2c/(a + b) \times 100$, where c is the common parts of two sets, a is the size of the first set and b is the size of the second set. The value of QS exceeding 80% indicates a high similarity of communities (see Biadun 1994a).

Statistical analyses were performed with non-parametric tests (Chi-square, Kruskal-Wallis 1-way Anova), since data were not normally distributed (Fowler & Cohen 1988, Sokal & Rohlf 1995), and with a Spearman correlation coefficient. The choice of test was each time preceded by a goodness of fit comparison of a distribution of a given variable with a normal distribution using the Kolmogorov-Smirnov test, a non-parametric test based on the comparison of medians. All statistical tests were performed with the SPSS 8.0/Windows statistical package. A $P < 0.05$ was considered significant.

Results

In both plots the House Sparrow reached the highest densities throughout the study (Table 2, 3). The greatest differences among bird assemblages and months, according to Sorensen's index, were between November - February and December Ð February in suburban areas, whereas in the centre of Žalec the greatest difference was found between December and February (Table 4). Comparisons between both plots with QS were: November (72.0 %), December (44.4%), January (50.0 %) and February (66.6 %). On both plots I registered 39 specimens of Blackbird; notably, males were much more common than females or subadults (Chi-square = 10.3, df = 2, $P < 0.01$).

Suburban areas

During the investigation I registered from 9 (January) to 16 (December) species. Only five species, House Sparrow, Tree Sparrow Passer montanus, Chaffinch Fringilla coelebs, Greenfinch *Carduelis chloris* and Great Tit *Parus major*, were registered in all surveys. The relationship between number of registered species and density (individuals/10 ha) was not significant ($r_s = -0.19$, $P > 0.5$, $n = 12$). Relationships between number of species and air temperature measured on the day of survey, pooled bird density and air temperature measured on the day of survey were also not significant. However, I found that density increased with absolute minimum temperature (rs = -0.73, $P < 0.01$, $n = 12$) - Figure 2. Moreover, I also found a positive relationship between density of birds and maximum snow cover ($r_s = 0.66$, $P < 0.05$, $n = 12$) - Figure 3.

Passer domesticus

Flock sizes in particular months are presented in Table 5. The number of House Sparrows varied significantly between months (Kruskal-Wallis 1-way Anova, Chi-square = 15.24, df = 3, $P < 0.005$, $n = 243$). On average, the largest flocks were registered in December and the smallest in February (rs = -0.15, $P < 0.05$, $n = 243$). Frequency of flock size for the whole study is presented in Figure 4. The relationship between absolute minimum air temperature and density of the House Sparrow is significant ($r_s = -0.66$, $P < 0.05$, $n = 12$) and the same is true for the relationship between density and thickness of snow cover ($r_s = 0.67$ $P < 0.02$, $n = 12$).

Parus major

Flock sizes of the Great Tit in particular months are presented in Table 6. Flock sizes differ significantly between months (Kruskal-Wallis 1-way Anova, Chi-square = 10.22, df = 3, $P < 0.05$, $n = 85$). Flock size increased from November to February ($r_s = 0.22$, $P < 0.05$, $n = 85$). Great Tit units of one and two (pair) birds were very common, and there were only a few larger flocks.

Fringilla coelebs

Flock size of the Chaffinch in the suburbs is presented in Table 7. Differences between flock size and months are significant (Kruskal-Wallis 1-way Anova, Chi-square = 7.88, df = 3, $P < 0.05$, $n = 74$). Flock size increased during the study ($r_s = 0.31$, $P < 0.01$, $n = 74$).

Carduelis chloris

Flock size in particular months of the Greenfinch is presented in Table 8. Flock size did not differ significantly between months (Kruskal-Wallis 1-way Anova, Chi-square =5.11, df = 3, $P > 0.05$, $n = 58$); however, flock size decreased between the start and the end of the study (rs = - 0.29, $P < 0.05$, $n = 58$).

Town centre

In the centre of Žalec up to seven species were registered. The lowest values of the number of species per month were registered in January (three), whereas the maximum numbers of species were registered in

November and February (seven species). Only the House Sparrow was registered during each census. The relationship between the number of registered species and density was not significant ($r_s = 0.43$, $P > 0.05$, $n = 12$). Relationships between number of species and temperature measured on the day of census, pooled bird density and temperature measured on the day of census, number of species and absolute minimum temperature, and relationship between pooled bird density and absolute minimum temperature were not significant in any case.

Passer domesticus

The flock size of the House Sparrow in the centre is presented in Table 9. The biggest flocks were registered in December and the smallest in February. Flock sizes differ significantly between months (Kruskal-Wallis 1-way Anova, Chi-square = 12.55, df = 3, $P < 0.01$, $n = 200$). Flock size decreased during the study ($r_s = -0.22$, $P < 0.005$, $n = 200$). The proportion of different flock sizes of the House Sparrow for the whole period is presented in Figure 5.

Discussion

According to Sorensen's index, identical bird assemblages were found in November and December and November and January in both study plots, and in the suburbs in December and January. The reason for the similarity of bird assemblages between months was the stability of species which were present in town. Only a few species were observed only once in a particular month. In suburban areas, such species comprised 6.3% in November, 21.0% in December, 13.3% in January and 26.7% in February respectively. In the town centre this share was slightly higher: 33.3% in November, 25% in December, 50% in January and 22% in February. Accordingly, we can assume that winter bird assemblages according to species composition are stable, especially in suburban areas.

Low air temperatures have a significant effect on pooled bird density in suburban areas, and on the density of the House Sparrow in the same plot. On both occasions, as I predicted, density increased when temperature decreased. This means that immigration from surrounding habitats occurs. In line with this observation, I must mention that in the nearest town, Celje, in 1999/2000 the winter temperature was about 2.7oC higher than in the surrounding environment (Drobne 2000).

Snowfalls also seem to have a negative impact on bird foraging behaviour, by making the search for food more difficult (see Maccarone 1987). When the available foraging surface (trees, ground) decreases, birds must adapt foraging techniques or find a new, more appropriate space. Because of the higher temperature in towns, snow cover tends to be lower on the ground, or even absent on the trees, than in surrounding habitats. Also, snow is cleared in towns. In such an environment, food is more available and higher bird densities can be expected. I also observed this trend in the suburban plot.

Single species

On both plots I find a similar trend in the House Sparrow, i.e. flock size decreases during the winter. I also found a similar trend in the Greenfinch. This trend could be related to mortality and predation pressure (but see below and Summers-Smith 1988). We must also take into account that at the end of the study, i.e. in the February breeding season had already started, at least for the sparrow. I observed some males of the House Sparrow near breeding holes on houses (Figure 6) and some Greenfinches were already singing.

On the other hand, flock sizes of the Great Tit and of the Chaffinch increased during winter. In my study area, especially near the end of the winter, the Great Tit foraged mainly in pairs, contrary to Cramp & Perrins (1993), who say that the Great Tit forage in larger flocks during the non-breeding season (see also Matthysen 1990 and references therein). Such differences in flock sizes could be connected with habitat (structure, vegetation) (Bilcke et al. 1986, Rolando & Menzio 1990, Szekely & Juhasz 1993, Donald et al. 1997), quantity of food and number of predators (Szekely et al. 1989), and weather (e.g. Bilcke et al. 1986, Szekely & Juhasz 1993).

Several studies have shown that one of the advantages of flock foraging is that individuals in a group have higher feeding rates than those foraging alone (Caraco 1979, HŽglund 1985). When food is found in a few localized areas, groups are likely to be larger (Vickery et al. 1991) and the reverse. Berner & Grub (1985), Grubb (1987), Szekely et al. (1989) tested the foraging efficiency hypothesis in the field. They found that after food addition, fewer birds were flocking.

Another way in which benefits can be spread among flock members is antipredator behaviour (Cresswell 1994 and references therein). Szekely et al. (1989) tested the antipredator hypothesis and found that birds joined flocks in the presence of a predator. In my study plots the main predators were domestic cats; no avian predator was present in the study area during the study (Table 2, 3). Domestic cats were more common in the suburbs (on average 1.6 cats/survey) than in the centre (only two cats were registered during 12 surveys). Since predators on both plots were rare, birds did not need to form flocks as antipredator behaviour. In urban environments there is also enough food during winter (Bezzel 1985) and predators were scarce; birds could forage alone or in pairs. At the end of the winter (February) there was a pronounced trend of pair formation in the Great Tit (Table 6) caused by the start of breeding season.

Flock size is therefore expected to increase in more severe conditions, when birds have difficulties in meeting their energy requirements and with increasing predation pressure. Such conditions are seen mainly in northern Europe, where the most detailed studies on flocking have been conducted. All authors (see Matthysen 1990) have found that the Great Tit is a flock-living species. However, according to my observations, it seems that during the winter the Great Tit from more southern areas lives mainly in pairs (see also Vogrin & Vogrin 2000). Baldi & Csorgo (1993) support this, since they found that artificial feeding, in comparison with northern Europe, has no effect in Central Europe.

According to Cramp (1988), Luniak et al. (1990) some individuals of the Blackbird migrate from Central Europe to southern Europe during winter, whereas from northern Europe, it is mainly females that migrate. If we take into account data for the same plots from Vogrin (1998a), we can ascertain that the average density of the Blackbird is the same during the breeding season as during winter. However, the sex ratio was completely different; mostly males were present during winter. It seems that in the region of Slovenia, most females migrate from more southern areas, not only from the northern areas, as Cramp (1988) found.

I obtained a very high density for the House Sparrow on both plots, in comparison with some other studies from Central Europe. For example, in an 8 ha allotment garden in Warsaw, Luniak (1980), obtained a density of 46 individuals/10 ha, whereas Biadun (1994b) obtained a density of 19.9 individuals/10 ha in a park measuring 2.5 ha in Lublin. One possible reason for such great differences (up to sixfold) could be the character of the observed plots (composition of the habitats) and their closest surroundings, the different years that investigations were carried out, the geographical location of the studied areas, and different stages of urbanization. Since Witt (1995) found a similar density for the House Sparrow in Berlin, the urbanization effect could be the main reason for great differences in House Sparrow density. Moreover, in less urban areas Luniak (1980) and Biadun (1994b) also found species such as Yellowhammer Emberiza citrinella, Rook Corvus frugilegus and Bullfinch Pyrrhula pyrrhula, which are not typically urban species.

In this region some interesting species were observed during the study. Black Redstart Phoenichuros ochuros was observed during December (Figure 7), Starling Sturnus vulgaris (5 specimens observed once in December), and Redwing Turdus iliacus was observed twice in December.

Comparisons between plots

From the results it is obvious that during winter more species are present in greater densities in the suburbs. In the suburbs more forest species (including tits, Robin Erithacus rubecula) are registered than in the centre, where only typically urban species are present. The Collared Dove Streptopelia decaocto was almost absent from the centre of Žalec during the study. The low density of this species on the same plot was also found during the breeding season (Vogrin 1998a). I assume that the Feral Pigeon greatly influences the Collared Dove as a competitor species, since both species nest in similar places and feed on similar food.

Acknowledgements

All work was conducted without financial support. Additional literature was kindly sent by prof. Maciej Luniak. Two anonymous reviewers provided suggestions which improved the presentation of results.

References

Antikainen, E. 1992: The vetical use of a city park by urban birds in Poland. Ornis Fennica 69: 92-96.

Baldi, A. & Csorgo, T. 1993: Social dominance in the resident part of a Great Tit (*Parus major*) population in winter. Ornis Hungarica 3: 7-12.

Berner, T.O. & Grubb, T.C. 1985: An experimental analysis of mixed species flocking in birds of deciduous wodland. Ecology 66: 1229-1236.

Bezzel, E. 1985: Birdlife in intensively used rural and urban environments. Ornis Fennica 62: 90-95.

Biadun, W. 1994a: Winter avifauna of urban parks and cemeteries in Lublin (SE Poland). Acta Ornithologica 29: 15-27.

Biadun, W. 1994b: The breeding avifauna of the parks and cemeteries of Lublin (SE Poland). Acta Ornithologica 29: 1-13.

Bilcke, G., Mertens, R., Jeurissen, M.& Dhondt, A.A. 1986: Influence of habitat structure and temperature on the foraging niches of the pariform guild in Belgium during winter. Le Gerfaut 76: 109-129.

Cramp, S. ed. 1988: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 5. Oxford University Press, New York.

Cramp, S. & Perrins, C.M. eds. 1993: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 7. Oxford University Press, New York.

Cresswell, W. 1994: Flocking is an effective anti-predator strategy in redshanks, Tringa totanus. Animal Behaviour 47: 433-442.

Drobne, N. 2000: Mestna klima celja. Diplomsko delo. Univerza v Mariboru. Pedagoška fakulteta, Oddelek za geografijo.

Elkins, N. 1983: Weather and bird behaviour. T & AD Poyser. Calton.

Fowler, J. & Cohen, L. 1988: Statistics for ornithologists. BTO Guide No. 22. BTO.

GILBERT, O.L. 1991: The ecology of urban habitats. Chapman & Hall, London.

Grubb, T.C. 1987: Changes in the flocking behaviour of wintering English titmice with time, weather and supplementary food. Animal Behaviour 35: 794-806.

Hidrometeorološki zavod Republike Slovenije 1998a: Mesečni bilten 5 (11). Ljubljana.

Hidrometeorološki zavod Republike Slovenije 1998b: Mesečni bilten 5 (12). Ljubljana.

Hidrometeorološki zavod Republike Slovenije 1999a: Mesečni bilten 6 (1). Ljubljana.

Hidrometeorološki zavod Republike Slovenije 1999b: Mesečni bilten 6 (2). Ljubljana.

Horak, P. 1993: Low fledging success of urban Great Tit. Ornis Fennica 70: 168-172.

Jokimaki, J. & Suhonen, J. 1993: Effects of urbanization on the breeding birds species richness in Finland: a biogeographical comparison. Ornis Fennica 70: 71-77.

Lentner, R. & Landmann, A. 1994: Vogelwelt und Struktur der Kulturlandschaft: r0umliche und saisonale Muster. Berihte des Naturwissenschaftlich-Medizinischen Vereins in Innsbruck, Supplementum 12: 1-130.

Luniak, M. 1980: Birds of allotment gardens in Warsaw. Acta Ornithologica 17: 297-320.

Luniak, M. 1981: The birds of the park habitats in Warsaw. Acta Ornithologica 18: 335-370.

Luniak, M., Jabkonski, P. & Marczak, P. 1986: Birds of the Lazienki Krolewskie park (Warsaw) in the years 1954-84. Acta Ornithologica 22: 23-50. In Polish with English summary.

Luniak, M., Mulsow, R. & Walasz, K. 1990: Synurbanization of the European Blackbird - expansion and adaptations of urban population. In. Luniak, M. ed: Urban Ecological Studies in Central and Eastern Europe. Polish Academy of Sciences, Institut of Zoology.

Maccarone, A.D. 1987: Effects of snow cover on starling activity and foraging patterns. Wilson Bulletin 99: 94-97.

Matthysen, E. 1990: Nonbreeding social organization in Parus. In: Power, D.M. ed.: Current Ornithology, vol. 7. Plenum Press, New York: 209-249.

Netwon, I. 1998: Population limitation in birds. Academic Press.

Rolando, A. & Menzio, B. 1990: Niche organization of a forest bird community in North-western Italy in autumn and winter. Le Gerfaut 80: 159-179.

Szekely, T. & Juhasz, T. 1993: Flocking behaviour of tits (Parus spp.) and associated species: the effect of habitat. Ornis Hungarica 3: 1-6.

Szekely, T., Szep, T. & Juhasz, T. 1989: Mixed species flocking of tits (Parus spp.): a field experiment.... Oecologia 78: 490-495.

Suhonen, J. & Jokimaki, J. 1988: A biogeographical comparison of the breeding bird species assemblages in twenty Finnish urban parks. Ornis Fennica 65: 76-83.

Southwood, T.R.E. 1978: Ecological Methods. Chapman & Hall. London.

Summers-Smith, J.S. 1988: The sparrows: a study of the genus Passer. T & AD Poyser Ltd.

Svensson, S. 1996: Predation on birds by the domestic cat in Sweden. Ornis Svecica 6: 127-130. (In Swedish with English summary).

Tomialojć, L., Wesolowski, T. & Walankiewicz, W. 1984: Breeding bird community of a primaeval temperate forest (Bialowieza National Park, Poland). Acta Ornithologica 20: 241-310.

Vickery, L.W., Giraldeau, L.A., Templeton, J.J., Kramer, L.D. & Chapman, A.C. 1991: Producers, scroungers, and group foraging. The American Naturalist 137: 847-863.

VOGRIN, M., 1998a: Bird communities in the suburbs and town centre of Žalec (Lower Savinja valley, Slovenia). Aquila 103-104: 95-100.

Vogrin, M. 1998b: Density and the flock size of the Magpie Pica pica on the agricultural landscape during winter period. Ornis Svecica 8: 167-170.

Vogrin, M. 1998c: Migration patterns of the Common Sandpiper Actitis hypoleucos and its habitat choice during migration in northeastern Slovenia. Avocetta 22: 74-77.

VOGRIN, M. & VOGRIN, N. 2000: Composition of wintering bird assemblages on meadows with hedges in the Lower Savinja Valley (Slovenia). Gozddarski vestnik 58: 304-315. In Slovene with English summary.

Witt, K. 1995: Censusing winter birds in different habitats of Berlin. The Ring 17: 69-75.

Žiberna, I. 1991: Nekatere značilnosti mestne klime Maribora. Dela Oddelka za geografijo Filozofske fakultete v Ljubljani: 5: 72-77.

Žiberna, I. 1996: Mestna klima Maribora. Doktorska disertacija. Univerza v Ljubljana. Filozofska fakulteta, Oddelek za geografijo.

Figure 7. *Black Redstart Phoenichuros ochuros in December 1998 in the centre of the town Žalec at - 12oC. Photo: Milan Vogrin*

Table 1. Monthly meteorological data according to Hidrometeorološki zavod Republike Slovenije (1998a, b, 1999a, b). Taver. (oC) - average temperature at 2 m height, Tam (oC) - absolute minimum air teperature at 2 m height, RR (mm) - monthly amount of precipitation, SS - number of days with snow cover, Dmax. (cm) - maximum thickness of snow cover for the weather station in Celje.

Month/Parameters	Taver.	Tam	RR	SS	Dmax
November	2.6	-6.1	173.3	6	10
December	-3.7	-12.3	34.5	30	20
January	0.8	-9.5	24.7	13	6
February	-0.2	-18.5	104.6	21	63

Table 2. Density (no. of specimens/10 ha) in suburbs of the town of Žalec in each survey in particular months.

Month-survey Species	XI - 1	XI - 2	XI - 3	XII - 1	XII - 2	XII - 3	I - 1	I - 2	I - 3	II - 1	II - 2	II - 3
Passer domesticus	146.0	129.0	137.0	161.3	153.2	145.2	119.4	125.0	197.6	275.8	200.0	237.9
Parus major	8.9	8.1	8.1	9.7	12.9	9.7	8.1	18.5	12.1	8.9	4.0	6.5
Carduelis chloris	6.5	32.2 1	9.4	11.3	33.1	10.5	22.6	0.8	12.9	51.6	25.8	36.3
Fringillla coelebs	11.3	6.5	8.9	3.2	3.2	16.1	5.6	11.3	4.0	16.1	19.4	17.7
Passer montanus	2.4	0.8	1.6	0.8	1.6	7.3	3.2	4.0	8.9	3.2	6.5	4.8
Turdus merula	4.8	2.4	3.2	4.0	-	0.8	0.8	1.6	2.4	4.0	4.0	4.0
Streptopelia decaocto	4.0	1.6	2.4	-	0.8	18.5	11.3	20.1	2.0	16.9	19.4	17.7
Pica pica		1.6	0.8	0.8	0.8	4.0	0.8	- 4.8	1.6	4.8	2.4	3.2
C. coccothraustes	0.8	0.8	0.8	-	6.5	0.8	-	0.8	0.8	-	0.8	-
Turdus pilaris	2.4	6.5	4.0	1.6	1.6	0.8	-	0.8	-	-	-	-
Erithacus rubecula	1.6	2.4	1.6	4.0	1.6	0.8	-	0.8	0.8	1.6	0.8	-
Sitta europaea	1.6	-	0.8	0.8	1.6	0.8	-	0.8	1.6	-	-	-
Parus caeruleus	0.8	3.2	1.6	1.6	-	1.6	0.8	2.4	-	-	-	-
Picoides major	-	2.4	0.8	-	-	0.8	-	-	-	-	-	-
Phoenichuros ochuros	-	1.6	0.8	-	-	-	-	-	-	-	-	-
Regulus regulus	-	0.8	-	0.8	-	-	-	-	-	-	-	-
Turdus iliacus	-	-	-	0.8	0.8	-	-	-	-	-	-	-
Sturnus vulgaris	-	-	-	4.0	-	-	-	-	-	-	-	-
Parus ater	-	-	-	-	0.8	1.6	3.2	0.8	0.8	-	-	-
Carduelis carduelis	-	-	-	-	-	0.8	-	-	-	0.8	3.2	1.6
Corvus cornix	-	-	-	-	-	-	-	1.6	-	0.8	0.8	0.8
Galerida cristata	-	-	-	-	-	-	-	-	-	-	0.8	-
Fringilla montifringilla	-	-	-	-	-	-	-	-	-	-	2.4	-
Turdus viscivorus	-	-	-	-	-	-	-	-	-	-	0.8	-
Together	192.7	199.2	191.9	204.8	221.8	216.9	175.0	195.2	268.5	384.7	291.1	331.5

Table 3. Density (no. of specimens/10 ha) in the centre of the town of Žalec in each survey in particular months.

Month - survey Species	XI - 1	XI - 2	XI - 3	XII - 1	XII - 2	XII - 3	I - 1	I - 2	I - 3	II - 1	II - 2	II - 3
Passer domesticus	148.0	176.0	162.0	142.0	114.7	168.0	89.5	181.0	134.7	203.1	164.2	124.2
Parus major	3.1	1.1	2.1	5.3	4.2	-	1.1	2.1	1.1	2.1	1.1	1.1
Pica pica	3.1	4.2	3.1	-	1.1	4.2	4.2	1.1	2.1	2.1	1.1	1.1
Fringilla coelebs	1.1	1.1	1.1	-	1.1	2.1	1.1	-	-	1.1	-	3.1
Passer montanus	2.1	-	1.1	-	-	-	1.1	-	-	-	1.1	-
Turdus merula	1.1	-	-	1.1	2.1	1.1	-	-	-	-	-	-
Streptopelia decaocto	-	-	-	-	-	-	-	-	-	2.1	3.1	-
C. coccothraustes	-	1.1	-	-	-	2.1	-	-	-	-	-	-
Erithacus rubecula	-	1.1	-	1.1	-	-	-	1.1	-	-	-	-
Carduelis chloris	-	31.5	15.8	-	-	-	-	-	-	1.1	-	-
Parus caeruleus	-	-	-	-	-	-	-	-	-	-	2.1	1.1
Phoenichuros ochuros	-	-	-	-	1.1	1.1	-	-	-	-	-	-
Galerida cristata	-	-	-	-	-	-	-	-	-	-	1.1	2.1
Together	159.0	215.8	185.0	149.5	124.0	179.0	96.8	185.2	137.9	211.6	173.7	131.6

Table 4. Comparison between bird assemblages in separate month with Sorensen's index (upper right part of the table: centre of the town of Žalec, lower left part of the table: suburbs of Žalec)

	XI	XII	I	II
XI	-	82.3	80.0	66.7
XII	85.7	-	71.4	58.8
I	83.9	82.4	-	66.7
II	64.5	64.7	73.3	-

Table 5. Flock size (no. of individuals) of *Passer domesticus* in suburbs of Žalec.

Month	Mean	Min.	Max.	SD	No. of flocks
November	7.6	1	35	8,0	44
December	11.1	1	48	10,9	61
January	4.1	1	22	4,4	65
February	7.8	1	59	11,7	73

Table 6. Flock size (no. of individuals) of *Parus major* in suburbs of Žalec.

Month	Mean	Min.	Max.	SD	No. of flocks
November	1.1	1	2	0.3	19
December	1.6	1	3	0.6	25
January	1.5	1	3	0.6	32
February	1.8	1	4	1.0	9

Table 7. Flock size (no. of individuals) of Fringilla coelebs in suburbs of Žalec.

Month	Mean	Min.	Max.	SD	No. of flocks
November	1.2	1	3	0.5	18
December	1.6	1	6	1.4	18
January	1.4	1	3	0.6	19
February	2.3	1	8	1.9	19

Table 8. Flock size (no. of individuals) of *Carduelis chloris* in suburbs of Žalec.

Month	Mean	Min.	Max.	SD	No. of flocks
November	6	1	14	5.4	8
December	4.3	1	10	2.3	16
January	3.8	1	15	4.0	12
February	4.1	1	21	5.7	22

Table 9. Flock size (no. of individuals) of *Passer domesticus* in centre of Žalec.

Month	Mean	Min.	Max.	SD	No. of flocks
November	7.9	1	37	78.0	39
December	9.6	1	38	10.6	42
January	9.2	1	53	11.1	28
February	5.2	1	53	8.5	91

Figure 2. Relationship between densities of all species (no. of individuals/10 ha) in suburbs of Žalec and absolute minimum air temperature.

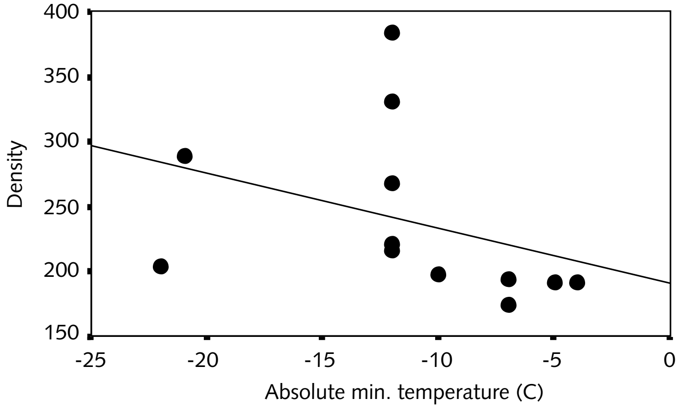


Figure 3. Relationship between densities of all species (no. of individuals/10 ha) in suburbs of Žalec and maximum thickness of snow cover.

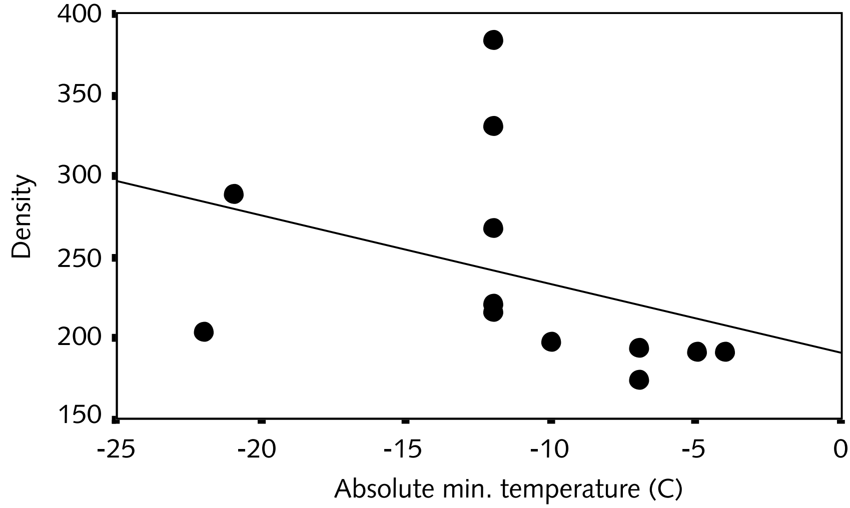


Figure 4. Frequency (%) of different flock size of *Passer domesticus* in suburbs of Žalec between November 1998 and February 1999. N = 243.

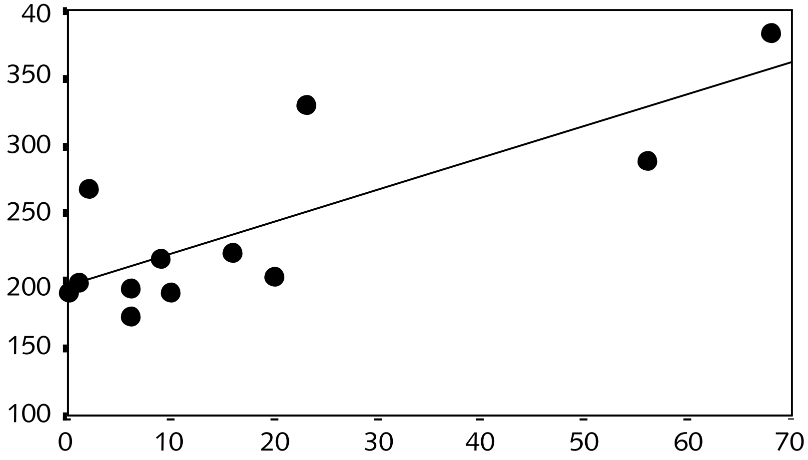
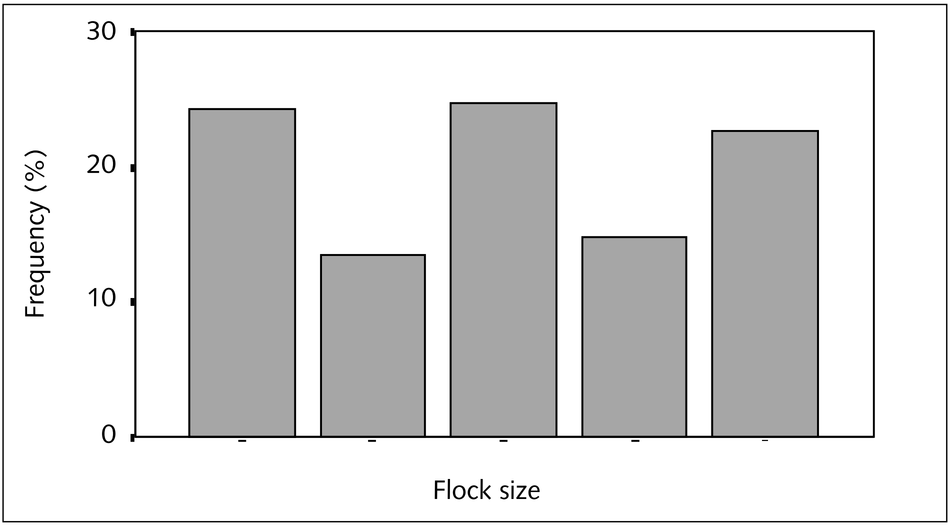
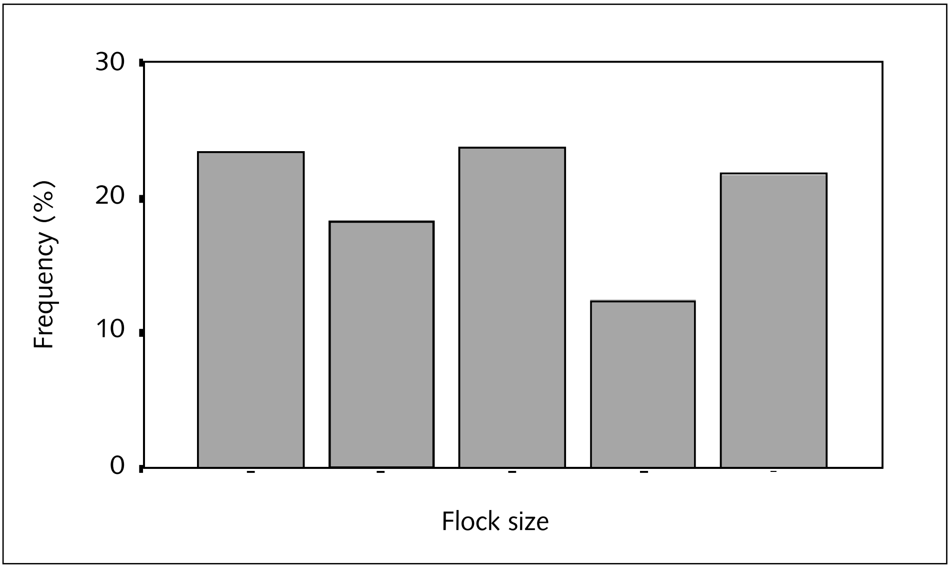


Figure 5. Frequency (%) of different flock size of *Passer domesticus* in centre of Žalec between November 1998 and February 1999. N = 200.





Ogroženost slovenskih gnezdilk: analiza rdečega seznama ogroženih ptic gnezdilk po ekoloških skupinah

Threats to Slovenian breeders: analyses of the Slovenian Red List of endangered breeding birds according to ecological groups

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Izvleček

Prispevek obravnava analizo ogroženosti ptic gnezdilk, ki jih najdemo na rdečem seznamu gnezdilk Slovenije. Vse vrste so razdeljene v tri ekološke skupine in sicer glede na gnezdišče, prehrano ter glede na status. Ugotovljeno je bilo, da najve? vrst z rde?ega seznama sodi med nepevke. Med posameznimi ekološkimi skupinami pa največ vrst najdemo v skupini, ki se prehranjujejo z nevretenčarji med vrstami, ki gnezdijo na tleh, in med transsaharskimi selivkami. Na osnovi te razdelitve se domneva, da so najbolj ogrožene tiste vrste, ki sodijo v dve ali celo tri zgoraj omenjene skupine.

Ključne besede: gnezdilke, rdeči seznam, ekološke skupine

Abstract

This article presents analyses of the Slovenian Red List of endangered breeding birds according to ecological groups, i.e. nesting guilds (hole breeders, open nest and ground breeders), feeding habits (insectivorous, carnivorous, omnivorous, herbivorous) and migratory habits (resident species, tropical migrants - species wintering south of the Sahara, short distance migrants). 122 birds from the national Red List of endangered breeding birds in Slovenia (Bračko et al. 1994) were used. The results are presented in Table 1. The most endangered species are those which migrate to tropical Africa, insectivorous and carnivorous species, and those which nest on the ground. At the top of the list are NonPasseriformes. The main threats are intensive agriculture, habitat fragmentation, global warming, and for some species, mainly colonial and/or rare species, predation. Most migrants may also be affected in their wintering habitats because of habitat fragmentation, pesticides, drought, etc. For species which breed at the edge of their distribution (e.g. Snipe *Gallinago gallinago*, Curlew *Numenius arquata*) and for glacial relicts (e.g. Ptarmigan *Lagopus mutus*, Three-toed Woodpecker *Picoides trydactylus*) global warming may also be the reason for their decline. One example in Slovenia is Ptarmigan, which bred about 150 years ago on Mt. Pohorje, 1540m, and is extinct in this area today. Thus we can predict that some species, e.g. Little Tern *Sterna albifrons*, Common Tern *S. hirundo*, European Bee-eater *Merops apiaster*, Little Bittern *Ixobrychus minutus*, Common Sandpiper *Actitis hypoleucos*, Nightjar *Caprimulgus europaeus* and various warblers (*Acrocephalus* spp., *Locustella* spp.) will be increasinly endangered.

Key words: breeders, Red List, ecological groups

Prispelo 15. 07. 2000; sprejeto 15. 9. 2000

Slika 2. *Čuk Athene noctua. Foto: Milan Vogrin*
Figure 2. *Little Owl athene noctua. Photo: Milan Vogrin*

Uvod

Na zadnjem Rdečem seznamu (Bračko et al. 1994) ogroženih ptic gnezdilk je 130 vrst (brez "premalo znanih vrst"), razvrščenih v različne kategorije ogroženosti. V seznamu je poudarek na ogroženosti vrst in vzrokih za ogroženost posamezne vrste.

V tem delu želim prikazati ogroženost posameznih ekoloških skupin ptic, torej ugotoviti, katere skupine gnezdilk so (naj)bolj ogrožene, opozoriti še na druge možne vzroke ogroženosti in razložiti nekatere že opisane.

Metode dela

Za osnovo sem imel Rdeči seznam ogroženih ptic gnezdilk Slovenije (Bračko et al. 1994). V tri osnovne ekološke skupine, ki jih predlaga Tomialojć et al. (1984) in Tomialojć & Wesolowski (1990) sem razdelil vse vrste z rdečega seznama razen vrst iz kategorije "premalo znana vrsta" in podkategorije "avtohtona populacija je v teku 19. in 20. stoletja prenehala gnezditi". Skupaj sem tako analiziral 122 vrst.

Vrste sem razdelil glede na gnezdišče v duplarje, prostognezdilce in talne gnezdilce (Tomialojć et al. 1984, Cramp 1988, Cramp 1992, Cramp & Simmons 1983). V skupino talnih gnezdilk sem razvrstil vse vrste, ki gnezdijo tudi v grmovju do višine 1,5 m (Luniak 1980, Luniak 1981, Tomialojć et al. 1984, Tomialojć & Wesolowski 1990, Biadun 1994), kakor tudi vrste, ki gnezdijo v zemlji (npr. vodomec *Alcedo athis*, čebelar *Merops apiaster*) ter na vodi (npr. čopasti ponirek *Podiceps cristatus*).

Glede na tip prehrane sem vrste razdelil v štiri skupine: vrste, ki se prehranjujejo pretežno z nevretenčarji (insektivori), vrste, ki se prehranjujejo pretežno z vretenčarji (karnivori), vsejede vrste(omnivori) ter vrste, ki se prehranjujejo z rastlinami in/ali s semeni (herbivore in granivore vrste) (Gensbol 1984, Tomialojć et al. 1984, Cramp & Simmons 1986, Tomialojć & Wesolowski 1990, Voisin 1991, Pearson & Lack 1992, Cramp & Perrins 1994a, Cramp & Perrins 1994b, Kooiker 1994), glede na status pa v stalnice, klateže in selivke (Cramp & Simmons 1977, Cramp & Simmons 1980, Cramp & Simmons 1983, Tomialojć et al. 1984, Morel & Morel 1992, Pearson & Lack 1992, Cramp & Perrins 1993, Newton 1995).

Za vrste, ki veljajo za transsaharske selivke, se pa pozimi občasno pojavljajo pri nas ali v posameznih zimah celo prezimujejo (npr. bela *Ciconia ciconia* in črna štorklja *C. nigra*, reglja *Anas querquedula*, mali martinec *Actitis hypoleucos* (Sovinc 1994)), je bilo odločujoče merilo velikost prezimovajoče populacije proti gnezdeči. V kolikor se odseli več kot 50% pri nas gnezdeče populacije, sem vrsto uvrstil med selivke.

Rezultati

Opredelitev posamezne vrste glede na status, prehrano in gnezdišče je predstavljena v tabeli 1.Med 122 vrstami je 78 (63,9%) nepevk (NonPasseriformes), 44 (36,1%) pa pevk (Passeriformes). Med vrste, ki se prehranjujejo pretežno z nevretenčarji, sodi 54 vrst (44,3%), med karnivore 28 (22,9%), med vsejede vrste 36 (29,5%) in med herbivore in granivore 4 vrste (3,3%). Od 122 vrst, jih 28 vrst (23%) sodi med duplarje (od tega 9 med primarne duplarje), 25 (20,5%) med prostognezdilke, 69 (56,5%) vrst pa med talne gnezdilke. Petinpetdeset (55) vrst (45,1%) sodi med transsaharske selivke, 47 vrst (38,5%) med stalnice, 20 vrst (16,4%) pa med klateže.

Diskusija

Med 122 ogroženimi vrstami prevladujejo nepevke. Gledano v celoti, torej pevke in nepevke skupaj, so najbolj ogrožene vrste tiste, ki se prehranjujejo z nevretenčarji, talne gnezdilke in selivke. Tudi med pevkami so najbolj ogrožene talne gnezdilke, selivke in žužkojede vrste. Med nepevkami so najbolj ogrožene talne gnezdilke, stalnice in karnivore vrste.

Selivke - Migratory birds

Vrste, ki se selijo, niso odvisne le od pogojev v gnezditvenem območju, temveč tudi od pogojev v prezimovalnem območju (npr. Winstanley et al. 1974, Svensson 1985). Odvisnost od vremena v prezimovališču je bila ugotovljena npr. za rjavo čapljo Ardea purporea, kmečko lastovko Hirundo rustica, belo štorkljo, bičjo trstnico *Acrocephalus* schoenobaenus in breguljko Riparia riparia (npr. Cave 1983, Moller 1989, Kanyamibwa et al. 1990, Peach et al. 1991, Szep 1995).

Selivke so tudi v prezimovalnem območju izpostavljene kontaminaciji s pesticidi. Bibby (1992) izmed najbolj ogroženih vrst v to skupino uvršča belo štorkljo, močvirskega lunja Circus pygargus in južno postovko Falco naumanni.

Prezimovalno območje za vse selivke ni enako veliko kot njihovo gnezditveno območje (Newton 1995). Kar 69 % od 62 vrst, ki jih je analiziral Newton (1995), ima prezimovalno območje, manjše od gnezditvenega. V kolikor pride do drastičnih posegov v njihovem prezimovalnem območju, lahko to močno prizadene posamezne vrste. Vrste, ki imajo najnižje razmerje med gnezditvenim in prezimovalnim območjem (Newton 1995), so (navajam le naše gnezdilke): močvirska trstnica *Acrocephalus* palustris, rečni cvrčalec *Locustella* fluviatilis, svetlooka penica Sylvia hortensis, črnočeli srakoper Lanius minor, navadni kupčar Oenanthe oenanthe, pogorelček Phoenicurus phoenicurus, črni hudournik Apus apus, divja grlica Streptopelia turtur, prepelica Coturnix coturnix, kačar Circaetus gallicus in škrjančar Falco subbuteo. Med temi jih kar osem vrst že najdemo na na?em rde?em seznamu. V kolikor bo prišlo do kakšnih večjih sprememb v njihovem prezimovalnem območju, se bo lahko njihovo stanje pri nas še poslabšalo.

Pri nas se je pred leti zelo povečalo število prepelic in to tudi na kmetijsko močno intenziviranih površinah (lastna opazovanja) kljub temu, da se na teh površinah še naprej intenzivno kmetuje. Mogoče lahko za povečanje števila prepelic iščemo vzrok prav v prezimovalnem obdobju.

Iz navedenega lahko sklepamo, da za upad nekaterih vrst lahko iščemo vzroke tudi v prezimovalnem območju.

Globalno segrevanje ozračja - Global warming

Pod vplivom človeka se naše ozračje segreva, kar vodi v dolgoročne klimatske spremembe. Tako se je od leta 1860 do danes povprečna temperatura dvignila za 0,7oC, v istem obdobju pa se je velikost ledenikov v Alpah zmanjšala za polovico (Enquete Commission of the German Bundestag 1992). Domneva se, da se bo v prihodnje ozračje segrevalo še bolj, v povprečju za 0,3 °C vsakih deset let (Houghton et al. 1990 v Huntley 1995). V kolikor se bo ozračje še naprej segrevalo s tako stopnjo kot do sedaj, lahko pričakujemo, da bo čez okrog sto let povprečna temperatura višja celo do 5 °C (Leatherman 1991, Enquete Commission of the German Bundestag 1992). Takšen dvig temperature pa lahko med drugim vpliva na dvig gladine morja, spremembo padavin in na naravne ekosisteme (npr. sprememba vegetacije). Ugotovljeno je bilo, da če dvig temperature za dobro stopinjo pomeni "prestavitev" vegetacijskega pasu za okrog 200 km (Enquete Commission of the German Bundestag 1992).

Vpliv globalnega segrevanja ozračja na ptice se najprej pokaže pri vrstah, ki so na robu določenega areala. Pri nas si glede tega vprašanja posebno pozornost zaslužijo tako imenovani glacialni relikti. V to skupino sodijo arktične, gorske in stepske vrste (Tyrberg 1991). Tipična takšna primera sta pri nas triprsti detel *Picoides tridactylus* in belka *Lagopus mutus*. Belka pri nas gnezdi le v najvišjih predelih Alp, triprsti detel pa v iglastih gozdovih (Geister 1995). Še pred sto petdesetimi leti je belka živela tudi na Pohorju (Reiser 1925), danes pa je na Pohorju ni več najti (Geister 1995, lastna opazovanja). Belka v današnjem času najnižje gnezdi na nadmorski višini 1650 m (Geister 1995). Z segrevanjem ozračja se vrste, ki jim je temperatura omejujoč faktor, umikajo na sever ali pa v višje lege. Izginotje belke s Pohorja bi torej lahko pripisali tudi klimatskim spremembam. Dolgoročno gledano lahko sklepamo, da bo belka iz naših gora izginila čez približno 80 let, če se bo segrevanje ozračja nadaljevalo v takšni meri kot do sedaj. Podobno izumiranje grozi tudi triprstemu detlu. V njegov življenjski prostor vse pogosteje vdira veliki detel *Dendrocopus major* (lastna opazovanja), ki je večji, močnejši in agresivnejši. Vzrok za naseljevanje velikega detla v strnjene sestoje iglavcev (poleg prilagoditve in intenzivne sečnje) je mogoče iskati tudi v otoplitvi ozračja.

Segrevanje ozračja lahko pripomore tudi k širjenju vrst. Takšen primer je verjetno svilnica *Cettia cetti*, ki se je s kontinenta razširila v Veliko Britanijo, kjer še pred tridesetimi leti ni gnezdila (Cramp 1992). Podobno velja tudi za nekatere druge vrste, ki širijo areal na sever (Thomas & Lennon 1999).

Podobno globalno segrevanje ozračja vpliva tudi na zimovalce. Vzemimo za primer beločelo gos *Anser albifrons*, ki je pred dvajsetimi leti množično prezimovala na Ormoškem jezeru (Sovinc 1994, lastna opazovanja), sedaj pa je pri nas le še redek zimski gost. V sedemdesetih in osemdesetih letih je beločela gos množično prezimovala tudi v drugih srednjeevrop-

Slika 3. *Samica pogorelčka Phoenicurus phoenicurus. Foto: Milan Vogrin*
Figure 3. *Female Common Redstart Phoenicurus phoenicurus. Photo: Milan Vogrin*

skih državah, v devedesetih letih pa je prišlo do občutnega upada (Mooij 1996). Istočasno se je povečala zimska populacija te vrste v severnejšem delu Evrope (Mooij 1996, Žalakevičius & Švažas 1997). Razlog za to so lahko prav klimatske spremembe, ki lahko vplivajo tudi na selitvene poti posameznih vrst (Žalakevičius & Švažas 1997).

Plenjenje - Predation

Na nekatere še po naravi redke vrste oziroma tiste, ki so omejene z neko naravno danostjo (npr. beločeli deževnik Charadrius alexandrius, ki pri nas gnezdi samo na nekaj mestih ob obali), lahko usodno vpliva tudi povečanje števila plenilcev, npr. zveri (kune, podlasice, lisice), ki so običajno posledica porušenega naravnega ravnotežja. Povečano plenjenje, ki je prisotno predvsem pri talnih gnezdilkah in prostognezdilkah, je bilo ugotovljeno, ko je bila gostota malih sesalcev (običajnega plena za male zveri) zelo nizka (npr. J‰rvinen 1985, Sorensen et al. 1990, Dunn 1997). Vpliv plenjenja na gnezditveni uspeh je dobro proučen pri kurah. S poizkusi je bilo ugotovljeno, da se število gnezdečih kur (v tem primeru ruševca *Lyrurus tetrix* in divjega petelina *Tetrao urogallus*) poveča po odstranitvi plenilcev (npr. Marcstr̂m et al. 1988).

Plenilci lahko močno ogrozijo tudi kolonialne gnezdilke, pri nas recimo ogroženo navadno čigro *Sterna hirundo* in malo čigro *Sterna albifrons*, posebej še, ker so si plenilci sposobni zapomniti določen vzorec ("search image") (Martin 1988, Hogstad 1983, Hogstad 1995). Podoben primer, ki je imel katastrofalne posledice za lokalno populacijo navadne postovke *Falco tinnunculus*, se je pri nas zgodil v Sečoveljskih solinah (Lipej 1993).

Dodati je še potrebno, da tako imenovane male zveri pričnejo s plenjenjem alternativnega plena, ko nenadoma upade število njihovega glavnega plena - malih sesalcev (Erlinge 1981, Hogstad 1995). Vrstna pestrost malih sesalcev je npr. na monokulturnih poljih sredi Dravskega polja nizka (Šorgo 1991), plenjenje med gnezdečimi vrstami na poljih pa je veliko (Vogrin 1998, lastna opazovanja).

Seveda pa je potrebno povedati, da plenjenje ne more povzročiti globalne ogroženosti (razen v izjemno redkih primerih, glej npr. Clout & Craig (1995), Day & Daltry (1996), pa še v teh primerih gre običajno za priseljene plenilce), v večini primerov gre le za lokalno ogroženost določene vrste.

Fragmentacija habitatov - Habitat fragmentation

Številne vrste močno prizadene tudi fragmentacija, dokazano je bilo, da so le redke vrste, ki zasedejo mokriščni habitat, ki meri manj kot 6 ha (Opdam et al. 1995). Fragmentacija močno prizadane tudi gozdne vrste, npr. črno žolno *Dryocopus martius*, triprstega in belohrbtega detla *Dendrocopus leucotos*, pogorelčka, brgleza S*itta europaea*,... (Helle 1985, Cieslak 1994, Opdam et al. 1993).

Fragmentacija na ptice negativno vpliva tudi posredno, s fragmentacijo upada številnost in pestrost žuželk, glavne hrane žužkojedih vrst (Roland 1993). V manjših izoliranih gozdičkih je tudi plenjenje večje (zbrano v: Wiens 1995).

Tudi gozdne kure (divji petelin, ruševec, gozdni jereb *Tetrastes bonasia*) so po eni strani ogrožene zaradi fragmentacije gozdov, po drugi strani pa zaradi različnih goličav, kjer se kure prehranjujejo in jih uporabljajo za rastišča. Zanemariti pa ne gre tudi vpliva kislega dežja, ki na kure lahko vpliva posredno in neposredno (Klaus 1991, Spidso & Korsmo 1993).

Med gozdnimi vrstami so najbolj ogrožene tiste, ki naseljujejo dva sukcesijska stadija, to so poseke, resave in podobne goličave, ki jih zasedajo predvsem selivke (Mˆnkkˆnen et al. 1992), ter zrele gozdove - pragozdove. Podobno je bilo ugotovljeno tudi za nevretenčarje (Thomas 1995). V prvo skupino ptic bi lahko šteli hribskega škrjanca, v drugo skupino pa recimo nekatere primarne duplarje. Različne goličave se pri nas vse bolj zaraščajo, posebej problematično je stanje npr. na krasu (npr. Vogrin 1996). Nekatere vrste, kot je npr. vijeglavka *Jynx torquilla* so v tem pogledu dvakrat ogrožene, prvič zaradi gnezdišča (duplar), drugič pa zaradi prehrane, ki si jo iščejo na goličavah. Če k temu dodamo še, da je vijeglavka transsaharska selivka, lahko z zanesljivostjo napovemo, da bo postala vedno bolj ogrožena (ne samo pri nas). Pri ogroženosti vrst, ki naseljujejo omenjena stadija, velja primerjavo izvajati tudi z nevretenčarji, npr. metulji (Thomas 1995).

Intenzivno kmetijstvo - Intensive agriculture

Intenzivno kmetijstvo na vrste ne vpliva le neposredno (npr. mehansko uničevanje, uničevanje življenjskih prostorov) temveč tudi posredno. Vrste, ki naseljujejo kmetijske površine, trpijo tudi zaradi pomanjkanja hrane. Intenzivna uporaba pesticidov zmanjša količino nevretenčarjev, ki so pomembna hrana za npr. mladiče jerebice *Perdix perdix* in poljskega škrjanca *Alauda arvensis* (Blank et al. 1967, Schlapfer 1988, Jenny 1990, Potts & Aebischer1995, Poulsen 1996).

Zaključek

Za nekatere vrste je vzrok ogrožanja potrebno iskati tudi v prezimovalnem območju, za določene vrste pa bi lahko kot vzrok ogrožanja navedli tudi globalno segrevanje ozračja, kar lahko ima posebno velik vpliv na vrste, ki so na robu areala, in pa na glacialne relikte.

Domnevamo lahko, da so najbolj ogrožene tiste vrste, ki sodijo v dve ali celo tri zgoraj oblikovane skupine. To velja tako za vrste, ki so še na rdečem seznamu, kakor tudi za tiste, ki jih na seznamu (še) ni. S takšno analizo lahko zelo zagotovo napovemo, da bodo določene vrste na rdečem seznamu npr. mala in navadna čigra, čebelar, mala bobnarica, breguljka, mali martinec, podhujka, trstnice, cvrčalci,... po kategorijah samo še napredovale navzgor, torej prešle v višjo kategorijo ogroženosti.

Literatura

Biadun, W. 1994: The breeding avifauna of the parks and cemeteries of Lublin (SE Poland). Acta Ornithologica 29: 1-13.

Bibby, C.J. 1992: Conservation of migrants on their breeding grounds. Ibis 134 (Supplement 1): 29-34.

Bračko, F., Sovinc, A., Štumberger, B., Trontelj, P. & Vogrin, M. 1994: Rdeči seznam ogroženih ptic gnezdilk Slovenije. *Acrocephalus* 15: 166-180.

Blank, T.H., Southwood, T.R.E. & Cross, D.J. 1967: The ecology of patridge I. Outline of population processes with particular reference to chick mortality and nest density. Journal of Animal Ecology 36: 549-556.

Cave, A.J. 1983: Purple Heron survival and drought in tropicsl West Africa. Ardea 71: 217-224.

Cieslak, M. 1994: The vulnerability of breeding birds to forest fragmentation. Acta Ornithologica 29: 29-38.

Clout, N.M. & Craig, L.J. 1995: The conservation of critically endangered flightless birds in New Zealand. Ibis (Supplement 1) 137: 181-190.

Cramp, S. (ured.) 1977: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 1. Oxford University Press, New York.

Cramp, S. & Simmons, K.E.L. (ured.) 1983: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 3. Oxford University Press, New York.

Cramp, S. & Simmons, K.E.L. (ured.) 1988: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 5. Oxford University Press, New York.

Cramp, S. (ured.) 1992: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 6. Oxford University Press, New York.

Cramp, S. & Perrins, C.M. (ured.) 1993: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 7. Oxford University Press, New York.

Cramp, S. & Perrins, C.M. (ured.) 1994a: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 8. Oxford University Press, New York.

Cramp, S. & Perrins, C.M. (ured.) 1994b: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 9. Oxford University Press, New York.

Day, M. & Daltry, J. 1996: Antiguan Racer conservation project. Fauna & Flora news 5: 6.

Dunn, E.K. 1997: Predation by Weasels (Mustela nivalis) on breeding tits (Parus spp.) in relation to the density of tits and rodents. Journal of Animal Ecology 46:633-652.

Enquete Commission of the German Bundestag 1992: Climate Change - A threat to Global Development. Economica Verlag. Verlag C.F. Müller.

Geister, I. 1995: Ornitološki atlas Slovenije. DZS.

Helle, P. 1985: Effects of forest fragmentation on bird densities in northern boreal forests. Ornis Fennica 62: 35-41.

Hogstad, O. 1983: Is nest predation really selecting for colonial breeding among Fieldfares Turdus pilaris? Ibis 125: 366-369.

Hogstad, O. 1995: Do avian and mammalian nest predators select for different nest dispersion patterns of Fieldfares Turdus pilaris? A 15-year study. Ibis 137: 484-489.

Huntley, B. 1995: Plant species' response to climate change: implications for the consevartion of European birds. Ibis (Supplement 1): 127-138.

Järvinen, A. 1985: Predation causing extended low densities in microtine cycles: Implications from predation on hole-nesting passerines. Oikos 45: 157-158.

Jenny, M. 1990: Nahrungsökologie der Feldlerche Alauda arvensis in einer intensiv genutzen Agrarlandschaft des schweuzerischen Mittellands. Ornithologishe Beobachter 87: 31-53.

Kanyamibwa, S., Schierer, A., Pradel, R. & Lebreton, J.D. 1990: Changes in adult annual survival rates in a western European population of the White Stork (Ciconia ciconia). Ibis 132: 27-35.

Klaus, S. 1991: Effects of forestry on grouse populations: Case studies from the Thuringian and Bohemian forests, Central Europe. Ornis Scandinavica 22: 218-223.

Kooiker, G. 1994: Struktur und Quantität einer urbanen Avifauna am Beispiel der Grossstadt Osnabrück. Acta ornithoecologica 3: 73-96.

Leatherman, S.P. 1991: Impact of climate induced sea level rise on coastal areas. V: Wyman, R.L. (ured.): Global climate change and life on earth. Chapman and Hall, New York: 170-179.

Lipej, L. 1993: Status in ogroženost gnezditvene populacije navadne postovke (Falco tinnunculus) na Sečoveljskih solinah. Annales - Anali Koprskega primorja in bližnjih krajev 3: 29-36.

Luniak, M. 1980: Birds of allotment gardens in Warsaw. Acta Ornithologica 17: 297-319.

Luniak, M. 1981: The birds of the park habitats in Warsaw. Acta Ornithologica 18: 335-372.

Marcström, V., Kenward, R.E. & Engren, E. 1988: The impact of predation on boreal tetraonids during vole cycles: An experimental study. Journal of Animal Ecology 57: 859-872.

Martin, T.E. 1988: Processes organizing open-nesting bird assemblages: Competition or nest predation? Evol. Ecol. 2: 37-50.

Moller, A.P. 1989: Population dynamics of a declining swallow Hirundo rustica population. Journal of Animal Ecology 58: 1051-1063.

Mooij, H.J. 1996: Winter distribution and population size of Whitefronted Geese in the Western Palearctic. Wetlands International Goose Specialist Group Bulletin 8: 13-21.

MönkkÖnen, M., Helle, P., Welsh, D. 1992: Perspectives on Palaearctic and Nearctic bird migration; comparisons and overview of life-history and ecology of migrant passerines. Ibis (Supplement 1): 134: 7-13.

Morel, G.J., Morel, Y.M. 1992: Habitat use by Palaearctic migrant passerine birds in West Africa. Ibis (Supplement 1) 134: 83-88.

Newton, I. 1995: Relationship between breeding and wintering ranges in Palearctic-African migrants. Ibis 137: 241-249.

Opdam, P., Apeldoorn, Van R., Schotman, A., Kalkhoven, J. 1993: Population responses to landscape fragmentation. V: Vos, C.C. & Opdam, P. (ured.). Landscape Ecology of a stressed Environment. Chapman and Hall, London: 147-171.

Opdam, P., Foppen, R., Reijnen, R., Schotman, A. 1995: The landscape ecological approach in bird conservation: integrating the metapopulation concept into spatial planning. Ibis (Spupplement 1) 137: 139-146.

Peach, W.J., Baillie, S.R. & Underhill, L. 1991: Survival of British Sedge Warblers (*Acrocephalus* schoenobaenus) in relation to West African rainfall. Ibis 133: 300-305.

Pearson, J.D. & Lack, C. P. 1992: Migration patterns and habitat use by passerine and near-passerine migrant birds in eastern Africa. Ibis (Supplement 1) 134: 89-98.

Poulsen, G.J. 1996: Behaviour and parental care of Skylark Alauda arvensis chicks. Ibis 138: 525-531.

Potts, G.R., Aebischer, J.N. 1995: Population dynamics of the Grey Partridge Perdix perdix 1793-1993: monitoring, modelling and management. Ibis (Supplement 1) 137: 29-37.

Roland, J. 1993: Large-scale forest fragmentation increases the duration of tent caterpillar outbreak. Oecologia 93: 25-30.

Schlapfer, A. 1988: Populationsökologie der Feldlerche Alauda arvensis in der intensiv genutzten Agrarlandschaft. Ornithologishe Beobachter 85: 309-371.

Sorensen, O.J., Hagvar, S. & Lund, E. 1990: Nest-box studies on hole-nesting passerines in spruce forest. II. Reproductivesuccess in the Pied Flycatcher Ficedula hypoleuca. Fauna Norv. Ser. C, Cinclus 13: 42-46.

Sovinc, A. 1994: Zimski ornitološki atlas Slovenije. Tehniška založba Slovenije.

Spidso, T.K. & Korsmo, H. 1993: Effect of acid rain on pine needles as food for capercaillie in winter. Oecologia 94: 565-570.

Svensson, S.E. 1985: Effects of changes in tropical environments on the North European avifauna. Ornis Fennica 62: 56-63.

Szep, T. 1995: Relationship between west African rainfall and the survival of central European Sand Martins Riparia riparia. Ibis 137: 162-138.

Šorgo, A. 1991: Mali sesalci gramoznic na Dravskem polju. Mavrični bojevnik: 9-11.

Thomas, J.A. 1995: Why small cold-blooded insects pose different conservation problems to birds in modern landscapes. Ibis (Supplement 1) 137: 112-119.

Thomas, C.D. & Lennon, J.J. 1999: Birds extend their ranges nortwards. Nature 399: 213.

Tomialojć, L., Wesolowski, T. & Walankiewicz, W. 1984: Breeding bird community of a primaeval temperate forest (Bialowieza National Park, Poland). Acta Ornithologica 20: 241-310.

Tomialojć, L. & Wesolowski, T. 1990: Bird communities of the primaeval temperate forest of Bialowieza, Poland. V: Keast, A. (ured.). Biogeography and ecology of forest bird communities. SPB Academic Publishing bv, The Hague: 141-165.

Tyrberg, T. 1991: Arctic, Montane and Steppe birds as Glacial relicts in the West Palearctic. Ornithologische Verhandlungen 25: 29-49.

Vogrin, M. 1998: Gnezditev pribe Vanellus vanellus na Dravskem polju. *Acrocephalus* 86: 14-20.

Vogrin, N. 1996: Zaraščanje Krasa - zmanjševanje biotske raznovrstnosti? Proteus 58: 402-405.

Wiens, A.J. 1995: Habitat fragmentation: island v landscape perspectives on bird conservation. Ibis (Supplement 1) 137: 97-104.

Winstanley, D., Spencer, R. & Williamson, K. 1974: Where have all the whitethroats gone? Bird Study 21: 1-14.

Žalakevičius, M. & Švažas, S. 1997: The impact of global climate change on wildlife in Lithuania: theoretical and practical aspects. Acta Zoologica Lituanica, Ornithologia 6: 14-19.

Tabela 1. Razdelitev vrst iz Rdečega seznama ogroženih ptic gnezdilk (glede na gnezdišče (PD - primarni duplar, D - sekundarni duplar, P - prosta gnezdilka, T - talna gnezdilka), prehrano (I - vrsta se prehranjuje pretežno z nevretenčarji (žužkojed), C- vrsta se prehranjuje pretežno z vretenčarji (karnivor), O - vsejed, H - rastlinojed in/ali, semenojed) in status (S - stalnica, TS - transsaharska selivka, K - klatež).
Rdeči seznam: Ex? - avtohtona populacija iztrebljena ali izginula, vendar so v zadnjih 20tih letih znani primeri gnezdenja ali poskusa gnezditve, E1 - vrsta, ki ji grozi izginotje, E2 -. močno ogrožena vrsta, V - ogrožena vrsta, R - potencialno ogrožena vrsta.

Table 1. Clasification of species from Red List of endangered breeding birds according to feeding, nesting and migratory habits:
PD - primary hole breeders (exavators), D - secondary hole breeders, P- open nest breeders, T -ground breeders, I - insectivorous, C- carnivorous, O - omnivorous, H - herbivorous, S - resident, TS - tropical migrants, K - short distance migrant.
Red List: Ex? - the autochthonous population exterminated or missing, but some cases of their breeding or breeding attempts reported in the last 20 years, E1 - species threatened with their total disappearance, E2 - very endangered species, V - endangered species, R - potentially endangered species.

Vrsta/ Species	Status/ Migratory habits	Prehrana/ Feedings habits	Gnezdišče/ Nesting habits
	Ex?		
Burhinus oedicnemus	K	I	T
Lanius senator	TS	I	P
Melanocorypha calandra	S	O	T
Anthus pratensis	K	I	T
Oenanthe hispanica	TS	I	T
Corvus frugilegus	S	O	P
Emberiza melanocephala	TS	O	T
	E1		
Botaurus stellaris	K	C	T
Nycticorax nycticorax	TS	C	P
Haliaetus albicilla	S	C	P
Aquila pomarina	TS	C	P
Himantopus himantopus	TS	I	T
Numenius arquata	K	I	T
Sterna albifrons	TS	C	T
Merops apiaster	TS	C	T

Coracias garrulus	TS	I	D
Falco naumanni	TS	I	P
Lanius minor	TS	I	P
	E2		
Podiceps grisegena	S	C	T
Ixobrychus minutus	TS	C	T
Anas clypeata	K	O	T
Anas crecca	S	O	T
Anas querquedula	TS	O	T
Aythya ferina	S	O	T
Aythya nyroca	K	O	T
Circaetus gallicus	TS	C	P
Milvus migrans	TS	C	P
Porzana porzana	TS	O	T
Porzana parva	TS	O	T
Charadrius alexandrinus	K	I	T
Tringa totanus	K	I	T
Gallinago gallinago	K	I	T
Sterna hirundo	TS	C	T
Riparia riparia	TS	I	T
Cettia cetti	S	I	T
Cisticola juncidis	S	I	T
Locustella luscinoides	TS	I	T
Acrocephalus melanopogon	K	I	T
Ciconia ciconia	TS	C	P
Alectoris graeca	S	O	T
Columba livia	S	H	D
Columba oenas	K	H	D
Dendrocopus medius	S	I	PD
Lullula arborea	K	O	T
Anthus campestris	TS	I	T
Emberiza hortulana	TS	O	T
Falco peregrinus	S	C	P
Rallus aquaticus	K	O	T
Crex crex	TS	O	T
Actitis hypoleucos	TS	I	T
Tyto alba	S	C	D
Otus scops	TS	I	D
Bubo bubo	S	C	D
Athene noctua	S	C	D
Alcedo atthis	S	C	T
Upupa epops	TS	I	D
Caprimulgus europaeus	TS	I	T

Phoenicurus phoenicurus	TS	I	D
Saxicola rubetra	TS	I	T
Acrocephalus arundinaceus	TS	I	T
	V		
Ciconia nigra	TS	C	P
Aquila chrysaetos	S	C	P
Scolopax rusticola	K	I	T
Larus ridibundus	S	O	T
Dendrocopus leucotos	S	O	PD
Dendrocopus lilfordi	S	O	PD
Acrocephalus scirpaceus	TS	I	T
Acrocephalus schoenobaenus	TS	I	T
Ficedula parva	TS	I	D
Emberiza schoeniclus	S	O	T
Lyrurus tetrix	S	O	T
Tetrao urogallus	S	O	T
Lagopus mutus	S	O	T
Glaucidium passerinum	S	C	D
Aegolius funereus	S	C	D
Strix uralensis	S	C	D
Motacilla flava	TS	I	T
Cinclus cinclus	S	I	T
Monticola saxatilis	TS	I	T
Sylvia nisoria	TS	I	T
Locustella naevia	TS	I	T
Locustella fluviatilis	TS	I	T
Ficedula albicollis	TS	I	D
Remiz pendulinus	K	O	P
Pernis apivorus	TS	I	P
Accipiter nisus	S	C	P
Accipiter gentilis	S	C	P
Falco tinnunculus	S	C	P
Falco subbuteo	TS	C	P
Tetrastes bonasia	S	O	T
Perdix perdix	S	O	T
Coturnix coturnix	TS	O	T
Charadrius dubius	TS	I	T
Streptopelia turtur	TS	H	P
Jynx torquilla	TS	I	D
Picus canus	S	I	PD
Picus viridis	S	I	PD
Dendrocopus minor	S	I	PD
Picoides tridactylus	S	I	PD

Galerida cristata	S	O	T
Sylvia communis	TS	I	T
Emberiza calandra	K	O	T
R			
Mergus merganser	S	C	D
Larus cachinnans	S	O	T
Dendrocopus syriacus	S	O	PD
Monticola solitarius	K	I	D
Sylvia cantillans	TS	O	T
Sylvia melanocephala	K	O	T
Tichodroma muraria	S	I	D
Corvus corone	S	O	P
Carpodacus erythrinus	TS	H	T
Podiceps cristatus	S	C	T
Ardea cinerea	S	C	P
Aythya fuligula	S	O	T
Dendrocopus martius	S	I	PD
Alauda arvensis	K	O	T
Sylvia borin	TS	I	T
Lanius collurio	TS	I	P
Limosa limosa	TS	I	T
Tringa ochropus	K	I	P
Hirundo daurica	TS	I	P
Sturnus roseus	TS	O	D

Unusual coloration of the Black Stork Ciconia nigra

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Received 10 October 2000; accepted 5 December 2000

Introduction

Black Stork *Ciconia nigra* is distributed from Central Europe and the Balkans east across central Eurasia to the Pacific (e.g. Cramp & Simmons 1977). It breeds in forested areas with wet meadows, rivers and marshes, and migrates singly or in small flocks. Like other storks, it prefers to use thermals while migrating. The coloration of feathers is mostly black with a green and purple gloss. On the underparts, belly and undertail coverts are white. Bill and legs are red. Juveniles resembles adults, but are drabber and browner (van den Bossche & Jadoul 1998).

In this note we describe the unusual coloration of the Black Stork.

Observations

On 20th August 2000, the first author visited, with other observers, the Lonjsko polje (Lonja field) in Croatia, about 100 km south-east of Zagreb. The weather was very hot, reaching 40oC. The Lonjsko polje is the flood plain of the rivers Sava and Lonja of about 11,500 ha (see Schneider 1988). This complex contains alluvial forests, meadows, pastures, oxbows, rivers and streams. In this area about 70 pairs of Black Stork breed (Schneider 1988, Schneider-Jacoby 1999).

In the vicinity of oxbow Krapje Đol near the village of Drenov Bok (approximately 5 km west of Jasenovac) we observed 7 Black Storks soaring above meadows about 200 m above us. I took some pictures of the storks and then we went further to the oxbow, which is a protected ornithological reserve. In less than one minute, I saw another Black Stork soaring alone about 100 metres

***Figure 1.** Black Stork* Coconia nigra *with white tail feathers, 20th August 2000, Lonjsko polje (Croatia). Photo: Milan Vogrin*

from the previous group. I checked the bird with binoculars and found, to my surprise, that it had white tail feathers (Figure 1). The stork was an adult bird, and was the same as normal Black Storks in the vicinity, except the tail. The tail was completely white, except the central tail feathers, which were black. After a few minutes of observation, all storks disappeared in a northerly direction.

Other observations of Black Storks with white tails have taken place in Belovezskaja Puszcza National Park, Belarus. Belove?skaja Puszcza is a forest in Poland and Belarus, ca. 1500 km^2 in size, with exceptionally preserved old trees and many wet areas. The breeding population of the Black Stork in Poland is 34 pairs (Pugacewicz 1997) and 10-20 pairs in Belarus (N.Czerkas, pers.comm., probably much more).

On 28th April 2000, in the area of Balota Glybokae, J.D. A.Go?awski, K.Lasocki and N.Czerkas saw two Black Storks, one with a white tail and another with a normal black tail. At a small distance and in comparison with a normal bird, it was evident that the outer retrices were indeed white, not stained with faeces or obscured by fluffed undertail coverts. Long undertail coverts extended over the central retrices (main tail feathers), but they appeared as white and semi-transparent as the outer tail. Both birds were adults and soared close together for several minutes low over the edge of old forest and open marsh. Judging from this behaviour, it was probably a pair circling over territory. On 29th April 2000, several km from the location of the previous observation, a single adult Black Stork with a white tail was seen in flight. It could be either the same, or a different individual.

There are two previous records of white-tailed Black Storks, with and without black central tail feathers, from Babuna Gorge, former Yugoslavia and Greece (Olsson, Asterling & Larsson 1980). It was suggested, however, that the white appearance of the tail was caused by billowing out white undertail coverts or faeces-staining (Ryder & Ryder and comment by Harvey 1982). We found no records of other unusual coloration of Black Storks in the literature.

References

Bossche van den, W. & Jadoul, G. 1998: Ageing of White Stork and Black Stork. Birding World 11: 195-199.

Cramp, S. & Simmons, K.E.L., (eds.) 1977: The Birds of the Western Palearctic. Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 1. Oxford University Press, New York.

OLSSON, J., ASTERLING, R. & LARSSON, L. 1980: White-tailed Black Storks. British Birds 73:10.

PUGACEWICZ, E. (1997): [Breeding Birds of the Bia?owie?a Forest.] Pó?nocnopodlaskie Towarzystwo Ochrony Ptaków, Bia?owie?a.

RYDER, J.H. & RYDER., B.A. 1982. White-tailed Black Storks. British Birds 75: 93.

SCHNEIDER, M. 1988: Endangered and rare birds in the alluvial wetlands of the Sava river on the Posavina/Croatia. Larus 40: 167-178.

Schneider-Jacoby, M. 1999: Breeding distribution and ecology of the Black Stork Ciconia nigra in the Sava alluvial wetlands, Croatia. Acrocephalus 20: 167-176.

Methods for surveying Tawny Owl Strix aluco populations in large areas

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Abstract
The playback method has been widely used during the breeding season to perform vocal experiments with the Tawny Owl, but it has not been used to census large areas without previous knowledge of the possible location of the territories. In this paper we compare the efficiency of two methods, namely, listening to spontaneous vocalisations and using a playback to elicit responses from the owls, to census the tawny owl in Bizkaia (N of Spain) over an area of 2348 km^2. We found 1704 occupied territories in a three year period. The playback method yielded more territories than the spontaneous calls method every month of the year. Seventy nine percent of the population would have gone unnoticed if census had been performed without playback. The overall pattern of male vocalisations included male numbers responding to playback equally all year round, males initiating the response in first place, especially in the courtship period, and turning to harsh voices during courtship and laying. The overall pattern for females included a seasonal effect on the number of females detected, and females delivering harsh voices when nestlings leave the nest and in the autumn territorial period.

Key words: Tawny Owls, Strix aluco, playback method, large areas Spain

Received 15 September 2000; accepted 15 November 2000

INTRODUCTION

The songs of many bird species are sexual signals that convey information on individual qualities that play a relevant role in advertising territory ownership and mate attraction (Galeotti & Pavan 1993, Catchpole & Slater 1995, Otter, 1996; Appleby & Redpath 1997, Galeotti et al., 1997; Galeotti 1998). When hearing an intruder, birds of either sex usually react by delivering territorial vocalisations. Accordingly, several studies have relied on the use of elicited calls to systematically obtain data on the relative abundance of owls (Sará & Zanca 1989, Proudfoot & Beasom, 1996; Zuberogoitia & Campos 1997, Manganaro et al. 1999, SEO/BirdLife 1999, Ranazzi et al. 2000, among others). This technique has been used to determine several aspects of the ecology of the Tawny Owl *Strix aluco* such as sex-specific responses (Appleby et al. 1999), correlates of hoot rate and structure of the vocalisations (Galeotti 1998) and individual recognition (Galeotti & Pavan 1991). Most studies are performed during the pre-breeding and breeding seasons, taking account of the fact that tawny owls aggressively defend the vicinity of their nests. However, the playback method has rarely been used to census large areas over long periods of time, i.e., without previous knowledge of the actual location of the nests (but see Galeotti, 1990; Redpath, 1994; Zuberogoitia & Campos 1997). Thus, its suitability as a census tool has not been thoroughly evaluated.

The objectives of this study were: (1) to test the efficiency of the playback method versus the listening to spontaneous calls method in a large area over a long period of time and without previous knowledge of the location of the nests and (2) to describe the effect of sex and season on the response of the owls.

STUDY AREA

The study area was the province of Biscay (N of Spain). The terrain is rugged, with altitudes ranging up to 1,481 m above sea level, and part of the surface of this densely populated and industrialised province (2348 km^2) is covered by woods and pastures. Streams are short and fast, and valleys narrow and incised. Most salt marshes formed at the outlet of the main rivers are highly degraded, as is the riparian vegetation, especially along the medium and lower water courses. The vegetation was modified long ago and today the lowlands are covered by pine and eucalyptus plantations, and the mountain tops by rough pasture. Most of the native forest has long been cleared, although some beech forests remain on steep mountain slopes (see Loidi 1987).

Moist NW Atlantic winds prevail. The climate is consequently humid with regular rainfall throughout the year, ranging from 1,000 mm on the coast to 1,900 mm in the mountains. A branch of the Gulf Stream, with an annual thermal oscillation of 11 to 12°C, results in mild temperatures.

METHODS

Between 30/12/93 and 29/12/96 we conducted 1408 different counts (counting stations) on 222 different nights (mean of 5 h/night) as part of a long term population study on Strigiformes (Zuberogoitia & Campos 1998). The census activity began at dusk. The sampled points were at intervals, in different sites that were close to each other, so that the cry of owls demarking territories could be heard. These points were separated 500 m on flat lands, and between 500 and 1000 m on censusing mountains. We usually played the tape at the highest sites of mountains and hills to better hear the responses of owls. Counts were performed under different weather conditions, and were only interrupted under extremely inclement weather. When owls did not respond to the playback as expected, we came back to the same place as many times as needed (2-3 times more, on some occasions 4 times) to ascertain the presence / absence of owls (Zuberogoitia & Campos, 1998).

Each experimental visit consisted of two phases:

Spontaneous Calls period (SC): Starting at dusk, we recorded the presence or absence of hooting tawny owls, male or female, that would call spontaneously at each counting station for a period of 5 minutes.

Playback period (PB): Immediately after the SC period, duetting male and female calls were broadcast for 5 minutes. Prior to the census period we performed several trials with tapes with different combinations of voices. Actually, male tawny owls defend against intruders of either sex but females are not defensive toward males when they intrude into their territories (Galeotti et al., 1997). Nevertheless, females defend their territories against other females. In the same periods and under the same weather conditions, owls were more likely to respond in pairs than alone to tapes with duetting male and female voices. Thus, since our goal was to obtain a good estimate of the actual owl population, we used the above mentioned tape. In this period we recorded the presence or absence of calling tawny owls, and determined which sex of a pair initiated the response to the playback.

Both in SC and PB periods, territories were coded as 1 when a tawny owl was detected, regardless of the sex of the owl, and as 0 when no owls were recorded.

The response of the owls was classified according to the degree of agonistic intensity. Increasingly distressed male tawny owls can turn their normally pure territorial hoot into a harsher female-like call (Galeotti 1998) that still retains the same 3 note structure typical of males (Galeotti 1998; personal observation), thus allowing for sex recognition. Distressed females yielded extra harsh vocalisations, distinguishable because of their noticeable "anxious staccato" quality. It is interesting to recall at this point that subjective assessment of the Tawny Owl's voice quality has been widely and successfully used for several purposes elsewhere (Southern 1970; Galeotti 1990). We recorded the number of males and females that responded with the harsh territorial hoot.

We pooled data from 3 different years, hoping to overrule possible biases due to variable weather conditions across the years. Nevertheless, according with Redpath (1994), there are not significant correlations between tawny owl response and weather conditions (Zuberogoitia & Campos, 1998).

Since data were not normally distributed we used non-parametric tests (Zar 1996). We made statistical comparisons using the Wilcoxon Signed Rank test (see Proudfoot and Beasom, 1996).

RESULTS

Sampling effort.

We did not find differences in the number of monthly survey days between months pooling the three years together (Chi-square = 9.027, n = 12, P > 0.5). However, there were differences in the number of counting stations conducted every month, pooling the three years together (Chi-square = 81.738, n = 12, P < 0.001). More counting stations were performed in March, June, July, August and October than in the rest of the year (Table 1). Differences were caused by severe weather conditions that imposed limits to the number of counts per night. This should not affect the results, since the minimum number of events recorded in the month with minimum sampling effort was as high as 75.

Spontaneous Calls technique versus Playback technique.

Figure 1 shows the number of territories found in each experimental period as grouped by month. We found a total of 1704 Tawny Owl territories in Bizkaia, and owl density was 0.72 territories/km^2.

We assessed the success of the two survey techniques by comparing the number of territories yielded in each period. We found differences in the number of territories between techniques (Wilcoxon Matched Pairs test, Z = -29.001, P < 0.001, n = 2187). We found a total number of 1587 territories with the playback method, and only 333 by listening to spontaneous vocalisations. We repeated the same analysis on a monthly basis, and we found differences in the number of territories yielded by each survey method (Wilcoxon Matched Pairs tests, Z = -3.059, P < 0.005, n = 12). The playback method yielded more territories than listening to spontaneous calls every month of the year.

We found differences in the number of individuals found between the SC and the PB periods according to the sex of the owl (males: Wilcoxon Matched Pairs test, Z = -24.100, P < 0.001, n = 1502; females: Wilcoxon Matched Pairs test, Z = -24.499, P = 0.001, n = 905).

The number of males that responded to playback did not vary between months (Chi-square = 11.6, n =12, P > 0.05), while there was a seasonal effect in the response of females (Chi-square = 20.55, n = 12, P < 0.05). The number of females that responded to playback was higher than expected by chance in July, August and October, and lower in January, February, March, and May.

Variations in the sex initiating the response

Overall, mated males were more likely to initiate the response to playback than mated females (Kruskal-Wallis

Test, Chi-square = 35.725, $P < 0.001$). We found seasonal differences in the order in which both members of a pair responded to the playback (Table 2). Males initiated the response more frequently than expected in January, February and March, while they responded less frequently in August, September and October (Chi-square = 24.0, n = 12, $P < 0.05$). Females initiated the response more frequently in April, May, June and July (Chi-square = 50.0, n = 12, $P < 0.001$).

Quality of the response

We found seasonal variations in the distribution of the harsh version of the territorial hoot of males in response to the intruder (Chi-square = 35.1, n = 12, $P < 0.001$), indicating seasonal changes in aggressive quality of the response. Males delivered the harsh version more often than expected in December, March, May and July. Females responded more frequently with harsh voices in spring, March, April, May and June, (Chi-square = 47.6, n = 12, $P < 0.001$), when the breeding season starts, than in the rest of the year. Laying of eggs started on March 24th during the study period (s.d. = 52.09, n = 126).

We tested if the presence of the mate had any effect on the quality of the response. Females turned to harsh voices when males were present more often than when they were on their own (Wilcoxon Matched Pairs test, Z = -2.514, $P < 0.05$). Such differences were not noticeable for males (Wilcoxon Matched Pairs test, Z = -1.330, $P > 0.05$). Females yielded harsh responses mainly in April, June, and July (Chi-square = 24.89, n = 12, $P < 0.05$) in the presence of their mates.

DISCUSSION

Southern (1970) found that Tawny Owls are highly territorial through the year, with a maximum of spontaneous vocal activity from February to May and August to October. Spontaneous manifestations of the Tawny Owl population in Bizkaia followed the same pattern, as they were highly territorial through the year.

Broadcasting of conspecific calls enhanced the detection of Tawny Owls, accordingly with other studies performed on elusive, secretive birds (Johnson et al. 1981, Marion et al. 1981, Mosher & Fuller 1996, Proudfoot & Beasom 1996, Zuberogoitia & Campos 1998). Tawny Owls in our study population responded to playback all year round. Indeed, the number of contacts yielded by the use of playback was higher than the number yielded by listening to spontaneous calls in every month. Seventy nine percent of the population would have gone unnoticed if the census had been conducted only by listening to spontaneous vocalisations. Redpath (1994) found that 90% of the responses to playback occurred in the first 15 minutes. Thus, it could be argued that even with the use of playback we could have not detected the whole of the population in Bizkaia. Most studies choose large time intervals because they are performed over short periods of time, traditionally during the breeding season. Our rationale was that the 5 minute period represented a good balance between time available for the project, resources, and surface to be surveyed (2348 km^2). It is advisable to optimise resources when performing census work.

Male response did not vary throughout the year but female response was higher from July to October than from January to May. A different pattern was observed for the Barn Owl Tyto alba in the same study area. The number of Barn Owls that responded to playback showed a strong decline in winter (Zuberogoitia & Campos 1998). The greater sensitivity of Barn Owls to weather conditions compared to Tawny Owls (see Taylor 1994, Zuberogoitia, 2000) could account for the differences in time and energy devoted to territorial defence in the study area between the two species.

The number of females that responded to playback was higher than expected in July, August and October, when nestlings abandon the nests and fly in the surrounding area, and less than expected in January, February, March and May, when laying occurs. In autumn, territory ownership is asserted by newcomers or reasserted by territorial birds (Southern 1970).

This would explain why more females were found in autumn than in spring. Female Tawny Owls can attack an intruder when it approaches the nest (Saurola 1995), and can also be extremely noisy while defending the vicinity of the nest, and thus detectable. Incubating females left their nest on several occasions to join hooting males at the territory boundary, and it is possible that territorial females prevent other females from settling (Rohner 1997). However, counting stations were not necessarily located close to the nests, and most of the females may have not considered the playback such a threat to their investment in breeding as to reveal their presence. This would explain the low number of females found during the breeding season.

We did not find differences between months in the number of males that responded to playback, indicating a lack of a seasonal pattern in male territorial behaviour. Thus, the number of contesting males was not a good estimator of the investment of males in defending their broods relative to their investment in territorial defence out of the breeding season. However, differences have been found in the type of voice delivered by season (Southern 1970, Redpath 1994) that may be better indicators of male investment. We found that mated males were more likely to initiate the response to playback during the onset of the breeding season (January, February and March), and they turned to harsh voices more than expected by chance in December, March, May and July. Mated females were more likely to initiate the response in April, May, June and July, and they increased the harshness of their voices in spring. This suggests that males took an more active role in territorial defence than females before and during laying. When owlets are out of the nest, it would be advantageous for the females to take over the defence because of their larger size compared to males, while the small male provides most of the food (see Mikkola 1983, Cramp 1985). This would explain the higher frequency of female harsh voices delivered in spring. This does not contradict the observation that Tawny Owl territorial defence is co-operative (Galeotti 1998, Appleby et al. 1999). In fact, females responded frequently with harsh voices when males were present in April, June and July.

Acknowledgements
Luca Salvati and an anonymous referee provided helpful comments for which we are appreciative. We thank Luisa Fernanda Campos, Julen Zuberogoitia, Fernando Ruiz, Lander Astorkia and Fernando Garitagoitia for their help in the field work. We thank Jose Antonio Donazar for his help in this and other papers.

REFERENCES

Appleby, B.M. & Redpath, S.M. 1997: Indicators of male quality in the hoots of Tawny Owls (Strix aluco). Journal of Raptor Research 31: 65-70.

Appleby, B.M., Yamaguchi, N., Johnson, P.J. & MacDonald, D.W. 1999: Sex-specific territorial responses in Tawny Owls Strix aluco. Ibis 141: 91-99.

Catchpole, C.K. & Slater, P.J.B. 1995: Bird Song. Biological Themes and Variations. Cambridge University Press, Cambridge.

CRAMP, S. (ed.). 1985: The Birds of the Western Paleartic. Vol. 4, Oxford University Press. Oxford.

Galeotti, P. & Pavan, G. 1991: Individual recognition of male Tawny Owl (Strix aluco) using spectograms of their territorial calls. Ethology, Ecology & Evolution 3: 113-126.

Galeotti, P. & Pavan, G. 1993: Differential responses of territorial Tawny Owls (Strix aluco) to the hooting of neighbourds and strangers. Ibis 135: 300-304.

Galeotti, P., Sacchi, R. & Perani, E. 1997: Cooperative defense and intrasexual aggression in Scops Owls (Otus scops): Responses to playback of male and female calls. Journal of Raptor Research 31: 353-357.

Galeotti, P. 1998: Correlates of hoot rate and structure in male Tawny Owls Strix aluco: implications for male rivalry and female mate choice. Journal of Avian Biology 29: 25-32.

Galeotti, P. 1990: Territorial behaviour and habitat selection in an urban population of the Tawny owl Strix aluco L. Bollettino di Zoologia 57: 59-66.

Hirons, G.J.M. 1985: The effects of territorial bahaviour on the stability and dispersion of Tawny Owl Strix aluco populations. Journal of Zoology, London 1B: 21-48.

Johnson, R.R., Brown, B.T., Haight, L.T. & Simson, J.M. 1981: Playback recordings as a pecial avian census technique. Studies In Avian Biology 6: 68-71.

Loidi, J. 1987: El País Vasco. In: Pinado-Lorca, M. & Rivas-Martínez, S. (eds). La vegetación de Espa?a.. Universidad de Alcalá de Henares. Madrid: 47-75

Maher, C.R. & Lott, D.F. 1995: Definitions of territoriality used in the study of variation in vertebrate spacing systems. Animal Behaviour 49: 1581-1597.

manganaro, a., pucci, l. & salvati, l. 1999. Notes on the Tawny Owl Strix aluco response to playback in three woods of central Italy. Avocetta 23:119.

Marion, W.R., O´Meara, T.E. & Maehr, D.S. 1981: Use of playback recordings in sampling elusive and secretive birds. Studies In Avian Biology 6: 81-85.

Mikkola, H. 1983: Owls of Europe. T. & A.D. Poyser.

Mosher, J.A. & Fuller, M.R. 1996: Surveying woodlands hawks with broadcasts of great horned owl vocalizations. Wildlife Society Bulletin 24: 531-536.

Otter, K. 1996: Individual variation in the advertising call of male Northern Saw-Whet owls. Journal of Field Ornithology 67: 398-405.

Proudfoot, G.A. & Beasom, S.L. 1996: Responsiveness of cactus ferruginous Pygmy-owls to broadcasted conspecific calls. Wildlife Society Bulletin 24: 294-297.

RANAZZI, L., MANGARANO, A., RANAZZI, R. & SALVATI, L. 2000.: Density, territory size, breeding success and diet of a Tawny Owl Strix aluco population in a Mediterranean Urban Area (Rome, Italy). Alauda 68: 133-143.

Redpath, S.M. 1994: Censusing Tawny Owls Strix aluco by the use of imitation calls. Bird Study 41: 192-198.

Rohner, C. 1997: Non-territorial "floaters" in great horned owls: space use during a cyclic peak of snowshoe hares. Animal Behaviour 53: 901-912.

Sará, M. & Zanca, L. 1989: Considerazioni sul censimento degli strigiformi. Rivista Italiana di Ornitologia 59: 3-16.

SEO/Birdlife. 1999. Seguimiento de Aves Nocturnas en Espana. Programa Noctua. Informe 1998. SEO/Birdlife, Madrid.

Saurola, P. 1995: Suomen Pöllöt. Hirjayhtymä Oy. Helsinki.

Southern, H.N. 1970: The natural control of a population of tawny owls (Strix aluco). Journal of Zoology, London 162: 197-285.

Taylor, I. 1994: Barn Owls. Predation-prey relationships and conservation. Cambridge University Press.

Zar, J.H. 1996. Biostatistical Analysis. Pretince-Hall, Inc. Englewood Cliffs.

Zuberogoitia, I. & Campos, L.F. 1997: Intensive census of nocturnal raptors in Biscay. Munibe 49: 117-127.

Zuberogoitia, I. & Campos, L.F. 1998: Censusing owls in large areas: a comparison between methods. Ardeola 45: 47-53.

Zuberogoitia, I. 2000: La influencia de los factores meteorológicos sobre el éxito reproductor de la Lechuza Común. Ardeola 47: 49-56.

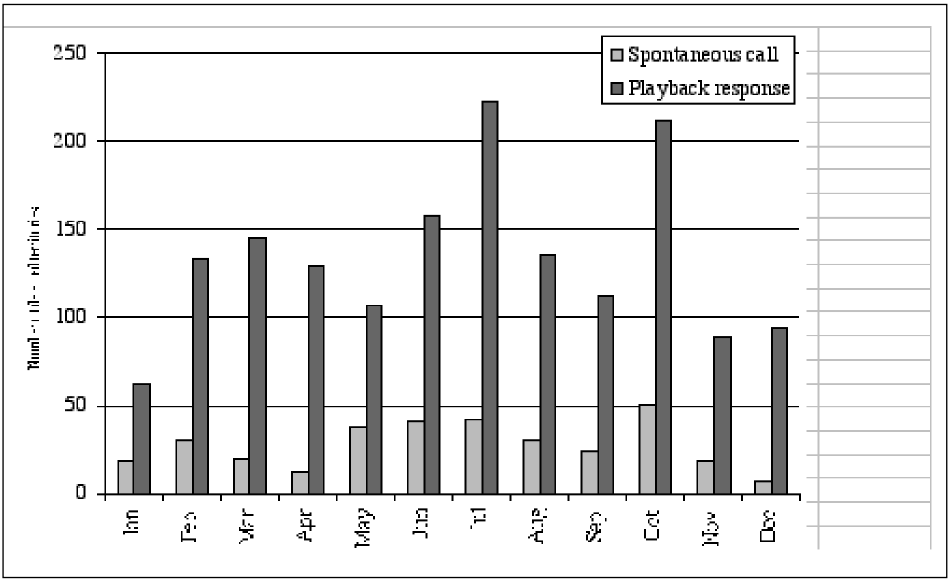
Table 1. Number of counting stations and survey days between months pooling the three years together (1994, 1995 and 1996).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Number of counting stations	88	107	131	118	121	129	168	139	99	156	75	77
Survey days	21	13	19	17	20	16	20	22	15	27	18	14

Table 2. Seasonal variation in the number of males and females that initiated the response.

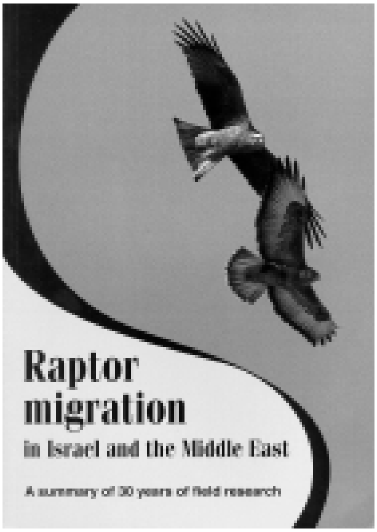
	Male 1st	Female 1st	Male 2nd	Female 2nd	Both	Male /Female ratio
Jan	74	16	7	19	26	2,3
Feb	128	36	16	28	44	2,3
Mar	132	32	13	31	44	2,3
Apr	101	39	13	26	39	1,8
May	108	35	14	19	33	2,3
Jun	134	61	20	28	48	1,7
Jul	158	103	27	36	63	1,3
Aug	89	76	21	24 4	5	1,1
Sep	74	60	19	9	28	1,3
Oct	153	105	36	33	69	1,4
Nov	73	33	13	13	26	1,9
Dec	72	26	8	18	26	1,8

***Figure 1**. Differences in the number of detected territories between months, considering spontaneous calls and playback responses.*



NOVE KNJIGE/BOOK REVIEWS

SHIRIHAI, H., YOSEF, R., ALON, D., KIRWAN, G.M. & SPAAR, R.
Raptor migration in Israel and the Middle East. A summary of 30 years of field research.
International Birding & Research Center in Eilat, Israel and Israel ornithological Center, SPNI, 2000.
Paperback, 192 pages.



It is well known that Eilat in southern Israel is one of the best places in the world for observing migrating Palearctic raptors. Moreover, the Middle East is, no doubt, the most significant migratory boottleneck for raptors on Earth.

This long-awaited book is, as pointed out by dr. K. Bildstein and prof. B. Meyurg, who wrote the foreword, "a road map for the competent study of migratory raptors elsewhere".

The book is divided into two parts: an introduction with subheadings (History of raptor research, Principal migration routes and numbers in the Middle East, Monitoring Palearctic raptor populations through the Middle east, Conservation of Palearctic breeding raptors during migration through the Middle East, Flight behaviour of migrating raptors in Israel, Methods and analysis of surveys in Israel, Notes concerning species accounts, and Notes concerning maps) and the main part concerning species accounts (140 pages). Each chapter contains a brief list of abbreviated references.

The section dealing with species accounts is organised species-by-species, and is well illustrated with tables, figures and photographs. 43 species which appear in the Middle East each spring and autumn are mentioned in the book. Special attention is given to the six species, Milvus migrans, Pernis apivorus, Accipiter brevipes, Buteo buteo vulpinus, Aquila pomarina and Aquila nipalensis, most abundant in Israel.

Individual chapters (including species accounts) generally provide enough introductory material to guide the non-specialist reader, but will be on the cusp of value to individuals already familiar with the topics.

The main section dealing with species accounts devotes one (Aquila verreaxii) to seven (the five most abundant species) pages to each species.

The book contains 16 pages to 32 colour plates featuring some superb photographs of raptors. Some of them are already well known from elsewhere, for example, British Birds (Shirihai & Christie 1992), but many of them are new, produced in spring 1999. The illustrations by J.D.

Fletcher are especially worth mentioning.

The book is carefully produced and includes a list of almost 8 pages of suggested readings that provides an entry into the recent literature. Overall, this is excellent book, summarising 30 years of raptor migration in Middle East, which is essential for anyone interested for raptors and their migration.

References

Shirihai, H. & Christie, D.A. 1992: Raptor migration at Eilat. British Birds 85 141-186.

Milan Vogrin

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V tekstu citiramo na naslednji način: Priimek (1998) ali (Priimek 1998) ali Priimek & Priimek (1998). Èe so veè kot trije avtorji pa: Priimek et al. (1998, 1999). V primeru, če citiramo več del istega avtorja, objavljenih v enem letu, posamezno delo označimo s črkami a, b, c, itd., npr. (Priimek 1998a, b).

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