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Local adaptation or dispersal? How pied flycatchers cope with climate change

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Document Version

Publisher's PDF, also known as Version of record

Publication date:

2014

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Burger, C. (2014). *Local adaptation or dispersal? How pied flycatchers cope with climate change*. [Thesis fully internal (DIV), University of Groningen]. s.n.

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References

A

- Adamík, P. & Bures, S. (2007) Experimental evidence for species-specific habitat preferences in two flycatcher species in their hybrid zone. *Naturwissenschaften*, **94**, 859–863.
- Ahola, M.P., Laaksonen, T., Eeva, T. & Lehikoinen, E. (2012) Selection on laying date is connected to breeding density in the pied flycatcher. *Oecologia*, **168**, 703–710.
- Ahola, M., Laaksonen, T., Sippola, K., Eeva, T., Rainio, K. & Lehikoinen, E. (2004) Variation in climate warming along the migration route uncouples arrival and breeding dates. *Global Change Biology*, **10**, 1610–1617.
- Altizer, S., Dobson, A., Hosseini, P., Hudson, P., Pascual, M. & Rohani, P. (2006) Seasonality and the dynamics of infectious diseases. *Ecology Letters*, **9**, 467–484.
- Armstrong, D.P. & Craig, J.L. (1995) Effects of Familiarity on the Outcome of Translocations. 1. A Test Using Saddlebacks *Philesturnus-Carunculatus-Rufusater*. *Biological Conservation*, **71**, 133–141.
- Armstrong, D.P. & Seddon, P.J. (2008) Directions in reintroduction biology. *Trends in Ecology & Evolution*, **23**, 20–25.
- Arnold, K.E., Ramsay, S.L., Henderson, L. & Larcombe, S.D. (2010) Seasonal variation in diet quality: antioxidants, invertebrates and blue tits *Cyanistes caeruleus*. *Biological Journal of the Linnean Society*, **99**, 708–717.
- Artemyev, A. V. (2004) Relationship of the Pied Flycatcher (*Ficedula hypoleuca*) to territory in the south-eastern Ladoga area [in Russian]. In V. B. Zimin [ED.], *Territorial behavior of birds*, p. 28–44. - Karelian Research Centre Petrozavodsk.
- Van Asch, M. & Visser, M.E. (2007) Phenology of Forest Caterpillars and Their Host Trees: The Importance of Synchrony. *Annu. Rev. Entomol.*, **52**, 37–55.

B

- Balbontin, J., Moller, A.P., Hermosell, I.G., Marzal, A., Reviriego, M., de Lope, F., Lope, F., Møller, A.P. & Balbontín, J. (2009) Geographic patterns of natal dispersal in barn swallows *Hirundo rustica* from Denmark and Spain. *Behavioral Ecology and Sociobiology*, **63**, 1197–1205.
- Van Balen, J.H. (1973) A Comparative Study of the Breeding Ecology of the Great Tit *Parus Major* in Different Habitats. *Ardea*, **61**.
- Bauer, Z., Trnka, M., Bauerová, J., Mozný, M., Stepánek, P., Bartosová, L., Zalud, Z., Bauerova, J., Mozny, M., Stepanek, P. & ... (2010) Changing climate and the phenological response of great tit and collared flycatcher populations in floodplain forest ecosystems in Central Europe. *International Journal of Biometeorology*, **54**, 99–111.
- Bel'skii, E. a. & Bel'skaya, E. a. (2009) Composition of Pied Flycatcher (*Ficedula hypoleuca* Pall.) Nestling Diet in Industrially Polluted Area. *Russian Journal of Ecology*, **40**, 342–350.
- Benard, M.F. & McCauley, S.J. (2008) Integrating across life-history stages: Consequences of natal habitat effects on dispersal. *American Naturalist*, **171**, 553–567.
- Bensch, S. & Hasselquist, D. (1992) Evidence for Active Female Choice in a Polygynous Warbler. *Animal Behaviour*, **44**, 301–311.
- Benton, T.G. & Bowler, D.E. (2012) Linking dispersal to spatial dynamics. *Dispersal ecology and evolution* (eds J. Clobert, M. Baguette, T.G. Benton & J.M. Bullock), pp. 251–265. Oxford University Press, United Kingdom.
- Berndt, R. & Sternberg, H. (1969) Alters- und Geschlechtsunterschiede in der Dispersion des Trauerschnäppers (*Ficedula hypoleuca*). *J. Ornithol.*, **110**, 22–26.
- Blows, M.W. & Hoffmann, A.A. (2005) A reassessment of genetic limits to evolutionary change. *Ecology*, **86**, 1371–1384.
- Both, C. (2000) Density dependence of avian clutch size in resident and migrant species: is there a constraint on the predictability of competitor density? *Journal of Avian Biology*, **31**, 412–417.
- Both, C. (2010) Flexibility of Timing of Avian Migration to Climate Change Masked by Environmental Constraints En Route. *Current Biology*, **20**, 243–248.
- Both, C. (2012) Insufficient adaptation to climate change alters avian habitat quality and thereby changes habitat selection. *Birds and Habitats* (ed R.J. Fuller), p. 554. Cambridge University Press, UK.

- Both, C., Artemyev, A. V., Blaauw, B., Cowie, R.J., Dekhuijzen, A.J., Eeva, T., Enemar, A., Gustafsson, L., Ivankina, E. V., Järvinen, A., Metcalfe, N.B., Nyholm, N.E.I., Potti, J., Ravussin, P.-A., Sanz, J.J., Silverin, B., Slater, F.M., Sokolov, L. V., Török, J., Winkel, W., Wright, J., Zang, H. & Visser, M.E. (2004) Large-scale geographical variation confirms that climate change causes birds to lay earlier. *Proceedings of the Royal Society of London Series B-Biological Sciences*, **271**, 1657–1662.
- Both, C., Van Asch, M., Bijlsma, R.G., van den Burg, A.B. & Visser, M.E. (2009) Climate change and unequal phenological changes across four trophic levels: constraints or adaptations? *Journal of Animal Ecology*, **78**, 73–83.
- Both, C., Bouwhuis, S., Lessells, C.M. & Visser, M.E. (2006) Climate change and population declines in a long-distance migratory bird. *Nature*, **441**, 81–83.
- Both, C., Robinson, R.A. & van der Jeugd, H.P. (2012) Long-distance dispersal in migratory pied flycatchers *Ficedula hypoleuca* is relatively common between the UK and the Netherlands. *Journal of Avian Biology*, **43**, 193–197.
- Both, C., Van Turnhout, C. a M., Bijlsma, R.G., Siepel, H., Van Strien, A.J. & Foppen, R.P.B. (2010) Avian population consequences of climate change are most severe for long-distance migrants in seasonal habitats. *Proceedings of the Royal Society B-Biological Sciences*, **277**, 1259–1266.
- Both, C. & Visser, M.E. (2001) Adjustment to climate change is constrained by arrival date in a long-distance migrant bird. *Nature*, **211**, 296–298.
- Both, C. & Visser, M.E. (2005) The effect of climate change on the correlation between avian life-history traits. *Global Change Biology*, **11**, 1606–1613.
- Bowler, D.E. & Benton, T.G. (2005) Causes and consequences of animal dispersal strategies: relating individual behaviour to spatial dynamics. *Biological reviews of the Cambridge Philosophical Society*, **80**, 205–225.
- Bowler, D.E. & Benton, T.G. (2009) Variation in dispersal mortality and dispersal propensity among individuals: the effects of age, sex and resource availability. *Biological Reviews*, **78**, 1234–1241.
- Brinkhof, M.W.G. & Cave, A.J. (1997) Food supply and seasonal variation in breeding success: an experiment in the European coot. *Proceedings of the Royal Society B: Biological Sciences*, **264**, 291–296.
- Brinkhof, M.W.G., Cave, A.J., Daan, S. & Perdeck, A.C. (2002) Timing of current reproduction directly affects future reproductive output in European coots. *Evolution*, **56**, 400–411.
- Brower, L., Tinbergen, J.M., Both, C., Bristol, R., Richardson, D.S. & Komdeur, J. (2009) Experimental evidence for density-dependent reproduction in a cooperatively breeding passerine. *Ecology*, **90**, 729–741.
- Brown, C.R. & Brown, M.B. (2000) Weather-mediated natural selection on arrival time in cliff swallows (*Petrochelidon pyrrhonota*). *Behavioral Ecology and Sociobiology*, **47**, 339–345.
- Brown, C.R., Brown, M.B. & Brazeal, K.R. (2008) Familiarity with breeding habitat improves daily survival in colonial cliff swallows. *Animal Behaviour*, **76**, 1201–1210.
- Bureš, S. & Weidinger, K. (2003) Sources and timing of calcium intake during reproduction in flycatchers. *Oecologia*, **137**, 634–641.
- Burger, C., Belskii, E., Eeva, T., Laaksonen, T., Mägi, M., Mänd, R., Qvarnström, A., Slagsvold, T., Veen, T., Visser, M.E., Wiebe, K.L., Wiley, C., Wright, J. & Both, C. (2012) Climate change, breeding date and nestling diet: how temperature differentially affects seasonal changes in pied flycatcher diet depending on habitat variation. *Journal of Animal Ecology*, **81**, 926–936.
- Burger, C. & Both, C. (2011) Translocation as a Novel Approach to Study Effects of a New Breeding Habitat on Reproductive Output in Wild Birds. *Plos One*, **6**.
- Burnham, K.P. & Anderson, D.R. (2010) *Model Selection and Multimodel Inference*. Springer-Verlag, New York, USA.

C

- Charmantier, A., McCleery, R.H., Cole, L.R., Perrins, C., Kruuk, L.E.B. & Sheldon, B.C. (2008) Adaptive phenotypic plasticity in response to climate change in a wild bird population. *Science*, **320**, 800–803.
- Chernetsov, N., Sokolov, L. V., Kosarev, V., Leoke, D., Markovets, M., Tsvey, A. & Shapoval, A.P. (2006) Sex-related natal dispersal of pied flycatchers: How far away from home? *Condor*, **108**, 711–717.
- Clobert, J., Baguette, M., Benton, T.G. & Bullock, J.M. (2012) *Dispersal Ecology and Evolution*. Oxford University Press, United Kingdom.
- Clobert, J., Le Galliard, J.-F., Cote, J., Meylan, S. & Massot, M. (2009) Informed dispersal, heterogeneity in animal dispersal syndromes and the dynamics of spatially structured populations. *Ecology letters*, **12**, 197–209.
- Clobert, J., Nichols, J.D., Danchin, E. & Dhont, A. (2001) *Dispersal*. Oxford University Press, Oxford, UK.
- Coltman, D.W. (2005) Evolutionary genetics - Differentiation by dispersal. *Nature*, **433**, 23–24.
- Coppack, T. & Both, C. (2002) Predicting life-cycle adaptation of migratory birds to global climate change. *Ardea*, **90**, 369–378.
- Crawley, M.J. (2007) *The R Book*. John Wiley & Sons Ltd., ISBN: 978-.
- Cresswell, W. & McCleery, R. (2003) How great tits maintain synchronization of their hatch date with food supply in response to long-term variability in temperature. *Journal of Animal Ecology*, **72**, 356–366.
- Crick, H.Q.P., Dudley, C., Glue, D.E. & Thomson, D.L. (1997) UK birds are laying eggs earlier. *Nature*, **388**, 526.

D

- Daan, S., Dijkstra, C. & Tinbergen, J.M. (1990) Family-Planning in the Kestrel (*Falco Tinnunculus*) - the Ultimate Control of Covariation of Laying Date and Clutch Size. *Behaviour*, **114**, 83–116.
- Daan, S. & Tinbergen, J.M. (1997) Adaptation of life histories. *Behavioural ecology, an evolutionary approach* (eds J.R. Krebs & N.B. Davies), pp. 311–333. Oxford University Press, Oxford, UK.
- Davis, A.K., Maney, D.L. & Maerz, J.C. (2008) The use of leukocyte profiles to measure stress in vertebrates: a review for ecologists. *Functional Ecology*, **22**, 760–772.
- Devicor, V., van Swaay, C., Brereton, T., Brotons, L.L., Chamberlain, D., Heliölä, J., Herrando, S., Julliard, R., Kuussaari, M., Lindström, Å., Reif, J.J., Roy, D.B., Schweiger, O., Settele, J., Stefanescu, C.C., Van Strien, A., Van Turnhout, C., Vermouzek, Z.Z., WallisDeVries, M., Wynhoff, I. & Jiguet, F.F. (2012) Differences in the climatic debts of birds and butterflies at a continental scale. *Nature Climate Change*, **2**, 121–124.
- Diffenbaugh, N.S. & Field, C.B. (2013) Changes in Ecologically Critical Terrestrial Climate Conditions. *Science*, **341**, 486–492.
- Dingemanse, N., Both, C., Noordwijk, A. Van, Rutten, A. & Drent, P. (2003) Natal dispersal and personalities in great tits (*Parus major*). *Proceedings. Biological sciences / The Royal Society*, **270**, 741–7.
- Doligez, B., Danchin, E. & Clobert, J. (2002) Public information and breeding habitat selection in a wild bird population. *Science*, **297**, 1168–1170.
- Doligez, B., Gustafsson, L. & Pärt, T. (2009) “Heritability” of dispersal propensity in a patchy population. *Proceedings of the Royal Society B: Biological Sciences*, **276**, 2829–2836.
- Doligez, B. & Pärt, T. (2008) Estimating fitness consequences of dispersal: a road to “know-where”? Non-random dispersal and the underestimation of dispersers’ fitness. *Journal of Animal Ecology*, **77**, 1199–1211.
- Drent, P.J. (1987) The Importance of Nestboxes for Territory Settlement, Survival and Density of the Great Tit. *Ardea*, **75**, 59–71.
- Drent, R., Both, C., Green, M., Madsen, J. & Piersma, T. (2003) Pay-offs and penalties of competing migratory schedules. *Oikos*, **103**, 274–292.

- Duckworth, R. A. & Badyaev, A. V. (2007) Coupling of dispersal and aggression facilitates the rapid range expansion of a passerine bird. *Proceedings of the National Academy of Sciences of the United States of America*, **104**, 15017–15022.
- Dunn, P. (2004) Breeding dates and reproductive performance (ed APF Moller W Berthold, P.). *Advances in Ecological Research*, **35**, 69–87.
- Dunn, P.O. & Winkler, D.W. (2010) Effects of climate change on timing of breeding and reproductive success in birds. *Effects of climate change on birds* (eds A.P. Moller, W. Fiedler & P. Berthold), pp. 113–128. Oxford University Press, New York, USA.
- Dunn, P.O., Winkler, D.W., Whittingham, L.A., Hannon, S.J. & Robertson, R.J. (2011) A test of the mismatch hypothesis: How is timing of reproduction related to food abundance in an aerial insectivore? *Ecology*, **92**, 450–461.
- E**
- Edelaar, P., Siepielski, A.M. & Clobert, J. (2008) Matching Habitat Choice Causes Directed Gene Flow: a Neglected Dimension in Evolution and Ecology. *Evolution*, **62**, 2462–2472.
- Eeva, T., Ahola, M., Laaksonen, T. & Lehikoinen, E. (2008) The effects of sex, age and breeding success on breeding dispersal of pied flycatchers along a pollution gradient. *Oecologia*, **157**, 231–238.
- Eeva, T., Lehikoinen, E. & Nikinmaa, M. (2003) Pollution-induced nutritional stress in birds: An experimental study of direct and indirect effects. *Ecological Applications*, **13**, 1242–1249.
- Eeva, T., Lehikoinen, E. & Pohjalainen, T. (1997) Pollution-related variation in food supply and breeding success in two hole-nesting passerines. *Ecology*, **78**, 1120–1131.
- Eeva, T., Ryömä, M. & Riihimäki, J. (2005) Pollution-related changes in diets of two insectivorous passerines. *Oecologia*, **145**, 629–639.
- Eeva, T., Veistola, S. & Lehikoinen, E. (2000) Timing of breeding in subarctic passerines in relation to food availability. *Canadian Journal of Zoology-Revue Canadienne De Zoologie*, **78**, 67–78.
- Ellwood, E.R., Primack, R.B. & Talmadge, M.L. (2010) Effects of Climate Change on Spring Arrival Times of Birds in Thoreau's Concord from 1851 to 2007. *Condor*, **112**, 754–762.
- F**
- Fischbacher, M., Naef-Daenzer, B. & Naef-Daenzer, L. (1998) Estimating Caterpillar Density on Trees by Collection of Frass Droppings. *Ardea*, **86**, 121–129.
- Fretwell, S.D. & Lucas, H.L. (1970) On Territorial Behavior and other Factors Influencing Habitat Distribution in Birds. *Acta Biotheoretica*, **19** 16–36, 16–36.
- G**
- Le Galliard, J.F., Massot, M. & Clobert, J. (2012) Dispersal and range dynamics in changing climates: a review. (eds J. Clobert, M. Baguette, T.G. Benton & J.M. Bullock), p. 317. Oxford University Press, United Kingdom.
- Garant, D., Kruuk, L.E.B., Wilkin, T.A., McCleery, R.H. & Sheldon, B.C. (2005) Evolution driven by differential dispersal within a wild bird population. *Nature*, **433**, 60–65.
- Garcia-Navas, V. & Sanz, J.J. (2011a) Seasonal decline in provisioning effort and nestling mass of Blue Tits *Cyanistes caeruleus*: experimental support for the parent quality hypothesis. *Ibis*, **153**, 59–69.
- Garcia-Navas, V. & Sanz, J.J. (2011b) The importance of a main dish: nestling diet and foraging behaviour in Mediterranean blue tits in relation to prey phenology. *Oecologia*, **165**, 639–649.
- Gienapp, P. (2005) Breeding in a Warming World. Evolution of Avian Breeding Time Under Climate Change. University of Groningen, The Netherlands.
- Gienapp, P., Teplitsky, C., Alho, J.S., Mills, J. a, Merila, J. & Merilä, J. (2008) Climate change and evolution: disentangling environmental and genetic responses. *Molecular Ecology*, **17**, 167–178.
- Goodenough, A.E., Elliot, S.L. & Hart, A.G. (2009) The challenges of conservation for declining migrants: are reserve-based initiatives during the breeding season appropriate for the Pied Flycatcher *Ficedula hypoleuca*? *Ibis*, **151**, 429–439.

- Goodenough, A.E., Hart, A.G. & Stafford, R. (2010) Is adjustment of breeding phenology keeping pace with the need for change? Linking observed response in woodland birds to changes in temperature and selection pressure A letter. *Climatic change*, **102**, 687–697.
- Greenwood, P.J. (1980) Mating systems, philopatry and dispersal in birds and mammals. *Journal of Animal Ecology*, **28**, 1140–1162.
- Grueebler, M.U. & Naef-Daenzer, B. (2010) Fitness consequences of timing of breeding in birds: date effects in the course of a reproductive episode. *Journal of Avian Biology*, **41**, 282–291.
- Gustafsson, L., Nordling, D., Andersson, M.S., Sheldon, B.C. & Qvarstrom, A. (1994) Infectious-Diseases, Reproductive Effort and the Cost of Reproduction in Birds. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences*, **346**, 323–331.
- H**
- Von Haartman, L. (1954) Der Trauerfliegenschnäpper. III. Die Nahrungsbiologie. *Acta Zoologica Fennica*, **83**, 6–96.
- Haas, C.A. (1998) Effects of prior nesting success on site fidelity and breeding dispersal: An experimental approach. *Auk*, **115**, 929–936.
- Hansson, B., Bensch, S. & Hasselquist, D. (2004) Lifetime fitness of short- and long-distance dispersing great reed warblers. *Evolution*, **58**, 2546–2557.
- De Heij, M.E., van den Hout, P.J. & Tinbergen, J.M. (2006) Fitness cost of incubation in great tits (*Parus major*) is related to clutch size. *Proceedings of the Royal Society B-Biological Sciences*, **273**, 2353–2361.
- Hoegh-Guldberg, O., Hughes, L., McIntyre, S., Lindenmayer, D.B., Parmesan, C., Possingham, H.P. & Thomas, C.D. (2008) Assisted colonization and rapid climate change. *Science*, **321**, 345–346.
- Husby, A., Kruuk, L.E.B. & Visser, M.E. (2009) Decline in the frequency and benefits of multiple brooding in great tits as a consequence of a changing environment. *Proceedings of the Royal Society B-Biological Sciences*, **276**, 1845–1854.
- Husby, A., Nussey, D.H., Visser, M.E., Wilson, A.J., Sheldon, B.C. & Kruuk, L.E.B. (2010) Contrasting Patterns of Phenotypic Plasticity in Reproductive Traits in Two Great Tit (*Parus Major*) Populations. *Evolution*, **64**, 2221–2237.
- I**
- IPCC. (2007) *Climate Change 2007 - The Physical Science Basis*.
- J**
- Jaenike, J. & Holt, R.D. (1991) Genetic-Variation for Habitat Preference - Evidence and Explanations. *American Naturalist*, **137**, S67–S90.
- Jiguet, F., Gadot, A.-S.S., Julliard, R., Newson, S.E. & Couvet, D. (2007) Climate envelope, life history traits and the resilience of birds facing global change. *Global Change Biology*, **13**, 1672–1684.
- Johansson, J., Jonzen, N. & Jonzén, N. (2012) Game theory sheds new light on ecological responses to current climate change when phenology is historically mismatched. *Ecology Letters*, **15**, 881–888.
- K**
- Kawecki, T.J. & Holt, R.D. (2002) Evolutionary consequences of asymmetric dispersal rates. *American Naturalist*, **160**, 333–347.
- Keller, L.F. & Van Noordwijk, A.J. (1994) Effects of Local Environmental Conditions on Nestling Growth in the Great Tit *Parus major* L. *Ardea*, **82**, 349–362.
- Klein Tank, A.M.G., Wijngaard, J.B., Können, G.P., Böhm, R., Demarée, G., Gocheva, A., Mileta, M., Pashiardis, S., Hejkrlik, L., Kern-Hansen, C., Heino, R., Bessemoulin, P., Müller-Westermeier, G., Tzanakou, M., Szalai, S., Pálsdóttir, T., Fitzgerald, D., Rubin, S., Capaldo, M., Maugeri, M., Leitass, A., Bukantis, A., Aberfeld, R., van Engelen, A.F. V., Forland, E., Miletus, M., Coelho, F., Mares, C., Razuvaev, V., Nieplova, E., Cegnar, T., Antonio López, J., Dahlström, B., Moberg, A., Kirchhofer, W., Ceylan, A., Pachaliuk, O., Alexander, L. V & Petrovic, P. (2002) Daily dataset of 20th-century surface air temperature and precipitation series for the European Climate Assessment. *International Journal of Climatology*, **22**, 1441–1453.

- Klomp, H. (1970) Determination of Clutch-Size in Birds - a Review. *Ardea*, **58**, 1–8.
- Kokko, H. & López-Sepulcre, A. (2006) From individual dispersal to species ranges: Perspectives for a changing world. *Science*, **313**, 789–791.
- Komdeur, J. (1994) Conserving the Seychelles Warbler *Acrocephalus-Sechellensis* by Translocation from Cousin Island to the Islands of Aride and Cousine. *Biological Conservation*, **67**, 143–152.
- Kruuk, L.E.B., Merilä, J., Sheldon, B.C. & Merila, J. (2001) Phenotypic selection on a heritable size trait revisited. *American Naturalist*, **158**, 557–571.
- L**
- Lack, D.L. (1966) *Population studies of birds*. Oxford University Press, Oxford, ISBN: 978-.
- Lack, D.L. (1968) *Ecological Adaptations for Breeding in Birds*. Methuen, London.
- Lambrechts, M.M., Perret, P., Maistre, M. & Blondel, J. (1999) Do experiments with captive non-domesticated animals make sense without population field studies? A case study with blue tits' breeding time. *Proceedings of the Royal Society of London Series B-Biological Sciences*, **266**, 1311–1315.
- Lehikoinen, E., Sparks, T.H. & Zalakevicius, M. (2004) Arrival and departure dates (ed APF Moller W Berthold,P.). *Advances in Ecological Research*, **35**, 1–31.
- Lehtonen, P.K., Laaksonen, T., Artemyev, A V, Belskii, E., Both, C., Bureš, S., Bushuev, A. V, Krams, I., Moreno, J., Mägi, M., Nord, A., Potti, J., Ravussin, P a, SirkiÄ, P.M., SÆtre, G.P & Primmer, C.R. (2009) Geographic patterns of genetic differentiation and plumage colour variation are different in the pied flycatcher (*Ficedula hypoleuca*). *Molecular Ecology*, **18**, 4463–4476.
- Lenormand, T. (2002) Gene flow and the limits to natural selection. *Trends in Ecology & Evolution*, **17**, 183–189.
- Liedvogel, M., Cornwallis, C.K. & Sheldon, B.C. (2012) Integrating candidate gene and quantitative genetic approaches to understand variation in timing of breeding in wild tit populations. *Journal of Evolutionary Biology*, **25**, 813–823.
- Lobato, E., Moreno, J., Merino, S., Sanz, J.J. & Arriero, E. (2005) Haematological variables are good predictors of recruitment in nestling pied flycatchers (*Ficeduld hypoleuca*). *Ecoscience*, **12**, 27–34.
- Lundberg, A. & Alatalo, R. V. (1992) *The Pied Flycatcher*. Poyser, London, United Kingdom.
- Lundberg, A., Alatalo, R. V, Carlson, A. & Ulfstrand, S. (1981) Biometry, habitat distribution and breeding success in the Pied Flycatcher *Ficedula hypoleuca*. *Ornis Scandinavica*, **12**, 68–79.
- Lynch, M. (1991) The Genetic Interpretation of Inbreeding Depression and Outbreeding Depression. *Evolution*, **45**, 622–629.
- M**
- Mägi, M., Mänd, R., Tamm, H., Sisask, E., Kilgas, P & Tilgar, V. (2009) Low reproductive success of great tits in the preferred habitat: A role of food availability. *Ecoscience*, **16**, 145–157.
- Magrath, M.J.L., Santema, P., Bouwman, K.M., Brinkhuizen, D.M., Griffith, S.C. & Langmore, N.E. (2009) Seasonal decline in reproductive performance varies with colony size in the fairy martin, *Petrochelidon ariel*. *Behavioral Ecology and Sociobiology*, **63**, 661–672.
- Marr, A.B., Keller, L.F. & Arcese, P. (2002) Heterosis and outbreeding depression in descendants of natural immigrants to an inbred population of song sparrows (*Melospiza melodia*). *Evolution*, **56**, 131–142.
- Martin, T.E. (1987) Food as a limit on breeding birds: a life-history perspective. *Annual Review of Ecology and Systematics*, **18**, 453–487.
- Te Marvelde, L., Visser, M.E. & Lof, M.E. (2012) Adaptive phenological mismatches of birds and their food in a warming world. *Journal of Ornithology*, **153**, 75–84.
- Te Marvelde, L., Webber, S.L., Meijer, H.A.J. & Visser, M.E. (2011) Mismatched reproduction is energetically costly for chick feeding female great tits. *Functional Ecology*, **25**, 1302–1308.
- Matthysen, E. (2005) Density-dependent dispersal in birds and mammals. *Ecography*, **28**, 403–416.
- Matthysen, E. (2012) Multicausality of dispersal: a review. *Dispersal ecology and evolution* (eds J. Clobert, M. Baguette, T.G. Benton & J.M. Bullock), p. 3. Oxford University Press, United Kingdom.

- Mayr, E. (1963) *Animal species and evolution*. Belknap Press of Harvard University Press, Cambridge, Massachusetts, USA.
- Merilä, J., Kruuk, L.E.B. & Sheldon, B.C. (2001) Cryptic evolution in a wild bird population. *Nature*, **412**, 76–79.
- Møller, A.P. (2008) Climate change and micro-geographic variation in laying date. *Oecologia*, **155**, 845–857.
- Møller, A.P., Rubolini, D. & Lehikoinen, E. (2008) Populations of migratory bird species that did not show a phenological response to climate change are declining. *Proceedings of the National Academy of Sciences*, **105**, 16195–16200.
- Monaghan, P. & Nager, R.G. (1997) Why don't birds lay more eggs? *Trends in Ecology & Evolution*, **12**, 270–274.
- Moreno, J., Merino, S., Potti, J., de Leon, A. & Rodriguez, R. (1999) Maternal energy expenditure does not change with flight costs or food availability in the pied flycatcher (*Ficedula hypoleuca*): costs and benefits for nestlings. *Behavioral Ecology and Sociobiology*, **46**, 244–251.
- Morris, D.W. (2003) Toward an ecological synthesis: a case for habitat selection. *Oecologia*, **136**, 1–13.
- N**
- Naef-daenzer, L., Naef-daenzer, B. & Nager, R.G. (2000) Prey selection and foraging performance of breeding Great Tits *Parus major* in relation to food availability. *Journal of Avian Biology*, **31**, 206–214.
- Naef-Daenzer, B., Widmer, F. & Nuber, M. (2001) Differential post-fledging survival of great and coal tits in relation to their condition and fledging date. *Journal of Animal Ecology*, **70**, 730–738.
- Nagy, L.R. & Holmes, R.T. (2005) Food limits annual fecundity of a migratory songbird: An experimental study. *Ecology*, **86**, 675–681.
- Newton, I. (1998) *Population Limitation in Birds*. Academic Press, San Diego, California, USA.
- Newton, I. (2008) Highlights from a long-term study of Sparrowhawks. *British Birds*, **101**, 607–623.
- Nicolaus, M., Michler, S.P.M., Jalvingh, K.M., Ubels, R., van der Velde, M., Komdeur, J., Both, C. & Tinbergen, J.M. (2012) Social environment affects juvenile dispersal in great tits (*Parus major*). *Journal of Animal Ecology*, **81**, 827–837.
- Niemela, J., Pajunen, T., Haila, Y., Punttila, P. & Halme, E. (1994) Seasonal Activity of Boreal Forest-Floor Spiders (Araneae). *Journal of Arachnology*, **22**, 23–31.
- Nilsson, J.A. (1989) Causes and Consequences of Natal Dispersal in the Marsh Tit, *Parus-Palustris*. *Journal of Animal Ecology*, **58**, 619–636.
- Van Noordwijk, A.J., McCleery, R.H.H. & Perrins, C.M.M. (1995) Selection for the Timing of Great Tit Breeding in Relation to Caterpillar Growth and Temperature. *Journal of Animal Ecology*, **64**, 451–458.
- Norris, D.R., Marra, P.P., Kyser, T.K., Sherry, T.W. & Ratcliffe, L.M. (2004) Tropical winter habitat limits reproductive success on the temperate breeding grounds in a migratory bird. *Proceedings of the Royal Society B-Biological Sciences*, **271**, 59–64.
- Nussey, D.H., Postma, E., Gienapp, P. & Visser, M.E. (2005) Selection on heritable phenotypic plasticity in a wild bird population. *Science*, **310**, 304–306.
- P**
- Paradis, E., Baillie, S.R., Sutherland, W.J. & Gregory, R.D. (1998) Patterns of natal and breeding dispersal in birds. *Journal of Animal Ecology*, **67**, 518–536.
- Parmesan, C. & Yohe, G. (2003) A globally coherent fingerprint of climate change impacts across natural systems. *Nature*, **421**, 37–42.
- Pärn, H. & Saether, B.E. (2012) Influence of temperature on dispersal in two bird species. (eds J. Clobert, M. Bagueette, T.G. Benton & J.M. Bullock), p. 349. Oxford University Press, United Kingdom.
- Pärt, T. (1995) The Importance of Local Familiarity and Search Costs for Age-Biased and Sex-Biased Philopatry in the Collared Flycatcher. *Animal Behaviour*, **49**, 1029–1038.

- Pärt, T., Arlt, D. & Villard, M.A. (2007) Empirical evidence for ecological traps: a two-step model focusing. *J Ornithol*, **148**, 327–332.
- Pärt, T. & Gustafsson, L. (1989) Breeding Dispersal in the Collared Flycatcher (*Ficedula-Albicollis*) - Possible Causes and Reproductive Consequences. *Journal of Animal Ecology*, **58**, 305–320.
- Partridge, L. (1974) Habitat selection in titmice. *Nature*, **247**, 573–574.
- Perfito, N., Jeong, S.Y., Silverin, B., Calisi, R.M., Bentley, G.E. & Hau, M. (2012) Anticipating Spring: Wild Populations of Great Tits (*Parus major*) Differ in Expression of Key Genes for Photoperiodic Time Measurement. *Plos One*, **7**, e34997.
- Perrins, C.M. (1970) The Timing of Birds' Breeding Seasons. *Ibis*, **112**, 242–255.
- Pimm, S.L. (2008) Biodiversity: Climate change or habitat loss - Which will kill more species? *Current Biology*, **18**, R117–R119.
- Postma, E. & van Noordwijk, A.J. (2005) Genetic variation for clutch size in natural populations of birds from a reaction norm perspective. *Ecology*, **86**, 2344–2357.
- Potti, J., Dávila, J. a, Tella, J.L., Frías, O., Villar, S., Davila, J.A. & Frias, O. (2002) Gender and viability selection on morphology in fledgling pied flycatchers. *Molecular Ecology*, **11**, 1317–1326.
- Potti, J. & Montalvo, S. (1991) Return rate, age at first breeding and natal dispersal of pied flycatchers *Ficedula hypoleuca* in central Spain. *Ardea*, **79**, 419–428.
- Q**
- Qvarnström, A., Svedin, N., Wiley, C., Veen, T. & Gustafsson, L. (2005) Cross-fostering reveals seasonal changes in the relative fitness of two competing species of flycatchers. *Biology Letters*, **1**, 68–71.
- R**
- Ramsay, S.L. & Houston, D.C. (2003) Amino acid composition of some woodland arthropods and its implications for breeding tits and other passerines. *Ibis*, **145**, 227–232.
- RDevelopmentCoreTeam. (2008) R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
- Robertson, B.A. & Hutto, R.L. (2006) A framework for understanding ecological traps and an evaluation of existing evidence. *Ecology*, **87**, 1075–1085.
- Roff, D.A. (1992) *The Evolution of Life Histories*. Chapman & Hall, New York, USA.
- Ronce, O. (2007) How does it feel to be like a rolling stone? Ten questions about dispersal evolution. *Annual Review of Ecology Evolution and Systematics*, **38**, 231–253.
- Rytkönen, S. & Orell, M. (2001) Great tits, *Parus major*, lay too many eggs: experimental evidence in mid-boreal habitats. *Oikos*, **93**, 439–450.
- S**
- Saether, B.-E.E., Engen, S., Møller, A.P., Matthysen, E., Adriaensen, F., Fiedler, W., Leivits, A., Lambrechts, M.M., Visser, M.E., Anker-Nilssen, T., Both, C., Dhondt, A. a, McCleery, R.H., McMeeking, J., Potti, J., Røstad, O.W. & Thomson, D. (2003) Climate variations and regional gradients in population dynamics of two hole-nesting passerines. *Proceedings of the Royal Society of London Series B-Biological Sciences*, **270**, 2397–2404.
- Saetre, G.P., Kral, M., Bures, S. & Ims, R.A. (1999) Dynamics of a clinal hybrid zone and a comparison with island hybrid zones of flycatchers (*Ficedula hypoleuca* and *F-albicollis*). *Journal of zoology*, **247**, 53–64.
- Saino, N., Ambrosini, R., Rubolini, D., von Hardenberg, J., Provenzale, A., Hüppop, K., Hüppop, O., Lehikoinen, A., Lehikoinen, E., Rainio, K., Romano, M. & Sokolov, L. (2011) Climate warming, ecological mismatch at arrival and population decline in migratory birds. *Proceedings. Biological sciences / The Royal Society*, **278**, 835–842.
- Sanderson, F.J., Donald, P.F., Pain, D.J., Burfield, I.J. & van Bommel, F.P.J. (2006) Long-term population declines in Afro-Palearctic migrant birds. *Biological Conservation*, **131**, 93–105.
- Sanz, J.J. (1998) Effect of Habitat and Latitude on Nestling Diet of Pied Flycatcher *Ficedula hypoleuca*. *Ardea*, **86**, 81–86.
- Sanz, J.J. (2001) Latitudinal variation in female local return rate in the philopatric Pied Flycatcher (*Ficedula hypoleuca*). *Auk*, **118**, 539–543.

- Sanz, J.J., Potti, J., Moreno, J., Merino, S., Frias, O. (2003) Climate change and fitness components of a migratory bird breeding in the Mediterranean region. *Global Change Biology*, **9**, 461–472.
- Schaper, S. V., Dawson, A., Sharp, P.J., Gienapp, P., Caro, S.P. & Visser, M.E. (2012) Increasing Temperature, Not Mean Temperature, Is a Cue for Avian Timing of Reproduction. *American Naturalist*, **179**, E55–E69.
- Schaub, M. & von Hirschheydt, J. (2009) Effect of current reproduction on apparent survival, breeding dispersal, and future reproduction in barn swallows assessed by multistate capture-recapture models. *Journal of Animal Ecology*, **78**, 625–635.
- Schlaepfer, M.A., Runge, M.C. & Sherman, P.W. (2002) Ecological and evolutionary traps. *Trends in Ecology & Evolution*, **17**, 474–480.
- Schoech, S.J. & Hahn, T.P. (2008) Latitude affects degree of advancement in laying by birds in response to food supplementation: a meta-analysis. *Oecologia*, **157**, 369–376.
- Sheldon, B.C., Kruuk, L.E.B. & Merilä, J. (2003) Natural selection and inheritance of breeding time and clutch size in the collared flycatcher. *Evolution*, **57**, 406–420.
- Shields, W.M. (1982a) *Philopatry, Inbreeding, and the Evolution of Sex*. State University of New York Press, Albany, NY, USA.
- Siepielski, A.M., DiBattista, J.D. & Carlson, S.M. (2009) It's about time: the temporal dynamics of phenotypic selection in the wild. *Ecology Letters*, **12**, 1261–1276.
- Siikamäki, P. (1995) Habitat Quality and Reproductive Traits in the Pied-Flycatcher - an Experiment. *Ecology*, **76**, 308–312.
- Siikamäki, P. (1998) Limitation of Reproductive Success by Food Availability and Breeding Time in Pied Flycatchers. *Ecology*, **79**, 1789–1796.
- Silverin, B., Massa, R. & Stokkan, K.A. (1993) Photoperiodic adaptation to breeding at different latitudes in Great Tits. *General and Comparative Endocrinology*, **90**, 14–22.
- Sirkkiä, P.M. & Laaksonen, T. (2009) Distinguishing between male and territory quality: females choose multiple traits in the pied flycatcher. *Animal Behaviour*, **78**, 1051–1060.
- Sisask, E., Mänd, R., Mägi, M. & Tilgar, V. (2010) Parental provisioning behaviour in Pied Flycatchers *Ficedula hypoleuca* is well adjusted to local conditions in a mosaic of deciduous and coniferous habitat. *Bird Study*, **57**, 447–457.
- Slagsvold, T. (1976) Annual and Geographical Variation in Time of Breeding of Great Tit Parus-Major and Pied Flycatcher *Ficedula-Hypoleuca* in Relation to Environmental Phenology and Spring Temperature. *Ornis Scandinavica*, **7**, 127–145.
- Slagsvold, T., Lifjeld, J.T., Stenmark, G. & Breiehagen, T. (1988) On the Cost of Searching for a Mate in Female Pied Flycatchers *Ficedula-Hypoleuca*. *Animal Behaviour*, **36**, 433–442.
- Slagsvold, T. & Wiebe, K.L. (2007) Hatching asynchrony and early nestling mortality: the feeding constraint hypothesis. *Animal Behaviour*, **73**, 691–700.
- Smith, K.W., Smith Charman, L., E. K., B., Burgess, M., Dennis, C., Harding, M., Isherwood, C., Isherwood, I. & Mallord, J. (2011) Large-scale variation in the temporal patterns of the frass fall of defoliating caterpillars in oak woodlands in Britain: implications for nesting woodland birds. *Bird Study*, **58**, 506–511.
- Southwood, T.R.E., Wint, G.R.W., Kennedy, C.E.J. & Greenwood, S.R. (2005) The composition of the arthropod fauna of the canopies of some species of oak (*Quercus*). *European Journal of Entomology*, **102**, 65–72.
- Studds, C.E., Kyser, T.K. & Marra, P.P. (2008) Natal dispersal driven by environmental conditions interacting across the annual cycle of a migratory songbird. *Philosophical Transactions of the National Academy of Science of the USA*, **105**, 2929–2933.
- T**
- Thackeray, S.J., Sparks, T.H., Frederiksen, M., Burthe, S., Bacon, P.J., Bell, J.R., Botham, M.S., Brereton, T.M., Bright, P.W., Carvalho, L., Clutton-Brock, T., Dawson, A., Edwards, M., Elliott, J.M., Harrington, R., Johns, D., Jones, I.D., Jones, J.T., Leech, D.I., Roy, D.B., Scott, W.A., Smith, M., Smithers, R.J., Winfield, I.J. & Wanless, S. (2010) Trophic level asynchrony in rates of phenological change for marine, freshwater and terrestrial environments. *Global Change Biology*, **16**, 3304–3316.

- Thomas, D.W., Blondel, J., Perret, P., Lambrechts, M.M. & Speakman, J.R. (2001) Energetic and fitness costs of mismatching resource supply and demand in seasonally breeding birds. *Science*, **291**, 2598–2600.
- Thomas, J.A., Telfer, M.G., Roy, D.B., Preston, C.D., Greenwood, J.J.D., Asher, J., Fox, R., Clarke, R.T. & Lawton, J.H. (2004) Comparative losses of British butterflies, birds, and plants and the global extinction crisis. *Science*, **303**, 1879–1881.
- Tilgar, V., Mänd, R., Kilgas, P. & Mägi, M. (2010) Long-term consequences of early ontogeny in free-living Great Tits *Parus major*. *Journal of Ornithology*, **151**, 61–68.
- Tinbergen, J.M. (2005) Biased estimates of fitness consequences of brood size manipulation through correlated effects on natal dispersal. *Journal of Animal Ecology*, **74**, 1112–1120.
- Tinbergen, J.M. & Boerlijst, M.C. (1990) Nestling Weight and Survival in Individual Great Tits (*Parus-Major*). *Journal of Animal Ecology*, **59**, 1113–1127.
- Tinbergen, J.M. & Dietz, M. (1994) Parental energy expenditure during brood rearing in the Great Tit (*Parus major*) in relation to body mass, temperature, food availability and clutch size. *Functional Ecology*, **8**, 563–572.
- Török, J., Hegyi, G., Tóth, L. & Könczey, R. (2004) Unpredictable food supply modifies costs of reproduction and hampers individual optimization. *Oecologia*, **141**, 432–443.
- Travis, J.M.J. & Dytham, C. (2012) Dispersal and climate change: a review of theory. *Dispersal ecology and evolution* (eds J. Clobert, M. Baguette, T.G. Benton & J.M. Bullock), pp. 337–348. Oxford University Press, United Kingdom.
- Tremblay, I., Thomas, D., Blondel, J., Perret, P. & Lambrechts, M.M. (2005) The effect of habitat quality on foraging patterns, provisioning rate and nestling growth in Corsican Blue Tits *Parus caeruleus*. *Ibis*, **147**, 17–24.
- Tremblay, I., Thomas, D.W., Lambrechts, M.M., Blondel, J. & Perret, P. (2003) Variation in Blue Tit breeding performance across gradients in habitat richness. *Ecology*, **84**, 3033–3043.
- V**
- Veen, T., Sheldon, B.C., Weissing, F.J., Visser, M.E., Qvarnstrom, A. & Saetre, G.P. (2010) Temporal differences in food abundance promote coexistence between two congeneric passerines. *Oecologia*, **162**, 873–884.
- Veistola, S., Eeva, T. & Lehtikoinen, E. (1995) Seasonal occurrence of arthropods as a source of food for birds in Finnish Lapland. *Entomologica Fennica*, **6**, 177–181.
- Verboven, N., Tinbergen, J.M. & Verhulst, S. (2001) Food, reproductive success and multiple breeding in the Great Tit *Parus major*. *Ardea*, **89**, 387–406.
- Verhulst, S. (1994) Supplementary Food in the Nestling Phase Affects Reproductive Success in Pied Flycatchers (*Ficedula hypoleuca*). *Auk*, **111(3)**, 714–716.
- Verhulst, S., Van Balen, J.H. & Tinbergen, J.M. (1995) Seasonal Decline in Reproductive Success of the Great Tit: Variation in Time or Quality? *Ecology*, **76(8)**, 2392–2403.
- Verhulst, S. & Nilsson, J.A. (2008) The timing of birds' breeding seasons: a review of experiments that manipulated timing of breeding. *Philosophical Transactions of the Royal Society B-Biological Sciences*, **363**, 399–410.
- Verhulst, S., Perrins, C.M. & Riddington, R. (1997) Natal dispersal of Great Tits in a patchy environment. *Ecology*, **78**, 864–872.
- Virelainen, M. (1984) Breeding biology of the Pied Flycatcher *Ficedula hypoleuca* in relation to population density. *Annales Zoologica Fennica*, **21**, 187–197.
- Visser, M.E. (2008) Keeping up with a warming world; assessing the rate of adaptation to climate change. *Proceedings of the Royal Society B-Biological Sciences*, **275**, 649–659.
- Visser, M.E. & Both, C. (2005) Shifts in phenology due to global climate change: the need for a yardstick. *Proceedings of the Royal Society B-Biological Sciences*, **272**, 2561–2569.
- Visser, M.E., Both, C. & Lambrechts, M.M. (2004) Global Climate Change Leads to Mismatched Avian Reproduction. *Advances in Ecological Research*, **35**, 89–110.
- Visser, M.E. & Holleman, L.J.M. (2001) Warmer springs disrupt the synchrony of oak and winter moth phenology. *Proceedings of the Royal Society B-Biological Sciences*, **268**, 289–294.

- Visser, M.E., Holleman, L.J.M. & Gienapp, P. (2006) Shifts in caterpillar biomass phenology due to climate change and its impact on the breeding biology of an insectivorous bird. *Oecologia*, **147**.
- Visser, M.E. & Lessells, C.M. (2001) The costs of egg production and incubation in great tits (*Parus major*). *Proceedings of the Royal Society B-Biological Sciences*, **268**, 1271–1277.
- Visser, M.E., Van Noordwijk, A., Tinbergen, J.M. & Lessells, C.M. (1998) Warmer springs lead to mistimed reproduction in great tits (*Parus major*). *Proceedings of the Royal Society B-Biological Sciences*, **265**, 1867–1870.
- W**
- Wardrop, S.L. & Ydenberg, R.C. (2003) Date and parental quality effects in the seasonal decline in reproductive performance of the Tree Swallow *Tachycineta bicolor*: interpreting results in light of potential experimental bias. *Ibis*, **145**, 439–447.
- Wiebe, K.L. & Slagsvold, T. (2009) Parental Sex Differences in Food Allocation to Junior Brood Members as Mediated by Prey Size. *Ethology*, **115**, 49–58.
- Wiggins, D.A., Pärt, T. & Gustafsson, L. (1994) Seasonal Decline in Collared Flycatcher *Ficedula albicollis* Reproductive Success - an Experimental Approach. *Oikos*, **70**, 359–364.
- Wiggins, D.A., Pärt, T. & Gustafsson, L. (1998) Timing of breeding and reproductive costs in collared flycatchers. *Auk*, **115**, 1063–1067.
- Wikelski, M. & Cooke, S.J. (2006) Conservation physiology. *Trends in Ecology & Evolution*, **21**, 38–46.
- Wiley, C., Fogelberg, N., Saether, S.A., Veen, T., Svedin, N., Kehlenbeck, J. V & Qvarnstrom, A. (2007) Direct benefits and costs for hybridizing *Ficedula* flycatchers. *Journal of Evolutionary Biology*, **20**, 854–864.
- Wilkin, T. a., King, L.E. & Sheldon, B.C. (2009) Habitat quality, nestling diet, and provisioning behaviour in great tits *Parus major*. *Journal of Avian Biology*, **40**, 135–145.
- Winkel, W. & Winkel, D. (1993) Zur Ansiedlung von Trauerschnäppern (*Ficedula hypoleuca*) nach Verfrachtung zu Beginn der Brutzeit. *Vogelwarte*, **37**, 50–54.
- Winkler, D.W., Wrege, P.H., Allen, P.E., Kast, T.L., Senesac, P., Wasson, M.F. & Sullivan, P.J. (2005) The natal dispersal of tree swallows in a continuous mainland environment. *Journal of Animal Ecology*, **74**, 1080–1090.
- Y**
- Yoder, J.M., Marschall, E.A. & Swanson, D.A. (2004) The cost of dispersal: predation as a function of movement and site familiarity in ruffed grouse. *Behavioral Ecology*, **15**, 469–476.
- Z**
- Zuur, A.F., Ieno, E.N. & Elphick, C.S. (2010) A protocol for data exploration to avoid common statistical problems. *Methods in Ecology and Evolution*, **1**, 3–14.
- Zuur, A.F., Ieno, E.N., Walker, N.J., Saveliev, A.A. & Smith, G.M. (2009) *Mixed Effects Models and Extensions in Ecology with R*. Springer Press, New York, USA.



