2. Sidharth, B. G., *Chaos, Solitons Fractals*, 2000, **11**, 1045–1046.
3. Sidharth, B. G., *Chaotic Universe: From the Planck to the Hubble Scale* (Nova Science, New York), Science Publishing, New York, 2001.
4. Dirac, P. A. M., *The Principles of Quantum Mechanics*, Clarendon Press, Oxford, 1958, pp. 4ff; 253ff.
5. Salecker, H. and Wigner, E. P., *Phys. Rev.*, 1958, **109**, 571–577.
6. Sidharth, B. G., In Proceedings of Fourth International Symposium on 'Frontiers of Fundamental Physics', Kluwer Academic/Plenum Publishers, New York, 2001, pp. 97–108.
7. Madore, J., *An Introduction to Non-Commutative Differential Geometry*, Cambridge University Press, Cambridge, 1995.
8. Burderi, L. and Di Salvo, T., arXiv: 1207.0207VI, grqc 2012.
9. Sidharth, B. G., *Indian J. Pure Appl. Phys.*, 1997, **35**, 456ff.
10. Lee, T. D., *Particle Physics and Introduction to Field Theory*, Harwood Academic, 1981, pp. 391ff.
11. Tassie, L. J., *The Physics of Elementary Particles*, Longman, New York, 1973.
12. Hawking, S. and Israel, W., *General Relativity: An Einstein Centenary Survey*, Cambridge University Press, Cambridge, 1979.
13. Feynman, R. P., *Lectures on Physics Vol. 3*, Addison-Wesley, Reading, MA, USA, 1965.
14. Angelopoulos, A. *et al*., *Phys. Lett. B*, 1998, **444**, 43.
15. Bernabeu, J., Martinez-Vidal, F. and Villanueva-Perez, P., *J. High Energy Phys.*, 2012, **064**, 1208.
16. Lees, J. P. *et al.*, *Phys. Rev. Lett.*, 2012, **109**, 211801.
17. Zeller, M., *Physics*, 2012, **5**, 129.

Received 30 November 2012; accepted 28 January 2013

B. G. SIDHARTH

G. P. Birla Observatory & Astronomical Research Centre,
B. M. Birla Science Centre,
Adarsh Nagar,
Hyderabad 500 063, India
e-mail: birlasc@gmail.com

Implications of temperature change on spring arrival dates of chiffchaff (*Pylloscopus collibyta* Vieillot) in a site in Croatia

Recent changes in climate have impacted plant and animal ecology worldwide[1]. In the past two decades, numerous papers have been published to describe long-term changes in phenology, demography, distributions and other important parameters in many species over the globe[2]. Significant changes in biological systems have already been reported from all the continents[3]. For instance, many plant species have extended their growing season[4] and warmer temperatures are associated with earlier spawning in some amphibians[5]. Likewise, climate change influences birds in different ways. In the United Kingdom, bird species have extended their breeding ranges northwards by a mean of 18.9 km, a shift which is potentially linked to increasing average temperatures[6]. Dolenec *et al*.[7] found that breeding dates for the tree sparrow *Passer montanus* have advanced between 1979 and 2009 in Croatia, in response to warming springs. Studies have demonstrated increased clutch sizes[8], brood sizes[9] and changes in population size[10] in relation to climate change. Furthermore, for many bird species in the Northern Hemisphere arrival dates have advanced in response to increase in spring temperature[11–13]. In general, studies have shown that short- and medium-distance migrant birds have earlier first arrival dates than long-distance migrant birds[14,15]. Studies on the timing of migration of birds have been an important model for characterizing the impacts of climate change. Warming affects the phenology of different species in different ways, which can have a negative effect on events such as migration and breeding, which were previously synchronized with the phenology of resources[16,17].

The main purpose of this note is to reveal long-term (1982–2010) trends in the arrival dates of chiffchaff *Phylloscopus collibyta* (Vieillot, 1817) to the Mokrice area, northwestern Croatia (46°00′N, 15°55′E; 140 m amsl) and to examine the relation with mean monthly temperatures. This area is mostly mixed landscape with deciduous woods (dominated by pedunculate oak *Quercus robur* and hornebeam *Carpinus betulus*; other tree species that occur in low proportion include common maple *Acer campestre*, ash *Fraxinus angustifolia* and common elm *Ulmus minor*). According to Cramp[18],

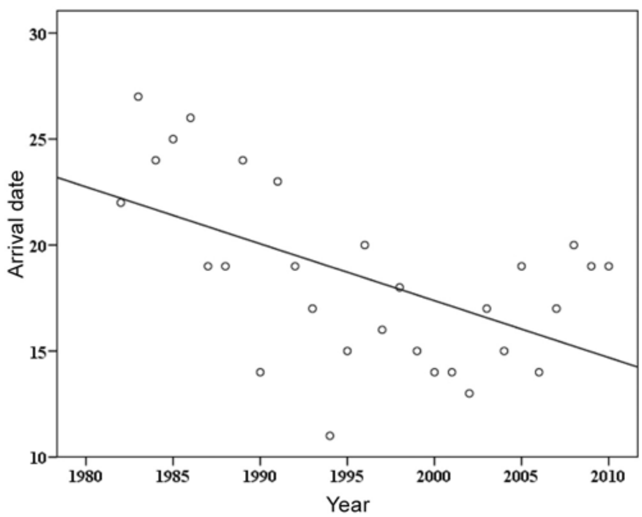

Figure 1. Temporal trend (1982–2010) in arrival date (1 indicates 1 March) of the chiffchaff in northwestern Croatia. Arrival date for each year was calculated as the mean of the first five bird arrivals recorded for that year.

the chiffchaff is a small, socially monogamous and insectivorous passerine. It is a short-distance migrant bird species (wintering mainly in the Mediterranean region)[18].

Arrival date for each year was calculated as the mean of the first five bird arrivals recorded for that year. This method was previously used by Both *et al.*[19]. Each year all records were made by the present author and so the method was consistent throughout the study period. Dates were converted to numerical values such that 1 indicates 1 March. Local air temperature is often considered the most important factor influencing phenological performances of birds[20–23]. February and March temperatures could be the most important environmental factors influencing spring migration. Meteorological data were obtained from the meteorological station at Maksimir (Meteorological Office in Zagreb), situated ca. 20 km away from research area (123 m amsl). Average air temperatures (1982–2010) for each year were calculated from the average temperatures for February and March (February–March, mean = 4.5°C, SD = 2.2, range = 0.3°C to 7.9°C; separately: February, mean = 2.3°C, SD = 3.0, range = –3.6°C to 6.9°C and March, mean = 6.7°C, SD = 2.1, range = 1.7°C to 10.3°C).

Correlation and regression methods were employed using SPSS 13.0 for Windows. Regression equations and parameters were used to better illustrate degree of ongoing changes on a yearly basis. Statistical treatment included Pearson's correlation (r) and regression analysis. P values higher than 0.05 were considered non-significant. All tests are two-tailed.

During the study period (1982–2010), the first arrival date (spring migration) of the chiffchaff varied from as early as 11 March (1994) to as late as 27 March (1983), mean 18 March and modal value 19 March. Correlation between arrival date and year was expressed as $y = 546.42 - 0.27x$ ($r = -0.540$, $n = 29$, $P = 0.002$; Figure 1), where the y-axis represents arrival dates and x-axis the year. Based on the linear regression slopes, we can infer that arrival dates for chiffchaff in northwestern Croatia have advanced by 0.27 days/year. Over the past 29 years, the mean arrival date of the species has advanced by about 7.83 days. Average arrival date was significantly negatively associated with mean temperature ($r = 0.614$, $n = 29$, $P < 0.001$; Figure 2). Mean temperature in February–March increased significantly during the study period ($r = 0.394$, $n = 29$, $P = 0.035$; Figure 3). The results suggest that changes in arrival date are linked to changes in local air temperatures.

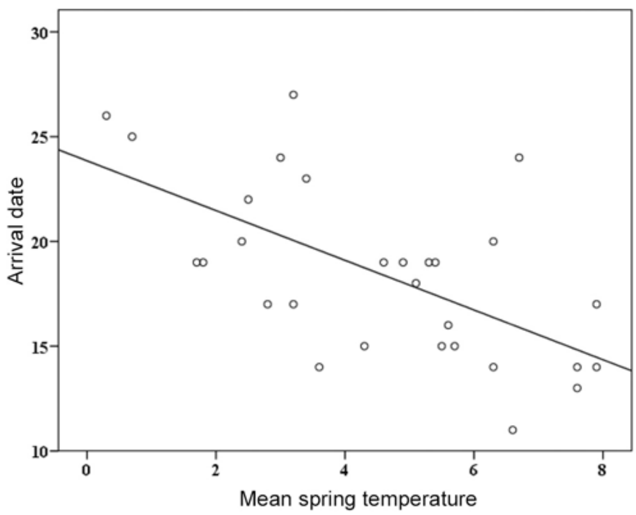

Figure 2. Arrival date (1 indicates 1 March) of chiffchaff in relation to mean February–March temperatures (°C), 1982–2010. Arrival date for each year was calculated as the mean of the first five bird arrivals recorded for that year.

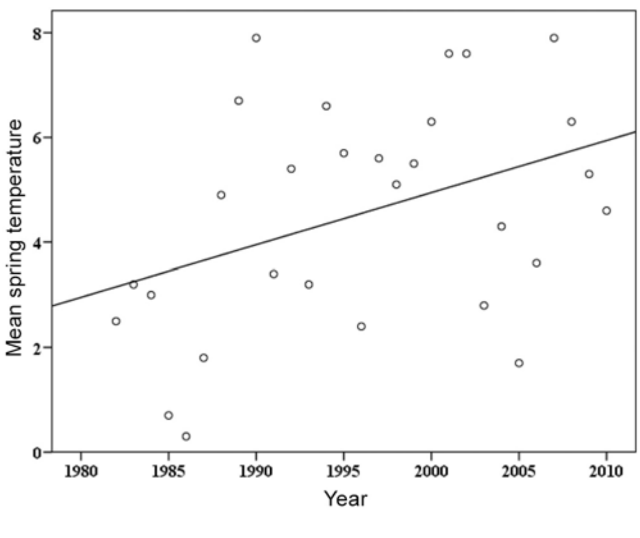

Figure 3. Relationship between mean February–March temperatures (°C) and year in the study area (1982–2010).

Our results are consistent with the findings of similar studies for the same species in United Kingdom[24] and Germany[25]. In other bird species, a few studies at single locations have also demonstrated shifts towards earlier arrival in response to warming local spring temperature in the recent 30–40 years. For example in Italy, Rubolini *et al.*[26] showed that changes in the mean arrival date of a population of swift *Apus apus* and barn swallow *Hirundo rustica* between 1982 and 2006 are linked to a shift in local air temperature. Furthermore, Dolenec and Dolenec[27] also found that arrival dates for the wood pigeon *Columba palumbus* had advanced between 1983 and 2007 in Croatia, in response to temperature change. However, these trends are not consistent across all localities. According to Barret[28], arrival dates of migrants in Norway have not advanced. It could reflect the fact that there is little evidence of climate warming in this country. In general, trends appear to vary within areas, within species and within populations of the same species.

Large changes in arrival dates may have important consequences for other parts of the annual cycle species. According to Saino *et al.*[29], failure to adjust phenological events to rapidly changing climatic conditions may be an important factor causing negative demographic and conservation effects among birds breeding in Europe. According to Sokolov *et al.*[30], the prognosis of future trends in the timing of spring migration in Europe and in other regions depends on the forecast for future climate change. Understanding how the strength and magnitude of such responses vary across species and with ecological context is critical to predict the consequences of ongoing and future climate change and to identify species most at risk[31].

1. IPCC, *Climate Change 2007: The Physical Science Basis.* In Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (eds Solomon, S. et al.), Cambridge University Press, Cambridge, 2007.
2. Parmesan, C. and Yohe, G. A., *Nature*, 2003, **421**, 37–42.
3. Parmesan, C., *Annu. Rev. Ecol. Evol. Syst.*, 2006, **37**, 637–669.
4. Menzel, A. and Fabian, P., *Nature*, 1999, **397**, 659.
5. Tryjanowski, P., Rybacki, M. and Sparks, T., *Ann. Zool. Fenn.*, 2003, **40**, 459–464.
6. Thomas, C. D. and Lennon, J. J., *Nature*, 1999, **399**, 213.
7. Dolenec, Z., Dolenec, P. and Møller, A. P., *Curr. Zool.*, 2011, **57**, 414–418.
8. Møller, A. P., *J. Anim. Ecol.*, 2002, **71**, 201–210.
9. Dolenec, Z., *Pol. J. Ecol.*, 2009, **57**, 817–820.
10. D'Alba, L., Monagham, P. and Nager, R. G., *Ibis*, 2010, **152**, 19–28.
11. Tryianowski, P., Kuźniak, S. and Sparks, T., *Ibis*, 2002, **144**, 62–68.
12. Dolenec, Z. and Dolenec, P., *Pol. J. Ecol.*, 2010, **58**, 605–608.
13. Dolenec, Z. and Dolenec, P., *Zoologia*, 2011, **28**, 139–141.
14. Butler, C. J., *Ibis*, 2003, **145**, 485–495.
15. Biaduń, W., Kitowski, I. and Filipiuk, E., *Pol. J. Environ. Stud*., 2011, **20**, 843–849.
16. Both, C. and Visser, M. E., *Nature*, 2001, **411**, 296–298.
17. Visser, M. E., Both, C. and Lambrechts, M. M., *Adv. Ecol. Res.*, 2004, **35**, 89–110.
18. Cramp, S., *Complete Birds of Western Palaearctic on CD–ROM*, Oxford University Press, Oxford, 1998.
19. Both, C., Bijalsma, R. G. and Visser, M. E., *J. Avian Biol*., 2005, **36**, 368–373.
20. Hušek, J. and Adamík, P., *J. Ornithol.*, 2008, **149**, 97–103.
21. Dolenec, Z., Dolenec, P., Kralj, J. and Kiš-Novak, D., *Pol. J. Ecol.*, 2009, **57**, 611–614.
22. Dolenec, Z. and Dolenec, P., *J. Environ. Biol.*, 2011, **32**, 625–627.
23. Dolenec, Z., Dolenec, P. and Kralj, J., *Curr. Sci.*, 2012, **102**, 970–972.
24. Croxton, P. J., Sparks, T. H., Cade, M. and Loxton, R. G., *Acta Ornithol.*, 2003, **41**, 103–111.
25. Peintinger, M. and Schuster, S., *Vogelwarte*, 2005, **43**, 161–169.
26. Rubolini, D., Ambrosini, R., Caffi, M., Bricheti, P., Armiraglio, S. and Saino, N., *Int. J. Biometeorol.*, 2007, **51**, 553–563.
27. Dolenec, Z. and Dolenec, P., *Turk. J. Zool.*, 2010, **34**, 267–269.
28. Barret, R. T., *Bird Study*, 2002, **49**, 270–277.
29. Saino, N. *et al.*, *Philos. Trans. R. Soc. London, Ser. B*, 2011, **278**, 835–842.
30. Sokolov, L. V., Markovets, M. Y., Shapaval, A. P. and Morozov, Y. G., *Avian Ecol. Behav.*, 1998, **1**, 1–21.
31. Hurlbert, A. H. and Liang, Z., *PLoS One*, 2012, **7**, e31662.

ACKNOWLEDGEMENTS. I thank the referees for comments that helped improve the manuscript. I also thank the Meteorological Office in Zagreb for providing temperature data. This study was supported by the Croatian Ministry of Science, Education and Sport (grant 119-1012682-1221).

Received 31 May 2012; revised accepted 28 January 2013

ZDRAVKO DOLENEC

Department of Zoology,
Faculty of Science,
University of Zagreb,
Rooseveltov trg 6,
HR-10000 Zagreb, Croatia
e-mail: dolenec@zg.biol.pmf.hr

Early Ediacaran (Terminal Neoproterozoic) sponges and additional associated microbiota from Chambaghat Formation, Krol Group, Himachal Lesser Himalaya

We report here the Early Ediacaran sponges as seen in the petrographic sections of phosphatic black chert lenticles associated with quartz arenite of Chambaghat Formation (Krol Sandstone), Krol Group belonging to Kamlidhar Syncline[1,2]. Associated microbiota comprising animal embryos, acritarchs, cyanobacteria and vase-shaped microfossils (VSMs) are also recorded. The rocks of Chambaghat Formation yielding the above microbiota are exposed near Jahar (30°45.778″N : 77°13.306″E), Sauti (30°48.216″N : 77°11.673″E), Khangugh (30°49.152″N : 77°11.856″E) and Ochhghat (30°52.013″N : 77°09.224″E) in Sirmaur and Solan districts of Himachal Pradesh (Figures 1 and 2). Geological studies of the area and sample collection were undertaken by a team of geologists from the Geological Survey of India (GSI), Northern Region, Lucknow. Micropalaeontological studies were carried out by scientists from the Birbal Sahni Institute of Palaeobotany (BSIP), Lucknow under a collaborative programme with GSI.

Twenty-two genera of brownish-yellow microbial remains represented by acritarchs, algae (cyanobacteria, rhodophytes) and VSMs have been earlier recorded in petrographic thin sections and macerated fractions of phosphatic chert lenticles of Chambaghat Formation, Krol Group, Himachal Lesser Himalaya[3]. Animal eggs and embryos have also been recorded from the same horizon[4].

The present study reveals 11 taxa of biological remains comprising micro-invertebrate: sponges (two taxa) and animal embryo, acritarchs (four taxa), cyanobacteria (four taxa) of coccoidal and filamentous forms and single taxon of VSM. The slides are preserved in the museum of BSIP (statement no. 1316).