The following supplement accompanies the article

Effects of urbanization on bird phenology: a continental study of paired urban and rural populations

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Supplement.

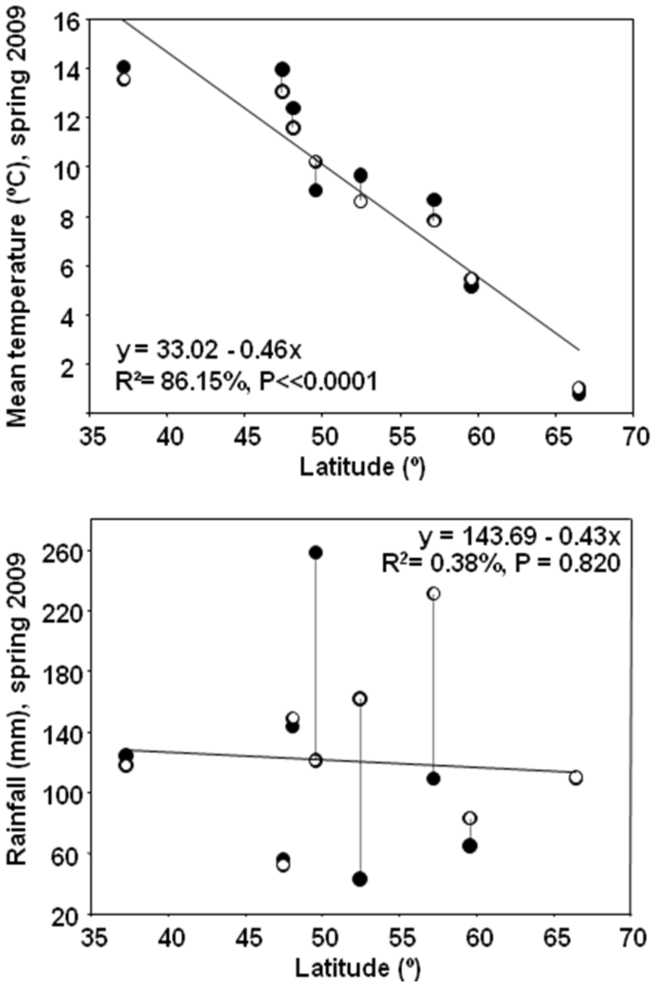

Figure S1 Latitudinal and urban/rural variation in mean spring temperature and total spring rainfall in 2009 for the eight study sites. Long-term data showed the same pattern, as demonstrated by lack of significant effects of data type (2009 or long-term) in a General Linear Model test (see text for details). Filled circles: urban stations; empty circles: rural stations. Continuous lines are the linear regressions detailed inside graphs, and pointed lines join nearby rural and urban stations. Data are provided in Table S2.

Table S1 Location, current human population and area of the eight cities. Current human population size and area were extracted from www.wikipedia.org, except for Brønderslev's area, that was measured from recent maps and aerial photographs.

City	Latitude	Longitude	Human population size	Area (km^2)
Rovaniemi	66°27' N	25 ° 37' E	59,000	55.70
Tallinn	59 ° 33' N	24 ° 52' E	406,000	159.20
Brønderslev	57 ° 12' N	10 ° 00' E	12,000	8.15
Poznan	52 ° 25' N	16 ° 55' E	856,000	261.85
Olomouc	49 ° 34' N	17 ° 15' E	110,000	103.36
Paris	48 ° 04' N	2 ° 11' E	11,769,000	2844.80
Budapest	47 ° 28' N	19 ° 02' E	2,503,000	525.20
Granada	37 ° 15' N	3 ° 40' W	238,000	88.02

Estimating duration of the singing period and testing for consistency among years and different sources of information.

We estimated duration of the singing period in urban and rural habitats in two ways. First, we estimated mean and standard deviation of singing date of birds for all species, localities and habitats. The standard deviation is larger when the duration of the singing period is longer. Second, we estimated 10- and 90-percentiles of singing date for all species, localities and habitats. These two sets of estimates were strongly positively correlated (model that included species and study plot as factors: $F = 355.17$, df = 1, 75, $r^2 = 0.83$, $P < 0.0001$, slope (SE) = 2.365 (0.126)). Furthermore, the difference in standard deviation between urban and rural populations was strongly positively correlated with the difference in 10- to 90-percentile between urban and rural populations (model that included species and study plot as factors: $F = 227.69$, df = 1, 75, $r^2 = 0.75$, $P < 0.0001$, slope (SE) = 2.372 (0.157)). Thus, the two estimates provided similar information. Therefore, we use 10- to 90-percentile of the singing period as a measure of duration of the singing period. These analyses were restricted to species with a minimum total number of 20 records of singing individuals from both paired sites.

We estimated the duration of the singing period for the same species in urban and rural habitats in Paris in 2008 and 2009 to assess degree of variation between years. The two series of estimates were highly consistent ($F = 2935.99$, df = 1, 46, $r^2 = 0.98$, $P < 0.0001$, slope (SE) = 1.004 (0.019)). Likewise, the difference in duration of the singing period between urban and rural birds for the two years was highly consistent ($F = 88.7$, df = 1, 22, $r^2 = 0.80$, $P < 0.0001$, slope (SE) = 0.516 (0.055)). Thus, estimates of duration of the singing period and difference in singing period between urban and rural populations from a single year provide reliable estimates.

We tested if duration of the singing period reflected duration of the breeding season in two ways. We extracted information on duration of the breeding season from Cramp & Perrins (1977-1994), using the annual cycle diagrams for the main period of reproduction. We found a positive correlation between the duration of the breeding season as reflected by 10- to 90-percentile of singing for the different pairs of populations and duration of the breeding season as reported by Cramp & Perrins (1977-1994) (urban: $F = 29.04$, df = 1, 132, $r^2 = 0.18$, $P < 0.0001$, slope (SE) = 3.888 (0.721); rural: $F = 16.03$, df = 1, 132, $r^2 = 0.12$, $P < 0.0001$, slope (SE) = 2.918 (0.729)). Thus duration of the singing period provides an estimate of the duration of the breeding season that is consistent with published information.

Second, we used direct information on reproduction in the study areas to estimate duration of the breeding season. During line transects and point counts we recorded all nest-building birds, all nests with eggs or nestlings, and all fledglings. These records were transformed into first egg laying dates, using information on duration of nest-building period, incubation period and nestling period from Cramp & Perrins (1977-1994), relying the mean estimate of minimum and maximum reported. We made conservative estimates, assuming that the last egg had just been laid and that fledglings had just fledged on the day of observation because we did not have more precise information. This information on timing of laying was available for Brønderslev, Paris, Budapest and Olomouc (the latter from Strachonová 2008). There was a positive correlation between these estimates of duration of the breeding season in the actual study sites and the duration of the singing period (Brønderslev: $F = 20.67$, df = 1, 13, $r^2 = 0.61$, $P < 0.0001$, slope (SE) = 0.685 (0.151); Paris: $F = 18.05$, df = 1, 43, $r^2 = 0.30$, $P < 0.0001$, slope (SE) = 0.679 (0.147); Budapest: $F = 21.05$, df = 1, 18, $r^2 = 0.54$, $P = 0.0002$, slope (SE) = 0.724 (0.158); Olomouc: $F = 6.95$, df = 1, 8, $r^2 = 0.50$, $P = 0.034$, slope (SE) = 0.669 (0.254)). Likewise, there was a positive correlation between these estimates of duration of the breeding season in the study sites and the duration of the breeding season according to Cramp and Perrins (1977-1994) (Brønderslev: $F = 10.39$, df = 1, 40, $r^2 = 0.21$, $P = 0.0025$, slope (SE) = 3.655 (1.134); Paris: $F = 23.02$, df = 1, 44, $r^2 = 0.34$, $P < 0.0001$, slope (SE) = 0.06 (0.013); Budapest: $F = 31.05$, df = 1, 22, $r^2 = 0.59$, $P < 0.0001$, slope (SE) = 8.268 (1.484); Olomouc: $F = 10.10$, df = 1, 8, $r^2 = 0.56$, $P = 0.013$, slope (SE) = 6.201 (1.951)). Thus use of singing period as an estimate of duration of the breeding season was justified.

Table S2 Weather data for the eight study cities and their rural surroundings for YEAR. Mean temperature and total rainfall for the three spring months March April May and for the whole spring period is shown both for the study year and for the time series available. Sources: NCDC (National Climatic Data Center; www.ncdc.noaa.gov), ECAD (European Climate Assessment & Dataset; www.ecad.edu), and Czech, Hungarian and Polish Weather Institutes (W.I.). Data for rural Tallinn in 2009 was estimated from the urban station using two equations computed from 224 daily records obtained between 1961 and 1977 at the stations of the Naissar Island (NCDC #260340), TEMP_NAISSAR= 0.95(0.15) + 0.87(0.01)*TEMP_TALLINN; $F_{1,\ 222}$=3613.0 P<0.0001, R^2= 0.94, and RAIN_NAISSAR= -0.11(0.64) + 1.27(0.16)*RAIN_TALLINN; $F_{1,\ 222}$ = 65.11, P < 0.00001, R^2 = 0.22. Urban Poznan rainfall data is the long-term average, as no data for 2009 was available. No long-term data for the Veska station (rural Olomouc) was available (www.worldweatheronline.com/Olomouc-weather-history/Olomoucky-Kraj/CZ.aspx).

		Study year (2009)								Time series available									
City	Location	Mean temperature (ºC)				Total rainfall (mm)				Mean temperature (ºC)				Total rainfall (mm)				source	time series
		March	April	May	spring	March	April	May	spring	March	April	May	spring	March	April	May	spring		
Rovaniemi	urban	-5.5	-0.7	8.8	0.8	16.5	18.3	74.4	109.2	-6.0	-0.4	6.3	-0.1	13.7	12.0	16.5	42.3	NCDC #28450	1973-2014
Tallinn	urban	-0.7	5.4	10.9	5.2	42.9	3.6	18.8	65.3	-1.9	3.8	9.7	3.9	43.4	35.4	35.4	114.2	NCDC #260380	1953-2014
Brønderslev	urban	4.4	9.7	12.0	8.7	46.5	13.2	50.0	109.7	2.6	6.6	11.3	6.9	12.5	11.2	18.3	42.1	NCDC #60300	1940-1943, 1973-2014
Poznan	urban	3.9	11.6	13.5	9.7	13.8	11.2	18.4	43.4	2.8	7.7	13.0	7.8	13.8	11.2	18.4	43.4	NCDC #123300, #123260	1952-1963, 1973-1980, 2002-2014
Olomouc	urban	2.9	11.4	12.8	9.0	149.1	23.1	86.3	258.5	3.4	8.6	13.9	8.7	71.5	52.0	38.7	162.1	Czech W.I., Olomouc	1901-2000
Paris	urban	8.3	13.1	15.7	12.4	31.2	42.2	70.4	143.8	8.7	11.7	15.3	11.9	69.2	68.9	95.9	234.0	NCDC #71560	1983-2014
Budapest	urban	6.9	16.7	18.2	13.9	43.5	4.1	8.4	56.0	6.2	11.5	16.5	11.4	64.0	51.2	36.3	151.5	Hungarian W.I., Budapest	1901-2000
Granada	urban	11.8	11.8	18.6	14.0	59.3	48.4	17.1	124.8	10.3	14.1	19.8	14.7	56.4	9.9	0.0	66.3	NCDC #80144	2004-2014
Rovaniemi	rural	-5.4	-0.4	9.0	1.1	18.3	17.1	74.7	110.1	-6.4	-0.6	6.1	-0.3	18.1	16.8	22.1	57.0	ECAD #146205, #146207	1959-2104
Tallinn	rural	0.3	5.6	10.4	5.5	54.6	4.4	24.0	83.2									estimated from Tallinn	
Brønderslev	rural	3.5	8.9	11.1	7.9	83.8	68.6	79.0	231.4	2.9	7.4	11.1	7.3	32.1	35.8	62.1	130.0	NCDC #60310	2009-2014
Poznan	rural	3.7	10.3	12	8.6	49.2	15.3	97.4	161.9	3.7	8.6	14.1	8.8	47.5	47.4	61.4	156.4	Polish W.I.,Turew	1970-2010
Olomouc	rural	3.3	13.1	14.2	10.2	37.2	6.9	76.9	121.0									Czech W.I., Veska, Dolany	
Paris	rural	7.3	12.5	15.1	11.6	28.7	43.9	76.5	149.1	7.5	10.5	14.2	10.7	19.3	18.6	24.9	62.8	NCDC #71490	1944-1956, 1973-2014
Budapest	rural	6.0	15.5	17.6	13.1	38.1	3.0	11.2	52.3	5.7	11.0	15.8	10.8	21.8	34.5	74.2	130.6	Hungarian W.I., Pestszentimre	1901-2000
Granada	rural	11.4	11.3	18.1	13.6	52.9	46.3	19.0	118.2	11.4	13.8	17.9	14.4	15.6	15.5	11.8	42.9	NCDC #80190	1973-2014