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PAST SOLAR AND ENVIRONMENTAL BIO SIGNIFICANT EVENTS AND CURRENT POPULATION STRUCTURE OF THE BIOTA

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Introduction

The structure of a living population being strictly controlled by biological rules and restrictions could be to a certain degree resistant to environmental processes. Nevertheless, a number of available facts regarding the age structure of populations contradict the expected population variables, distributions and trends. The deviations are presumably generated by environmental events and can be robust over the whole life span of the population. The aim of the study presented is the analysis of such sustainable deviations, which provide information about the life history of individuals forming the population and reciprocal reconstruction, if possible, the past bio significant environmental events with respective clarification of cosmic or solar contribution.

It is known that some long living organisms are capable of storing the year-to-year time series protocol of environment and climate dependent morphological changes, e.g. tree rings, scallop shell, and fish scale. But the ensembles of organisms can be also highly responsive to the definite environmental events. For instance, earlier there was described the phenomenon of the domination of an age class in the total population age distribution. Such fact was first documented for the age structure of Norwegian herring population determined on the basis of multiannual catch data for the 1907 to 1919 range (Hjort, 1926). The 1904 born quote of fish markedly 4-5 fold prevailed throughout the whole surveillance period as compared to quotes of the population born in preceding or following years. Thus, the single variable factor for inter populations comparison, was the birth time, so in 1904 the environmental conditions were, presumably, favorable to fish development and followed the survival. As our analysis had revealed, the most significant for the organism the first year of the fish history was the 1905, the year of the solar activity maximum. Thus, the population observed in 1919 bore marks of the favorable 1904-1905 conditions which appeared as 15 years temporal gap imprint in dynamic population structure. Another recently obtained example of human birth data dependence for Great Britain adult (older 30 years) women population age parameters were demonstrated by L.A. Gavrilov and N.S. Gavrilova (1999). They found among adult women that the cohorts have been born in May-June and December tend to live 3 years longer on the average by comparison with women born in August. The adult or old human population in GB bears the imprints of the birth data month, which occurred some decades ago. Thus, the month of birth was a predictor of the life expectancy. The half-year cycles in geophysical processes is reliably documented, see for instance (Russel, Pherron, 1973). According to contemporary approaches, such rhythms might have been built-in in genome at earlier evolution stages (Cornelissen et al., 2002) or be currently driven by half-year cyclic geophysical processes. This unevenness of onset conditions for life might result in so called individual annual cycle (IAC) in life expectancy, which, in turn, modulates the instant age structure of human population by annual or semiannual cycles.

According to Mathematical Modeling for Aging Processes Laboratory in Kiev Institute of Gerontology, the month of birth was significantly associated with the month of death in 102.265 individuals who died in Kiev during the period 1990-2000. A consistent trend in deaths was revealed with excess around the birthday. This excess on the actual anniversary of birth was 44.4% in men ($\chi^2 = 11.48$, $P < 0.001$) and 36.2% in women ($\chi^2 = 7.64$, $P < 0.01$) over the expected value. Significant variations in the mortality rate were obtained, according to the month of the IAC. The excess of mortality was associated with the first and the last month of IAC in different age groups as well as in all major causes of death: circulatory (heart and cerebrovascular) diseases, malignant neoplasms and violent death. Neither the emotional stress nor the behavioral changes associated with the birthday can explain the results obtained. The authors hypothesized that `birth stress` might be imprinted in a structure of the biological rhythms of the organisms, thus resulting in periodic changes of vulnerability and survival during the course of the IAC (Vaiserman et al., 2003).

The data regarding the plant kingdom aging are very scarce. Available monitoring long-term time series for the perennial plants in Polar Alpine Botanical Garden (PABGI) allow one to check the above mentioned life history start data dependence in relation to plant diversity.

Results and discussion

The special issue of the paper presented is an age structure of perennial herbaceous plants cultivated since 1930^{th} at the outdoor nurseries of Polar Alpine Botanical Garden situated at WS valley of Khibiny mountains, (67°38'N, 33°37'E) 300-400 m a.s.l. The various plant species started their life history here in various years since 1932. The year-to-year batch additions of newly plant species were approximately the same, which resulted in slight, even and monotonous total mixed species population size growth through the whole surveillance period. Nevertheless, as it is seen in Fig. 1 and 2, the survival of various yearly subpopulations was quite different and respective cohorts seemingly modulated by the Schwabe solar cycles at least up to the 60th- 70th. It is known that the plant species are highly variable in adaptation capability and in their resistance to the Northern environment. To explore the difference we consider here the less resistant rare species subpopulation separately. Fig.1 and Fig.2 depict the age distribution for the rare and for the total (more then 6000) plant species yearly quotes planted in the various years since 1932 until 2000 in relative and absolute units, respectively in comparison with yearly Wolf numbers. The data for rare species are presented as three years mean quotes and obtained by every three point data averaging.

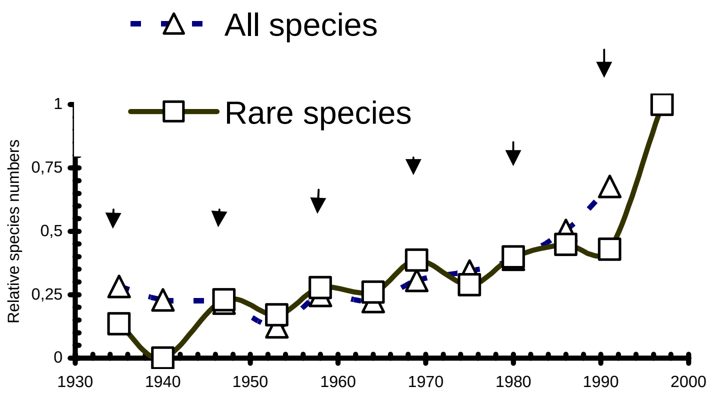

Fig. 1 Ratios of survived rare perennial herbaceous plant species planted in PABGI outdoor nurseries yearly. The points are three year means. The arrows mark solar activity maxima of Schwabe cycle

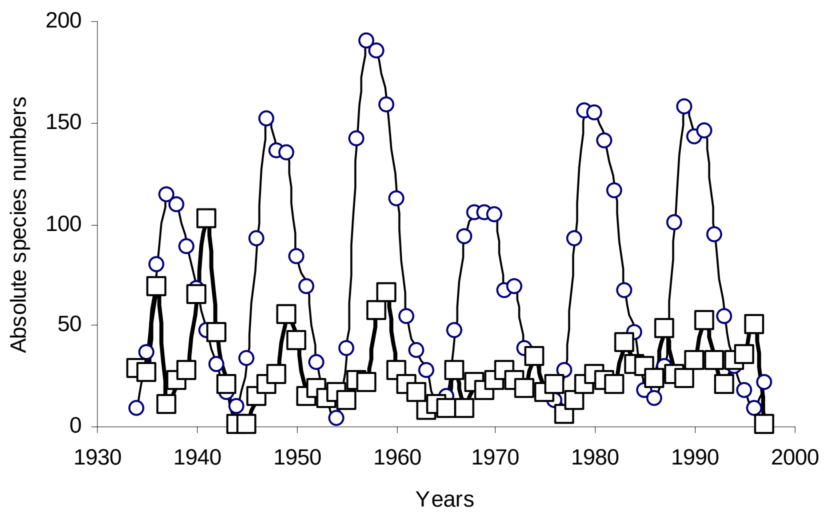

Fig. 2 Absolute sizes of yearly planted and survived up 2000 quotes of total 6000 plant species vs Wolf numbers

The modulation of the curve by solar activity cycles seems to be more pronounced for the rare species and can be explained by their less resistance and by higher sensitivity to environmental effects. On the other hand, the data show the age distribution of the total generalized herbaceous plant population existing in the Botanical Garden. As it can be seen, some years of 30th, 40th and 50th were extremely favorable for the plant survival. It should be taken into consideration that life expectancy for most organisms is age dependent and decreased, generally speaking, according to Gompertzian statistics, which in turn means approximately exponential mortality rate growth with age.

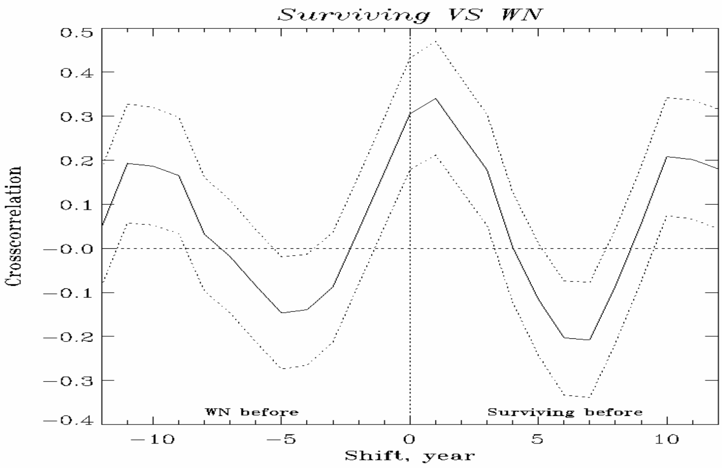

Fig. 3
Crosscorrelation of absolute sizes of yearly planted and survived up to 2000 quotes of rare plant species vs yearly Wolf numbers

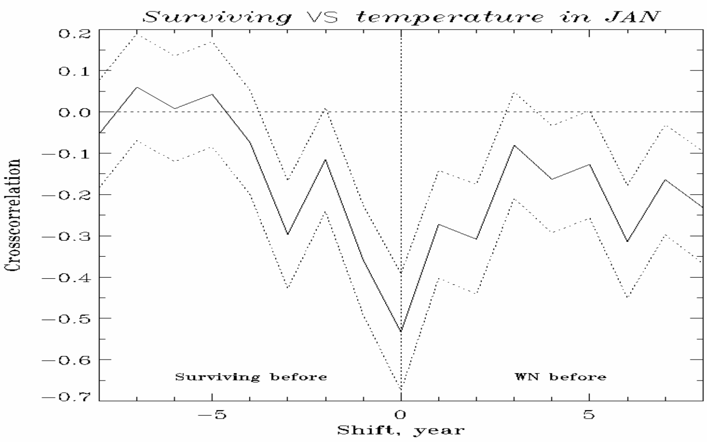

Fig. 4
Crosscorrelation of rare plant survival vs January mean surface temperatures

Thus, the older the individuals survived are, the more apparent breaking of biotic rules, the more significance of presumed abiotic reasons for their survival peaks.

The drop of correlation since mid 60^{th} for total and since mid 70^{th} for rare species populations resulted in low but significant total correlation $r = 0.31 \pm 0.13$ for the whole surveillance period, see Fig. 3, 4.

The decrease of total correlation due to outbreak of chaotic behavior of mortality since 70^{th} was seemingly related to sharp rise in industrial effects by airborne atmospheric precipitation on the plant nurseries. The main commonly accepted chaotic environmental factor affecting the plant expectancy and mortality is surface ground temperature. The respective analysis for the rare plants shows the significant relation of survival to yearly surface winter temperature Fig. 5. The inputs of temperature influence could essentially destruct the cyclic pattern of the dynamics of population variables.

Conclusions

Thus, the contemporary age structure of the perennial herbaceous plants introduced in the Polar Alpine Botanical Garden is modulated by past solar cycles, mainly by 17 to 19. The following solar cycles show much less influence at the plant life span via the vegetation starting date. Thus, the total plant population appears as a cooperative structure having a specific dynamic ‘memory’ in 50 to 70 years span. The results agree with findings that the population structure for either humans or other biota representatives might be modulated by near past exogenous heliogeophysical bio significant events including the solar ones, which occurred during their life history, or/and by far ago past relic events which were built-in in organisms genome at the early stages of their evolution (Ehret, 1974; Cornelissen et al., 2002). The last built-in rhythms underline the IAC described recently in humans, nevertheless the molecular mechanisms of genome long-term memory for the embedded program for the organism eigen biorhythms is not known yet. The both ways entail the unusual “quasicyclic” current dynamical age structure of populations.

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