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NOTES ON THE REPRODUCTION POSSIBILITIES OF HUMAN
PREHISTORICAL POPULATIONS *

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INTRODUCTORY REMARKS

The investigation of the numerical increase dynamics of human groups provides essential information concerning their cultural state, their capacity for numerical and, consequently territorial expansion as well as the social mechanisms regulating the size of the group etc. From the point of view of the paleobiology of human populations, the knowledge of group dynamics is necessary, for the determination of the eco-cultural state, and for the elucidation of the intensity, rate and direction of the gene pool transformations and especially of evolutionary trends (or microevolution).

For the biological and social dynamics of human populations, two essential vital phenomena are decisive: fertility and mortality. The two are interrelated in human groups, these connections being of a complicated nature, especially in populations applying birth control.

Problems of mortality in prehistorical times are comparatively well known; on the other hand, the attempts made by physical anthropologists with the aim of studying reproduction problems often yield dubious and even contradictory results, as it is illustrated in Table 1.

This is due to the application of three different methods of estimating the number of births given by women, each of these methods requiring to a smaller or larger extent initial assumptions, based on presuppositions.

In the most easily applicable of these methods, the one based on the duration of intervals between births from the same woman (birth intervals), the average duration of the reproductive period of women is calculated from the mortality data and divided by the average birth intervals (Angel 1969, Nemeskéri 1970, 1972, Polgar 1972, Susman 1972). This interval is mostly assumed to last 2,5 years, yet it

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Table 1. Lists of results bearing on the fertility and natural increase obtained by various methods. Data according to Angel (1969) and Nemeskéri (1970), supplemented by our recalculations

Series Method	Lerna			Nea Nikomedeia			Soprónkohida		
	n.*	n.i.*	d.p.**	n.	n.i.	d.p.	n.	n.i.	d.p.
intervals between births	4.8	+2	334	4.4	-2.5	274	6	+22	32
pelvic determinations	5.0	+4	177	5.0	+2	334	-	-	-
mortality and assumed fertility	5.0	+7	100	4.6	-3	232	7,4	+28	25

* - natality - average birth number per woman

** - natural increase determined by Lotka's coefficient in promille per year

*** - doubling period - period of population reduplication, in years

is known that this value in populations which do not apply conscious birth control (non-Malthusian) varies according to age, order of births, and so on (Henry 1972). The average duration of the reproductive capacity period is calculated from the value of life expectancy and hence the result is affected by available data concerning the deaths of women beyond the reproductive age. As it is difficult to estimate the influence of secondary factors on the result obtained using this method, the results it leads to are merely of the nature of rough estimations.

A method which permits us to define with more accuracy the numbers of births consists in observations of changes in the pelvic bones and particularly the pubic symphysis. Births and pregnancies leave distinctive traces on the bones i.a. in the shape of grooves and pits formed owing to injuries accompanying the giving of birth (Angel 1969, Putschar 1931, Stewart 1957). However, this method is inapplicable in the case of cremated or strongly damaged materials. Nor can it be used when having recourse to paleodemographical data based on the examination of epithaphs. An additional difficulty arises here through an individual variability of the degree of changes as well as for a lack of exact standards. Hence, by examining the pelves, all we can say is whether this or that woman gave birth a larger or smaller number of times, without being able to determine how many times exactly.

The third method applicable consists in the multiplication of the previously reconstructed number of women, living in successive age categories, by the specific fertility rates corresponding to these age categories (Bürgdorfer's Method) [Acádi Nemeskéri 1970, Wstęp do demografii 1967]. The fertility rates are chosen hypothetically from observations of contemporary non-Malthusian populations.

The aim of this publication is to propose a method which permits one to obtain comparable results, concerning fertility and natural increase, based on the known mortality structure and regularity of progenitive increase common for various non-Malthusian populations. In this method, the potential reproductive capacity of a population is determined i.e. one investigates what part of the progeniture achievable by an individual li-

ving throughout the reproductive period (i.e. living at least to the age of 50) will have been achieved by an average adult individual of a given population with well defined mortality conditions. One thus determines the portion of the offspring achievable by a population with zero mortality of reproductive adults that will be achieved with the mortality structure ascertained in the group under investigation.

ARCHETYPE OF FERTILITY

The main difficulty when applying the above mentioned methods resided in the determination of average birth numbers of children born by the women due to different fertility levels in non-Malthusian populations (Fig. 1) (Lorimer 1954, Pressat 1966, Wstęp do demografii 1967, Pakrasi Halder 1971). The differentiation of fertility

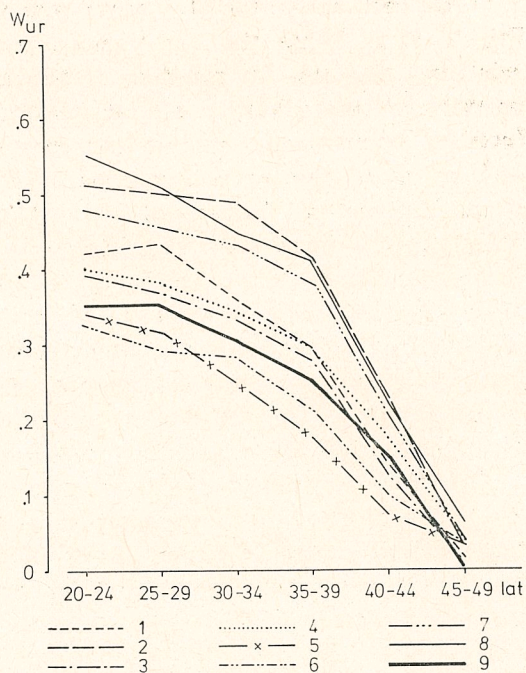


Fig. 1. Age-specific fertility rates for various non-Malthusian populations

1 — Crulai 1674-1742. 2 — Canadian Frenchmen (1700-1729). 3 — Geneva, husband born before the year 1600. 4 — Norway 1874-1876. 5 — French Guinea 1954-1955. 6 — Bengal, Hindu villages 1954-1955. 7 — Hutterites, marriages contracted before the year 1921. 8 — Hutterites, marriages 1921-1930. 9 — Hypothetical fertility rates for pre-historical populations, according to Acsádi and Nemeskéri (1970). Source 1-8: Pressat (1966)

in the non-Malthusian populations seems to derive mainly from the differentiated duration of intervals between births; of lesser significance can be: the differentiated ages of the beginning and end of sex activity (conjugal and extra-conjugal) as well as the total exclusion of certain individuals from the progenitively active group. The duration of the intervals between births is influenced by many complicatedly interrelated eco-cultural factors. It seems, however, that social activities aimed at regulating the frequency of births in non-Malthusian populations

are not a function of the number of already possessed progeniture but are rather the result of care given to mother and infant to ensure optimal conditions for them, or of social standards of sexual behaviour regulating the frequency of coitus („Anthropology and Population Problems”, Discussion 1972, Hall 1972, Hinshaw et. al. 1972, Nag 1972, Polgar 1972, Saucier 1972, Sussman 1972). The multiplicity of factors influencing the number of progeniture in various non-Malthusian groups does not allow to find for them a common model of the average number of children.

However, a common law for these populations is to be found in the increase of relative, cumulative number of births with the age of the parents. The above mentioned regulation of intervals between successive births does not perturb their characteristic distribution over the lifetime of the parents due to changes with age in the capacity of impregnation, spontaneous abortions, and other biological phenomena.

This regularity, for the same populations as in Fig. 1, is shown in Fig. 2. It is found that, in various populations with primitive fertility relations, the rise in number of the progeniture with the age of the parents follows a highly similar pattern. This suggests an „archetype of fertility”, constructed in the following way: on denoting the probability of bearing all the possible number of children by an average individual living at least to the age of 50 as 1.0, this probability for lower ages will take the form shown in Fig. 2. It is calculated as the ratio of the cumulative birth number for a given age and a total cumulative number of births (U_c). The probability of not having given the total number of births at a given age x is the difference between unity and the probability to possess the total number of descendants. This probability is denoted by s_x . The number s_x provides information about the amount of reproductive loss caused by cessation of reproduction at the age x .

For the enormous majority of prehistorical populations, the measurable cause of reproduction cessation at an age x lower than 50 is mortality. Our further considerations will thus concern the possibility to measure the potential reproductive capacity conditioned by the mortality structure.

CHOICE OF A MODEL AND DEMOGRAPHIC STANDARDS

The fertility of a given human group, its age and mortality structure are closely interrelated. As it is necessary to reconstruct the first two characteristics for prehistorical populations from data concerning mortality, one should assume a model of stable population, i.e. a population in which the fertility and mortality relationships remain unchanged over long periods of time (about 100 years or more) causing

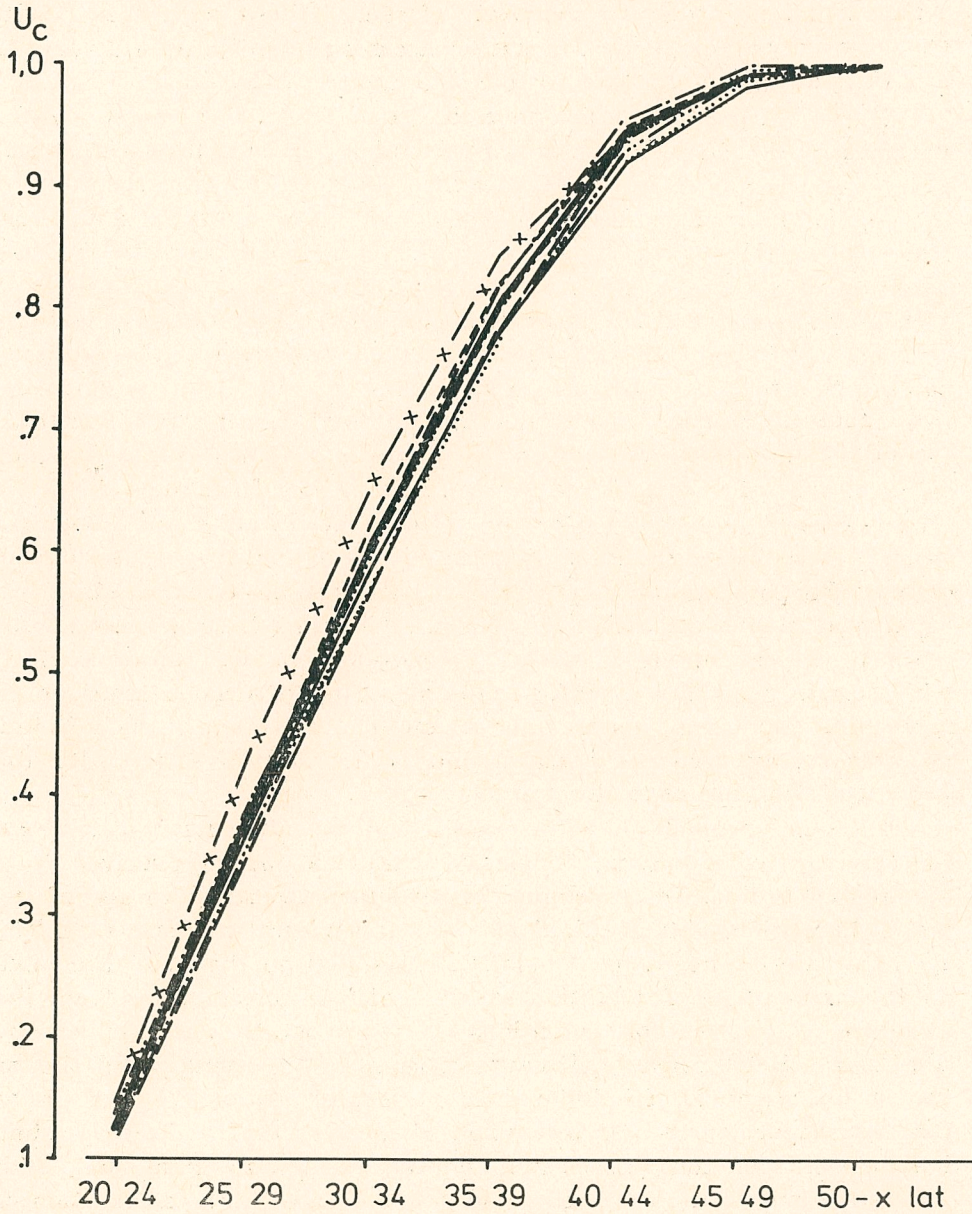


Fig. 2. Age specific increase in progeniture number expressed as the probability of having given, at a given age, the complete achievable number of births (U_c) for a populations as in Fig. 1

a stabilisation of the structure according to age (Holzer 1969, 1970, Pressat 1966).

The majority of the populations of concern to human paleobiology possessed cemeteries exploited sufficiently long to treat them in accor-

dance with this model. The necessity of such a line of approach results from the very frequent lack of data concerning quantitative fluctuations of groups during the exploitation of the cemetery.

In a stable population, the morality structure is determined by the parameters of the life table. In the particular case of stationary population, the total mortality rate equals the total fertility rate; accordingly, the population number does not change, and the mortality structure corresponds directly to the structure of the living population. In the case of prehistorical populations, about whose numerical increase we have no archeological-prehistorical information and no suspicions concerning conscious birth-control, only in one case we maintain with high probability that the population had a stationary character. This is when the morality rate (m) approaches the highest total fertility rate for man (about 50 promille) corresponding to a life expectancy at age 0 years, equal to about 20 years, since $m=1/e_0$. In the case of finding a distinctly lower value e_0 , one should take into account the possibility of a negative natural increase and decay of the group; if e_0 distinctly exceeds 20 years of age, the population can potentially possess a positive increase — a capacity of numerical expansion. We have in mind here a potential for natural increase in given mortality conditions, as we cannot exclude with certainty possible fertility limitations due to social reasons or an inbreeding depression, diseases and so on. The detection of such factors requires highly accurate research and is not fully feasible with the present possibilities of exploration.

In a stable population with a positive or negative natural increase, the structure of the living population cannot be directly derived from the life table data. To determine the structure according to age of the living population, it is required to know the natural increase rate. The age structure of the living population calculated on the same life table on the assumption of a stationary state differs considerably from the structure calculated for conditions of a moderate natural increase (Pressat 1966). The age structure problem of the living population as well as the numbers of individuals in various groups of age is of essential importance for the reconstruction of the structure and size of stem families and can also cast some light on the problems of the social differentiation, division of labor, and so on. Hence the reconstruction of the age structure of a living population according to the stationary population model can be insufficient in some cases.

Our further considerations will deal with the possibility to estimate the parameters describing the natural increase in human population. In accordance with what has been said above, we shall rely on estimations of the potential fertility of a human group. Since in the case of prehistorical materials we most frequently deal with samples of popu-

lations, often incomplete as to age structure, we have to consider the parameters of natural motion concerning average individuals or generations. This is moreover justified by the impossibility to estimate the number of individuals in a group without making arbitrary assumptions; this makes it impossible to apply directly coefficients concerning the population number, for example the number of births per 1,000. These coefficients, in the present case, can be evaluated indirectly. As a basis for our analysis, we thus take the gross reproduction rate (R) and net reproduction rate (R_0).

In research on population biology, these rates have to be given a form and interpretation slightly different from those assumed in demography. This is due to the nature of the material at the disposal of investigators of human prehistoric populations and to the application of the results i.a. to the study of microevolutionary trends. The changes introduced should not, however affect, essentially the comparability of numerical data concerning natural increase in prehistorical and contemporaneous populations.

We shall be referring to the average number of births per couple of adult individuals during their lifetime, as the gross reproduction rate, and to the average number of adult descendants per adult individual of the parental generation as the net reproduction rate. Thus defined, the gross reproduction rate informs about the total number of births from the cohort of individuals beginning to reproduce in given conditions of mortality and fertility, whereas the net rate provides a measure of replaceability of generations. If, at stable mortality structure, there is exactly one descendant achieving the age of reproduction per one average individual entering the age of reproduction capacity in the parental generation, then $R_0=1$, meaning that the parental generation will be replaced numerically by the next generation of descendants and thus the size of the group will not change. At $R_0>1$ the descendants generation will be more numerous than the parental generation and the group will increase in size. Inversely, at $R_0<1$ the size of the group will decline.

In a stable population, the size R_0 is related with the natural increase rate (expressed in promille per year) by A. J. Lotka's equation (Pressat 1966)

$$(1 + \rho)^x = R_0$$

where: ρ — the rate of natural increase, and x — the duration time of a generation.

For a known subadult mortality structure, it is possible to determine the net rate from the known number of births, expressed by the gross reproduction rate.

RECONSTRUCTION OF NATURAL INCREASE

This last coefficient in potential form can be reconstructed for a given human group with known structure of adult mortality and age distribution of the probabilities of not achieving the total number of descendants. The gross reproduction rate in potential form informs us what fraction of the total number of births achievable throughout the full reproductive period (U_c) occurs per average couple of adult individuals in the given conditions of mortality.

In order to calculate the potential gross reproduction rate (R_{pot}) for a given population, it suffices to multiply the observed frequency of adults deceases in the various categories of age by the probabilities of not possessing the complete progeniture numbers corresponding to these categories and then to add the results obtained and to subtract from unity. An example of such a calculation is shown in Table 2, the se-

Table 2. Example of calculation of potential gross reproduction rate for the population of Lerna (Angel 1969)

x	D_x	d_x	s_x	$d_x \cdot s_x$
15 - 19	8	.078	.95	.074
20 - 24	7	.069	.77	.053
25 - 29	17	.167	.55	.092
30 - 34	24	.235	.35	.082
35 - 39	19	.186	.17	.032
40 - 44	14	.137	.05	.007
45 - ω	13	.128	—	—
15 - ω	102	1,000	—	.340

$$R_{\text{pot}} = 1 - 0.340 = 0.660$$

ries s_x assumed here corresponds to the common „archetype of fertility” in non-Malthusian populations; the difference in comparison with Fig. 2 results from not taking into account the fertility rate of women aged 15 - 19 in Fig. 2.

The potential gross reproduction rate calculated in this way expresses the reproduction capacity of a group with given mortality structure, is directly adapted for interpopulation comparisons, and provides an accurate measure of the total intensity of selection pressure resulting from adults mortality.

To determine the absolute number of descendants born to an average adult couple we have to rely on a hypothetically estimated value of U_c . Assuming that the entire number of progeniture procreated by an individual living at least to the age of 50 is 8, 10 and so on, and multiplying this number by the potential gross reproduction rate ($R_{\text{pot}} \cdot U_c$), one obtains the absolute number of births per average adult couple. This number provides a basis for the reconstruction of the size and

structure of stem families, and can cast light upon the economical and social relations by which the populations are ruled. In Table 3, we list the potential gross reproduction rates as well as the numbers of children for prehistorical populations with well explored mortality.

According to Acsádi and Nemeskéri (1970), for prehistorical times, the estimate closest to reality for the complete possible number of births (U_c) amounts to 8 live births per average woman achieving

Table 3. Average fertility in prehistorical populations calculated from potential gross reproduction rates on the assumption of an ultimate number of children (U_c) 8 and 10 births per adult couple

Series, author	R_{pot}	Average number of births per adult couple at:		N adults
		$U_c = 8$	$U_c = 10$	
Neandertal	.56	4.5	5.6	24
Maghreb-type (epipaleolithic)	.75	6.0	7.5	≈ 100
Upper Paleolithic	.49	3.9	4.9	47
Mesolithic	.42	3.4	4.2	50
Volni (Neolithic)	.69	5.5	6.9	27
Nea Nikomedeia (Early Neolithic)	.58	4.6	5.8	44
Karatas (Early Bronze)	.58	4.6	5.8	231
Catal Hüyük (Early Neolithic)	.58	4.6	5.8	216
Germany, Neolithic	.66	5.3	6.6	69
Nordhausen (Neolithic)	.57	4.6	5.7	33
Niederbösa (Neolithic)	.57	4.6	5.7	42
Grossbrenbach (Early Bronze)	.53	4.2	5.3	55
Lerna (Middle Bronze)	.66	5.3	6.6	102
Tiszapolgár-Basatanya (Copper Age)	.76	6.1	7.6	110
Alsónémedi (Copper Age)	.80	6.4	8.0	24
Mezőcsat (Bronze Age)	.77	6.2	7.7	22
Keszthely-Dobogó (Late Roman Era)	.83	6.6	8.3	82
Athens and Corinth (Classic times)	.76	6.1	7.6	78
Sopronköhida (9th cent. A. D.)	.93	7.4	9.3	67
Model of 10th - 12th cent. A. D. Hungary	.80	6.4	8.0	≈ 300
Espenfeld 11th - 12th cent. A. D.	.60	4.8	6.0	216
Reckahn 12th - 14th cent. A. D.	.66	5.3	6.6	194

The mortality data necessary for computations are taken from the papers of the following authors: Angel (1969), Acsádi and Nemeskéri (1970), Ullrich (1972), Bach and Bach (1971), Vallois (1937), Schott (1964)

50 years of age. A slightly lower estimate ($U_c=7.45$) is proposed by L o r i m e r (1954) on the basis of vast demographic material. If, when exploring prehistorical populations with the aid of potential gross reproduction rates, the same estimate is assumed in all cases, one obtains a comparative picture providing a basis for correct interpretations.

The potential gross reproduction rate is related with the net re-

production rate and hence with the natural increase by the following equation

$$R_o = R_{\text{pot}} \frac{100 - d_{0-14}}{100} 0.5U_c$$

where: R_o — is the net reproduction rate, R_{pot} — the potential gross reproduction rate, d_{0-14} — the frequency of deceased subadults (deceased previous to the age 15) in percents, U_c — the total cumulative number of births for the individuals achieving at least the age of 50.

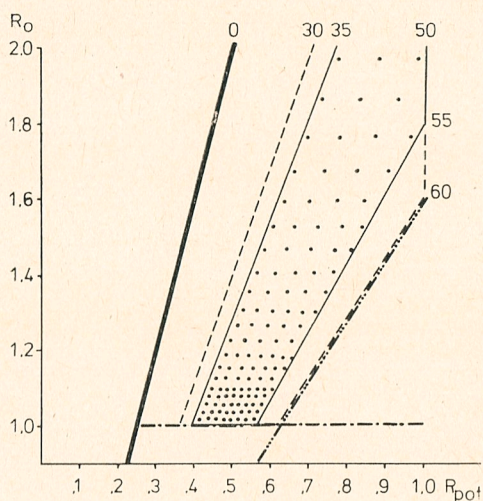


Fig. 3. Dependence between R_o and R_{pot} at $U_c=8$, for various mortality frequencies of subadults (d_{0-14}). To the percentage values d_{0-14} , correspond straight lines denoted by numbers in the top right-hand corner of the figure. For further explanations, see text

This dependence, for $U_c=8$, is shown in Fig. 3. The dotted zone corresponds to the states of prehistorical populations most frequently found, the zone below the horizontal line (—.—.—) is reserved for populations with a negative natural increase, and a population entering the zone below the sloping line (...—...—...) suggests with high probability the application of widespread birth control.

The above discussed relations between the reproduction rates allow to draw conclusions, in many a case, about the natural increase of a group from incomplete data, bearing only on the mortality of adult individuals. However such conclusions have merely orientative significance and must be deduced with due caution; a complete analysis requires the exact knowledge of the mortality structure of the whole population, on the basis of extensive material.

Essential help when using the above proposed method can be derived from archeological and historical informations concerning migration processes, as well as social control of the size of the group in question.

AN EXAMPLE OF APPLICATION OF THE METHOD

In order to illustrate the application of the above proposed procedure of reconstruction of natural increase, we give in Table 4 data calculated for prehistorical populations with a well known mortality structure. A detailed analysis of the results for each population would

Table 4. Natural increase estimates for prehistorical populations at different ultimate numbers of children (U_c). The increase was estimated relying on the dependence between R_{pot} , the subadults mortality, the net reproduction rate and Lotka's equation

Series	R_{pot}	d_{0-14}	Natural increase in ‰ per year at $U_c =$:			N
			7	8	10	
Neanderthal	.56	38.5*	- 4	+ 2	+11	39
Maghreb-type	.75	53.2	+ 8	+13	+23	≈ 100
Upper Paleolithic	.49	38.2*	+ 2	+ 8	+16	102
Mesolithic	.42	29.5*	+ 2	+ 7	+16	65
Nea Nikomedeia	.58	58	- 7	- 3	+ 6	105
Germany, Neolithic	.66	26,6	+18	+24	+33	94
Nordhausen	.57	34.0	+11	+17	+26	50
Niederbösa	.57	43.3	+ 5	+10	+19	74
Grossbrenbach	.53	41.5	+ 5	+10	+19	94
Lerna	.66	56	+ 2	+ 7	+16	234
Tiszapolgar-Basat.	.76	19,3	+31	+36	+46	161
Alsónémedi	.80	35.9	+24	+31	+38	42
Keszthely-Dobogó	.83	28.3	+30	+36	+45	120
Athens and Corinth	.76	47	+13	+19	+28	144
Sopronköhida	.93	45.9	+23	+28	+38	145
Model of 10th - 12th cent. A. D. Hungary	.80	39.4	+22	+29	+37	≈ 500
Espenfeld	.60	49.2	+ 3	+ 9	+18	425
Reckahn	.66	28.1	+20	+25	+35	270

* - data for d_{0-12} , according to Vallois (1937) paper.

exceed the framework of this article. Nevertheless it is worth noting that almost all the considered populations have the capacity of numerical increase, in some cases very rapidly even at low values of U_c . Such a result may well be influenced by the non preservation, in some cases, of the entire number of children's skeletons in the research material, but even on raising the decease frequency of children (subadults) to 60‰ i.e. a value approaching the maximum, the majority of the groups conserve the capacity of natural increase, as it is shown in Table 5. The values of the fertility rates of Table 5, as well as the average intergenetic intervals are comprised within the range observed by the demographers in non-Malthusian populations (Henry 1972, Pressat 1966, Holzer 1970, Wstep do demografii 1967).

It is not to be excluded that the groups examined here do not represent all the states of populations, existing in prehistoric times if for no other reason than because populations living in favourable eco-cultural conditions had better opportunities to establish cemeteries with well protected graves. This objection however does not diminish the importance of the fact that human groups existed with the ability

Table 5. Fertility rates (in promille per year per couple of adults) of prehistorical and early historical populations in moderate natural increase conditions ($R_0=1.10$; $\rho=+4$) and very high children mortality ($d_{0-14}=60\%$)

Series	Mean interval between* births, in months	Fertility rate** ‰	U_c
Neanderthal	30.6	330	9.8
Maghreb-type	41.2	240	7.3
Upper Paleolithic	26.8	370	11.2
Mesolithic	23.0 (25.2)***	430 (400)***	13.1 (11.9)***
Volni	37.6	270	8.0
Nea Nikomedeia	31.6	320	9.5
Karatas	31.6	320	9.5
Catal Hüyük	31.6	320	9.5
Germany, Neolithic	36.2	280	8.3
Nordhausen	31.0	320	9.7
Niederbösa	31.0	320	9.7
Grossbrembach	28.8	350	10.4
Lerna	36.2	280	8.3
Tiszapolgár-Basatanya	41.6	240	7.2
Alsónémedi	45.5	220	6.6
Mezőcsat	41.6	240	7.2
Keszthely-Dobogó	45.5	220	6.6
Athens and Corinth	41.6	240	7.2
Sopronköhida	51.0	200	5.9
Model of 10th - 12th cent A. D. Hungary	43.5	230	6.9
Espenfeld	32.6	310	9.2
Reckahn	36.1	280	8.3

* - intervals between births for average woman calculated on the assumption of a twenty five years reproductive capacity period

** - calculated per 1,000 couples of adult individuals

*** - in brackets - values for stationary population ($R_0=1$)

of rapid numerical increase in the period of very slow increase of the total number of population of large regions, thus in Europe and elsewhere.

In the light of the above results, the claim of a nearly stationary state of most human prehistorical populations generally accepted by

the anthropologists investigating prehistorical cemeteries, seems hardly plausible. This thesis reposes merely on the stated low numerical increase of the population of Europe and of the world up to the modern times. It would appear that this low population increase throughout large regions occurring in the presence of groups capable of fast expansion was conditioned by the sudden vanishing of human groups or of their considerable fractions due to elementary disasters and intergroup relations (competition, and so on). Some influence on the slowing down of the rate of increase of a group with high reproductive potential may have been exercised by social birth control. However, any action of this factor on a large scale is, according to Sandison (1970), hardly probable.

The role of social intragroup and intergroup relations in the regulation of the population number and its dynamics, as well as the social and economical problems which accompany changes in group dynamics, lie within the research possibilities of cultural anthropology. The ultimate answers to the questions concerning the regulation mechanisms of the population number and the effects of changes in biological dynamics can only be given by the biologists and humanists concomitantly.

CONCLUSIONS

1. For a lack of possibilities to estimate exactly the fertility and numbers of children in prehistoric populations, one should study the potential reproductive capacity of the population derived from the mortality structure and from the progenitive regularity common to non-Malthusian populations.

2. A general progenitive regularity in non-Malthusian populations consists in the way in which the ultimate number of born descendants is determined by the age of the parents — i.e. the increase of the relative, cumulative number of births. This regularity is independent of the level of fertility and number of children born.

3. In a population with a given mortality structure, there exists a simple dependence between the potential reproductive capacity of adult individuals, the frequency of subadults deceases, the total achievable number of births throughout the entire reproductive period of life, and the natural increase.

4. The capacity of many prehistorical populations for fast numerical expansion, if established, points to the necessity to search for reasons of population increase limitation in intergroup relations, the history of the groups and social mechanisms controlling the size of the population.

5. The reconstruction of the structure of populations living in given prehistorical environment with a stated potential capacity for fast natural increase should not be based on the model of a stationary popu-

lation, but rather on that of a stable population with an evaluated increase rate.

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UWAGI O MOŻLIWOŚCIACH BADANIA REPRODUKCJI POPULACJI
PRADZIEJOWYCH

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Podjęmowane dotychczas, nader cenne, próby określenia płodności grup ludzkich w pradziejach dają jednak wyniki szacunkowe, trudne niejednokrotnie do porównań. Jest to rezultatem stosowania trzech różnych metod szacowania płodności: 1) dzielenia przeciętnej długości okresu zdolności reprodukcyjnej przez długość odstępów między urodzeniami, 2) określania dzietności zmarłych kobiet w oparciu o zmiany poporodowe na kościach miednicy, 3) przemnażania odtworzonej liczby kobiet żyjących przez hipotetyczne współczynniki płodności. Zasadniczą trudnością przy stosowaniu powyższych metod jest dokładne ustalenie liczby urodzeń. Liczba ta w populacjach nie stosujących świadomej kontroli urodzeń (tj. kontroli będącej funkcją liczebności już posiadanego potomstwa) zależy od wielu czynników ekologiczno-kulturowych, powiązanych ze sobą w sposób skomplikowany, o zmiennym przy tym międzypopulacyjnie natężeniu i sposobie działania. Trudno więc znaleźć ogólną prawidłowość dotyczącą liczby urodzeń w populacjach pradziejowych. Wspólną, natomiast, dla populacji nie stosujących świadomej kontroli urodzeń prawidłowością jest przyrost względnej, kumulatywnej liczby urodzeń z wiekiem rodziców. Na podstawie tej prawidłowości można skonstruować „archetyp” płodności w następujący sposób: jeżeli szansę posiadania cał-

kowej, możliwej do osiągnięcia w pełnym okresie reprodukcyjnym (tj. do około 50 roku życia) kumulatywnej liczby urodzeń — U_c — oznaczymy jako 1,0, to dla osobników umierających przed zakończeniem okresu zdolności reprodukcyjnej szansa ta ($1-s_x$) — będzie się z wiekiem kształtować jak na rysunku 2 i w tabeli 2. Wartość s_x określa prawdopodobieństwo nieposiadania pełnej liczby urodzeń w wieku x .

Opierając się o tak skonstruowany „archetyp”, przy znanej strukturze wymieralności danej populacji, można określić jej potencjalny współczynnik reprodukcji brutto — R_{pot} — przemnażając częstości zmarłych w kolejnych grupach wieku przez odpowiadające tym grupom wartości s_x , sumując iloczyny i odejmując sumę od jedności. Współczynnik R_{pot} informuje o tym, jaka całościowa możliwość do osiągnięcia liczby urodzeń (U_c) przypada na przeciętną parę dorosłych z danej populacji. Omawiany współczynnik wyraża więc potencjalną zdolność grupy o danej strukturze wymieralności do reprodukcji, nadaje się bezpośrednio do porównań międzypopulacyjnych i jest miernikiem ogólnej intensywności nacisków selekcyjnych wynikających z wymieralności dorosłych. Przyjmując określoną bezwzględną wartość U_c i przemnażając ją przez R_{pot} otrzymuje się przeciętną liczbę urodzeń przypadającą na parę osobników dorosłych, co jest podstawą do szacunków wielkości rodziny.

Dla przyjętej wartości U_c wielkość przyrostu naturalnego grupy daje się odtworzyć z równania

$$R_o = R_{pot} \frac{100 - d_{0-14}}{100} U_c 0,5$$

gdzie R_o — współczynnik reprodukcji netto, d_{0-14} — częstość zgonów osobników poniżej 15 roku życia (w ‰). Przechodząc do przyrostu naturalnego wyrażonego współczynnikiem w promillach na rok (ρ) (równanie Lotki): $R_o = (1 + \rho)^x$, gdzie x — długość trwania pokolenia. Populację badaną traktujemy tu jak populację ustabilizowaną, co jest do przyjęcia w przypadku większości cmentarzyk pradziejowych.

Z tabeli 4 wynika, że nawet przy założonych, niezbyt wysokich wartościach U_c istniały w pradziejach liczne grupy zdolne do szybkiej ekspansji liczebnej. W zestawieniu ze słabym tempem przyrostu zaludnienia Europy czy Świata, wskazuje to na konieczność szukania przyczyn powolnego powiększania się liczby ludności dużych regionów w zjawiskach doprowadzających do zanikania grup ludzkich w wyniku działania czynników kulturowych, ewentualnie klęsk żywiołowych, epidemii itp. Istotny wpływ kontroli urodzeń wydaje się tu mało prawdopodobny.

Otrzymane wyniki przeczą również dość powszechnie przyjmowanej przez antropologów tezie o zastojowym charakterze większości badanych populacji pradziejowych. Wobec tego odtwarzanie struktury wieku ludności żyjącej w takich populacjach winno opierać się na modelu ludności ustabilizowanej o określonym przyroście naturalnym.