

## TOWARDS THE DEFINITION OF THE BIOCULTURAL SYSTEM

Janusz PIONTEK, Ph.D\*

### INTRODUCTION

Studies on biological and cultural changes in human species are performed in both natural and social sciences. However, the postulates of interdisciplinary studies on biocultural evolution within the research programs, constructed on a common theoretical and philosophical plane are not being realized.

The mono-aspectual approach is decidedly prevalent, where the given discipline, in dealing with a particular aspect of the biocultural evolution of man, distinguishes defined factors and, independently from other disciplines and factors, describes and explains a different kind of a process or phenomenon.

Generally speaking, studies on the biocultural evolution of man are conducted on the basis of miscellaneous interpretative theories, and within the frames of different cognitive orientations.

As the mono-aspectual studies do not promise any cognitive success, we would like to present an outline of multi-aspectual studies, simultaneously submitting an explanatory theory, methodology of studies and an epistemological orientation.

### APPROACH

The proposed model of multi-aspectual studies on the biocultural evolution of man is characterized by:

1. the theory of evolution as a general explanatory theory,
2. the general theory of systems as a method,
3. the idealizational conception of research as an epistemological orientation,
4. the multi-aspectuality as the range of substantial studies.

---

\* University of Poznan, Institute of Anthropology, Department of Human Evolutionary Biology, Poznan, ul. Fredry 10, Poland.

## MODEL

Man's biocultural evolution is shaped under the influence of interactional factors, both biological and cultural, the activities of which are combined with the environmental conditions.

The essence of the presented, multi-aspectual model depends on the fact that in the descriptions and explanation of phenomena and processes of biocultural evolution both biological and cultural events are taken into consideration, while applying the idealizational method.

According to this method, the revealing of the most essential determinants (factors) of any process or phenomenon (hence also of biocultural evolution) should be carried out through isolation and elimination of considerations (on the basis of a defined theory) of arbitrary, unsubstantial determinants, which accompany the process of biocultural evolution.

In multi-aspectual studies on the biocultural evolution of man we suggest discussing not the individual, but the class of the main factors isolated in such a way, that each of them is at the same time the main factor of the distinguished aspects of studies when the idealizational method is being applied.

Let us, therefore, consider the following model of situation. If we assume that studies on biocultural evolution are carried out in five aspects (from I to V), distinguishing in each aspect one main factor (from A to E), and two side factors (from a to j), then following the idealizational conception of scientific research we can build aggregated essence structure of factors (SAG) determining the biocultural evolution (Table 1).

This can be presented as follows :

SAG : (2) [A,B,C,D,E]

(1) [A,B,C,D,E][a,b,c,d,e]

(0) [A,B,C,D,E] [a,b,c,d,e] [f,g,h,i,j]

In explaining the above given essential structure we would like to draw attention to the fact that index 2 means the level represented by the aggregated class of the main factors and is called the internal level, where the A,B,C,D,E factors are main ones of each of the five aspects of studies. The other factors, marked from a to j, defined as side factors, appear on successive levels of essentiality.

In every human system at least five the most important elements (minimal number) can be distinguished : (A) human population, (B) human environment (abiotic, biotic, cultural), (C) economic structure, (D) social structure, (E) ideological control subsystem. The following elements (factors) are among the most important, which shape the biocultural state of a human population (Fig. 1 and 2).

Factors forming biological structure of the human population operate in the environment of cultural agents and in this connection their role and significance must be estimated from the point of view of general characteristic of socio-cultural system.

We proposed definition of the biocultural system as a class of a certain number of important elements ensuring the realization of human biological and cultural needs, and also system duration and reproduction. In the human system is generated of adaptive strategy.

Adaptive strategy is understood as *"a pattern of adaptation, adaptability or/and adjustment to the environment in biological and/or cultural way"* (N. Wolański 1990:4). If human system is a class of elements, then adaptive strategy is a pattern of these elements arrangement.

## HYPOTHESIS

We make the hypothesis that at successive stages of the biocultural development of human populations, the above factors interacted on different significance levels and that significant factors showed different essential structures (different adaptive strategies).

Thus, we assume that in Palaeolithic times (and contemporary hunthens-gatherers populations) relations between such factors as the size of a population, the capacity of the ecological niche and the type of economic exploitation are most important (Fig. 3, A), while in transition to agriculture, relation between the main elements changed. Abiotic and biotic environment became the components of secondary importance. Relationship between human population, new type of the economic structure and social structure became the principal relation (Fig 3, B). In contemporary populations (after industrial evolution) relations between the type of economic structure, the social structure of the group and its ideological control subsystem are the most important (Fig. 3, C).

## TRANSITION TO AGRICULTURE : EXAMPLE OF THE BIOCULTURAL ANALYSIS

In Palaeolithic times the relationship between elements : human population, human environment, economic structure was the most important relation. In Palaeolithic population the most important was also biological adaptation (relation between : population - in biological sense and environment - abiotic and biotic), which caused processes of rasogenesis; in transition to agriculture abiotic and biotic environment became the components of secondary importance. relationship between population, type of the economic structure and type of the social structure became the principal relation. Relation change between the main elements

in transition to agriculture carried the substantial ecological and biological consequences. Palaeolithic populations displayed characteristic pattern of population growth relative to carrying capacity (Model B, Fig 4), while Neolithic populations Model A (Fig. 4, A). In transition to agriculture abiotic and biotic environment stopped to be the most essential criterion of natural selection. As a result of cultural information these population (ideological control subsystem) could also alter the level of carrying capacity with regard to typical of them economic structure. It caused an expansive type of population growth, but also frequent economic and ecological crises, considering the extensive forms of natural environment exploitation (short-lived increase of carrying capacity caused environmental degradation).

General characteristic of the Palaeolithic and agricultural adaptive strategy represents table 2. It is patterned after the model for r-selection and K-selection E.R. Pianka's (1970:593). Characteristic of two adaptive strategy corresponds to the definitions proposed by Pianka.

Table 3 represents characteristics of biological traits (or traits complex) in this two of types adaptive strategy (data from different papers). Table 3 presents evident effects of increased ecosensitivity in agricultural population. This effects are nowadays recorded in research of morphological stresses in skeletal populations. In agricultural populations individuals' ecosensitivity and morphological structure, meeting new living conditions (nutritional stress, diseases, developmental stress) became an essential adaptive criterion, so morphological processes of structural reduction (body size reduction, gracilisation, sexual dimorphism etc.) increased.

Elements of the biocultural system (discipline)	Theoretical knowledge-main processes	Main factor - side factors	Essential structure of the factors
A. Man, Population (Anthropology)	Theory of evolution - natural selection	A. Size of the population a. density of population b. age structure	A A, a A, a, b
B. The natural environment (Environmental sciences)	Theory of evolution adaptive dependence	B. Affluence of the environment c. utilization of the niche d. distribution of wealth	B B, c B, c, d
C. Society (Sociology, History, Prehistory)	Theory of social development adaptive dependence	C. Social structure e. distribution of the groups f. the relation : man-artifacts	C C, e C, e, f
D. Economy, Technology (Economy, History, Prehistory)	Theory of social development - adaptive dependence	D. Exploitation efficiency g. production h. production of tools and implements	D D, g D, g, h
E. Consciousness (Philosophy, Psychology)	Competitive dependence - mechanisms of ideological control	E. Ideological control system i. technique of education j. ritual magical-religious interventions	E E, i E, i, j

Tab. 1 : A model of multi-aspectual studies on Biocultural evolution of man.

	<b>PALAEOLITHIC POPULATIONS</b>	<b>POST-PALAEOLITHIC POPULATIONS</b>
<b>CLIMATE</b>	Fairly constant and/or predictable; more certain	Variable and/or unpredictable; uncertain
<b>MORTALITY</b>	More-directed	Non-directed
<b>POPULATION SIZE</b>	Fairly constant in time, equilibrium, at or near carrying capacity	Variable in time, non-equilibrium; usually well below or above carrying capacity
<b>INTRAGROUPS VARIABILITY</b>	Low	Medium to high
<b>INTERGROUPS VARIABILITY</b>	Strong	Medium to small
<b>OPPORTUNITY FOR NATURAL SELECTION</b>	By differential mortality	By differential fertility
<b>ECOSENSITIVITY</b>	Low	High
<b>NUTRITION</b>	Good quality protein	Poor quality protein
<b>LEADS TO</b>	Efficiency	Productivity
<b>SELECTION FAVOURS</b>	<ul style="list-style-type: none"> <li>- Slower development</li> <li>- Delayed reproduction</li> <li>- Larger body size</li> <li>- Low maximal rate of increase</li> </ul>	<ul style="list-style-type: none"> <li>- Rapid development</li> <li>- Early reproduction</li> <li>- Small body size</li> <li>- High maximal rate of reproduction</li> </ul>
<b>MICROEVOLUTION</b>	Rasogenesis and/or origin of local races	Secular trends in morphological traits

Tab. 2. : GENERAL CHARACTERISTICS OF THE PALAEOLITHIC AND POST-PALAEOLITHIC TYPES OF ADAPTIVE STRATEGY (E.R. Pianka's models for r-selection and K-selection : E.R. Pianka 1970:593 with modifications)

TRAITS OR TRAITS COMPLEX	PALAEOLITHIC POPULATIONS	POST-PALAEOLITHIC POPULATIONS
<b>BODY BUILD</b>		
Stature	+	-
Skeletal robusticity	+	-
Bone size	+	-
Muscle growth	+	-
Dental size	+	-
Dolichocephalization	+	-
<b>SEXUAL DIMORPHISM</b>		
Cranium	+	-
Long bones	+	-
<b>PALAEODEMO-GRAPHY (AND BIODEMOGRAPHY)</b>		
Fertility	-	+
Mortality	-	+
- total	-	+
- childre	-	+
- reproductive period	+	-
Interbirth interval	-	+
Number of children in family	-	+
Natural increase	-	+
<b>PALAEOPATHOLOGY</b>		
Periosteal reactions	-	+
Dental caries	-	+
Hyperostosis	-	+
Infectious diseases	-	+
Harris lines	-	+
Enamel hypoplasia	-	+
Physiological stress	-	+
Porotic hyperostosis	-	+
Degenerative joint diseases	+	-
Mechanical stress reaction	+	-
Muscular hyperfunction	+	-
<b>ONTOGENETIC PROCESS</b>		
Reduced muscle activity	-	+
Reduced muscle growth	-	+
Reduced bone growth	-	+
Regularity of process of growth	+	-
Reduced at menarche	-	+

(Sources : data from differents paper : see references)

Tab. 3. : CHARACTERISTICS OF BIOLOGICAL TRAITS OR TRAITS COMPLEX IN TWO TYPES OF ADAPTIVE STRATEGY

## REFERENCES

- BENNETT J.W., 1976,  
*The Ecological Transition : Cultural Anthropology and Human Adaptation*. Oxford, Pergamon Press.
- BIELICKI T., 1975,  
Natural selection and human morphology. In : F.M. Salzano, ed.,  
*The Role of Natural Selection in Human Evolution*, pp. 203-216.  
North-Holland Publishing Company.
- BORGOGNINI TARLI S.M., E. REPETTO, 1986,  
Skeletal indicators of subsistence patterns and activity regime in the  
Mesolithic sample from Grotta dell'Uzzo ,Trapani, Sicily, : a case  
study. *Human Evolution*, 1 : 331-352.
- BRACE C.L., P.E. MAHLER, 1971,  
Post-Pleistocene changes in the human dentition. *American Journal  
of Physical Anthropology*, 34 : 191-204.
- BUIKSTRA J.E., D.C. COOK, 1980,  
Palaeopathology : An American Account. *Annual Review of  
Anthropology*, 9 : 433-470.
- CARLSON D.S., D.P. VAN GERVEN, 1973,  
Masticatory function and post-Pleistocene evolution in Nubia.  
*American Journal of Physical Anthropology*, 46 : 495-506.
- COHEN M.N., G.J. ARMELAGOS, 1984,  
*Paleopathology at the Origins of Agriculture*. Academic Press, Inc.
- FOLEY R., 1987,  
*Another unique species. Patterns in human evolutionary ecology*.  
Longman Group UK Limited.
- FRAYER D. W., 1981,  
Body Size, Weapon Use, and Natural Selection in the European  
Upper Paleolithic and Mesolithic. *American Anthropologist*, 83 : 57-  
73.
- FRAYER D. W., 1984,  
Biological and Cultural Change in the European Late Pleistocene and  
Early Holocene. In : F.H. Smith, F. Sponsor, eds., *The Origins of  
Modern Humans : A World Survey of the Fossil Evidence*, pp.211-  
250. Allan R. Liss, Inc.
- FRAYER D.W., 1980,  
Sexual dimorphism and cultural evolution in the Late Pleistocene  
and Holocene of Europe. *Journal of Human Evolution*, 9 : 399-415.

- GOODMAN A.H., D.L. MARTIN, G.J. ARMELAGOS ,1984,  
 Indications of stress from bone and teeth. I : M.N. Cohen, G.J. Armelagos, eds., *Palaeopatology at the Origins of Agriculture*, pp. 13-49. Academic Press, Inc.
- HASSAN F.A. ,1981,  
*Demographic Archaeology*. Academic Press, Inc.
- HENNEBERG M. ,1988,  
 Decrease of Human Skull Size in the Holocene. *Human Biology*, 60 : 395-405.
- HENNEBERG M., J. PIONTEK, J. STRZAKO ,1978,  
 Natural Selection and Morphological Variability : The Case of Europe from Neolithic to Modern Times. *Current Anthropology*, 19 : 67-82.
- HUSS-ASHMORE R., A.H. GOODMAN, G.J. ARMELAGOS ,1982,  
 Nutritional Inference from Paleopathology. *Advances in Archaeological Method and Theory*, 5 : 395-474.
- KEY P. ,1980,  
 Evolutionary trends in femoral sexual dimorphism from the Mesolithic to the Late Middle Ages in Europe. *American Journal of Physical Anthropology*, 52 : 244.
- LARSEN C. S. ,1987,  
 Bioarchaeological Interpretations of Subsistence Economy and Behavior from Human Skeletal Remains. *Advances in Archaeological Method and Theory*, 10 : 339-445.
- LARSEN C.S. ,1981,  
 Skeletal and dental adaptations to the shift to agriculture on the Georgia coast. *Current Anthropology*, 22 : 422-423.
- PIANKA E.R. ,1970,  
 On r- and K-Selection. *American Naturalist* 104 : 592-597.
- PIONTEK J. ,1979,  
 Microevolution of European Human Populations : Morphological and Biological Dynamics Analysis. *Journal of Human Evolution*, 10 : 647-652.
- PIONTEK J. ,1989,  
 Biological Consequences of the "Neolithic Revolution" : The case of the Middle European Populations. In : I. Hershkovitz, ed., *People and Culture in Change*, BAR International Series 508,i,

- PIONTEK J., 1990,  
Demographic Variables as Measures of Biological Adaptation : A Case Study of Postneolithic Populations. *Collegium Antropologicum*, 14 : 205-218.
- PIONTEK J., A. MARCINIAK ,1990,  
*Biocultural perspectives on ecology of the prehistoric populations from Central Europe*. Wydawnictwo SGGW-AR, Warszawa 1990.
- PIONTEK J., A. MARCINIAK ,1992,  
Anthropological Structure and Culture Adaptive Strategies of the Neolithic Populations in Central Europe. *International Journal of Anthropology*, 7 : 71-86.
- PIONTEK J., A. WEBER ,1985,  
Studies on Biocultural Evolution - a multiaspectual model. *Collegium Antropologicum*, 9 : 215-222.
- PIONTEK J., A. WEBER ,1990,  
Controversy on paleodemography. *International Journal of Anthropology*, 5 : 71-83.
- RUFF C.B., W.C. HAYES AND C.S. LARSEN ,1983,  
Changes in femoral structure with the transition to agriculture in the Georgia coast. *American Journal of Physical Anthropology*, 60 : 247-248.
- RUFF CH. B., C.S. LARSEN, W. C. HAYES ,1984,  
Structural Changes in the Femur With the Transition to Agriculture on the Georgia Coast. *American Journal of Physical Anthropology*, 64 : 125-136.
- SCHACHT R.M. ,1980,  
Two Models of Population Growth. *American Anthropologist*, 82 : 783-798.
- SCHWIDETZKY I., A. WIERCÍŃSKI, A. WIERCÍŃSKA ,1982,  
Long-Trends in European Populations. *Modern Man, Anthropos*, 22 : 301-310.
- TRINKAUS E. ,1983,  
Human biocultural change in the Upper Pleistocene. In; E. Trinkaus, ed., *The Mousterian Legacy*, pp. 165-200. B.A.R. International Series, 164.
- TRINKAUS E., R.L. TOMPKINS,1990,  
The Neandertal Life Cycle : The Possibility, Probability, and Perceptibility of Contrasts with Recent Humans. In : C.J. DeRousseau, ed., *Primate Life History and Evolution*, pp.153-180. Wiley-Liss, New York, Chichester, Brisbane, Toronto, Singapore.

- TURNER C.G. II ,199 ,  
 Dental Anthropological Indications of Agriculture Among the Jomon  
 People of Central Japan. *American Journal of Physical Anthropology*,  
 51 : 619-636.
- WARD R.H., K.M. WEISS ,EDS.,1976,  
*The demographic evolution of human populations*. Academic Press,  
 London.
- WELINGER A. ,1979,  
*Prehistoric Demography*. Acta Archaeologica Lundensia, series in 8.
- WIERCÍŃSKI A. ,1978,  
 The Meaning and Scope of Anthropology. *Collegium  
 Antropologicum*, 2 : 10-16.
- WIERCÍŃSKI A. ,1985,  
 Bioanthropological consequences of the "neolithic revolution".  
*Studies in Physical Anthropology*, 8 : 105-110.
- WITTEWER-BACKOFEN U.,1989,  
 Zur Palaodemographie des Neolithikums. *Homo*, 40 : 117-123.
- WOLANSKI N. ,1990,  
*Glossary of Terms and Annotated Bibliography for Human Ecology*.  
 Warsaw.
- ZUBROW EZRA B.W. ,1975,  
*Prehistoric carrying capacity : A model*. Cummings, Menlo Park, Calif.

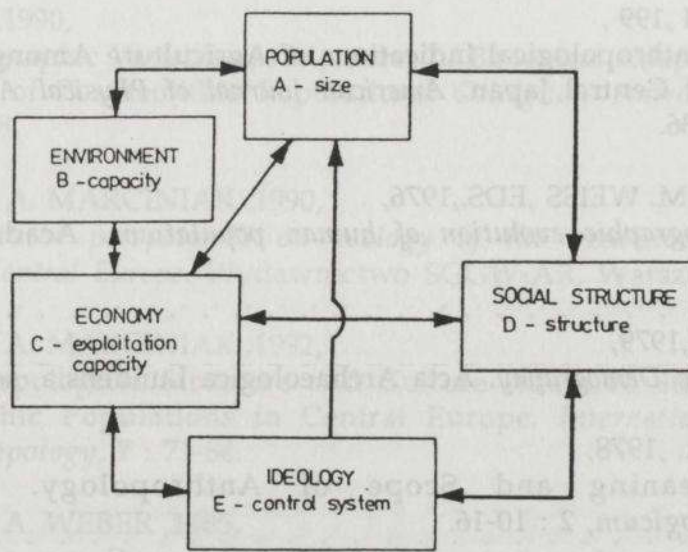


Fig. 1. : Relations between most significant factors.

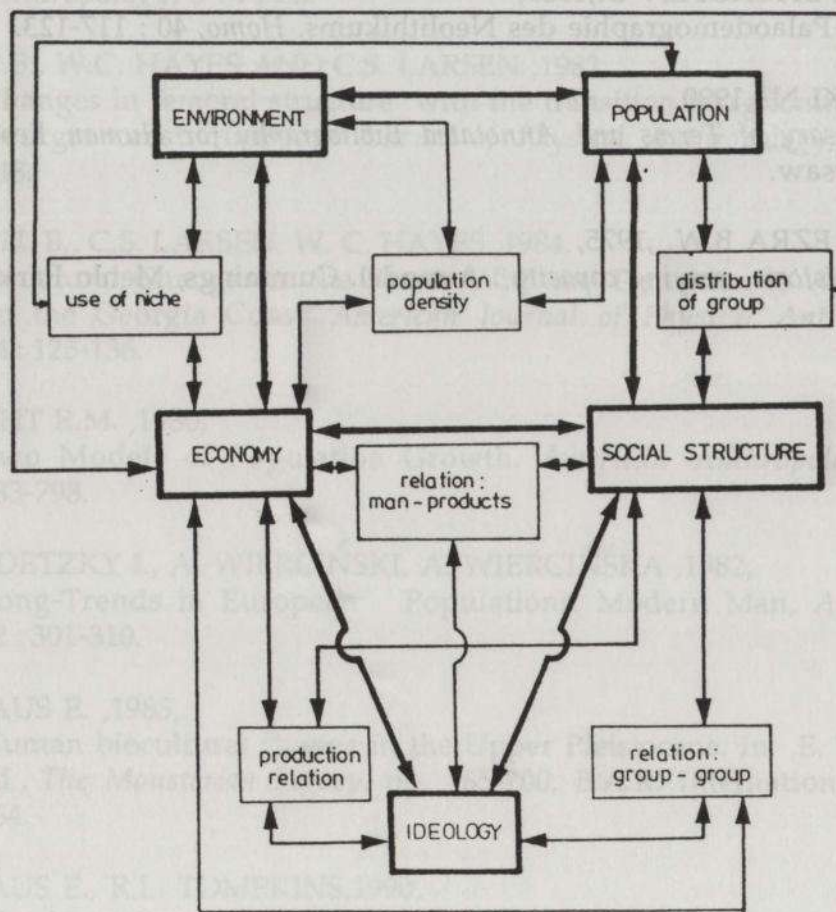
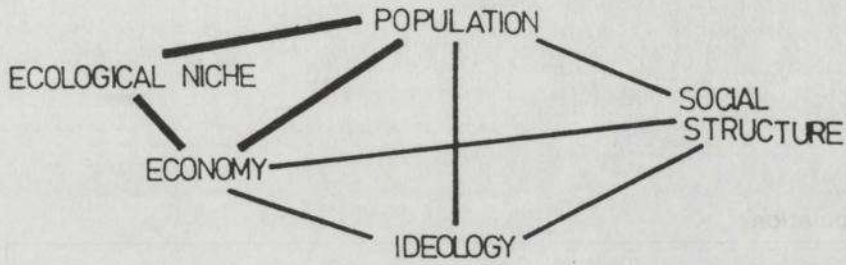
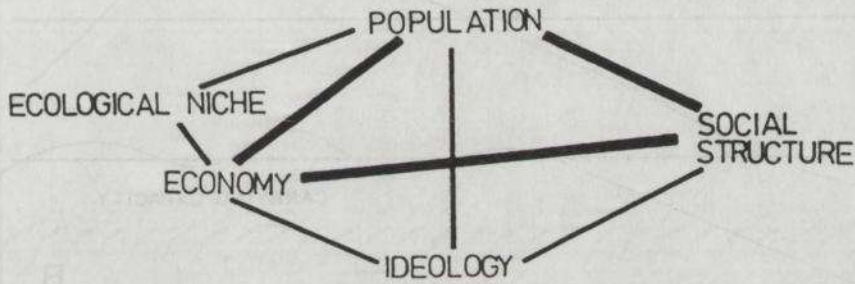


Fig. 2. : Relations between most significant and secondary factors.

**PALAEOLITHIC POPULATIONS (A)**



**TRANSITION TO AGRICULTURE (B)**



**CONTEMPORARY POPULATIONS (C)**

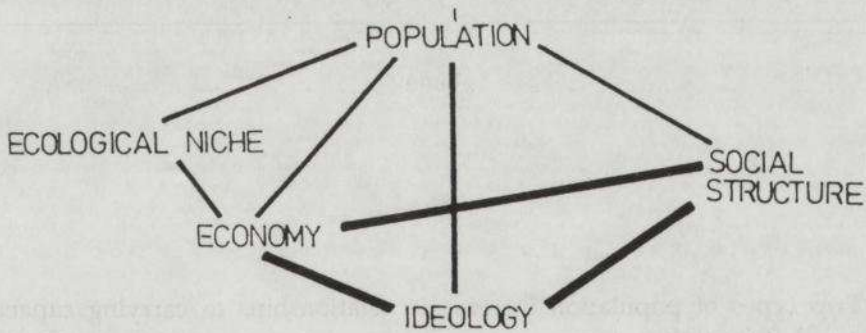


Fig. 3. : The most important relations between biological, ecological and cultural factors in the three stages of man's socio-economic development : (A) Palaeolithic populations, (B) transition to agriculture, (C) contemporary populations.

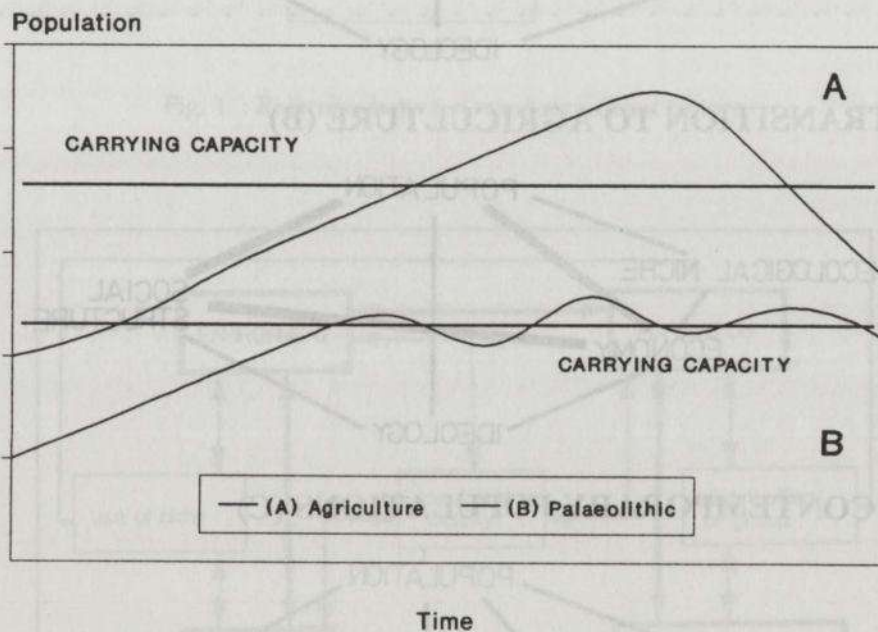


Fig. 4. : Two types of population increase in relationships to carrying capacity : (A) Agriculture, (B) Palaeolithic.