

two practices, among members of Western societies.

Secondly, why has there been growing concern among many educated peoples of the world regarding the "population explosion"? Why are more and more people using contraceptives—or accepting contraceptive practices? Why do we frequently hear that types of legislation should be effected to increase the knowledge and the use of birth-control devices and to legalize abortion? Why do many people attempt to control the size of their families and thereby give their children proper living standards, advanced educations, and so forth? Could these be evidence for at least a remnant of population-control mechanisms in modern man, if such systems were present in pre-Neolithic *Homo sapiens*?

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. . . The self-regulating mechanisms that Wynne-Edwards says existed in primitive man have not been lost. In the ecological interaction between man and his environment, the hostile forces that inhibit population growth are somewhat dependent on man's ability to control his surroundings—his technological power. The constraints that define the level of population saturation are thus partially dependent upon a self-organizing capacity of the constrained population. . . . Modern man expands the constraints from within by improved efficiency in surviving. This produces slack in the system much as does a thinning of population. The system adjusts to the slack in both cases by population "explosion." If the rate at which the constraints expand does not exceed the rate of adjustment, the natural regulatory processes must (and will) do their duty. If inertia and momentum are involved, there will be a time-lag which could be troublesome. . . .

I would like someone to analyze the problem of technological progress versus population explosion and demonstrate the self-regulation that is (or will eventually be) imposed, either willingly through rational self-management, or unwillingly through stress induced by conventionalized rivalry (cold war, keeping up with the Joneses, and so forth) or nuclear self-destruction. . . .

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. . . The economic and demographic transition observed in modern history provides ample evidence of a self-regulating system in human population growth. This system of homeostasis may have been obscured by relating the reduction in the birth rate to the rise in the level of living when, in fact, the reduction in the birth rate appears to be a consequence of the reduction in the death rate.

Longitudinal as well as cross-sectional correlations between economic and demographic variables from 21 countries for which comparable data were available in the postwar era (to be published in *Economic Development and Cultural Change*) indicate strong associations of the birth rate with other demographic variables but weak associations of the birth rate with economic variables. The coefficient of correlation between the logarithms of the decennial percentage changes in the birth rate and the product per capita at constant prices is only -0.23 . But the logarithm of the decennial percentage change in natality is inversely proportional to the logarithm of the rate of natural increase in the base year, the coefficient of correlation being -0.73 .

Thus, a reduction in the death rate would seem to be the precursor of a reduction in the birth rate. Combination of empirical equations for the relative change in natality and mortality indicates the dynamic equilibrium of economic and demographic transition: Mortality varies inversely with the level of living, and natality, in a balancing movement, tends towards net reproduction at unity.

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Wynne-Edwards neglects to mention the work of other investigators who have already "[drawn] attention . . . to the intimate way in which physiology and behavior are entwined in providing the regulatory machinery" for population control. Data in support of the postulate that density of natural populations operates through physiological adaptive mechanisms to regulate productivity (reproduction and recruitment) were first assembled in 1950 by J. J. Christian (*J. Mammal.* **31**, 247). During the following decade this postulate was expanded to recognize that "social interaction," which is characteristic of the species, rather than den-

sity per se, was a major factor in population control and dispersion and in the frequency of disease. A paper by Christian in 1956 (*Ecology* **37**, 258) is an excellent example of a series of studies on the mechanism of density control in confined populations. More recent papers by Christian and by R. L. Snyder [*Proc. Natl. Acad. Sci.* **47**, 428, 449 (1961)] contain numbers of references to the studies of many other highly competent investigators in North America and Europe. The concept of population regulation through physiological adaptive responses to the social environment is not new. Its origins are certainly multiple and its advocates many.

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Women as Graduate Students

Allyn Rule's contention that women are handicapped in obtaining graduate education in science by their family responsibilities and by the inflexibility of many graduate programs (Letters, 2 Apr., p. 21) seems to be supported by evidence. But her third point, that most graduate programs discriminate unfairly against women, is debatable.

In a recent book entitled *Academic Women* (Pennsylvania State University Press, University Park, 1964), Jessie Bernard cites evidence to show that women are admitted to graduate programs on a basis nearly equal to that of men. They also obtain financial assistance, such as fellowships and assistantships, in a proportion equal to that in which they apply for it. The amount of financial assistance available for graduate students is increasing at a rapid rate, stimulated by the influx of federal funds, and many graduate departments find it difficult to locate enough highly qualified students to support. As a result, sex is becoming a relatively unimportant variable in making this decision.

It can be argued, by contrast, that women are receiving more consideration in graduate school admission and in financial assistance than they deserve. The attrition rate among female graduate students is greater than among men, and many women who receive graduate degrees do not make productive use of them for any substantial

length of time. Thus a graduate department may be justified in feeling that the time, effort, and money which it invests in educating a male student is more likely to produce dividends for the profession as well as for society in general than is the same amount of time, effort, and money invested in a female.

If women are truly concerned with breaking down prejudices which exist toward admitting them to graduate study, they must recognize that such prejudices have some basis in fact. Those women who are admitted to graduate programs should therefore feel an obligation to complete the program and to use the resulting degree professionally, so as to encourage those persons in graduate departments who believe that women should be given an equal chance.

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Balance of Payments and Government Policies

Abelson's editorial "Science, technology, and the gold drain" (26 Feb., p. 989) calls attention to a problem that can only become more acute with time as overseas manufacturers continue to regain ground lost because of World War II.

In our company's area of production—analytical instrumentation—the U.S. had an overwhelming technical lead in nearly all types after the war. There were also quite substantial import duties on foreign apparatus. But as the technical gap narrowed, the U.S. government decreased the duty; hence some foreign concerns began to be successful in selling instruments of one type or another in the U.S. market. The U.S. sales increased their volume considerably, making still lower prices possible, in the classical pattern. This attracted some U.S. companies with strong instrument sales organizations to enter into agreements whereby they would sell the foreign equipment in this country instead of attempting to manufacture here and compete. I think it is fair to say that, with a very few exceptions, such apparatus competes in the U.S. with U.S.-made equipment solely on the basis of lower price—which is, of course, a reflection of cost differences, largely in hourly labor rates. Major instruments

like mass spectrometers require a very large direct labor input, measured in the thousands of hours, and a large number of "overhead" work hours as well. The U.S. manufacturer pays perhaps \$2 to \$10 per hour more for such labor than his foreign counterpart. This cost disadvantage is only somewhat offset by the present import duty (say \$5000 on a \$50,000 spectrometer) and shipping costs (about \$500 from Europe and \$1000 from Japan).

Pertinent to the editorial, however, is the fact that the federal government is itself the chief reason for the increased sale of foreign apparatus in this country. This has come about because:

1) The government and its contractors must ordinarily accept the lowest bidder meeting specifications, after application of any differential under the "Buy American" Act (presently only 6 percent); hence, if specs are loosely drawn, a person desiring to purchase a U.S. instrument may find himself with a foreign one. Further, the more complex the apparatus, the harder it is to draw really meaningful detailed specifications; so much depends on manufacturers' know-how.

2) The government does not require that university contractors or grantees under NSF, NIH, and other agencies follow the differential guideline of the "Buy American" Act at all.

3) Individual congressmen sometimes introduce, upon request, private bills exempting from import duty imports to universities in their areas, when U.S. equivalents are readily available.

4) Fund-granting agencies, chronically long on projects worthy of support and short on funds, try to stretch funds by granting fewer dollars per project. They seem to prefer to cut back on equipment, not salaries. Thus, from time to time, one of our prospects will report to us that his project has been funded—but with the requested allowance for a mass spectrometer cut to below the cost of a U.S.-made instrument but, surprisingly, exactly right to enable him to "buy Japanese."

5) When the government procurement rules apply, the government requires the U.S. manufacturer to certify that he complies with the minimum wage and working-condition laws, the 40-hour-week and 8-hour-day overtime laws, the fair employment practices law, and so on, seemingly ad infinitum,

while of course being in no position to make such demands on the foreign concern.

On the other hand, when U.S. manufacturers go overseas to sell, they are finding more and more discriminatory rules, such as the 15 percent surtax that the British government recently enacted and the 35 percent "value-added" tax in France—measures aimed at keeping the U.S. from selling there unless one sets up one of those foreign subsidiaries described in the editorial.

It is clear from this that there are ways, other than encouraging would-be tourists to "see America first," to help our balance of payments. The government can hardly expect individuals to take seriously a code that it itself violates daily in its own purchases or through its agents and beneficiaries. Public funds should be spent to achieve public purposes. Two current national purposes of great importance are the achievement of a better balance of payments and the maintenance of full employment. The Administration itself could assist materially in the achievement of these goals by filling its own and its contractors' requirements from domestic sources except in exceptional circumstances.

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Air-Pollution Control

I have been engineering and selling equipment for the control of air pollution for the last 20 years and would like to comment on the editorial on that subject (26 Mar., p. 1527).

Increasing "the study of all aspects of air pollution" is not the primary requisite for pollution control. Additional research and development would undoubtedly lead to increased knowledge, but the knowledge of the causes and effects of air pollution already greatly exceeds the efforts at control. What we greatly need is uniformity in the many codes and a uniform enforcement of these codes. A federal code with adequate trained personnel to enforce it would do more to reduce air pollution than any additional research grants. . . .

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