GEOGRAPHICAL RECORD

NORTH AMERICA

REGIONAL POPULATION GEOGRAPHY OF THE NORTHEASTERN UNITED STATES. United States Census Bureau statistics have proved to be a source of data for an infinite variety of studies in the social sciences. Many of these have been in the realm of geography, though geographers have often been the first to discover drawbacks to using census material (see, for example, Brian J. L. Berry: Metropolitan Area Definition: A Re-Evaluation of Concept and Statistical Practice, *U. S. Bureau of the Census Working Paper 28,* 1968). In seeking to explain population distribution, geographers have usually concentrated on one aspect of census data, for instance, substandard housing (see, for example, George W. Hartman and John C. Hook: Substandard Urban Housing in [the] United States: A Quantitative Analysis, *Econ. Geography,* Vol. 32, 1956, pp. 95–114), and have applied it to most, if not all, of the United States.

In sharp contrast to such extensive studies is the regional population geography of the northeastern United States recently presented by G. Malcolm Lewis (Levels of Living in the North-eastern United States *c.* 1960: A New Approach to Regional Geography, *Inst. of British Geogrs. Trans. No. 45,* 1968, pp. 11–37). By dealing with a comparatively small area, Lewis was able to analyze population distribution according to twelve quantitative, but non-monetary, characteristics based on Bureau of the Census and other government data for county units. These characteristics comprised in-migration from 1955 to 1960, persons over 25 with an inadequate formal education, persons over 25 with a college education, people employed as "professional, technical and kindred workers," unemployed persons, sound housing units, unsound housing units, housing units with a telephone, voters in the 1960 presidential election, live births in 1959 that took place in hospitals with physicians in attendance, deaths in 1960 from infectious and parasitic diseases, and divorces and annulments in 1960. By ranking the 397 northeastern counties from best (1) to worst (397), according to each of the twelve characteristics, and then adding these totals, Lewis arrived at a level-of-living index for each county. These indexes, ranging from highest (Nassau County, New York) to lowest (Accomack County, Virginia) are shown on a map.

Other maps show (1) five groups of counties with general indexes ranging from the highest to lowest quintile; (2) standard deviations of counties from the regional mean; (3) five classes of counties each containing a fifth of the population, ranked by level of living; (4) five classes of counties each comprising 20 percent of the area, ranked by level of living; and (5) a composite of all of these highest and lowest categories, thereby delimiting the "central high," "northern low," and "southern low" level-of-living regions. In order to arrive at more homogeneous and contiguous regions, Lewis produced a final map indicating six regions with counties having the most similar level-of-living indexes. Essentially empty areas, based on the work of Lester E. Klimm (The Empty Areas of the Northeastern United States, *Geogr. Rev.,* Vol. 44, 1954, pp. 325–345), are shown, as are counties whose indexes deviated by one and a half standard deviations above or below the regional mean.

Region I, essentially coextensive with Jean Gottmann's "megalopolis," ranked first in level of living, in population, in degree of urbanization, and in the proportion of people employed in service industries. Here the number of people employed in manufacturing, however, ranked lower than in the northeast as a whole. The move to the suburbs is evident from deviations of the central-city counties below the regional level of living. As population and employment have declined in the central cities, the suburbs have witnessed an increase in white population, in industries (especially light manufacturing), and in service occupations. However, even central county figures do not reveal the lowest income areas, which might be evident from an analysis by census tract.

Region II, consisting mainly of western New York and the southern parts of Vermont, New Hampshire, and Maine, is much less densely populated than Region I, even though half of the population is concentrated in six Standard Metropolitan Statistical Areas. Despite the somewhat higher levels of living and the greater opportunities for employment in the large cities, there is no sharp contrast in the socioeconomic characteristics of the counties in this stable dairying region, which is also heavily Republican and Catholic.

The smallest yet second densest region, Region III, comprises southeastern Pennsylvania and Delaware, central Maryland, and the part of Virginia adjacent to Washington, D.C. It has a fairly high number of people employed in manufacturing, has experienced large population increases (partly owing to Negro migration from the South), and is highly urbanized. Unlike Region I, Region III has a higher percentage of nonwhites, a lower percentage of foreign born, a lower average level of living, and a greater degree of homogeneity in its counties' levels of living, despite the contrast between rural and urban areas.

The Appalachians and the Shenandoah Valley of Virginia, Region IV, are similar to Region II in size and in their "proportion of urban dwellers, non-whites and persons employed in manufacturing." In contrast to Region II, however, Region IV's population is heavily concentrated in its valleys, and the average level of living is lower. These lower levels reflect the economic stagnation of the area, which is heavily dependent on coal mining, a declining industry. Lewis attributes the low levels of living on farms here solely to the fact that most farmers are only part-time workers. But other factors must predominate in this area, since part-time farm operators elsewhere—in the spring and winter wheat belts, for example—have prospered. In contrast with the coal-mining areas of Region IV, the Shenandoah Valley and northern Virginia Piedmont have higher levels of living. Apple, turkey, and chicken production, manufacturing, and tourism contribute to this regional high.

The least populated and least densely settled region, Region V, lies north of Region II in Maine, New Hampshire, and Vermont. This hilly section, with the smallest proportion of urban dwellers, has the highest proportion of workers employed in manufacturing and agriculture and the lowest number of service workers. Owing to the infertile and harsh environment, the region's fairly recent immigrant population is concentrated along its southern edge or in the northeastern Aroostook potato area. The migration of younger people from this largely rural area has been high because of sharp declines in employment from 1950 to 1960.

Region VI extends from the southern part of the Delmarva peninsula southwestward to the Allegheny Plateau of southern West Virginia. Moreover, the region has eastern and western divisions. The eastern plains area, with a comparatively high proportion of Negroes, is further subdivided. There are the urbanized counties with a high level of living, where the population has increased with the growth of cigarette, textile, and ship manufacturing and with government employment. The rural farming counties in the east do not share this prosperity and have lower levels of living, more nonwhites, and many tenant-operated farms. These rural counties have experienced heavy out-migration as a result of declining tobacco production and suffer from a notable lack of urban services and facilities. In the western, largely rural area low levels of living prevail, and the population is decreasing owing to a decline in both coal mining and agriculture; only a small percentage of the people are employed in manufacturing, and 12.4 percent of the area's housing units were classified as dilapidated by the Bureau of the Census in 1960.

Although it is somewhat doubtful that the number of divorces, annulments, and voters in 1960 are indicative of a "level of living," Lewis's original approach to population geography provides an excellent overall view of the economic, geographical, social, and political characteristics of the northeastern United States.—MARY P. DONAHUE

EUROPE

THE TURNIP AND THE AGRICULTURAL REVOLUTION IN ENGLAND. An English farmer of the year 1066 would have found little that was strange if he could have returned to his farm in 1666, because English (and European) farming practices had changed remarkably little during those six centuries. The medieval farmer used his cropland only to grow grain for himself and his family. After a year or two the field became choked with weeds, and the farmer had to cultivate it continuously during a year of bare fallow in order to eradicate them; such was the basis for the two-field (grain-fallow) and three-field (grain-grain-fallow) systems of medieval agriculture. Communal working of the open fields precluded agricultural innovations, such as the introduction of new crops, and the system did not produce enough winter feed to support the number of livestock needed to provide enough manure for the maintenance of soil fertility. Crop and livestock operations were supposed to remain completely separate, as Little Boy Blue discovered to his sorrow: livestock might be turned onto the cropland after harvest, but for most of the year their droppings enriched only the common pastures, which were never used to produce crops.

The rigid medieval agricultural system was first breached during the enclosure movement that began early in the eighteenth century. The strips of the old open fields were consolidated into solid blocks of land. The farmer was released from his communal obligations and could experiment on his own land with better implements and techniques of cultivation, new crops such as clover and turnips, and improved rotations. These were combined in the Norfolk Four-Course Rotation, developed on the light sandy soils of the county of Norfolk in eastern England, where the traditional three-field rotation of wheat, barley, and fallow had been replaced by a four-year rotation of wheat, turnips, barley, and clover. Clover, one of the new fodder crops, contributed to the fertility of the soil because it was a legume. It also provided better grazing than the old common pastures, and this helped to erase the medieval division of land into permanent cropland and permanent pasture.

Although clover was important, turnips were the key to the Norfolk System, since they enabled a farmer to integrate his crop and livestock operations, which formerly had been separate. The rows of turnips had to be hoed or cultivated to keep down weeds, and by eradicating the weeds in his turnip field the farmer saved the expense of having to keep a third of his land in bare fallow each year. Turnips also provided abundant winter feed for more and better livestock, with attendant increases in manure production and soil fertility, which in turn helped to increase crop yields. The resulting upward spiral (higher yields, more livestock, more manure, richer soil, higher yields) is commonly dubbed the agricultural revolution.

Some scholars have been baffled by the fact that the Norfolk System, despite its apparent attractiveness, failed to spread across England. A recent paper by C. Peter Timmer (The Turnip, the New Husbandry, and the English Agricultural Revolution, *Quart. Journ. of Economics,* Vol. 83, 1969, pp. 375–395) has an extremely interesting and detailed input-output analysis of two "model" farms, one using the old wheat-barley-fallow rotation with part of the land in permanent pasture, and the other using the new wheat-turnips-barley-clover rotation on almost the entire farm. The new farm is not much more profitable than the old one if estimates of crop yields, costs, and returns are based on all-England averages, which may help to explain why the Norfolk System was not adopted by many farmers on the heavier soils of wetter areas. The new system apparently would have been most profitable on the lighter sandy soils of the drier eastern counties, however, and it was most extensively adopted in precisely these areas.

Timmer has also examined two myths that have long been associated with the English agricultural revolution. The traditional view held that innovation was a function of leadership by such epic figures as Jethro Tull, Lord Townshend, and Thomas Coke of Norfolk, plus popularization by writers such as Arthur Young, Nathaniel Kent, and William Marshall. The work of contemporary economic historians, however, has indicated that innovations traditionally associated with the agricultural revolution are actually somewhat older. The erstwhile epic figures were not great innovators but simply popularizers of techniques that were already well established, and the adopters of these techniques were mere captives of underlying economic forces.

The other myth is the notion that the English agricultural revolution of the eighteenth century might provide guidelines for some of the less developed nations of today. Some students of economic development, for example, have assumed that great increases in agricultural output must have released larger numbers of farm workers for jobs in the new textile mills of the industrial revolution, but such was not the case; the new system increased the productivity of land, not of labor. The lowly turnip is one of the most labor-demanding of crops, and it required more farm workers, rather than fewer. Increases in farm production and profits resulted from more efficient use of more workers on the same amount of land by spreading the work load more evenly throughout the year, but increases in the productivity per worker were negligible, at best. The agricultural revolution did not release an army of farm workers for factory jobs, but it did enable English soil and English toil to provide food for a rapidly growing industrial and agricultural labor force.—JOHN FRASER HART

DISUSED AIRFIELDS IN BRITAIN. Mackinder once called Great Britain "a moated aerodrome." This statement has been neatly documented, so to speak, in a recent article by R. N. E. Blake on "The Impact of Airfields on the British Landscape" (*Geogr. Journ.,* Vol. 135, 1969, pp. 508–528). His map of airfields in the United Kingdom in 1945 shows a spread almost literally from Lands End to John o'Groats, and beyond to the Orkneys and Shetlands. Twenty-five years ago there were 720 airfields (including seaplane bases), which occupied some 360,000 acres, or "rather less than 1 per cent of the area of the United Kingdom." The distribution, of course, was by no means uniform; the greater number were in the south and east, facing the enemy's approach and defending his main targets. In some parts of Britain 2.5 percent of the land was in airfields that were spaced on the average 7.5 miles apart or, in the more congested areas, only 4 miles apart.

Ten years earlier there had been only 150 airfields occupying 37,000 acres. The concentration in the south and east was then more marked, and a relationship to chalk and limestone scarplands was noted. Paved runways had not been developed, good drainage was necessary, and scarplands provided few obstructions to takeoff and landing. During the 1935–1945 interval, much of the growth of airfields was in the north and west, reducing somewhat the dominance of southern and eastern England.

The 1965 map resembles that of 1935 somewhat more than it does that of 1945. The number of airfields had dwindled to 225, but the acreage remained high, 150,000 in use and reserve, which indicated the increasing size of at least the more important fields. Closures of military fields had been most pronounced in Scotland, in Northern Ireland, and near the larger cities; many small, unpaved fields in Kent, Sussex, and Berkshire had also dropped out. Today only about 0.5 percent of the United Kingdom is in airfield land use, but when one considers the impact of an airfield on its surroundings, it can certainly be called a major landscape type.

Airfields have different shapes, sizes, and arrangements. The layout of runways, perimeter roads, and buildings affects not only the appearance of the abandoned fields but also the way in which they have been used or reclaimed. "The internal lay-outs of disused airfields are more critical to the understanding of current land use patterns than are their original boundaries." Grass fields have now largely returned to agriculture. Many of these were rectangular in shape and without permanent runways. Surplus paved fields have disappeared more slowly, but the demand for concrete fragments for use in road construction has resulted in the tearing up of even these solid runways. Other surplus fields have been converted to other uses—for example, nuclear research, depots of various kinds, small-scale industry, parking, motor racing, and even mushroom and poultry farms. Some remain in ancillary military use, such as parachute training. Blake estimates that in 1965 about 30,000 acres of concrete remained to be removed or converted.

Blake derived his data from a variety of sources, including measurements from maps. He says—and one hopes this is a promise—that "the role of operational airfields in generating population, employment, trade, traffic and noise merits a completely separate study." If one may guess that an operational airport strongly affects an area ten times its own, then 1,500,000 acres of British soil, or one-fortieth of the country's total, are so affected and this might well be a gross underestimate.—Stephen B. Jones

DEVELOPMENTS IN SCOTLAND. A 1970 estimate claims that Scotland has lost 92 percent of its population in the last two decades and that between 1961 and 1966 Scotland experienced the highest rate of net emigration in Europe, apart from Malta. Scotland's losses were much more severe than those of any other region of the United Kingdom. This represents the worsening of a condition that has caused concern for some time. In 1801 Scotland's share of the population of Great Britain was 18.1 percent. As late as 1901 it was 13.7 percent. It has now dropped to 9.8 percent. Scotland had barely shown a threefold increase between 1801 and 1951, and its growth rate had fallen from an estimated 18 percent a decade then to 4 percent now; in the same 150 years England had shown a fivefold increase. Yet the annual

Scottish birth rate, 19.1 per 1000, is distinctly higher than that of England, 16.5; indeed, the Scottish rate is greater than that of Italy, 18.4, which is usually thought to be a rapidly growing country, or that of West Germany, 17.6. The disparity is due to loss by migration, now at a peak.

In the Highland and Southern Upland counties the loss is greater than the natural increase; in the Central Lowlands there is a small net gain, but this scarcely hides the outward drain of more than three-quarters of the potential population. Regional differences create additional problems. The flight from the Highlands and Borders and the drift from the North East have led to overcrowding in the Central Lowlands. In 1755 the lowlands had only a slight margin over the outer regions, with 51.1 percent of the population; now they have 82.3 percent of the total. Clydeside, with less than 1 percent of Scotland's area, has more than 35 percent of its population. Congestion has led to appalling housing conditions, and no less than 15 percent of the people are living more than two to a room, as compared with 6 percent for Scotland as a whole and 1 percent for England. Here the problem is to relocate 270,000 people, or one-twentieth of the nation, in a massive decentralization "overspill" program ("Central Scotland: A Programme for Development and Growth" [H.M.S.O., Edinburgh, 1963]).

To alleviate these critical conditions the government declared Scotland a Development Area in 1963, eligible to receive special aid for economic and social development. It decided, quite rightly, not to spread this aid evenly and thinly over the country. Instead, it concentrated on the only growing region, Central Scotland, and, more specifically, on the already growing areas within the region, on the theory that economic benefits would then flow to the rest. The development plan designated "growth and rehabilitation areas" in the periphery of Clydeside (mid-Clyde River, lower Clyde estuary, and east of the Firth of Clyde) and in the Forth basin (upper Forth estuary and the east and west sides of the mid-firth). The plan suggested that existing growth points such as Motherwell, Irvine, Dumbarton, Falkirk, and Grangemouth be strengthened by establishing new iron and steel plants and automobile, engineering, and petrochemical industries; that new towns be built at East Kilbride and Cumbernauld south and east of Glasgow, and at Livingston and Glenrothes west and east of Edinburgh; that overspill population from Clydeside be resettled in some sixty-three municipalities; that motorways be built from England to Glasgow and thence to Edinburgh and Stirling; and that the new Forth and Tay road bridges be constructed and a tunnel be built under the Clyde.

All these things have been done. They gave rise to three other major reports—one on the Scottish economy as a whole, the Five-Year Plan which, based on central development, saw an outflow to the Borders, the Highlands, and the North East (The Scottish Economy, 1965–70: A Plan for Expansion, [*British Command Papers*] *Cmnd. 2864,* Edinburgh, 1966), and two on special development areas within the Central Lowlands, namely, Falkirk-Grangemouth, Scotland's new major petrochemical center and most rapidly growing port, and West Lothian (Livingston), destined for swift expansion in electronics ("The Grangemouth/Falkirk Regional Survey and Plan" [2 vols.; H.M.S.O., Edinburgh, 1968]; and "The Lothians Regional Survey Plan" [2 vols.; H.M.S.O., Edinburgh, 1966]). The establishment of the European Free Trade Association greatly helped Grangemouth to become a major center for trade with Scandinavia.

To assist in the fulfillment of the Five Year Plan, the Highlands and Islands Development Board was set up, and plans for the West Borders and for North East Scotland were published (Highlands and Islands Development Board, Third Report [Highland and Islands Development Board, Inverness, 1969]; Johnson Marshall, edit: The West Borders [H.M. S.O., Edinburgh, 1968]; Maxwell Gaskin, edit.: North East Scotland: A Survey of Its Development Potential [H.M.S.O., Edinburgh, 1969]). Here again, lesser growth points outside the Lowlands were seized on for new development, in part as interceptor centers to catch some of the drift to Glasgow and Edinburgh. In the Highlands, Fort William was expanded as a focus for electrometallurgical and pulp and paper industries, and Invergordon as an electric-power point and aluminum center. In the West Borders, the woolen-mill towns of Galashiels, Selkirk, and Hawick were to be resuscitated with textile-engineering and man-made fiber plants. The North East was faced with the problem of having no active center except Aberdeen, which depends on services rather than on products. A lagging area, characterized by a net outflow of people, a higher than average unemployment rate, "a widespread use of labour at low levels of productivity," and little work for women, the North East has now been supported in competing for industry which is on the move, especially "bio-clean" industries in need of an unpolluted environment. This is a major advantage in the competition for new manufacturing plants.

Further plans are soon to be published. The British government suggested that a major effort should be made to develop the Severn, Humber, and Tay estuaries, and as part of this a survey of the Tay basin has been made. A recent government survey of the South West has resulted from a controversial private plan for a dam on the Solway to reclaim the extensive marshes at the head of the firth for intensive agriculture and to carry an expressway from England north and an aqueduct for Scottish water south. Meanwhile, the initial report of Strathclyde University of Clydeside has sparked off a government study of the West Central region of Scotland.

Thus tremendous changes are taking place in Scotland, or are soon to take place, altering much of its basic geography. In this, American industry has taken a notable part, together with the shift north of major British firms seeking sites for new plants. One problem confronting the developers is the small scale of Scottish administrative districts. Clydeside, which cries out for a major metropolitan scheme of administration, is still divided among four counties and twenty-four municipalities. A larger framework is needed for local planning and government. Consequently, a Royal Commission was set up, which, among other things, suggested dividing the country into seven major regions, the four largest of which would be based on the city-regions of Glasgow, Edinburgh, Dundee, and Aberdeen (Royal Commission on Local Government in Scotland, 1966–1969, [*British Command Papers*] *Cmnd. 4150,* Edinburgh, 1969). A two-tier system is envisaged, in which regional "governments" would deal with the overall planning and finances of the larger areas, and municipal and county councils would manage local matters. If this were to materialize, a more rational approach to Scottish development, based on geographical regions, would help to implement the plans for rehabilitation of the country, would keep more Scots in Scotland, and would reactivate its growth.—J. WREFORD WATSON

ASIA

THE INDIGENOUS ORIGIN OF CHINESE CIVILIZATION. Two new and conflicting challenges to old concepts concerning the development of Chinese civilization have been propounded recently. One results from archeological discoveries and interpretation, and the other derives from historical Sinology. Wilhelm G. Solheim II, who has done cave-floor excavations in northwestern Thailand, claims to have discovered positive indications of domestication of food plants in Southeast Asia beginning some 10,000 years ago and predating that from anywhere else in the world, and also indications of the manufacture of bronze a thousand years before the emergence of the northern China Shang dynasty bronzes ("They're Re-shaping Old History," *Honolulu Star Bulletin*, March 26, 1969, p. D-6; for an account of the site, see Chester F. Gorman: Hoabinhian: A Pebble-Tool Complex with Early Plant Associations in Southeast Asia, *Science*, Vol. 163, 1969, pp. 671–673). The implications are that agriculture and bronze-making were transmitted northward to the Chinese rather than being Yellow River Chinese derivations transmitted to Southeast Asia as believed heretofor.

The other thesis asserts that the loess highlands of northern China have an earlier claim than Southeast Asia to the independent invention of agriculture and denies the necessity of relating the rise of a great civilization (for instance, the Chinese) to floodplain irrigation (Ping-ti Ho: The Loess and the Origin of Chinese Agriculture, *Amer. Hist. Rev.*, Vol. 75, 1969–1970, pp. 1–36). This thesis directly contradicts the theory proposed some years ago by another Sinologist, Karl A. Wittfogel (Oriental Despotism: A Comparative Study of Total Power [New Haven and London, 1957]), and Ho flatly states that "in so far as ancient China is concerned, the theory of the 'hydraulic' genesis of culture or of 'despotism' is completely groundless."

Professor Ho's article, although addressed primarily to Wittfogel's thesis, contains a postscript indicating that the interpretation of the finds in northwestern Thailand is premature and needs more study, since the indentification of several fossil seeds appears to be suspect. One aspect that he points out as dubious is the strange association of tropical plants with cool-temperate plants adapted to a Mediterranean environment (*Pisum* and *Vicia*). Moreover, at most Professor Ho concedes that these finds seem to establish the early existence of "proto-horticulture" or horticulture, which "cannot be equated with agriculture."

In general, Professor Ho's article appears to validate his contention "that, in so far as theories of the genesis of culture are concerned, China may well hold as crucial a position as do Mesopotamia and Meso-America." He holds that the Chinese agricultural system evolved independently and in a way that differed from the floodplain irrigation systems of the Indus Valley, Mesopotamia, and Egypt.

To establish this he needed to verify three conditions: (1) that the earliest Chinese agriculture was not carried out on floodplains and by irrigation methods; (2) that the earliest food plants cultivated were associated with the droughty conditions of the loess highlands; and (3) that the climate during the period of evolution of the unique Sinitic culture was essentially the same as that of the present time. New techniques of scientific sleuthing and a scholarly search of historical and philological materials in ancient Chinese documents have helped him to establish these propositions.

Climatic conditions and associated botanical species in the loess highlands during the last million years have been revealed through pollen-grain studies by the Chinese Geological Survey of the entire sample column from a 121-meter depth of loess in Wu-ch'eng County, Shansi Province. The upper 20 meters correspond approximately to the period in which

Sinitic culture has evolved. That the loess-covered highlands have always been an unwooded steppe region is revealed by the fact that 95.4 percent of the pollen grains counted were from herbaceous plants, and 64.8 percent were from *Artemisia*, a plant of the dry steppe. The percentage of *Artemisia* pollen for the upper 20 meters was 71.8, as compared with only 53.3 for the strata below, which indicates increasing aridity in late Pleistocene times. The mere 5.6 percent of the pollen derived from *Gramineae* in the upper 20 meters shows the relative poverty of cereal food plants of the early Chinese.

"The Book of Odes" is a Chou dynasty record of Chinese cultural life from the eleventh to the sixth century before Christ. The frequency with which specific plant names are mentioned in it provides evidence of plants that were of prominent concern to the early Chinese. Of 150 references to plants in this book, nineteen were to the genus *Artemisia*, twenty-seven were to millet, and twenty to mulberry. The *Artemisia* references corroborate the climatic inferences of the pollen counts. Millet and mulberry were cultivated by the early Chinese of the Shang and Chou periods. That millet is indigenous to the Chinese loess highlands is indicated by the continued presence of its wild forms today. According to Professor Ho, no wild species occur in India, and this would seem to invalidate the theory that Chinese millet was derived from India, as A. Engler, Hermann von Wissmann, and others have claimed. Philology does not support an Indian origin for millet, whereas in China the name of the mythical ancestor of the Chou tribe literally means "God of Millets."

Almost all the sites of the earliest Sinitic settlements in northern China are on terraces or mounds elevated twenty feet to hundreds of feet above the upper reaches of streams tributary to the Yellow River rather than on its floodplain. Professor Ho cites this as the best evidence that the earliest agriculture was not irrigated, since water could not be lifted to these areas before the invention of waterwheels. However, though unlikely, it is not impossible that settlements were elevated, whereas the cultivated fields were on the floodplain below. Yet this would not invalidate Professor Ho's general thesis that the development of Chinese agriculture owed little or nothing to the Yellow River's main stream or floodplain, contrary to the views expressed by the late Henri Maspero (La Chine antique [Paris, 1927], pp. 20–26) and by Arnold Toynbee (A Study of History, Vol. 1 [London, 1934], pp. 318–321).

The dry loess upland millet agriculture of the early Chinese, which developed in a region of summer rainfall, was fundamentally different from the agricultural systems that developed in Mesopotamia, Egypt, and the Indus Valley, two of which were in Mediterranean climates and all of which were based on the common triad of floodplain, primitive irrigation, and a cropping system that had wheat and barley as the core. From these arguments it seems reasonable to concur with Professor Ho's conclusion that it is unsound to believe in a single center for the development of agriculture and civilization. The evidence he has presented and the multiple origins of agriculture in Meso-America should be sufficient to change traditional views about the development of culture and the rise of civilizations everywhere.—HEROLD J. WIENS

CLIMATOLOGY

CLIMATE AND HISTORY. Although Ellsworth Huntington was mainly responsible for enunciating the hypothesis of postglacial desiccation and climatic pulsations in dry lands, several historians share the distinction of linking climatic variation to human activities and events.

Considering that the meteorologist C. E. P. Brooks as recently as 1949 (Climate through the Ages [London, 1949]) made unqualified use of nomadic migrations as evidence of diminishing rainfall, geographers since Huntington have been remarkably cautious in this arena. A recent attempt at synthesis by Mario Pinna (Le variazioni del clima in epoca storica e i loro effetti sulla vita e le attività umane, *Boll. Soc. Geogr. Ital.*, Ser. 9, Vol. 10, 1969, pp. 198–275), despite its suggestive title, is no exception. Pinna posits the potential interest of this field of investigation but concentrates on some of the methods and results of paleoclimatic research as applied to Western Europe for the last four or five millennia. The treatment is well balanced and obiective, though perhaps overambitious in attacking questions of possible climatic change in late prehistoric and Greco-Roman times on an inadequate selection of literature. His outline of the medieval warm phase (*ca.* A.D. 1000–1300), the glacial readvances of recent centuries (*ca.* 1550–1900), and the warm-up of the twentieth century (until the 1950's) are more effective. Particular emphasis is given to the available analyses of recent meteorological records, to the history of glacier fluctuations in the Alps, and to the rich harvest of historical records assembled and interpreted by Emmanuel Le Roy Ladurie (Histoire du climat depuis l'an mil [Paris, 1967]) and by H. H. Lamb (The Changing Climate [London, 1966]). Pinna concludes by pleading for further paleoclimatic studies and a search for documented influences of climate on human events in Europe.

Unfortunately, some archeologists and historians have not been willing to await or otherwise fully to consider the paleoclimatic evidence. Raphael Pumpelly and V. Gordon Childe decades ago attributed the origins of agriculture to the stress of alleged postglacial desiccation, and Childe and Carleton S. Coon invoked a similar explanation for the agricultural dispersals out of the Near East (for a discussion of these theories see Karl W. Butzer: Environment and Archeology [Chicago, 1964], pp. 435–437 and 439–440). Solely of historical interest too, now, is the "physical challenge" of impending desiccation that Arnold Toynbee envisaged as the origin of Egyptian and Mesopotamian civilization and as the beginnings of nomadic pastoralism. It is even more perplexing to find a primitive neodeterminism in the modern writings of Rhys Carpenter and Franz Altheim.

Carpenter, in his "Discontinuity in Greek Civilization" (Cambridge, England, 1966), attributes the breakdown of the Mycenaean economy (*ca.* 1200–1100 B.C.) to repeated crop failures caused by a supposed climatic change in southern Greece. Intensification and prolongation of the summer dry season into spring and autumn are also considered as an explanation for the low level of cultural and economic activity in the eastern Mediterranean Basin during the seventh century of the present era. H. E. Wright, Jr., in a well-stated critique of Carpenter (Climatic Change in Mycenaean Greece, *Antiquity*, Vol. 42, 1968, pp. 123–127), points out that pollen profiles from Dalmatia, the Peloponnesus, and western Anatolia give no indications of a significant, long-term climatic change around 1200 B.C. and A.D. 600 or, for that matter, at any point during the historical era. Even in the climatically more "sensitive" parts of higher latitudes, neither century marks a transition or watershed in climatic history. Of course, this does not exclude significant short-term anomalies, with a greater frequency of severe droughts. But even here the evidence is certainly lacking in the twelfth century before Christ; in fact, Carpenter's somewhat specious arguments include famines reported by Herodotus seven centuries later, the postulated emigration of Anatolian groups, and a value judgment concerning the "vigor" of contemporary Egyptian culture. The lack of a positive correlation between Mediterranean rainfall (for example, in Athens), and Nile discharge is certainly relevant here, and in fact Ethiopian rainfall was so high about 1300 B.C. that Lake Rudolf probably overflowed into the Nile system by a threshold some 85 meters above present lake level (K. W. Butzer, F. H. Brown, and D. L. Thurber: Horizontal Deposits of the Lower Omo Valley: The Kibish Formation, *Quaternaria,* Vol. 11, 1970, in press).

Turning to the seventh century of the present era, Carpenter seems to reinforce Altheim (Geschichte der Hunnen [5 vols.; 2nd edit.; Berlin, 1969]), who interprets the pre-Islamic Arab infiltration into the Fertile Crescent and the subsequent deluge of dromedary nomads from the Arabian deserts in terms of a series of droughts, inferred from Classical and Islamic sources. Altheim generalizes these short-term dry spells from the eastern Mediterranean Basin to all of Central Asia to help explain the unrest of the Huns and of later horse nomads. The resulting interpretation of waves of nomadic horsemen periodically sweeping out of the Turanian and Mongolian steppes recalls Huntington's "The Pulse of Asia" (Boston and New York, 1907). A small fact overlooked by Altheim is that recent climatic anomalies in the Fertile Crescent and in Central Asia are inverted (K. W. Butzer: Climatic Change in Arid Regions since the Pliocene, *in* A History of Land Use in Arid Regions (edited by L. Dudley Stamp), *Arid Zone Research* [UNESCO], Vol. 17, 1961, pp. 31–56), which comes as no surprise since we are dealing with a winter-rainfall belt in the first case, a summer-rainfall province in the second. Altheim's claims for dry anomalies in Central Asia lack factual support, and most Byzantine and Islamic historians will agree that the internecine wars between Byzantium and Sassanid Persia (particularly those in A.D. 572–591 and 603–628) were paramount in making possible the Arab migrations and the ultimate Arab conquest of the Fertile Crescent.

It would seem that all alternative explanations for historical processes and "discontinuities" should be explored before climatic changes are evoked. At the very least, such natural events must be demonstrable in their own right.—KARL W. BUTZER

METEOROLOGY AND THE SUPERSONIC TRANSPORT. Before World War II the stratosphere was generally regarded as of limited meteorological interest or consequence, though in truth little more was known of its characteristics than its basic thermal stability. More recent observations have changed our views. Sufficient stratospheric data have now been acquired— for the Northern Hemisphere, at least—to cause the abandonment of all ideas of spatial and temporal uniformity and simplicity. A great deal about the stratosphere remains unknown or unexplained, but we now have the outlines of its weather characteristics, puzzling though these sometimes are. The advent of the supersonic transport (SST) has added practicality and some urgency to high-altitude studies, for this new generation of aircraft will cruise at heights of 18 to 21 kilometers, or nearly twice the height of present-day aircraft. Meteorological conditions in the stratosphere will obviously be critical to the aircraft's technical and economic efficiency and safety, and some meteorologists have expressed concern about the effects of the aircraft on the stratosphere ("Meteorological Problems of Supersonic Aircraft," *Quart. Journ. Royal Meteorol. Soc.,* Vol. 95, 1969, pp. 779–796; and Frederick G. Finger and Raymond M. McInturff: Meteorology and the Supersonic Transport, *Science,* Vol. 167, 1970, pp. 16–25).

Although the SST will cruise in the stratosphere, it will of course have long subsonic climbs, descents, and landing flight paths through the lower stratosphere and troposphere. On a flight from London to New York, for instance, about one-third of the total 2 1/2-hour flight time will be spent at heights below the cruising level. During these times, the SST will require meteorological information similar to that already supplied to subsonic aircraft, but it is clear that in the transonic and sonic sections of the flight different meteorological conditions will apply, calling for special forecasts. Moreover, because of the high speeds at which these aircraft will fly, several entirely new problems must be faced.

Hazards of hydrometeor impact, though not unique, will be made more acute by the supersonic speeds. Hailstones are dangerous to all aircraft, but at high speeds even raindrops could cause the failure of the airframe by peeling back metal rivet heads, by opening joints, and by causing the metal skin to shatter and even flow. The SST must clearly avoid raindrop as well as hailstone impact in the upper parts of cumulonimbus clouds near the transonic section of the flight. Cumulonimbus clouds are also dangerous because of their high windspeeds and wind shears, and they undoubtedly constitute the single most important hazard to supersonic aircraft. The forecasting of cloud-top heights in relation to the flight path will be important.

Conditions of both wind and temperature will affect the operational behavior of the SST as they do of subsonic aircraft. Lower stratospheric turbulence near to severe thunderstorms and in mountain lee waves will best be avoided, but in general—particularly in summer, when strong stratospheric wind shears are less common—passengers in an SST are likely to have a much smoother ride than in present-day subsonic aircraft. Detailed temperature forecasts, especially of the characteristic winter stratospheric warmings, will need to be made to prevent the airframe, heated by friction and by the absorption of solar radiation, from exceeding the critical temperature above which there is a marked structural weakening. There is also the problem of maintaining acceptable temperatures inside the aircraft.

In all these cases, the problems are essentially the same as those already faced by subsonic aircraft, though made more serious by the higher speeds. Two problems unique to the SST because of the height at which it will cruise will be the high concentrations of ozone and the strength of cosmic radiation at times of major solar flares. More information is needed about maximum concentrations of ozone, but it is expected that the aircraft's air-conditioning plant will easily reduce these to acceptable levels inside the aircraft. Intense cosmic radiation could occasionally prove serious, especially in high latitudes, but these infrequent occurrences will be monitored on board and rapid descent to below 16 kilometers will provide the protection of the overlying air. Stratospheric meteorology is clearly important to both the design and the operation of the SST. Improved and more numerous observational techniques will be needed up to about twice the height of present-day forecast limits, and there is no doubt that meteorological satellites will play an important role in the new forecasting organization.

It remains to be seen, however, what chemical and physical effects, if any, the SST will have on the stratosphere. Some meteorologists have already expressed concern about increases in the amount of thin cirrus cloud in the upper troposphere and lower stratosphere produced by the spreading of contrails from high-flying jet aircraft; the phenomenon obviously needs careful watching, for a significant increase in cirrus clouds could affect the radiation balance and possibly, thereby, the general circulation of the atmosphere. But many authoritative estimates of the amount of water vapor and carbon dioxide likely to be ejected into the stratosphere by supersonic transports suggest that the relative change in natural concentrations will be far too small to have any real effect ("Weather and Climate Modification: Problems and Prospects: Final Report of the Panel on Weather and Climate Modification to the Committee on Atmospheric Sciences," *NAS-NRC publ. No. 1350,* 2 vols., Washington, D. C., 1966, Vol. 2, pp. 97–99).

The advent of the SST, coupled with improved techniques of observation and analysis, have enormously increased our meteorological knowledge of the stratosphere. We already know a great deal, and soon the flight testing of the Anglo-French Concorde will confirm or invalidate our present theory concerning the effects of air on aircraft and of aircraft on air. In their turn, the supersonic transports will further extend our knowledge of the upper atmosphere.—T. J. CHANDLER