6

Historical Ecology

CAROLE L. CRUMLEY

A remarkable accomplishment of the human species is that its consciousness and its numbers are great enough to modify many of the immediate effects of climate and the land on human endeavors, for instance by the construction of shelters or the keeping of reserves. Yet climate and geology place constraints on human activity even today; beach erosion affects development, a summer hailstorm destroys crops.

In order to explain the dynamic relations among weather, parent material, and biota, two very specific and important questions must be answered: the distance of a particular place from the poles and the equator (latitude), and its relation to the earth's water and land masses (the importance of longitude). Latitude reveals a number of things about climate (solar radiation intensity and transpiration rate, ambient temperature). Longitude fits the spot into the geological structures that constitute the earth's crust. Differential solar heating of the earth's various surfaces (e.g., land, water, ice) results in convection currents in the atmosphere, which differentially distribute warmth and moisture.

The purpose of this chapter is to explore the dynamic relations between and among the environmental systems discussed in Chapter 2 (lithosphere, atmosphere, hydrosphere, biosphere) and the various cultures that have inhabited Burgundy since the Iron Age.

The study of processes whereby the elements constituting the earth's crust are agglomerated and dispersed, as well as the forms they take, is termed *physical geology*. *Historical geology* is the study of particular sequences of formation, deformation, and dissolution of lithic facies. In the geological history of Burgundy, the most salient events occurred at a much earlier time than the Iron Age, but the order of their occurrence and other specifics still interest us, for such information both explains and (to a certain extent) predicts the distribution of rocks and minerals.

Historic inhabitants of Burgundy had not the wealth of information we have today, but each culture was aware (to a different extent, to be sure) of the locations of concentrations of certain resources (for example, iron mines and marble quarries). The topography of Burgundy, as well as the subsurface geology has changed very little in the past two thousand years. What changes there have been are subtle ones: the fluctuating processes of erosion and deposition are to be seen at work from Mont Dardon to the banks of the Arroux River. Although associated vegetational and habitational patterns have changed many times, the mountains and valleys of the region are essentially those the Celts contemplated two millennia ago.

Major climatic events are generally considered to be contained within the geological ages and their internal divisions. The last glacial age, some twelve thousand years ago, has given way to a period of relative warmth termed the Holocene (or Recent). The Holocene is further divided into various periods of greater or lesser warmth and rainfall. One such period, the sub-Atlantic, has been identified as beginning ca. 1000 B.C. and continuing to the present (Figure I and Appendix A). The climatic variations to be discussed below distinguish themselves from one another only in terms of the past three thousand years. What focuses our interest on this period of relative geological quiescence and climatic variation is its value as a measure of the effect human activity has had in modifying the visage of Burgundy, as well as the role that the climate and geology of the region have played in shaping the cultures of its inhabitants.

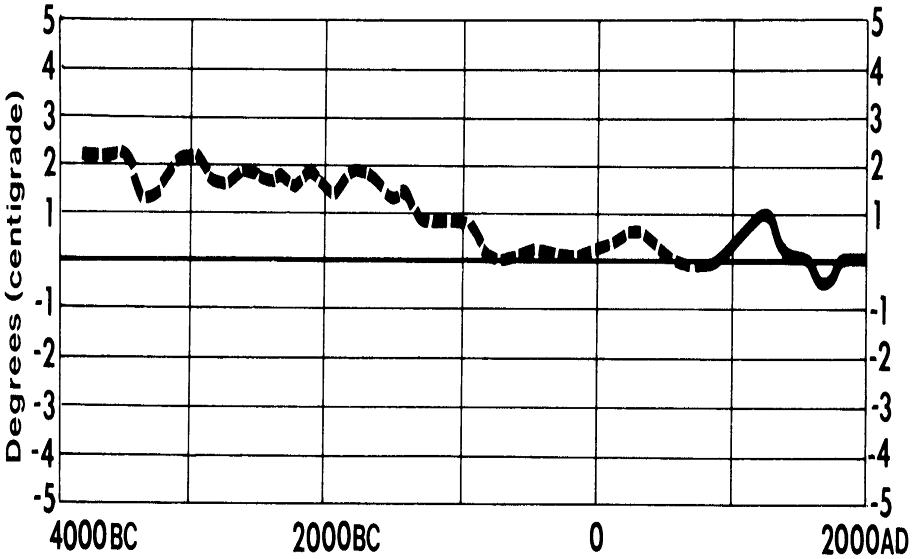

Figure 1 Average temperatures in Western Europe, illustrating the Altithermal High (4000–1000 B.C.), the second- and twelfth-century A.D. warm peaks, and the "Little Ice Age" of the fourteenth to seventeenth centuries; variations are from the twentieth-century average (adapted from Lamb 1977:figure 16.23).

The Nature of the Evidence

Many different sources afford us evidence of variations in climate and in patterns of erosion and deposition, as well as humans' exploitation of concentrations of mineral and lithic materials and of biota, their role in reducing or producing erosion and deposition, and their response to fluctuations of the weather.

Literary sources include evidence from individuals' journals and diaries, published and unpublished historical accounts, and government records. An important supplement to such narratives is the archaeological record, sometimes interestingly at odds with eyewitness accounts. Archaeologists recover spatial data frequently missing from the literary sources; a combination of archaeological excavation and survey produces spatial information on both settlement and land use. Archaeological (cultural) and geological stratigraphy help identify the direction of causal relationships and subsequent human responses.

Besides geology, other natural sciences-palynology (the study of pollen grains) and paleoethnobotany and zooarchaeology (the study of the relationships of humans to plants and animals in the past)-contribute distinctive but heavily intercorrelated chronologies. Where possible (e.g., the botanical sequence from Mont Dardon), radiocarbon dates have been used to construct a framework of absolute dates.

Gaps in the historical presentation of the relation of humans to geology, biota, and climate are inevitable, and we must remain mindful that the missing data might have changed our characterizations considerably. All available information, whatever its nature, has been considered and is presented here in appropriate topical blocks. The internal organization of each topical block of information is historical.

A hypothetical example may illustrate the interrelated nature of the evidence. Suppose a policy encouraging sheep-raising leads to the clearing of large upland areas. This widespread deforestation, coupled with overgrazing, diminishes established communities of water- and soil-retaining grasses and other ground cover, causing upland erosion. As grazing areas are reduced, previously uneroded areas are too heavily grazed, compounding the problem and stimulating emigration. Eroded soil from the highlands is deposited in the valleys, where enriched soils are put to new uses, highlanders are put to work, and land prices increase. Repopulation of the highlands eventually recurs by means of adaptive strategies such as contour plowing, reforestation, and more varied agricultural practices. The policy that generates this hypothetical chain of events may be a government's response to the physical environment (e.g., deteriorating climate) or sociohistorical conditions (e.g., international competition) or both. Such a scenario might be constructed by combining information obtained from pollen and geologic profiles, administrative records of taxation and commerce, and an ecclesiastical account of a reduced, impoverished highland population in midperiod.

Although such a variety of data poses a considerable interpretive challenge, it is the ecologist's responsibility to identify systemic relations and the historical ecologist's charge to search out chains of causation (as illustrated above) pointing out sociohistorical as well as physical environmental determinants.

Climatic Evidence

A climatic history of Western Europe may be compiled from the work of Lamb (1977:424-549) and others (Beug 1982; Ladurie 1971; Rotberg and Rabb 1981). In the following discussion I extrapolate from such a compilation and offer a tentative history of Burgundian climate based on an understanding of the region's geographical location at the center of three major climatic regimes, the oceanic (sometimes called Atlantic), the Mediterranean, and the continental (see Chapter 2, this volume). Evidence of variation in temperature, moisture, and season of occurrence reveals which of Burgundy's regimes dominated in different periods.

Period I: 900 B. C.-300 B.C. From ca. 900 to 300 B. C. vegetational and literary evidence shows a cold period of particularly severe winters; isolated severe winters continued into the second century B.C. Westerlies (oceanic climatic regime) dominated throughout most of the year, yielding early in the period to winter continental influences. Generally wet conditions prevailed 750-500 B.C.

Period II: 300B.C.-A.D.500. During this period Mediterranean climate dominated year-round, although by late in the period a winter continental regime was reestablished. After the second century B.C. there began a general warming trend whose effects lasted through the fourth century A.D. By the first century B.C., Mediterranean vegetation (grapes, olives) was surviving further north, until cold winters of the third century A.D. halted its progress. During the first two centuries A.D., winter flooding occurred, indicating a pattern of autumn oceanic and winter Mediterranean dominance.

Period III: A.D. 500-A.D. 900. Cold winters, frosts, and floods characterize this period. Summers were cool, becoming warmer, then cooler again. Increasing dryness was reported in the latter half of the period. Alpine glaciers advanced A.D. 400-750; the Nile had ice on it in 829. The continental regime dominated during most of the year in this period, especially in winter. In summers early in the period, the oceanic regime dominated, being replaced midperiod by the continental summer regime. Toward the end of the period summer westerlies (oceanic regime) were again strong.

Period IV: A.D. 900-A.D. 1300. This warm period culminated in what is termed the Little Optimum (A.D. 1150-1300). Warm summers early in the period became cooler mid-period, then warm again at its close. In the eighty years before 1000, droughts were widespread; along with ice on the Nile (A.D. 1011), the evidence suggests generally unsettled conditions at the millennium. The Mediterranean regime dominated this period year-round, except for the importance of the westerlies (oceanic regime) mid-period.

Period V: A.D. 1300-A. D. 1900. Climatic events for this period may be described as varied and extreme. Severe winters and wet summers dominated, giving the period its name, the Little Ice Age. This was a period of widespread glacial advance, particularly between 1590 and 1850. There was a slight warming trend after 1700. In the second half of the period (1600-1900) there were some exceptionally hot, dry summers. Winters during this period were dominated by the continental regime. In summer, westerlies (oceanic regime) dominated the majority of the time, but as the glaciers grew to the north and east, hot, dry Mediterranean air occasionally flowed northward in the summer, into the colder "sink" at the glaciers.

Period VI: The Twentieth Century. With the advent of the twentieth century, record keeping and record-keeping devices have improved markedly; however, as has been seen, it is difficult to identify significant trends within a single century. Many researchers argue for a warm period lasting through the 1960s, followed by a decade of cool, wet, variable weather. Whether such oscillations are particularly meaningful at present is doubtful, except in the sense discussed in Chapter 2 (macroclimate/microclimate) or below, in terms of what duration of conditions is perceived at the time to be a trend and what subsequent human adjustments are made.

Forests and Their Decline

A history of the demise of the forests that completely covered western Europe is in itself a history of human settlement and land use-"the triumph of land over forest" (Grenier 1929:28). Of particular importance is the dialectical relation between forested and agricultural land, although it is acknowledged that hunting and gathering societies do play some role in forest clearance (see, e.g., Chapman *et al.* 1982). In general, however, it can be said that the distribution of vegetation in Europe began to be markedly altered by humans in the Neolithic (Brunhes and Deffontaines 1926; Burkill 1983; Clark 1947; Davis 1981; Grenier 1930; Huntley and Birks 1983; Maury 1849, 1850, 1856, 1867). The New Stone Age of *pierre polie* (polished stone) signaled an attack by agriculturalists on the forests, initially those growing in light soils easily tilled by hand, and later, with the introduction of the plow, those that grew on heavier soils. Neolithic clearance was nonetheless temporary, partial, and local (Burkill 1983:47; Clark 1947:49). This was particularly true in the early part of the period, when the density of hunting and gathering and agrarian populations alike was relatively low and short-term clearing (slash and burn) was practiced. A somewhat ephemeral assault on the woodlands of Europe was transformed into a war on the primary vegetative cover of the continent. With this change, climate, soil, and geography and topography were no longer relatively accurate, collective predictors of vegetation; human activity itself could now permanently change soils and alter plant distributions (Clark 1947:45ff.). With mixed results, humans selected certain species of vegetation for extensive manipulation, altering the species range, changing-by manuring, burning, erosion, etc.-the constituents of the soil, and culling cohabitant species.

The study of the motivations behind these activities, particularly in the period since the Neolithic, also constitutes a history of social relations, one that places in high relief the vested interests of social class and economic and political (both sacred and secular) aggrandizement. Early to mid-Neolithic settlement in Burgundy is distinctive in a preference for high sites on light calcareous soils as well as a greater range of site types (lakeside, cave) than in adjacent areas (Burkill 1983:42). High sites dominate late Neolithic settlement in the region, suggesting a greater need for defense than in the earlier part of the period. In addition, sites along the Sa6ne and other rivers appeared, as the plow made possible the tilling of heavier soils. Human impact on the forest cover in Burgundy was, then, restricted to the calcareous uplands to the northeast and to the larger river valleys throughout the area. P. Rat (personal communication, July 1983) and others have remarked that erosion was greater during the late Neolithic than at any time since, which probably indicates initially inept plow agricultural practices, resulting in the widespread denudation of higher elevations. Despite the subsequent reforestation of many of these areas, soil profiles and species distributions were altered permanently.

In many ways the late Neolithic of Burgundy continued what was probably an even older regional tradition of economic variety (Burkill 1984:46), and the forests were not simply the nemesis of agriculturalists but the source of many useful products. Being stock-keepers as well as farmers, the Neolithic inhabitants of Burgundy nourished pigs on plentiful acorns, kept goats, sheep, and cattle, which nibbled at new green shoots at the edge of the forest, employed wood in a variety of ways (e.g., structures and stockades, tools, fuel), and hunted wild game (Burkill 1983:45ff.). By the end of the Neolithic a distinctive and varied regional economy, now called the *Civilisation Saine-Rhone, had* emerged (Burkill 1983:39).

Early and middle Bronze Age settlement in Burgundy differed little from that of the late Neolithic (Coles and Harding 1979:243) except for the region's increased importance as a commercial corridor for the exchange of metals and other goods in Europe. The latter necessitated an even more marked tendency toward settlement in high, defended strongholds by the later Bronze Age; wealthy graves and other excavated materials from the period attest to social and economic distinctions based on commercial success.

Pollen analyses do not indicate a significant alteration of the forest cover in the Bronze Age (Coles and Harding 1979:468), although the "sluggishness" of biotic responses at certain temporal scales would cause some researchers to qualify the utility of palynological data (Webb 1975:172). Denudation of the uplands undoubtedly continued as a result of circum-hillfort foraging for timber and firewood as well as greater activity (and hence increased clearing) in river valleys. Bronze Age settlement in the Burgundian highlands differed from that of the Neolithic in that the latter was found only on calcareous soils; Bronze Age upland settlement was also located on promontories of gneiss, shist, and granite. Pollen profiles from late in the period (Argant 1981) indicate the presence of pine, birch, alder, hazel, oak, hornbeam, elm, and walnut.

The Iron Age in Burgundy could well be termed the First Industrial Age, in that regional commercial activity included extensive mining and manufacture, as well as transport. With the establishment of Marseille (600 B.C.), the Rhone Saone corridor gave access to iron ore and other mining centers of west-central Europe, and Etruscans, Greeks, and finally Romans sought to exchange wine and luxury objects for manufactured metal goods, and perhaps slaves. Wells (1980) reports regional-scale manufacture and circulation of objects in Germany and northern Burgundy in the early Hallstatt (800-600 B.C.), as contrasted with extensive manufacturing activities and evidence of a wide range of Mediterranean imports by the late Hallstatt (600-450 B.C.). Thus the importance of the establishment of Marseille as a port of trade connecting the Mediterranean with the interior of Europe cannot be overemphasized, although Wells's evidence of transalpine trade during the period suggests widespread commercial incursions from south to north. The founding of Marseille also marks the beginning of literary evidence pertaining to the state of western European forests, first in Greek and then Latin.

The effect of iron mining and manufacture on forests are devastating. As Phillips (1980:229) notes, iron metallurgy requires a great deal of timber for charcoal; thus the activity is generally carried out where such a resource is available. The hillforts of the Iron Age were undoubtedly cleared for some kilometers around, and at least one profession, that of charcoal-maker, was practiced in the forests. The steep flanks of the Aeduan stronghold of Bibracte (Mont Beuvray) must have been bared, both to supply fuel for the furnaces and to aid in defense, although certain trees within the walls may have been spared.

Groves of a particular species of oak *(Quercus robur)* sacred to the Celts and frequently associated with the equally venerated mistletoe *(Viscus)* may, through culling, have served as single-species sacred spots and points of political assembly; if one accepts D616age's argument (1941:65) that communities of mixed species existed in Celtic times but not subsequently, such places could be considered examples of early forest management. There is no doubt that particular members of venerated species were protected and worshiped; this practice was still extant in Burgundy as late as the nineteenth century (Maury 1849:293). The summer, or forest oak (e.g., *Q. robur or Q. sessiflora,* the Gaulish *dervus)* prefers granitic, well-drained upland locales *(D616age* 1941:41), thus tying the sacred Aeduan heartland to the granitic spine of the Morvan massif. That the forests accounted for a large part of the economic resources of the Aedui (Levainville 1909:107) as well increases the likelihood that the forests were managed, to some extent, by powerful Aeduans; whether they were owned outright cannot be determined with certainty (but see Chapter 13, this volume). Nonetheless control of harvesting in the forests would have been maintained for both religious and economic reasons, and in my opinion that control rested with the druids.

In sum, the Iron Age woodlands of southwestern Burgundy were heavily exploited in the granitic highland areas near iron-smelting centers, and less so in the calcareous highlands of the northeastern part of the region (excepting particularly defensible promontories). Near navigable rivers (e.g., the Sa6ne, Loire, and Arroux) throughout the research area, mature trees were selected for ships' timber. Some observers (see MacKendrick, Chapter 14, this volume) mention Burgundian shipbuilding activities in Roman times and, it seems certain, the Aedui would have already begun that tradition during the Iron Age. In the Arroux Valley, this suggested pattern of deforestation would have left the highlands around Bibracte treeless, and the lower valley with its forests culled. The rolling slopes between would have remained forested, as would have certain sacred mountaintop groves.

The effects of Roman presence on the region's forests were not immediate, but they were lasting. The mountains' populations were removed to the valleys, where many were employed in the extensive agricultural activities of Roman *villae.* Although at first Roman agricultural activities centered around cities Decetia (Decize), Augustodunum (Autun), Matisco (Macon)-an increasing lowland population and the demand for grain in a growing empire soon increased Burgundian agricultural lands at the expense of the forests (Maury 1849:293). D616age (1941:76) notes that the schist valleys of the Arroux and the Bourbince rivers were partly cleared in Roman times, with the exception of the completely deforested area of the Autun Basin. The Bragny plateau between the two rivers bears only Roman and later place names, and D616age (1941:77) argues for its complete clearance in Roman times.

On the other hand, Roman interest in Aeduan mining and smelting activities waned. Alesia (Alise-Ste.-Reine), the capital of the Mandubii (Aeduan clients) became more favored, partly as a result of a conscious attempt to re-establish centers of power on Roman terms (similar examples were the removal of the Aeduan capital from Bibracte to Augustodunum, and patronage of the defeated city of Alesia); but also with all Gaul at Rome's disposal, Aeduan ore was less important than that of the Bituriges or the Senones (Desjardins 1968:411). At Alesia the extremely popular process of silver-plating (tinning of copper to resemble silver) was practiced, primarily for horse ornaments and harnesses (Desjardins 1968:423). Forests on calcareous soils around Alesia continued to be exploited, while upland forests on granitic soils (such as on Mont Dardon and Mont Beuvray) were allowed to regenerate (D616age 1941:80ff.). Late in the Roman period the strip of forest at middle elevation between mountain and valley, untouched during the Iron Age, became the location of Gallo-Roman villages (D616age 1941:83; Berry, Chapter 15, this volume).

Thus local and early imperial increase and movement of population were the immediate causes for a major Roman exploitation of the Burgundian woodlands. But it should also be noted that in destroying the forests and particular sacred groves (which they surely did), the Romans were also undercutting the basis of druidic sacred and secular power and shifting a large segment of the Aeduan population away from an extremely varied economy that used the forests in a number of ways, toward Roman "agribusiness," hastening the demise of the woodlands.

During the early Middle Ages the forest was conserved or grew in size on calcareous plateaus, on sandy plains, and on plains and hills of the Loire river valley (D616age 1941:83), while the northeast and northwest-the Morvan and all the Saone river valley-were deforested by Burgundian emigrants moving from east to west and a Frankish emigration from the northwest. Maury (1849:294ff.; see also Maury 1850, 1866, 1867) notes the growing role of Christianity in razing the forestland, particularly the efforts of Saint Fiacre and of Saint Deicol (or Diel) around A.D. 600. However, the dieties of copse and grove were not without their protectors: severe laws protected forests, which the Franks, like the Celts, considered sacred. Frankish use of the forests was reserved for the king and his officers. This marked the beginning of explicit conservation of the now much diminished forests by again placing them in the hands of the most powerful.

By the ninth century forest again covered the Morvan (Levainville 1909:107). This state of affairs lasted until the eleventh century, when the Christian abbeys, having gained control of the forests as gifts from aristocratic families, allowed peasants again to exploit them (Levainville 1909:108). By the thirteenth century Paris had expended its nearby forest resources and began to exploit the margins of the Paris Basin, although it was not until the sixteenth century that the metropolis came to rely heavily on firewood from the Morvan. Between the sixteenth and eighteenth centuries the forests of Burgundy were cut but not replanted, and famines and other economic hardships caused even protected forests to be diminished by theft. Not only firewood went to Paris: women from the Morvan were popular as wet nurses during this period as well. The aristocracy of forest towns was comprised of owners and operators of sawmills, and timber shippers (Brunhes and Deffontaines 1926:348).

In addition to using the forests for fuel and building materials, a variety of cottage industries reliant on wood (the manufacture of chariots, carts, barrels, furniture, cork, and shoes) used even the branches pruned from trees. The northwest Morvan, drained by the Yonne and the Seine rivers, supplied Paris with firewood and framing timber; the southeastern Morvan, drained by the Arroux and the Loire rivers, supplied boatbuilders and local and regional practitioners of *petits matiers.* An ordinance of 1669 prohibited such practitioners from erecting their shops within a half-league of the mountainous forests (Brunhes and Deffontaines 1926:346), but to little avail.

The eighteenth century heralded another period of industrialization, and glassmaking, forging, and paper production became forest-associated industries (Brunhes and Deffontaines 1926:355). With this diversification, immigrants from the Ardennes and the German forests arrived in Burgundy. An edict of 1776 exempted newly cleared land from taxation for fifteen years (Darby 1956:202). Although gas and oil became the fuels of choice in the nineteenth century and reforestation began as early as 1803 (Brunhes and Deffontaines 1926:362), further

XXXXX

Inasmuch as the forested Morvan mountains sheltered and nourished wild boar and (since the Neolithic) domesticated pigs, the open, grassy areas of the valleys offered sweet, tender grass for horses. As early as the Upper Paleolithic, there is evidence that wild horses passed through the region in great numbers during seasonal migration. At the famous site of Solutr6 (Saone-et-Loire) humans waited for and slew them in large numbers.

Both pig-keeping (in the mountains and other heavily wooded areas) and horse-raising (in the valleys) were extremely important in the Iron Age (jullian 1920:195; Oaks, Chapter 8, this volume; Poulain 1976:109). Cattle-raising, while critical to agricultural pursuits and local consumption, did not rival in importance the export of hams, war horses, and sheep wool (jullian 1920:195, 247n.). Sheep and goats, less particular of their pasture, could be raised on soils relatively poorer in nutrients; they were thus to be found throughout the region at a variety of elevations. jullian (1920:125) reports quite a vogue in Rome for Gaulish wool and hides. Cattle-raising, for which the Morvan-Charolais-Brionnais *pays* are at present best known, was not lucrative until the introduction, in the late eighteenth century, of the Charolais breed (Bonnamour 1966:66ff.; Brunhes and Deffontaines 1926:492; Clout 1983; Lennel 1896:478). These very large, nearly white beef cattle soon prospered as had the horses; they quickly replaced the wiry, reddish Morvandieu breed of the mountains in numbers, although these indigenous cattle continued to be employed in agriculture until the advent of the tractor. Pastureland currently comprises 17 percent of land use in the normal scale research area (S. L. H. Madry, personal communication).

In sum, open-pasture grazing animals have been husbanded in Burgundy since the Neolithic, with stepped-up activity in the Iron Age (horses, sheep) and in the late eighteenth century (Charolais cattle). Because grazing animals are effective in preventing the regeneration of the forest (Clark 1947:49), these must be considered periods of increased pastureland at the expense of the forests.

Agriculture, Horticulture, and Viticulture

A history of Burgundian patterns of exploitation of nonarboreal vegetation is a mirror of that of forests, recording as well their increasingly adversarial relation. As with forests, the findings of palynologists and paleobotanists (see Alpern *et al.* 1968) form the scientific basis for such a history, although they are aided by archaeologists (e.g., Bonnamour 1964) and agricultural historians (e.g., Van Bath 1963).

Quantitative analysis of botanical samples collected from archaeological sites over recent decades has enabled Hubbard (1980; see also Helbaek 1966) to trace Eurasian agricultural history. Hubbard dates the initial presence of cultivated species in northwestern and southeastern Europe; I have calculated intermediate dates for Burgundy, reflecting (despite its inclusion in northwestern Europe) the region's particularly amenable situation for agriculture and its accessible location to northeastern influences from central Europe via the Rhine Basin and from southeastern Europe via the Rh6ne-Sa6ne corridor.

First to be cultivated were the bread (or summer) wheats *(Triticum aestivum)* ca. 4700 B.C., followed almost immediately by emmer wheat *(T. dicoccum), rye (Secale cerale),* and 2-row hulled barley *(Hordeum Piston and H. spontaneum). By* 4500 B.C. cultivated oats *(Avena sativa* and A. *strigosa),* common millet *(Panicummiliaceum), peas (Pisum sativum and P. elatius), lentils (Lens culinare, L. orientalis,* and L. *nigricans)*, einkorn wheat (T. *monococcum),* and 6-row hulled barley (H. *vulgare)* were also cultivated. By 3900 B.C., 6-row naked barley *(H. vulgare coeleste)* was under cultivation, and the Neolithic foundations of the agrarian history of Europe were complete.

Whether all were cultivated in Burgundy and, if so, their degrees of importance, remains unknown. Although much work has been done elsewhere in Europe (e.g., Huntley and Birks 1983, Van Zeist 1967), Hubbard (1980:53) points out that Iron Age Hallstatt societies in northwestern Germany exploited einkorn wheat while societies in Holland, 150 km away, did not grow the crop at all. Thus considerable botanical evidence from Burgundy, in specific temporal contexts, is necessary to complete a picture of the region's agrarian economic history.

Fortunately some information does exist: Bugnon, Rameau, and Brunaud, (1981:10ff.) review the palynological information to 1981, but primarily with regard to forests. In Combier's (1962) report on the excavation of a Bronze Age burial mound at Masiod (Jura), archaeobotanical appendixes by R. Laurent and M. Coquillat identify wheat, barley, and oats. Bonnamour (1964) reports, with an appendix by M. Coquillat, on the important early Iron Age (Hallstatt Ilb) valley site of Orroux-sur-Sa6ne in southern Burgundy, where in addition to oak and hawthorn, remains of wheat *(T. vulgare and T. spelta), barley (H. vulgare),* oats *(A. strigosa)* and wild grape *(Vitis silvestris)* were found.

Excavation at Mont Dardon by our research group from 1975 to 1979 yielded abundant archaeobotanical material. In particular the 1975 and 1976 seasons included a rigorous program for recovering remains; samples of equal volume of earth were collected every 5 cm as designated units were excavated. In the laboratory the samples were weighed, then subjected to flotation analysis in an apparatus modified slightly by W. H. Marquardt from that described by Watson (1976) as the "garbage-can technique," to utilize materials locally available. This is, to our knowledge, the first controlled flotation to retrieve botanical remains from an archaeological site in Burgundy, as our goal was specifically to be able to compare material from one cultural level with that of another.

The floated material was divided into light and heavy fractions by the apparatus, dried, weighed again, tagged, and bagged. J. B. Newsom examined the heavy fractions during the 1977 field season and found no additional material; in contrast, the fine samples were extremely rich and abundant. The light fraction samples number slightly more than 400 from 1975 and nearly 600 from 1976.

Preliminary examination of this material has been made by a number of people. Henri Parriat first identified material in a selected sample from the Iron Age level of the site, but his death in December 1975 resulted in both his work and the sample being lost. His preliminary notes indicate that he had identified barley *(Hordeum hexastichum* L.), emmer wheat *(Triticum dicoccum* Schrank), and two kinds of millet *(Panicum miliaceum* L. and *P. italicum* L.). The bulk of the material, and a copy of these notes, is stored at the University of North Carolina and awaits analysis on a more comprehensive scale than funds and personnel now allow.

Literary evidence of agricultural practices in Burgundy from the Iron Age and subsequent periods is abundant. However, it is simultaneously less rigorous and more complete: while we are generally less sure of particular species and subspecies than with palynological and paleoethnobotanical evidence, we may be more confident of the economic and cultural setting.

It may be assumed that many Roman agricultural patterns (see White 1970) were practiced in Gaul (e.g., in *villae and latifundia).* A recent study of rural settlement in central Gaul in the Roman period (Leday 1980) may reflect the pattern of agricultural settlement in Aeduan territory as well. A great part of the success of macro-scale Roman agricultural endeavors is attributable to Gaulish expertise in soil fertilization (Fontenay 1878), many components of which (lime, marl) are present in abundance in the Aeduan heartland (Ragut 1838:91ff.).

From Gallo-Roman times through the Middle Ages, Burgundian agrarian history becomes indistinguishable from the region's (and, for that matter, all of Europe's) social, political, and economic history. The interested reader is referred to Berry's detailed chronicle of the changing nature of farms and estates, pasturelands and forests (Chapter 15, this volume). As has been noted, the regeneration of forests suggests that less agriculture was practiced between the fifth and eighth centuries than in the Roman period, and that only with the collapse of the manorial system and the reintroduction of a money economy did cultivation, even of marginally agricultural soils, recommence (Van Bath 1963:31ff.). High cereal prices brought an increase in arable land, while low prices encouraged animal husbandry (especially sheep). Greater population and increases in agriculture and husbandry alike contributed to the diminution of the forests.

The practice of horticulture-gardening, the care of fruit trees and the like has no consistent recorded history, which masks its considerable importance in Burgundy. Today nearly everyone in the greater research area who has access to a plot of land plants a garden; viewed from the air, even towns as large as Gueugnon (pop. 12,500) are seen to have a checkerboard of gardens behind the walls of each house (see Chapter 9, Figure 10), and more plots are found near the town limits, where apartment dwellers rent space from the town or private owners. This pattern extends beyond the valley towns; only an abandoned dwelling in the Morvan is without a garden.

The gardens themselves reflect regional abundance in miniature: salad greens, peas, potatoes, and other produce grow side by side with grapevines and fruit trees (apricot, cherry, peach, plum, pear, apple) and share space with rabbit hutches, pigeon coops, and the occasional *escargot* (snail) "hotel." Yet yearly compilations of types of agricultural exploitation (see, e.g., Ministere d'agriculture de Saone-et-Loire 1979, 1981) for agriculturally distinct areas of Saone-etLoire (Autunois, Morvan, Sologne Bourbonnaise, Brionnais, Charolais), report a negligible number of farmers who exploit garden produce as a cash crop. This is not to say, of course, that the produce is not occasionally sold (see Chapter 9, this volume, on periodic markets in the region), but it is much more likely to be eaten immediately or canned for later domestic consumption. This constitutes many Burgundians' insurance against failed crops, low sale prices, or lost factory jobs.

The antiquity of this horticultural "family contingency project" cannot be documented but since all the floral and faunal components have been present in the region since at least the late Iron Age (except perhaps viticulture; see below), I believe that such stores, as in many parts of the world, are and have been a ubiquitous hedge against climatic or cultural uncertainties.

Most researchers (see MacKendrick, Chapter 14, this volume) argue that wine, and wine grapes, arrived with the Romans, and that local Gaulish entrepreneurs quickly began to exploit the crop's potential in the calcareous soils of eastern Burgundy. I have absolutely no solid evidence to offer to the contrary, but I find it difficult to believe that it did not occur to Gaulish residents of the Rh6ne and Sa6ne river valleys, who saw and enjoyed massive imports of wine from the Greek colony of Marseille in profitable exchange for Gaulish goods, to attempt its manufacture themselves. As has been demonstrated above, Gaulish plant husbandry (even as early as 600 B.c.-mid-Hallstatt-when the colony was established) was certainly advanced enough to grow wine grapes successfully. Whether the rainy, cool climate of the Iron Age would have precluded their cultivation as far north as Burgundy might be answered by Figure 1 and discussion above, which indicate that Iron Age temperatures in western Europe were roughly the same as those of today and that viticulture may have preceded Roman rule.

The important question is, however, not *when* the wine grape arrived in Burgundy, but when its economic and ecological impact was first felt. That may be quite firmly documented as occurring in the first century A.D. (MacKendrick, Chapter 14, this volume) and reaching its first apogee in the next three centuries. That its cultivation was denied the Gauls periodically (as was owning mines) points to its considerable early economic importance. More geographically widespread cultivation of grapes than at present is documented not only for the warmer period of the first centuries A.D. (when grapes were cultivated all the way from the Mediterranean to Britain), but also for the relatively cooler seventeenth century as well; administrative documents (Dumay 1876) include not only the mention of vineyards at Rigny in the Arroux valley, but at Grury in the Morvan highlands. Charmasse (1877:169) republished evidence that in 1789 increased wine production was at the expense of the forests, driving up the price of wood. Civil documents at Uxeau (L. Dauvergne, personal communication) report vineyards growing on Mont Dardon in the eighteenth century. In our extensive survey of a 60 square km area west of the Arroux between Mont Dardon and Mont D6ne in 1976 and 1977 (see Chapter 4, this volume), we encountered only one modern commercial vineyard.

Relative Population Density

Estimation of population is perhaps the most difficult area of historical investigation. At best the record of population is at the mercy of distorting acts and individuals, and at worst no records (written, oral, or archaeological) survive at all. Spatial units of measure vary with both the recorder and the time period, and administrative units are altered as their human components realign themselves. Researchers who base their estimates on household size risk error in properly understanding the economic requirements and the social dynamics of family life, and even exhaustive per capita data available from some places in certain periods present huge problems as concerns their social inclusiveness or their integration with less precise information. Russell (1958) discusses many of these difficulties as they pertain to late ancient and medieval populations in Europe and the Mediterranean. It is clear that a thorough inquiry into Burgundian population trends from classical times to the present would itself consume years and volumes. It is my intention to undertake only an initial inquiry into French (defined geographically as roughly contemporary France) and Burgundian population trends; based on a few estimates that Russell accepts as generally reliable, Figure 2 illustrates relative increases and reductions of the population in France over two millennia.

Briefly, a period of moderate population decline occurred in the late Empire, but regained Constantinian (A.D. 306-337) levels by 543. The plague of the sixth century reduced the population by 40 percent but was followed by a steady increase to the mid-tenth century, when both Constantinian and sixth-century numbers were restored. A somewhat more rapid increase occurred between the tenth and mid-fourteenth centuries; in the eleventh and twelfth centuries, population grew in cities north of the Loire, east of the Massif Central and along the Rh6ne-Sa6ne corridor. In the thirteenth and early fourteenth centuries, urban population increased in the southwest and the Massif Central and continued to increase in the Rh6ne-Sa6ne corridor (see Figure 3). The plague of the fourteenth century reduced the population by as much as 60 percent (Russell 1958:121), yet the population recovered and surpassed previous highs in about 150 years (by 1500). Subsequent growth slowed considerably, and a notable period of decline in rural areas during the nineteenth century was more than matched by the burgeoning cities of the period.

Although much research effort has gone into estimating Celtic and Gallo Roman population in Burgundy, I concur with Russell (1958:83ff.) that all sources can be proven either somewhat or extremely unreliable. Despite Caesar's enu-

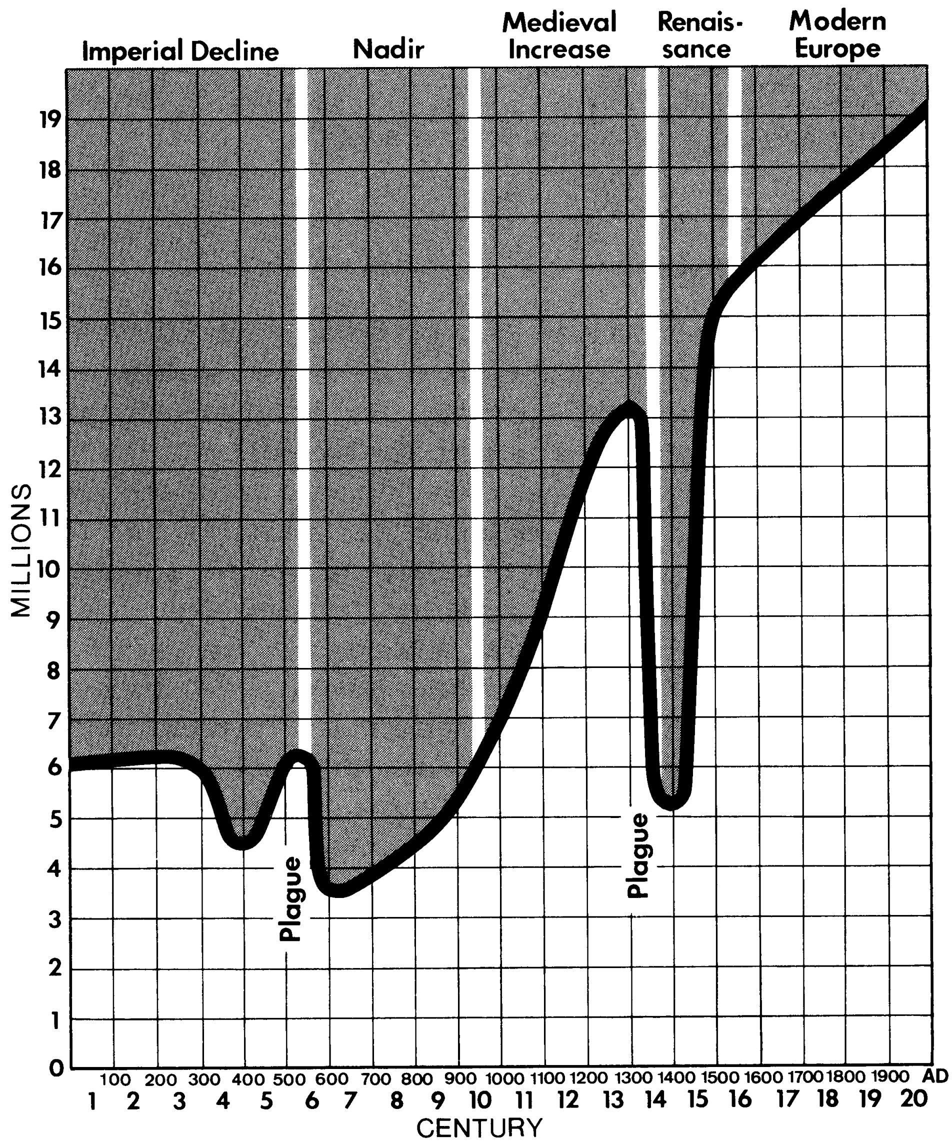

Figure 2 Estimated population curve for France (after Russell 1958).

meration *(De Bello Gallico* 1.29, 7.75) of the Aeduan polity and of the three Gauls (Belgica, Aquitania, and Gallia, excluding Gallia Narbonensis), it seems for a variety of reasons foolhardy to give his counts or those of his apologists any credence. Fortunately, there remain other ways by which we might deduce certain relative population figures. Autun in the first century A.D. enclosed within its city walls 200 ha; by the fourth century the enclosed area had shrunk to 12 ha (Grenier 1931:339, 354, 356; Berry, Chapter 15, this volume). This suggests that Autun, despite its continued importance until the tenth century, had lost considerable population by the end of the imperial period. Whether this represents a shift away from cities, as villas and other types of habitation in the Arroux valley accounted for more of the population, is taken up at length by Berry (Chapter 15, this volume).

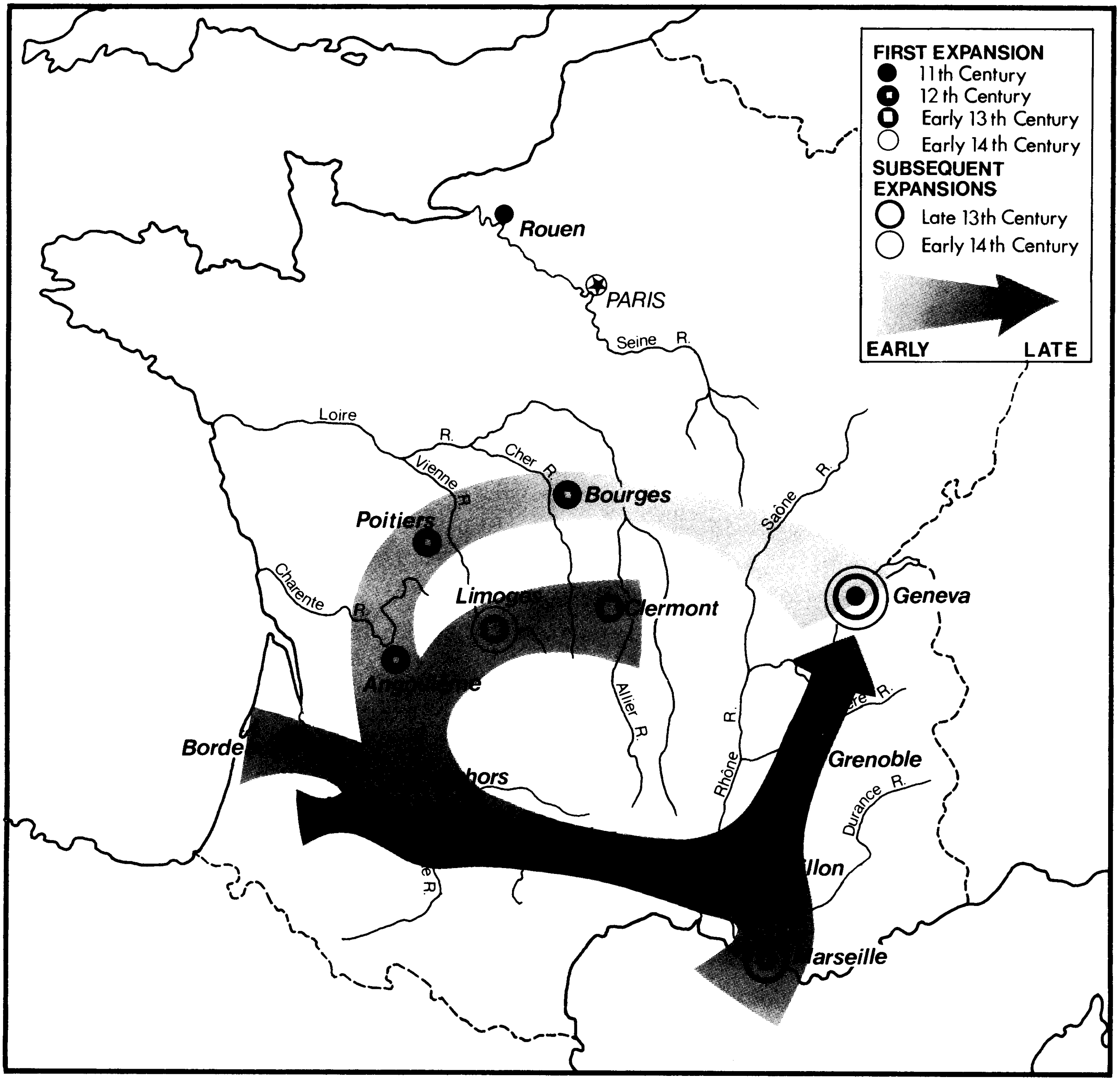

Figure 3 Urban population increase, tenth through fourteenth centuries, extrapolated from data on periods of city wall expansions.

Burgundy is one of the few regions of contemporary France for which medieval population data are available. The records of the Burgundian parish of Givry, near Chalon-sur-Sa6ne, illustrate several important demographic effects of the Great Plague in a part of the region characterized by heavy commercial traffic. Though in general France suffered a population reduction of 40 percent (Russell 1958:119, but see p. 121), Givry lost 50 percent of its population (Russell 1958:43, Gras 1939) in the years immediately following 1348. Marriages, which had averaged 18 yearly between 1336 and 1341, increased to 86 in 1349 and 33 in 1350, while the period 1351-1357 averaged 15 a year (Gras 1939:308).

The pattern of mortality from the plague was age-specific: the older the individual, the more likely he or she was to die (Russell

1958:43). Data from the Haute Auvergne (Boudet and Grand 1902) allege that the plague killed the rich and babies but spared women. At any rate, the increase in marriages (and subsequent increased births) after the onset of the plague in Givry, in combination with the little town's geographical situation at the edge of the Rh6ne-Sa6ne corridor (attractive and convenient to newcomers) quickly restored the population to pre-plague levels. Some more isolated parts of Burgundy (e.g., Uchon) were entirely plague-free. Population in Burgundy as a whole dropped until near the end of the fourteenth century, was stable until the mid-fifteenth century, then increased sharply until the end of the fifteenth century.

The plague was not the only burden of late medieval populations. In Autun famine was so widespread in 1438 and 1439 that members of the abbey of Saint Martin were forced to mix their bread dough with clay. In 1519 the plague again swept Autun, followed by cholera in 1529-1532 and *trousse galant* (several related complications from cholera) in 1557-1558, 1564, 1586, and 1597. Autun was not completely plague-free until 1628, and as late as 1637 a pilgrimage was made by 4,800 Autunois to the church of Saint Sebastian at Uchon to pray for the cessation of yet another epidemic afflicting the population (Guyton 1862-1864).

The early modern decline of rural populations in favor of urban increase is marked in Burgundy due to considerable industrialization as early as the seventeenth century; this trend reached a peak in the late nineteenth century and has since stabilized. Although many excellent records have been preserved that offer intriguing evidence of population shifts in the past four centuries in Burgundy, their collective analysis awaits the ambitious and patient scholar.

Such a sweeping summary of course leaves out many important distinctions between urban and rural, highland and lowland, not to mention differences in fertility and mortality due to climate, cultural practices, and the like. The sampling problems of such data, even if available, are legion. Yet the rapid overall increase in French population during the Middle Ages despite the ravages of the plague is truly remarkable, suggesting mutually augmenting biological and cultural explanations. Positive biological effects of the plague (e.g., selection for resistant individuals) would not alone account for the steep postplague ascent of the population curve. As tenth- to fourteenth-century increases could be seen as a result of immigration from the east, so might the apparent rapid recovery after the fourteenth century outbreak be seen as migration from rural areas to cities (see Cowgill 1975). Urban population figures are more available than parish records for the fourteenth century, and it may be that the decimation of the plague was confined to dense population agglomerations and heavily traveled commercial routes, while the countryside remained relatively free of disease. In Burgundy cities and low-lying commercial towns were hard hit, but mountain villages and other areas of dispersed population (agricultural areas with isolated farms) gained reputations for being plague-free. Thus one might argue that postplague population increase was the result of (1) migration from less affected rural areas into cities to claim available lands and jobs; (2) an incidence of mortality increasing with age; and (3) a marked increase in the number of marriages. Subsequent shifts in Burgundian population have more pronounced cultural and economic explanations, although the role of geography continues to be important.

Geomorphological Events

Atop the solid plates of rock that shield the earth's liquid core lies a mantle of soil, ice, and water. In dynamic tension with both the atmosphere and the lithosphere, particles are physically moved by the great forces of wind and water. Even the role of temperature, so important to biotic elements of this study, is diminished by the abrasive and bouyant capabilities of water, ice, and the wind on the earth's rock face. Study of these processes is termed *geomorphology*.

In the two-thousand-year period encompassed by this study, the role of erosion, flooding, and other fluvial and aeolian processes in Burgundy is instructive. We can begin to understand the systemic relation between geomorphological "events" (periods of greater or lesser geomorphological activity) and other circumstances, already discussed, that modify or are modified by human act and intent.

Periods of Erosion and Redeposition

As discussed above, deforestation coupled with inadequate agricultural practices led to widespread erosion in the Neolithic. Evidence for this is apparent in stratigraphic sections of river valleys throughout Burgundy (P. Rat, personal communication, July 1983; Mangin 1961-

1962).

Around Iron Age hillforts (situated, for the most part, on granitic promontories) nearby forested areas served both domestic and ferroindustrial needs. Rat (personal communication, July 1983) argues that the region is characterized by fast-growing ground cover and that erosion due to deforestation was not widespread in the Iron Age. Though accepting his point in general, I nonetheless must note in passing the devastating effects of modern roads cut on steep granitic slopes, fires, toxic dumping, strip-mining, and the like. Whenever the root system of the vegetation on granitic slopes is destroyed, sheetwash rapidly carries downhill the relatively undeveloped A horizon, and even the hardy and ubiquitous *balai* (broom bush) native to the region cannot stabilize the active erosion of bedrock. I concur with Rat that such effects would have been local in the Iron Age as today, and that upland deforestation need not necessarily result in widespread erosion and redeposition. It should also be noted that certain climatic sequences (e.g., an exceptionally dry period followed by a very wet period, where dead vegetation fails to retard erosion) might have considerable effect either alone or in concert with human activity. In the drought of 1976, for example, even conifers had begun to die; soon weakened or destroyed root systems and rock-hard ground surfaces would have led to massive sheetwash, had not gentle, soaking rains come, to preserve both upland soils and the grape harvest of that year.

Medieval clearing more closely resembled that of the Neolithic in that upland forests were replaced permanently by fields, and vegetation characteristic of the region was not allowed to return. In Chapter 4 (this volume), we discuss the site of Les Essarts, at the base of a promontory called the Bois St. Martin, where the profile is a telling comment on medieval erosion. Surface material is late Iron Age; medieval ceramics are encountered about I m deeper and at the bottom of a relatively homogeneous stratigraphic unit. This stratigraphic inversion, while itself undatable for a variety of reasons, suggests massive local erosion at the end of a period of medieval exploitation of the summit of Bois St. Martin. A likely time for such activity would have been somewhere between the early fourteenth and the eighteenth centuries, when rural population was high, controls on the forests and on agricultural techniques ineffective, and land and wood at a premium.

In sum, although major clearing of erosion-prone highland areas took place in three periods (Neolithic, Iron Age, and late medieval-early modern), only the first and last, due to their predominantly agricultural nature, resulted in even locally recognizable geomorphological events, and only one (Neolithic clearing) had widespread effects. Thus the inclusion of considerable highland'detritus in valley sediments in the research area (as elsewhere in Europe) would be limited to a period of late Neolithic redeposition.

This discussion implies that little major redeposition in the valleys of the research area has occurred in the last three thousand years. There is reason to believe that the Arroux River is following a relatively predictable cut-and-fill regime, meandering across valley fill (colluvium) that is no later than late Neolithic. Strong evidence for this is supplied by our discovery of the third- or fourth-century Gallo-Roman villa La Grenouillere (Crumley and Madry 1985), covered by only a few centimeters of fine-grained, flood-deposited alluvium. The effect of deforestation and subsequent erosion on the quality of highland soils, however, while debilitating in the Neolithic, would have been devastating in the Middle Ages.

Flooding, Hailstorms, and Frosts

As a result of the interaction of three major climatic regimes with its varied topography, Burgundy experiences frequent periods of unsettled weather. Unseasonable frosts and freezes affect the productivity of vineyards (see Ladurie 1971) and fruit trees for years afterward, and agricultural disasters of quite different origin (frost, hail, flood) wipe out successive years of grain harvests. In the year 1645 alone (Dumay 1876; Guyton 1862-1864) inhabitants of southern Burgundy suffered a devastating winter storm that toppled church steeples and chimneys, and a second consecutive year of late spring and summer freezes and hailstorms with hail as big as nuts. Records of such devastation exist from the Middle Ages to the present (see, e.g., Mocquery 1898, 1899, 1904).

Despite modern flood-control measures, even contemporary Burgundy is affected by flooding of its major rivers and their tributaries. Both winter floods (such as that of January 1982) and summer floods (as in August 1977) take their toll, although quite obviously the latter are more destructive to agriculture. In sum, a variety of geomorphological events in Burgundy can affect harvests and the general well-being of the population, and may be shown to have done so in the past. But the long- and short-term effects of such destabilization depend on human characteristics of flexibility and adaptation.

Summary and Conclusions

The most salient characteristic of climate in Burgundy is its incredible variability. Lennel (1896:430) has noted that the diurnal change in temperature and moisture is nearly the greatest in France. It is also clear that *within* Burgundy local differences in elevation and geographical location require careful analysis at the subregional as well as regional and continental scales. The long-term dominance of one of the region's three major climatic regimes on Burgundian topography is an important factor in at least four periods of Burgundian history: Periods 11, 111, IV, and V.

Period II. The year-round dominance of Mediterranean climate from the second century B.C. to the third century A.D. enabled Mediterranean vegetation (particularly grapes and olives) to survive well north of the modern northern limit of the regime. Mediterranean peoples, ideas, and economy figured prominently in Burgundian history during this entire period, and population reached new levels.

Period III. The subsequent year-round dominance of continental climate (roughly A.D. 500-900) coincided with cessation of many commercial and other relations between inhabitants of Burgundy and Mediterranean peoples. Interaction was predominantly with peoples from the east and north, whose polities expanded to encompass Burgundy. Population was reduced by plague early in the period but had recovered by its end, due as much to immigration as natural increase.

Period IV. The following warm period (A.D. 900-1300) coincided with a period of sharp increase in population; social and economic conditions were apparently in turmoil (see Berry, Chapter 15, this volume). The coeval expansion of Scandinavian peoples (especially the Vikings) in this ameliorating period may account for circumstances in Burgundy.

Period V. The period A.D. 1300-1900 may be characterized as varied and extreme, and the environmental toll of unbridled population increase was exacted from both the people and the land. The greatest depredations against forest and soil were committed in this period, and deaths from famine and disease were at an all-time high early in the period. The most remarkable fact about this period is, however, the amazing numerical recovery of the population (both in Burgundy and elsewhere) after the "plague century" (the fourteenth), when food production did not keep pace with increased population and dense population agglomeration preceded the administrative structure to maintain it.

In speaking of medieval crop failures, Appleby (1981:83) notes that "the crucial variable in the elimination of famine was not the weather but the ability to adapt to the weather." He further remarks that differences of economic and administrative structure between medieval France and England account for the latter's ability to reduce the impact of failed harvests on the population. DeVries (1981) reviews the literature (e.g., Postan 1975; Ladurie 1971; see also Bryson and Murray 1977) that addresses the importance of climate on culture and concludes that sociohistorical elements play a critical role in adaptation to adverse climatic conditions. He offers a striking contemporary example (1981:50): a photograph of a road that crosses the Dutch-Belgian border shows the Dutch side clear and dry, the Belgian side choked with snow and impassable.

Despite Appleby's point that the ability to adapt to changing first and second order (years, decades) climatic conditions is sociohistorical, it also must be recognized that at a third order (several centuries) scale, various administrative structures prove relatively fragile in the face of major shifts in climatic regime, and surrounding peoples better adapted to prevailing conditions tend to expand into Burgundy. Bryson and Murray (1977), Gunn (n.d.), and others have documented similar third order effects on indigenous populations and societies in North America, Europe, North Africa, and the Indian subcontinent. Bryson and Murray (1977:153ff.) further argue that some shifts may be quite rapid, as they are connected with wholesale changes in the pattern of westerlies (which must form whole-number "loops" around the poles) after a period of incremental changes.

The implications of this study are twofold: economic flexibility must be considered an available and valued tool in short-term (first and second order) human adaptation to Burgundian climatic variability; but the sustained (third order) effects of a dominant climatic regime attract outside interests better adapted to the circumstances and tempt newcomers to make land-use and other decisions that limit subsequent adaptive flexibility (e.g., Roman monocropping in the late Empire).

The economic heterogeneity of contemporary Burgundy would seem to render it less fragile than in the past, less at the mercy of killing frosts or an extended period of rain or drought. The decisions of many farmers and various commercial interests were nonetheless affected by the severity of the 1976 drought and its selective effects on cereal agriculture and animal husbandry, and on certain parts of the region (see Chapter 2, this volume). Interestingly, an extended rainy period and heavy flooding can also negatively affect low-lying grain fields and the quality of pasturage and the health of livestock everywhere in the region. Thus the cumulative effect of quite opposite climatic phenomena has caused many farmers to reduce the number of hectares planted in cereals and the size of herds. These decisions are of necessity tailored to each farmer's economic and geographic resources.

Such homely and essentially accurate knowledge of microclimatic and soil differences on the part of Burgundian farmers has not, however, solved environmental problems at another scale: riverine pollution is severe, flooding remains relatively uncontrolled, toxic wastes frequently go unmonitored. Sheep-raising has suffered from Common Market competition, and cheap foreign labor has helped other countries usurp the markets of the great steel companies, which renders less viable the option of holding an industrial job while continuing to farm.

However, a lesson extracted from Burgundian history is heeded by most of its inhabitants: variety insures flexibility. The practice of this dictum may be seen in the integrated physical landscape of industry and agriculture and in the kitchen gardens of both townspeople and country dwellers. It may also be found in the complex fabric of social, political, and economic relations that characterize the landscape of the mind. As I discuss in Chapter 9, the periodic market (an institution of considerable antiquity in Burgundy) serves important abstract functions of economic, social, and political integration. Equally important is the *geographic* integration it fosters, between highland and lowland, farmer and town dweller. This unique quality of southern Burgundy is appreciated only when compared with areas of more homogeneous climate and economy such as the center and central west of France (oceanic climate, cereal agriculture). An American parallel might be between rural Michigan (Great Lakes climatic regime; fruits, vegetables, grains, light industry) and rural Kansas (continental climatic regime; primarily grain). A great variety of microclimates, soils, and commerce separates Burgundy into distinct subregions, yet it is the variety itself that at once and forever separates Burgundians, even in the absence of salient, defensible boundaries, from their more economically and geographically homogeneous neighbors.

Acknowledgments

The comments of Reid A. Bryson, Karl W. Butzer, Joel Gunn, and Thomas M. Robinson, Jr. were particularly helpful and are appreciated.

Appendix: Climatic/Vegetational Periods and Their Characteristics from the Iron Age to the Present

Based on evidence from peat bogs and pollen analysis, derived from Guillet *etal.* (1976).

Zone IX (Subatlantic 1)

IXa (800-300 B.C.)

Fir maximum (35%); also beech (50-65%) and hornbeam

lXb (300-50 B.C.)

Retreat of fir; first evidence of soil degradation and of human agency. Evidence of cereal crops, but principally pastoral activities. Celtic.

IXc (50 B.C.-A.D. 250)

Firs still in mountains but regress elsewhere. High beech areas are now in pasture. New species: chestnut *(Castanea sativa)* and walnut *(juglans regia).* Agricultural practices evident in plains and valleys; maximum of synanthropic pollen.

IXd (A.D. 250-700)

Minimum of synanthropic pollen; maximum of alder *(Alnus), hazel (Corylus),* birch *(Betula),* and hornbeam *(Carpinus).* Period of invasions and abandonment of human activities; reconquest by the forest; cereals rare. Hornbeam growing on calcareous soils, birch on acidic soils.

Zone X (Subatlantic 11)

Xa (A.D. 700-900)

After the eighth century a hesitant resurgence of agricultural activities; evidence of pastures; beeches cut for profit. Cereals, chestnut, and walnut reappear; birch regresses.

Xb-d (A.D. 850-1800)

Evidence of major deforestation after the tenth century; decline,of fir.

Xe (A.D. 1800-present)

References

Alpern, B., A. Compaz, P. Corsin, S. Jardine, J. Tangourdeau, and J. P. Verdier

1968 Pal6obotanique et palynologie en France: aper@u historique. *Review of Paleobotany and Palynology* 7:149-199.

Appleby, Andrew B.

1981 Epidemics and famine in the Little Ice Age. In Rotberg and Rabb (1981:61-83).

Argant, Jacqueline

1981 Apport de la palynologie quaternaire @ la connaissance de la forest bourguignonne. Bul*letin de la Soci@t@ botanique de France* 128. Actualit6s botaniques 1981, 3-4:87-94.

Aymonin, G. G.

1981Sur quelques especes remarquables des complexes bois6s de Bourgogne et leur situation de regression en Europe. *Bulletin de la Soci@t@ botanique de France* 128. Actualit6s botaniques 1981, 3-4:95-100.

Beug, Hans-Turgen

1982 Vegetation history and climatic changes in central and southern Europe. In Harding (1982:85-102). Edinburgh: The University Press.

Bonnamour, Jacqueline

1966 *Le Morvan: la terre et les hotnmes.* Paris: Presses universitaires de France.

Bonnamour, Louis

1964 Un habitat protohistorique A Orroux-sur-Sa6ne (Sa6ne-et-Loire). *Revue archgologique de* I'Est 15:143-159.

Boudet, M., and R. Grand

1902 Etude historique sur les 6pid6mies de peste en Haute-Auvergne. *Revue de la HauteAuvergne,* no. 37-38.

Bouzek,jan

1982 Climatic changes and central European prehistory. In Harding (1982:179-191).

Brunhes, Jean, and Pierre Deffontaines

1926 *Geographie politique et geographic du travail.* Vol. 2, t6me 2 *of Histoire de la France.* Edited by Gabriel Hanotaux. Paris: Societe de I'histoire nationals and Librairie Pion.

Bryson, R. A., and T. J. Murray

1977 *Climates of hunger: mankind and the world's changing weather.* Madison: University of Wisconsin Press.

Bugnon, Francois

1972 Problemes lies a la conservation de la nature dans le cadre d'une region: cas de la region de programme Bourgogne. *Revue geographique de I'Est*, no. 4:345-349.

Bugnon, Franqois, M. Becker, G. Dupias, J.-C. Rameau, and J. M. Royer

1981a Problmes de floristique ou d'autoecologie poses par des espaces sylvatiques de Bourgogne. *Bulletin de la Societe botanique de France* 128. Actualites botaniques 1981, 3-4:101Ill.

Bugnon, Francois, J.-C. Rameau, and A. Brunaud

1981b Etudes sur les series de vegetation en Bourgogne: les types forestiers correspondent aux feuilles 34 (Dijon) et 41 (Autun) de la Carte de la vegetation. *Bulletin de la Societe botanique de France* 128. Actualites botaniques 1981, 3-4:7-20.

Burkill, Mark

1983 The Middle Neolithic of the Paris Basin and northeastern France. In *Ancient France: Neolithic societies and their landscapes, 6000-2000 B.C.,* pp. 34-61. Edited by Christopher Scarre. Edinburgh: The University Press.

Chapman ,Jefferson, Paul A. Delcourt, Patricia A. Cridlebaugh, Andrea B. Shea, and Hazel R. Delcourt

1982 Man-land interaction: 10,000 years of American Indian impact on native ecosystems in the lower Little Tennessee River valley, eastern Tennessee. *Southeastern Archaeology* 1:115-121.

Charmasse, A. de

1877 Cahier des dol6ances de la Maitrise des eaux et for@ts d'Autun, Montcenis, BourbonLancy, Semur-en-Brionnais, Charolles et partie de Saulieu pour les Etats-g6n6raux de 1789. *M@moires de la Societe @duenne* 6:166.

Clark, Grahame

1947 Forest clearance and prehistoric farming. *Economic History Review* 17, no. 1-2:45-51.

Clout, Hugh D.

1983 *The land of France, 1815-1914.* Research Series in Geography, 1. London: George Allen & Unwin.

Coles, J. M., and A. F. Harding

1979 *The Bronze Age in Europe.* London: Methuen.

Combier, Jean

1962 Fouille de sauvetage d'un tertre fun6raire de]'Age du Bronze a Masiod (Jura). *Revue archaeologique de I'Est* 31, no. 3:192-216, with appendices.

Cowgill, George L.

1975 On the causes and consequences of ancient and modern population changes. *American Anthropologist* 77:505-525.

Crumley, Carole L., and S. L. H. Madry

1985 La Grenouilliere perdue. *Echos du passe* 54:6-9.

Darby, H. C.

1956 The clearing of the woodland in Europe. In *Man's changing role in changing the face of the earth*, pp. 183-216. Edited by William L. Thomas, Jr. Chicago: University of Chicago Press.

Davis, M. B.

1981 Quaternary history and the stability of forest communities. In *Forest succession, 132-153.* Edited by D. C. West, H. H. Shugart, and D. B. Botkin. New York: Springer.

De1eage, Andre

1941 *La vie rurale* en *Bourgogne jusqu'au debut du onzieme siecle.* 2 vols. Macon: Protat Fr4@res.

Desjardins, Ernest

1968 *Geographie de la Gaule romaine. Vol.* 1. Brussels: Culture et Civilisation. First published 1876.

DeVries, Jan

1981 Climate and economy. In Rotberg and Rabb (1981:19-50).

Dumay, G.

1876 Proces-verbal de la visite des feux du bailliage d'Autun en 1645. *Memoires de la Societe Aduenne* 5:285-484.

Fontenay, Henri de

1878 Note sur 1'emploi de la chaux, de la marne, et des phosphates en agriculture chez les Gaulois. *Memoires de la Societe Aduenne* 7:169-174.

Gras, P.

1939 Le registre paroissial de Givry (1334-1357) et la peste noire en Bourgogne. *Bibliotheque de I'Ecole des chartes* 100:295-308.

Grenier, Albert

1929 Aux origines de I'economie rurale. *Annales d'histoire economique et sociale, 26-47.*

1931- *Manuel d'archaeologie gallo-roinaine.* 2 vols. Paris: Picard.

1934

Guillet, B., C. R. Janssen, A. J. Kalis, and E.-J. de Valk

1976 La vegetation pendant le Post-Glaciaire dans l'est de France. In Lapr@ histoire francaise, vol. *2: Les civilisations neolithiques et protohistoriques de la France*, pp. 82-94. Under the direction of Jean Guilaine. Paris: CNRS.

Gunn, Joel

n. d. Mobility patterns in central Texas. In *Aboriginal central Texas: culture change along the central Texas ecotone.* Edited by John W. Fox. Forthcoming.

Guyton, Dr.

1862- Notice sur les maladies epidemiques contagieuses et pestilentielles qui ont afflige Autun 1864 aux 16eme, 17eme, et 18eme siecles. *Memoires de la Societe Aduenne* 6(a):75-119.

Harding, Anthony, ed.

1982 *Climatic Change in Later Prehistory.* Edinburgh: The University Press.

Helbaek, Hans

1966 Commentary on the phylogenesis of *Triticum and Hordeum. Economic Botany 20:* 350-360.

Hubbard, R. N. L. B.

1980 Development of agriculture in Europe and the Near East: evidence from quantitative studies. *Economic Botany* 34, no. 1:51-67.

Huntley, B., and H. J. B. Birks

1983 An *atlas of past and present pollen maps for Europe: 0-13000 years ago.* 2 vols. Cambridge:Cambridge University Press.

Jullian, Camille

1920 Histoire de la Gaule, vol. 5: *La civilisation gallo-roinaine: Etat materiel.* Paris: Hachette.

Ladurie, Emmanuel Le Roy

1971 *Times of feast, times of famine: a history of climate since the year* 1000. New York: Doubleday.

Lamb, H. H.

1977 *Climate: past, present and future.* 2 vols. London: Methuen.

Leday, A.

1980 *Rural settlement in central Gaul in the Roman period.* 2 vols. BAR International Series, 73. Oxford: BAR.

Lennel, M. F.

1896 *Le Morvan: etude de geographie physique. Memoires de la Societe bourguignonne d'histoire et de geographic 12:403-503.*

Levainville, J.

1909 *Le Morvan: etude geographique humaine.* Paris: A. Colin.

Mangin, J. P.

1961 Les cycles de depet des alluvions anciennes aux abords de Dijon et en quelques points de

1962 Cote-d'Or. *Bulletin scientifique de Bourgogne 21:151-157.*

Maury, L. F. A.

1849 Des grandes forets de la Gaule et de I'ancienne France. *Memoires de la Societe nationals des antiquaires de France,* n.s. 9: 263-389.

1850 *Histoire des grandes forets de la Gaule et de I'ancienne France.* Paris: A. Leleux.

1. *Les forets de la France dans I'antiquite et au Moven Age.* Paris: Imprimerie Imp6riale.

1867 *Les forets de la Gaule et de I'ancienne France.* Paris: Ladrange.

Milisauskas, Sarunas

1978 European prehistory. New York: Academic Press.

Ministere d'agriculture de Sa6ne-et-Loire

1979 *Inventaires preliminaires.* Copy on file, Department of Anthropology, University of North Carolina, Chapel Hill.

1981 *lnventaires preliminaires: fiche communale.* Copy on file, Department of Anthropology, University of North Carolina, Chapel Hill.

Mocquery, Charles

1898 Le grole de I'annee 1897 dans le departement de *bourguignonne de geographic et d'histoire* 14:397-490.

1899 La grole de I'annee 1898 dans le departement de *bourguignonne de geographic et d'histoire 15:413-431.*

1904 La grole de I'annee 1902 dans le departement de *bourguignonne de geographic et d'histoire* 20:143-232.

Pearsall, W. H.

1977 Mountains and moorlands. London: Collins.

Pfister, Christian

1984 Klimatgeschichte de Schweiz 1525-1860: das Klima der Schweiz von 1525-1860 und seine Bedeutung in der Geschichte von Bev6lkerung und Landwirtschaft, Academica Helvetica, 6. 2 vols. Bern and Stuttgart: Paul Haupt.

Phillips, Patricia

1980 *The prehistory of Europe.* London: Allen Lane.

Postan, M. M.

1975 *The medieval economy and society.* 2nd ed. London and Harmondsworth: Penguin.

Poulain, Therese

1976 La faune sauvage et domestique en France du Neolithique a la fin de I'Age du Fer. In *La prehistoire francaise,* vol. 2: *Les civilisations neolithiques et protohistoriques de la France, pp.* 104-115. Under the direction of Jean Guilaine. Paris: CNRS.

Ragut, Camille

1838 Statistique du departement de Saone-et-Loire. MAcon: De Dejussieu.

Rotberg, R. I., and T. K. Rabb, eds.

1981 *Climate and history.* Princeton: Princeton University Press.

Russell, J. C.

1958 *Late ancient and medieval population.* Transactions of the American Philosophical Society, n.s. 48, part 3. Philadelphia: American Philosophical Society.

Van Bath, B. H. Slicher

1963 *The agrarian history of western Europe, A.D. 500-1800.* New York: St. Martin's Press.

Van Zeist, W.

la Cote-d'Or. *Memoires de la Societe*

1967 Archaeology and palynology in the Netherlands. *Review of Palaeobotany and Palynology,* no. 4:45-65.

Watson, Patty Jo

1976 In pursuit of prehistoric subsistence: a comparative account of some contemporary flotation techniques. *Mid-Continental Journal of Archaeology 1,* no. 1:77-100.

Webb, Thompson, III

1985 Holocene palynology and climate. In *Paleoclimate analysis and modeling,* pp. 163-195. Edited by Alan D. Hecht. New York: John Wiley & Sons.

Wells, Peter S.

1980 Culture contact and culture change: early Iron Age central Europe and the Mediterranean world. Cambridge: Cambridge University Press.

White, K. D.

1970 *Roman farming.* London: Thames & Hudson; Ithaca: Cornell University Press.