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Humidity, Atmospheric

Atmospheric humidity is the amount of water vapour, or moisture, in the air. On a weather chart it is related to the source of an air mass and its potential for storms; in a newspaper it is related to the comfort of the reader. Humidity is usually combined with temperature and ventilation to state the condition of the air because it is the most variable factor in the atmosphere, and it is important in both weather and biology.

At 30° C (86° F) 4 percent of the volume of the air may be occupied by water molecules. But where the air is colder than −40° C (−40° F), less than one-fifth of 1 percent of the air molecules can be water. Although the water vapour content may vary from one air parcel to another, these limits can be set because vapour capacity is determined by temperature. Temperature has profound effects upon some of the indices of humidity regardless of the presence or absence of vapour.

The connection between an effect of humidity and an index of humidity requires simultaneous introduction of effects and indices. Vapour in the air is a determinant of weather because it first absorbs the thermal radiation that leaves and cools the Earth and then emits thermal radiation that warms the Earth. Calculation of absorption and emission requires an index of the mass of water in a volume of air. Vapour also affects the weather because it condenses into clouds, and falls as rain or snow. Tracing the moisture-bearing air masses requires a humidity index that changes only when water is removed or added. Finally, the cooling effect of perspiration, the transpiration of water by vegetation, and evaporation from reservoirs is proportional to humidity differences.

For these reasons there are many means of expressing the water vapour content of the atmosphere. This article treats these indices and the relevance of humidity in climate and human affairs. For further information on these latter aspects see CLOUDS; PRECIPITATION; and CLIMATE.

HUMIDITY INDICES

Absolute humidity. Absolute humidity is the vapour concentration or density in the air. If m_v is the mass of vapour in a volume of air, then absolute humidity d_v is simply $d_v = m_v/V$, in which V is the volume and d_v is expressed in grams per cubic metre (g/m³). This index indicates how much vapour a beam of radiation must pass through. It also indicates the amount of water that can be extracted from the constant volume of air passing over a refrigerator coil or a cold carburetor. The ultimate standard in humidity measurement is made by weighing the amount of water gained by an absorber when a known volume of air passes through it, and this measures absolute humidity, which may vary from 0 g/m³ in dry air to 30 g/m³ when the vapour is saturated at 30° C. The d_v of a parcel of air changes, however, with temperature or pressure even though no water is added or removed because, as the gas equation states, the volume V increases with the absolute or Kelvin temperature and decreases with the pressure.

Specific humidity. The meteorologist requires an index of humidity that does not change with pressure or temperature. A property of this sort will identify an air mass when it is cooled or when it rises to lower pressures aloft without losing or gaining water vapour. Because all the gases will expand equally, the ratios of the weight of water to the weight of dry air, or the dry air plus vapour, will be conserved during such changes and will continue identifying the air mass.

The mixing ratio r is the dimensionless ratio $r = m_v/m_a$, where m_a is the mass of dry air, and the specific humidity q is another dimensionless ratio $q = m_v/(m_a + m_v)$. Because m_v is less than 3 percent of m_a at normal pressure and temperatures cooler than 30° C, r and q are practically equal. These indices are usually expressed in grams per kilogram (g/kg) because they are so small; the values range from 0 in dry air to 28 g/kg in saturated air at 30° C. Absolute and specific humidity indices have specialized uses, and so they are not familiar to most people.

Relative humidity. Relative humidity (U) is so commonly used that a statement of humidity, without a qualifying adjective, can be assumed to be relative humidity. U can be defined, then, in terms of the mixing ratio r that was introduced above. $U = 100r/r_w$, which is a dimensionless percentage. The divisor r_w is the saturation mixing ratio, or the vapour capacity. Relative humidity is, therefore, the water vapour content of the air relative to its content at saturation. Because the saturation mixing ratio is a function of pressure, and especially of temperature, the relative humidity is a combined index of the environment that reflects more than water content. In many climates the relative humidity rises to about 100 percent at dawn and falls to 50 percent by noon. A relative humidity of 50 percent may reflect many different quantities of vapour per volume of air or gram of air, and it will not likely be proportional to evaporation.

An understanding of relative humidity therefore requires a knowledge of saturated vapour, which will be discussed later in the section on the relation between temperature and humidity. But at this point the relation between U and the absorption and retention of water from the air must be considered. Small pores retain water more strongly than large pores; thus, when a porous material is set out in the air, all pores larger than a certain size (which can be calculated from the relative humidity of the air) are dried out.

The water content of a porous material at air temperature is fairly well indicated by the relative humidity. The complexity of actual pore sizes and the viscosity of the water passing through them makes the relation between U and moisture in the porous material imperfect and slowly achieved. The great suction also strains the walls of the capillaries, and the consequent shrinkage is used to measure relative humidity.

Development of the hygrometer

Leonardo da Vinci used a porous hygrometer, a ball of wool that became moister and heavier as the relative humidity rose. The commonest hygrometer of porous material, however, is the hair hygrometer introduced in 1783 by Horace B. de Saussure. When a hair is moved from an atmosphere of 100 percent to one of zero percent relative humidity, it shrinks about 2.5 percent of its length. The change in length per change of relative humidity U is proportional to $1/U$. This decreasing response at high humidity is compensated by cams that make the needle change regularly with humidity, and the hair hygrometer is eminently practical, even if somewhat inaccurate.

The absorption of water by salt solutions is also related to relative humidity without much effect of temperature. The air above water saturated with sodium chloride is maintained at 75 to 76 percent relative humidity, at a temperature between 0° and 40° C (32° and 100° F).

The absorption of water by lithium chloride is the principle of an electrical hygrometer of relative humidity.

Thus, relative humidity is a widely used environmental indicator, but U does respond drastically to changes in temperatures as well as moisture, a response caused by the effect of temperature upon the divisor r_w in U.

RELATION BETWEEN TEMPERATURE AND HUMIDITY

Tables that show the effect of temperature upon the saturation mixing ratio r_w are readily available. Humidity of the air at saturation is expressed more commonly, however, as vapour pressure. Thus, it is necessary to understand vapour pressure and in particular the gaseous nature of water vapour.

The pressure of the water vapour, which contributes to the pressure of the atmosphere, can be calculated from the absolute humidity d_v by the gas equation:

$$e = \frac{m_v}{V}\frac{RT}{M_w} = d_v\frac{RT}{M_w},$$

in which R is the gas constant, T the absolute temperature, M_w the molecular weight of water, and e is water vapour pressure in millibars.

Relative humidity can be defined as the ratio of the vapour pressure of a sample of air to the saturation pressure at the existing temperature. Further, the capacity for vapour and the effect of temperature can now be presented in the usual terms of saturation vapour pressure.

Within a pool of liquid water some molecules are continually escaping from the liquid into the space above, while more and more vapour molecules return to the liquid as the concentration of vapour rises. Finally, equal numbers are escaping and returning, the vapour is then saturated and its pressure is known as the saturation vapour pressure e_w. If the liquid and vapour are warmed, relatively more molecules escape than return, and e_w rises. There is also a saturation pressure with respect to ice. The vapour pressure curve of water has the same form as the curves for many other substances. Its location is fixed, however, by the boiling point of 100° C (212° F), where the saturation vapour pressure of water vapour is 1,013 millibars (mb), the standard pressure of the atmosphere at sea level. The decrease of the boiling point with altitude can be calculated. For example, the saturation vapour pressure at 40° C is 74 mb, standard atmospheric pressure near 18,000 metres (58,860 feet) above sea level is also 74 mb, and that is where water boils at 40° C.

The everyday response of relative humidity to temperature can be easily explained. On a summer morning the temperature might be 15° C (59° F) and the relative humidity 100 percent. The vapour pressure would be 17 mb and the mixing ratio about 11 g/kg. During the day the air could warm to 25° C (77° F), while evaporation added little water. At 25° C the saturation pressure is fully 32 mb. If, however, little water has been added to the air, its vapour pressure will still be about 17 mb. Thus with no change in vapour content, the relative humidity of the air has fallen from 100 to only 53 percent, illustrating why relative humidity does not identify air masses.

On the other hand, porous materials such as cloth will dry between morning and noon, seeking a water content that is in equilibrium with the new relative humidity. Thus the behaviour of porous materials is better indicated by the varying relative humidity than the invariant vapour pressure or mixing ratio; this again illustrates the different utilities of the different indices.

Dew-point temperature. The meaning of dew-point temperature can be illustrated by a sample of air with a vapour pressure of 17 mb. If an object at 15° C is brought into the air, dew will form on the object. Hence, 15° C is the dew-point temperature of the air; that is, the temperature at which the vapour present in a sample of air would just cause saturation, or the temperature whose saturation vapour pressure equals the present vapour pressure in a sample of air, is the dew point. Below freezing, this index is called the frost point. There is a one-to-one correspondence between vapour pressure and dew point, and one serves as well as the other. The dew point has the virtue of being easily interpreted because it is the temperature at which a blade of grass or a pane of glass will become wet with dew from the air. Ideally, it is also the temperature of fog or cloud formation.

The clear meaning of dew point suggests a means of measuring humidity. In 1751 J.B. LeRoy invented a dew-point hygrometer. He added cold water to water in a vessel until dew formed on the vessel, and the temperature of the vessel, the dew point, was a direct index of humidity. The greatest use of the condensation hygrometer has been to measure humidity in the upper atmosphere where a vapour pressure of less than a thousandth millibar makes other means impractical.

The saturation deficit

Another index of humidity, the saturation deficit, can also be understood by considering air with a vapour pressure of 17 mb. At 25° C the air has (31 − 17) or 14 mb less vapour pressure than saturated vapour at the same temperature. Or the saturation deficit is 14 mb.

The saturation deficit has the particular utility of being proportional to the evaporation capability of the air. The saturation deficit can be expressed as

$$e_w - e = e_w\left(1 - \frac{U}{100}\right),$$

and because the saturation vapour pressure e_w rises with rising temperature, the same relative humidity will correspond to a greater saturation deficit and evaporation at warm temperatures.

HUMIDITY AND CLIMATE

The small amount of water in atmospheric vapour, relative to water on the earth, belies its importance. Compared to one unit of water in the air, the seas contain at least 100,000 units, the great glaciers 1,500, the porous earth nearly 200, and rivers and lakes 4 or 5 units. The effectiveness of the vapour in the air is magnified, however, by its role in transferring water from sea to land by the media of clouds and precipitation, and that of absorbing radiation.

The vapour in the air is the invisible conductor that carries water from sea to land, making terrestrial life possible. Fresh water is distilled from the salt seas and carried over land by the wind. Water evaporates from vegetation, and rain falls on the sea, too, but the sea is the bigger source and rain that falls on land is most important to man. The invisible vapour becomes visible near the surface as fog when the air cools to the dew point. The usual nocturnal cooling will produce fog patches in cool valleys. Or the vapour may move as a tropical air mass over cold land or sea, causing widespread and persistent fog, such as occurs over the Grand Banks off Newfoundland. The delivery of water by means of fog or dew is slight, however, and condensation in clouds yields a far greater amount.

When air is lifted it is carried to a region of lower pressure where it will expand and cool as described by the gas equation. It may rise up a mountain slope or over the front of a cooler, denser air mass. If condensation nuclei are absent, the dew point may be exceeded by the cooling air, and the water vapour becomes supersaturated. If nuclei are present or if the temperature is very low, however, cloud droplets or ice crystals form, and the vapour is no longer in the invisible guise of atmospheric humidity.

The invisible vapour has another climatic role, namely, absorbing and emitting radiation. The temperature of the earth and its daily variation is determined by the balance between incoming and outgoing radiation. The wavelength of the incoming radiation from the sun is mostly shorter than three micrometres. It is scarcely absorbed by water vapour and its receipt depends largely upon cloud cover. The radiation exchanged between the atmosphere and earth and the eventual loss to space is in the form of long waves. These long waves are strongly absorbed in the 3 to 8.5 micrometre band and in the greater than

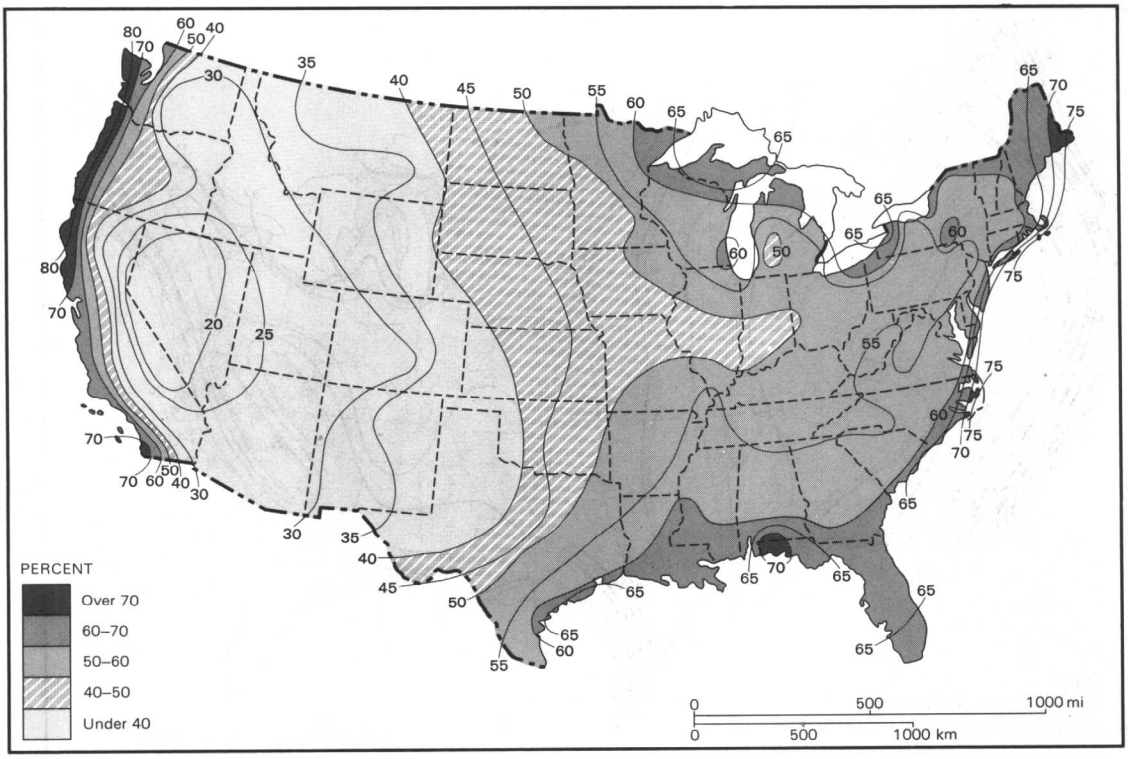

Figure 1: Average relative humidity, local noon, July.

11-micrometre range, where vapour is either partly or wholly opaque. Much of the radiation that is absorbed in the atmosphere is emitted back to earth, and the surface receipt of long waves, primarily from water vapour and carbon dioxide in the atmosphere, is slightly more than twice the direct receipt of solar radiation at the surface. Thus the invisible vapour in the atmosphere combines with clouds and the advection (horizontal movement) of air from different regions to control the surface temperature.

World distribution of humidity

The world distribution of humidity can be portrayed for different uses by different indices. To appraise the quantity of water carried by the entire atmosphere, the moisture in an air column above a given point on earth is expressed as a depth of liquid water. It varies from 0.5 millimetre over the Himalayas and 2 mm over the poles in winter, to 8 mm over the Sahara, 54 mm in the Amazon region, and 64 mm over India during the wet season. During summer, the air over the United States transports 16 mm of water vapour over the Great Basin and 45 mm over Florida.

The humidity of the surface air may be mapped as vapour pressure, but a map of this variable looks much like that of temperature. Warm places are moist and cool ones are dry; even in deserts, the vapour pressure is normally 13 millibars, whereas over the northern seas it is only about 4 millibars. Certainly the moisture in materials in two such areas will be just the opposite, and relative humidity is a more widely useful index.

The average relative humidity for July reveals the humidity provinces of the Northern Hemisphere when aridity is at a maximum. At other times the relative humidity generally will be higher. The humidities over the Southern Hemisphere in July indicate the humidities that comparable regions in the Northern Hemisphere will attain in January, just as July in the Northern Hemisphere suggests the humidities in the Southern Hemisphere during January. A contrast is provided by comparing a humid cool coast to a desert. The midday humidity on the Oregon coast, for example, falls only to 80 percent at midday, whereas in the Nevada desert it falls to 20 percent. At night the contrast is less, with averages being over 90 and about 50 percent in these two places.

Although the dramatic regular decrease of relative humidity from dawn to midday has been attributed largely to warming rather than declining vapour content, the content does vary regularly. In humid environments, daytime evaporation increases the vapour content of the air and the mixing ratio, which may be about 12 grams per kilogram, rises 1 or 2 g/kg in temperate places and may attain 16 g/kg in a tropical rain forest. In arid environments, however, little evaporation moistens the air and daytime turbulence tends to bring down dry air; this decreases the mixing ratio by as much as 2 g /kg.

Humidity also varies regularly with altitude. On the average, fully half the water in the atmosphere lies below .25 kilometres (820 feet), and satellite observations over the United States in April revealed one millimetre or less of water in all the air above 6 km (19,680 ft). A cross section of the atmosphere along 75° W longitude shows a decrease in humidity with height and toward the poles. The mixing ratio is 16 g/kg just north of the Equator, but it decreases to 1 g/kg at 50° N latitude or 8 km above the Equator. The transparent air surrounding mountains in fair weather is very dry indeed.

Nearer the ground, the vapour content also changes with height in a regular pattern. When vapour is condensing on the earth at night, the content is greater aloft than at the ground; during the day the content is usually less aloft than at the ground because of evaporation.

Evaporation and humidity

Evaporation, mostly from the sea and from vegetation, replenishes the humidity of the air. It is the change of liquid water into gaseous state, but it may be analyzed as diffusion. The rate of diffusion, or evaporation, will be proportional to the difference between the pressure of the vapour in the free air and the vapour that is next to, and saturated by, the evaporating liquid. If the liquid and air have the same temperature, evaporation is proportional to the saturation deficit. It is also proportional to the conductivity of the medium between the evaporator and the free air. If the evaporator is open water, the conductivity will increase with ventilation. But if the evaporator is a leaf, the diffusing water must pass through the still air within the minute pores between the water within and the dry air outside. In this case, the porosity may modify the conductivity more than ventilation.

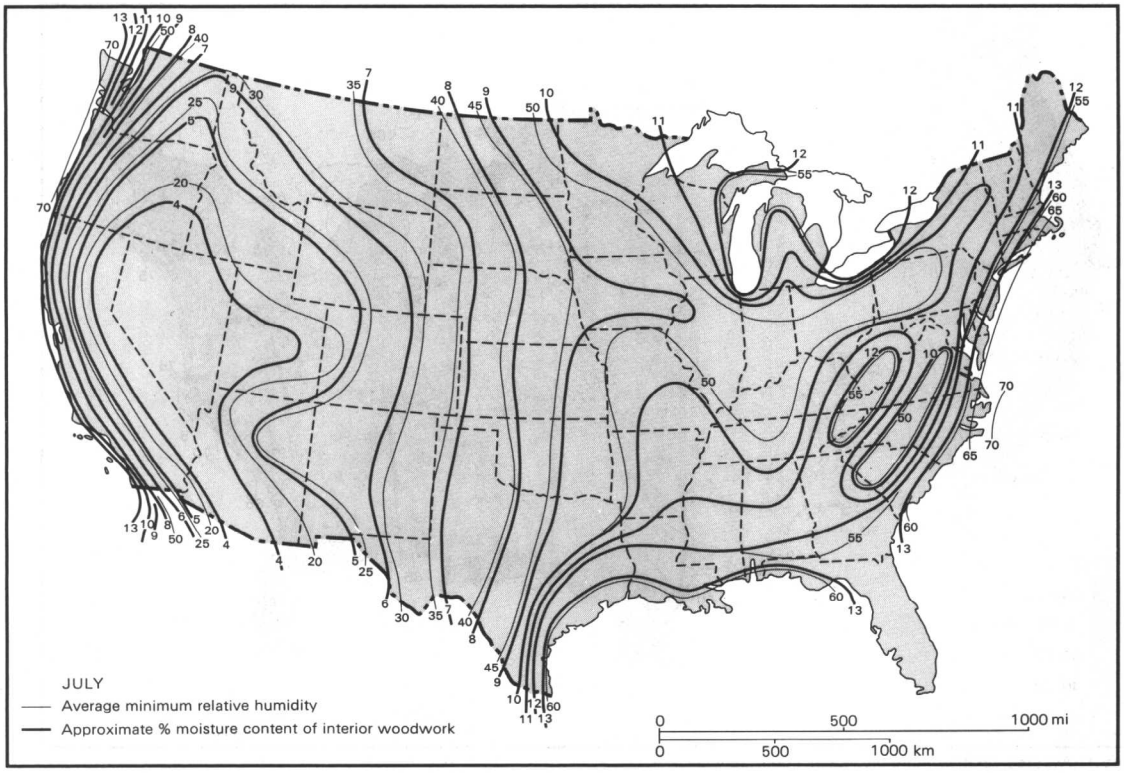

Figure 2: Relation of the moisture content of interior woodwork to outdoor relative humidity of various areas of the United States in July.

From *Humidity and Moisture: Measurement and Control in Science and Industry* by A. Wexler, © 1965 by Litton Educational Publishing, Inc.; reprinted by permission of Van Nostrand Reinhold Company

The temperature of the evaporator is rarely the same as the air temperature, however, because each gram of evaporation consumes about 600 calories and thus cools the evaporator. The availability of energy to heat the evaporator, therefore, is as important as the saturation deficit and conductivity of the air. Outdoors, some of this heat may be transferred from the surrounding air by convection, but much of it must be furnished by radiation. Evaporation is faster on sunny than cloudy days not only because the sunny day may have drier air but also because the sun warms the evaporator, thus raising the vapour pressure at the evaporator. In fact, according to the well-known Penman calculation of evaporation, this loss of water is essentially determined by the net radiation balance during the day.

The relation of humidity and evaporation also is illustrated by the wet-bulb hygrometer. A wet wick wrapped around a thermometer and ventilated rapidly in the shade will lose heat by vaporization and gain from convection until its temperature reaches an equilibrium at the wet-bulb temperature; this lies between the air and dew-point temperatures. The cooling of the wet bulb and the air temperature are indicators of the humidity, and wet-bulb psychrometers (a wet-bulb and a dry-bulb thermometer) are used as secondary standards for the calibration of other hygrometers.

HUMIDITY AND HUMAN AFFAIRS

The invisible water vapour in the air can harm man or the animals and plants around him by upsetting normal heat and water budgets or encouraging disease in these organisms.

The connection between humidity and some human diseases is clear. Malarial mosquitoes, for example, clearly thrive in moist places. But the connection between many diseases and humidity is too tenuous to discuss.

Most animals must maintain a stable internal temperature to function normally. This stability is accomplished by balancing gains and losses through radiation, convection, evaporation, and metabolism. The most striking effect of humidity is that of controlling the evaporation of perspiration that pours through the skin of a man labouring in a hot place. The cooling increases with the wetted area and as the square root of the measured ventilation. It also increases with the difference in vapour pressure between the wet skin and the air. Thus in warm weather, the ease of balancing the energy budget, and hence comfort, are determined by humidity in addition to temperature, ventilation, and radiation.

Indices of environmental stress

Numerous indices have been devised to indicate the stress or discomfort of an environment. The "effective temperature" employed by air-conditioning engineers integrates the effects of humidity, temperature, and ventilation and is linearly related to the heart rate of working men. Ventilation is often omitted, and then the comfortable "effective temperature" of 20 is obtained with an air temperature of 26° C (79° F) and a relative humidity of 10 percent or a combination of 20° C (68° F) and 100 percent. The discomfort, or temperature–humidity, index, employed by the U.S. Weather Bureau is also calculated from air temperature and humidity and it disregards ventilation and radiation. Hygienists have attempted to set sultriness limits on room conditions, although the variation in people and clothing makes the setting difficult. A sultriness limit for resting people has been tabulated by H.E. Landsberg:

Temperature, ° C.	40	35	30	25	20
Relative humidity, percent	20	33	44	60	85

Wilted leaves are a familiar manifestation of drought. Humidity modifies the evaporation that desiccates and kills them. Because leaves have a relatively impermeable epidermis but must assimilate carbon dioxide from the air for photosynthesis and growth, most leaves have pores, or stomata, that admit carbon dioxide. These same pores, however, let water evaporate, and the evaporation from a succulent field or forest is nearly as great as from a lake. This loss, which is equivalent to about 25 millimetres of rain per week, must be replaced by water drawn from the soil by roots. By modifying evaporation, humidity can prolong the time until soil water must be replenished by rain or irrigation.

While humidity is affecting the plants by changing evaporation, the plants can affect microclimates (*q.v.*) by modifying the humidity of the air within the canopy of leaves. For example, the relative humidity above a barren field fell to 20 percent at midday, but above a nearby irrigated sugarcane field the humidity decreased only to 40 percent.

Humidity has a distinct effect upon many plant diseases. The fungi that mildew shoes prosper in humid air, and many plant pathogens are other fungi that require humid air before they can bear spores on infected leaves or germinate and infect new leaves. Thus the Irish Famine in the mid-19th century was caused by a potato mildew encouraged by humid weather, and modern weather forecasts employ humidity observations to predict epidemics in crops.

Many other man-made objects also are affected by humidity. The corrosion of metal is related to relative humidity, not to rainfall or temperature, and things made of porous materials respond most dramatically to humidity. Their behaviour is exemplified by woodwork. The moisture content of wood at air temperature is about 30 percent when it has set (aged) in saturated vapour that is 100 percent relative humidity. At high humidities the content of wood declines considerably with a decrease in humidity, reaching 15 percent at 75 percent relative humidity. To attain 5 percent content, the wood must equilibrate with air at 20 percent relative humidity. In the United States in July (Figure 2), as elsewhere, the moisture content of interior woodwork is remarkably well predicted by the average minimum relative humidity. In the winter, the relative humidity of a heated building is determined largely by the drying of air outdoors in the cold, and the winter moisture content of woodwork is related to average temperature outdoors.

The shrinkage of drying wood is well-known and has even been employed in a sluggish hygrometer. Typically wood shrinks about 5 percent across the grain when the relative humidity changes from 100 to 20 percent.

The probability of ignition of wood decreases sharply to near zero when the moisture content of wood, in a house or on a forest floor, attains 30 percent as it does in saturated air. Thus forest fire danger ratings employ observations of relative humidity, and most great forest fires have burst forth in dry air.

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(P.E.W.)

Humour and Wit

In all its many-splendoured varieties, humour can be simply defined as a type of stimulation that tends to elicit the laughter reflex. Spontaneous laughter is a motor reflex produced by the coordinated contraction of 15 facial muscles in a stereotyped pattern and accompanied by altered breathing. Electrical stimulation of the main lifting muscle of the upper lip, the zygomatic major, with currents of varying intensity produces facial expressions ranging from the faint smile through the broad grin to the contortions typical of explosive laughter.

The laughter and smile of civilized man is, of course, often of a conventional kind, in which voluntary intent substitutes for, or interferes with, spontaneous reflex activity; this article is concerned, however, only with the latter. Once laughter is realized to be a humble reflex, several paradoxes must be faced. Motor reflexes, such as the contraction of the pupil of the eye in dazzling light, are simple responses to simple stimuli whose value to survival is obvious. But the involuntary contraction of 15 facial muscles, associated with certain irrepressible noises, strikes one as an activity without any utilitarian value, quite unrelated to the struggle for survival. Laughter is a reflex but unique in that it has no apparent biological purpose. One might call it a luxury reflex. Its only function seems to be to provide relief from tension.

Paradoxes of laughter

The second related paradox is a striking discrepancy between the nature of the stimulus and that of the response in humorous transactions. When a blow beneath the kneecap causes an automatic upward kick, both "stimulus" and "response" function on the same primitive physiological level, without requiring the intervention of the higher mental functions. But that such a complex mental activity as reading a comic story should cause a specific reflex contraction of the facial muscles is a phenomenon that has puzzled philosophers since Plato. There is no clear-cut, predictable response that would tell a lecturer whether he has succeeded in convincing his listeners; but when he is telling a joke, laughter serves as an experimental test. *Humour is the only form of communication in which a stimulus on a high level of complexity produces a stereotyped, predictable response on the physiological reflex level.* Thus the response can be used as an indicator for the presence of the elusive quality that is called humour—as the click of the Geiger counter is used to indicate the presence of radioactivity. Such a procedure is not possible in any other form of art; and since the step from the sublime to the ridiculous is reversible, the study of humour provides the psychologist with clues for the study of creativity in general.

THE LOGIC OF LAUGHTER

The range of laughter-provoking experiences is enormous, from physical tickling to mental titillations of the most varied kinds. There is unity in this variety, however, a common denominator of a specific and specifiable pattern that reflects the "logic" or "grammar" of humour, as it were. A few examples will help to unravel that pattern.

1. A masochist is a person who likes a cold shower in the morning so he takes a hot one.
2. An English lady, on being asked by a friend what she thought of her departed husband's whereabouts: "Well, I suppose the poor soul is enjoying eternal bliss, but I wish you wouldn't talk about such unpleasant subjects."
3. A doctor comforts his patient: "You have a very serious disease. Of ten persons who catch it, only one survives. It is lucky you came to me, for I have recently had nine patients with this disease and they all died of it."
4. Dialogue in a French film:
   "Sir, I would like to ask for your daughter's hand."
   "Why not? You have already had the rest."
5. A marquis of the court of Louis XV unexpectedly returned from a journey and, on entering his wife's boudoir, found her in the arms of a bishop. After a moment's hesitation, the marquis walked calmly to the window, leaned out, and began going through the motions of blessing the people in the street.
   "What are you doing?" cried the anguished wife.
   "Monseigneur is performing my functions, so I am performing his."

Is there a common pattern underlying these five stories? Starting with the last, a little reflection reveals that the marquis's behaviour is both unexpected and perfectly logical—but of a logic not usually applied to this type of situation. It is the logic of the division of labour, governed by rules as old as human civilization. But his reactions would have been expected to be governed by a different set of rules—the code of sexual morality. It is the sudden clash between these two mutually exclusive codes of rules—or associative contexts—that produces the comic effect. It compels the listener to perceive the situation in two self-consistent but incompatible frames of reference at the same time; his mind has to operate si-

multaneously on two different wavelengths. While this unusual condition lasts, the event is not only, as is normally the case, associated with a single frame of reference, but "bisociated" with two. The term bisociation was coined by the present writer to make a distinction between the routines of disciplined thinking within a single universe of discourse—on a single plane, as it were—and the creative types of mental activity that always operate on more than one plane. In humour, both the *creation* of a subtle joke and the *re-creative* act of perceiving the joke involve the delightful mental jolt of a sudden leap from one plane or associative context to another.

Bisociation

Turning to the other examples, in the French film dialogue, the daughter's "hand" is perceived first in a metaphorical frame of reference, then suddenly in a literal, bodily context. The doctor thinks in terms of abstract, statistical probabilities, the rules of which are inapplicable to individual cases; and there is an added twist because, in contrast to what common sense suggests, the patient's odds of survival are unaffected by whatever happened before; they are still one against ten. This is one of the profound paradoxes of the theory of probability, and the joke in fact implies a riddle; it pinpoints an absurdity that tends to be taken for granted. As for the lady who looks upon death as "eternal bliss" and at the same time "an unpleasant subject," she epitomizes the common human predicament of living in the divided house of faith and reason. Here again the simple joke carries unconscious overtones and undertones, audible to the inner ear alone.

The masochist who punishes himself by depriving himself of his daily punishment is governed by rules that are a *reversal* of those of normal logic. (A pattern can be constructed in which *both* frames of reference are reversed: "A sadist is a person who is kind to a masochist.") But there is again an added twist. The joker does not really believe that the masochist takes his hot shower as a punishment; he only pretends to believe it. *Irony* is the satirist's most effective weapon; it pretends to adopt the opponent's ways of reasoning in order to expose their implicit absurdity or viciousness.

Thus the common pattern underlying these stories is *the perceiving of a situation in two self-consistent but mutually incompatible frames of reference or associative contexts.* This formula can be shown to have a general validity for all forms of humour and wit, some of which will be discussed below. But it covers only one aspect of humour—its *intellectual structure.* Another fundamental aspect must be examined—the *emotional dynamics* that breathe life into that structure and make a person laugh, giggle, or smile.

LAUGHTER AND EMOTION

When a comedian tells a story, he deliberately sets out to create a certain tension in his listeners, which mounts as the narrative progresses. But it never reaches its expected climax. The punch line, or point, acts as a verbal guillotine that cuts across the logical development of the story; it debunks the audience's dramatic expectations. The tension that was felt becomes suddenly redundant and is exploded in laughter. To put it differently, laughter disposes of emotive excitations that have become pointless and must somehow be worked off along physiological channels of least resistance; and the function of the "luxury reflex" is to provide these channels.

A glance at the caricatures of the 18th-century English artists William Hogarth or Thomas Rowlandson, showing the brutal merriment of people in a tavern, makes one realize at once that they are working off their surplus of adrenalin by contracting their face muscles into grimaces, slapping their thighs, and breathing in puffs through the half-closed glottis. Their flushed faces reveal that the emotions disposed of through these safety valves are brutality, envy, sexual gloating. In cartoons by the 20th-century American James Thurber, however, coarse laughter yields to an amused and rarefied smile: the flow of adrenalin has been distilled and crystallized into a grain of Attic salt—a sophisticated joke. The word witticism is derived from "wit" in its original sense of intelligence and acumen (as is *Witz* in German). The domains of humour and of ingenuity are continuous, without a sharp boundary: the jester is brother to the sage. Across the spectrum of humour, from its coarse to its subtle forms, from practical joke to brainteaser, from jibe to irony, from anecdote to epigram, the emotional climate shows a gradual transformation. The emotion discharged in coarse laughter is aggression robbed of its purpose. The jokes small children enjoy are mostly scatological; adolescents of all ages gloat on vicarious sex. The sick joke trades on repressed sadism, satire on righteous indignation. There is a bewildering variety of moods involved in different forms of humour, including mixed or contradictory feelings; but whatever the mixture, it must contain a basic ingredient that is indispensable: an impulse, however faint, of aggression or apprehension. It may appear in the guise of malice, contempt, the veiled cruelty of condescension, or merely an absence of sympathy with the victim of the joke—a momentary anesthesia of the heart, as the French philosopher Henri Bergson put it.

The aggressive element

In the subtler types of humour, the aggressive tendency may be so faint that only careful analysis will detect it, like the presence of salt in a well-prepared dish—which, however, would be tasteless without it. Replace aggression by sympathy and the same situation—a drunk falling on his face, for example—will be no longer comic but pathetic and will evoke not laughter but pity. It is the aggressive element, the detached malice of the comic impersonator, that turns pathos into bathos, tragedy into travesty. Malice may be combined with affection in friendly teasing; and the aggressive component in civilized humour may be sublimated or no longer conscious. But in jokes that appeal to children and primitive people, cruelty and boastful self-assertiveness are much in evidence. In 1961 a survey carried out among American children aged 8 to 15 made the researchers conclude that the mortification, discomfort, or hoaxing of others readily caused laughter, but witty or funny remarks often passed unnoticed.

Theories of laughter

Similar considerations apply to the historically earlier forms and theories of the comic. In Aristotle's view, laughter was intimately related to ugliness and debasement. Cicero held that the province of the ridiculous lay in a certain baseness and deformity. Descartes believed that laughter was a manifestation of joy mixed with surprise or hatred or both. In Francis Bacon's list of what causes laughter, the first place is again given to deformity. One of the most frequently quoted utterances on the subject is this definition in Thomas Hobbes's *Leviathan* (1651):

> The passion of laughter is nothing else but sudden glory arising from a sudden conception of some eminency in ourselves by comparison with the infirmity of others, or with our own formerly.

In the 19th century, the Scot Alexander Bain, one of the pioneers of experimental psychology, thought along the same lines:

> Not in physical effects alone, but in everything where a man can achieve a stroke of superiority, in surpassing or discomforting a rival, is the disposition of laughter apparent.

In Bergson's view, laughter is the corrective punishment inflicted by society upon the unsocial individual: "In laughter we always find an unavowed intention to humiliate and consequently to correct our neighbour." Sir Max Beerbohm, the 20th-century English wit, found "two elements in the public's humour: delight in suffering, contempt for the unfamiliar." The American psychologist William McDougall believed that "laughter has been evolved in the human race as an antidote to sympathy, a protective reaction shielding us from the depressive influence of the shortcomings of our fellow men."

However much the opinions of the theorists differ, on this one point nearly all of them agree: that the emotions discharged in laughter always contain an element of aggressiveness. It must be borne in mind, however, that aggression and apprehension are twin phenomena, so much

so that psychologists are used to talking of "aggressive–defensive impulses." Accordingly, one of the typical situations in which laughter occurs is the moment of sudden cessation of fear caused by some imaginary danger. Rarely is the nature of laughter as an overflow of redundant tensions more strikingly manifested than in the sudden change of expression on a small child's face from anxious apprehension to the happy laughter of relief. This seems to be unrelated to humour; yet a closer look reveals in it the same logical structure as in the joke: the wildly barking little dog was first perceived by the child in a context of danger, then discovered to be a harmless pup; the tension has suddenly become redundant and is spilled.

Laughter as the release of tension

Immanuel Kant realized that what causes laughter is "the sudden transformation of a tense expectation into nothing." Herbert Spencer, the 19th-century English philosopher, took up the idea and attempted to formulate it in physiological terms: "Emotions and sensations tend to generate bodily movements. . . . When consciousness is unawares transferred from great things to small," the "liberated nerve force" will expend itself along channels of least resistance—the bodily movements of laughter. Freud incorporated Spencer's theory of humour into his own, with special emphasis on the release of repressed emotions in laughing; he also attempted to explain why the excess energy should be worked off in that particular way:

> According to the best of my knowledge, the grimaces and contortions of the corners of the mouth that characterise laughter appear first in the satisfied and over-satiated nursling when he drowsily quits the breast. . . . They are physical expressions of the determination to take no more nourishment, an "enough" so to speak, or rather a "more than enough" . . . This primal sense of pleasurable saturation may have provided the link between the smile—that basic phenomenon underlying laughter—and its subsequent connection with other pleasurable processes of de-tension.

In other words, the muscle contractions of the smile, as the earliest expressions of relief from tension, would thereafter serve as channels of least resistance. Similarly, the explosive exhalations of laughter seem designed to "puff away" surplus tension in a kind of respiratory gymnastics, and agitated gestures obviously serve the same function.

It may be objected that such massive reactions often seem quite out of proportion to the slight stimulations that provoke them. But it must be borne in mind that laughter is a phenomenon of the trigger-releaser type, where a sudden turn of the tap may release vast amounts of stored emotions, derived from various, often unconscious, sources: repressed sadism, sexual tumescence, unavowed fear, even boredom. The explosive laughter of a class of schoolboys at some trivial incident is a measure of their pent-up resentment during a boring lecture. Another factor that may amplify the reaction out of all proportion to the comic stimulus is the social infectiousness that laughter shares with other emotive manifestations of group behaviour.

Patterns of association

Laughter or smiling may also be caused by stimulations that are not in themselves comic but signs or symbols deputizing for well-established comic patterns—such as Charlie Chaplin's oversized shoes or Groucho Marx's cigar—or catchphrases, or allusions to family jokes. To discover why people laugh requires, on some occasions, tracing back a long, involved thread of associations to its source. This task is further complicated by the fact that the effect of such comic symbols—in a cartoon or on the stage—appears to be instantaneous, without allowing time for the accumulation and subsequent discharge of "expectations" and "emotive tensions." But here memory comes into play, having already accumulated the required emotions in past experiences, acting as a storage battery whose charge can be sparked off at any time: the smile that greets Falstaff's appearance on the scene is derived from a mixture of memories and expectations. Besides, even if a reaction to a cartoon appears to be instantaneous, there is always a process in time until the reader "sees the joke"; the cartoon has to tell a story even if it is telescoped into a few seconds. All of this shows that to analyze humour is a task as delicate as analyzing the composition of a perfume with its multiple ingredients, some of which are never consciously perceived while others, when sniffed in isolation, would make one wince.

In this article there has been a discussion first of the logical structure of humour and then of its emotional dynamics. Putting the two together, the result may be summarized as follows: the "bisociation" of a situation or idea with two mutually incompatible contexts in a person's mind and the resulting abrupt transfer of his train of thought from one context to another put a sudden end to his "tense expectations"; the accumulated emotion, deprived of its object, is left hanging in the air and is discharged in laughter. Upon hearing that the marquis in the story told earlier walks to the window and starts blessing the people in the street, the intellect turns a somersault and enters with gusto into the new game. The malicious and erotic feelings aroused by the start of the story, however, cannot be fitted into the new context; deserted by the nimble intellect, these feelings gush out in laughter like air from a punctured tire.

Separation of thought and emotion

To put it differently: people laugh because their emotions have a greater inertia and persistence than their thoughts. Affects are incapable of keeping step with reasoning; unlike reasoning, they cannot "change direction" at a moment's notice. To the physiologist, this is self-evident since emotions operate through the genetically old, massive sympathetic nervous system and its allied hormones, acting on the whole body, while the processes of conceptual thinking are confined to the neocortex at the roof of the brain. Common experience provides daily confirmation of this dichotomy. People are literally "poisoned" by their adrenal humours; it takes time to talk a person out of a mood; fear and anger show physical aftereffects long after their causes have been removed. If man were able to change his moods as quickly as his thoughts, he would be an acrobat of emotion; but since he is not, his thoughts and emotions frequently become dissociated. It is emotion deserted by thought that is discharged in laughter. For emotion, owing to its greater mass momentum, is, as has been shown, unable to follow the sudden switch of ideas to a different type of logic; it tends to persist in a straight line. Aldous Huxley once wrote:

> We carry around with us a glandular system which was admirably well adapted to life in the Paleolithic times but is not very well adapted to life now. Thus we tend to produce more adrenalin than is good for us, and we either suppress ourselves and turn destructive energies inwards or else we do not suppress ourselves and we start hitting people. (From *Man and Civilization: Control of the Mind*, ed. Seymour M. Farber and Roger H.L. Wilson. Copyright 1961. Used with permission of McGraw-Hill Book Company.)

A third alternative is to laugh at people. There are other outlets for tame aggression, such as competitive sports or literary criticism; but they are acquired skills, whereas laughter is a gift of nature, included in man's native equipment. The glands that control his emotions reflect conditions at a stage of evolution when the struggle for existence was more deadly than at present—and when the reaction to any strange sight or sound consisted in jumping, bristling, fighting, or running. As security and comfort increased in the species, new outlets were needed for emotions that could no longer be worked off through their original channels, and laughter is obviously one of them. But it could only emerge when reasoning had gained a degree of independence from the urges of emotion. Below the human level, thinking and feeling appear to form an indivisible unity. Not before thinking became gradually detached from feeling could man perceive his own emotion as redundant and make the smiling admission, "I have been fooled."

VERBAL HUMOUR

The foregoing discussion was intended to provide the tools for dissecting and analyzing any specimen of humour. The procedure is to determine the nature of the two (or more) frames of reference whose collision gives

rise to the comic effect—to discover the type of logic or "rules of the game" that govern each. In the more sophisticated type of joke, the logic is implied and hidden, and the moment it is stated in explicit form, the joke is dead. Unavoidably, the section that follows will be strewn with cadavers.

Puns

Max Eastman, in *The Enjoyment of Laughter* (1936), remarked of a laboured pun by Ogden Nash: "It is not a pun but a punitive expedition." That applies to most puns, including Milton's famous lines about the Prophet Elijah's ravens, which were "though ravenous taught to abstain from what they brought," or the character mentioned by Freud, who calls the Christmas season the "alcoholidays." Most puns strike one as atrocious, perhaps because they represent the most primitive form of humour; two disparate strings of thought tied together by an acoustic knot. But the very primitiveness of such association based on pure sound ("hol") may account for the pun's immense popularity with children and its prevalence in certain types of mental disorder ("punning mania").

From the play on sounds—puns and Spoonerisms—an ascending series leads to the play on words and so to the play on ideas. When Groucho Marx says of a safari in Africa, "We shot two bucks, but that was all the money we had," the joke hinges on the two meanings of the word buck. It would be less funny without the reference to Groucho, which evokes a visual image instantly arousing high expectations. The story about the marquis above may be considered of a superior type of humour because it plays not on mere words but on ideas.

It would be quite easy—and equally boring—to draw up a list in which jokes and witticisms are classified according to the nature of the frames of reference whose collision creates the comic effect. A few have already been mentioned: metaphorical versus literal meaning (the daughter's "hand"); professional versus common sense logic (the doctor); incompatible codes of behaviour (the marquis); confrontations of the trivial and the exalted ("eternal bliss"); trains of reasoning travelling, happily joined together, in opposite directions (the sadist who is kind to the masochist). The list could be extended indefinitely; in fact *any* two frames of reference can be made to yield a comic effect of sorts by hooking them together and infusing a drop of malice into the concoction. The frames may even be defined by such abstract concepts as "time" and "weather": the absent-minded professor who tries to read the temperature from his watch or to tell the time from the thermometer is comic in the same way as a game of table tennis played with a soccer ball or a game of rugby played with a table tennis ball. The variations are infinite, the formula remains the same.

Jokes and anecdotes have a single point of culmination. The literary forms of *sustained humour*, such as the picaresque novel, do not rely on a single effect but on a series of minor climaxes. The narrative moves along the line of intersection of contrasted planes, such as the fantasy world of Don Quixote and the cunning horse sense of Sancho Panza, or is made to oscillate between them. As a result, tension is continuously generated and discharged in mild amusement.

Comic verse

Comic verse thrives on the melodious union of incongruities, such as the "cabbages and kings" in Lewis Carroll's "The Walrus and the Carpenter," and particularly on the contrast between lofty form and flat-footed content. Certain metric forms associated with heroic poetry, such as the hexameter or Alexandrine, arouse expectations of pathos, of the exalted; to pour into these epic molds some homely, trivial content—"beautiful soup, so rich and green / waiting in a hot tureen"—is an almost infallible comic device. The rolling rhythms of the first lines of a limerick that carry, instead of a mythical hero such as Hector or Achilles, a young lady from Ohio for a ride make her ridiculous even before the expected calamities befall her. Instead of a heroic mold, a soft lyrical one may also pay off:

> . . . And what could be moister
> Than tears of an oyster?

Another type of incongruity between form and content yields the bogus proverb: "The rule is: jam tomorrow and jam yesterday—but never jam today." Two contradictory statements have been telescoped into a line whose homely, admonitory sound conveys the impression of a popular adage. In a similar way, nonsense verse achieves its effect by pretending to make sense, by forcing the reader to project meaning into the phonetic pattern of the jabberwocky, as one interprets the ink blots in a Rorschach test.

Satire and allegory

The *satire* is a verbal caricature that shows a deliberately distorted image of a person, institution, or society. The traditional method of the caricaturist is to exaggerate those features he considers to be characteristic of his victim's personality and to simplify by leaving out everything that is not relevant for his purpose. The satirist uses the same technique, and the features of society he selects for magnification are, of course, those of which he disapproves. The result is a juxtaposition, in the reader's mind, of his habitual image of the world in which he moves and its absurd reflection in the satirist's distorting mirror. He is made to recognize familiar features in the absurd and absurdity in the familiar. Without this double vision the satire would be humourless. If the human Yahoos were really such evil-smelling monsters as Gulliver's Houyhnhnm hosts claim, then Jonathan Swift's *Gulliver's Travels* (1726) would not be a satire but the statement of a deplorable truth. Straight invective is not satire; satire must deliberately overshoot its mark.

A similar effect is achieved if, instead of exaggerating the objectionable features, the satirist projects them by means of the *allegory* onto a different background, such as an animal society. A succession of writers, from the ancient Greek dramatist Aristophanes through Swift to such 20th-century satirists as Anatole France and George Orwell, have used this technique to focus attention on deformities of society that, blunted by habit, are taken for granted.

SITUATIONAL HUMOUR

The coarsest type of humour is the practical joke: pulling away the chair from under the dignitary's lowered bottom. The victim is perceived first as a person of consequence, then suddenly as an inert body subject to the laws of physics: authority is debunked by gravity, mind by matter; man is degraded to a mechanism. Goose-stepping soldiers acting like automatons, the pedant behaving like a mechanical robot, the Sergeant Major attacked by diarrhea, or Hamlet getting the hiccups—all show man's lofty aspirations deflated by his all-too-solid flesh. A similar effect is produced by artifacts that masquerade as humans: Punch and Judy, jack-in-the-box, gadgets playing tricks on their masters as if with calculated malice.

In Henri Bergson's theory of laughter, this dualism of subtle mind and inert matter—he calls it "the mechanical encrusted on the living"—is made to serve as an explanation of *all* varieties of the comic. In the light of what has been said, however, it would seem to apply only to *one* type of comic situation among many others.

From the "bisociation" of man and machine, there is only a step to the man–animal hybrid. Walt Disney's creations behave as if they were human without losing their animal appearance. The caricaturist follows the reverse procedure by discovering horsey, mousy, or piggish features in the human face.

This leads to the comic devices of imitation, impersonation, and disguise. The impersonator is perceived as himself and somebody else at the same time. If the result is slightly degrading—but only in that case—the spectator will laugh. The comedian impersonating a public personality, two pairs of trousers serving as the legs of the pantomime horse, men disguised as women and women as men—in each case the paired patterns reduce each other to absurdity.

The most aggressive form of impersonation is the *parody*, designed to deflate hollow pretense, to destroy illusion, and to undermine pathos by harping on the

weaknesses of the victim. Wigs falling off, speakers forgetting their lines, gestures remaining suspended in the air: the parodist's favourite points of attack are again situated on the line of intersection between the sublime and the trivial.

Playful behaviour in young animals and children is amusing because it is an unintentional parody of adult behaviour, which it imitates or anticipates. Young puppies are droll because their helplessness, affection, and puzzled expression make them appear more "human" than full-grown dogs; because their growls strike one as impersonations of adult behaviour—like a child in a bowler hat; because the puppy's waddling, uncertain gait makes it a choice victim of nature's practical jokes; because its bodily disproportions—the huge padded paws, Falstaffian belly, and wrinkled brow—give it the appearance of a caricature; and lastly because the observer feels so very superior to a puppy. A fleeting smile can contain many logical ingredients and emotional spices.

Both Cicero and Francis Bacon regarded *deformity* as the most frequent cause of laughter. Renaissance princes collected dwarfs and hunchbacks for their merriment. It obviously requires a certain amount of imagination and empathy to recognize in a midget a fellow human, who, though different in appearance, thinks and feels much as oneself does. In children, this projective faculty is still rudimentary: they tend to mock people with a stammer or a limp and laugh at the foreigner with an odd pronunciation. Similar attitudes are shown by tribal or parochial societies to any form of appearance or behaviour that deviates from their strict norms: the stranger is not really human; he only pretends to be "like us." The Greeks used the same word, barbarous, for the foreigner and the stutterer: the uncouth barking sounds the stranger uttered were considered a parody of human speech. Vestiges of this primitive attitude are still found in the curious fact that civilized people accept a foreign accent with tolerance, whereas imitation of a foreign accent strikes them as comic. The imitator's mispronunciations are recognized as mere pretense; this knowledge makes sympathy unnecessary and enables the audience to be childishly cruel with a clean conscience.

Other sources of innocent laughter are situations in which *the part and the whole* change roles, and attention becomes focussed on a detail torn out of the functional context on which its meaning depended. When the phonograph needle gets stuck, the soprano's voice keeps repeating the same word on the same quaver, which suddenly assumes a grotesquely independent life. The same happens when faulty orthography displaces attention from meaning to spelling, or whenever consciousness is directed at functions that otherwise are performed automatically. The latter situation is well illustrated by the story of the centipede who, when asked in which order he moved his hundred legs, became paralyzed and could walk no more. The self-conscious, awkward youth, who does not know what to do with his hands, is a victim of the paradox of the centipede.

Comedies have been classified according to their reliance on situations, manners, or characters. The logic of the last two needs no further discussion; in the first, comic effects are contrived by making a situation participate simultaneously in two independent chains of events with different associative contexts, which intersect through coincidence, mistaken identity, or confusions of time and occasion.

Tickling

Why tickling should produce laughter remained an enigma in all earlier theories of the comic. As Darwin was the first to point out, the innate response to tickling is squirming and straining to withdraw the tickled part—a defense reaction designed to escape attacks on vulnerable areas such as the soles of the feet, armpits, belly, and flank. If a fly settles on the belly of a horse, it causes a ripple of muscle contractions across the skin—the equivalent of squirming in the tickled child. But the horse does not laugh when tickled, and the child not always. The child will laugh only—and this is the crux of the matter—when it perceives tickling as a *mock attack*, a caress in mildly aggressive disguise. For the same reason, people laugh only when tickled by others, not when they tickle themselves.

Experiments at Yale University on babies under one year revealed the not very surprising fact that they laughed 15 times more often when tickled by their mothers than by strangers; and when tickled by strangers, they mostly cried. For the mock attack must be recognized as being only pretense, and with strangers one cannot be sure. Even with its own mother, there is an ever-so-slight feeling of uncertainty and apprehension, the expression of which will alternate with laughter in the baby's behaviour. It is precisely this element of tension between the tickles that is relieved in the laughter accompanying the squirm. The rule of the game is "let me be just a little frightened so that I can enjoy the relief."

Thus the tickler is impersonating an aggressor but is simultaneously known not to be one. This is probably the first situation in life that makes the infant live on two planes at once, a delectable foretaste of being tickled by the horror comic.

Humour in the visual arts and music

Humour in the visual arts reflects the same logical structures as discussed before. Its most primitive form is the distorting mirror at the fun fair, which reflects the human frame elongated into a column or compressed into the shape of a toad. It plays a practical joke on the victim, who sees the image in the mirror both as his familiar self and as a lump of plasticine that can be stretched and squeezed into any absurd form. The mirror distorts mechanically while the caricaturist does so selectively, employing the same method as the satirist—exaggerating characteristic features and simplifying the rest. Like the satirist, the caricaturist reveals the absurd in the familiar; and, like the satirist, he must overshoot his mark. His malice is rendered harmless by the knowledge that the monstrous potbellies and bowlegs he draws are not real; real deformities are not comic but arouse pity.

The artist, painting a stylized portrait, also uses the technique of selection, exaggeration, and simplification; but his attitude toward the model is usually dominated by positive empathy instead of negative malice, and the features he selects for emphasis differ accordingly. In some character studies by Leonardo da Vinci, Hogarth, or Honoré Daumier, the passions reflected are so violent, the grimaces so ferocious, that it is impossible to tell whether the works were meant as portraits or caricatures. If one feels that such distortions of the human face are not really possible, that Daumier merely *pretended* that they exist, then one is absolved from horror and pity and can laugh at his grotesques. But if one feels that this is indeed what Daumier saw in those dehumanized faces, then they are not comic but tragic.

Humour in *music* is a subject to be approached with diffidence because the language of music ultimately eludes translation into verbal concepts. All one can do is to point out some analogies: a "rude" noise, such as the blast of a trumpet inserted into a passage where it does not belong, has the effect of a practical joke; a singer or an instrument out of tune produces a similar reaction; the imitation of animal sounds, vocally or instrumentally, exploits the technique of impersonation; a nocturne by Chopin transposed into hot jazz or a simple street song performed with Wagnerian pathos is a marriage of incompatibles. These are primitive devices corresponding to the lowest levels of humour; more sophisticated are the techniques employed by Maurice Ravel in *La Valse*, a parody of the sentimental Viennese waltz, or by Zoltán Kodály in the mock-heroics of his Hungarian folk opera, *Háry János*. But in comic operas it is almost impossible to sort out how much of the comic effect is derived from the book and how much from the music; and the highest forms of musical humour, the unexpected delights of a lighthearted scherzo by Mozart, defy verbal analysis, unless it is so specialized and technical as to defeat its purpose. Although a "witty" musical passage that springs a surprise on the audience and cheats it of its expectations certainly has the emotion-relieving effect that tends

to produce laughter, a concert audience may occasionally smile but will hardly ever laugh: the emotions evoked by musical humour are of a subtler kind than those of the verbal and visual variety.

STYLES AND TECHNIQUES IN HUMOUR

The criteria that determine whether a humorous offering will be judged good, bad, or indifferent are partly a matter of period taste and personal preference and partly dependent on the style and technique of the humorist. It would seem that these criteria can be summed up under three main headings: (1) originality, (2) emphasis, and (3) economy.

Originality, emphasis, and economy

The merits of originality are self-evident; it provides the essential element of surprise, which cuts across our expectations. But true originality is not very often met either in humour or in other forms of art. One common substitute for it is to increase the tension of the audience by various techniques of suggestive emphasis. The clown's domain is the rich, coarse type of humour: he piles it on; he appeals to sadistic, sexual, scatological impulses. One of his favourite tricks is repetition of the same situation, the same key phrase. This diminishes the effect of surprise, but it has a tension-accumulating effect: emotion is easily drawn into the familiar channel—more and more liquid is being pumped into the punctured pipeline.

Emphasis on local colour and ethnic peculiarities, such as Scottish or Cockney stories, for example, is a further means to channel emotion into familiar tracks. The Scotsman or Cockney must, of course, be a caricature if the comic purpose is to be achieved. In other words, exaggeration and simplification once more appear as indispensable tools to provide emphasis.

In the higher forms of humour, however, emphasis tends to yield to the opposite kind of virtue—economy. Economy, in humour and art, does not mean mechanical brevity but implicit hints instead of explicit statements—the oblique allusion in lieu of the frontal attack. Old-fashioned cartoons, such as those featuring the British lion and the Russian bear, hammered their message in; the modern cartoon usually poses a riddle that the reader must solve by an imaginative effort in order to see the joke.

In humour, as in other forms of art, emphasis and economy are complementary techniques. The first forces the offering down the consumer's throat; the second tantalizes to whet his appetite.

RELATIONS TO ART AND SCIENCE

Earlier theories of humour, including even those of Bergson and Freud, treated it as an isolated phenomenon, without attempting to throw light on the intimate connections between the comic and the tragic, between laughter and crying, between artistic inspiration, comic inventiveness, and scientific discovery. Yet these three domains of creative activity form a continuum with no sharp boundaries between wit and ingenuity, nor between discovery and art.

It has been said that scientific discovery consists in seeing an analogy where nobody has seen one before. When, in the Song of Solomon, Solomon compared the Shulamite's neck to a tower of ivory, he saw an analogy that nobody had seen before; when William Harvey compared the heart of a fish to a mechanical pump, he did the same; and when the caricaturist draws a nose like a cucumber, he again does just that. In fact, all the logical patterns discussed above, which constitute a "grammar" of humour, can also enter the service of art or discovery, as the case may be. The pun has structural equivalents in the rhyme and in word games, which range from crossword puzzles to the deciphering of the Rosetta Stone, the key to Egyptian hieroglyphic. The confrontation between diverse codes of behaviour may yield comedy, tragedy, or new psychological insights. The dualism of mind and inert matter is exploited by the practical joker but also provides one of the eternal themes of literature: man as a marionette on strings, manipulated by gods or chromosomes. The man–beast dichotomy is reflected by Walt Disney's cartoon character Donald Duck but also in Franz Kafka's macabre tale *The Metamorphosis* (1915) and in the psychologist's experiments with rats. The caricature corresponds not only to the artist's character portrait but also to the scientist's diagrams and charts, which emphasize the relevant features and leave out the rest.

Synthesis, juxtaposition, and collision

Contemporary psychology regards the conscious and unconscious processes underlying creativity in all domains as an essentially combinative activity—the bringing together of previously separate areas of knowledge and experience. The scientist's purpose is to achieve *synthesis;* the artist aims at a *juxtaposition* of the familiar and the eternal; the humorist's game is to contrive a *collision.* And as their motivations differ, so do the emotional responses evoked by each type of creativity: discovery satisfies the exploratory drive; art induces emotional catharsis; humour arouses malice and provides a harmless outlet for it. Laughter has been described as the "Haha reaction"; the discoverer's Eureka cry as the "Aha! reaction"; and the delight of the aesthetic experience as the "Ah . . . reaction." But the transitions from one to the other are continuous: witticism blends into epigram, caricature into portrait; and whether one considers architecture, medicine, chess, or cookery, there is no clear frontier where the realm of science ends and that of art begins: the creative person is a citizen of both. Comedy and tragedy, laughter and weeping, mark the extremes of a continuous spectrum, and a comparison of the physiology of laughter and weeping yields further clues to this challenging problem, which lies, however, beyond the terms of reference of the present article.

THE HUMANIZATION OF HUMOUR

The Bushmen of the Kalahari desert of South West Africa are among the oldest and most primitive inhabitants of the earth. An anthropologist who made an exhaustive study of them provided a rare glimpse of prehistoric humour:

> On the way home we saw and shot a springbok, as there was no meat left in camp. The bullet hit the springbok in the stomach and partly eviscerated him, causing him to jump and kick before he finally died. The Bushmen thought that this was terribly funny and they laughed, slapping their thighs and kicking their heels to imitate the springbok, showing no pity at all, but then they regard animals with great detachment.

But the Bushmen remained "in good spirits, pleased with the amusement the springbok had given them." (From Elizabeth Marshall Thomas, *The Harmless People;* Alfred A. Knopf, New York, 1959.)

Obviously the Bushmen, like most primitive people, do not regard animals as sentient beings; the springbok's kicking in his agony appears to them funny because in their view the animal *pretends* to suffer pain like a human being, though it is incapable of such feelings. The ancient Greeks' attitude toward the stammering barbarian was similarly inspired by the conviction that he is not really human but only pretends to be. The ancient Hebrews' sense of humour seems to have been no less harsh: it has been pointed out that in the Old Testament there are 29 references to laughter, out of which 13 are linked with scorn, derision, mocking, and contempt and only two are born of joy.

As laughter emerged from antiquity, it was so aggressive that it has been likened to a dagger. It was in ancient Greece that the dagger was transformed into a quill, dripping with poison at first, then diluted and infused with delightfully lyrical and fanciful ingredients. The 5th century BC saw the first rise of humour into art, starting with parodies of Olympian heroics and soon reaching a peak, in some respects unsurpassed to this day, in the comedies of Aristophanes. From here onward, the evolution of humour in the Western world merges with the history of literature and art (see also COMEDY; SATIRE; and CARICATURE, CARTOON, AND COMIC STRIP).

If the overall trend was toward the humanization of

humour from primitive to sophisticated forms, there also have been ups and downs reflecting changes in political and cultural climate. George Orwell's satire of the 20th century, for example, is much more savage than that of Jonathan Swift in 18th-century England or of Voltaire in 18th-century France. If the Dark Ages produced works of humorous art, little of it has survived. And under the tyrannies of Hitler in Germany and of Stalin in the Soviet Union, humour was driven underground. Dictators fear laughter more than bombs.

Non-Western styles. About non-Western varieties of humour, the Westerner is tempted to repeat the middle-aged British matron's remark on watching Cleopatra rave and die on the stage: "How different, how very different from the home life of our dear Queen." Humour thrives only in its native climate, embedded in its native logic; when one does not know what to expect, one cannot be cheated of his expectations. Hindu humour, for instance, as exemplified by the savage pranks played on humans by the monkey-god Hanuman, strikes the Westerner as particularly cruel, perhaps because the Hindu's approach to his mythology is fundamentally alien to the Western mind. The humour of the Japanese, on the other hand, is astonishingly mild and poetical, like weak, mint-flavoured tea:

> The boss of the monkeys ordered his thousands of henchmen to get the moon reflected in the water. They all tried various means but failed and were much troubled. One of the monkeys at last got the moon in the water and respectfully offered it to the boss, saying "This is what you asked for." The boss was delighted and praised him, saying, "What an exploit! You have distinguished yourself!" The monkey then asked, "By the way, master, what are you going to do with this?" "Well, yes . . . I didn't think of that." (From *Karukuchi Ukibyotan*, 1751; in R.H. Blyth, *Japanese Humour*, 1957.)

The next dates from about a century later:

> There was once a man who was always bewailing his lack of money to buy saké (rice wine) with. His wife, feeling sorry for him, dutifully cut off some of her hair and sold it to the hairdresser's for twenty-four mon, and bought her husband some saké. "Where on earth did you get this from?" "I sold my hair and bought it." "You did such a thing for me?" The wretched man shed tears, and fondling his wife's remaining hair said, "Yes, and there's another good half-bottle of saké here!" (From *Chanoko-mochi*, 1856; in Blyth.)

The combination of maudlin tears and brazen selfishness, and the crazy logic of equating the wife's coiffure with a liquid measure of saké, show the familiar Western pattern of the clash of incompatibles, even though transplanted into another culture.

Humour in the contemporary world. Humour today seems to be dominated by two main factors: the influence of the mass media and the crisis of values affecting a culture in rapid and violent transition. The former tends toward the commercialized manufacture of laughter by popular comedians and gags produced by conveyor-belt methods; the latter toward a sophisticated form of black humour larded with sick jokes, sadism, and sex.

Fashions, however, always run their course; perhaps the next one will delight in variations on the theme of the monkey boss who, having gained possession of the moon, does not know what to do with it. The only certainty regarding the humour of the future is contained in Dr. Samuel Johnson's dictum: "Sir, men have been wise in many different modes, but they have always laughed in the same way."

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(A.Ko.)

Hunan

Hunan (Hu-nan in Pin-yin romanization) is one of the 21 provinces, or *sheng*, of the People's Republic of China. It is a landlocked province covering an area of 81,274 square miles (210,500 square kilometres). A major rice-producing area, Hunan is situated to the south of the Yangtze River Basin. It is bounded by the provinces of Hupeh to the north, Kiangsi to the east, and Kwangtung to the southeast, by the Kwangsi Chuang Autonomous Region to the southwest, and by the provinces of Kweichow and Szechwan to the west. The name Hunan is formed from the Chinese words *hu* ("lake") and *nan* ("south"), meaning the land to the south of the lakes from Sha-shih, Hupeh, to Chiu-chiang, Kiangsi. Hunan's population is estimated at 38,000,000. The capital and most important city of the province is Ch'ang-sha, situated in the northeast, on the banks of the Hsiang Chiang (Siang Kiang).

Although mining and industry have been developed since 1949, Hunan's economy remains basically agricultural. It ranks third among China's provinces in rice production; two crops a year are planted in the south. From the earlier decades of the 20th century, Hunan was a centre of revolutionary activity; it was the birthplace of many Chinese Communist leaders, including Mao Tse-tung, revolutionist and founder of the Chinese Communist state, and Liu Shao-ch'i, theoretician and former chairman of the People's Republic. (For an associated physical feature, see YANGTZE RIVER; for historical background, see CHINA, HISTORY OF.)

History. From 350 to 221 BC, Hunan formed the southernmost extension of the state of Ch'u, which nominally was ruled by the Chou dynasty. From 221 to 206 BC, Hunan was ruled by the Ch'in dynasty, which subdued contending feudal states and joined them into the first unified state of China, of which Hunan formed part of the central area. Most of Hunan at this time was covered with dense primeval forest that was sparsely inhabited by tribes who engaged in hunting, fishing, and clearing land by burning or cutting for temporary cultivation. These tribes also supplied the copper and tin that was used in the north for making bronze.

Early migrations

After the downfall of the Ch'in dynasty, the area became quickly incorporated into the Chinese Empire ruled by the Han dynasty from 206 BC to AD 220. During this period persistent waves of migrant Han-jen (northern Chinese) occupied the land, and the indigenous tribesmen (Miao, T'uchia, T'ung, and Yao) were pushed west and southwest into the hills, which they still occupy. By the end of the Chin dynasty in AD 317, the Tung-t'ing flood plain to the north and the Hsiang Chiang (Hsiang River) Valley in the east were relatively well populated. Chinese migration from the north continued under subsequent dynasties, with migrants fleeing first from Mongol and then from Manchu invasions. Those who went further south, crossing the Nan Ling (Nan Mountains) in the southern part of the province to enter Kwangtung, have since considered themselves T'ang Jen, or southern Chinese, but the Hunanese have remained Han-jen in both culture and speech.

Population pressures on the land increased markedly in the 19th century during the latter part of the Ch'ing dynasty (1644 to 1911), leading to peasant unrest, particularly among the non-Chinese tribes. When the Taiping Rebellion broke out in Kwangsi in 1850, it spread northward into Hunan along the Hsiang Chiang Valley. Hu-

nan, together with other provinces on the lower Yangtze River Basin, was desolated in the subsequent fighting, although the city of Ch'ang-sha withstood a Taiping siege in the 1850s. It was a Hunanese, Tseng Kuo-fan, who ultimately crushed the rebellion.

Hunan was not opened to foreign trade until 1904, following the conclusion of the Treaty of Shanghai between China and Japan. A foreign settlement was established at Ch'ang-sha; British and Japanese firms built warehouses there. The first uprisings against Yüan Shih-k'ai's attempted regency over the Chinese Empire occurred in the province in 1910, although the more widespread revolution that finally overthrew the tottering Manchu dynasty and established the Republic of China did not occur until the following year. Thereafter, Hunan remained in a state of unrest from which it had little respite until 1949, when the People's Republic of China was established. Mao Tse-tung, who was born in Shao-shan-ch'ung, near the border with Kiangsi, was largely responsible for encouraging the peasants and miners to make the abortive Autumn Harvest Uprising of 1927. He subsequently held the Communist forces together in Chin-kang Shan, where they withstood repeated attacks by the forces of Chiang Kai-shek, the Chinese Nationalist leader. In 1934 Mao set out from the Hunan-Kiangsi border region, leading his forces westward on what later came to be known as the Long March.

The years of unrest (1910–49)

During the Sino–Japanese War (1937 to 1945), Hunan was the scene of bitter fighting between 1939 and 1941, when, after the fall of Hunan to the Japanese, the Chinese general Hsueh Yueh successfully defended Ch'ang-sha against the Japanese invaders until 1944. Between 1946 and 1949 the province was relatively peaceful. In 1949, despite damage to bridges and communications, the province experienced comparatively little destruction when the Chinese Nationalist forces retreated rapidly southward before the Chinese Communist forces.

The landscape. *Relief.* More than one-quarter of the terrain lies at a height of more than 1,650 feet, and much of it is well over 3,000 feet above sea level. The highlands in the west run from northeast to southwest, forming the eastward edge of the Kweichow Plateau, whose extension, the Hsüeh-feng Shan (Hsüeh-feng Mountains) lie in the heart of the province. These mountains are composed mainly of hard, metamorphic rocks (*i.e.*, rocks that have been structurally changed as a result of heat and pressure) consisting of slate, quartzite, and sandstone; they are deeply incised by river valleys.

The Nan Ling in the south run from east to west at altitudes of between 500 and 1,650 feet, forming a broad mountain border between Hunan, Kwangtung Province, and Kwangsi Chuang Autonomous Region. They are largely dome shaped and granitic; although in lower-lying areas, limestone and red clay are found. In the east, the mountain ranges of Chu-kuang Shan and Wu-kung Shan form the border with Kiangsi; they generally run from northeast to southwest. The Chukuang Shan, in the extreme southeast of the province, rise to a height of 6,600 feet.

The uplands of the west, south, and east fall steadily in altitude toward the plain of the Tung-t'ing Hu (Tung-t'ing Lake) in the north, which is contiguous to the Hupeh plain and forms part of the flood plain of the Yangtze River. The part of the plain that lies within the borders of Hunan has an area of 3,800 square miles; it has been formed by the silt carried down from the mountains by the Yangtze and its right-bank tributaries. The Tung-t'ing Hu is a broad and shallow lake, consisting of the remnants of a former inland sea, which once filled the entire Yangtze Basin. Its area varies considerably between summer and winter; it acts as a filter and regulator for waters draining into the Yangtze.

Tung-t'ing Lake

Drainage. Hunan's entire river system drains into the Tung-t'ing Hu, with the exception of the Lin Shui (Lin Stream), which divides into two parts, with one distributary draining directly into the Yangtze River, and the other draining into the Tung-t'ing Hu. The western highlands are drained by the Yüan, the Tzu, and the Li rivers. The Yüan and the Tzu in their upper courses are torrents, fast-flowing in summer, that run through deep gorges, broadening out to wider valleys in their lower courses. Hunan's largest river, the Hsiang Chiang, rises in the heart of the Nan Ling, as do its tributaries the Ch'un-ling Shui and the Lei Shui. Many smaller rivers that rise in the mountains along the eastern border flow westward to join the Hsiang in its northward course.

Climate. The north generally experiences more extreme weather conditions, both in summer and in winter, than does the south. In winter, occasional waves of cold air from a high-pressure zone centred over Mongolia sweep southward, injuring tea bushes and fruit trees in northern Hunan. The average minimum temperature for December and January is 43° F (6° C). Summers are long and humid, and temperatures are slightly higher in the north. The average maximum temperature in July and August is 86° F (30° C). The north has an average of 260 frostless days a year, while in the south the average is 300 days. Rainfall is ample, with the maximum precipitation occurring between spring and summer, at which season the humidity is highest. The total annual rainfall of 56 inches (1,602 millimetres) decreases from south to north. Hunan lies in the path of cyclones that pass from west to east along the Yangtze Basin in summer, bringing with them at times long periods of heavy rain, resulting in extensive flooding of low-lying lands around the Tung-t'ing Hu.

Soils. The soils of the province are largely pedalferic (rich in alumina and iron), and are mainly lateritic (leached, iron-bearing) yellow earths or Quaternary red clays (*i.e.*, formed within the past 2,500,000 years). In the hilly regions of central and southern Hunan, the soils are for the most part lateritic heavy clays that are strongly acidic and poor in organic material. These regions are subject to soil erosion, especially when deforestation has occurred and plant cover is poor. The alluvial soils of the northern plains are less acidic and form a neutral zone between the pedalfers (iron and alumina-rich soils) of the south and the pedocals (arid or semiarid soils, enriched with lime) that occur further north; they are used for growing rice.

Vegetation and animal life. The natural vegetation of Hunan was originally dense deciduous and coniferous forest. Over the centuries, as the population has increased, all the lowlands and much of the highlands have been cleared to make way for cultivation. Despite this vast deforestation, however, large stands of pine, cedar, bamboo, and camphor are found in the western highlands. Other important trees and shrubs include tung (from which tung oil is obtained), tea (from which tea seed oil is obtained), and the liquidambar. Bamboo groves planted along the roadsides are characteristic of Hunan and provide a source of supply for the province's craft industries. As elsewhere in central and southern China, groves of bamboo, camphor, and cedar are usually found around villages, contributing greatly to the charm of the countryside.

Tree species

During the early decades of the 20th century, heavy and wasteful cutting of Hunan's timber reserves occurred. In 1954 attention was focussed on the problem of deforestation in the province, and at that time it was estimated that commercially accessible timber reserves amounted to some 350,000,000 cubic feet. Since then, stricter control of cutting has been enforced, and some reforestation carried out. Experiments in sowing pine seed by air, as well as in spraying insecticide from the air, were tried over wide areas in the 1960s.

Wild life on the densely settled plains has largely disappeared. Rodents, such as rats, rabbits, and hares, abound, as also do snakes, scorpions, and centipedes. There is abundant bird life, including pheasant, wild ducks, blue jays, and golden orioles. Some deer are found in the wooded hills of the plains. The mountains to the west abound in gibbons and deer. There are also some tigers and wild pigs.

Population. Hunan covers 2 percent of China's land area, and contains about 5 percent of its population. In

China's first scientific census in 1953, the province's inhabitants numbered about 33,000,000, and in 1970 they were estimated to total 38,000,000. The average population density is 469 persons per square mile, but in some of the more fertile districts it rises to between 1,000 and 1,600 persons per square mile. In the more remote mountain regions density drops to between 130 and 260 persons per square mile. The demarcation between rural and urban population is not clear. Agricultural communities of 2,000 people or less are classed as rural, but mining communities of the same size are classed as urban. There is no doubt, however, that the overwhelming majority of the population is rural.

Ethnic composition and distribution. The population is primarily concentrated on the Tung-t'ing Plain and in the main river valleys. Over 97 percent of it is Han-jen (northern Chinese).

The minority tribes

In addition, there are some 900,000 members of tribes living in the western highlands. These minority peoples consist mainly of four tribes, the Miao, numbering about 370,000; the T'uchia, 390,000; the T'ung, 124,000; and the Yao, 70,000. The way of life and economy of the Miao and the T'uchia are similar, and much intermarriage has occurred between them. The two tribes were not differentiated in the 1953 census, when they were officially referred to as the Miao and reported to number about 750,000. They live in the southwest, where their economy is based on the cultivation of terraced fields in the foothills and narrow valleys. They grow corn on mountain slopes and elsewhere cultivate tung, tea, and galla nuts, from each of which they express oil. Each tribe has its own distinctive handicrafts, notably embroidery and cross-stitch work; they engage little in trade.

The T'ung inhabit their own autonomous counties (*hsien*) in the extreme southwest, with their centres at T'ung-tao and Hsin-huang. Their language, economy, and way of life are similar to those of the Han-jen; their cultural standards are higher than those of the other minority peoples. The Yao are widely scattered over the mountainous regions of the south and west. They practice dry farming (a mode of farming depending largely upon methods of tillage that render the soil more receptive to moisture and reduce evaporation) and are known for their expertise in cedar-tree culture. Much of their livelihood comes from forestry; the lumber they cut is floated down the tributaries of the Tzu Shui and the Lien Shui.

Linguistic patterns. The Han-jen of the province speak a dialect—Hunanese—that approximates quite closely to Mandarin. Radio broadcasting has had the effect of slowly reducing differences in local dialects, which can be considerable. The written language is the same in Hunan as in Peking. The minority languages were unwritten until missionaries devised scripts for some of them, such as the Samuel Pollard script for the Miao language. Since 1949 these scripts have been revised, extended, or replaced by a phonetic script, based on the Latin alphabet, that is akin to the Pin-yin script adopted for the Chinese (Han) language. There is growing literacy among both the Miao and T'ung peoples.

Religious affiliations. The interweaving of Confucianism, Buddhism, and Taoism, as well as Islām and Christianity, are most complicated. Since 1949, the growth of Maoism has infiltrated and directed life in all its aspects. The extent of de facto religious freedom and the number of open temples and churches varies from district to district.

Patterns of urban and rural settlement. Villages are usually small, and it is not unusual for an entire village to belong to one extended family, from which the settlement takes its name. Most of the farms on the plain south of the Tung-t'ing Hu are built on islands of Yangtze alluvium, protected by dikes from summer flooding.

The cities

Urban population was estimated at only 2,600,000 in 1957. There are 30 cities with populations of between 10,000 and 30,000; these are located mainly on the plains and function as marketing centres for local produce. In addition, there are ten cities with populations between 30,000 and 100,000 and five cities of 100,000 or more. Ch'ang-sha (population 700,000), Hsiang-t'an (250,000), and Chu-chou (190,000) lie close together at the intersection of road, rail, and river communications along the Hsiang Chiang. They are growing rapidly and are already coming to form a single vast conurbation. Other large cities include Heng-yang, the economic and communications centre of southern Hunan, and Ch'ang-te, the marketing centre for the Yüan Chiang Basin.

Administration. From 1949 to 1954 Hunan was part of the South Central Administrative Area, which extended from Hupeh in the north to Kwangtung and Kwangsi in the south. In 1954 provincial (*sheng*) government was re-established throughout the country. Since then the province's administrative structure has gone through several changes. In 1968 the administrative divisions were two municipalities (*shih*), nine special districts (*chuan-ch'ü*), and one autonomous district (*tzu-chih-chou*). These were further divided into five municipalities, 84 counties (*hsien*), and four autonomous counties (*tzu-chih-hsien*).

In 1958 the establishment of communes led to considerable change in the pattern of local government. Each commune, grouping together a number of cooperatives into a single unit, assumed the functions of *ch'ü*, rural districts, and towns, and became responsible for the political, economic, and cultural life of its enlarged area, including such matters as ideology, agriculture, industry, education, public health, local militia, and recreation. There was much variation in practice from commune to commune. The outbreak of the Cultural Revolution in 1966, when so much of the Chinese Communist Party authority was challenged, once again threw local government into confusion. It was not until 1970 that the position became clear, by which time Revolutionary Committees had been established for all provinces. One of the earliest of these was Hunan's, appointed in 1968. It consists of 14 members who are appointed by provincial groups and approved by Peking; eight are members of the People's Liberation Army (PLA), four are revolutionary cadres (members of the party élite) and two are representatives of the revolutionary masses (those who are politically correct, not only party members). From this it will be seen that there is a decided military predominance in Hunan. The communes have lost many of their former functions.

The Revolutionary Committee

Social conditions. *Education.* Before the revolution, Western learning was largely acquired through Christian missionary schools, and some 90 percent of the population remained illiterate. Since the establishment of the People's Republic in 1949, a countrywide literacy drive has been pursued with vigour and enthusiasm and a large measure of success. In formal education, political (ideological) correctness is given pre-eminence at all levels. Since the formation in 1958 of the communes, which were made responsible for primary and middle education, and particularly since the Cultural Revolution and the formation of part-work–part-study schools, great emphasis has been placed on the teaching of self-reliance and technical skills. In the mid-1960s, 30,000 commune members in Hunan were trained as pump operators, electricians, and mechanics, capable of working in the fields and tending machines. Ch'ang-sha has retained its historic role as the province's cultural and educational centre and is the focus of higher education in the province. It is the location of technical institutes, teacher-training colleges, and institutes for minorities.

Health. Emphasis is laid on preventive medicine. After 1949, doctors' training was reduced from six to three years and public health teams were sent into the country to vaccinate and inoculate and to advise on and supervise public hygiene. Debilitating diseases such as malaria and schistosomiasis—a disease of the blood and tissues that is spread by larvae in the droppings of animals in the rice fields—have been attacked. Dermatitis of the hands and feet, common among rice farmers, is receiving special attention. While these teams of "barefoot" doctors are increasing, doctors are once more receiving the full six years' training; full use is made of traditional Chinese medicine. By 1964 it was claimed that every county