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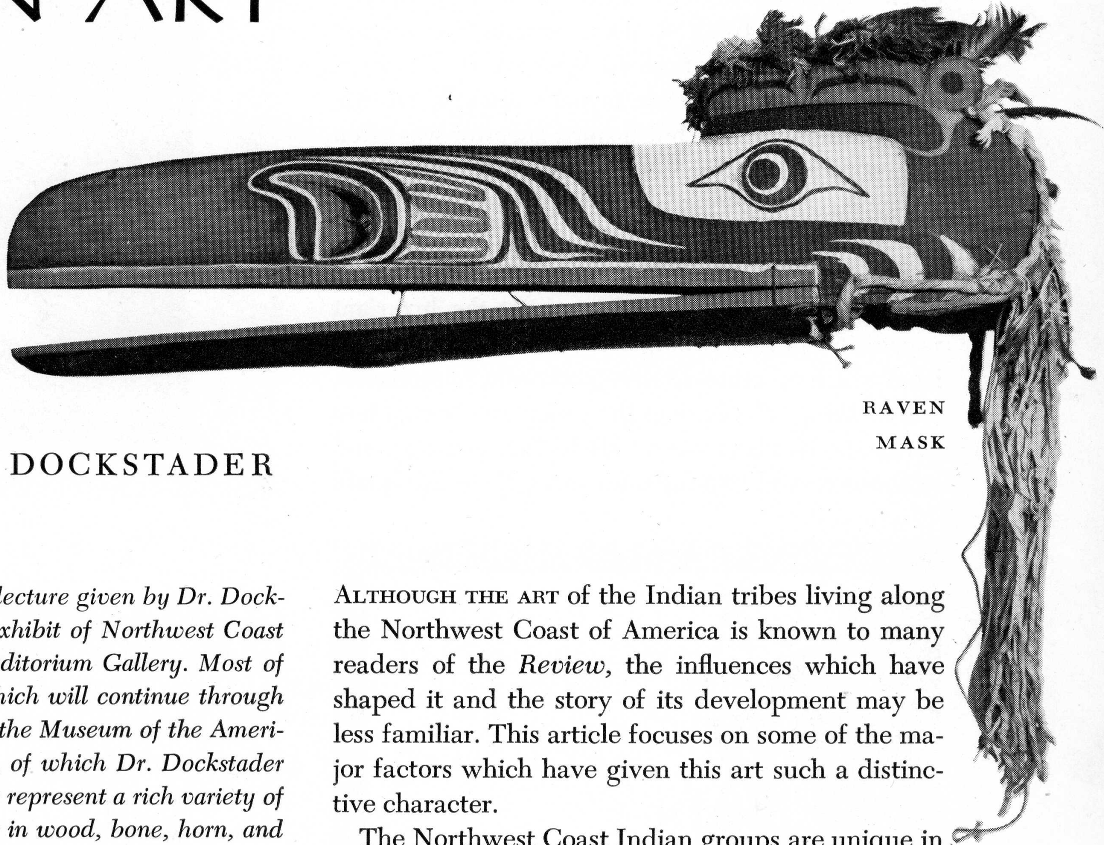
NORTHWEST COAST INDIAN ART



RAVEN MASK

BY FREDERICK J. DOCKSTADER

This article is adapted from a lecture given by Dr. Dockstader at the opening of the exhibit of Northwest Coast Indian Art in the Caspary Auditorium Gallery. Most of the objects in the display – which will continue through June 1966 – are on loan from the Museum of the American Indian, Heye Foundation, of which Dr. Dockstader is director. These masterpieces represent a rich variety of characteristic sculptural forms in wood, bone, horn, and stone. Some of them have rarely been displayed outside the Museum, which houses the largest collection of American Indian art in the world. Dr. Dockstader is himself a practicing silversmith, having been introduced to the craft during his years as a youth on Navajo and Hopi reservations in the Southwest; several art museums have since awarded him highest honors for his work. He is also a member of the Indian Arts and Crafts Board of the U.S. Department of Interior, and author of a number of books including "Indian Art in America," 1960, "Indian Art in Middle America," 1963, and a study of Hopi religious life, "The Kachina and the White Man," 1954. Dr. Dockstader – a strong advocate of increased recognition of Indian peoples – also compiled and edited the pioneering work, "The American Indian in Graduate Studies."

ALTHOUGH THE ART of the Indian tribes living along the Northwest Coast of America is known to many readers of the *Review*, the influences which have shaped it and the story of its development may be less familiar. This article focuses on some of the major factors which have given this art such a distinctive character.

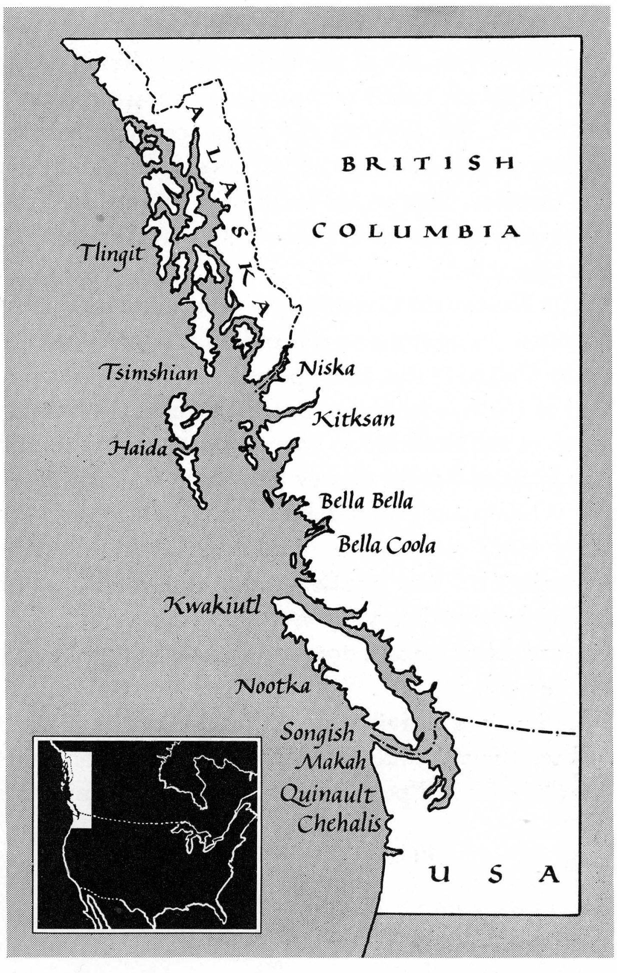
The Northwest Coast Indian groups are unique in America. In contrast to the Indian tribes of the rest of the United States, these peoples enjoyed a long period of relative isolation. But their culture – lacking much of the hardship so common to the more southerly Indians – more closely paralleled the culture of the White man. The Indians of the Northwest Coast were more capitalistic, more industrialized, more realistic, and less mystical than almost any other Indian group; thus their system of values and divisions of labor were more readily understood by the White man.

Living in a heavily forested mountainous region, whose rugged interior resisted penetration, the Northwest Coast people built their villages along the

shore in a thin line rarely extending inland more than a few hundred yards. The sloping, rocky shore provided space for drawing large dugout canoes out of the water. The numerous small islands dotting the shoreline furnished excellent fishing. Large dwellings housing several families were made of planks from the huge cedar and spruce trees, split with wedges and adzed into flat siding. Two or three rows of these structures constituted village "blocks"; up to twenty houses formed a town with a population of 250-300. In front of many houses were great carved totem poles whose designs served as a visual introduction to the house owner's lineage, wealth, and social position. While a spirit ancestor was often incorporated into the design, these poles were social rather than religious in content and were in no sense shrines for worship.

The gray mists and abundant rainfall give an air of somberness to the Northwest, yet the luxuriant vegetation provided ample food and the materials from which to create dwellings, utensils, implements, and clothing. The bark of the cedar was beaten into garments, its fibers were twisted into cordage, and its limbs carved into hafts for tools. Even fish hooks for catching salmon and halibut were fashioned from wood parts tied with fiber and finished with bone, ivory, or metal barbs.

WOODEN STORAGE BOX



The mountains which confined the Indian to the shore contributed game, fruit, and medicinal herbs, but food came primarily from the sea. Every possible form of water life was eaten, including shellfish, octopus, seal, walrus, salmon, and whale. The variety was so abundant that foraging for food was a problem only in the rare years when the schools of fish temporarily disappeared. Great wooden canoes, some fifty feet in length with provision for accommodating a dozen men during long periods at sea, regularly went three and four hundred miles off shore in search of whales. War canoes often carried as many as forty or fifty armed men. It is not surprising that the tiny vessels of the first White explorers seemed puny indeed to the hardy Northwest Coast Indian whalers.

Comparatively little use was made of stone. Jade, valued for its qualities as a tool, was fashioned into chisels, ax blades, and adzes; shale was carved occa-

CEREMONIAL RATTLE

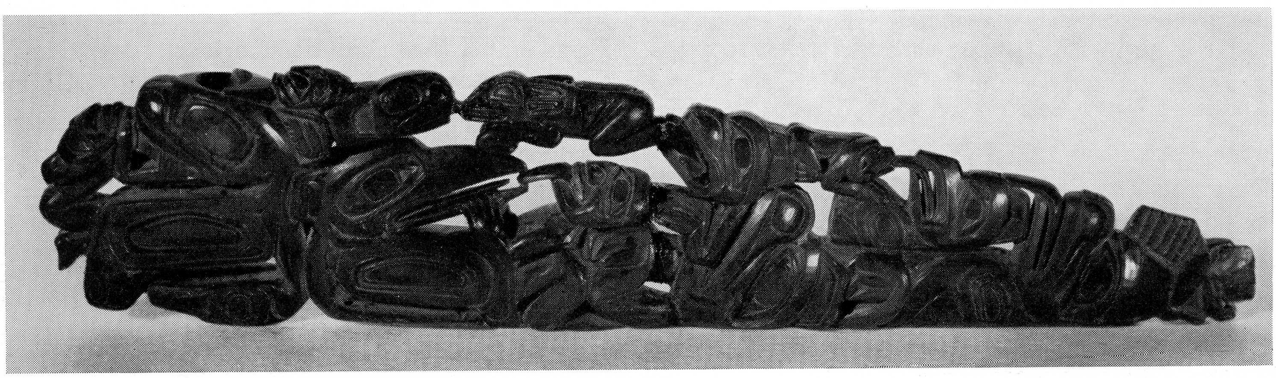
sionally; but by and large the readily obtained and easily worked wood precluded any need to resort to stone. However, surviving stone objects such as clubs, mauls, and mortars demonstrate the Indian's complete mastery of even the hardest granite; the cutting and grinding of such stone objects was well developed before the White man came, as well as in more recent times.

Tribal groups

The tribal composition of this region is mixed, yet more cohesive than in many other North American regions. Anthropologists divide the Northwest Coast Indians into three major classifications based largely upon location and language, since the cultural composition is essentially similar.

First, the more northerly group includes the Tlingit and Haida, who speak an Athapascan branch of the Na-Dené language, and bordering them (and speaking a related Penutian tongue), the Tsimshian, the Kitksan, and Niska. Second, the central, Wakashan, language group in Vancouver and British Columbia includes the Kwakiutl and the Bella Bella, and (distantly related and slightly to the south) the Nootka and Makah Indians. Third, farther south, extending to the Columbia River, the great Salish-speaking group includes many tribes such as Bella Coola, Lillooet, Chehalis, and Quinault.

The maximum population of the Northwest Coast tribes was probably around 75,000 persons before the coming of the White man; disease, warfare, and other forces have reduced this number to about 25,000 today (according to A. L. Kroeber in "Cultural and Natural Areas of Native North America," *University of California Publications in American Archeology and Ethnology, No. 38*, 1939, p. 135).



SLATE PIPE

This was a surprisingly short-lived culture, enjoying a Golden Age of approximately one hundred years from 1775 to 1875. The explorers Bering and Cherikof in 1741 found a highly sophisticated civilization which thrived under the influence of new wealth (from fur trading) and communication with the outside world. It reached a peak and then collapsed entirely under pressures to which the indigenous social structure could not adjust rapidly enough: pressure from the "culture exterminators" — government and military personnel, missionaries, and traders — none of whom stay, but exploit and then move on.

Indeed, the Northwest Coast history presents in microcosm the entire record of Indian-White relations: a given area with an established Indian culture makes maximum use of its environment for local needs; the Whites with their alien culture intrude; the Indians hospitably receive the newcomers for a relatively brief period, during which the Indian culture expands and flourishes, stimulated largely by imported materials; the Indians are disillusioned and confused by their loss of established values and the unsatisfactory or little-understood substitutes — the new religion, for example, which forced abandonment of old forms without meaningfully introducing new ones; disease and/or warfare reduce the populations and political strength; and, lastly, the Indians exist only marginally and in isolation.

CEDAR-BARK MATTING

The great period of this culture is represented by sculpture surprisingly rich in design and so ornately decorated as to appear almost nonfunctional, such as the SLATE PIPE, *page 3*. Beauty and display did, however, have a specific function: the more decorated the object, the more valuable it became; and the greater a person's material wealth and his proportionate ability to be wasteful and extravagant, the greater his prestige. Even WOODEN STORAGE BOXES for household objects, *page 2*, provided surfaces for carving, inlaying, and painting; CEREMONIAL RATTLES, *page 3*, became stylized art forms; CEDAR-BARK MATTING, *at right*, used for garments, resting mats, screens, and the like, provided a surface for the artist. The design frequently became a record, as in huge totem poles, or an advertisement of wealth, as in the COPPER TINNEH, *page 5*, or a mode of identification, as in the HEADDRESS, *page 5*. The dramatic CEREMONIAL DANCE SHIRT, *page 7*, functional as a wrap, lent prestige and indicated family relationship when decorated with a shell design.

Only occasionally do their carvings embody qualities considered sacred. The CANOE FIGUREHEAD, *page 7*, was believed by seamen to provide supernatural protection to their vessel. A MASK, *page 7*, might conjure up benevolent or menacing beings, but more often displayed individual wealth, prestige, or politico-social prominence. The Northwest Coast religious credo is not readily assayed; it lacks much of the immediacy and pervasive qualities found in many other Indian regions. For example, the Indians of the Northwest attributed spirits to all living things; the Indians of the Southwest, to inanimate things as well. The Northwest Coast Indian was more like the Sunday churchgoer whose religious impulses are submerged during the week. His religion was less elaborately formalized and generally lacked the ceremonial pageantry of the Southwestern tribes. Improvised and barbaric, his observances, however, had a wealth of religious drama, in-

cluding great masks and colorful costumes. A closer parallel to the observances of the Northwest Indian might even be the traditional pomp of English political life, or military protocol, or fraternal organization parades.

In the animistic religion of the Northwest Coast Indian, all living things — human beings, plants, and animals — had spirits with supernatural powers to help or injure. Shamans could summon these spirits and thus control the destinies of a person, and could also use beautifully carved SOUL CATCHERS, *page 7*, to imprison the spirits of the unwary. Once captured, the victim was able to escape only by means of counter-charms or payments of stipulated fees. These latter were not always money — servitude was frequently demanded.

The huge food catches required special attention. The lack of refrigeration coupled with small village populations made it imperative to consume food promptly, since as many as a dozen walruses might be brought in at one time. When a whale was captured, for example, it was customary to call all one's relatives together for a great feast, at which enormous FOOD DISHES, *page 7*, became useful. On particularly important occasions rival leaders were invited and a *potlatch* would be given. A potlatch was basically a ceremonial challenge between chieftains at which large amounts of food, goods, and intrinsically valuable possessions were given away in a grandiose gesture calculated to enhance the donor's prestige. Such a demonstration proved the wealth of the giver and gave him a certain edge over his rival. The recipient was obliged to return the gift with interest, increasing the debt. This retaliatory teeter-totter went on until it eventually became too onerous for one or the other, and was settled by warfare, suicide, or bankruptcy. Sometimes a whole village would be potlatched into slavery because of this murderous game of swap.

This pseudo-disdainful attitude towards possessions resulted in tragic waste. Many thousands of objects of the sort illustrated in this article were thrown into the fire or the sea, or deliberately smashed — in order to demonstrate one's scorn for wealth. It must be admitted that this scorn was occasionally tempered by canny provision for the return of the articles. A huge COPPER TINNEH, *page 5*, which

COPPER
TINNEH

HEADDRESS

SHAMAN'S HEADDRESS

represented the ultimate in wealth, was often thrown into shallow water where it could later be retrieved; or, if broken into pieces by stone clubs, riveted together. Our museum has two such repaired examples in its collection. Today Government fiat has halted the waste of material products, but the urge to achieve prestige through the grand gesture is not dead: at a Tlingit ceremony held this year I witnessed a presentation of valued objects under circumstances exactly similar to those a century earlier. During a welcoming ceremony at Sitka we were entertained by a group of local Indian men and women. One elderly clan chieftain was so carried away that he got up and spontaneously presented his carved speaker's staff to one of the visitors. This was not at all called for under the circumstances, but he felt impelled by the ritual to make an impressive gesture.

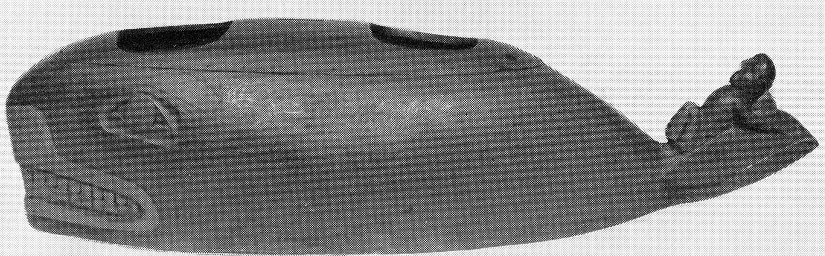
This was truly a capitalistic world, with the main emphasis on material possessions, individual ownership, and achievement of status through the acquisition of wealth. Artists were hired as professional retainers to design, paint, and carve objects which enhanced their patron's prestige. The entire village supported its leader in his craze for acquisition and display, since a villager's own prestige was dependent on the glory of his chieftain. Also, since the economy was supported by slavery and since the necessities of life were easily obtained, wealth could be devoted primarily to the acquisition of valuable objects. This wealth was primarily gained from trading furs; records show that as many as 35,000 otter furs were exported in a single shipment. Under such conditions it is not surprising to find sculptors par excellence; their talent was the result of long practice, and their wealthy patrons were ready to pay handsomely for long hours of painstaking craftsmanship. True, the creators were individual artists and, as today, not all of them carved with equal skill. A common fault among collectors is to accept Indian art uncritically — just because it is Indian. The really fine artistry was then, as now, in the hands of the relatively few whose talent and technical skill placed them above their fellows, enabling them to create objects of outstanding esthetic quality. Although the Indians of the Southwest used appliqué in textiles and metalwork, applied art is less often seen in the Northwest, perhaps because the lighting was not generally as good. More powerful forms were developed to take advantage of deep shadows. The delicacy of shallow carving and sand-painted pastels, so effective in the ambient sunlight of the Southwest, would have been less effective in the Northwest.

The variety of creative expression was almost unlimited. Wood was carved, painted, and inlaid (frequently with abalone, a univalve found in California and traded north), as shown in many of these illustrations, such as the HEADDRESS, *at left.* Line and color were as important as form; the Kwakiutl people made use of stronger color than most other groups, as in the RAVEN MASK, *page 1,* but many tribes used red, blue, green, brown, white, and black extensively. The ability to fit involved forms into restricted space is highly developed, as demonstrated by totem poles and Haida argillite carvings. The modern world discovered this art in terms of its abstract qualities—the X-ray design of the KILLER WHALE, *page 8,*

SOUL CATCHER

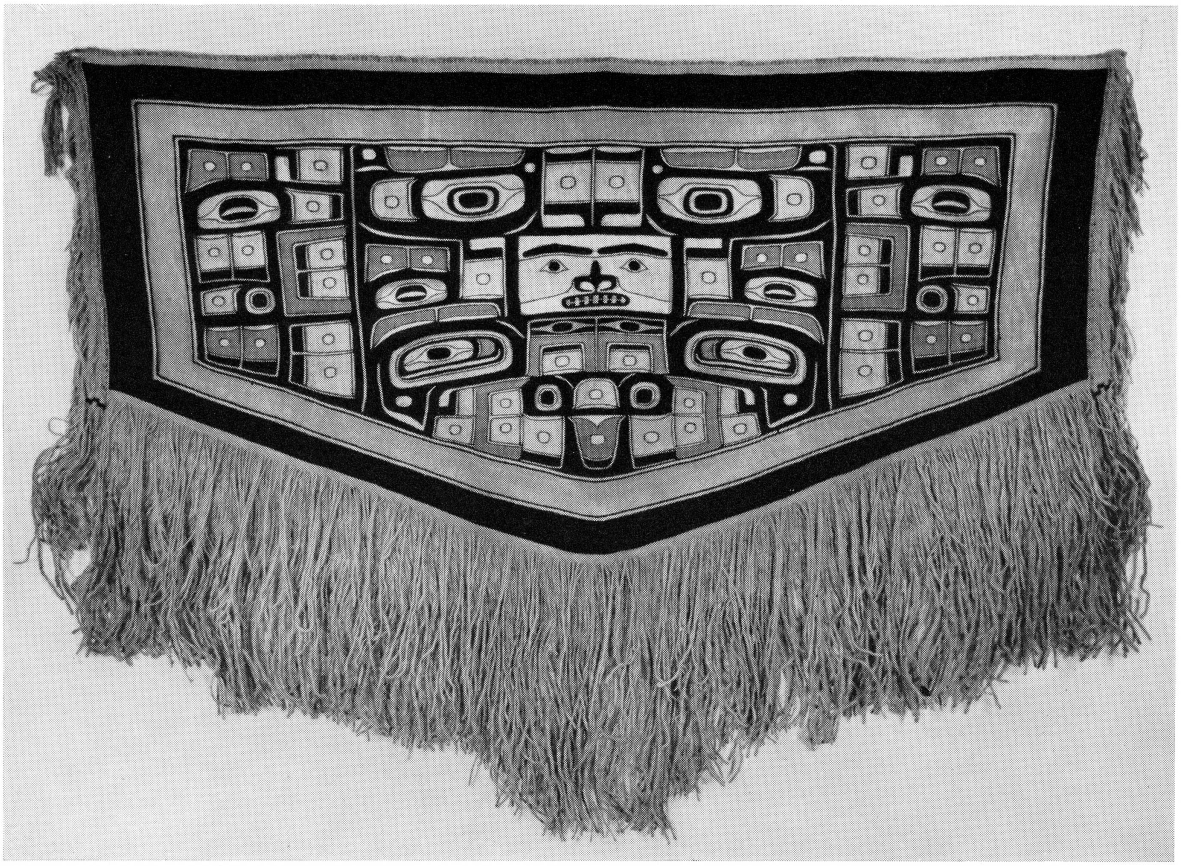
CEREMONIAL
DANCE SHIRT

CANOE
FIGUREHEAD



FOOD DISH

SPIRIT
MASK



KILLER WHALE MOTIF, CHILKAT CEREMONIAL BLANKET

portrays all the composite motifs making up the animal—and in color, dominance of design, balance, and esthetic force this art harmonizes well with almost any contemporary setting.

The world of the Northwest Coast Indian changed abruptly with the coming of the White man. There had been earlier contacts with Asia, probably through Japanese sea traders—note the similarity of some of the Northwest Indian masks to the Japanese Noh masks and the spectacular use of tiny carved charms so like the ivory netsuke of the Japanese. Later came the whaling vessels, but with the recurring visits of the fur trader and the explorer, and the availability of an outside market, much of the carving became "tourist fare."

At the outset this term was not necessarily pejorative. Craftsmanship declined, however, as the tradition began to yield to economic pressures, and by 1900 the great period of the arts had disappeared. Few objects made after that date show the strength and beauty typical of the earlier works. Hastily carved "junk shop totem poles" were carved in quantity, with shallow designs scratched in quickly, and the early rich forms became hardly recognizable.

Today a small number of truly creative artists are emerging. The Indian Arts and Crafts Board (an agency of the Department of Interior) is active in the Northwest Coast region, and together with local organizations sponsors facilities designed to assist the native artist—for example, the new arts and crafts center at Sitka National Monument. Also, museums help to familiarize the public with good work. The most important collections of Northwest Coast art today are in the American Museum of Natural History, New York; the Chicago Museum of Natural History; the Museum of the American Indian, Heye Foundation, New York; the United States National Museum, Washington; the University Museum, Philadelphia; the National Museum, Ottawa, Canada; the Royal Ontario Museum; the Provincial Museum, Victoria; and the Anthropological Museum, Vancouver.

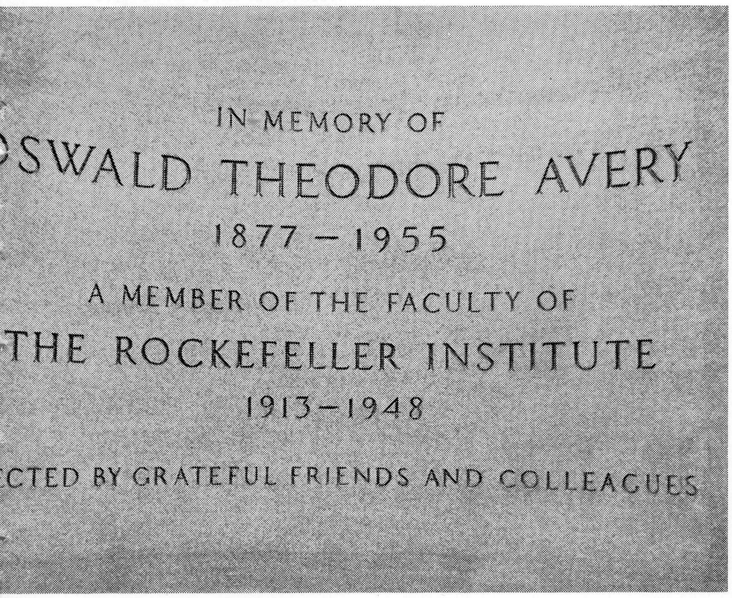
OSWALD T. AVERY

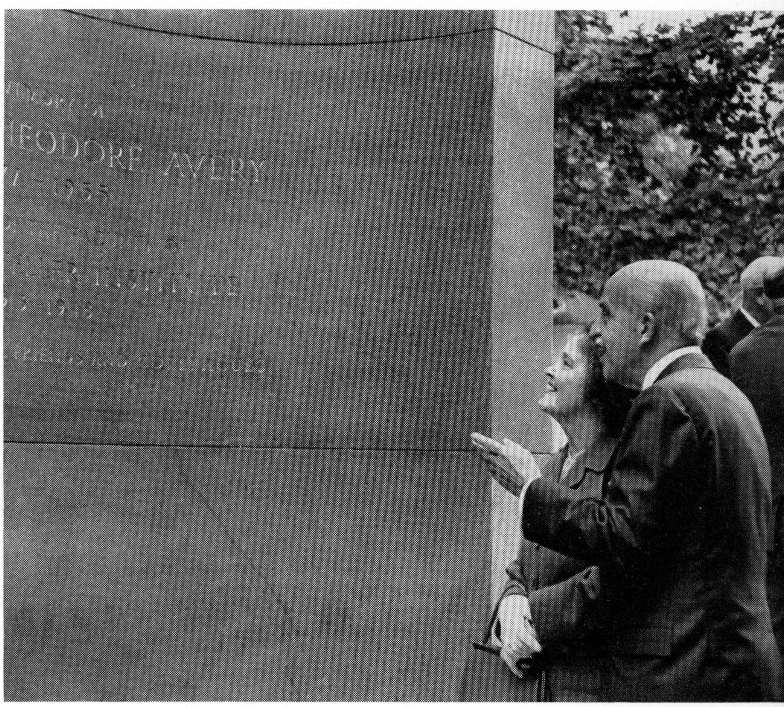
AND HIS SCIENTIFIC LEGACY

FRIENDS AND ADMIRERS of Oswald T. Avery gathered from many parts of the country on Wednesday, September 29, for an afternoon of reminiscence and appreciation of a bacteriologist who became one of the great pioneers in the modern science of genetics. The occasion was the dedication of the Avery Memorial Gateway at the northwest entrance to Rockefeller University, where Avery devoted over thirty years of his life to research and made his outstanding contributions to science.

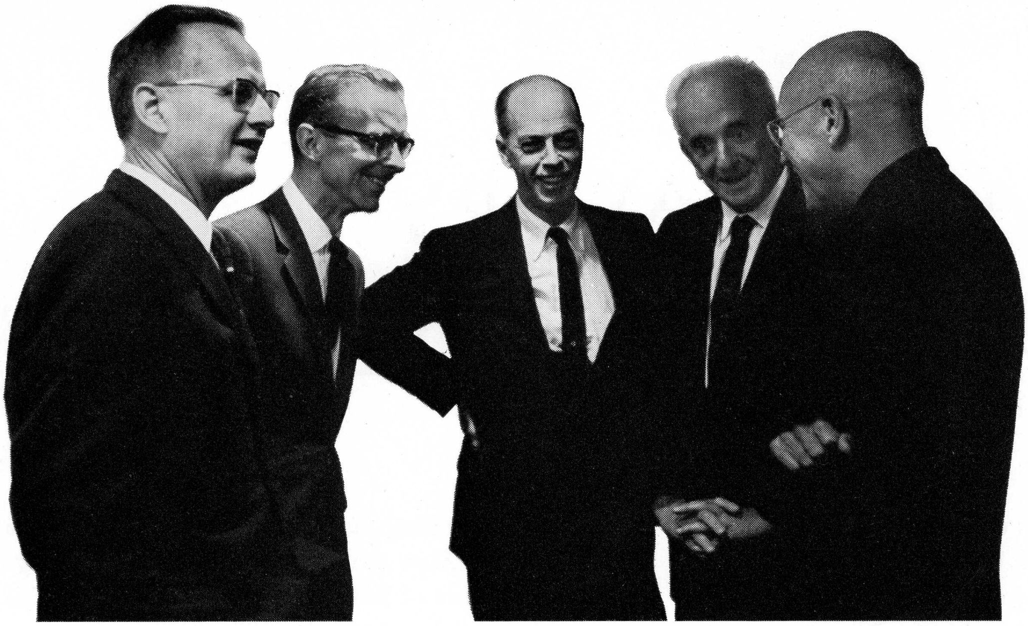
The program in Caspary Auditorium was opened by President Bronk, who spoke with affection of Avery. He recalled summer days together in the company of Alan Chesney "on the fir-clad, fog-shrouded coast of Maine. There he told me with enthusiasm of his research. With modesty he gave no hint of its profound significance. With characteristic generosity he gave much credit to two young colleagues."

Warm tributes then followed from the "two young colleagues" — Maclyn McCarty, now Vice President and Professor at Rockefeller, and Colin MacLeod, Deputy Director of the Office of Science and Technology — who in 1944 had published with Avery the





ABOVE: *Avery Memorial Gateway bears this inscription in Laurentian granite from Oswald T. Avery's native Canada*
RIGHT: *Roy C. Avery with Mrs. Avery*



Speakers at the program in Caspary Auditorium included Maclyn McCarty, Robert W. Holley, Colin M. MacLeod, Theodosius Dobzhansky, and Wendell Stanley

classic paper* identifying the pneumococcal transformation agent as DNA, thus laying the foundation for modern chemical genetics. "Highly polymerized nucleic acid," they wrote, "must be regarded as possessing biological specificity, the chemical basis of which is as yet undetermined."

"That statement," said the next speaker, Nobel laureate Wendell Stanley, "presents one of the greatest discoveries of biological science in this century." Stanley, a virologist long associated with Avery, had gone on record in the mid-thirties as recognizing the viruslike nature of the transforming phenomenon. But many biologists of the day attributed the activity of the transformation principle to "contamination by protein."

Appropriately, Theodosius Dobzhansky, Professor at Rockefeller, followed Dr. Stanley on the program. For Avery and his colleagues had moral support in the late 1930's and early 1940's from the discussion of pneumococcal transformation in the first edition of Dobzhansky's book *Genetics and the Origin of Species*. "Directed mutation is and always was a geneticist's dream," Dr. Dobzhansky said in his closing remarks, "and the Avery group has made this dream a reality — that is — a reality in pneumococci. The possibilities that would be opened if something of this sort were achieved in man stagger the imagination. The Avery group has made the first step in this direction. As described by Teilhard de Chardin, 'The dream which human research obscurely fosters is, by grasping the very mainspring of evolution, seizing the tiller of the world.'"

The sixth speaker, Dr. Robert Holley of Cornell University, was the only one who did not have personal contacts with Avery. "The memorial gate is especially fitting," he began, "to honor a man whose work has opened up such a vast world of new ideas and experimental opportunities." Dr. Holley — a representative of the large group of young, modern investigators whose work has its roots in the contributions of Avery's laboratory — related some of the important developments that are following in the wake of Avery's pioneering studies on the nucleic acids, particularly contemporary research on the structure of RNA.

As the program drew to a close, President Bronk introduced Oswald Avery's brother, Dr. Roy Avery, who happily was able to be present with his wife.

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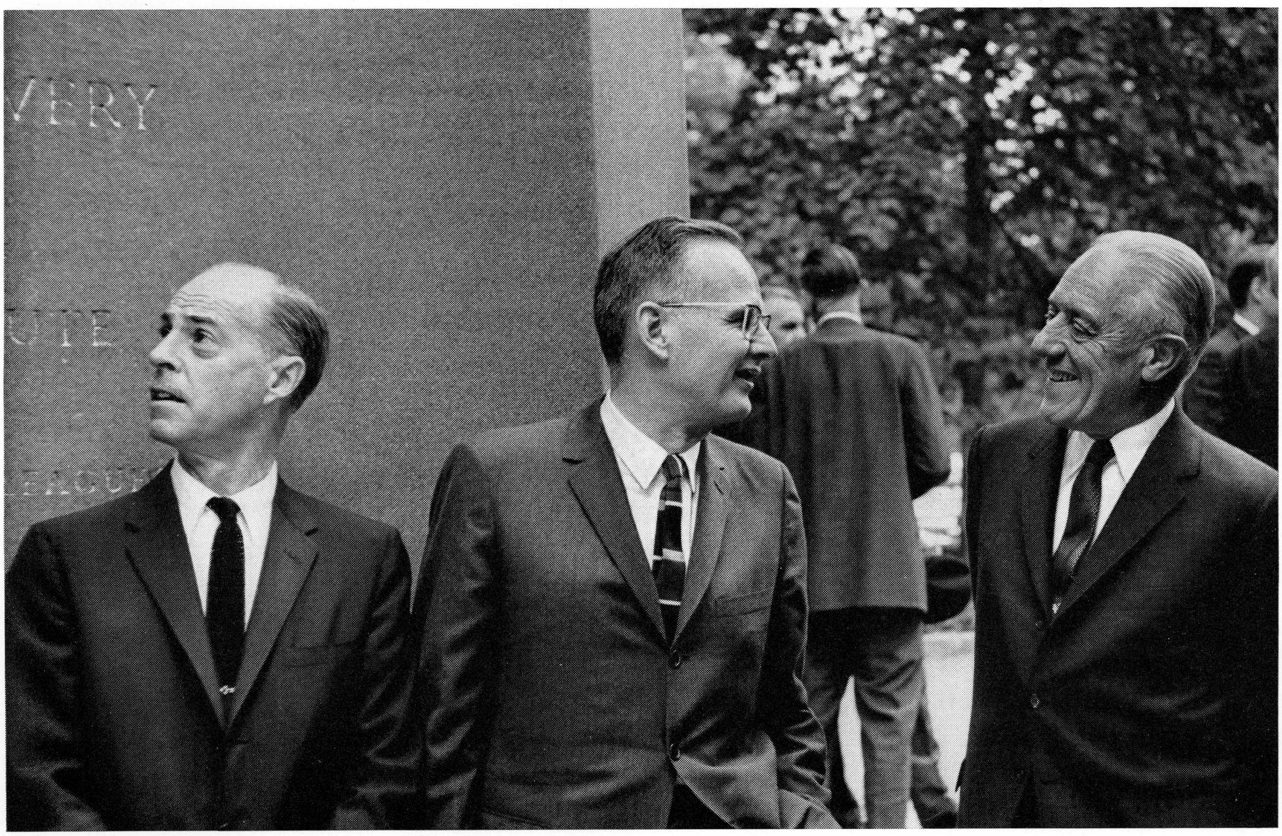
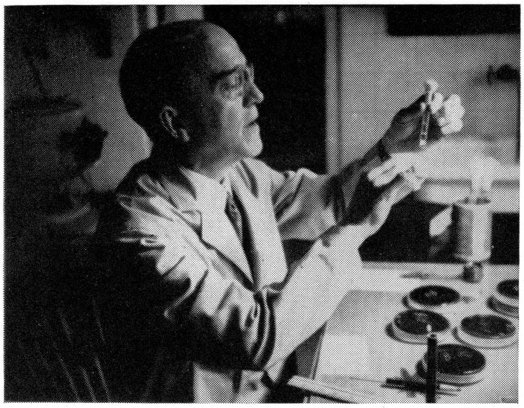
*O. T. Avery, C. M. MacLeod, and M. McCarty, "Studies on the Chemical Nature of the Substance Inducing Transformation of Pneumococcal Types. I. Induction of Transformation by a Desoxyribonucleic Acid Fraction Isolated from Pneumococcus Type III," *Journal of Experimental Medicine* 79 (1944), 137.

ABOVE: *Rufus Cole at the Gateway after the dedication; Cole was instrumental in bringing Avery to Rockefeller in 1913.* BELOW: *President Bronk,* RIGHT, *with Colin MacLeod and Maclyn McCarty, who in 1944 collaborated with Avery on the classic paper on transformation of pneumococcal types.*

"Those who have had the privilege of hearing these lucid accounts of the great work of Fess Avery," Dr. Bronk concluded, "know now, if they did not know before, that Oswald T. Avery needs no physical memorial to keep his memory alive and immortal. Yet his many friends and admirers – desiring to have some part in the perpetuation of his memory – have generously created this dignified and beautiful gateway. In behalf of the University's Trustees I wish to express to them our appreciation for their regard for Avery, and for this fine tribute which now graces our campus."

At the end of the afternoon there was an informal reception in Welch Hall for the 160 friends of Avery who joined in contributing to the construction of the memorial gateway that bears his name. The great piers of red Laurentian granite, quarried in Avery's native Canada and designed by Nelson W. Aldrich of Boston, will recall to the hundreds who enter the gateway each day one of The Rockefeller University's most original and productive scientists.





Oswald T. Avery in his laboratory, the mid-thirties

THE MAN

. . . each morning on arrival in the laboratory the results of the experiment of the day before were waiting in the incubator to be read. Fess and I had an unspoken agreement that prevented either of us from obtaining a sneak preview of the results before the other had arrived. The old protocols serve to recall the image of Fess as we converged on the incubator each morning, and in particular I see his expression, which was a curious mixture of eager anticipation and of apprehension for fear something had gone wrong with our complex biological test system — which, alas, was all too frequently the case. A multitude of such pictures remain . . . as testimony of the lasting impact of his personality on his associates. This legacy is inextricably enmeshed in our minds with the more durable and objective legacy of his scientific accomplishments. Maclyn McCarty

We talked about whether he should say that bacteriology is the Queen of the Biological Sciences, or, as I might suggest, the Crown Princess, because she hadn't arrived yet; and so we spent the last half hour of the late afternoon, until Fess would say, "Let's go and see Do (Dochez)." And then a short three and one-half block walk across town to see Do, who would greet us, rubbing his hands and saying with enthusiasm, "Hey, you're late, Fess." . . . We might end up on this occasion declaring that bacteriology was not a Crown Princess or even a Cinderella, but more likely a pumpkin. But you can be sure we had a stimulating time — perhaps even blowing a few scientific bubbles, "which is all right" as Fess was wont to remark, "so long as you prick them yourself." Fess was fond of another and related small aphorism, "Ideas are wonderful things," he would say, "the trouble with them is that they don't work unless you do." Colin M. MacLeod

THE "MARVELOUS ANIMALS"

BY HELENA CURTIS

FILIPPO BUONANNI, the Jesuit scientist, surprised no one in his seventeenth-century world when he described a type of timberwood that, if soaked in the sea, produced worms that engendered butterflies which in turn became bright-colored birds. Not long before, the Belgian physician Jean Baptiste van Helmont had asserted that full-grown mice are produced in three weeks from wheat in a glass stopped with dirty linen and that scorpions are formed from the herb basil crushed in a cavity between two bricks. After all, it had been known since the time of the Egyptians that snakes rose from the mud of the Nile. Aristotle, greatest of the biologists, had stated that simple living things took shape from dust and mud – "from all dry things which become moist and all moist things which become dry." Even common folk were well aware that plant lice formed from dew drops, and snakes, of course, from a lady's hair dropped in a rain barrel.

Today we all know far more about how living things take their form. As children we watched a spotted mass of jelly turn to shapeless black embryos which slowly grew eyes and legs and then, quite suddenly, lost their tails and hopped from the pond – or even more surprisingly from the household aquarium. This past summer we may have shown other children how the mosquito larvae hang by their tails from the air-water interface and how one may glimpse in their dark, fierce eyes the promise of the insect to come. And when the wan moth fluttered from our clothes closet this fall, we readily recalled the life stages through which our winter coat had nourished him. Even in our own species we watch every day the slow cycle of birth, maturation, senescence, and death.

Growth, change, metamorphosis, are accepted in today's world with as much equanimity as spontaneous generation in the world of three centuries ago. Yet, in truth, we know little more than van Helmont about how living things take shape, and it is clear that this problem – morphogenesis – will be a central concern in biology in the decades that lie ahead, as it was in the time of the Greeks.

If one wishes to see the problem stated in bewildering simplicity, one need only visit the laboratories of Maria Rudzinska, an associate professor at Rockefeller. Here can be found what is undoubtedly the world's highest concentration of an extremely unusual animal which bears the name of *Tokophrya infusionum*. Readers who might be deterred by nomenclature so seemingly foreign and exotic may be reassured to learn the source of the strain of Tokophrya with which much of the work reported here has been accomplished: it was found by Dr. Rudzinska one June morning in 1959 in a quiet corner of the pool on the Rockefeller campus. In fact, Tokophrya grows there still.

Even one who is a specialist in the more familiar ciliates – such as Paramecium, the classic slipper animalcule, or Stentor, the crowned king of this one-celled realm – will be surprised on first encountering this strange member of the ciliate family. Tokophrya is tiny – the species that Dr. Rudzinska is studying is twenty to fifty microns in diameter – but so characteristic in form as to be instantly identifiable. First one notices the tentacles, which look like the most delicate imaginable rods of fine-spun glass. A cell may have as many as sixty of these, sticking out stiffly from its body. They are very slender – less than one micron in diameter except at the tip, where they

round out into a knob — and are often longer than the body of the animal.

If Tokophrya is seen in profile, it does not appear spherical, as it does from on top, but rather club-shaped. The tentacles — which stick out like toothpicks — are grouped in two clusters on each side of the top of the club, and the club's handle is a short stalk of the protozoan's own manufacture. The stalk terminates in a flat disc which anchors the cell firmly to its substrate for all of its adult life.

Tokophrya sits absolutely motionless. The only sign of life a discerning eye might catch is the slow pulsation of one or two small intracellular vesicles. These are the contractile vacuoles, present in one form or another in all freshwater protozoa, which enable the animal to expel excess fluids. They beat with the slow, steady rhythm of an automatic bilge pump.

Tokophrya, like all protozoa, is a voracious eater, and since it spends its entire eating life in the same spot, its meals must come to it. One of its favorite foods is Tetrahymena, which somewhat resembles the more familiar Paramecium in shape, although it is much smaller. When a luckless Tetrahymena brushes across an outstretched tentacle of Tokophrya, it stops, apparently stunned, and tentacle and prey become firmly attached. Tokophrya is smaller than Tetrahymena; but, despite its small size and the seeming fragility of the rodlike tentacle, the larger ciliate can almost never free itself, and often its attempts to break loose succeed only in its becoming fastened to additional tentacles of the captor. Once attached, the tentacle broadens and shortens; and, as painstaking light microscopy studies have shown, a stream of tiny granules moves up the rod to the Tetrahymena. The struggling animal becomes immobilized. Dr. Rudzinska has shown that if the captive is rescued from the tentacles at this stage, it will remain motionless from several minutes to several hours, depending on the duration of its exposure, but in most cases it regains its normal mobility.

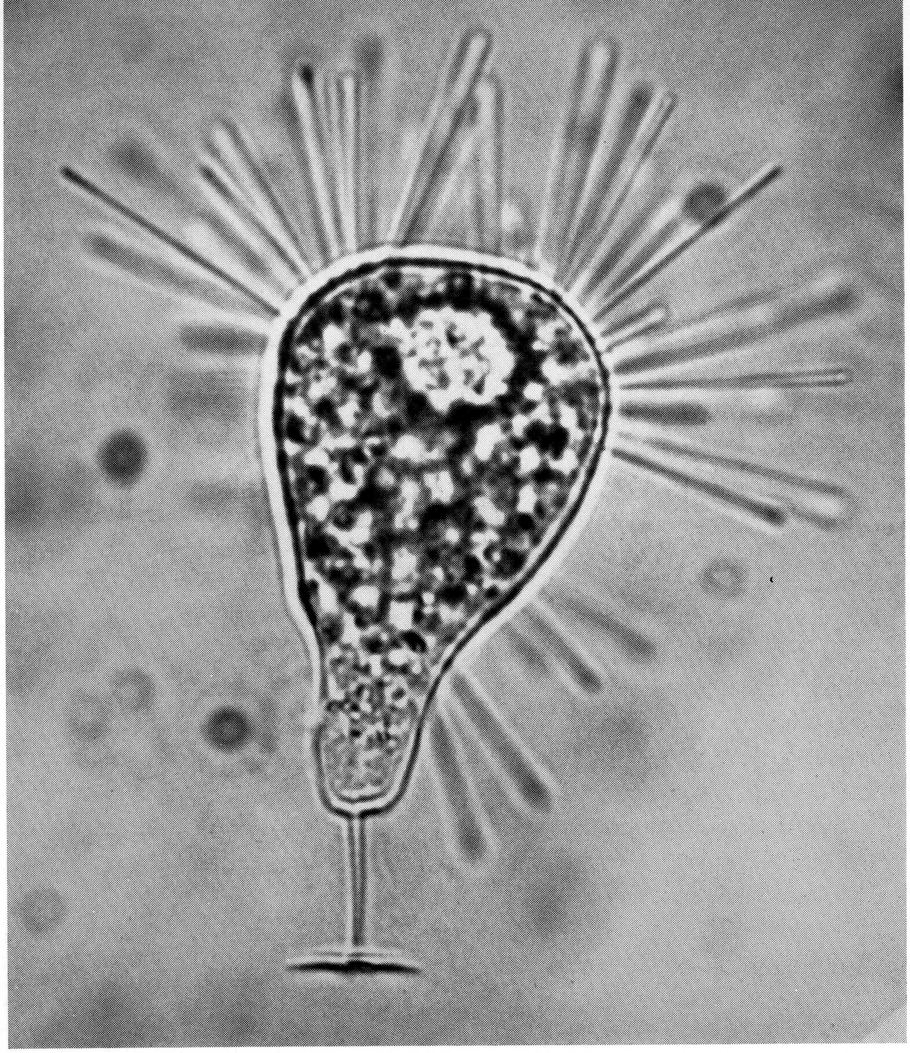
A larger ciliate, such as Paramecium, though equally esteemed by Tokophrya, may frequently break free from a single captor. Often, however, Tokophrya is found in clusters, the spikes almost touching, like the barbs in a roll of barbed wire, and the Paramecium that wanders into this no man's land rarely escapes. It touches one tentacle, pulls loose, seemingly stunned, and staggers into another, until it is entirely immobilized. Sometimes a single Tokophrya will fasten onto Paramecium with such a firm grip that it will be pulled loose from the substrate and swept off, still attached to the relatively giant animal. In such cases Paramecium soon slows down and finally stops; then Tokophrya reanchors itself and begins to feed. Clearly the tentacles are the source of some sort of toxin — a protozoan curare — although it has not been isolated or identified. Curiously, the tentacles adhere only to ciliates; Amoeba and its relatives and the flagellates may pass the tentacles without danger.

Once the prey is attached to the tips of one or more tentacles of one or more Tokophrya, the poison-producing barbs become sipping straws. One can see a flow in the other direction, from Tetrahymena to Tokophrya. The prey remains alive during the feeding process; the continued pulsing of its contractile vacuole is readily visible. In fact, as soon as the victim dies, Tokophrya discards it as unfit for consumption. The whole process takes about twenty minutes.

It is presumed that the tentacles exert a sucking action (hence the order to which Tokophrya belongs is called the Suctoria), but just how the suction is produced is not clear. Some have suggested it is a result of peristaltic movements of the tentacles, and some believe increased pressure within the body of the victims may drive its contents down the tubes. Others have suggested that increased action of the contractile vacuoles may turn Tokophrya into a tiny, lethal suction cup, but none of these explanations seems adequate. In any case, the feeding mechanism is extraordinarily efficient. All of the fifty or sixty tentacles can feed simultaneously should nature or Dr. Rudzinska provide such bounty. And Tokophrya is a glutton. It will feed continuously for forty-eight hours or more and, under such conditions, will grow to 120 times its normal volume.

Birth

As we learned in school, most protozoa reproduce by binary fission: the cell divides into two identical twins and each swims off to lead a life of its own. Tokophrya, however, goes through an elaborate process of embryogenesis. First, a tiny opening, the birth pore, forms at the top of the animal, between



Tokophrya infusionum
seen from the side, showing attachment disc, stalk, and tentacles

the two clusters of tentacles. Then, beneath the surface, below the pore, the embryo begins to form, scooping itself out of the body of the mother animal as one might scoop out a melon ball. Cilia begin to appear — five rows of them — and even before the embryo has pinched itself off from the mother cell, the cilia begin to beat. Soon the larva is free of all connection with the adult cell but still trapped within the birth chamber. For ten or twenty minutes it whirls, beating its cilia, within the chamber. Then, suddenly, like a bullet, it shoots out through the birth pore. The adult Tokophrya is left empty and distorted, but soon composes itself and, in fact, within two hours or less, may be ready to produce another embryo.

Once the larva escapes, there is a period of frenzied activity. The young potato-shaped Tokophrya whirls through the water with great speed with what Dr. Rudzinska describes as a highly characteristic "screwy" motion, zigzagging as though in some frantic but ineffective pursuit. The chase may last for a few minutes to several hours.

Suddenly the larva stops and stands on what was formerly its head. It spins a few times more in place, the girdle of cilia beating about its equator. Then the seeming miracle begins. Right before one's eyes, the creature transforms itself. The cilia, which were beating vigorously just a moment before, vanish. Then the attachment disc appears. No one knows with certainty where it comes from, but Dr. Rudzinska hypothesizes that it may be formed by the polymerization of a droplet of some substance released from within the larva. The disc is very thin, composed of a network of fine fibrils, but it adheres so strongly that it will hold Tokophrya fast even when several captured Tetrahymena tug at its tentacles simultaneously.

Once the disc has formed, the stalk appears, and as

it takes shape it lifts the animal up from the substrate. Next, and most remarkable, come the tentacles, moving out from the body, stiff as spokes, a dozen or so powerful, slender rods. All this happens almost simultaneously, and within five minutes the swimming embryo is transformed into a sessile form with all the characteristics of the parent organism. It is somewhat like seeing the frog change to the prince right on one's own doorstep.

The microcosm

Dr. Rudzinska takes advantage of the rapid motion of the embryo to isolate the protozoan for life in the laboratory. Using a very fine pipette and extraordinary patience, she tracks and catches a swarmer and then transfers it to a fresh droplet of water. After it whirls around the circumference of the drop for a few minutes, she catches it again, and transfers it again, checking each time under the dissecting microscope to make sure the tiny embryo has not eluded her. After ten such transfers, the young larva, as a result of its own activities, has rinsed itself clean of any bacteria. From then on it and its offspring will live in a sterile medium. This is extremely important; bacteria take over a culture rapidly, as every amateur protozoologist knows, and Tokophrya cannot thrive in a culture that is dense with bacterial growth, nor can Dr. Rudzinska carry out her precise and elegant studies with other than a pure culture.

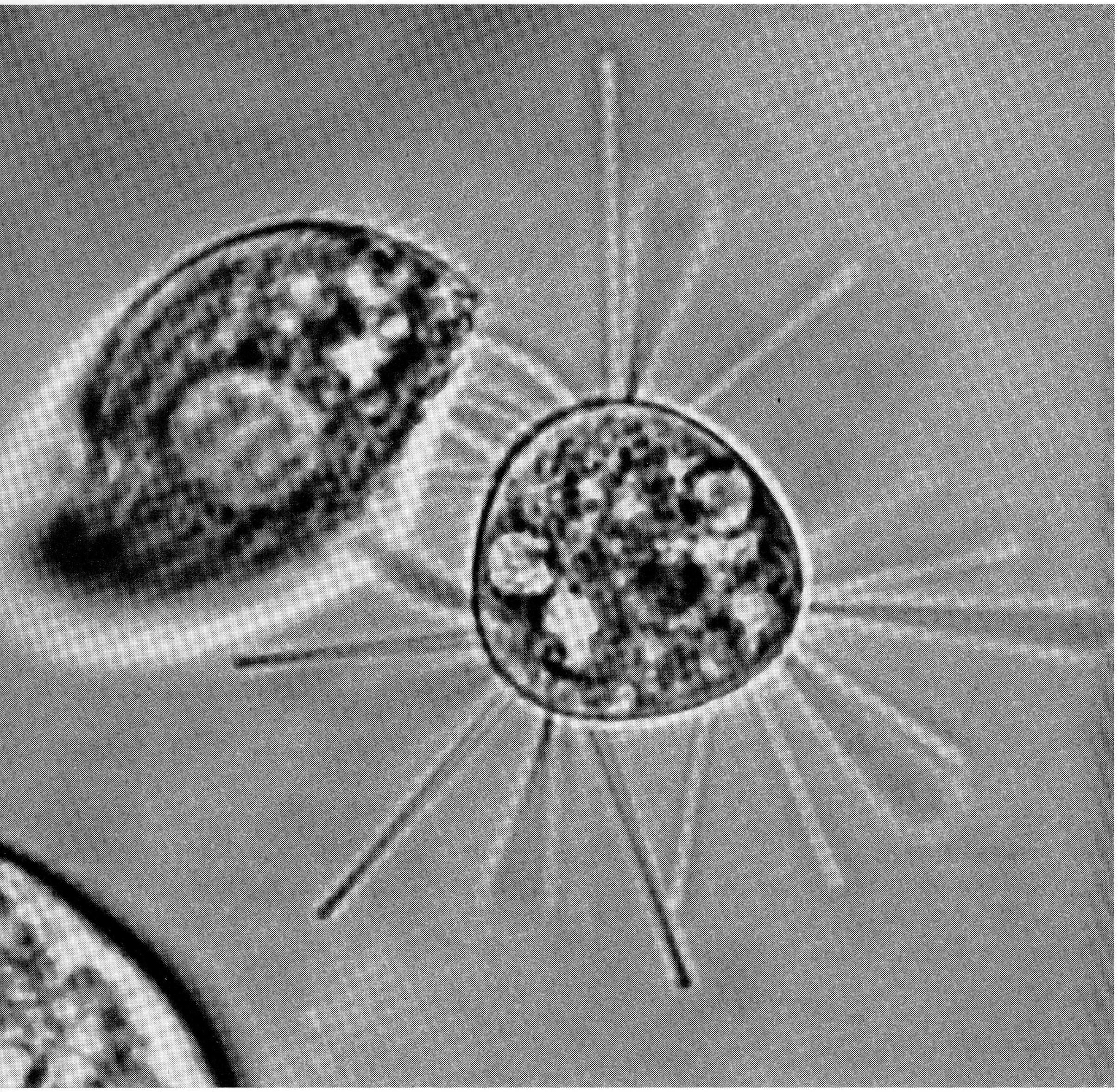
Tetrahymena, by a happy coincidence, can also be grown in a bacteria-free state, although bacteria are its natural food. In fact, Tetrahymena was the first of the protozoa to be grown in a precisely defined chemical medium and, indeed, the first animal cell ever to be grown under these conditions. By supplying the right amount of Tetrahymena, Dr. Rudzinska is able to keep Tokophrya alive in a perfectly controlled microcosm. One embryo and its descendants can be kept for as long as two weeks in a single drop of water. Yet this single drop of water, Dr. Rudzinska has found, contains more questions than all of modern biology can answer.

The tentacles

Perhaps the most fascinating of all the features of Tokophrya are its tentacles. Dr. Rudzinska's studies of their fine structure make their rapid morphogenesis seem even more remarkable. Each tentacle is made up of two concentric cylinders. The outer wall of the outer cylinder is covered with a delicate plasma membrane — the same sort of membrane that covers the surfaces of all cells, including our own. In addition, outside this membrane, is a more rigid and thicker coat, the pellicle. The plasma membrane covers the entire tentacle, including the lumpy surface of the knob; but the pellicle reaches, like a coat sleeve, only to the base of the knob.

The wall of the inner cylinder is composed of a double row of forty-nine — or, occasionally, fifty — microtubules arranged in loose bundles of seven tubules each, four on the inside, three on the outside. Dr. Rudzinska presumes that these tubules, which extend deep within the cell, are contractile and so are responsible for the shortening and broadening of the tentacle during feeding. Its lumen, usually only one-fourth of a micron in diameter, expands greatly during feeding so that even relatively large morsels — mitochondria, for instance, which are a micron wide — can pass smoothly through.

The outer cylinder, Dr. Rudzinska's studies show, is the carrier for the tide of minute, dense oval bodies, the bodies that in light microscopy can be seen flowing from predator to prey immediately following capture. As Dr. Rudzinska points out, they are missile-shaped, rounded on one end, pointed on the other. She concludes, on the basis of many electron micrographs, that these missiles arise in the cytoplasm of Tokophrya and travel up the outer lumen of the tentacle to the knob, where they pierce the naked plasma membrane with their pointed ends. These ends, which protrude from the knob, look fuzzy under the electron microscope. This fuzziness may well mean that they are sticky, and Dr. Rudzinska suggests that it is the protruding missile ends that cling to the cilia of the prey and hold it fast. They probably also secrete the paralyzing poison. The missiles also seem to be the carriers of a number of enzymes which perhaps serve to dissolve the pellicle of the captured ciliate and also to make its cytoplasmic contents less viscous, facilitating their smooth flow down the tentacles. It is not known how the missiles work, but apparently they discharge their contents from the tip of the knob; their dense, characteristic forms have never been found outside Tokophrya or within the body of the prey.

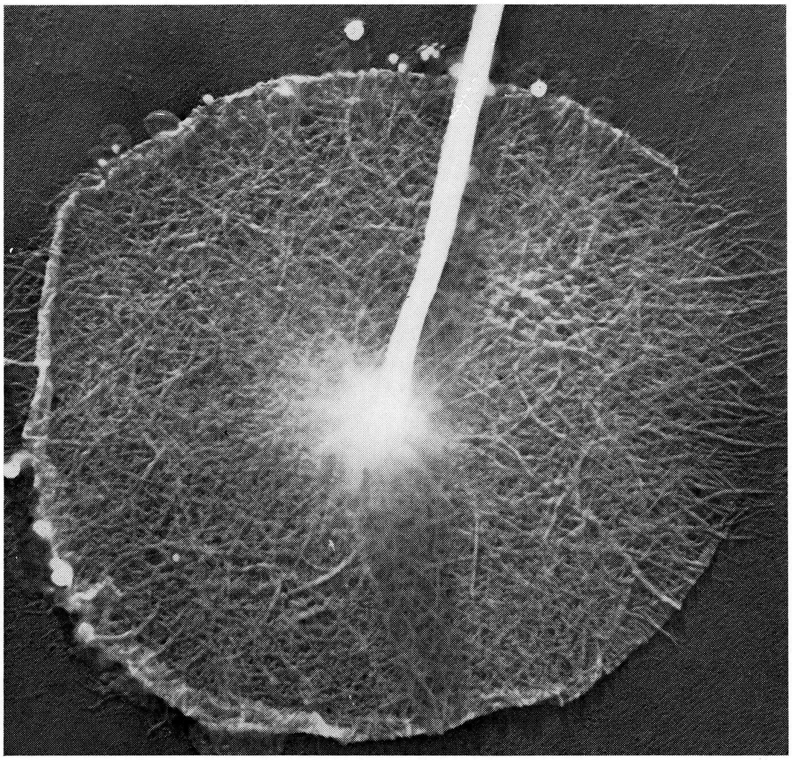


Tokophrya feeding on Tetrahymena

Electron micrographs taken of the knobby end of a feeding tentacle reveal another unexpected phenomenon. The knob is apparently driven like a fist into the soft body of Tetrahymena and then, once this occurs, in a matter of microseconds the pellicle, or outer sleeve, of the tentacle becomes continuous with the pellicle of the captured ciliate. No wonder the struggling animal cannot free itself from this seemingly fragile rod. Also, of course, this strange union results in a perfect seal, so none of the contents of the captive can leak out or spill. In less than a second the two become a single organism.

Sex in Tokophrya

Recently Dr. Tracy M. Sonneborn of Indiana University reported another unprecedented morphological change in this same organism. One of the common features of all ciliates is the presence of two nuclei: a micronucleus and macronucleus. The micronucleus is generally presumed to contain a sort of microfilm version of the hereditary code, a duplicate of which is passed on to the embryo; but it supposedly plays no role in the day-to-day existence of the cell. In ciliates the cellular phenotype appears to be under the direction of the macronucleus, which



Attachment disc, a network of fine fibrils

apparently contains a large number of duplicate versions of the material safeguarded in the micronucleus. All ciliates whose life cycles are well known have been found to participate in a process known as conjugation, during which a type of mating takes place. This involves a reduction-division of the micronuclei, with half of the genetic material of each going to the partner cell. Then the two halves fuse, the new and the old, mingling the genetic material from each partner. The old macronuclei dissolve and new ones form. Unlike mating in higher forms, no infant cell is produced; the postconjugal ciliates, each with a store of fresh genetic information, simply part; and further reproduction is accomplished, as previously, by some form of cell division.

Conjugation presents a special problem for Tokophrya, since it spends all its adult, conjugable, life anchored firmly in the same spot. Using three different strains of *Tokophrya infusionum,* including one borrowed from Dr. Rudzinska, Dr. Sonneborn has been able to show how the animal solves this problem. When two mating adults are placed close to one another in the absence of food, their rigid pellicles, which ordinarily look as stiff as glass, begin to waver in shape. Both animals elongate and, within several hours, begin to develop amoeboid projections. Finally, stretching out pseudopodal arms toward one another, they meet and conjugate. Lest this sound the least romantic, it is necessary to add that the entire process can be interrupted instantly by the introduction of an edible ciliate.

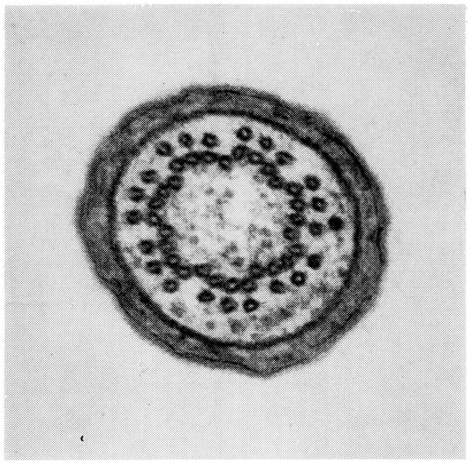
Senescence

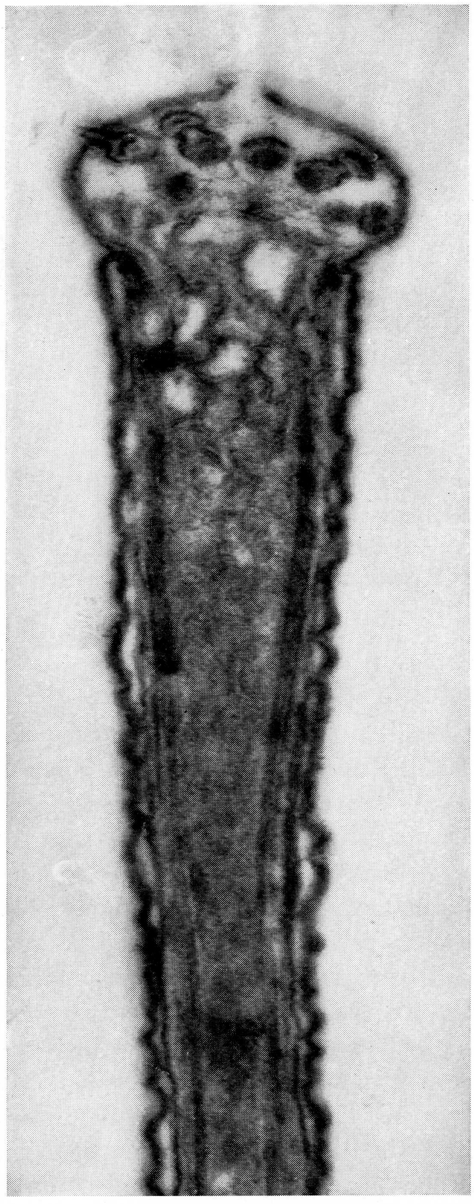
Most protozoa, through ceaseless cell division, achieve a kind of impersonal immortality, but Tokophrya shares with man and other many-celled animals an identifiable life span that ends with aging and eventual death. As Tokophrya grows older, it undergoes another series of morphological changes — less rapid and dramatic than those associated with its birth and metamorphosis, but changes which bear interesting correlations with those seen in aging cells in our own bodies. Most colonies of cells or tissues are made up of a mixed population of young and old individuals; Tokophrya, which can spend its entire life in a solitary microdrop clinging to the surface of a glass slide, offers a rare opportunity to study maturation and aging in a single cell.

Young Tokophrya is almost perfectly spherical, about twenty-five microns in diameter, and has an average of ten strong, firm tentacles. For the first twelve hours or so of its sessile life it feeds actively, growing more tentacles, but is unable to reproduce. Its macronucleus is a compact dark mass which, in the electron microscope, can be seen to be made up of a number of small, dense granules, the chromatin bodies. The most prominent of its cytoplasmic organelles are its numerous mitochondria scattered uniformly throughout the cytoplasm.

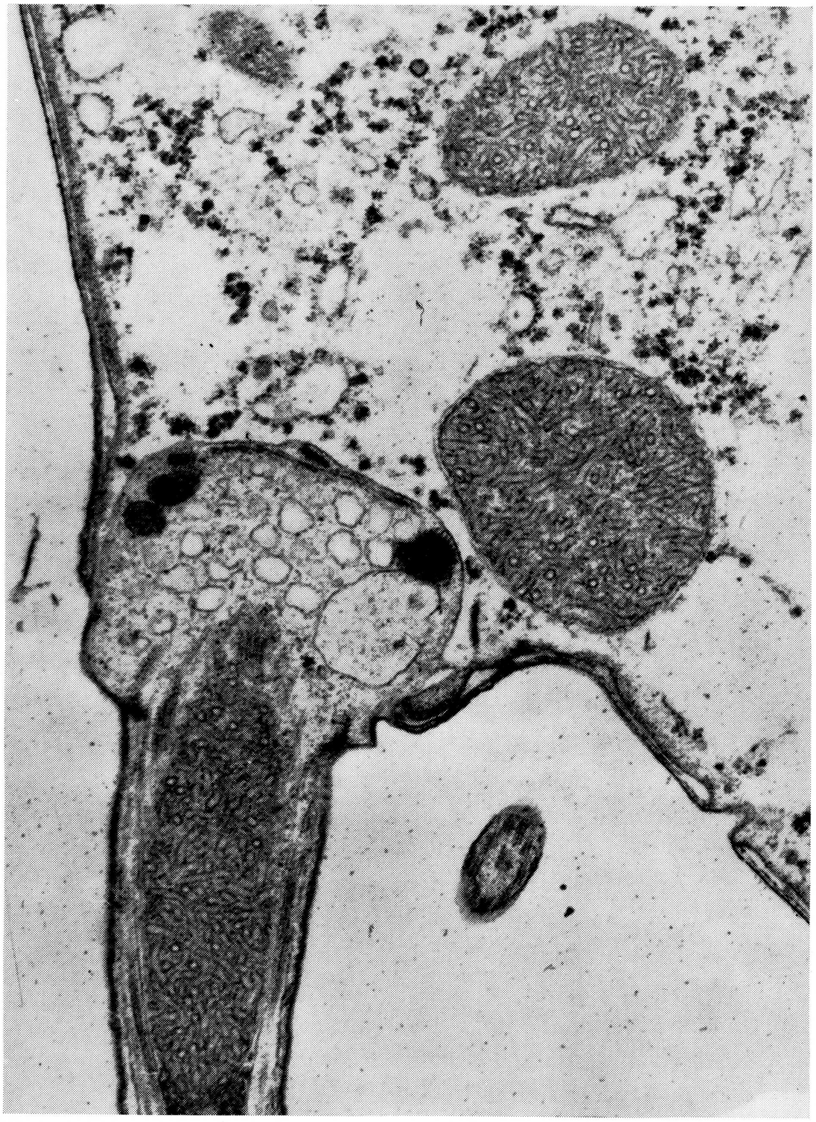
By the end of its first day Tokophrya is a young adult, at the height of its powers. During this period of vigorous maturity it possesses an average of fifty functioning tentacles and is able to produce as many as twelve embryos during a twenty-four hour period, each supplied with a micronucleus, produced by mitosis, and with a pinched-off segment of macronucleus. During this period its body, now about forty microns across, assumes a more definite shape, not unlike that of a Seckel pear.

After four or five days of this peak activity, the cell begins to age. It grows slightly larger and more irregular in outline. The number of tentacles dwindles and those remaining grow weaker; Tetrahymena can now quite easily break away, and even when a tentacle is firmly attached the aging cell takes as long as two hours to feed. Reproductive powers wane until only one or two embryos are produced a day. The number of mitochondria decreases, and those that remain tend to gather around the periphery of the cell. Cross sections of the mitochondria in aging cells show signs of breakdown in their internal structures, the enzyme-holding membranes. The cell begins to look bloated, filled with vacuoles which contain small granules, about twice the size of ribosomes, which Dr. Rudzinska interprets as insoluble waste materials. Unlike almost all other animals, including one-celled animals, Tokophrya lacks any means for disposing of these insoluble wastes, and their accumulation may be directly related to aging.





TOP: *Cross section of tentacle showing double row of microtubules and inner and outer lumens.* BELOW: *Tentacle of Tokophrya; the dark bodies, complicated in structure, at the periphery of the knob are missiles. One of them has penetrated the plasma membrane and its pointed end is protruding.*



Feeding process; the knob of Tokophrya is embedded in the cytoplasm of the prey, and the pellicles of the two cells have become continuous. Three mitochondria of Tetrahymena can be seen, one of them already in the tentacle

Grossly overfed Tokophrya begin to show signs of old age more rapidly than animals on a more Spartan diet, and it is probable that the near-starvation diet of Tokophrya in its natural habitat may favor its long survival, as indeed does undereating in many animals, including, sadly, man.

Certain cells in the mammalian body also grow old: these are the cells of the central nervous system, Purkinje and other nerve cells, that cease dividing early in the life of the organism. The most characteristic finding in these aging mammalian nerve cells is the accumulation within the cell of what is known as "senility pigment"—pigmented granules of lipid-like material. Dr. Rudzinska has found lipid granules similar in appearance in Tokophrya. Both in Tokophrya and in human neurons, the pigment is never found in the young cells; it begins to accumulate in the adult and is always present in the old cells. Her electron micrographs of aging Tokophrya show that these granules accumulate in the region of the mitochondria, and some of the photographs indicate strongly that they actually arise from the mitochondria themselves, perhaps as these bodies degenerate with age. On the evidence available, the cause of death in Tokophrya, and perhaps in nerve cells as well, may be from autointoxication, caused by the animal's inability to eliminate these waste products.

Another conspicuous feature of the aging cell is the degeneration of the macronucleus, which grows

much larger, reaching three or four times the diameter of the macronucleus in the adolescent animal, and becomes irregular in shape. The chromatin bodies increase in size and number and decrease in density. In some cases the macronucleus begins to undergo divisions, and sometimes as many as four macronuclei are found in one aging cell. Additional nuclei are also found in aging Purkinje cells, and it might be that this phenomenon reflects in both cases a desperate attempt by the cell to repair its central controlling machinery in order to regenerate its energies and prolong its life.

Finally, unable to reproduce or eat, reduced to a mere fifteen worn, weak tentacles, its mitochondria emptied and its macronucleus in disarray, Tokophrya dies. This extraordinary cycle of life and death has taken just ten days.

In a porcelain teacup

Leeuwenhoek, almost three centuries ago, took some water from a well and put it in his porcelain teacup with some grains of pepper. A few days later, when he looked at a droplet through his minute, improbable microscope, he found that "the whole water seemed to be alive with these multifarious animalcules. This was for me, among all the marvels that I have discovered in nature, the most marvelous of all; and I must say, for my part, that no more pleasant sight has ever yet come before my eye than these many thousands of living creatures, seen all alive in a little drop of water, moving among one another, each several creature having its own proper motion."

Today new instruments and new techniques have rendered the microscopic world far more visible than it was even to the sharp-eyed Leeuwenhoek. And even more important, new ideas have changed the nature of our vision. A century ago man learned to accept his ties, extending back through the millennia, with those protozoa that were our ancestors. Modern biochemistry has revealed our remarkably close affinities with the protozoa that are our contemporaries. Studies on Tetrahymena, for example, have made clear that its nutritional needs — and, of course, by implication, its enzyme systems — differ little from those of the cells of the chicken, the rat, or indeed of our own tissues. As a consequence Tetrahymena and other protozoa as well are being used increasingly for biological assays of substances relevant to man and for toxicological studies, an employment for the one-celled animal that would surprise the classical protozoologists. Similarly, they would be taken aback to find that Dr. Rudzinska's studies on the life span of Tokophrya have been published not in the journals of protozoology but in the journals of the gerontologists who, on their part, have greeted the little Suctorian with some surprise but with great interest.

It is, however, in basic biological research that the little animalcules may have the most to offer. The problem of shape and form, of how living things generate their structure — their *morphē* — has intrigued all great biologists since Aristotle, and today molecular biology, with its new techniques, is on the threshold of confronting this age-old problem. Perhaps only in the protozoan microcosm does nature present such a rich variety of forms and even of metamorphoses, or pose this still unanswered question more simply and dramatically.

So *Tokophrya infusionum* may serve to remind us that, after all, we live in a world no less marvelous and no less fearsome than the world in which butterflies turned to birds, and mice were generated from soiled linen and grain. We may even, from time to time, pause to speculate about what else may lie in wait in the quiet pools of our own gardens.

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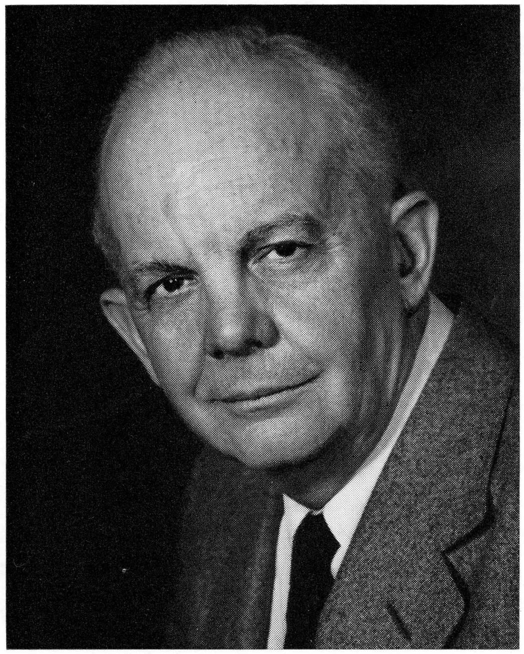
DUNCAN A. MACINNES

1885-1965

DUNCAN A. MACINNES, Member Emeritus of The Rockefeller University, died on September 23 in New Hampshire, where he was on vacation. Dr. MacInnes, who was 80 years of age, remained active in scientific research until the time of his death.



Duncan MacInnes had been associated with the University for almost forty years. He came to The Rockefeller Institute in 1926 as a result of the persuasion of Dr. W. J. V. Osterhout. Dr. Osterhout, a physiologist, believed that physiology could benefit from advances in fundamental electrochemistry; and so Dr. MacInnes became the University's first senior investigator trained in a physical science rather than in biology or medicine.

When Dr. MacInnes first joined the Rockefeller, he undertook studies of what was then a central problem of general physiology – ionization and its physical concomitants. He was soon joined by a group of younger men, including Theodore Shedlovsky and Lewis G. Longsworth, who are still members of the University faculty.

The work of MacInnes and his associates at the Rockefeller forms the core of his book, *Principles of Electrochemistry*. Preparation for this now classic text was begun in 1926. It was first published in 1939 and reprinted in a paperback edition in 1961, to ensure the widest possible distribution. The clarity of exposition, which characterized all of his writing, is particularly evident in this work and contributes to its continuing widespread use.

After reaching emeritus status, Dr. MacInnes continued his research, focusing his interest on the difficult task of redetermining the value of the faraday with a precision that had not been previously attained.

Born in Salt Lake City on March 31, 1885, Dr. MacInnes took pride in belonging to the generation which saw the last of the Western Frontier. He was graduated from the University of Utah in 1907 with a B.S. in chemical engineering, and received his Ph.D. degree in physical chemistry in 1911 from the University of Illinois. Dr. MacInnes remained at that University doing teaching and research until 1917, when he joined the faculty of the Massachusetts Institute of Technology. In 1926 he became an Associate Member of The Rockefeller Institute; in 1940 a Member; and Member Emeritus in 1950.

Many honors were conferred upon Dr. MacInnes. He was a member of the National Academy of Sciences and the American Philosophical Society and received the Nichols Medal in 1942, awarded by the American Chemical Society. In 1948 he received the Acheson Medal, awarded every two years by the Electrochemical Society. The same year he was also honored with the Presidential Certificate of Merit by President Truman.

Dr. MacInnes, a bachelor, was intensely devoted to The Rockefeller Institute and to his research. His friends, of whom he had many, remember him as a person of warm courtesy and natural distinction with a broad range of interests, including reading, music, and the outdoors. He worked ardently as a conservationist to save the natural beauty that was of such personal importance to him, and he was a skilled and enthusiastic mountain climber.

THE ROCKEFELLER UNIVERSITY NEWS

Addresses

MEMBERS of the Rockefeller faculty gave major addresses at many universities across the country during September and October.

On October 7, President Bronk received the honorary degree of Doctor of Civil Law at the 108th annual Charter Day Convocation of Alfred University following his convocation address on "Law and the Social Role of Science." He delivered the dedication address at the opening of the Dana Hall of Chemistry at Bates College on October 2nd. On October 24th, Dr. Bronk was the speaker at the dedication of the new Princeton Day School of which Mrs. J. Richardson Dilworth, wife of Rockefeller University Treasurer Dilworth, is Chairman of the Board of Trustees.

Edward L. Tatum, Professor of The Rockefeller University, was one of the speakers at the convocation for the groundbreaking of the new Life Sciences Center on the campus of Trinity College in Hartford, Connecticut. The theme of the convocation, which was held on October 30, was "Reflections on the Future – the Life Sciences." The emphasis of Dr. Tatum's speech, "Frontiers in Molecular Genetics," was that "our understanding of molecular genetics, of the nature and functioning of protein and nucleic acid macromolecules, is basic to our understanding of life itself. This, in turn, is a prerequisite to our understanding of ourselves as individuals and as a species. Certainly, the future of man depends on his understanding of himself as one living organism in a community of organisms living together in a common environment, and depends on his ultimate success or failure in fitting into this environment, and modifying it as well as himself, in accordance with the basic laws of nature."

René J. Dubos delivered two addresses on September 29: the Jules Freund Memorial Lecture at the National Institutes of Health, "Immunological and Physiological Aspects of Resistance to Intracellular Infections"; and the dedication speech for the new Pan-American Health Organization Building in Washington, "Man in His Environment; Biomedical Knowledge and Social Action." On October 11 he gave a second dedication speech, for the AMA Institute for Biomedical Research in Chicago, speaking on "Social Determinants of Medical Knowledge." Social awareness of the need for enlarged concepts of biomedical research, he mentioned, led to the creation of The Rockefeller Institute for Medical Research, whose "broad formula of medical research has now been incorporated in the structure of modern medical schools all over the world. . . . The purpose of its founders was to create facilities, and an intellectual atmosphere, in which investigators could dedicate themselves to the development of the biological, chemical, and physical sciences relevant to knowledge of the human body and to the control of its diseases."

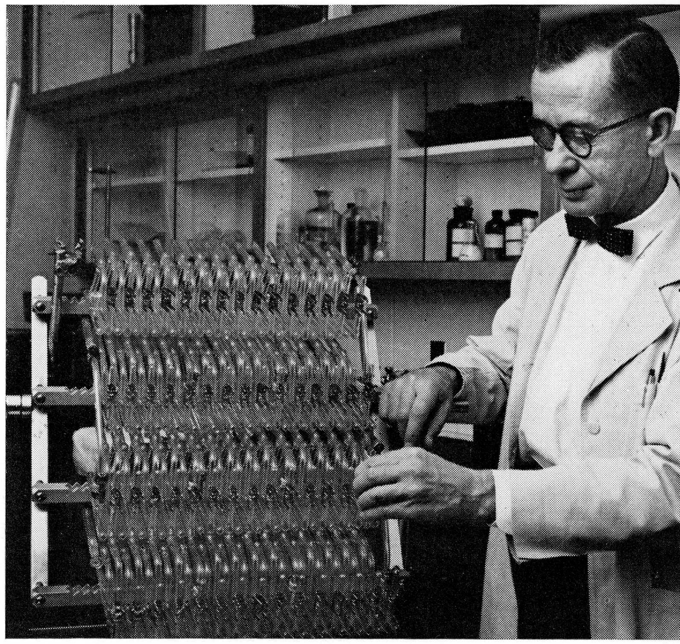
The same day George E. Uhlenbeck addressed the Autumn Meeting of the National Academy of Sciences in Seattle at the University of Washington. He presented the evening public lecture, "Is There a Direction in Time," pointing out that the "arrow in time" problem "haunts both the physical and the life sciences and . . . divides these two sciences." He continued, "In fact, I believe that any serious discussion about the relation between the biological and physical sciences must come to grips with their basic conflict about the nature of time. On the one hand the physicists maintain that the basic laws of physics do *not* show the arrow of time or, said more mathematically, are invariant with respect to time reversal; while on the other hand there seems to be overwhelming evidence to the contrary! This evidence includes not only the enormous evidence for the existence of a biological evolution, but also the fact so deeply ingrained in our consciousness that we know that we grow older and have to die." He closed with the idea that the "big bang theory" of the origin of the universe "could perhaps be generalized to a *universal* evolutionary process, which would include not only the cosmic, biological, and human evolutions but include even the evolution of the laws of nature themselves."

In October Professor Theodosius Dobzhansky delivered the Thirty-Fourth Course of Lane Medical Lectures, "The Genetic Load," at Stanford University School of Medicine, Palo Alto. Founded in 1896

by Dr. Levi Cooper Lane, the Lectures are given biennially on medical subjects and are open to the medical profession, students, teachers, and research workers in medicine and allied sciences. In his first lecture, "A Geneticist's View of Human Equality," Dr. Dobzhansky remarked: "All men should be equal in order that they can grow to be all different. This is not a paradox. Biological as well as cultural evolutions tend towards diversity, not towards uniformity ... human diversity is not a regrettable caprice of nature, it is a biological and cultural necessity." Several previous Lane Lectures have been given by scientists associated with Rockefeller: by Dr. William H. Welch in 1904, when he was professor of pathology at Johns Hopkins; by Dr. Simon Flexner in 1917, when he was Director of Laboratories at Rockefeller; and by Dr. Thomas M. Rivers in 1939, when he was Director of the Hospital.

On October 15 Rebecca C. Lancefield, professor emeritus at Rockefeller, presented the T. Duckett Jones Memorial Lecture at the annual meeting of the American Heart Association in Bal Harbour, Florida. Although the puzzle of rheumatic fever is not completely solved, there is overwhelming evidence that, directly or indirectly, a causal relationship exists between the disease and one of the groups of bacteria that Dr. Lancefield has studied extensively – Group A streptococci. In reviewing the evidence, Dr. Lancefield also mentioned recent work by John B. Zabriskie and other colleagues at Rockefeller similar to that reported by Kaplan in Cleveland showing that Group A streptococci and human myocardial fibers share a cross-reactive antigen. In her speech she observed that whereas the world-wide decrease in incidence of rheumatic fever may be chiefly connected with improved living conditions, "it is undoubtedly also due to some extent to the better control of scarlet fever and streptococcal pharyngitis by drugs and antibiotics." Moreover, she added, the striking reduction in severe heart disease is unquestionably the result of effective attempts to prevent the occurrence of streptococcal pharyngitis in rheumatic fever patients. Unfortunately, however, the causal mechanism between infection and the symptoms of rheumatic fever is still inadequately understood.

On October 25 Professor Emeritus Paul A. Weiss spoke in Seattle at the ceremony for the presentation of the first Arches of Science Award to Dr. Warren Weaver of the Rockefeller and Sloan foundations. In his presentation speech on behalf of the Pacific Science Center Foundation Dr. Weiss said that Dr. Weaver was being honored not so much for bringing the results of science to public attention, but for emphasizing their meaning in those endeavors where the public is the beneficiary. As a member of the federal government's National Planning Board, Dr. Weiss helped with the development of the Seattle World's Fair U. S. Science Exhibit – which later became the Pacific Science Center.



ACS 150th

At the 150th National American Chemical Society Meeting, Atlantic City, September 12-17, it was announced that Professor Lyman C. Craig, *photograph above,* had won the $1000 Fisher Award in Analytical Chemistry. The Award, sponsored by the Fisher Scientific Company, will be presented next spring at the Society's 151st national meeting in Pittsburgh. According to the Award nomination, many of the important advances made in biochemistry in the past several years would not have been possible without Dr. Craig's counter-current distribution technique. Counter-current distribution separates chemicals by small differences in their solubility, and has been success-

fully used to purify synthetic antimalarial drugs, penicillins, proteins, and hormones. "The basic principle involved is not new, but the particular mode of applying the principle is so ingenious, so theoretically sound, and so practical that the method introduced a revolution in the realm of the separation of mixtures containing very similar components."

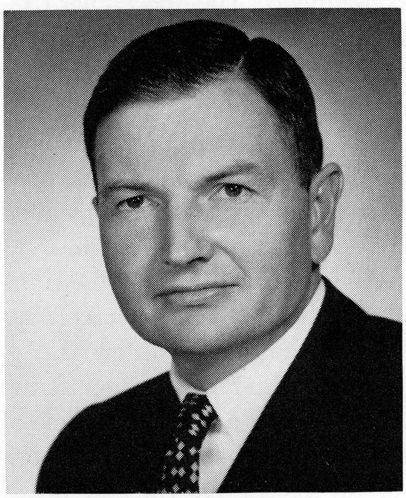
Other participants at the ACS meeting included Associate Professors Gertrude E. Perlmann and Gerald M. Edelman, who presented the Garvan Medal and Eli Lilly Award addresses respectively. Dr. Edelman spoke September 13 at the Symposium on Gamma Globulins (Professor William H. Stein presiding) on "The Structure and Activity of Antibodies." The next day Dr. Perlmann addressed the Symposium on Protein Structure, speaking on the "Anatomy of a Protein Molecule." At the same Symposium Doctors Stein, Liu, Gerwin, and Moore presented a paper entitled "Studies on Streptococcal Proteinase"; and on September 16 Doctors Hinsdill and Goebel spoke on "The Chemical Properties of Colicines," and Doctors Stewart and Woolley on the "Effect of Proline Configuration of Pro- and Antiactivity of Bradykinin Peptides."

Trustees Honored

THREE OF THE Trustees of the University have recently been honored for their contributions to community service, chemistry, and education. In recent months Chairman David Rockefeller received the Gold Key Award from the Avenue of the Americas Association for his outstanding contributions to the unity of the Western Hemisphere and the Gold Medal Award of the Hundred Year Association "in recognition of outstanding achievement for the advancement of New York." Less than a year ago Mr. Rockefeller was given the West Side Award gold medal, and it has been announced that the New York Chapter of the American Institute of Architects will present him with the Award of Merit at their meeting in December.

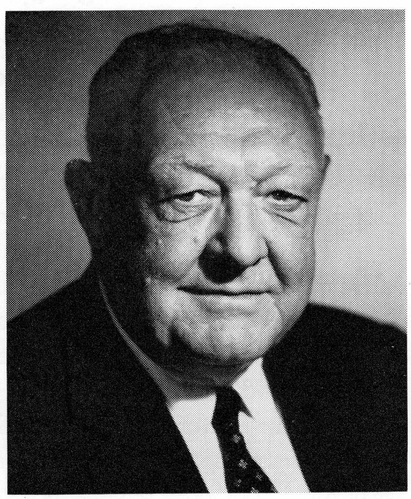
The award of the Priestley Medal for "distinguished services to chemistry" to Dr. William O. Baker was announced by the American Chemical Society in September. The award — considered the highest honor in American chemistry — will be presented to Dr. Baker next spring at the Society's 151st national meeting in Pittsburgh. Noted for his research on polymer molecules, Dr. Baker holds fifteen patents and is Vice President for Research of Bell Telephone Laboratories.

The Harvard Business School has established a Professorship of Business Administration with an endowment of $500,000 in honor of Donald K. David, Trustee of Rockefeller University and Vice Chairman of the Ford Foundation. Mr. David — for thirteen years Dean of the Harvard Business School — was one of the innovators of the case method of teaching business administration and among those invited by Mr. Ford in 1948 to become the first Trustees of the Ford Foundation to be elected outside of the immediate circle of the Ford family.



DAVID ROCKEFELLER

WILLIAM O. BAKER



DONALD K. DAVID

Automated Peptide Synthesis

R. B. Merrifield, Associate Professor of the University, describes in the October 8 *Science* the methods he and Associate Professor John M. Stewart have developed for the automated synthesis of peptides. Several biologically active compounds, including bradykinin and angiotensin, have already been prepared by this method, and Dr. Merrifield predicts its extension to the synthesis of much larger peptides—and possibly even proteins. The ability to synthesize proteins automatically would, of course, have broad implications for medical treatment and research.

Dr. Merrifield defines his method as "solid-phase" peptide synthesis, because the basic idea underlying the new procedure is the use of an insoluble, easily filterable, solid particle as an anchor for the growing peptide chain. The desired amino acids are added one by one to the anchored chain, while the soluble reagents and by-products can be removed at each step by washing. Since the entire procedure can take place within one reaction chamber, all operations consist of transferring solutions to and from this chamber, making automation of the method highly practicable. By use of the automated techniques, complete synthesis of bradykinin (which contains nine building blocks of amino acids) can be achieved, with good yield, in thirty-two hours of continuous automated operation.

Sloan-Kettering Symposium

Three Rockefeller University professors participated in the Symposium on Macromolecules and Cancer held October 18-20 in commemoration of the Twentieth Anniversary of the Sloan-Kettering Institute for Cancer Research. Edward L. Tatum was chairman of the Monday morning session on "Genetics and Macromolecules"; the next day Vincent G. Allfrey spoke on "Control Mechanisms in Ribonucleic Acid Synthesis"; and Theodosius Dobzhansky chaired the Wednesday morning meetings on "Macromolecules and Man."

The Sloan-Kettering Institute, the research affiliate of Memorial Hospital for Cancer and Allied Diseases, is not only a neighbor of the Rockefeller but has had many close personal ties with the University. Sloan-Kettering's first director was Cornelius P. Rhoads from the Rockefeller. After Dr. Rhoads's death in 1959 Rockefeller's Frank L. Horsfall, Jr., Vice President for Clinical Studies and Physician-in-Chief to the Hospital, became President and Director of Sloan-Kettering. Peyton Rous, Richard E. Shope, and Edward L. Tatum all serve as members of Sloan-Kettering's Board of Scientific Consultants, and President Bronk is a Member of the Board of Trustees. The most recent contribution of the Rockefeller to Sloan-Kettering is Peter J. Gomatos, who joined Sloan-Kettering this fall as Associate Member and Chief of the Division of Virology [July-August *Review*, page 23].

...from the bookshelf

Viral and Rickettsial Infections of Man, 4th edition, edited by Frank L. Horsfall, Jr., and Professor Igor Tamm. J. B. Lippincott Company: Philadelphia, October, 1965. Illus., 1282 pages.

When Thomas M. Rivers conceived and edited *The Filterable Viruses* in 1928, the emergent science of virology began for the first time to come into focus. This relatively slim volume not only described the properties of the viruses then identified, but in it Rivers established the important principle that viral multiplication is absolutely dependent on the living cell. Concurrently, as a result both of his personal research activities and his remarkable capacities for clear judgment, Rivers was for decades the unofficial dean and arbiter of viral and rickettsial research in this country. As a consequence, The Rockefeller University, with which Rivers was associated for most of his professional career, came to be a center for the study of virology.

Viral and Rickettsial Infections of Man was both the product and the reflection of Rivers' unique position in research and training. The first edition, edited by Rivers, was published in 1948, the second in 1952, and the third, edited by Rivers with Frank L. Horsfall, Jr., his long-time colleague and coworker, appeared in 1959. This fall the fourth edition has appeared, edited by Horsfall with Professor Igor Tamm of the University. This edition, a massive volume of fifty-four chapters and almost 1300 pages, bears eloquent testimony to the recent growth and broad scope of medical virology. Among the fifty-seven con-

tributors are several from Rockefeller, besides Dr. Tamm: Richard E. Shope, Purnell W. Choppin, and Hans Eggers (now in Tübingen).

Dr. Rivers died in 1962. At the beginning of the fourth edition the editors state: "The contributors, many of whom were associated with him, share with us the belief that he would have considered this, the fourth edition of his book, an appropriate tribute and a fitting memorial."

HEREDITY AND THE NATURE OF MAN, by Professor Theodosius Dobzhansky. London: George Allen & Unwin, Ltd., 1965. 179 pages.

The British edition of this work follows the American version published by Harcourt, Brace & World in 1964, and has been well received by British critics. For example, the September 9 *Times Literary Supplement* says, "This book, by one of the leading world authorities on genetics and evolution, is based on talks given for the Holiday Science Lecture series at Los Angeles and Minneapolis. The purpose of the series [introduced in this country by The Rockefeller University and sponsored by the American Association for the Advancement of Science] is 'to broaden the scientific horizons of the audience, and to communicate to them some of the excitement and inspiration of the scientific endeavor,' and Dr. Dobzhansky has fulfilled that purpose triumphantly. With exemplary clarity he describes the nature of heredity . . . with a simplicity that any intelligent boy or girl can follow he shows how the DNA molecule can reduplicate itself . . . he brings home the magnitude of the achievement 'to have understood the method of construction of the genetic messages, even if, for the time being, we cannot spell many of them out ourselves in the laboratory.'"

MAN ADAPTING, by Professor René Dubos. New Haven: Yale University Press, October, 1965. 527 pages (including a fifty-two page bibliography and a generous index).

"The dominant theme of the present book," in the words of Professor Dubos, "is that the states of health or disease are the expressions of the success or failure experienced by the organism in its efforts to respond adaptively to environmental challenges." Dr. Dubos distinguishes between *reaction with* and *response to* the environment. To be really relevant to the human condition, the concept of adaptability must include not only reaction with environmental forces, but also responses not necessarily aimed at coping with the environment. Such responses "often correspond rather to an expressive behavior and involve the use of the environment for self-actualization." Dr. Dubos, a microbiologist, states in the preface that his concern with "the biological and social implications of man's response to his total environment" emerged from "an increasing awareness of the fact that the prevalence and severity of microbial diseases are conditioned more by the ways of life of the persons afflicted than by the virulence and other properties of the etiological agents. Hence the need to learn more of man and of his societies, in order to try to make sense of the pattern of his diseases."

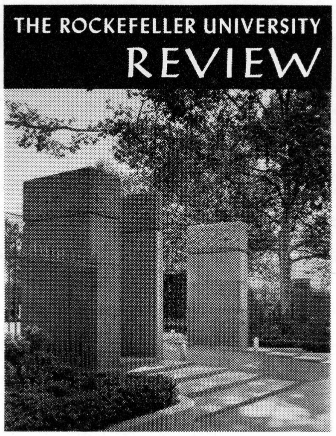
Environmental pollution, the population avalanche, medical ethics, and some of the dilemmas posed by modern medicine and technology are among the problems dealt with by the author. The book is based on the six Silliman Lectures delivered by Dr. Dubos at Yale in the fall of 1964.

Dr. Dubos closes by re-emphasizing the importance of differentiating among the world's many different ways of life when practicing medicine: "Medicine and public health do not develop or function in a social void. They provide the social adaptive mechanisms that complement the biological adaptive responses to the conditions of life at a given time. They can fulfill their purpose, to improve the people's health, only if they are fitted to the needs and resources of the community as well as to the special conditions created by the total environment."

During the opening weeks of the academic year new members of the faculty and new students were welcomed at a reception given by President Bronk and the University Trustees. Over three hundred and fifty were present in the large recreation room of the Graduate Students Residence on October 18 to greet the new members. The motif for the décor was sprays of sea oats provided by Mrs. Patricia Berlin, who also chose this occasion to display some striking paintings from Lester Wolfe's collection of contemporary Mexican art. An expanded selection will be on exhibit through the academic year, including works by Raúl

Anguiano, José Luis Cuevas, Enrique Echeverria, José Clemente Orozco, Diego Rivera, and Rufino Tamayo.

⁋ Among the organizations that the University has been host to recently are the American Institute of Physics, which held its Eighth Annual Meeting of Corporate Associates on September 30; the Armed Forces Epidemiological Board, which held a meeting of the Committee on Radiation and Infection early in October; the Executive Committee of the New York City Health Research Council; the New York Branch of the American Society for Microbiology; the Space Science Board of the National Academy of Sciences; and the National Tuberculosis Association, which sponsored a Seminar on Emphysema for Science Writers. One of the links between the Association and the University is through Professor Dubos, whose work on the tubercle bacillus led to his being awarded the Trudeau Medal by the Association in 1951.



THE COVER shows the Avery Memorial Gateway on an afternoon in early fall, story on page 9 of this issue. The photograph is by Don C. Young.

ACKNOWLEDGMENTS: Pages 1–8 photographs by Carmelo Guadagno courtesy of the Museum of the American Indian, Heye Foundation. Page 9 photograph *left* by The Rockefeller University Illustration Service, *right* by Heka. Pages 10 and 11 photographs by Heka. Pages 15–20 light microscope photographs and electron micrographs by Maria Rudzinska. Pages 22 and 24 photographs by The Rockefeller University Illustration Service. Page 25 photograph of Rockefeller by Jan Jachniewicz, The Chase Manhattan Bank; photograph of Baker courtesy of Bell Telephone Laboratories Publication Department; photograph of David courtesy of the Ford Foundation.