epitaxially grow silicon layers on silicon wafers, oxidize silicon surfaces, deposit insulating films on silicon, and deposit metal films on silicon, all at low temperatures as compared to the usual practices. While little or no comparable work on such a process is under way in the United States, the Japanese equipment maker, the Anelda Corporation, has already translated the NTT design into commercial instruments.

In summing up the reasons for the Japanese success in developing new electronic materials processing technologies, Poate pointed to four factors identified in the report. The first is *commitment* as manifested by the willingness of Japanese industry to dedicate both people and money to long-term research and development projects with a 10-year perspective. Oversight and funding from the Ministry of International Trade and Industry also helps.

The second factor is *coupling*, which occurs in two ways. Within a Japanese semiconductor company, there is a close coupling between exploratory research and development and product development. There is also a close interaction between the semiconductor company and the equipment makers. As one person commented from the floor during the seminar, U.S. equipment makers are often prevented by nondisclosure agreements from exploiting what they learn by working with a semiconductor company on a new processing technology.

The third factor is *commerce*. Japan's semiconductor industry comprises at least ten firms that are large enough and farsighted enough to pursue research across a broad range of technologies and to cover product development at every stage from the laboratory to the marketplace. Only two American companies can match this scale of effort. Though not mentioned by name, presumably these are AT&T and IBM, both of whom make chips for internal use only.

Finally, the fourth factor is *creativity*, which, in contrast to their past copy-cat image, the Japanese are demonstrating in their research and development programs for advanced electronic materials processes.

In the afternoon discussion of policy implications, which was chaired by White, no one seriously questioned these findings, although John Armstrong of IBM and others expressed much interest in upgrading university laboratories and getting them to contribute more directly, and Robert Stratton of Texas Instruments pointed out the low status in the United States of the manufacturing engineer as another important factor. All in all, the sentiment was that some way to fill in the gap between short-term development and long-range research has to be found. ■ ARTHUR L. ROBINSON

Anthropologists Suggest Cannibalism Is a Myth

The anthropology literature is full of stories of cannibalism, but increasingly many anthropologists are now saying that unequivocal evidence for this practice is nonexistent

WILLIAM Arens of the State University of New York at Stony Brook says he got interested in cannibalism for the most innocent of reasons. He was teaching an introductory course in anthropology in 1977 when, halfway through the semester, a student asked why he was lecturing "on kinship, politics, and economics instead of more interesting things like witchcraft, fieldwork experiences, and cannibalism."

The student's question, says Arens, "struck a sympathetic chord since I remembered that these were very much like the topics which first attracted me to anthropology." But like nearly all anthropologists, Arens notes, he ended up paying "more attention to the esoteric than the exotic." So he decided to prepare a lecture on cannibalism for his students. He ended up, however, provoking a debate among anthropologists that shows no signs of letting up.

What Arens concluded after investigating countless accounts of cannibalism is that there are no reliable firsthand witnesses to this practice. Even in New Guinea, where cannibalism is presumed to have spread the slow virus disease kuru, there is no good evidence for cannibalism, Arens and others say. This is not to say that no one ever ate human flesh. Survival cannibalism—eating another human being in order to survive a plane crash in the Andes, for example—clearly has occurred. But Arens argues that there is no evidence of ritualistic cannibalism—the routine and systematic eating of human flesh. "If I'm right, anthropologists are engaged not in a lie, not in a hoax, but in a myth. They are retelling what is always assumed to be true," he remarks.

Arens has gathered a sizeable group of supporters and has stimulated anthropologists and archeologists to take a careful look at the cannibalism evidence and to ask why cannibalism was ever attributed to various groups in the first place. The question of whether people are or ever were cannibals, says Erik Trinkaus of the University of New Mexico, "is very much tied into our views of who we are and what we are." Lyle Steadman of Arizona State University remarks, "I think Arens is right on target. But he really threatens a lot of anthropologists." Tim White of the University of California at Berkeley is now traveling around the world, looking at cut marks on hominid fossils that have been attributed to cannibalism, to try and determine their origin. And William Durham of Stanford says that Arens's arguments have made him a lot more skeptical of reports of cannibalism.

But not everyone has decided that cannibalism is a myth. D. Carleton Gajdusek of the National Institute of Neurological and Communicative Diseases and Stroke, who won a Nobel prize for his studies of kuru in New Guinea, says that the evidence of cannibalism in New Guinea is so clear that "it's beneath my dignity to answer the argument. The people who are involved with it or know of it have not deigned to get into the argument." And at least one group reports what it considers extremely strong circumstantial evidence that cannibalism was practiced during the Neolithic era. Led by Paola Villa of the University of Colorado and Claude Bouville and Jean Courtin of the University of Provence, these researchers argue that a group of Neolithic cave dwellers in France most likely were cannibals.

When he began to investigate reports of cannibalism, Arens immediately learned that groups never say that they themselves are or even recently were cannibals. It is always their enemies or strangers or other more primitive groups of people who are said to eat human flesh. When people do refer to themselves as cannibals, it is only far back in the most distant past—a way of showing how civilized they have become. Thus the Chinese said the Koreans were cannibals and the Koreans in turn said the Chinese were cannibals. Africans charged that Europeans were cannibals and Europeans said the Africans were. In fact, anthropologists themselves have been mistaken for cannibals. John Middleton of Yale University reported in 1970 that when he worked among the Lubgara of Uganda, the tribe had to redefine him, in Arens's words, "as one of those rare Europeans who did not eat African babies." Arens notes that "I soon learned

that the cannibal epithet has been applied at one time or another to someone in every human group."

This is not to say that there are no eyewitness reports of cannibalism in the anthropology literature. But those reports are highly suspect. For example, the Tupinamba Indians of South America are well known to anthropologists as cannibals, largely on the basis of reports by Hans Staden, a 16th century seaman on a Portuguese trading ship that visited the coast of South America. Staden was shipwrecked and captured by the Tupinambas. He eventually was rescued and returned to Germany where he published a book entitled in part *Hans Staden: The True History and Description of a Country of Savages, a Naked and Terrible People, Eaters of Men's Flesh, Who Dwell in the New World Called America*. The book is illustrated by woodcuts showing the cannibals in action. "Staden is easily identified in these scenes as the one in the fig leaf with hands clasped in prayer," Arens notes.

Staden gives a detailed description of a grisly party that ends with the natives devouring a captive. The victim is brought forth, bound, whereupon he is taunted by women. Then he is forced to watch as the Indians build a fire to roast him and show him the club that they will use to kill him. Once he is clubbed to death, the women seize his body, dismember it, and run around the village brandishing the victim's limbs. Finally, the body is cooked and eaten. Staden, in telling this tale, notes, "I was present and have seen this with my own eyes."

But Arens is doubtful. First, he remarks, the book was written 9 years after the events and was almost certainly written by ghostwriters under Staden's supervision. "Therefore, we are not dealing with the work of a single individual trained in the craft of ethnography but rather with a committee, only one of whom was on the scene," Arens says.

A second reason for skepticism is that the book has numerous internal inconsistencies. For example, Staden quotes verbatim the Indians' discussion on the first day of his captivity in which they spoke of how, when, and where they would eat him. However, Staden could not possibly have understood the Indians' language on the very day he arrived. In another scene, Staden repeats a psalm in German and the Indians immediately respond. Again, it is inconceivable that the Indians could have understood German so well and so quickly.

Others who visited the Tupinamba after Staden confirmed the cannibalism among these Indians. But Arens notices that these reports seem to echo Staden's, even to the dialogue. These later visitors, Arens remarks, "take some liberties with Staden's account of the scene without having given him due credit for having propounded this dramatic little scene and dialogue in the first place. Plagiarism of this sort, which has been documented for other times and places, was fairly common in the reports of travelers to foreign lands so as not to be outdone by the colorful accounts of other sojourners."

Perhaps the best known example of cannibals are tribes of New Guinea, and particularly the Fore, who live in the highlands. The Fore developed kuru, a degenerative neurological disorder that is caused by a slow virus that inhabits the brain. The Fore were infected by the virus, it is said, because they ate human brains.

Here, again, there is a long tradition of reports of cannibalism, but this time the reports are by professional anthropologists. Nonetheless, Arens and others argue, these reports turn out to be highly questionable on close examination.

Among the first to do fieldwork in New Guinea was Margaret Mead, who visited in the 1920's and 1930's. She called chapter two of her book on the New Guinea tribes "The Pace of Life in a Cannibal Tribe." But she noted that she did not actually witness the eating of human flesh because the practice had been outlawed by the Australian government 3 years before she arrived. She used the present tense in her book, she explained, because she was referring to the practices when the people were cannibals. In fact, she told her readers, she learned of the cannibalistic practices of the Mundugumor tribe not from the tribe itself but from its neighbors, "the gentle Arapesh."

Cannibalism among the Fore was very much in the New Guinea tradition. The Fore women, in particular, were reported to be outrageous cannibals, often, according to reports, combining unusual sexual acts with the consumption of human flesh. Arens comments, "if there was such a thing as cannibalistic perversion to accompany the sexual variety, the word 'Fore' would become synonymous with the idea."

When D. Carleton Gajdusek arrived in New Guinea in 1957, he immediately heard of the Fore's propensity to eat human flesh. Upon investigating the disease kuru and finding that it was caused by an infectious

What are these people eating? *This photo of Fore tribesmen of New Guinea was published in* Science *(2 Sept. 1977, p. 956) as part of D. Carleton Gajdusek's Nobel lecture. Just above the photo was another of a kuru victim. The caption reads, "All cooking, including that of human flesh from diseased kinsmen, was done in pits with steam made by pouring water over the hot stones, or the flesh was cooked in bamboo cylinders in the hot ashes. Children participated in both the butchery and the handling of cooked meat, rubbing their soiled hands in their armpits or hair and elsewhere on their bodies. They rarely or never washed. Infection with the kuru virus was most probably through the cuts and abrasions of the skins, or from nose picking, eye rubbing, or mucosal injury." Although many readers have assumed that this is a photo depicting cannibalism, it is not. Gajdusek, when asked, replied that the people are actually eating roast pork. He never publishes actual pictures of cannibalism, he says, because they are "too offensive."*

agent, a slow virus, Gajdusek said that the disease was spread by cannibalism. He has written that the kuru virus gets into the mucous membranes of the Fore when they engage in their cannibalistic rituals, thereby infecting them.

Kuru was especially prevalent among women and children, which fit well with the reports that the Fore women were the cannibals. Moreover, the reports stated that the Fore became cannibals at the turn of the century, which is when kuru first appeared among them.

Yet, says Lyle Steadman "there is no evidence of cannibalism in New Guinea." Steadman, who spent 2 years doing fieldwork in New Guinea, notes that he often heard tales of cannibalism but when he probed, the evidence evaporated. "It is really interesting that cannibalism has been talked about in print since the time of the Greeks, but no solid reporter has ever witnessed it," he remarks.

Steadman proposes that the kuru virus was transmitted to Fore women when they handled the bodies of their deceased relatives. Throughout New Guinea, women engage in mortuary rituals, including exhuming bodies soon after burial or suspending bodies in the houses while they decay. As part of these rituals, New Guinea women frequently handle skulls, sometimes removing the brain from the skulls. The virus could easily penetrate mucous membranes during such rituals, and so, Steadman points out, cannibalism is actually not at all necessary for kuru transmission.

It is ironic, Steadman notes, that the turn of the century, when kuru was first noticed among the Fore, is also the time of the first European contact. "What's probably happened is that kuru is a variant of Creutzfeldt-Jakob disease, another slow virus disease, which was almost certainly introduced by the Europeans. Rather than a savage disease transmitted savagely, kuru is a European disease."

Gajdusek vehemently disagrees. "The whole of Australia knows these people are cannibals. It is 100% documented." Countless tribe members have been arrested for cannibalism by Australian authorities, Gajdusek points out. Moreover, he says, he has actual photographs of cannibalism, but he would never publish them because they "so offend the relatives of the people who used to do it." He does sometimes show the slides to medical audiences, he remarks. (Steadman contends that these are slides showing dismembered bodies but not photos of Fore actually eating human flesh. "They are pictures of a hack murder," Steadman says.) The anthropologists who question the cannibalism data, says Gajdusek, are "desk anthropologists sitting around in chairs. If they would just get off their asses and go to New Guinea, they would find hundreds of cases." Steadman and others remain to be convinced. "Gajdusek has no evidence. I think that's real clear," Steadman says.

Cannibalism seen?
A woodcut from Staden's book telling of the cannibalistic nature of the Tupinamba Indians. Staden, notes William Arens, "is easily identified as the one in the fig leaf with hands clasped in prayer."

The cannibalism literature is not just a literature of savage tribes living within the past few hundred years. It is also a literature of human ancestors living thousands or even millions of years ago, and here the evidence is more indirect and requires real state-of-the-art archeological methodology for verification. In many instances, the cannibalism reports have not held up.

Among the most famous archeological sites of cannibalism is Krapina, a Neanderthal site in Yugoslavia. At that site, archeologists found bones from as many as 70 individuals. This is in sharp contrast to other sites where remains of no more than four individuals were found. Moreover, the Krapina bones, says Mary Russell of Case Western Reserve University, "were all scratched and badly broken. The idea was that they are the remains of a Neanderthal feast."

Krapina was first excavated at the turn of the century by Draguton Gorjanović-Kramberger who was, according to Russell, "a superb paleontologist. He was literally decades ahead of his time and was not likely to miss a trick." Gorjanović-Kramberger reasoned that since the bones at Krapina were badly broken and animal bones were mixed in with human bones, the Neanderthals were treating all meat-bearing species alike.

But is was also possible that the Krapina bones were scratched and broken as a result of a secondary burial ritual. These rituals are quite common in all parts of the world and involve exhuming bodies and defleshing the bones. So, Russell asked, "How would you be able to tell the difference between a secondary burial and cannibalism?" She decided to compare the cut marks on bones that were treated for secondary burial with those on bones that were defleshed for meat to see if there was a difference in the pattern of cut marks. Her hypothesis was that the secondary burial bones should have many more cut marks because they were scraped until they were clean. The meat bones should have significantly fewer cut marks because they were scraped just enough to get off the meat.

Russell compared secondary burial bones of American Indians to the bones of reindeer that were eaten for meat. Her hypothesis held. Then she examined the Krapina bones. They had cut mark patterns almost identical to those of the Indian bones and entirely different from the patterns on the reindeer bones. She concludes that "the Krapina Neanderthals were not cannibals."

Yet, say another group of archeologists, they now have evidence that strongly suggests cannibalism among people dwelling in a cave during the Neolithic era, several thousand years ago. Paola Villa, Claude Bouville, Jean Courtin, and their colleagues began by excavating Fontbrégoua Cave in southeastern France and discovered disposal pits that were dug intentionally by the cave's inhabitants. They found animal bones in some pits and human bones in others. And, tellingly, the the animal bones and the human bones appeared to have cut marks and the cut marks on the animal bones were in

the same places as the cut marks on the human bones.

The researchers consulted Pat Shipman of Johns Hopkins University School of Medicine, asking whether the marks were indeed cut marks and not just marks from scraping of the bones across the cave by carnivores or marks from weathering. "What came across very clearly for my part was that if anything is a cut mark, these are cut marks," Shipman says. "The marks are *extraordinarily* well preserved. They are in very pristine condition."

With Russell, Shipman did experiments to determine when after death the cut marks on the bones were made. If the cut marks were made during a secondary burial, the bones would have been older than the marks. If they were made during cannibalism, the bones and the marks would have been contemporaneous. Their conclusion, says Shipman, is that, "you can distinguish between immediate and delayed processing. It has to do with the weathering of the bone and the weathering of the mark. Within the limits that we can detect—and there is some slop in there—the bones were not weathered when the marks were made."

"From the evidence we have, it looks like there wasn't any distinction between people and animals," Shipman remarks. "If that was true—and it's a big if—that says something very interesting. These *were* people. They were *Homo sapiens*, they had domestic animals and pots." Perhaps the Fontbrégoua residents did not eat each other but instead ate members of other tribes. They may not have distinguished between members of other tribes and animals, Shipman speculates. "Many tribal people have as words for themselves 'humans' and for all others 'non-humans.' It is the ultimate sort of us and them."

But, of course, the Fontbrégoua site is far from ironclad evidence of cannibalism, and even if it were cannibalism, there is no way of knowing whether it was survival cannibalism or whether is was a systematic, cultural practice of eating other human beings. Since saying that others are cannibals is perhaps the ultimate derogatory comment, Arens notes, and since "there is no evidence of cannibalism, we have a moral responsibility not to portray people in such a way." ■

GINA KOLATA

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Lost Neurons Identified in Alzheimer's Disease

The mental deterioration of Alzheimer's disease is caused by an extensive and irreversible degeneration of brain neurons, especially in regions, such as the cerebral cortex and hippocampus, that are concerned with memory. For the most part, however, little is known about the specific identities of the neurons lost from the cortex and hippocampus, and the biochemical changes underlying the neuronal degeneration also remain mysterious. As Carol Miller of the University of Southern California in Los Angeles points out, "You can't do molecular biology on what has already been lost," unless you have some way of identifying the affected neurons before they degenerate.

Speaking at a recent meeting* in Galveston on "Molecular Neuroscience: Expression of Neural Genes," Miller described research from her laboratory that may contribute to a better understanding of Alzheimer's disease by doing just that. "We have identified a cortical subset of cells that may be selectively vulnerable in Alzheimer's disease," she concludes.

For the past few years, Miller and her colleagues have been using monoclonal antibodies to define populations of human brain neurons that are chemically and, presumably, functionally distinct. Many of the antibodies were originally produced by Seymour Benzer and his colleagues at the California Institute of Technology to antigens from the brains of the fruit fly *Drosophila melanogaster*. Somewhat to the surprise of Benzer and Miller, nearly half of the *Drosophila* antibodies also proved to stain specific cells in the human brain.

In the current work, the USC workers compared the antibody-staining patterns of brains removed at autopsy from Alzheimer's patients with the staining patterns of brains from individuals who died of other causes. One antibody, which was made against a human brain antigen, stained a broad group of nerve cells in the hippocampus and cerebral cortex.

Staining with two of the *Drosophila* antibodies identified two distinct subsets within this group. One antibody reacted with the stellate neurons in layers 4 and 6 of the cortex and the second stained a subset of pyramidal cells located in layers 2, 3, and 5 of the cortex and also in some areas of the hippocampus. The pyramidal subset was associated with cellular pathology and the corresponding antigen was reduced in the Alzheimer's brains.

This fits, Miller notes, with what is already known about the patterns of neuronal loss in the disease. Cortical and hippocampal pyramidal cells are decreased in the patients' brains. There may be more than one type of pyramidal cell, however, and use of the antibodies may help to pinpoint the losses more accurately.

The cholinergic neurons of the basal forebrain, which use acetylcholine as their neurotransmitter and innervate the hippocampus and parts of the cortex, also decline in Alzheimer's disease. Miller is currently determining the relation between the pyramidal subset identified in her laboratory and the cholinergic neurons. ■

*The meeting was held at the University of Texas Medical Branch in Galveston on 8 to 10 May.

Nerve Activity Alters Neurotransmitter Synthesis

As researchers begin to apply the techniques of molecular biology to the study of nerve cells, they are finding that neurotransmitters may have a broader role than was previously thought. Neurotransmitters, the chemical signals released by nerve cells onto their target cells, are known to act within milliseconds to bring about target responses. The new work is showing that the agents may also have much longer-term effects that can alter the activities of responding nerve cells for days and weeks. Such alterations may contribute to memory formation.

Ira Black of Cornell University Medical College in New York City provided a recent case in point at the Molecular Neuroscience symposium. He and his colleagues have been studying how stimulation, or the lack thereof, alters neurotransmitter synthesis by peripheral and brain neurons. For example, peripheral neurons from the sympathetic ganglion make the classic neurotransmitter norepinephrine and also the neuroactive peptide substance P. When the nerve cells are grown in culture, where they are deprived of the incoming nerve signals that they would receive in the living animal, their concentrations of substance P increase. According to Black, this effect is preceded by an increase in the amount of the messenger RNA (mRNA) for the peptide and may