Volunteers Honored

An impressive, record total of 49,621 hours were contributed by 280 Field Museum volunteers in 1978. Volunteer work was performed in a variety of Museum departments and divisions: anthropology, photography, botany, education, exhibition, geology, zoology, the library, membership, public relations, and publications, among others.

Expertise was provided in cataloguing new acquisitions, textile conservation, collating, specimen identification, reorganizing old collections, typing, editing and writing, instructional facilitating, filing, and even in routine maintenance tasks.

In honor of their outstanding contributions, a buffet dinner was held for the volunteers in Stanley Field Hall on February 27. Museum President and Director E. Leland Webber presented gifts of appreciation to the volunteers; he gave special tribute to Sol Gurewitz, a Field Museum volunteer for eighteen years. The evening was concluded with a presentation of songs by Field Museum staff.

Solomon Gurewitz Carol Small Kaplan

Solomon Gurewitz: The Volunteer as Unpaid Museum Professional

Most of Field Museum's staff rarely appreciate how unusually lucky we are in our volunteers, even though we seem to have more of them, and to get more and better work from them, than any comparable institution in the area. Visiting staff from other museums tend to be astonished when told that many volunteers here put in as much as several hundred man- or woman-hours in an average year. We, however, are not surprised. We take such remarkable performances almost for granted, and all because of one man: Mr. Solomon Gurewitz, the volunteer who set the pattern 18 years ago. He still works three days a week every week. Though unpaid, he is as professional as any member of the paid staff. All of us have come to expect that other volunteers will have at least part of the talent and dedication of a Gurewitz.

He came to the Museum in 1961, freshly retired and enthusiastically interested in Asian culture. As there was no regular volunteer program in those days, he had to talk his way in. He succeeded easily, being then as now a good talker. Within a month he had shown he was capable of doing many of the tasks of a trained museum anthropologist. Within a year he was an indispensable member of the Anthropology Department's staff.

He was given responsibility for rearranging and restoring the Museum's large Oriental collections. He became expert enough on these materials to give many lectures and to guide high-powered professional visitors to materials they wished to study. He was often asked to advise on materials for exhibition, on the selection and packing of loans, and on cataloguing. He helped with almost everything and took charge when necessary, having become a true jack-of-all-museum-trades.

About 15 years ago, he started to branch out in a new direction. Much of the Museum's collection had never been photographically recorded even though, as he pointed out, contemporary museological standards required this for reasons of both security and research. He convinced the authorities that the Museum's regular photography department could hardly keep up with new accessions, much less work its way through the enormous backlog of unrecorded material acquired in earlier years. He received authority to set up a special photography section within the Anthropology Department. Since then he has been the departmental photographer. He and several associates, all volunteers, take several thousand highly professional pictures annually.

In the midst of this never-ending task, Sol still finds time to help orient new volunteers, to advise on numerous problems, to act as unofficial Departmental historian, and to be active in the Museum's professional and social life. It is an amazing achievement and, although we may appear to take it for granted, we are naturally both impressed and grateful. To show this gratitude, Sol was several years ago made an Associate of the Museum, and this year the annual Volunteer Party is being dedicated to him. But we have an ulterior motive besides gratitude. We want to publicize him as an example. His influence has already produced a few unpaid staff members almost as good as Sol. We hope that his example will help bring in more Gurewitzes in future years. — *Bennet Bronson, associate curator of Asian archaeology and ethnology*

Special Recognition

Over 500 Hours

Patricia Talbot (828 hours): *Geology;* compiling Mazon Creek fauna guide

James Swartchild (742 hours): *Anthropology;* photography of new acquisitions and objects for special research and exhibition projects

Sol Century (714 hours): *Anthropology;* cataloging new acquisitions; working on plans for more efficient storage of collections

David Weiss (702 hours): *Anthropology;* working as general assistant to the curator; helping develop new security routines

Miya Esperanza Diablo (671 hours): *Education;* educational facilitator and statistical analyst

Jeanette Leeper (611 hours): *Anthropology;* textile conservation

Claxton Howard (607 hours): *Library;* sorting, typing, and reading room assignments

James Burd (606 hours): *Anthropology;* general assistant to the curator; in charge of planning departmental reorganization; cataloger

John O'Brien (598 hours): *Education;* assisting in preparation of Harris Extension materials and resources

Sol Gurewitz (579 hours): *Anthropology;* photography of new and unphotographed specimens; advising on Chinese collections

Peter Gayford (578 hours): *Anthropology;* editorial and research work connected with forthcoming catalog of Chinese rubbings

Alice Schneider (574 hours): *Anthropology;* editorial and research work on Chinese rubbings catalog

Burke Smith, Jr. (501 hours): *Zoology* (Division of Insects); curatorial assistance with orthoptera collection

Over 400 Hours

Louva Calhoun: *Anthropology;* illustrating stone tools for publication

Anne Leonard: *Anthropology;* tapacloth project researching

Margaret Martling: *Botany;* cataloging library reprints

Carolyn Moore: *Anthropology;* research and cataloging on Japanese collections

LeMoyne Mueller: *Anthropology;* conservation of North American Indian beadwork collection

Sylvia Schueppert: *Anthropology;* conservation of North American Indian beadwork collection

Eleanor Skydell: *Education;* researching and developing the Weaver's Walk for Adult Group Programs

Over 300 Hours

Virginia Beatty: *Botany;* organizing and cataloging collection of New Zealand hepatics and general assistant to curator

Rose Buchanan: *Education;* educational and public facilitator

Mark Clausen: *Public Relations;* editing and writing

Eugenia Cooke: *Zoology,* Division of Mammals; cataloging specimens; filing in departmental library

Connie Crane: *Anthropology & Exhibition;* researching Northwest Coast mythology and working on related projects

Julie Hurvis: *Education;* educational and public facilitator, and resource coordinator for Place for Wonder

Ira Jacknis: *Education;* co-developer for "Festival of Anthropology on Film"

Carol Landow: *Education;* educational and public facilitator

Withrow Meeker: *Anthropology;* cleaning and conservation of Chinese shadow puppets; work on Philippines collections

Debra Moskovits: *Zoology,* Division of Birds; researching and compiling a gazetteer for bird collecting localities in Brazil

Gary Ossewaarde: *Education;* exhibit facilitator

Elizabeth Rada: *Botany;* cataloging botanical periodicals and typing research monographs

Robert Rosbert: *Anthropology;* cataloging Kish and Pompeii collections

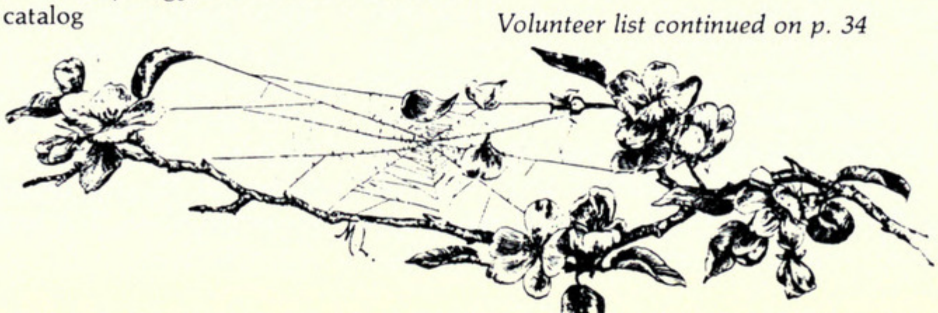
James Skorcz: *Library;* compiling reference statistics, interfiling directory additions, and reading room projects

Llois Stein: *Anthropology;* cataloging and researching Oceanic collections

Lorain Stephens: *Zoology,* Division of Birds; researching and compiling a gazetteer for bird collecting localities in Peru

Beatrice Swartchild: *Anthropology;* research on Philippine textile collections—to be published as a catalog. *Education;* statistical analyst

Volunteer list continued on p. 34



ROSS'S ROSY GULL

Twice in the past four years this beautiful arctic species has been a mysterious visitor to the lower 48 states —once to Chicago, once to Massachusetts.

BY JANETTE NEAL

Not many birds make the front page of the *New York Times,* but the Ross's gull did. The appearance of one in Newburyport, Massachusetts, in 1975 was called the birding event of the century, and caused a sensation among bird lovers. The bird was seen and identified on March 2 of that year. On the morning of March 3, a group of 50 or so people, including the distinguished naturalist Roger Tory Peterson, who had left his Connecticut home at 3:45 a.m., waited and watched in the cold. At 10:00 they saw the Ross's gull feeding with a flock of Bonaparte's gulls. It was the 668th bird on Peterson's U.S. life list. As the word spread and the excitement grew, flocks of birders from the U.S. and beyond crowded into Newburyport. They lined the sea wall overlooking the Merrimack River estuary and the state beach on the Salisbury side of the river to see the gull. They frequently saw it feeding with Bonaparte's gulls three times daily. It didn't leave Newburyport until early May.

Then, less than four years later, another Ross's gull briefly made the bird-watching headlines. This one happened along the wintry shoreline of Lake Michigan, not far from the Chicago Loop. The bird was first spotted mingling with Bonaparte's gulls on November 29, 1978. The following day it was seen by several expert birders in the vicinity of Lincoln Park, a few miles north. The news spread quickly, and by December 2, a Saturday, dozens of eager birders braved the bitter onshore winds in search of the bird. It was seen fleetingly only once more, and never again. Hundreds of birdwatchers around the country waited in vain for one more sign that the bird was going to be as cooperative as the famous Newburyport gull, but this second sight record for the the "lower 48" vanished as suddenly as it had appeared.

The Ross's gull is usually found in the high arctic. Before the 1975 sighting, never before had one been seen so far south. This was the first sighting of the bird in the U.S. outside of Alaska. We can only speculate on how the bird, in 1975 and 1978, came to be so far from its usual habitat. It may have become separated from its own kind, joined a flock of Bonaparte's gulls in their breeding grounds in northern Canada and flown south with them. It may have been blown south by bad weather. Or it may have suffered from a case of mistaken identity and believed itself to be a Bonaparte's gull.

The Ross's gull has a circumpolar distribution in the arctic. It is seldom seen south of the Arctic Circle, although there are occasional sightings of the bird in northern Europe and Canada. Our knowledge of the gull is limited by the remoteness and inaccessibility of its habitat; however, we do know the basic facts of its life history. The gulls breed in Siberia, arriving there in late May or early June. They nest and raise their young quickly. By August they have left their nesting grounds and begun an eastward migration. They pour through the Bering Straits in September and October. They continue northeastward until they meet the pack ice and spend the winter at sea among the ice fields. In spring they follow the ice north as it melts, returning to their breeding grounds.

The Ross's gull is small for this particular bird group—12 to 14 inches (30.5-35.5cm.) long. In breeding plumage the head, neck, underparts, and tail are a delicate rosy pink. The back and wings are soft pearl gray. The trailing edges of the wings are white with gray outer tips. A narrow black band encircles the neck. The eyes are red, the feet vermilion. The beak is black and somewhat smaller and weaker than the beak of other gulls. The wingspan is about 10 inches (25.4cm.). The distinctive wedge-shaped tail is 5 inches (12.7cm.) at the center, 4 inches (10cm.) at the outer edges. The bird weighs 8 to 10 ounces (200-250gms.).

In winter the pink color fades to white, and the necklace disappears. A patch of gray appears on the back of the crown.

In juvenal plumage, the crown, neck, and mantle are brownish-black. The forehead and cheeks are white with dark patches behind the eyes. A dark band runs along the upper sides of the wings and back forming a W. The tail is white with a wide black terminal band. The feet are plum. The rest of the plumage is white with gray wing linings and considerable brown in the wing tips and coverts.

Newly hatched chicks are about 5 inches (13cm.) long. Their down is dusty yellow with flecks of gray and black. The flecks tend to be darker on the head and lighter on the flanks. The breast is unspotted and whitish. The eyes are dark brown. The legs, feet, and bill are flesh-colored or gray, with a brown tip on the bill.

The distinguishing characteristics of the Ross's gull are its pink color, its wedge-shaped tail, and the collar around its neck.

The bird has a higher, more melodious, and more varied voice than other gulls. Its flight is more buoyant and ternlike.

In summer the gull's diet consists of gnats, beetles, small mollusks, aquatic insects and larvae, worms, and crustaceans. In winter the diet consists of small fish and crustaceans.

The history of the Ross's gull is as interesting as the bird is beautiful. The first scientific discovery of the bird was made by Sir James Clark Ross, a nineteenth-century British arctic and antarctic explorer. Ross was born in 1800 and joined the Royal Navy at the age of twelve. Between 1819 and 1827 he sailed on four arctic expeditions with Sir William Edward Parry. In 1831 he was a member of Booth's expedition, and with his uncle, Sir John Clark, helped determine the position of the north magnetic pole. Ross led an expedition to the antarctic in 1839 with two ships, the *Erebus* and the *Terror*. He led an attempt to rescue Sir John Franklin in 1848/49 with the ship *Endeavor*. He was recognized as an expert on the arctic and antarctic until his death in 1862.

On June 27, 1923, Ross shot a gull at Igloolik on the east side of the Melville Peninsula in the Canadian Arctic. Parry's journal records the event:

Mr. Ross had procurred a specimen of a gull having a black ring around its neck, and which, in its present plumage, we could not find described. This bird was alone when it was killed, but flying at no great distance from a flock of tern, which latter it somewhat resembles in size as well as in its red legs; but is on closer inspection easily distinguished by its beak and tail, was well as by a beautiful tint of most delicate rose-colour on its breast. *

This was probably the first written description of the Ross's gull. Several days later another member of the expedition shot another gull. The two skins were prepared and carried back to Great Britain. One was given to the University of Edinburgh Museum, the other to a Joseph Sabine.

The bird was described from the Edinburgh skin by Dr. John Richardson and named the cuneate-tailed gull (*Larus rossii*) in 1824. At the same time William MacGillivray, assistant keeper of the museum, gave the bird the temporary name of Ross's rosy gull (*Larus roseus*). Both men intended for Richardson's names to be used, but somehow it was MacGillivray's names that stuck. Today the scientific name for the bird is *Rhodostethia rosea,* from the Greek words *rhoden,* meaning "rose," and *stethos,* meaning "breast"; and the Latin word *rosea,* meaning "rose-colored." MacGillivray proposed this name after he learned that the name *Rossia* was used as the generic name of a mollusk.

Virtually nothing more was learned about the Ross's gull for the next 50 years. In the 35 years after its discovery only two individuals were seen, one of them by Ross at Spitzbergen in 1827. In 1844 Audubon wrote that the only two Ross's gulls known to exist in museum collections were the two from the second Parry expedition. Audubon did not see or paint a Ross's gull. He confessed that, "not having met with this beautiful little gull, I am obliged to refer to Dr. Richardson's description of it in the *Fauna Boreali-Americana*."**

By 1881 only 23 specimens could be found in the world's museums, and no eggs or nests had been collected.

To illustrate the rarity and value of Ross's gull specimens, consider the story of R. L. Newcomb. In October 1879 Newcomb shot eight Ross's gulls from the ship *Jeannette,* which was imprisoned in the ice and drifting away from Wrangall Island towards the northernmost of the New Siberian Islands. Large numbers of the gulls were seen flying over the ice. In June 1881 the *Jeannette* foundered near Henrietta Island. Many men perished during the journey in the ship's boats across ice and water through the New Siberian Islands, across the Laptev Sea, to the Siberian mainland at the Lena River delta. Throughout the long ordeal Newcomb kept three skins under his shirt. Not only did he save the skins, they helped to save him by providing insulation against the cold.

In the late ninteenth and early twentieth centuries our knowledge of the Ross's gull increased greatly. Sightings were recorded and specimens collected. The basic facts of the bird's life history were determined.

In August 1894 Fridtjof Nansen shot eight

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*Journal of a Second Voyage for the Discovery of a Northeast Passage from the Atlantic to the Pacific Performed in the Years 1821-22-23 in His Majesty's Ships Fury and Hecla Under the Orders of Captain William Edward Parry (*London: John Murray, 1824*), *p. 449.*

***Audubon, John James,* Birds of America (*Philadelphia: Audubon, 1944*), VII, 130.

Ross's gulls from the ship *Fram,* which had been frozen in the ice pack for 10 months. Nansen left the *Fram* and saw more gulls about 30 miles northeast of Hvidtenland, the northeast group of the Franz Josef Archipelago. From July 11 to August 8 Nansen and his companion, Johansen, saw single birds and sometimes small flocks. The crew of the *Fram* who remained on the ship also saw Ross's gulls about the same time. Nansen saw the gulls again in August 1899 near Franz Josef Land. This made it clear that the birds inhabited the pack ice north of Franz Josef Land and Spitzbergen, and suggested that they bred farther west in Siberia, or that they migrated westward.

In 1897 S. A. Andree died attempting to cross the North Pole in a balloon. His body and diary were found in 1930 on White Island, which lies off the coast of North-East Land and between it and Franz Josef Land. The diary reported that after the balloon crashed Andree and his companions struggled 200 miles south. They saw 15 to 17 Ross's gulls 120 to 190 miles north of White Island in late July and August.

John Murdoch observed Ross's gulls at Point Barrow, Alaska, in the fall of 1881. For a month, beginning September 28, he saw the gulls traveling northeast. The next year he saw them from September 20 to October 9. In 1897 he saw only two Ross's gulls, on September 9 and 23. Murdoch reported seeing large loose flocks of the birds. He took more specimens, mostly immature birds, than were contained in all the world's museums at that time.

The gulls appeared at Point Barrow on gray overcast days with easterly winds. They flew in from the southwest, sometimes stopping to feed on the beach, then cóntinued on to the northeast. They appeared and disappeared quickly. The birds were seen in the fall more or less regularly, but their numbers varied. Some years many were seen, some years few, or none at all. The fact that the birds were not seen at Point Barrow in spring or summer led Murdoch to guess correctly that their breeding grounds were west of Wrangall Island, and that they reached the breeding grounds by following the melting ice north, not by a return migration through Point Barrow.

Dr. Charles Brower was in charge of the trading post at Barrow in the 1920s. On September 26, 1928, thousands of Ross's gulls passed through Barrow. Brower wrote that he could have killed several hundred if he'd had the time. The skins were once so rare that they brought up to $200. By 1929 they were no longer so valuable. Although they were still eagerly sought by museums and collectors, they commanded a price of only $10 or so. Ross's gulls were shot for food by Eskimos and were eaten fried or roasted. They tasted like golden plover!

Sergius Buturlin conducted the major study of the species on its breeding grounds in 1905. He described the limits of the breeding area in northeastern Siberia—from the Kolyma River delta near the Arctic coast, south to Aby Mlaya and Svedne Kolymsk, east to the Chaun and Indigirka Rivers, and west to Swjatai Nos. The southern part of the area is forested, but most of it is a mixture of swamp, moor, wet ground, lakes and rivers. The birds nest in dense alder thickets, not on the open tundra.

Buturlin reported that the first gulls arrived on May 30. The next day he saw several dozen. They appeared tired, sitting quietly on the ice and not flying far away if they were approached. Buturlin found the gulls on a small shallow lake formed by snow melt, accompanied by terns and Sabine's gulls. They spent their time swimming, catching insects, and resting. The gulls were constantly seen in pairs, the males identifiable by their more intense coloration. The males courted the females by pecking at their heads and necks with open beaks, as if they were trying to kiss the females. The males stepped around the females, trilling, with their heads and breasts lowered, their tails and wings raised.

After June 3 the gulls dispersed and established territories. The males, and sometimes the females, defended the territories. The nests were constructed of dry grass, sedge stalks, dwarf willow and dwarf birch leaves and twigs, and often lined with lichens. They were built on small mossy areas free of wet grass or on small islands above the water. Some nests were built in hollows in patches of dry dead grass. The nests were shallow cups about 4 inches (10cm.) in diameter and ¼ inch (.6cm.) thick, standing 4 to 10 inches (10-25.4cm.) above the surface. The nests were generally damp.

The gulls nested in small colonies of four to thirty birds, almost always in the company of arctic terns. Other birds that shared the breeding grounds were glaucous-winged fulls, hoary redpolls, snow buntings, white-tailed eagles, willow ptarmigan, pectoral sandpipers, curlew sandpipers, dunlin, red and northern phalaropes, snipe, golden plovers, ruff, oldsquaw, white-fronted geese, bean geese, and whistling swans.

Buturlin found the first incubated eggs on June 13. By June 23 he had collected 36 eggs and 38 skins. On June 26 he found an egg close to hatching. There were usually three eggs per nest, but some nests held two or four eggs. The eggs measured 1.7 inches (43.3mm.) long and 1.2 inches (31.6mm.) wide. They were dark olive green spotted with chocolate brown. They were roundish, the small ends not pronounced, and more spotted towards the longer ends. The spots were not sharply defined and varied in color, some being lighter and some darker.

The incubation period lasted more than 3 weeks. Second clutches were sometimes laid if the first clutches were lost. During the day the females left the nests to feed. At night the males defended the colonies. The gulls constantly fought with the terns, making the colonies noisy places. The gulls'

Continued on page 34

Quetico Wilderness Canoe Trip for Members

July 19 - 29

Martin Oudejans

QUETICO PROVINCIAL PARK, in western Ontario, is a mosaic of pure glacial lakes, pre-Cambrian rocks, and virgin boreal forest. Together with Minnesota's Boundary Waters Canoe Area, which it adjoins, this park is one of our continents's last remaining wilderness areas.

Field Museum is sponsoring for the fifth consecutive year, a canoe trip to Quetico for its high school-age members. The Voyageur Wilderness Program, of Atikokan, Ontario, is cosponsor. The ten-day trip is not primarily for fishing, nor is it a crash course in ecology; rather, it is intended as a wilderness experience and, as such, can mean different things to different participants. To truly experience wilderness is to forsake many of the comforts and crutches of civilized life. It means hard work —paddling long hours and carrying canoes and gear over portage trails that range from a few yards to more than a mile long. But it also means entire days during which one's group will encounter no others; it means lakes clean enough to drink from; it means periods of intense silence and opportunities to see wild animals and to experience the northern lights.

The group of 30 will be divided into single-sex units of five or six persons, each with a counselor or guide. All equipment, food, and guide services, as well as bus transportation between Field Museum and Quetico are included in the trip cost: $225.00. Applicants must be between 14 and 19 years old. Previous camping or wilderness experience is not necessary. The prime qualifications are proven swimming ability, good health, maturity and reliability. All applicants will be interviewed by Field Museum counselors; the deadline for applications is May 25. Those chosen for the trip will be so notified by June 2.

Slide presentations by Voyageur Wilderness Program representatives will be given on Field Museum's Members' Nights, May 2, 3, and 4. Program times and location will be announced in Members' Night literature or may be obtained by phoning 922-9410, X-251. For an application or additional information, phone or write Michael J. Flynn, Field Museum Tours, Field Museum, Roosevelt Road at Lake Shore Drive, Chicago, IL. 60605.

ILLINOIS ARCHEOLOGY FIELD TRIP

For many of us, the word "archeology" conjures up visions of great architecture in distant places: Egypt's Pyramids and Sphinx, Cambodia's Angkor Wat, and Mexico's Pyramids of the Sun and Moon at Teotihuacan. These sites, with their relics, are limitlessly fascinating.

But right here in Illinois we also have exciting archeological sites, including the largest aboriginal structure north of Mexico—Monk's Mound at Cahokia. One of the most broadly based archeological research centers in the country is the Foundation for Illinois Archeology, at Kampsville; and one of the largest covered excavations with the longest continuing research programs is at Dickson Mounds, near Lewistown.

If you are interested in learning more about Illinois prehistory, as well as how scientific archeological research is conducted, you can join the Field Museum field trip of June 1-5, which will visit Dickson Mounds, Kampsville, and Cahokia Mounds. Limited to 30 participants, the trip includes site visits, lecture and slide presentations, workshops and discussions led by staff archeologists working at the respective sites. The field trip director is Robert Pickering, a doctoral candidate at Northwestern University.

The per person cost of this field trip is $240.00. For full details and registration information, write or call Michael J. Flynn, Field Museum Tours, Roosevelt Rd. at Lake Shore Drive, Chicago, Ill. 60605. Phone: (312) 922-9410, X-251.

Helton Mound, in the Lower Illinois River Valley, is typical of the sites to be visited during the June archeology field trip.

Observations On the Mutability Of Time

BY ALAN EDWARD RUBIN

About 600 years ago Geoffrey Chaucer wrote:

The tyme, that may not sojourne,
But goth, and never may retourne,
As water that doun renneth ay,
But never drope retourne may,

and therein expressed the obvious irreversibility of time. More recently, in "Chronomoros," Edward FitzGerald told of time's unvarying flow:

Whether we wake or we sleep,
Whether we carol or weep,
The Sun with his Planets in chime,
Marketh the going of Time.

These phrases typify the concept of time as inexorably ticking away, marking the passage of innumerable events and relegating them to an indifferent oblivion. The sands of time flow on.

Contrary to the notions of Chaucer and FitzGerald, however, time cannot be considered as flowing at a constant rate along a one-way street. The measurement of the finite velocity of light (first performed by the Danish astronomer, Olaus Roemer, in 1676) lay the groundwork for the destruction of this concept.

Light is the carrier of information, be it the spectral type of the nearest stars, the radial velocity of a remote galaxy, or the fact that there may be an ideal green wall clock on the other side of my office indicating a time of 9:07:04 to me.

At a speed of approximately 300,000 km/sec, the light reflected off the clock will span the five meters to my eye in less than 0.000000017 second. For all practical purposes, then, when I observe the clock to say 9:07:04, it actually *is* 9:07:04.

Suppose I sent my cousin (of whom I'm not very fond) 300,000 kilometers away, lent him a telescope, and asked him to observe my wall clock. Clearly, it would take light precisely one second to travel from the clock to my cousin. When he reads 9:07:04, fully one second will have elapsed since the clock indicated that time to me. At that point, I will read 9:07:05. Another observer, 600,000 kilometers from my clock would judge it to be just 9:07:03. It can now be seen that there must be a quantum of light carrying that information of 9:07:04 along with it, and if one were to ride on the light beam, it would stay 9:07:04 forever.

At the speed of light, time stands still—in contradistinction to what I observe while sitting and watching my clock successively ticking off 9:07:04, 9:07:05, 9:07:06. . . .If I were astride the light beam, however, I would be moving at 300,000 km/sec relative to the clock, while in reality I'm not moving with respect to the clock at all. If I were to suddenly increase my velocity relative to the clock, I would notice a corresponding slow-down in the passage of the clock's time. The faster I went, the longer it would take the clock to get from 9:07:04 to 9:07:05. I would be able to measure how sluggish my wall clock had become by glancing at the Timex on my wrist. My Timex would tick away the seconds at the same rate my wall clock did before I started moving. But since my wristwatch would not be moving relative to me, it would be keeping what is referred to as "proper time." We can define proper time as the time kept by a clock that is stationary with respect to the observer.

Let us imagine that my cousin has come back to earth for the moment to find me. I owe him money. As he enters my office, he notices me jumping out the window at 259,000 km/sec. Quickly, he pulls out his telescope and focuses on my wristwatch. He notes that two seconds of the wall clock pass for every one second indicated by my Timex, and concludes that my wristwatch is in bad adjustment. But the sluggishness he observes on my Timex is exactly equivalent to the sluggishness I observe on the wall clock back in my office. It can now be seen that an observer will note that every relatively moving clock is slow; the faster the relative velocity, the slower the moving clock seems to run.

This effect is known as "time dilation" and has been experimentally verified in the decay of high-speed muons. Muons are unstable massive sub-atomic particles that break down very rapid-

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Alan Edward Rubin is a graduate student at the University of Illinois at Chicago Circle. He has been a lecturer at the Adler Planetarium and has taught a course on "Geology of the Solar System" at Field Museum.

ly. In fact, half of the muons that are stationary with respect to an observer will have decayed in about one millionth of a second. However, if an observer locates some muons which are moving relative to him, he will note that the muons live longer. The faster the muons are moving, the longer they will seem to live.

So far, I have only discussed the apparent sluggishness of time in systems which are in relative motion. Many of the examples presented above are derived from Einstein's special theory of relativity. Time also appears to slow down, however, when it is being measured in a system that is being accelerated or in one that is experiencing a gravitational field. Before we discuss this, it is germane to illustrate Einstein's "principle of equivalence," which states that the effects of gravitation are completely indistinguishable from the effects of uniform acceleration.

Suppose I were to go to the moon (where the effects of air resistance are zero) and take along with me a cough drop and a silver dollar. Placing the cough drop in one hand and the silver dollar in the other, I will experience the weights of each of these objects as pressures on my hands and will judge that the weights differ. If I were to move my hands quickly downwards, the pressures exerted by these objects on my hands would decrease. An increase in the downward motion of my hands would correspond to a decrease in the pressure exerted by these objects. If I were to continue this motion ever more rapidly, there would come a time when the objects would fly off my palms and lag behind in the downward motion. This will occur when the downward motion of my hands exceeds the free fall velocity of the objects. Now, the cough drop and silver dollar will fall at the same rate, remaining at an equal height, although they are no longer in contact with my hands.

Let me now capture a scientifically minded small green demon and imprison him in an opaque box along with the cough drop and the silver dollar. The box rests comfortably in my hand. When my hand is at rest, the demon will note that the cough drop and silver dollar have different weights by placing them on a tiny green scale he always carries in his pouch. If I were to bring my hands downwards, the demon would note a sudden decrease in the weights of the objects. He would not be able to tell that the box was moving since he could not see through the walls. Again, if the free fall velocity of the objects were exceeded by the downward movement of my hand, the cough drop, silver dollar, scale, and demon would all start flying upwards. It would be as if these formerly heavy objects had suddenly aquired a negative weight, or that gravitation, which had up to that moment always acted downwards, suddenly began acting upwards.

The demon could conclude that either the box was being accelerated in the direction of the unaltered gravitational field or that the masses below the box, which previously had pulled everything down, had disappeared, and new masses had appeared above the box, pulling everything toward the ceiling. There is no known experiment that the demon could perform inside the box to distinguish between these two possibilities.

Let us now examine how time is altered by the presence of either a uniform acceleration or a gravitational field. Imagine a freely floating glass room which is far out in space and subject to no gravitational influences. My cousin and I are inside, having tea. Outside the room is a circular disk which is rotating at a constant velocity. After synchronizing our watches, we decide to perform a little experiment. My cousin leaps onto the circular disk and fastens himself there securely. After a while, we decide to compare watches and I notice that my cousin's watch is running a bit slow. We repeat this experiment several times more, varying only the distance from the center of the rotating disk to the point where my cousin straps himself down. I observe that the farther my cousin is from the center of the disk, the faster he is being accelerated and the slower his watch appears to run. Since Einstein's principle of equivalence equates an accelerating system with one that possesses a gravitational field, it can be concluded that clocks will also run slow when subjected to gravitational attraction.

In an intense gravitational field, time will be much slowed down with respect to a distant observer. In the vicinity of a black hole, the distortion of time is maximized. A black hole gets its name from the fact that no light can escape from it and it can therefore never be directly observed. Around every black hole there is a spherical boundary called the event horizon, which lies at a radius (numerically equal to 2.95 kilometers times the mass of the black hole in solar mass units) from the singularity inside. Any shoe, cat, rocketship, cigar, gastropod, or light beam that penetrates the event horizon will be swallowed up by the black hole and never emerge. The closer these objects come toward the event horizon, the slower the time will appear on their clocks as judged by a distant observer. Consequently, such an observer would never actually see any of these objects penetrate the event horizon. They would appear frozen at the surface of this boundary with their clocks remaining stopped for all infinity.

Let us assume that I have just discovered a nonrotating black hole of ten solar masses and decided to send my cousin to investigate it. His mission is to approach and penetrate the event horizon, while keeping his clock on display at the stern of his spacecraft. I remain a good safe distance away. When my cousin is only 33 km from the hole, three seconds on my Timex will pass for every one second recorded by his clock. Events at this distance from the black hole transpire at one-third their normal rate.

As my cousin's spacecraft came closer to the event horizon, his clock would run ever more slowly. It would take an infinite time for the clock to tick at the event horizon and the spacecraft would appear to be suspended there forever.

My cousin, however, would not see himself as being frozen against the boundary of the event horizon. He would pass through it in what he would judge to be a reasonable amount of time and notice no strange pathological effects whatsoever. A glance at his clock would indicate to him that his was functioning quite normally and if he were to look back outward toward my Timex, he would find it corresponds rather well with the clock in his ship. (The only discrepancy he would notice would be due to the relative motion of his clock with respect to mine, as discussed above.) The observation of his ship being frozen against the event horizon is therefore only a consequence of my point of view from the outside.

Although I would be able to see my cousin poised in space forever, he himself would be heading toward the center of the black hole. As he approached the center, the tidal forces would grow ever stronger. Assuming the hole was ten solar masses, he would reach the center in 67 millionths of a second according to his clock after he penetrated the event horizon. The tidal forces, however, would have torn him apart long before this. At the center of the hole there would be a singularity, a mathematical point containing all the mass of the hole, including, now, my cousin's. It is an object of zero volume, and consequently of infinite density. I could then assume that my cousin would not participate in any of my future experiments.

I have stated above that "time cannot be considered as flowing at a constant rate along a one-way street." I have shown that time slows down with increased velocity according to the postulates of special relativity and that gravitational fields also will cause clocks to slow in accord with general relativity. So much for time's constant rate. But what about the second part of my statement? Can time still be thought of as flowing along a one-way street? Perhaps time can be slowed down and stopped, but can it ever actually flow backwards? Is the irreversibility of time absolute?

According to electromagnetic quantum field theory, an anti-particle moving forward in time is equivalent to a particle moving backward in time. In the nuclear physical process of pair production, a photon is annihilated and an electron and a positron (an anti-electron) are created. The positron can be represented by an electron going backwards in time. This postulate was first presented by R. P. Feynman in 1949, but it must be kept in mind that this time-reversal anti-particle equivalence has not been empirically verified. Perhaps it is empirically unverifiable. Nevertheless, mathematically, at least, time can be considered as occasionally flowing backwards when dealing with particle—anti-particle pairs.

There is yet another mathematical solution dealing with the reversibility of time that stems, in this instance, from some of the theoretical speculation about black holes. If you recall, the black hole that I sent my cousin into was nonrotating. But just how reasonable is it to suppose that any star (including black holes) would possess no rotational velocity? Our sun rotates (with a period at its equator of 25.4 days); the pulsar—neutron star in the Crab Nebula rotates (about 30 times each second); in fact, all stars rotate. In general, the more massive the star, the greater is its rotational velocity. In order for a star to have collapsed upon itself to form a black hole, it must have been at least three times as massive as the sun. As the star's radius decreased, the potential black hole would have had to rotate more rapidly in order for angular momentum to have been conserved.

From this we can conclude that a nonrotating black hole is most likely a fictitious entity. It was necessary to consider the nonrotating hole, however, because up until 1963 there were no known mathematical treatments that could account for rotation of black holes. In that year, R. P. Kerr published such a treatment. Instead of the black hole having one event horizon, there are actually two. Also, a trip through the first event horizon does not necessarily doom the traveller into being sucked up by the singularity. It is possible for him (if he chooses his course carefully) to pass through the event horizons and emerge in another universe. Once there (wherever that might be) our adventurer could conceivably find another rotating black hole and return to our own universe at any point in time that he may choose. The Kerr solution allows him to possibly return to earth a million years in the future or ten billion years before he left.

The main flaw in this solution is that it is necessary when performing the calculations to entirely disregard the star that created the black hole in the first place—a most fundamental oversight. This "wormhole" to the future or the past must therefore be regarded as a purely mathematical construction, and one that, given our present state of knowledge, cannot be taken too seriously.

What, then, is time? It cannot be defined as flowing at a constant rate, as has been shown by special and general relativity. Moreover, there are certain mathematical solutions which seem to question time's apparent irreversibility. But in the daily personal worlds of most of us, time seems to exhibit no behavioral abberations, for this is in fact the world for which the concept of time was created, as a classically useful and fundamentally human expedient. □

FIELD MUSEUM TOURS

Exclusive Tour Packages for Members and Their Families

Fabulous Machu Picchu, one of the sites to be visited on Field Museum's Peru tour.

PERU

IN 1978 FIELD MUSEUM was host to a dazzling exhibit of golden treasures from ancient Peru. Now Field Museum members and their families can visit some of the archeological sites where those treasures were discovered. A 20-day tour (Oct. 27-Nov. 15) will visit the famed ruins of Machu Picchu, Chan Chan, Pachacamac, Purgatario, and others. Also on the itinerary are the Plains of Nazca (viewed from low-flying aircraft), the offshore Guano Islands, and the famous Pisac Indian Fair. The group, limited to 20 persons, will be led by Dr. Michael Moseley, associate curator of middle and South American archeology and ethnology, and by Robert Feldman, assistant in archeology. Both Moseley and Feldman have done extensive archeological work in Peru; a tour escort will also accompany the group.

The tour cost—$2,998 (which includes a $500 donation to Field Museum)—is based upon double occupancy and includes round trip air fare between Chicago and Peru, as well as local flights in Peru. Delta Airlines will be used between Miami and Chicago, connecting with Aeroperu.

Deluxe hotel accommodations will be used throughout. The package includes all meals, including inflight meals; all sightseeing via deluxe motor coach; all admissions to special events and sites, where required; all baggage handling throughout, plus all necessary transfers; all applicable taxes and tips; all applicable visa fees. Advance deposit required: $250.00 per person.

FIELD MUSEUM TOURS

COOK ISLANDS

THE UNIQUE OPPORTUNITY to see a hidden corner of the fabled South Seas awaits a select group of Field Museum Members. Accompanied by three staff scientists, from July 14 to 31, a visit to the Cook Islands will involve comfortable living in a still-unspoiled paradise. It will be the dry season, with clear lagoon waters, sunshine guaranteed, and comfortable temperatures.

Located between Tahiti and Fiji, the Cook Islands offer one of the last relatively unspoiled island areas. Rarotanga, with towering peaks and narrow valleys, is surrounded by a reef and coral islets. A new 150-room hotel provides a base with modern comforts. Aitutaki, an hour away by small plane, is a classic atoll lagoon, rich in marine life and superb for snorkeling or SCUBA diving. There, a comfortable, country-style hotel will provide two nights' accommodation right next to a lagoon reef, with the simple, friendly services of the Polynesian community. Mangaia, also a short flight away, will be visited for a day, with an inland hike and a journey to the lagoon areas. The last three days of the tour will be spent in Hawaii.

The tour's scientific lecturer/escorts will be Dr. Alan Solem, curator of invertebrates, Dr. Robert K. Johnson, associate curator of fishes, and Dr. Elizabeth L. Girardi, research associate in invertebrates. Dr. Solem has participated in many expeditions to this part of the globe and has written extensively on its fauna. Dr. Johnson, a certified SCUBA diver and expert on coral reef fishes, has participated in many diving expeditions to both the South Pacific and the Caribbean. Dr. Girardi has also made many collecting trips to the South Pacific, concentrating on marine invertebrates.

The tour, limited to 25 persons, will travel via Air New Zealand. The tour cost—$2,650 (includes a $400 donation to Field Museum)—is based upon double occupancy and includes round trip air fare to and from Chicago. Also included is all inter-island transportation, all meals (except lunches in Hawaii) and all inflight meals, all admissions to special events, where required; all baggage handling, plus all transfers, all applicable taxes and tips. Advance deposit required: $400 per person.

For full itinerary and other information, write or call Michael J. Flynn, Field Museum Tours, Roosevelt Road at Lake Shore Drive, Chicago, Ill. 60605. Phone: (312) 922-9410, X-251.

Tour members will stay at the Rarotangan, the Cook Islands' new luxury hotel.

Air New Zealand

VOLUNTEERS *continued from p. 23*

1978 Volunteers

Bruce Ahlborn
Amy Alluisi
Carrie Anderson
Cleo Anderson
Signe Anderson
Dolores Arbanas
Judy Armstrong
Beverly Baker
Margaret Baker
Dennis Bara
Gwen Barnett
Sanda Bauer
Dodie Baumgarten
John Bayalis
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Marvin Benjamin
Frances Bentley
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Kristine Bradof
Carol Briscoe
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James Burd
Katherine Burdick
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Arden Frederick
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Sol Gurewitz
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Ralph Hogan
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Claxton Howard
Ruth Howard
Elmer Hulman
David Humbard
Julie Hurvis
Adrienne Hurwitz
Diane Hutchinson
Lucinda Hutchison
Ellen Hyndman
James Jack
Ira Jacknis
Penny Jacobs
Mabel Johnson
Ernest Paul Jones
Malcolm Jones
Julia Jordan
Letitia Kaminski
Dorothy Karall
Dorothy Kathan
Gayle Kedrick
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Eleanor Skydell
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Ken Young
Karen Zaccor
Joanne Zak
Lynn Zeger
Faith Zieske

GULLS *continued from page 26*

only enemies were skuas and vega gulls, which took eggs and chicks. Buturlin found that the gulls showed little fear of humans. If he disturbed them from their nests, they would return if he remained quiet as close as 30 or 40 yards away.

Buturlin found three-day-old chicks on July 1. On July 6 and 7 he found seven downy young in different stages of growth. The chicks hid from humans in clumps of carex, where they were well camouflaged, or they avoided humans by creeping through the grass to water and swimming away. The adults tried to distract humans by fluttering low over ground or water, then settling on the water, calling, and looking here and there. Sometimes they even tried to draw the human's attention to terns' eggs or nests by fluttering near them or landing near them. Fights with the terns were likely to ensue.

The gulls began to leave the breeding grounds as soon as the young were strong enough to fly. This could be as soon as 20 days after hatching. On July 22, Buturlin found only three immature birds, and by August the breeding grounds were deserted.

Relatively little has been learned about the Ross' gull since Buturlin's study. Much remains to be learned, but no matter how much is learned about the bird, it will retain its aura of mystery and fascination. It is a symbol of the endless enchantment of the arctic. This small dainty-looking bird not only manages to survive in one of the most severe climates on Earth, it thrives there. □