The Borden-Field Museum 1927 Alaska Arctic Expedition

Part II

By TED KARAMANSKI

Four of the surviving Sea Scout veterans of the Northern Light's *cruise, shown at the helm of another schooner during a 1978 reunion. Left to right: Bruce Andrews, Rev. Theodore Purcell, Ken McClelland, and Otto Carstensen. Rev. Purcell will be at Field Museum on Saturday, Feb. 3, to narrate a feature-length film on the 1927 expedition.*

The first installment of the account of the Borden-Field Museum 1927 Alaska Arctic Expedition appeared in the November 1978 *Bulletin*. That segment told of preparations for the adventure, of the group's departure from San Francisco on April 21, 1927, aboard the schooner *Northern Light*, and subsequent events to July 15. At this point the vessel was in the Arctic Ocean at Cape Serdzekamen, on the northeastern coast of Siberia.

Mrs. John Borden (now Mrs. Foster Adams), wife of the expedition's sponsor and a member of the expedition, subsequently wrote a book-length account of the venture, *The Cruise of the Northern Light* (MacMillan, 1928). The following text (italics), with the author's permission, is excerpted from the book:

July 15: All we could think of when we made out the grotesquely familiar forms was Alice in Wonderland: *" 'The time has come' the walrus said." The tremendous ugly creatures were a shapeless mass until their heads were raised to peer around; then they jabbed one another with their tusks and a few minutes later were again asleep. The light-colored boat with its white figures probably seemed to them a cake of moving ice . . . . The great Nansen and Johansen and other explorers on their dash to the North Pole, have been attacked by these huge monsters. We cruised up in the launch and took some moving pictures as the enraged bulls neared us, somersaulting their huge bodies in and out of the water, showing us their stupid whiskered faces as they came up snorting.*

July 16: An umiak *is the most valuable part of an Eskimo's equipment, an efficient craft, fully equal to one of our ship's boats, and in some ways preferable. [It] is about thirty feet long and in smooth water will hold a cargo of more than two tons yet it is so lightly constructed that two men can carry it over the ice, an important feature north of Bering Strait where a boat may be hemmed in by the ice for a long period, and inability to escape means serious suffering. A whaleboat is much heavier and the slightest accident may stove it in, while the skin boat can be jammed into ice and remain uninjured. Its broken ribs need not be repaired until convenient . . . .*

July 17: Our position was 55 miles east of Wrangel and forty-three miles south of Herald Island, 330 miles north of the Arctic Circle, and 180 miles from the Siberian shore. We were swallowed up within the Arctic whiteness of the North. The great Polar ice-pack, that relentless terror, nearly surrounded our little ship on its sweep across the Pole of Inaccessibility and a million square miles of unexplored territory . . . .

Leaving the Siberian coast, the *Northern Light* headed eastward again, and after several days reached Pt. Hope, Alaska.

July 23: Primitive implements of carved ivory and jade, which the Eskimos are beginning to realize are in-

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teresting to white men, have recently been excavated from underneath the mounds. We made an important collection of these articles which were pressed upon us by the male population, and they are now part of a much larger collection that we presented to the Field Museum. There were ivory labrets *formerly used by the men as chin ornaments, whaling knives, flints, and crude stones for killing birds . . . .*

The igloos *that the Eskimos live in today stand above ground, mere hovels of moss-covered whalebone, We called on the native mayor [of Tikeraq, a Pt. Hope Eskimo settlement] and were nauseated by the stench of seal blubber, and intestines lying in the main entrance. The center chamber was a small square box, used for sleeping and eating, into which light penetrated from [a gut-covered] aperture in the mud roof . . . . Four squaws sat on the floor, each holding a small child and anxiously watching the supper that hissed on a very modern stove. Sugar, tea, and tobacco, luxuries beyond the reach of the less fortunate Chuckchees, were in evidence . . . . The oldest woman, . . . became ecstatic over my gay colored coat, although Mrs. Slaughter was wearing a far more attractive blue parka . . . .*

July 25: Little John [one of the Eskimo guides] joined us near the pilot-house, where we were standing enjoying the shimmering, golden sunshine, and announced, "Now Capt'n, you can come see your kayak."

"*My* kayak?" *my husband looked a trifle puzzled.*

I followed, and witnessed the formal and touching gift of a kayak, *harpoon, poke, and* immamidik. *They were childishly happy in their ability to please "Cap'n"; their black eyes fairly sparkled with delight. Little John explained: "Wood in boat seven years old—skin new every two years."—And then—"You give Museum."*

The gut coat and harpoon was given by the older and more silent John. We shook hands all round,—and nearly kissed.

August 1: Mr. Hine, [Field Museum's chief bird taxidermist], while waiting for us, stopped at the [Nome] hotel and made trips back into the foothills for bird specimens. [The U.S. Department of Agriculture had issued a special permit for Hine to obtain migratory and nonmigratory bird species for the Museum.] He collected fox, golden-crowned, and Savannah sparrows, an Alaskan longspur, red poll, and a golden plover, rare in that vicinity. The plover, he explained, migrates through China and India to Australia and Polynesia covering many thousand miles. The Eskimos came on board just before we sailed, seemingly delighted to be with us again.

August 2: We stopped at Fairway Rock, a small granite formation five or six hundred feet high, to let Mr. Hine shoot water birds. The soft colors of green, yellow, pink, and lavender were lovely rising out of a dull blue sea and as the fog came and went we had a full view of the turreted, castle-like rock. We could just see thousands of little heads above a soft green carpet, and after the first shot millions of birds flew in all directions. We there acquired murres, paroquet auklets, horned and tufted puffins, pigeon guillemots, and a glaucous-winged gull. The feathers of the tufted puffin are like silk. It was interesting to compare the many yellow vermilion, orange, and scarlet vermilions in the bird's legs and claws,—the colors still brilliant in the first hour after death. In fact, a notable change can be seen almost instantly in the flesh part of a bird as the warmth of life leaves its body. What surprised us most about the Arctic water birds is the exact similarity of coloring of male and female in auklets, murres, and guillemots . . . .

In Nome my husband later acquired a collection of ivory carvings, valuable to a museum of Natural History, which had been dug up by the natives themselves from an upper and two lower stratas of earth below the present settlement on Little Diomede. There were three distinct periods of civilization represented. We added this collection to the Pt. Hope articles and presented them to the Museum.

August 5: The next day was beautiful, thank goodness, and a glorious day in the Arctic is more wonderful than anything any of us had ever seen anywhere else in the world. We realized why explorers, such as Stefansson and Amundsen, continually return to the Frozen North and gladly undergo many hardships along with the glorious life. We had heard in Unalaska that "north of St. Lawrence Island the sun would shine." We found it to be true. Good weather in the Polar Sea meant calm waters, radiant sunsets, and the long white nights burning with sunshine, more exquisite than any hour on the blue Mediterranean or any clear white day in Switzerland. The North has a weird, intoxicating beauty which is indescribable. No one can grasp the full ecstasy of an Arctic summer night without having drunk deep of its spell . . . . A thrilling element of hovering danger followed us always. There were no harbors for hundreds of miles at a stretch and no lighthouses of a civilized coast to guide us . . . .

There are summers when navigation to Wrangel is impossible at any time. We of course could not take any chances on being caught in the pack north and west of Alaska, and off the Arctic coast of Siberia, or our helpless vessel would drift to a cold, unmarked grave. On the other hand if a ship is

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The Borden-Field Museum 1927 expedition is the subject of a feature-length film to be shown in James Simpson Theatre on Saturday, Feb. 3, at 1:30 p.m. Mrs. Foster Adams (the former Mrs. John Borden) will introduce the film, and the narrator will be Rev. Theodore Purcell, S.J., who, like Mrs. Adams, served as a member of the expedition.

The 60-minute film was a recent gift to the Museum by Mrs. George L. Simpson, a niece of Mrs. Rochester B. Slaughter, who was the expedition's official photographer.

Admission to the film is $3.00 for non-members, $1.50 for members and for students with I.D.

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caught in the ice of the European Arctic it usually drifts south into open water and freedom. The danger was so constantly with us that I began to feel that the pack was a giant octopus, thrusting its deadly tentacles in all directions. The mere word "ice" brought shivers and goose-flesh. My readers may think I overestimate this silent, white enemy and wonder why we continued—but they must remember that we were sailing in search of Museum specimens in the graveyard of the seven seas. More ships have gone to "Davy Jones' Locker" in the waters north of Bering Strait, considering the comparatively short span of years since the Bering Sea was first discovered, than on any other body of water in all the world. The great polar ice-pack, that fiend of the North, continues to take its relentless toll.

August 6: That night Captain Borden and a mate sighted Wrangel Island at 10:30. After a continuous watch of thirty-six hours my husband then went below, but two hours later was suddenly awakened by the engines being signalled off. Hearing much confusion on deck he dressed hurriedly and disappeared; in a few minutes I heard: "Ice ahead!" . . . Ice! Ice!—What a word!—The water was now 29° (one degree over the freezing point of salt water) . . . .

Climbing down from the high bed I pulled on my heaviest trousers, two sweaters, two parkas, *and the invaluable* mukluks *over many woolen socks, and started up the steps . . . . Everyone was staring out toward land not far distant . . . . There lay Wrangel . . . .*

Turning my head in the other direction there shone nothing but an endless sweep of ice. Out there—a thousand miles or so—challenged the North Pole. The veil that hid it from view—and continually lured ambitious, strong men to their doom—had been torn away by Peary, Amundsen, Ellsworth, and Byrd. How simple it seemed—to be able to fly from the deck of the Northern Light*—still further north—out over that field of both solid and floating ice . . . .*

August 11: "May we hang our flags to the shrouds?" asked Ryan. In a few minutes the Jackson Park and Columbia Yacht Club pennants fluttered, one above the other, from the turnbuckles. These little flags waved into shreds before the boys took them down, preparing to bring back in triumph "flags that had flown at Wrangel Island."

Mr. Hine was equally excited. His thrill lay in the prospect of bringing the first birds from this Arctic island to the Field Museum . . . . Suddenly—"We see polar bear!" cried both Eskimos in the same breath.

Nothing can adequately describe our feelings. "Polar bears! Polar bears!" rang over the ship . . . . Here were the wild beasts we had sailed thousands of miles to find. I believe we did not know whether to laugh or cry in our frantic excitement.

"Look at them!—They are just standing there," called Mrs. Slaughter . . . . Yes—there they were—two huge white bears on that gleaming streak of moving ice. We could even see them with our naked eye. Whether they saw the boat we didn't know, because bears are supposed to have poor eyesight. But their smelling powers are excellent . . . . Both animals were evidently startled . . . .

We went below for warmth and relaxation. Sometimes I was Caliban secretly fearing the elements, but on this night of many thrills, the dangers and the possible fate of seafarers were soon forgotten. The victrola played incessantly and we sang loudly to our favorite tunes. Strange as it may sound on reading this, while sitting snug and safe at home, we knew we were safer on the Northern Light, *although riding out a storm, or piloting through dense fog among reefs and shoals, than we would have been crossing State and Madison Streets, Chicago . . . .*

August 12: Wrangel Island is approximately 75 miles long and 25 wide. So far—we had been steaming along only one shore—the east. We knew from the chart that there is a good harbor on the south coast where both the Corwin *and the* Rodgers *anchored in 1881. There also Stefansson's little colony had landed in September, 1921, and made their camp. But they each met a tragic death before August, 1923 . . . .A stark barren island—shadowed by tragedy.*

We now sought Rodgers Harbor as the logical place for the recent Russian settlement, the probability of which we were strongly doubting as we had carefully watched for any possible trace of human life or activity . . . .

We were steaming nearer and nearer to the tiny group of houses we were watching so intently. Smoke poured out of only one chimney, curling lazily through the crisp, cool air up into the mountains behind . . . . We managed to stand in toward the village, about a half mile off shore. On deck lay cases of sugar, tobacco, tea, cartridges, canned goods, and other necessities of life. Also we hoped to send out for these wretched people, any radio news for the outside . . . . Three blasts of our whistle echoed shrilly against the brown mountains.

At first we saw no one. Except for the smoke it could have been an abandoned village. There were three small, well-built wooden houses . . . . From the center house smoke continued to rise. Huddled near these larger houses were ten or twelve much smaller dwellings . . . . Further to the right were three other houses, probably wood . . . . While we watched, hoping for some sign of human activity, a woman came to the door of the house from where we had seen smoke . . . . She stood there, it seemed to us, several minutes, but no other sign of life was noticeable . . . . We blew the whistle again,—merely a friendly salute. (If only others could imagine how terribly exciting it was to stand there—not knowing what would happen next.—My heart was in my throat most of the time.)

When still no other people were visible a red flag of the "Union of Soviet Socialist Republic" suddenly flung out from the flagpole behind this same house. Someone had at last admitted our arrival . . . .

A few minutes later quite a considerable number assembled on the beach, looking out toward the schooner . . . . We thought that they would immediately find their umiaks *and set out toward the boat, in the way that we were visited by the Chukchees. But no—there was no boat of any description along the beach.—They made not the slightest attempt to speak with us.*

That was a strange turn in events! These human beings, perhaps thirty or thirty-five Cossacks and Siberian natives in all, were living on a desolate, ice-bound island, not far from the very edge of the Pole of Inaccessibility. The great polar ice-pack hemmed them in on the north and west coasts, leaving them only the exceedingly slim possibility of a navigable passage opening in the drift ice near the island again the following summer—perhaps not again for two or three years. Yet,—they did not make a move to beg for any supplies we would undoubtedly be carrying . . . . Whether the Cossacks kept the natives from coming out, whether they had no boats,—whether they one and all feared us,—perhaps we may never know.

As anxious as we all were to climb on those shores—to be able to collect specimens of flora and fauna on that much-wrangled-over Wrangel Island—Captain Borden did not permit anyone to go ashore. We were glad enough to be safe on the yacht, in those uncertain ice-filled waters.

How we would have enjoyed giving food or help to those lonely, stranded inhabitants! . . . . But we reluctantly and even sorrowfully left them to continue in their desperate struggle for food and existence in that ice-bound solitude of the Frozen North . . . .

Mrs. Foster Adams (the former Mrs. John Borden), author of The Cruise of the Northern Light, *with her husband at the Prague, Czechoslovakia, airport in 1976. Mrs. Adams notes that she and her husband continue to be "inveterate travelers," adding that their recent trips have been by airliner rather than by schooner. Mrs. Adams will be at Field Museum on Saturday, Feb. 3, to introduce a film on the expedition.*

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It was then we first realized that Eskimos are deathly afraid of a polar bear. This savage beast has meant destruction of Eskimo hunters, women, and children . . . . They would not paddle nearer to the wounded prey that was thrashing angrily in the water, much too close. Instead they wanted to back away—jumping up and down in the boat, frantically excited, trying to scare off the offending, raging animal. We stood by, hardly daring to breathe at the thrilling scene enacted before our eyes. The whaleboat,—a hunter standing in the bow,—gun raised, two frightened natives, and a plunging, furious beast.

August 13: Having acomplished everything and even more than we dared hope for on leaving San Francisco, our thoughts turned toward home, and the flags were hoisted. From the main mast soon floated a lovely thin streamer over a hundred feet long with thirteen stars in a row, followed by the red and white stripes. It was our Homeward Bound Pennant, following the time-honored custom of whaling ships on the Arctic after they had boiled down their fill of whale oil . . . .

Before reluctantly turning away from our hunters' paradise everyone came on deck to watch the lavender-tinted hills of the island, and the pink afterglow of a wonderful Arctic sunset. Over the bow hung a large round pink moon covering the white vessel in its silvery radiance. By ten o'clock we were under full sail. The sea-scouts beamed with delight and everyone forward and aft rejoiced in a splendid climax to a long successful voyage. We had cruised for four cloudless days along the shores of this thrilling Arctic island. We had been sailing for many weeks along the white upper crust at the "Top of the world." And we were the first white women ever to reach Wrangel Island. Our party was the first to see the Russian village. Anyone with a spark of romance in his or her city-bred soul could not help but feel the enchantment of that pale but glowing night. A magical lure gripped our senses. A fresh breeze blew almost caressingly, the flapping of the sails filled one with passionate ecstasy. It was a moment when one could easily appreciate a sailor's love for his ship, far greater than his desire for home. A fair wind, a fine ship and we were homeward bound!

August 16: The next morning at eight o'clock Cape Onman came in sight. A fine warm day with a light northwest breeze and smooth sea. I had noticed the crew staring through their glasses most of the day and wondered why, then decided to ask my husband.

"We are searching for a lost Hudson Bay steamer that was abandond two years ago and has been reported to have drifted south near Kolyuchin Island two different times," was my answer.

This was certainly blood-curdling! And here is the story:

The Lady Kindersleys, *insured for three hundred and fifty thousand dollars, was crushed in the pack and abandoned August 31, 1924, about 34 miles northwest of Pt. Barrow. Everything had been all right until her engines broke down. While the men worked on the engines, the ice closed in. They hurriedly wired the* Boxer, *the Board of Education boat, but she was unable to get any nearer than five miles on account of the solid ice-field. The men left the trading steamer almost immediately to escape with their lives, taking nothing with them but the clothes on their backs and managed to get over the five miles of ice where the* Boxer *picked them up. A vessel with a valuable cargo, and one insured for a heavy amount, now started on its helpless drift, not sinking immediately as was expected.*

In 1925 natives from Cape Onman and Kolyuchin Island reported seeing a stranded ship, caught in pack-ice, and drifting off Cape Jinretlin.

In 1926 the same ghostlike apparition appeared again, this time inside Kolyuchin Island.

The steamer had evidently missed the northwest current, and like the Vigilant *was caught in the drift that circles south off the Siberian shore. It probably went north in the winter, and again south the following summer. The drift that the ship followed is of course, only problematical. A Russian in Nome informed [the Coast Guard] that he had visited among Chukchees who had served him butter packed in tin cases marked* Lady Kindersleys. *Whether the natives and Russians succeeded in stripping the deserted, crumbling vessel, or whether she sank—no one knows.*

August 24: At 4 P.M. we were lying to, off the southwest side of Bogoslof Island in water too deep to anchor, sixty-five fathoms less than four hundred yards from the beach. We went ashore, the crew following in two separate watches. In the launch we were surrounded by hundreds of sea lions. Two persevering large bulls swam under us, a strange sensation. We had good opportunities for moving pictures and snapshots as the beasts came nearer and nearer. Here, in 1916 my husband had much the same experience: he was literally attacked by an angry herd of these huge monsters. The men in the boat were at first frightened but soon realized the ferocity was a bluff.

On reaching shore we were amazed at the millions and millions of Pallas murres roosting in ledges of New Bogoslof, or Castle Rock . . . . We walked round old Bogoslof to see the new eruption which had arisen in the center of the crater. The first thing we did was to take the temperature of the hot sulphur water which surrounded it and found it to be 72½°.

My husband and most of the crew decided to swim in the hot crater; Frances Ames and I hurriedly walked along the spit to get away. They had a beautiful time splashing about the greenish and copper colored water, finding below the surface a slimy green ooze in which they sank until their feet reached a hard strata too hot to stand on . . . . The crater continually threw off steam, and strong sulphur fumes enveloped the adventurous men.

While the men had their small boys' picnic, we crossed a narrow piece of lava-covered land toward the sea, and here sat on one of the many lava deposits to watch the hundreds of sea lions. The animals were over cautious on our approach and stampeded into the breakers before we could approach very close. When the sand colored beasts reached the water they bellowed and snorted at us from their safe distance. The bulls were larger and heavier than bull hair-seals but much smaller than the Pacific Walrus. More extraordinary still, the cows were smaller than hair-seal cows, and our first impression was that of many bulls and half-grown pups. We suddenly realized, however, that sea lions also have harems. There were the useless bulls, and small groups of bachelors who seemed to be "talking it all over."

On September 10, 1927, the *Northern Light* sailed through the Golden Gate back into San Francisco harbor, nearly five months since her departure. More than 10,000 miles of water had passed beneath her keel. As a scientific enterprise the expedition had fulfilled all expectations and, to all accounts, it had proven to be a thrilling, highly enjoyable venture for everyone aboard. Ashley Hine returned to his duties at Field Museum, the Bordens, the Goodspeeds and the Slaughters resumed their professional and social activities in Chicago. Frances Ames returned to San Francisco and the Sea Scouts rejoined their families.

In very short order the Museum took stock of the specimens acquired by the Borden expedition. On October 12, Museum director D. C. Davies wrote Frances Ames in appreciation for her collected plant specimens:

"I am informed that the plants recently received by Field Museum from the Borden-Field Museum Alaska-Arctic Expedition were collected by you. It is found that 106 of the plants are good specimens which will be a most welcome addition to the Herbarium. On the whole they are much better than the usual collections received from Alaska, some are very excellent indeed, and they are very acceptable to the Department of Botany. Permit me to congratulate you and to thank you for your interest . . . ."

On October 14, Berthold Laufer, head of the Department of Anthropology, filed with Davies the following report on the ethnological specimens acquired by the expedition:

"I beg to report that the Eskimo material collected by Mr. John Borden . . . has been duly accessioned and listed, and consists of a total of 533 objects. The collection is most interesting and attractive, and has been brought together with intelligence and discrimination. It represents a very valuable addition to the Museum's previous collections relating to Eskimo life, and many objects in it are entirely new to the Museum, above all, copper knives and copper arrowheads from the so-called Blond or Copper Eskimo of northern Canada, of which the Museum heretofore did not have a single example, and a wonderful series of ancient mammoth ivory carvings engraved with designs of a style which reveals an ancient phase of Eskimo art hitherto unknown. The abundance of walrus ivory carvings, many of great beauty and artistic merit, renders the collection particularly valuable to the student of Eskimo art and very attractive to the general public.

"I am exceedingly grateful to Mr. Borden for having exercised so much care in labeling his material exactly according to the localities where it was obtained, and this accurate information enabled me to make a temporary exhibit of selected material from this collection in Stanley Field Hall within a short time.

"As an interesting incident I may mention here that one day while I was going over Mr. Borden's collection Mr. Collins of the United States National Museum of Washington called on me. He had just returned from an expedition to Alaska on behalf of the National Museum, hunting for old Eskimo material. I showed him Mr. Borden's collection, and he was amazed at its fine quality and rarity, especially the stone and pottery cooking vessels, and said with reference to several objects that he had been unable to obtain them or that they were not even in the National Museum—all of which no doubt will be gratifying to you and the Board of Trustees as it is to myself."

(Continued on p. 29)

Treasures of Russia and the Ukraine

20-day tour for Field Museum Members and their families

The Kremlin, Moscow

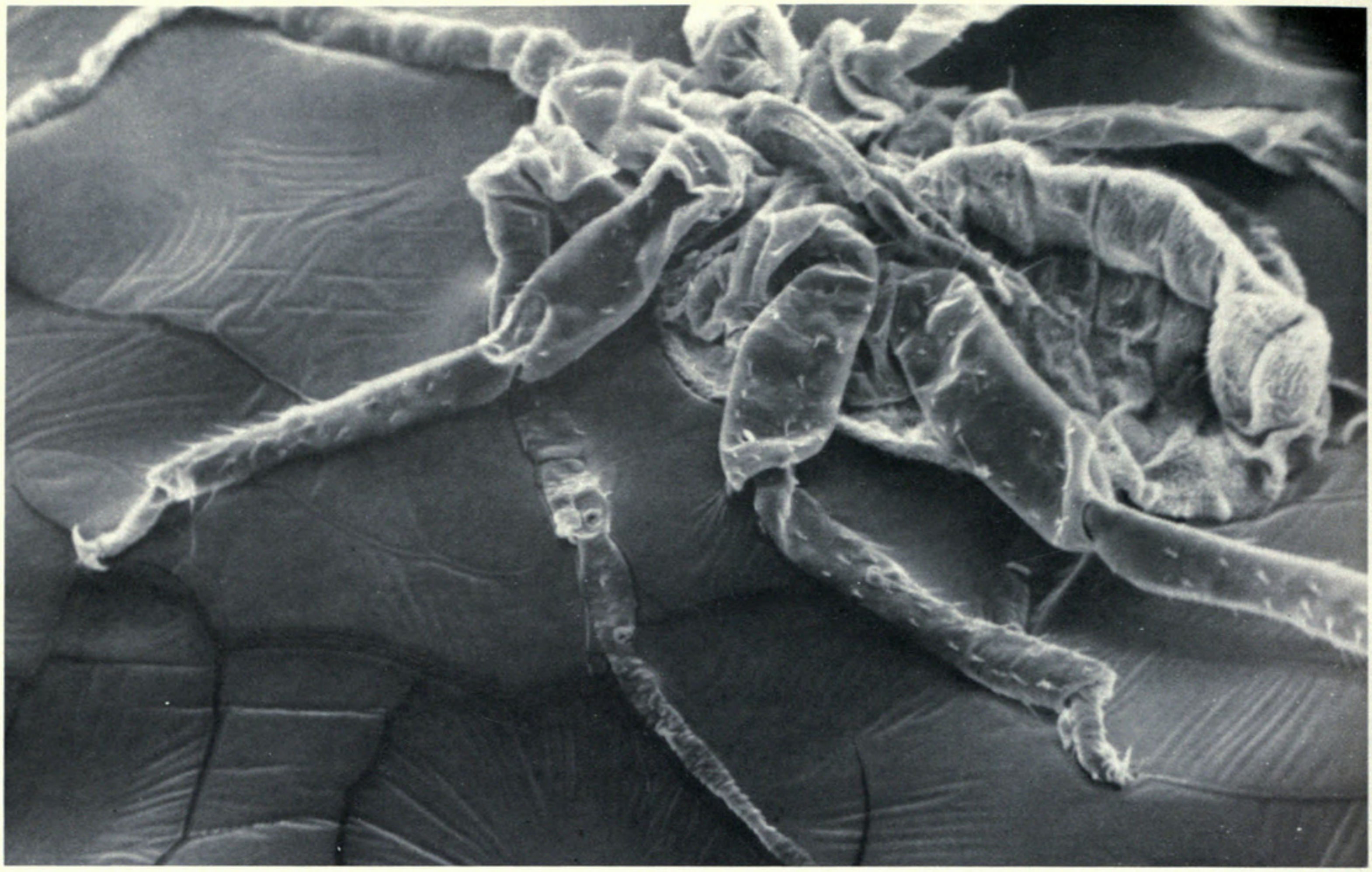
THE SPLENDORS OF OLD RUSSIA, the excitement of the New are in store for Field Museum Members and their families who join the tour "Treasures of Russia and the Ukraine," leaving Chicago's O'Hare Airport June 19 and returning July 8.

Highlights of this exclusive tour will include visits to the cities of Moscow, Vladimir, Kiev, Leningrad, Petrovorets, Novgorod, and Petrozavodsk. The group, limited to 35 persons, will be led from Chicago by two Russian-speaking escorts, with additional guides while in the Soviet Union provided by Intourist *(the Soviet Travel Bureau).*

The tour cost—$2,970 (which includes a $500.00 donation to Field Museum)—is based upon double occupancy and includes round trip air fare from Chicago to Moscow, with intra-Russian air transportation where required. The transatlantic airline is Swissair.

Deluxe hotel accommodations will be used throughout or, where necessary, the best hotels available. 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.

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



1. Green peach aphid air dried onto rubber cement and coated with gold for viewing in the SEM. Magnification 204x.

Chance Encounter Of A Good Kind

BY ALAN SOLEM

Scientists have been defined as "children who never lost their sense of wonder and never stopped asking 'Why?'." There is no question but what the thrill of discovery and satisfaction of finding out "Why?" is a major part of our professional world.

Part of the joy of science at Field Museum is continually being surprised by the variety of structure and function in nature. Often, these surprises come very unexpectedly. One such occurrence is shared with you here.

As part of the evening adult education course on scanning electron microscopy offered last spring at Field Museum, I prepared objects and specimens brought in by the students for examination and photographing in later sessions of the course. The range of things contributed included semiconductors, millipore filters, human hairs, snow leopard claws, spiders, flies, and an aphid off a house plant. One of the participants, Mary Ellen Rinkus, had asked how to get rid of aphids from a new house plant and a week later brought in one lone survivor on a leaf of the purple velvet plant, *Gynura aurantiaca*.

When prepared for viewing and first seen, the limp and shrunken aphid did not look particularly impressive (*fig. 1*). Its mouthparts were hidden and the abdomen and legs were far less spectacular than those of a fly or spider. Just as I was about to abandon this aphid for a different sample, I noticed a couple of little bumps on its antenna. A slight reorientation and higher magnification view (*fig. 2*) confirmed my interest. This picture would have been past the limit of viewing with a dissecting microscope. Another click of the dial and refocusing showed that these bumps were hollow (*fig. 3*). Here would have been near the limit of a compound microscope.

Later, I found out that the presence of these "bumps," or "primary sensoria," had been known for many years. Indeed, whether there are one or two on each antenna is significant to entomologists trying to identify families and genera of aphids. Standard monographs on aphids illustrate these "primary sensoria" as circles on outline drawings of the antenna (*fig. 4*). The limitations of optical microscopes had prevented more detailed study. But this evening we had fun in seeing something that was equally unknown and marvelous to teacher and students.

Quickly focusing on the lower sensorium (*fig. 5*) and a nearby seta (projecting sensory hair) showed that the former had a hard covering, center hole with flanged edges, and a large, partly

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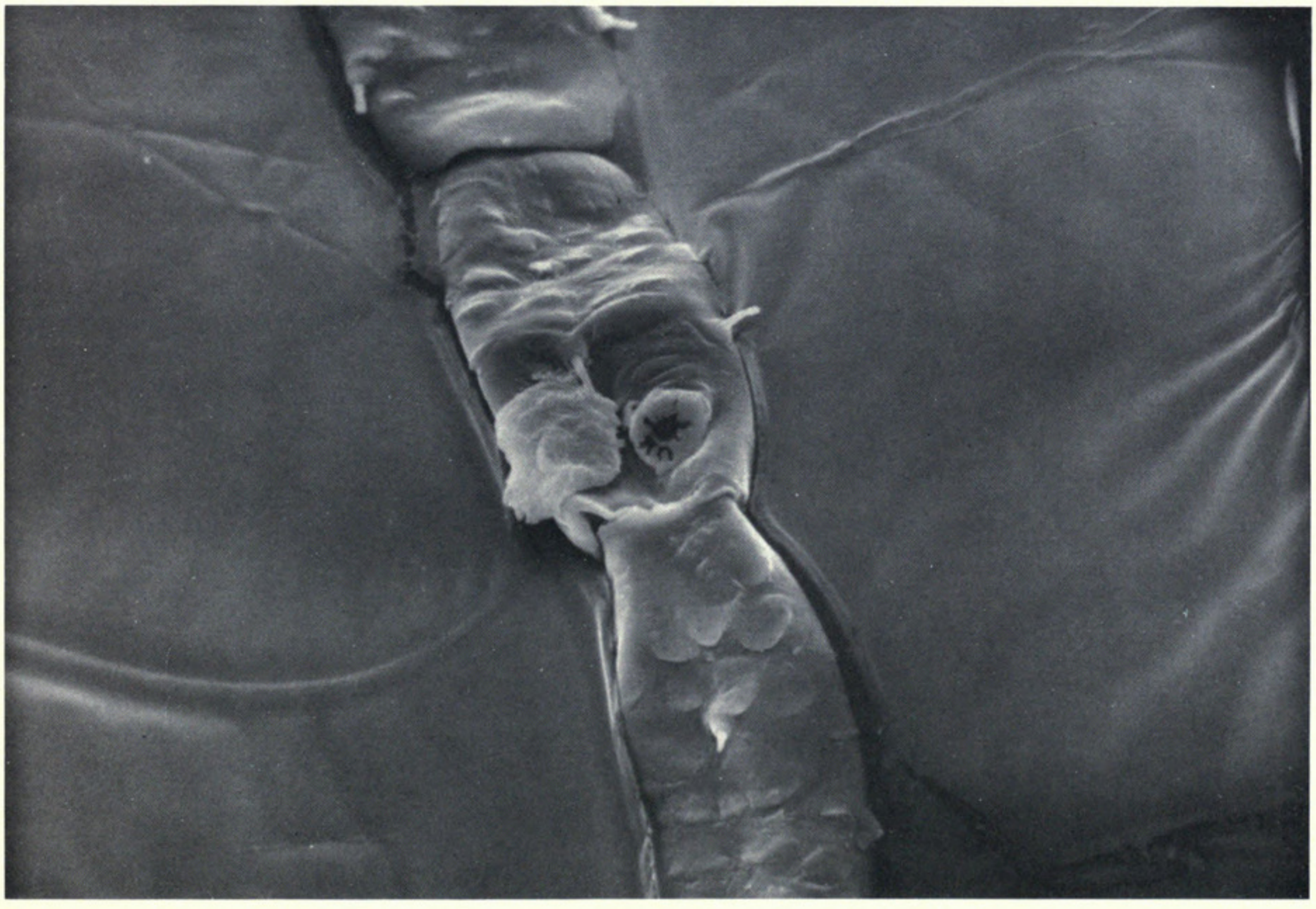
Alan Solem is curator of invertebrates.

2. *Portion of aphid antenna. Magnification 338x.*

collapsed pillowlike structure inside. Viewing at another angle and slightly higher modification (*fig. 6*) confirmed the type of edges and the collapsed internal soft structure.

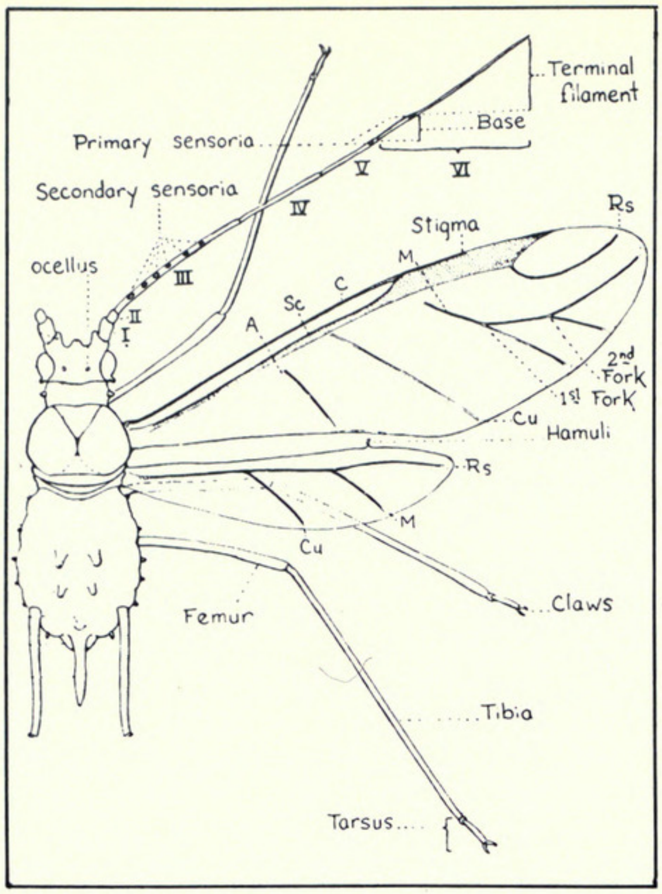
The upper sensorium proved to be much more complex. The entire structure was subdivided into six areas (*fig. 7*), each with a separate little organ inside. The low partitions between each area are clearly seen at the lower left, and the protective nature of the "canopy" which mixes openness with narrowing projections shows more clearly than at lower magnifications. A slight change in viewing angle (*fig. 8*) was followed by a high magnification look at one of the individual sense organs (*fig. 9*). The actual function of these organs can only be guessed at. Probably they sample minute traces of chemicals in the air, but since previously they were not even recorded in the



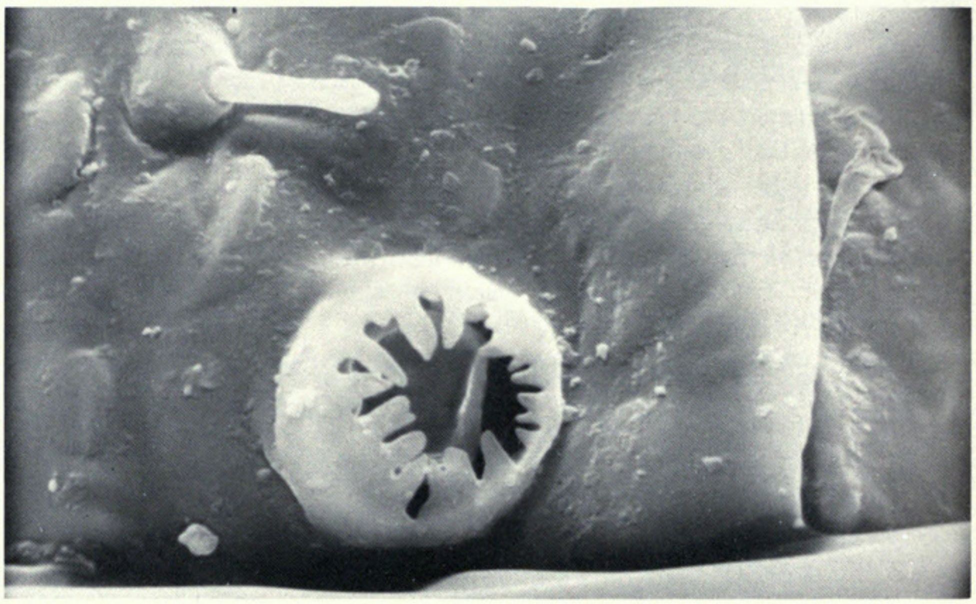
3. *Portion of antenna at 876x magnification.*

technical literature, our lack of understanding as to their function must be expected.

The next morning, our entomologists were visited by me with a sheaf of pictures in my hand. They were as amazed and delighted as the class and I were with these photographs. Quick checks in standard taxonomic works showed the published level of knowledge revealed in fig. 4. Our minds filled with many questions. First we had to find out which of the many thousands of aphid species we had been looking at. Field Museum has no specialist on aphids and, with the commerce in cultivated plants, aphids are continually being introduced to new areas. Mary Ellen Rinkus searched her plant in vain, visited the florist where two weeks before she had obtained her purple velvet plant, and triumphantly delivered aphid-loaded leaves to the Museum's shipping room. The aphids were preserved in alcohol. Curator of Insects Henry Dybas was planning to visit a major agricultural insect laboratory in California and agreed to hunt for an aphid specialist willing to identify the aphid. In due course, the specimens were shipped to Dr. T. Kono in Sacramento, who identified them as the green peach aphid, *Myzus persicae* (Sulzer).



4. External anatomy of aphid. Drawing from "The Plant Lice, or Aphiidae, of Illinois," Bulletin of Illinois Natural History Survey, *19 (3).*

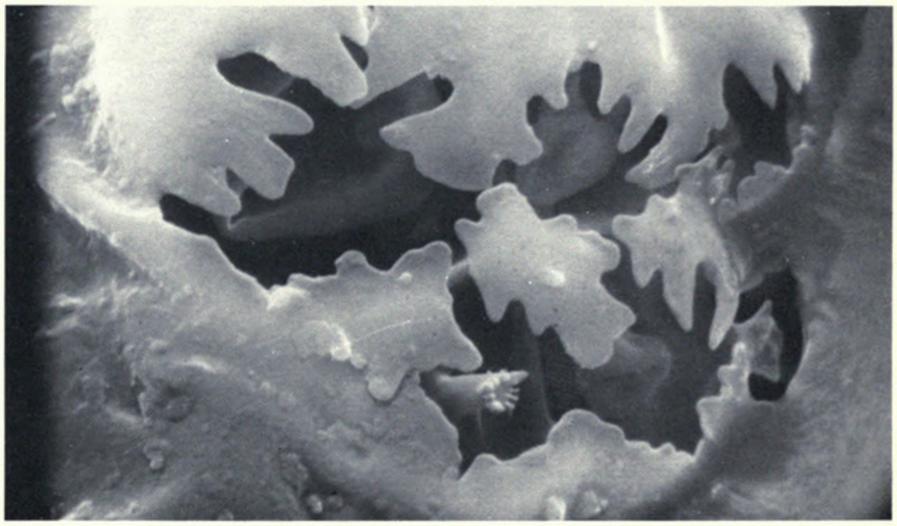


5. Lower primary sensorium and seta of aphid antenna at 2,697x magnification.

6. Lateral view of lower sensorium at 7,250x magnification.

7. Upper primary sensorium in vertical view at 8,316x magnification.

8. (Middle) *Slightly lateral view of upper primary sensorium at 5,544x magnification.*
9. (Below) *Detail of one organelle from upper primary sensorium at 24,092x magnification.*



Specialists in insect structure and function will have to work out the meaning and variation of these structures. Are most aphid sensoria alike or do they differ radically among groups? What are their functions? Are they unique to aphids or found in related insects? These and new questions derived from seeking the answers can occupy scientists in many places, since initial chance observations such as these only open the door to research.

In the same way that in the early 1600s the original Dutch and English microscopists looked into a new world with their new tool, the optical microscope, this generation of biologists is looking at a new submicroscopic world with our new tool, the scanning electron microscope. Thousands of scientists since the 1600s have used and continue to use optical microscopes to investigate the world too small for our eyes to see, and have far from exhausted research possibilities. It will take thousands of scientists working for hundreds of years to exploit the research opportunities revealed by use of the scanning electron microscope. To be able to participate in the beginning phases of this exploration is indeed one of the great joys in science at Field Museum, even knowing that following up most of the queries raised must be left to others, perhaps even generations removed in time.

Other chance encounters occur in my own research and some are followed up by me, but this is a series of different stories. □

Of Land Bridges, Ice-Free Corridors, And Early Man In The Americas

BY GLEN COLE

Photos by the author
Artwork by Louva Calhoun

Several questions which have long intrigued scholars interested in the native peoples of the New World are: Where did these people come from?, how did they get to this hemisphere?, and how long have they been here? Present day students of Early Man* in the New World are still concerned with these questions or certain aspects of them, although the emphasis has shifted to the time of arrival of the earliest immigrants. In general, there is no longer any real question as to where the ancestors of the American Indians came from although more specific problems remain. The means by which they arrived, particular routes taken after arrival, and manner of dispersal through the Americas remain unsettled issues.

Individual papers devoted to Early Man in the New World have long been standard fare at scholarly meetings. Sessions within such meetings and occasionally an entire meeting might be given over to the subject. These are usually held under the aegis of anthropological or archeological organizations, and although contributions from persons in disciplines outside anthropological ones are usual enough, probably none has heretofore had such a diversity of input as did a recent meeting of the American Quaternary Association (AMQUA) held in Edmonton, Alberta, in September 1978.

Ten years ago AMQUA was founded for the purpose (amongst others) of promoting the study of the North American Quaternary, a period of geologic time covering the last 1.6 or 1.8 million years, and facilitating communication between workers in different fields. These communications are facilitated by the sponsoring of biennial scientific meetings that are built around a symposium on a topic of broad interest to constituent AMQUA groups. These groups include general disciplines ranging from archeology to zoology, narrower disciplines such as climatology, ecology, limnology, physical geography, soil science and various biological and geological subdisciplines.

Archeology might seem somewhat out of place in this company, at least from the viewpoint of the academic scheme of things in the United States; here it is usually grouped with the social sciences, as a subdivision of anthropology. As such, it is the only major discipline within AMQUA which falls outside the biological and physical sciences. More importantly, archeology is peculiar in that it is the only one of the disciplines represented which is concerned only with a particular part of Quaternary time. Whether one considers that humans have been in the New World for 15,000 years or twice that long, this constitutes a very small portion — less than 2 percent — of the Quaternary Period.

This doubtless has been a factor in determining the symposium topics of the four AMQUA meetings held previously. Three of these focused on particular aspects of the last part of the Quaternary. The fifth biennial AMQUA meeting in Edmonton followed this pattern but, in addition, was the first to use an archeological subject as a theme of the symposium. Accordingly, this symposium on "The Ice-Free Corridor and Peopling the New World" drew a large contingent of archaeologists.

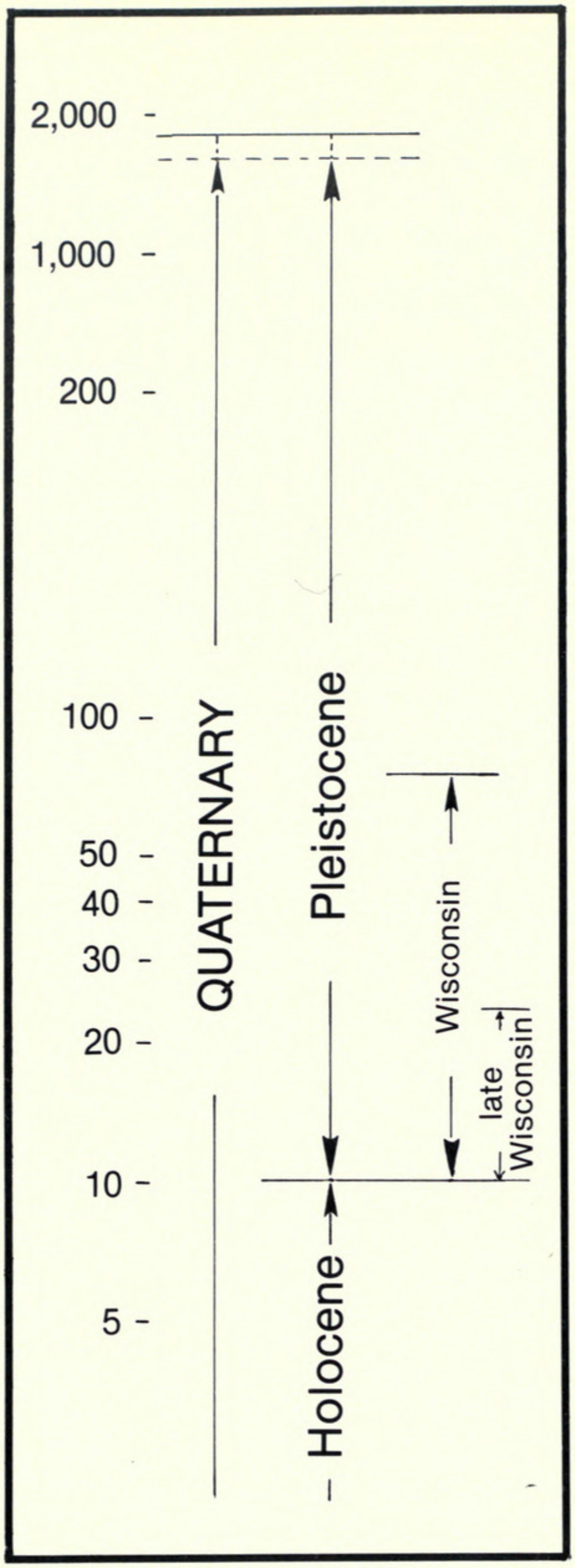
AMQUA symposium topics and meeting places are not unrelated. Edmonton lies in the "ice-free corridor" area and field sessions before and after the regular meeting permitted participants to examine glacial features pertaining to mountain and continental glaciation.

The whole subject of peopling the New World is marked by a dearth of sound evidence and, as a usual corollary to such situations, by a wealth of speculation. There is general agreement that the ancestors of the native American populations must have come from Asia and, for want of reasonable alternatives, that they must have

"Early Man," as used here, refers to Early Man in the New World. From the vantage point of the Old World, Early Man in the New World is very late indeed.

Glen Cole is curator of prehistory. He describes himself as "an Old World prehistorian who is generally concerned with a much earlier time period than is covered in this article." Cole is, additionally, a charter member of the American Quaternary Association (AMQUA) and has followed with interest studies relating to Early Man in the New World. In this article he discusses recent developments in North American Early Man studies as presented at the 1978 biennial meeting of AMQUA, at Edmonton, Alberta.

←*Athabasca Glacier. One of several descending from the Columbia Icefield in the Canadian Rocky Mountains southwest of Edmonton, Alberta. This is a remnant of a once extensive glacial system which extended beyond the mountain front to meet Laurentide ice and form the southern end of the late Wisconsin ice barrier.*



The Quaternary Period, which covers the last 1.6-1.8 million years of geologic time, is divided into two epochs, the Pleistocene and the Holocene. The last major glacial stage, ending 10,000 years ago, is known, in North America, as the Wisconsin. The Wisconsin, punctuated by several cold stadials and warmer intervals has been variously subdivided. For purposes of this article, it is simply divided into an earlier and a later portion. The more recent, late Wisconsin, will be that period from 23,000 before present (B.P.) to the beginning of the Holocene. The figures represent thousands of years.

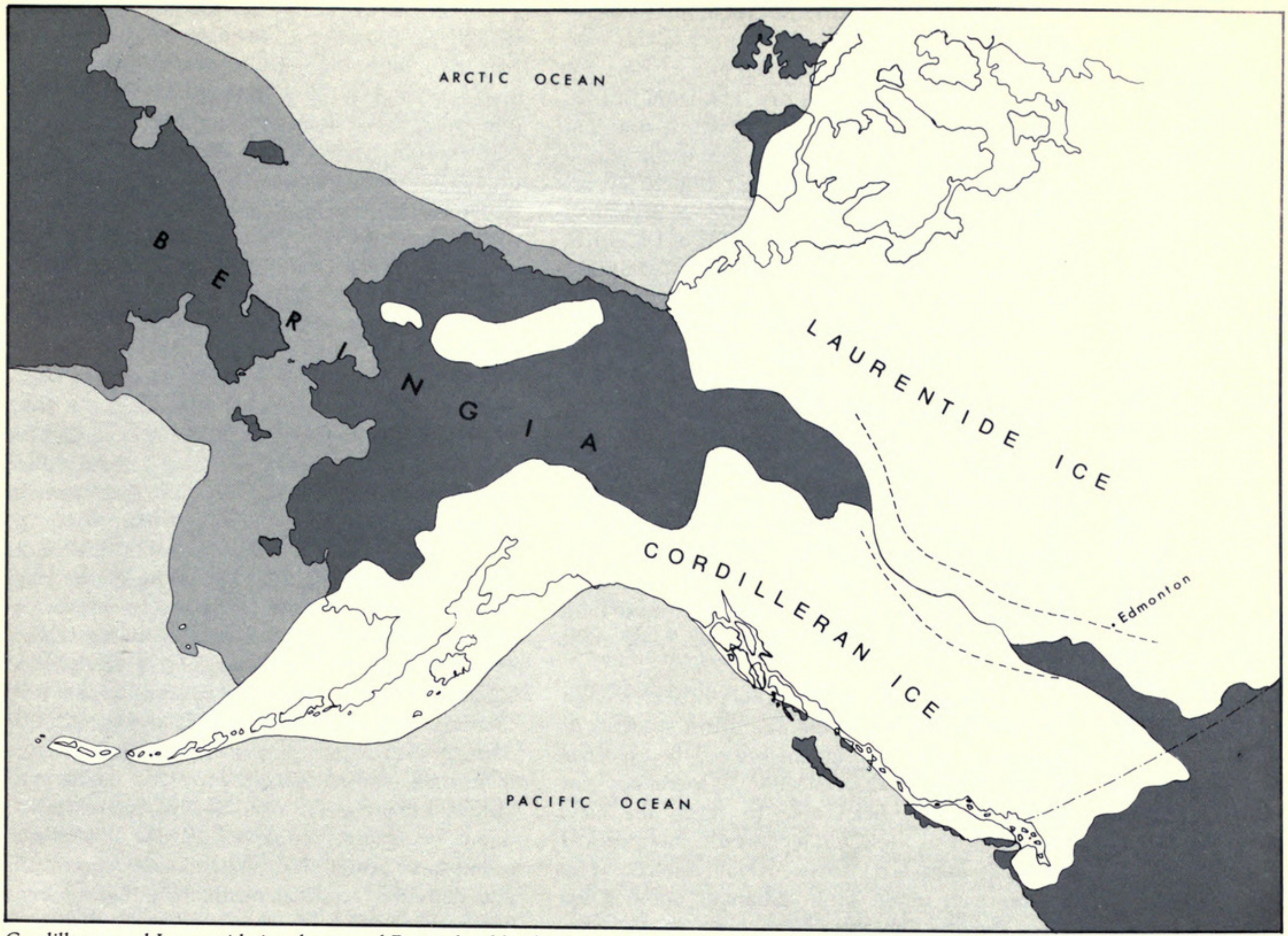
entered the New World through Alaska. The obvious place to seek the "roots" of the native American, then, is the adjacent part of Asia. But vast areas of northern Asia — Siberia, Mongolia, Manchuria along with much of the rest of China — and much of the northwestern part of North America for that matter, are virtually unknown archeologically. Students of Early Man in the New World have had to seek comparative material as far afield as the Ukraine and other eastern European areas. Some of the more important sites in the Lake Baikal region of central Siberia, although a good deal closer to the Bering Straits area, are as far removed from it as are many well known Paleo-Indian sites in the lower 48 states. Nor is much known of the later Pleistocene archeology of the maritime provinces of China and other Asian countries of the north Pacific area.

As more students of the American Quaternary have been learning the languages of the countries concerned, increasing amounts of information on the little that is known of those vast areas is becoming available. Even so, the New World archeologist has little comparative data to draw on. Not only are the data sparse, but the scholar who takes the trouble to learn Russian (or Chinese) soon finds that many of the Asian prehistorians are not nearly as interested in problems of peopling the New World as he or she might have wished, and their reports are often not very informative or useful in this regard.

Probably because of this paucity of direct evidence, students of Early Man in the New World have relied heavily on nonarcheological data in attempting to answer these questions. Incursions of people into the New World have been assigned to periods when land connections existed between Asia and North America. And then it has been supposed that man would not have been able to reach the central part of North America until the ice barrier separating the extreme northwestern portion of the continent from the rest of it was breached.

Unfortunately, the nonarcheological data have been none too secure either. Not too many years ago there were those—including some geologists—who denied the existence of an Asian-American land connection. More recently there has been, and remains a lack of agreement on whether an ice-free corridor came into existence before the Paleo-Indians were well established in the New World.

The single most important contribution to Early Man studies in recent years (and to archeological studies in general) has been the development of radiometric dating techniques. These, especially radiocarbon dating, have been making possible a much more concise chronology than was attainable a generation ago and new dates are appearing regularly. And, other new data are continually being produced. New archeological finds pertaining to Early American



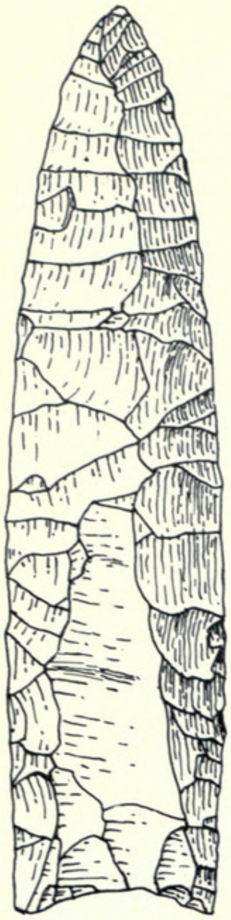
Cordilleran and Laurentide ice sheets and Bering land bridge boundaries at the time of the late Wisconsin maximum. Dashed lines indicate approximate position of the ice-free corridor, perhaps 12,000 years ago.

Man are being made and some long standing studies are continuing. In addition to new and ongoing geological mapping projects, there are studies in geomorphology, glacial geology, sedimentology, and stratigraphy. There are paleontological and climatological investigations, studies of plant successions and faunal distributions, to cite a few — studies that are not directed to the question of peopling the New World, of course, but which often provide information relevant to that subject.

Before discussing some of the contributions presented and more pertinent information disseminated at the AMQUA sessions, it would be well to go over a little background material:

Although ice in the form of mountain glaciers and polar ice caps has been on the earth since long before the Pleistocene Epoch, it seems that the period of the classic "Ice Age" marked by extensive continental glaciation in the Northern Hemisphere did not set in until ¾ million years ago. There is considerable debate concerning earlier Pleistocene glaciations and correlations between those of North America, Europe, and Asia; but that need not concern us here — there is quite enough disagreement concerning late Pleistocene glaciation. What is relevant to the question of getting Early Man to North America is the last major glacial period. A warm interglacial interval which ended an earlier glacial stage about 125,000 years ago was terminated by a cooling trend 75,000 years ago. The following period of extensive continental and mountain glaciations punctuated by intervals of glacial retreat is known in North America as the Wisconsin Age. By common, if not unanimous agreement, the Wisconsin is considered to have ended at the convenient figure of 10,000 years ago. The present nonglacial interval in which we are now living is known as the Holocene.

The ice-free corridor was a narrow strip of land along the eastern flank of the Rocky Mountains, which was exposed when coalescing mountain (Cordilleran) and continental (Laurentide) glaciers had begun to retreat after the late Wisconsin glacial maximum. This is not to say that there were not earlier glacial episodes. It is this last corridor that has loomed large in discussions of peopling the New World which is conventionally referred to as *the* ice-free corridor and which was the concern of the AMQUA symposium and field sessions.



Fluted Clovis point (actual size) from Blackwater Draw locality no. 1 near Clovis, New Mexico. This type of point characterizes earlier Paleo-Indian occurrences (ca. 11,500-11,000 B.P.).

Perhaps the area most crucial to the question of peopling the New World is the so-called Bering land bridge, a broad plain joining Asia and North America which was dry land from time to time during the Pleistocene but which now lies beneath the sea. Sea level fluctuated considerably during the Pleistocene because of climatic events which favored formation of enormous masses of ice at higher latitudes and elevations of the earth. On occasions when sea level had dropped by 150 feet, enough of the floor of the Bering and Chukchi Seas emerged to form a land connection between Siberia and Alaska. This "vast arctic lowland," the land bridge along with the contiguous low-lying areas of Siberia and Alaska plus a little of the Canadian Yukon Territory, is known as Beringia. Much of Beringia was not glaciated even during periods of maximum glacial advance and so provided a refugium for arctic plants and animals. So much water was locked up in ice during the maximum extent of the late Wisconsin glaciation that sea level was lowered by more than 300 feet, exposing a land bridge over 1,000 miles wide.

The question of when man first arrived in the New World is a vexed one. Most students of Early Man have been inclined to see the existence of the Bering land connection as necessary for people to have been able to reach the New World. In this view hunters would have drifted gradually eastward into new terrain as directed by the presence of the large mammals upon which they preyed. The most likely time would have been during the period of 22,000 to 15,000 years ago, although people, if any were living in western Beringia then, could have reached the New World during an earlier period of reduced sea level before 30,000 B.P. (before present).

Others argue that man could just as well have moved across the Bering strait on winter pack ice or negotiated small passages between ice floes and islands by boat. Also in favor of the idea that boats were used are a few who are inclined to favor colonization by seafaring people from Asiatic maritime provinces. By either of these views there would be no reason to restrict the time of man's entry into the New World to a period of low sea level.

In any event, the entry of human immigrants into the Americas would have depended on the degree of technological advancement they had reached. A string of islands such as the Aleutian chain would have been useless to people without boats, but it is now known that man, with the aid of boats or other means of crossing appreciable stretches of open water, reached Australia as much as 40,000 years ago. There is no reason to think that other people farther north in the Asian Pacific coastal area wouldn't have been similarly advanced technologically, and such people could have worked their way around the Pacific Rim, eventually reaching parts of the Pacific coast of North America.

The presence of the Bering land bridge would be of no use to man if the cultural paraphernalia which would permit living in an arctic or subarctic environment had not yet come into being. Man does seem to have been able to exist in cold environments 200,000 years ago in the European area at least. Closer to Beringia, we know that Peking Man was living in northern China some 300,000 years ago, although under somewhat milder conditions, and there is no reason to suppose that this represents the northernmost extension of human distribution at that time.

None of this, of course, can be taken to indicate that humans actually did reach the New World at these early dates, but it does mean that certain arguments that have been used to discount claims for Early Man in the Americas can no longer carry the weight they once did.

Firmly dated archeological evidence is needed to determine when peopling of the New World occurred, but no really secure evidence is found until the very end of the Pleistocene. This is now available in relative abundance since about 12,000 years ago. Between 11,500 and 11,000 B.P. there is a rash of Early Man occurrences. Most of these in North America are characterized by a distinctive, fluted projectile point known as "Clovis" (after a site near Clovis, New Mexico, one of several in the Llano Estacado, where such points have been found). The complex of artifacts and activities centered around hunting of large Pleistocene mammals, particularly elephants, is known as the Llano, or Clovis, Culture (this is to be discussed in more detail later). There is sparse evidence of other big game hunters in Central and South America at the same time or even somewhat earlier.

By 10,000 B.P. evidence of Paleo-Indian occupation is widespread in the Americas, extending from the tip of South America to Alaska. Before 12,000, however, the evidence is much more meager. There is a mere handful of likely Early Man sites in the Americas between 15,000 and 12,000 years ago. One of the most promising is the Meadowcroft Rockshelter in Pennsylvania, now being excavated, which has good evidence of human occupation as early as 15,000 to 16,000 years ago and perhaps even before.

There are a few possible Early Man sites which have been dated to the 20,000 to 30,000 years ago range, notably a couple in Mexico, and a few more on the basis of equivocal evidence, to even greater ages.

Probably the most exciting recent evidence in this *very* Early Man area, vying in interest with the Meadowcroft site, has been coming from the Old Crow Basin of the Canadian Yukon Territory. Although the work along the Old Crow River wasn't discussed per se at the symposium, some of the results of the work were presented at a "poster session" and during an informal talk given during the post-meeting field session. Two groups of

Canadian researchers have been working in the area and a number of participants were present at Edmonton and on the field sessions, so there was ample opportunity for discussion.

The Old Crow River has entrenched itself in a thick sequence of old lake and alluvial deposits. Large glacial lakes were formed in the basin on two separate occasions when the Porcupine River, to which the Old Crow is tributary, was blocked by glaciers. During the interval between the lakes, deposits from coalescing alluvial fans covered much of the basin.

Bones of various later Pleistocene mammals have been found in abundance at numerous sites along the Porcupine and Old Crow. Along with these bones were found several hundred bone artifacts; that is, bones that have been altered by man, whether from butchering activities, breaking to extract marrow, or as raw material for tool making. These have come mainly from secondary alluvial deposits, which means that earlier sediments have been reworked by riverine activity so that material of different ages has been mixed. An age cannot be assigned, therefore, to the few stone tools that have been found associated with the worked bone on gravel bars in the river, but the bone pieces themselves can be directly dated by means of the radiocarbon in them. Several bone tools have yielded dates in the range of 25,000 to 29,000 radiocarbon years B.P. R. Morlan of the Archeological Survey of Canada, a member of one of the projects, reported that some recently obtained dates on broken or flaked bones, which are apparently artifactual, are considerably older, in some cases exceeding the limits of the carbon 14 method.

There is a possibility that the bone tools and other artifacts were made in the relatively recent past by Indians using the old mineralized bone, or perhaps, old nonmineralized bone preserved in frozen condition in permafrost and released from the river bluffs by stream action. Experimental work on mineralized bone from the Old Crow basin sediments indicates that such bone cannot be worked, as can green bone, to produce the kind of fractures seen in Old Crow artifacts. The possibilities concerning frozen bone are still being explored.

During the last few field seasons, two horizons in the river bluffs have been located from which the bone artifacts seem to be coming, but none have yet been found in undisturbed context.

The presence of humans in Beringia 25,000 to 30,000 and perhaps to more than 50,000 years ago doesn't necessarily mean that these people figure in the peopling of the Americas. Eastern Beringia has on occasion been connected with Asia at times when it was more or less isolated from the rest of the North American continent. At these times it can more properly be considered as an extension of northeastern Asia than as a part of North America. Various Asiatic animals are known from eastern Beringia that either never established themselves elsewhere in North America or did so at a time long after their appearance there. This may also have been true of some early human inhabitants of the area.

There are a few archeological sites scattered throughout Alaska which have yielded material for radiocarbon dates in the range of 10,000 to 12,000 years ago. A long gap separates these dates from the 25,000 years and older dates from Alaska and the Yukon. This gap also pertains to the situation as known so far from the Old Crow Basin. This could simply be a chance result of the incomplete archeological record but, as one AMQUA discussant, T. D. Hamilton of the U.S. Geological Survey, suggested, other factors may also be involved. Hamilton has worked for the last 16 years in another part of the Yukon drainage on the south side of the central Brooks Range in Alaska. Although he has studied and mapped more than 100 late Pleistocene to Holocene exposures in this area, no artifacts or other evidence of man's presence before about 6,000 years ago has been found. The absence of such evidence for a relatively well studied area "suggests that the distribution of Early Man in northwestern North America may not have been continuous in either space or time."*

J. D. Jennings, in introducing his recently edited book on *Ancient Native Americans* (W. H. Freeman & Co., 1978), states that "at once the most important and least dramatic event in American history was the passage of the first man from Asia into the New World 30,000 or more years ago." In writing this, Jennings evidently supposes that the first people to set foot in the New World would *ipso facto* have become the ancestors of the Paleo-Indians and eventually the American Indians found at the time of European contact. Actually, there would be nothing particularly odd in the early human inhabitants of eastern Beringia dying out or withdrawing during the deteriorating climate of the late Wisconsin glaciation. Within historic times we know of large areas of the American arctic that have become depopulated and of the extinction of entire local populations. It should also be remembered that technologically more advanced peoples in recent times were unsuccessful in establishing themselves on the opposite corner of the North American continent. Norse settlements founded in the tenth century A.D. failed to survive, evidently due to deteriorating climatic conditions in the fourteenth and fifteenth centuries. Although not without interest, the presence of those early colonists was essentially irrelevant to the peopling of the New World. So may it have been with the early Beringians.

From time to time during the Quaternary,

**All quotations, unless otherwise indicated, are taken from the* Abstracts *of the fifth biennial meeting, American Quaternary Association, Edmonton, Alberta, 1978.*

at the maxima of certain glacial episodes, continental ice encroaching on the mountain front was met by tongues of Cordilleran ice to form a continuous ice sheet. Just how often this happened is not known, since deposits of the earlier glacial episodes are much less well preserved or exposed than are those of recent glaciations. But even the configurations of late Wisconsin ice are unclear. Earlier Wisconsin glacial deposits are more extensive than those of the late Wisconsin in the corridor area. It is not always easy to distinguish between the earlier and later deposits occurring there. Organic material which would be suitable for radiocarbon dating is usually absent from these deposits.

Not all fronts of an ice sheet were synchronized. An ice lobe in one area could be advancing while another front was at a standstill or even retreating. A warming trend, which could result in ice thinning and accelerated flow at the terminus, could effect separate ice masses, or discrete portions of the same one, differently. Effects of the warming could be manifest at the toe of a mountain glacier system long before they would be felt at the front of the more massive Laurentide ice sheet. Such seems to have been the case in Alberta, where Laurentide ice overran deposits of the retreating Cordilleran ice. (Because of the very different rocks contained in the deposits derived from the two glacial systems, it is not difficult to distinguish between them.) However, the Laurentide ice did not reach the mountains in this area and did not encounter Cordilleran ice until much farther north. Laurentide ice did reach the Richardson and MacKenzie mountains in the Northwest Territories, but there the late Wisconsin glaciation was not extensive. Terminal moraines of the valley glaciers occur well back from the Laurentide ice margin so a rather rugged ice-free zone remained. Thus, even at the height of late Wisconsin glaciation there were appreciable ice-free reentrants at either end of the incipient corridor. It was in the central part of the corridor mainly along the mountains in northeastern British Columbia and a little of adjacent Alberta that there seems to have been a formidable late Wisconsin ice barrier.

In summarizing geological evidence pertaining to the corridor area, N. W. Rutter, a University of Alberta geologist, concluded "there was only a short period of time when Laurentide-Cordilleran ice could have coalesced in Wisconsin time . . . . This could have been in Early Wisconsin time, which we know little about, and in Late Wisconsin time . . . for a maximum of about 10,000 years." That is, the corridor has been blocked by ice for only about 10,000 of the past 70,000 years.

According to geologist W. H. Mathews of the University of British Columbia, who has been working in the British Columbian part of the corridor, retreat of the ice there seems to have begun about 13,500 years ago. He estimated that it took nearly 2,000 years for the ice to withdraw to a point 150 miles to the northeast.

Even after converging ice masses had withdrawn sufficiently to provide an ice-free corridor, one shouldn't think that easy passage southward would have been assured. Melting ice provided a large volume of meltwater to supplement runoff from the mountins and local rainfall. Old drainage lines were still blocked by Laurentide ice and local drainages choked with glacial debris so that much of the floor of the corridor must have been inundated by the water of lakes—some of them very large — and by bogs and streams. These features in themselves would not necessarily have been serious obstacles to the movement of man and other animals, for they became quite passable when frozen over—a condition which must have prevailed for at least several months of the year.

A more crucial factor for human occupation than water barriers would have been the availability of sufficient food plants to support the animals upon which man, in turn, depended for subsistence. (Such environments provide little in the way of vegetable foods suitable for human consumption.) It would seem likely that the appropriate regional vegetation would have become established quickly enough in suitable terrain within the corridor, but it is difficult to guess how long it might have been before this was sufficient to support sigificant numbers of game animals. It may be that this situation would not have been realized before a normal drainage connection with the MacKenzie River had been reestablished. At present there seems to be no very good estimate as to just when that might have been.

Unfortunately, "The Paleoecology of the Ice-Free Corridor," discussed at the AMQUA meeting by J. C. Ritchie, a University of Toronto biologist, is too poorly known to contribute much to the subject of peopling the New World. There are a few scattered indications that the late Wisconsin glaciation was preceded by a period of environmental conditions similar to modern ones. There is no evidence as yet from the southern half of the corridor area for conditions prevailing from the time of the beginning of ice retreat until about 13,000 B.P., at which time forested conditions already existed in many localities. Ritchie suspects a prior one or two thousand years may be unaccounted for in the known sections. In the northern corridor area there is a little general information on regional changes in vegetation patterns between 14,000 and 13,000 B.P., but nothing, it seems, that might apply to the early stages of the corridor itself.

With the abundance of water in the early corridor, one might think that fish would have provided a possible food base. Zoologist C. C. Lindsey, of the University of Manitoba, in discussing "Aquatic Zoogeography and the Ice-Free Cor-

View across the toe of the Athabasca Glacier. Such views with wasting ice, meltwater streams, and lakes would have been commonplace to any inhabitants of the ice-free corridor in its earlier phases.

ridor," cited distribution of Yukon varieties of fish to indicate that streams normally tributary to the MacKenzie River, while still dammed by Laurentide ice, backed up to eventually spill over to the Yukon drainage; this temporarily extended its headwaters far to the southeast. Besides indicating that this part of the corridor, at least, was a very watery place, this suggests that fish may have been introduced at a very early stage of its development but again, no precise age can be assigned to the event. It may also be that refugia for fish persisted through the late Wisconsin. Lindsey cited one such possibility somewhat farther south in the corridor.

The results of recent field work have tended to indicate that late Wisconsin ice was less extensive than had once been supposed. A. MacS. Stalker, a geologist with the Geological Survey of Canada, is primarily responsible for working out the geology of the southern corridor area and is one who advocates a relatively weak advance of late Wisconsin ice. He nevertheless strongly doubts that an ice-free corridor had opened early enough to account for human occupation south of the ice sheet as early as 14,000 or 15,000 B.P. However, with the possibility that an essentially ice-free corridor may have come into being much earlier than currently seems to have been the case, Stalker, in his prepared comments for the Edmonton symposium, considered the nature of such a corridor.

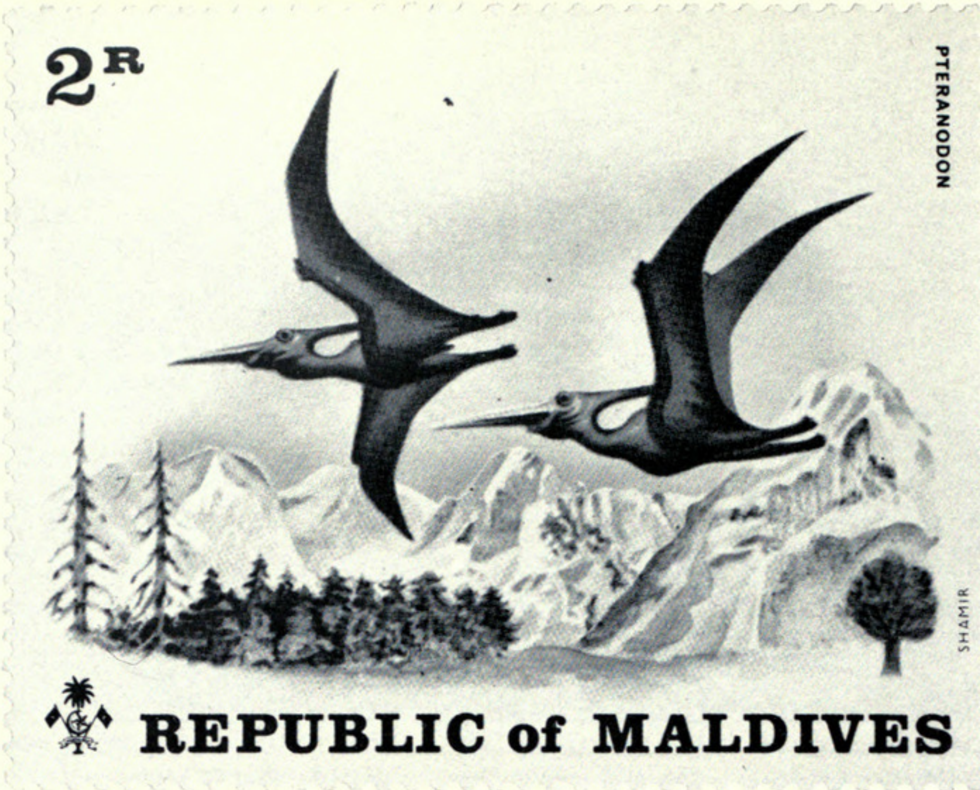
He finds it difficult to imagine that passage of Early Man through a corridor at this early time would have been feasible, for reasons such as have already been given. In addition to lingering spurs of ice, bogs, and barren landscape left by retreating glaciers, frigid glacial lakes, and turbulent rivers, "there would have been the chilling winds blowing from the glaciers . . . and extended periods of intense cold as man slowly worked his way 1,000 km south through the narrow part of the corridor, not knowing where he was going or what he had to face. . . ."

Although some of the obstacles and disagreeable conditions Stalker envisages probably loom larger to the geologist studying the deposits and landforms left by long departed glaciers than they did to a people adapted to an arctic environment, he stresses an important point: if anyone emerged from the southern end of the corridor, it was incidental to occupation of the corridor area. There is no reason at all to think that Early Man arrived either in eastern Beringia or in the central part of North America as the result of purposeful migration. Traversal of the corridor would not necessarily have taken a great deal of time. It is not inconceivable that a group of individuals, within the lifetimes of some of them, might have worked its way the length of the corridor and emerged onto the plains of southern Alberta and into Montana, but they could not have done so until sources of subsistence — food, clothing, and shelter — were available there. The concept of an ice-free corridor involves a good deal more than simply some more or less dry ground to walk on.

On the basis of evidence currently available, the corridor does not appear to be a very promising route for immigrants into the central part of North America before 12,000 to 13,000 years ago. Stalker suggests that "perhaps it is just as well that the finding of indications of the presence of man in North America prior to the maximum of the [late] Wisconsin renders an ice-free corridor unnecessary, and offers the possibility that man may have migrated south in comfort and ease much earlier."

("Of Land Bridges, Ice-Free Corridors, and Early Man in the Americas" will be concluded in the March Bulletin.*)*

CONFLICTS BETWEEN DARWIN AND PALEONTOLOGY



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Part of our conventional wisdom about evolution is that the fossil record of past life is an important cornerstone of evolutionary theory. In some ways, this is true — but the situation is much more complicated. I will explore here a few of the complex interrelationships between fossils and darwinian theory, but let me first set the stage by commenting about the geologic record itself.

There are about 250,000 different species of fossil plants and animals known. These have been named and described and specimens have been deposited in museums throughout the world. Field Museum has in its collections representatives of perhaps 20 percent of these known species. In combination with other museums, we thus have an enormous amount of statistical information on changes in the biological world that have occurred since the origin of life on Earth. In spite of this large quantity of information, it is but a tiny fraction of the diversity that actually lived in the past. There are well over a million species living today and known rates of evolutionary turnover make it possible to predict how many species *ought* to be in our fossil record. That number is at least 100 times the number we have found. It is clear that fossilization is a very chancy process and that the vast majority of plants and animals of the past have left no record at all.

To many people, the most interesting fossils are the oldest ones and the youngest ones. The oldest ones (up to 3,500 million years old) give us information about the origin and early evolution of life — at a time when physical and chemical environments were very different from those that prevail today. The youngest rocks, on the other hand, are of interest because they include fossils of early man. These, of course, have been worked on with particular success by the Leakeys in East Africa.

But these extremes account for only a small part of the quarter of a million fossil species — and for one interested in the broad range of evolutionary change, the extremes do not contribute much. In between is a long geologic interval which contains the basic record of the evolution of all major groups of plants and animals. Time control and quality of preservation are excellent compared with the rather thin record of the oldest or youngest fossils. (I might point out here that the East African material the Leakeys have worked on is relatively poor, there are only a couple hundred specimens, and age-dating is very uncertain.)

Darwin's theory of natural selection has always been closely linked to evidence from fossils, and probably most people assume that fossils provide a very important part of the general argument that is made in favor of darwinian interpretations of the history of life. Unfortunately, this is not strictly true. We must distinguish between the *fact* of evolution — defined as change in organisms over time — and the *explanation* of this change. Darwin's contribution, through his theory of natural selection, was to suggest *how* the evolutionary change took place. The evidence we find in the geologic record is not nearly as compatible with darwinian natural selection as we would like it to be. Darwin was completely aware of this. He

By David M. Raup, curator of geology

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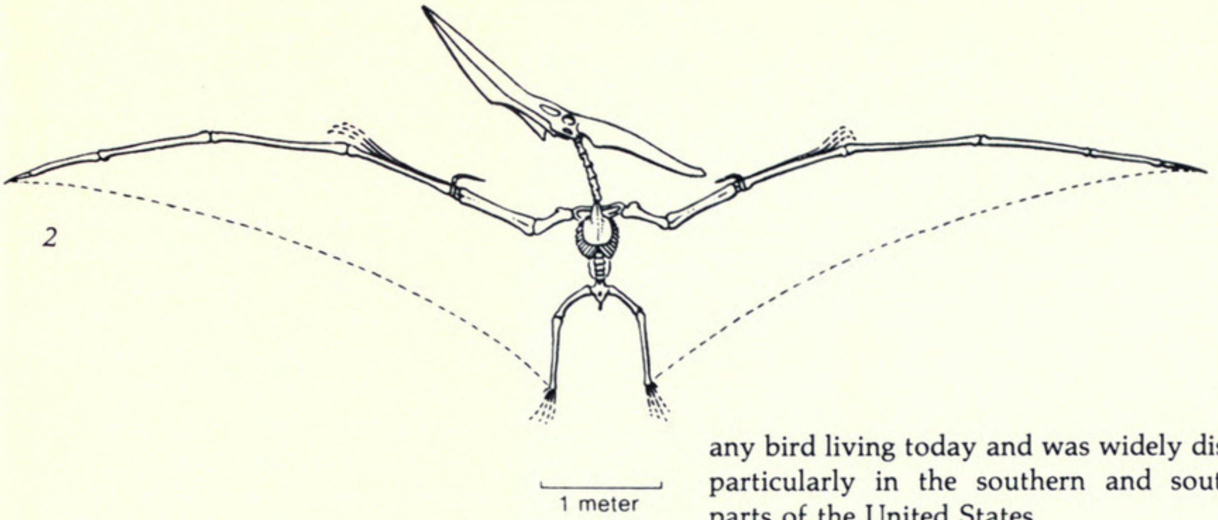

was embarrassed by the fossil record because it didn't look the way he predicted it would and, as a result, he devoted a long section of his *Origin of Species* to an attempt to explain and rationalize the differences. There were several problems, but the principal one was that the geologic record did not then and still does not yield a finely graduated chain of slow and progressive evolution. In other words, there are not enough intermediates. There are very few cases where one can find a gradual transition from one species to another and very few cases where one can look at a part of the fossil record and actually see that organisms were improving in the sense of becoming better adapted. To emphasize this let me cite a couple of statements Darwin made in his *Origin of Species*: At one point he observed, "innumerable transitional forms must have existed but why do we not find them embedded in countless numbers in the crust of the earth?"; in another place he said, "why is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely graduated organic chain, and this perhaps is the greatest objection which can be urged against my theory."

Instead of finding the gradual unfolding of life, what geologists of Darwin's time, and geologists of the present day actually find is a highly uneven or jerky record; that is, species appear in the sequence very suddenly, show little or no change during their existence in the record, then abruptly go out of the record. And it is not always clear, in fact it's rarely clear, that the descendants were actually better adapted than their predecessors. In other words, biological improvement is hard to find. Let me give an example: During the interval from about 65 to 200 million years ago there were a lot of flying reptiles known as pterosaurs (see "Pterosaur," by John Bolt, in the May, 1976, *Bulletin*). Their fossil record is quite good in spite of the fact that the skeleton of these animals is difficult to preserve. The giant *Pteranodon* was particularly spectacular. It was much larger than any bird living today and was widely distributed, particularly in the southern and southwestern parts of the United States.

Figure 1 shows a reconstruction of *Pteranodon* as it probably looked. The mountains in the background are not there by accident: it is felt by some people that these reptiles could become airborne only by climbing up on cliffs and jumping. *Figure 2* shows the skeleton. Wings were formed by greatly extending the bones of one finger on each hand and filling in with skin the area enclosed by the dotted line. This is basically the device used also by some modern bats. There is little question that this animal was capable of flight — a conclusion based on sophisticated engineering studies involving extensive analysis of weight, lift, drag, and other aerodynamically important factors — along with wind tunnel experiments with scaled models.

Figure 3 shows what *Pteranodon* probably looked like at rest and when flying. The most striking aspect of *Pteranodon* is its size, demonstrated

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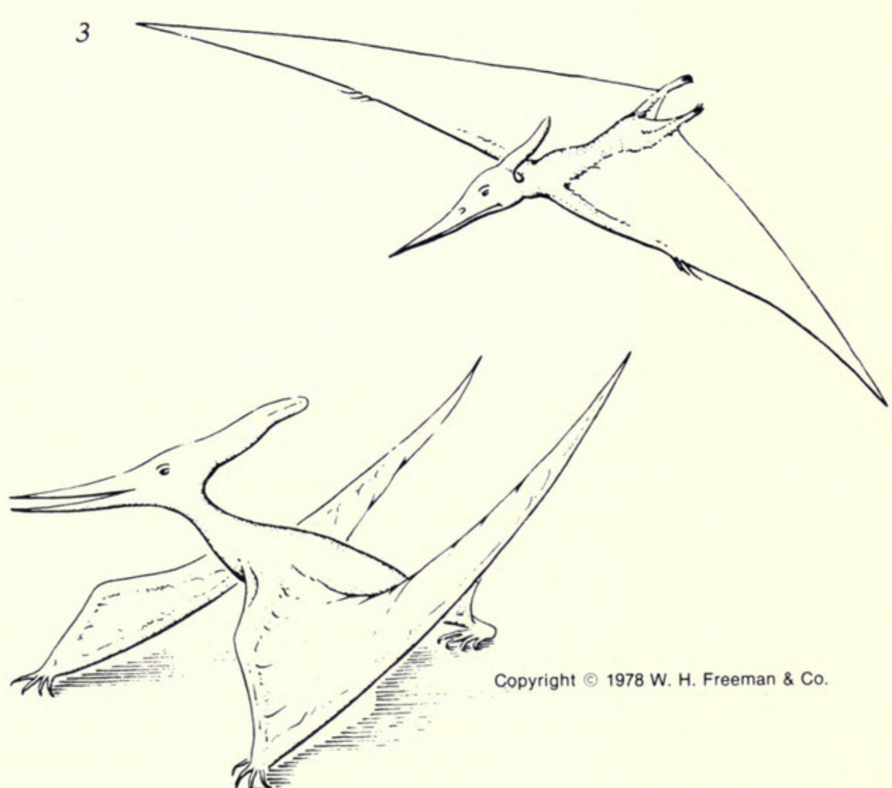

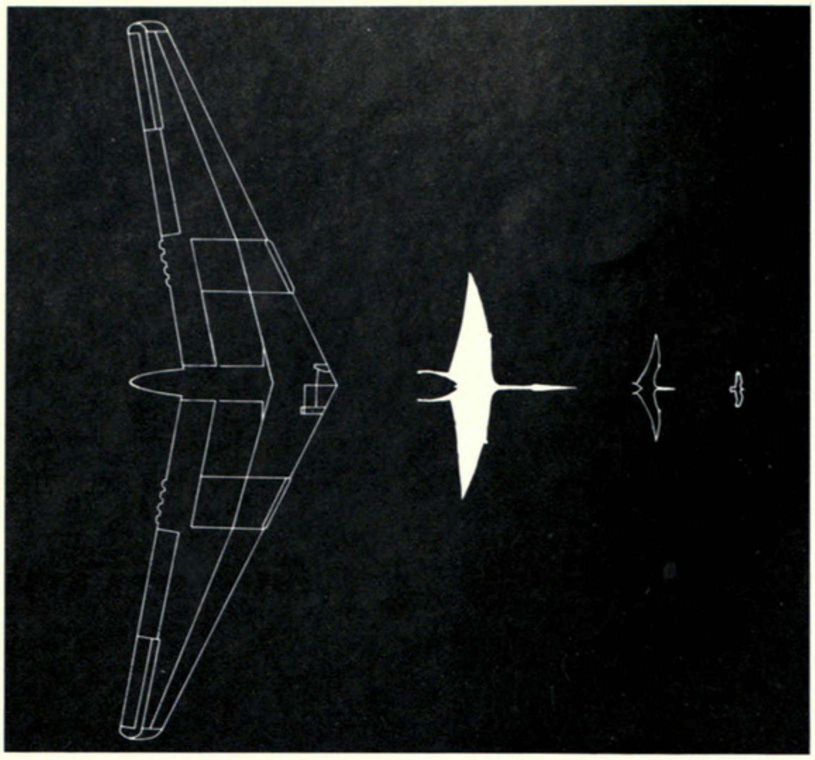

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in *Figure 4*, where it is shown in comparison with other flying objects. On the left is a modern tailless aircraft — the Northrop YB-49 — with a wingspan of about 170 feet. Next to it is the largest known pterosaur, which had a wingspan of about 50 feet. Next is a smaller pterosaur. The drawing on the far right shows one of the largest living birds — a condor with a wingspan of about nine feet. Thus, some pterosaurs were larger than all flying birds and even many small airplanes. They achieved this size and were still able to fly because their design was nearly optimal.

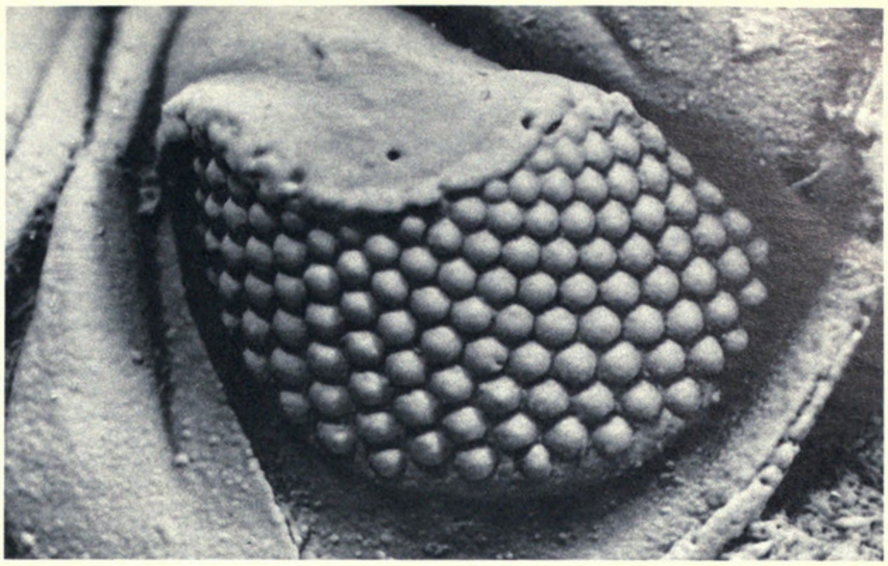
So here we have an adaptation which was apparently successful for many millions of years but which is now extinct and has not been repeated. That this animal went extinct implies some sort of failure. At least that is the conventional wisdom. *Pteranodon,* along with most other large reptiles, was replaced by mammals and birds. Mammals and birds were already around, but in small numbers. We assume in darwinian fashion that the big reptiles went extinct because there was something wrong with them; that is, they either couldn't compete with new forms that had evolved, or there was some change in environment that they couldn't adapt to fast enough to survive. As we will see, this interpretation may not be correct. We don't have any real evidence that there was anything wrong with the flying reptiles—in fact, they lived on the earth for a much longer time than humans have been around. During their tenure on earth the flying reptiles diversified into several quite distinct species but it is very difficult to put these species into any sort of series of improvement.

Here is another example: Figure 5 shows a fossil trilobite—a member of an extensive but now extinct group of arthropods. Figure 6 is a closeup of one eye of a trilobite. The eyes were generally large and quite similar to the eyes of modern insects, crabs, and other arthropods. But if we look at the individual elements of the trilobite eye, we find that the lens systems were very different from what we now have. Riccardo Levi-Setti (a Field Museum research associate in geology and professor of physics at the University of Chicago) has recently done some spectacular work on the optics of these lens systems. *Figure 7* shows sketches of a common type of trilobite lens. Each lens is a doublet (that is, made up of two lenses). The lower lens is shaded in these sketches and the upper one is blank. The shape of the boundary between the two lenses is unlike any now in use — either by humans or animals. But the shape is nearly identical to designs published independently by Descartes and Huygens in the seventeenth century.

The Descartes and Huygens designs had the purpose of avoiding spherical aberration and were what is known as aplanatic lenses. The only significant difference between them and the trilobite lens is that the Descartes and Huygens lenses were not doublets — that is, they did not have the lower lens. But, as Levi-Setti has shown, for these designs to work underwater where the trilobites lived, the lower lens was necessary. Thus, the trilobites 450 million years ago used an optimal design which would require a well trained and imaginative optical engineer to develop today — or one who was familiar with the seventeenth century optical literature.

Most fossils are not as easily understood as this. We have no idea why most structures in extinct organisms look the way they do. And, as I have already noted, different species usually appear and disappear from the record without showing the transitions that Darwin postulated.

Darwin's general solution to the incompati-



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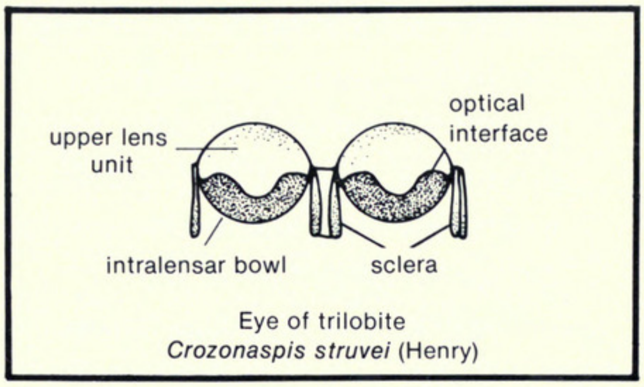
R. Levi-Setti



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R. Levi-Setti

bility of fossil evidence and his theory was to say that the fossil record is a very incomplete one — that it is full of gaps, and that we have much to learn. In effect, he was saying that if the record were complete and if we had better knowledge of it, we would see the finely graduated chain that he predicted. And this was his main argument for downgrading the evidence from the fossil record.

Well, we are now about 120 years after Darwin and the knowledge of the fossil record has been greatly expanded. We now have a quarter of a million fossil species but the situation hasn't changed much. The record of evolution is still surprisingly jerky and, ironically, we have even fewer examples of evolutionary transition than we had in Darwin's time. By this I mean that some of the classic cases of darwinian change in the fossil record, such as the evolution of the horse in North America, have had to be discarded or modified as a result of more detailed information — what appeared to be a nice simple progression when relatively few data were available now appears to be much more complex and much less gradualistic. So Darwin's problem has not been alleviated in the last 120 years and we still have a record which *does* show change but one that can hardly be looked upon as the most reasonable consequence of natural selection. Also the major extinctions such as those of the dinosaurs and trilobites are still very puzzling.

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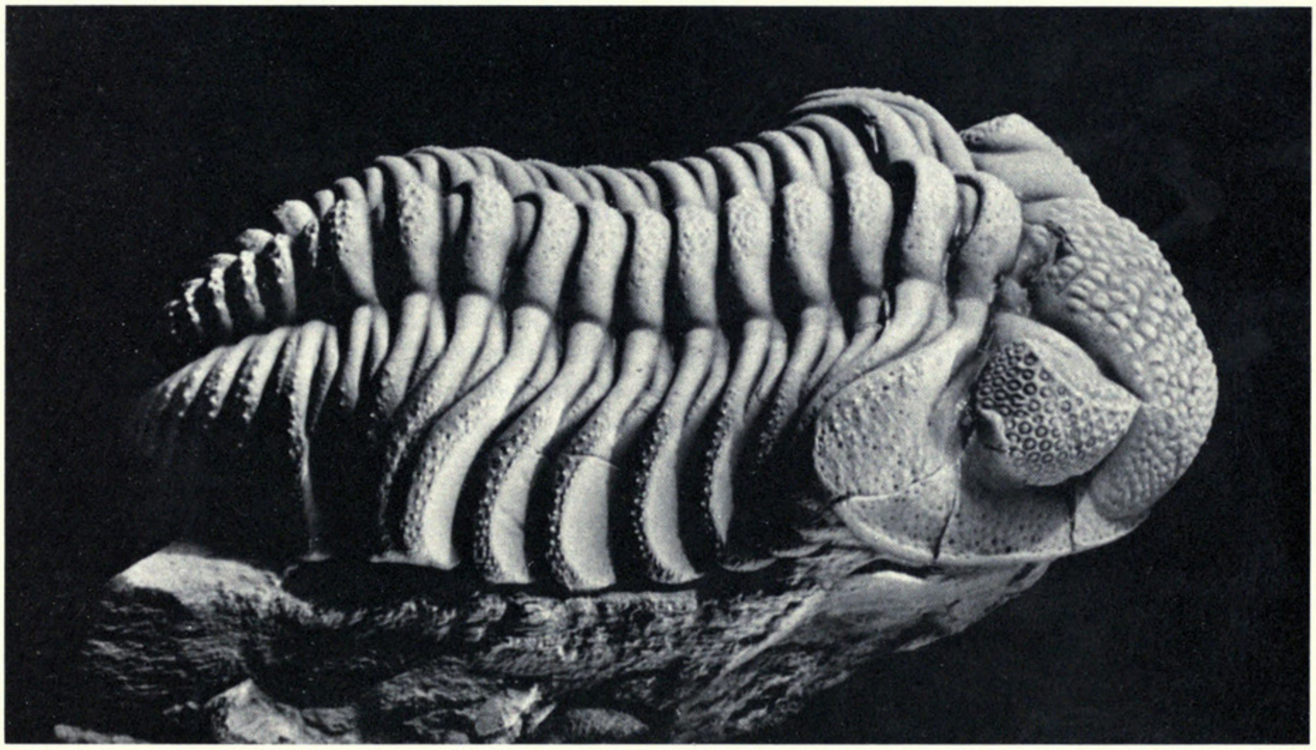


R. Levi-Setti. Copyright © 1975 The University of Chicago

Now let me step back from the problem and very generally discuss natural selection and what we know about it. I think it is safe to say that we know for sure that natural selection, as a process, does work. There is a mountain of experimental and observational evidence, much of it predating genetics, which shows that natural selection as a biological process works. Darwin's strongest evidence for selection actually came from the experience of plant and animal breeders who were employing artificial selection to produce evolution by breeding. And selection, be it natural or artificial, can clearly lead to better adapted types through a series of generations and through gradual transformation of a population.

So natural selection as a process is okay. We are also pretty sure that it goes on in nature although good examples are surprisingly rare. The best evidence comes from the many cases where it can be shown that biological structures have been optimized — that is, structures that represent optimal engineering solutions to the problems that an animal has of feeding or escaping predators or generally functioning in its environment. The superb designs of flying reptiles and of trilobite eyes are examples. The presence of these optimal structures does not, of course, prove that they developed through natural selection but it does provide strong circumstantial argument.

Now with regard to the fossil record, we certainly see change. If any of us were to be put down in the Cretaceous landscape we would immediately recognize the differences. Some of the plants and animals would be familiar but most

"The average duration of a species on the earth is less than 10 million years. And the record of really abundant life goes back at least 600 million years, so there has been complete turnover in the biological world many times."

would have changed and some of the types would be totally different from those living today. The average duration of a species on the earth is less than 10 million years. And the record of really abundant life goes back at least 600 million years, so there has been complete turnover in the biological world many times. This record of change pretty clearly demonstrates that evolution has occurred if we define evolution simply as change; but it does not tell us how this change took place, and that's really the question. If we allow that natural selection works, as we almost have to do, the fossil record doesn't tell us whether it was responsible for 90 percent of the change we see, or 9 percent, or .9 percent.

The very obvious question at this point is: what alternative mechanisms do we have to explain the changes that we observe? A great many alternatives have been suggested both before and after Darwin. Some of the evolutionary theories that have been proposed belong to the lunatic fringe, but others are serious propositions by competent scholars. A currently important alternative to natural selection has to do with the effects of pure chance. It has been suggested that there are traits which are not important enough to the organism to be "seen" by natural selection, and that a purely random system of evolution could work for these traits. Let me give an example which may be important in the fossil record: Many organisms have shells which are coiled in a spiral fashion, such as snails, the pearly nautilus, and a great many other fossil and living organisms. Sometimes the spiral is left-handed, sometimes it's right-handed. One is just the mirror image of the other. In most cases, whole species of snails are either exclusively left-handed or exclusively right-handed. In a few cases, both left-handed and right-handed forms occur within the same species. And it is pretty clear that this is a hereditary trait — although the genetic mechanism is often complex.

In most cases, it's difficult to find an advantage the left-handed form would have over the right-handed form, or vice-versa. In such cases, the coiling direction that dominates the species may just be a matter of chance; that is, the one that got there first, or happened by chance to have more offspring gradually came to dominate the population. This is the sort of trait that might be subject to random evolution — a clear difference between animals but one not seen by natural selection because it does not affect the general life and hard times of the organism. I should add that in some snails it has been shown that this situation is a little bit more complicated because copulatory behavior is affected by coiling direction; specifically, the left-handed ones get along better with other left-handed ones than with shells of opposite coiling direction. This gives a selective advantage to homogeneity in a population without giving preference to left or right. So a left-handed strain that got started might be aided by natural selection even though its origin was a matter of chance. In the general case, however, the symmetry difference is probably neutral.

It would seem that if evolution of shape and form in animals were a random affair, the result would be one of chaos. This, of course, is one of the major counter-arguments to the idea of random evolution (or random walk evolution as it is sometimes called). It is certainly true that one would be most unlikely to develop a functioning flying insect, reptile, or bird by a chance collection of changes. Some sort of guidance is necessary. And in these cases, of course, natural selection is the only mechanism we know of to produce a workable combination of characteristics. On the other hand, it may be that a great many of the differences that we observe within major animal groups are differences which do not have much effect on fitness. We are thus talking about the survival of the lucky as well as the survival of the fittest.

A large number of evolutionary biologists these days are studying the question that I've just considered — it's called neutral or nondarwinian evolution. Much of this research is concentrated in the Chicago area. Most of the work so far has been done with proteins of relatively minor importance in the biological scheme where the case for selective neutrality can be made much more easily. Paleontologists have to work with obvious traits, and therefore, traits which are more likely to be seen by natural selection, so paleontologists are working at a scale different from that used by biologists. The whole problem of neutral evolution represents a very exciting area and is one of the most hotly debated topics in evolutionary biology today.

I would like now to concentrate on just one aspect of the problem. This has to do with the extinction of large groups such as the dinosaurs, the trilobites, and also somewhat smaller groups such as the flying reptiles that I have already discussed.

We know that the dinosaurs went extinct about 65 million years ago and we know they went extinct rather suddenly. Now, when we say the dinosaurs went extinct we are saying that a couple of prominent reptilian orders died out at about the same time. It is important to remember that what taxonomists call a class or an order does not exist as such. It's an abstraction denoting a collection of species descended from a common ancestor. It is an abstraction just as a family name in a human community is an abstraction. Therefore, when we say the dinosaurs went extinct what we are actually saying is that the dinosaur species living at a certain time didn't leave any descendants which we would call dinosaurs. The conventional wisdom is that the dinosaurs must have had traits in common or requirements in common such that they couldn't cope with changes in environment. And paleontologists have gone to great lengths to try to find out what happened.

Conventionally, the approach is a completely darwinian one based on the faith or belief that extinction can only be explained by finding some sort of Achilles heel shared by all members of the group. Along with this is the strong implication that the successor group — mammals in the dinosaur case — was somehow better than the dinosaurs, and this implies that if both were living today, the dinosaurs would again lose out to the mammals. This scenario may be true, but it is a very difficult one to prove. We don't have any convincing arguments for why the dinosaurs died out. It has even been suggested that we have a tendency to make what can only be called a *moral judgement* in cases of extinction. If a group went extinct, it must have been bad. The good prosper, the bad die.

What I would like to develop is an idea based on chance or randomness which may lead to the conclusion that the dinosaurs were simply unlucky. One way to approach this is to look at a completely different but analogous situation: one having to do with the evolution of surnames in human families. We know that family names die out. Surnames disappear from our communities. And the same question could be asked of them that is asked of the dinosaurs — does a human surname die out because its members are weak, or do something wrong, or does the family just have bad luck?

"It was clever of the pterodactyls to think of flying, but that's all you can say for them. They were doomed from the start because they had no feathers and no wishbone, or furcula, as flying vertebrates should have. They didn't belong in the picture and public opinion was against them. The Archaeopteryx was not much of a bird, but at least it had feathers. As for the pterodactyls, the best thing to do is just forget them. Bats are going to flop, too, and everybody knows it except the bats themselves." — How to Become Extinct, *by Will Cuppy (1941)*

One reason to turn to the evolution of surnames for help is that the subject has been worked on extensively for about 150 years and several effective mathematical techniques have been developed for working with the problem.

One of the first references to extinction of family names is found, of all places, in Malthus — in his famous *Essay on Population*. We normally associate Malthus with birth and population growth rather than death and extinction. But he mentioned in passing some data on the extinction of families in the town of Berne, Switzerland. He noted that over the 200-year period from 1583 to 1783, fully three-quarters of the prominent families that were present at the start of the period went extinct before the end of the 200 years. This was a startling figure. The same phenomenon was found later in other situations — including the English peerage and various European royal families. Wherever information was available, it showed that the average life expectancy of a family name is surprisingly short. This was intuitively unreasonable. Because all the data came from the upper classes of society, it was assumed that there was something debilitating or weakening about membership in the upper classes — and this gave rise to all sorts of sociological theory and speculation. But these speculations could not be checked because information was not available for the lower classes of society.

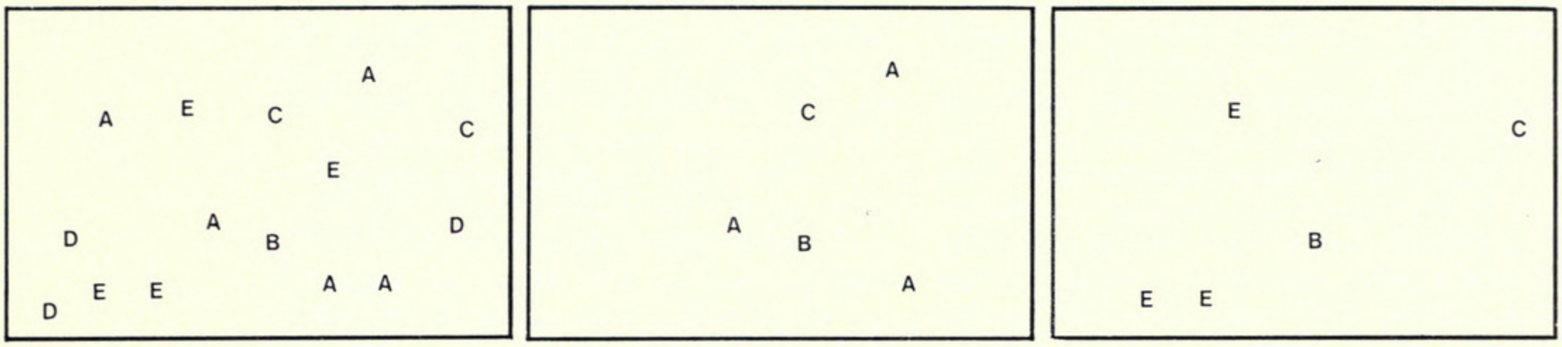
It turned out, after some now classic mathematical analysis by Galton and Watson* that what Malthus and others had observed was exactly what should be expected by chance alone, and the social class had nothing to do with it! This was later confirmed by studies of whole communities.

What this means is that families are inher-

**F. Galton and H. W. Watson, 1875, "On the Probability of the Extinction of Families," in the* Journal of the Anthropological Society of London, *Vol. IV, pp. 138-44.*

ently prone to extinction even though the population as a whole is stable — or even growing. Now this is still counter-intuitive and hard to accept. We all know of families that are enormous and which have long histories. The biography shelves of any library are full of examples. But the fact is that the ultimate extinction of any family name is statistically inevitable. The only uncertainty is *when.* It is perhaps best understood by noting that a family has about an equal chance of increasing or decreasing in size during a single generation. This is because the chances are about 50-50 of any marriage producing a male heir unless, of course, the couple keeps having children for the express purpose of having a male heir. I must apologize for my emphasis on the male line but since it is the name-bearing line, it is easier to work with. The same results can be gotten with the female lines but it is less convenient to analyze. Anyway, the number of males in a family fluctuates up and down as a random walk. If the number happens to drop to zero, the family is, so to speak, out of the game. The surname is extinct and cannot recover. But there is no such limit on the high side. That is, success cannot guarantee immunity to extinction to the degree that extinction guarantees immunity from success. Thus, ultimate extinction is inevitable and the smaller a family, the greater the chances of its becoming extinct in the next generation. Most families die out quickly because they generally start out small and thus are dangerously close to extinction at the beginning. Most published family histories are written about those families which do survive to become large. And most family histories are written by family members and thus are about families that have not yet become extinct. The biography shelves of a library thus contain a most unrepresentative sample of families. And even these families are doomed in the long run by the random walk nature of family evolution.

For the reader who is still skeptical, I recommend any of the published catalogs of the English peerage. The English peerage provides a particularly clear-cut situation. When a single individual is declared to be a peer of England, with the title to be inherited through the male line, we have the start of what is, in effect, a new family with a single founder. Some lines last a long time but most disappear in the first one, two, or three generations.



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A good example of such disappearance is that of the earldom of Rochester. Henry Wilmot was declared the First Earl of Rochester in 1652 but died seven years later leaving one son, John, who became the Second Earl. John died 21 years after that and *his* only son died as a child and the title became extinct. Now all three earls died of specific causes — John died of syphilis for example. One can say that John was unlucky, but the extinction of the line cannot be said to have happened without cause. *But* if we look at a whole group of such families, their histories are indistinguishable from a system controlled only by chance. By assuming a system of chance, we can accurately predict the approximate number of families that will be short-lived — even though we cannot predict in advance which families will be short-lived.

Now, suppose we have an imaginary human community which has a variety of surnames. Most of the families will be small — either because they just started or because they are on the verge of extinction. Only a few families will be large. This imaginary community would have a telephone book much like that of Chicago in the sense that a few names are very abundant but most are not. Now suppose that the population were suddenly reduced by epidemic disease. And suppose that family affiliation was not a factor in the reduction: that is, assume that Smiths were not more susceptible to disease than Browns. If this were to happen, there would be simultaneous extinction of many families. Most of the disappearing families would be the small ones but some large ones would be included. If someone were to look at family records later, it might *appear* that the reduction in population size was due to extinction of families — rather than the other way around — and one might be tempted to search for common denominators of failure among the families that died out in order to find out *why* they died out. But this would be entirely wrong because surname extinction was the effect rather than the cause of the population drop.

I can illustrate the general principle by a hypothetical example. The left side of *Figure 8,* above, shows a random array of 15 letters —ranging from *A* to *E*. Each letter may be thought of as representing a different surname; *A* is the most common and *B* the least common. Now, if we remove letters randomly, we may get something like the middle of *Figure 8*. Ten letters were selected for removal by using a table of random numbers. The letter *A* survived which is not surprising because it was the most common to begin with. But *B* also survived — by good luck. *D* and *E* went extinct. The right side of *Figure 8* shows another try with the same original pattern. This time, *A* and *D* went extinct and *B*, *C*, and *E* survived. *B* was lucky both times.

Let me return now to the fossil record of evolution. The dinosaurs died out at the end of the Cretaceous period (about 65 million years ago). Several other important animal groups also died out at about the same time. The groups seem to have little in common. Some lived on land, others in the sea. Some were large animals, some were small. And so on. (There is nothing surprising, by the way, in the fact that all these groups died out near the boundary two periods in the geologic time scale because the boundary itself is defined on the basis of the extinctions.) Many paleontologists have spent years trying to figure out what failing was shared by such different animal groups. Some explanations have been suggested but none of them is really convincing (to me, at least). The only thing we know for sure is that a lot of groups died out at about the same time. The fact of the extinctions is not geologically unusual — only the number of extinctions in a short time.

The business about extinction of human surnames may provide a solution. We may postulate that the end of the Cretaceous period was a time when an unusually large number of species died out. This could have resulted from some sort of epidemic, or a worldwide change in climate, or from a rare astronomical event. If a lot of separate species died out, some families and orders would inevitably also die out, as we have seen through the surname analogy. Some species would survive by luck and some would survive because they were fit. But these differences in fitness need not have anything to do with membership in a group such as reptiles and mammals.

Thanks to the mathematical techniques developed by people working with surnames, it is possible to test the geologic case against the proposition that species extinctions are not biased by the group to which the species belongs. It turns out that tests of several mass extinctions in the fossil record show that group membership (family name, if you will) is not statistically correlated with the extinctions. The dinosaur extinctions have not been fully tested yet. But experience with other extinction events leads one to look at the dinosaur extinctions as a possible chance phenomenon. It may be that the mammals were not better than the dinosaurs but just luckier at a time when an unusually large number of species were dying. This leads to the rather disquieting conclusion that if the Cretaceous extinctions were to be reenacted, a different suite of groups might have survived and this suite might not include our ancestors.

The ideas I have discussed here are rather new and have not been completely tested. No matter how they come out, however, they are having a ventilating effect on thinking in evolution and the conventional dogma is being challenged. If the ideas turn out to be valid, it will mean that Darwin was correct in what he said but that he was explaining only a part of the total evolutionary picture. The part he missed was the simple element of chance!

BORDEN EXPEDITION
Continued from p. 8

The Museum's *Annual Report* for 1927 carried this description of the zoological specimens collected:

". . . The zoological results of this expedition include a . . . group of Peninsula Brown Bears (*Ursus dalli gyas*) which are the largest carnivorous animals now living, rivalling in size the Cave Bear of Pleistocene times. Of the four specimens selected for a group, two were shot by Mrs. John Borden, one by Miss Frances Ames, and the fourth, . . . by Mrs. R. B. Slaughter. The expedition also obtained . . . Polar Bears and the complete skin and skull of a large male Pacific Walrus, . . ."

Five of the eight Sea Scouts survive today: Andrews, Purcell, Carstenson, Ram and McClelland. Andrews, who became an engineer, and Carstenson, who became a tool and die maker, are living in Florida. Ram, the only scout to become a professional mariner, is with the merchant marine. Purcell, a Jesuit priest, is a research professor at Georgetown University and a distinguished industrial labor relations authority. McClelland, a Chicago resident, is a retired physics teacher. Shortly after the expedition, McClelland made a name for himself by skippering the winning schooner, *Blue Moon*, in the 1929 Chicago-Mackinac yacht race.

Frances Ames, who collected botanical specimens on the expedition, is now Mrs. Douglas Wolseley, of Santa Barbara, CA. Mrs. Charles B. Goodspeed, widowed and remarried, is now Mrs. Gilbert W. Chapman, of New York. Mrs. John Borden (née Courtney Letts), subsequently wife of the Argentine ambassador to the United States (1931-43), Felipe Espil (deceased), is now Mrs. Foster Adams, of New York. Mrs. Adams will be at Field Museum on Saturday, February 3, to introduce the film "The Cruise of the Northern Light," which will be shown in James Simpson Theatre. □