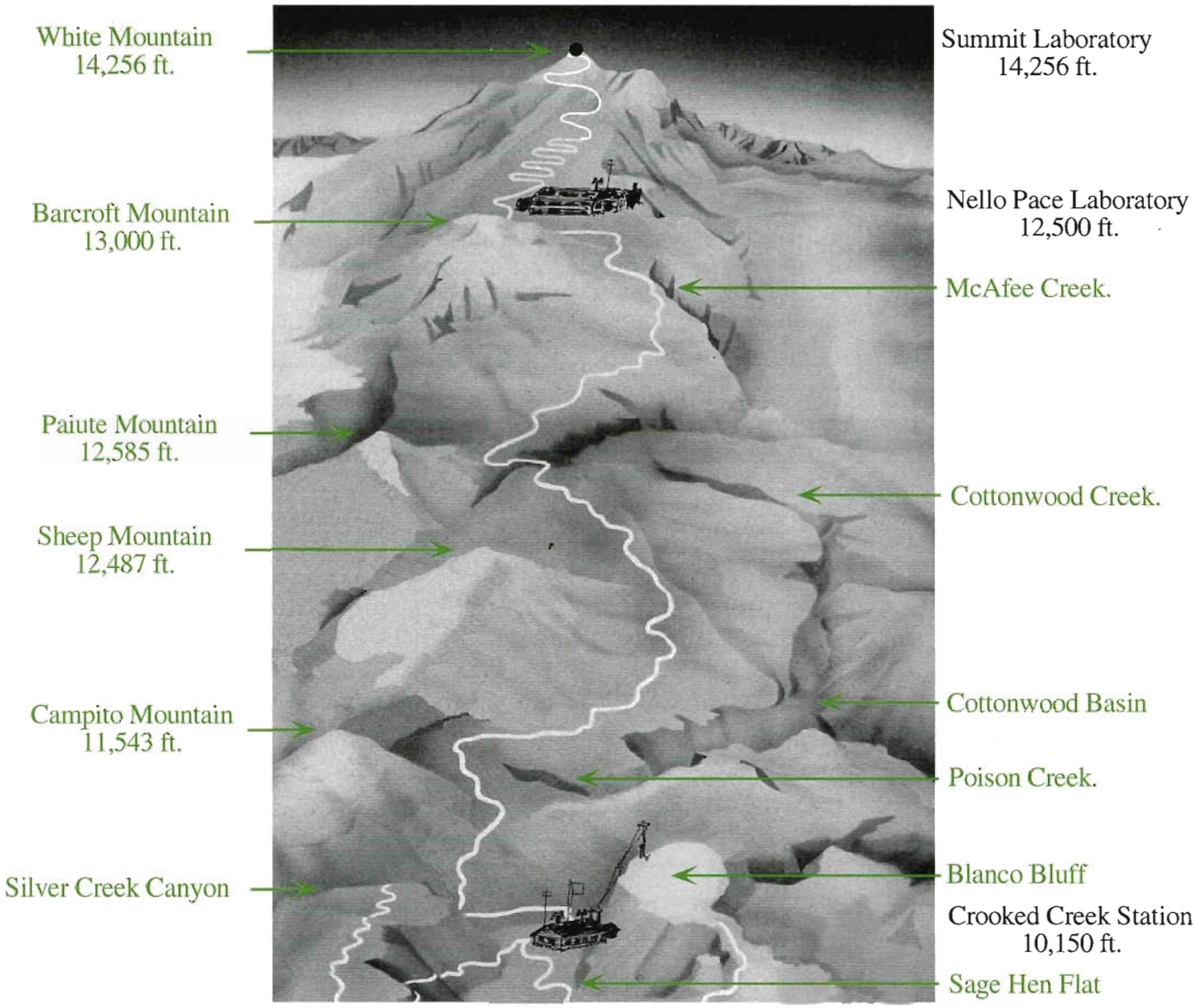
White Mountain Research Station
Barcroft & Summit Laboratories
—An Account of Their Inception—
1950-1956

by Burt Vaughan



This account is dedicated to Artis, my wife, for her patience and loving support. During my six years of study and work in both the White Mountains and the Antarctic, I saw very little of my family, and she found it necessary to shoulder the responsibilities of both husband and homemaker with two small children. Any success I have enjoyed over the past fifty years is due as much or more to her efforts and thoughtful consideration as to my own efforts. —B

Contents

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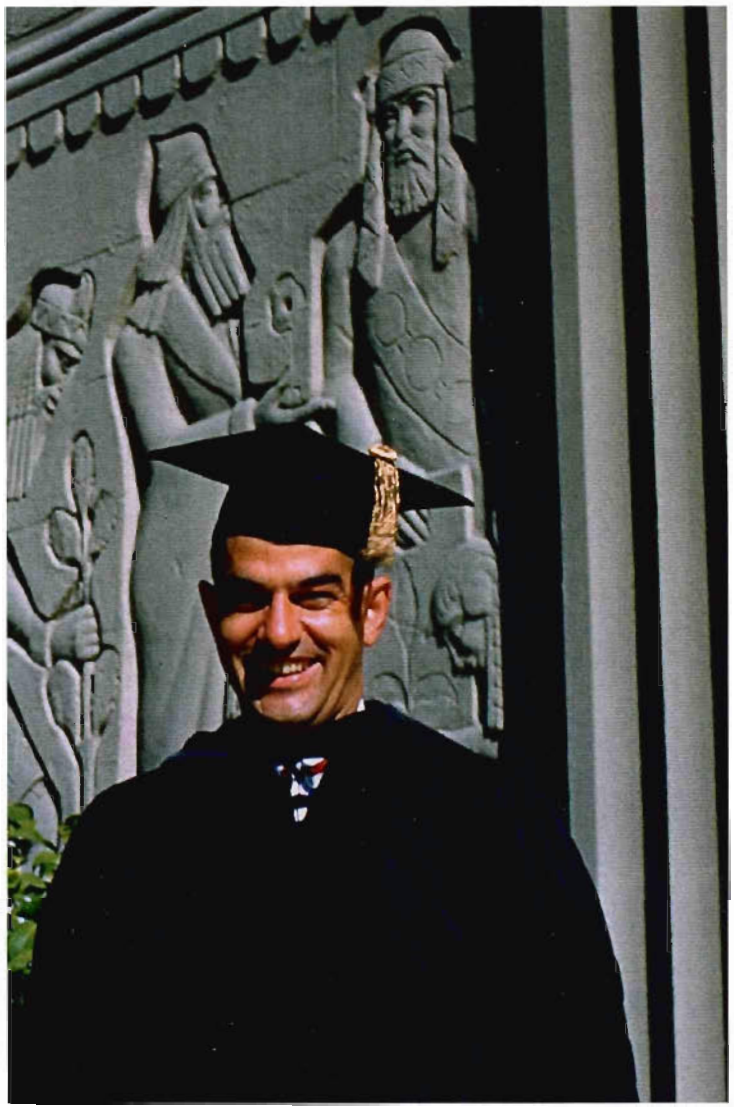
1- New Venture

The White Mountain range lies along California's eastern border with Nevada. From its peak, it appears as a mountain range fragmented in geologic times from the Sierra Nevada scarp 60 miles to the West. Drive through the tree covered Sierras, pass Mono Lake, Owens Valley and Big Pine, then climb through West Guard Pass in the White Mountains. Verdant greenery progresses to arid desert, and the stage is set for bleak expectations. In Spring of 1951, on first arriving on the slope of Mt. Barcroft, in the White Mountains, I thought I was seeing a moonscape. Everywhere bleached rock, scorching sun, a few dying bristlecone pines at 9,000 feet, and no streams to be seen —that was my first impression! There is much more to these mountains, but you need to live and work there to find out.

This is a rather personal account of my involvement with the White Mountain Research Station (WMRS) and the people I worked with. Nello Pace was responsible for the development of unique laboratory facilities on Mt. Barcroft and the summit of White Mountain peak. He was also my graduate advisor and first director of WMRS. My interest is definitely proprietary, as in 1951, I was one of a small number of graduate students from Berkeley, who dug trenches, blasted dynamite, poured concrete, and erected the Mt. Barcroft laboratory building at 12,500 feet. I also set up the first research studies done at the Mt. Barcroft laboratory, and four years later, I participated with Ralph Kellogg in the first acclimatization studies done in the Summit laboratory, at 14,246 feet. Our experiences were exhilarating. How it all came about was yet another story!

2. The Navy Connection



(Above) Nello Pace in 1955, on steps of UCB's Life Sciences Building

A rather unique combination of circumstances following WW II, plus encouragment and support from the Office of Naval Research (ONR), made possible both the high altitude laboratories of WMRS and my own research studies there.

Nello Pace —on the Berkeley faculty, and at the time an assistant professor in his mid 30s— had galvanized my interests in physiology. Like me, he was a Navy veteran fresh from World War II (WW II). Ten years my senior, he persuaded me to undertake doctoral studies on high altitude acclimatization, and he was my graduate advisor.

Nello was an extraordinarily interesting lecturer in environmental physiology. With a magnetic personality, his persuasive ability could bend even the most hardened bureaucrat. These traits and the unique circumstance of post WW II were all it took for the beginning of a long roller coaster ride culminating in completion of the WMRS laboratories at 12, 500 ft and 14,256 ft.

Today, I doubt that anyone could again build WMRS, certainly not in the way we did. In 1950, ONR's idea was to support basic research at White Mountain, with Nello making creative use of surplus military equipment as needed for research. Since the University of California at Berkeley (UCB) did not commit to building or operating any institutional facility in the White Mountains, "creative use" turned out to be a remarkably elastic idea.

By today's standards, I think any of us might go to jail for creative use of government equipment and funds. In the '50s, however, research contracts were more broadly written, not too many questions were asked, and surplus military equipment was widely available to universities. Perhaps the ONR thought the university would carry the facility burden, but this did not happen. The result, during the 1950-1955 period, was that we usually operated on a remarkably thin shoestring —'though more about that, at a later point!

Nello's creativity also extended to Navy politics in the most interesting of ways. During the 1949-1950 academic year, I undertook at Nello's urging intensive course preparation for my Ph.D. and studied on my own meager funds, supplemented by a part-time teaching assistantship. During the following year, however, I was offered a "summer in the mountains" at Navy officer's pay, as were quite a number of other people!

3. "A Summer in the Mountains"

Most of us involved in the Mt. Barcroft construction had been members of a local Naval Reserve unit, while doing graduate study or post-doc work at Berkeley. Only three of us were actually Nello's students. All were recalled to active duty as ONR Unit #1 ("ONRU-1," later renamed "ONRU-2"). Nello's two research technicians, Muriel Johnston and and Elaine Lis, had no prior military experience whatever. Yet, they were directly commissioned and also called to active duty in ONRU-2. Don Green and Jack Shriber, were newly enlisted for the occasion and assigned to the unit, as well. We all became either the construction or the support team for the Mt. Barcroft laboratory; and, who would you guess was the Officer-in-Charge of ONRU-2?

Like the other men, my "summer in the mountains" amounted to room and board on Mt. Barcroft, digging trenches, blasting rock, pouring concrete, and other construction labor. I don't know how many Navy officers have —outside military prison, that is— dug trenches and pick-axed rock, but in this case the Navy pay was real and Navy-related support for my professional graduate studies continued for several years. We did, of course, have many other concurrent research responsibilities for the Navy during this period, but WMRS was a major part of my life for nearly 7 years.

(Left) Eve Moreland was not actually a member of ONRU-2. She was employed at Berkeley, had previously worked as a secretary at the Navy base in Inyokern, CA, and played an invaluable role as *de facto* Business Operations Officer for WMRS during 1950-1956.

(Above) Office of Naval Research Unit #2; *(from left to right)* Elaine Walker Lis, Burton Vaughan, Donald Green, John Kilbuck, Kenneth Jackson, John Peterson, Carl Cramer, David Wiltsie, David Jensen, J. Thomas Hanson, Alan Bassham, Muriel Johnston, Frederick Schaffer, Nello Pace (Officer in Charge), Jack Shriber. [photographer unknown]

4. Bristlecone Pines

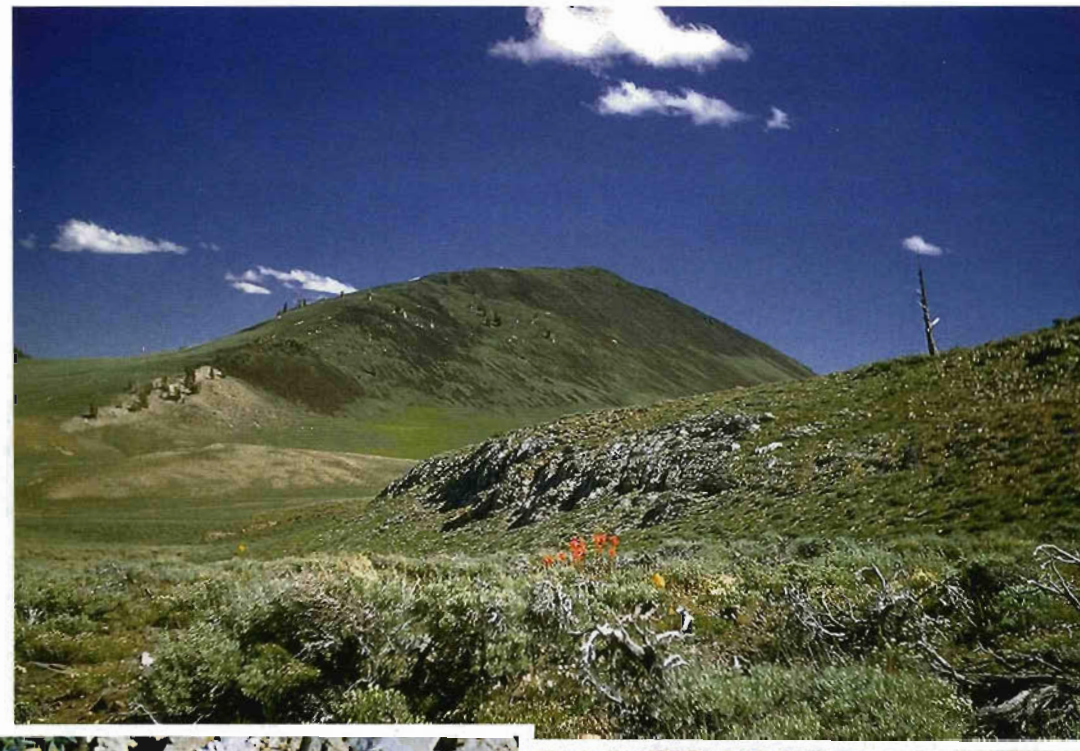
The most dramatic impression one gets in the White Mountains, is one of bleakness, with few trees, no bushes and rarely seen flowers. Most notable are the Bristlecone Pines. Although sparse, they reach as much as 4,700 years in age, and they are found on windswept slopes up to an atitude of about 11,000 feet. Appearing nearly dead, a slim ribbon of live bark nevertheless supports living needles. Dead wood does not decay; rather, it very slowly erodes under the combined action of the strong ultraviolet radiation and dry winds characteristic of these altitudes.

Here, Bristlecone Pines have been used to construct a master tree ring index, for both paleontological dating and for assessing earlier climates.

Color photo courtesy of Jack Shriber

5- Flora, 10,000 ft.

Spring flowers bloom and disappear in a remarkably short time on these arid mountains. Sun-baked, dry soil is the rule, along with dead or dying trees *(right)*.

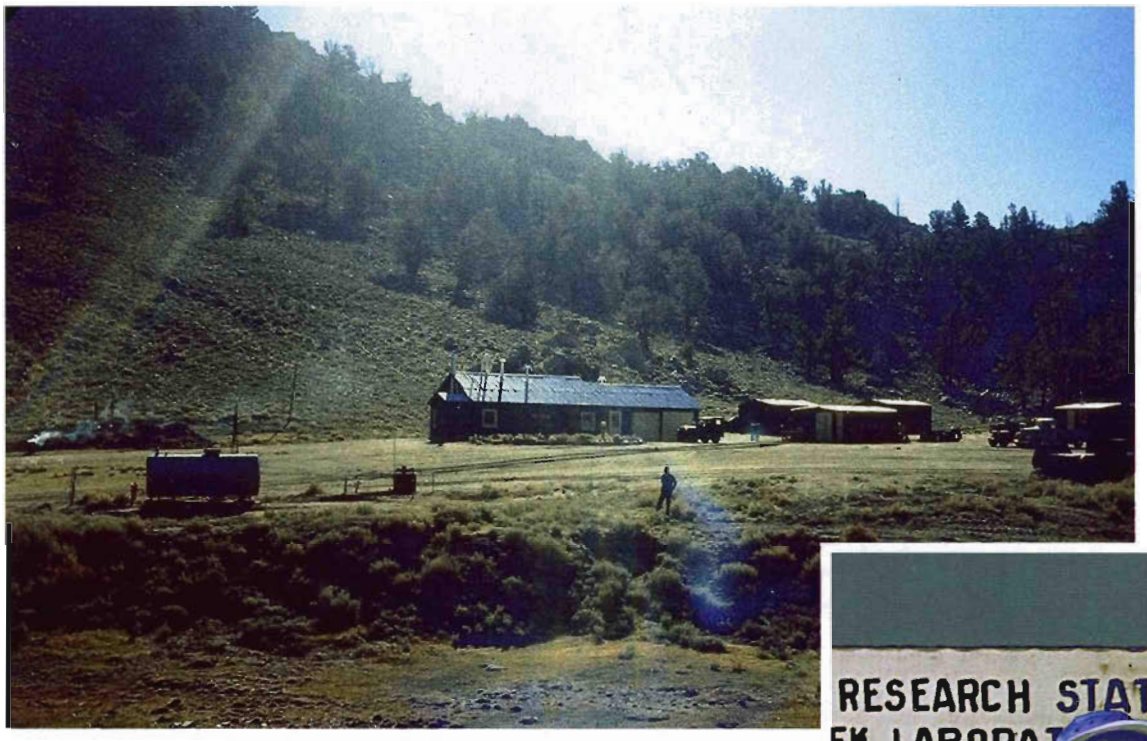


During a wetter than usual Spring, we were lucky enough to catch a much more verdant alpine scene on the way to Crooked Creek station. Note the red paintbrush blooms amidst sagebrush.

(Clockwise from middle left —photos courtesy of Jack Shriber) Sedum, alpine aster, and lupine, briefly in flower.

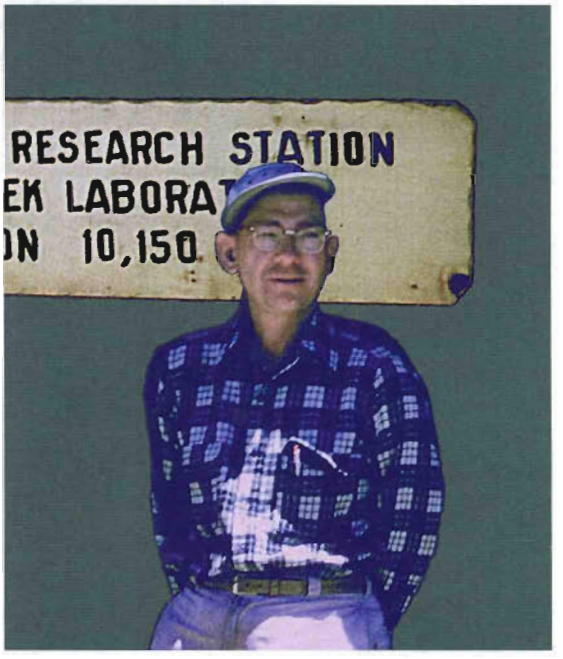
Most of these plants are more commonly found in subalpine locations. Paintbrush (Castilleja, sp.) is ubiquitous throughout the West, as is lupine. The red sedum is a short species, characteristic of moist, rocky cliffs and talus.

6- Crooked Creek



(Left) Crooked Creek Station as it appeared in 1950, the only facility on White Mountain until the building of the Barcroft laboratory.

(Bottom) Paul Manis in 1950; resident manager of WMRS, until his retirement in 1963.

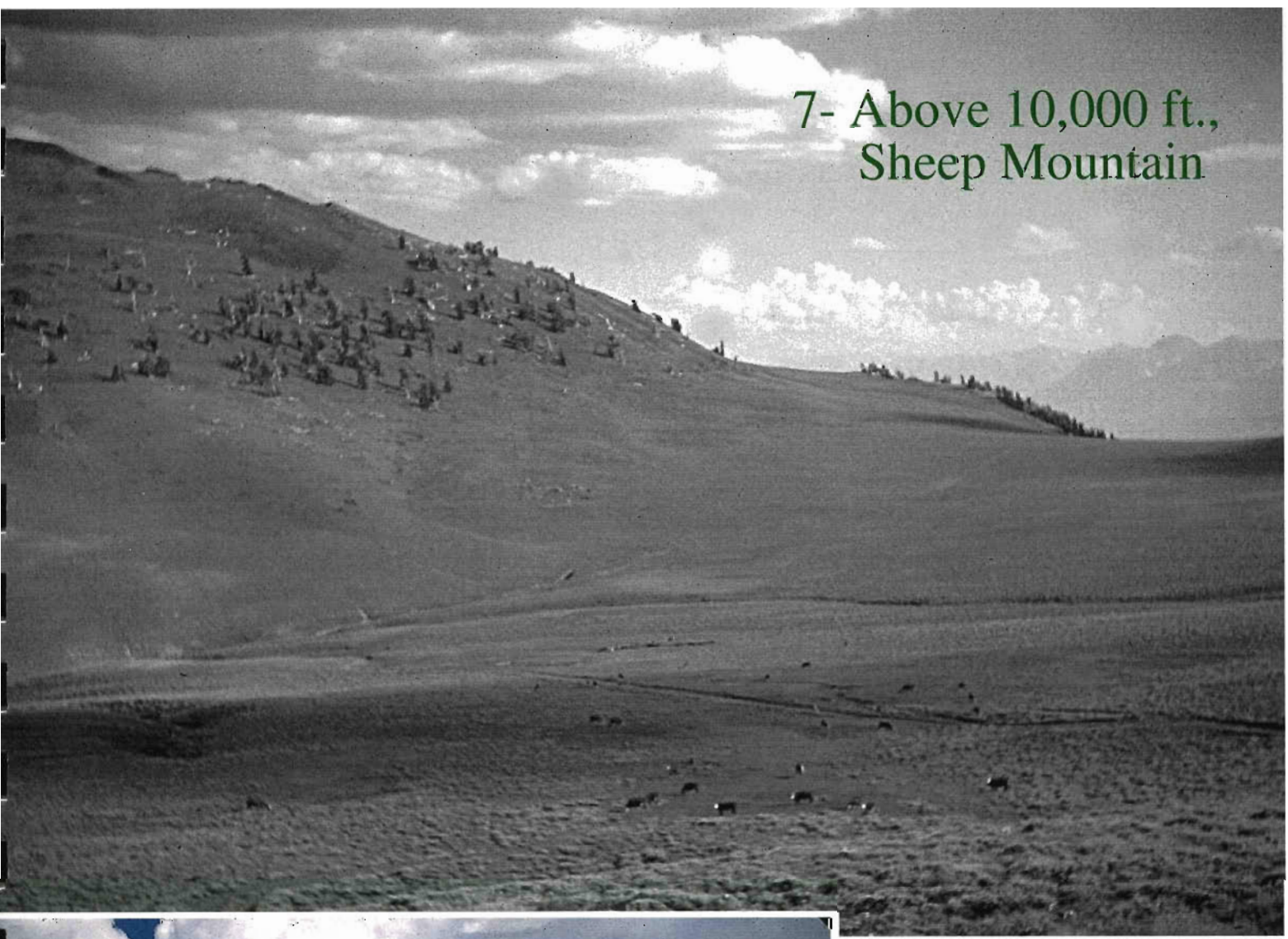


Crooked Creek Station served primarily as a way station for people bound for upper elevations. In 1950, the building provided mainly dormitory, dining, restroom, and kitchen space, along with a garage and various detached storage buildings here and above, on Blanco Bluff. Those of us bound for Mt. Barcroft usually stayed here a day or two before proceeding upward, for very practical reasons.

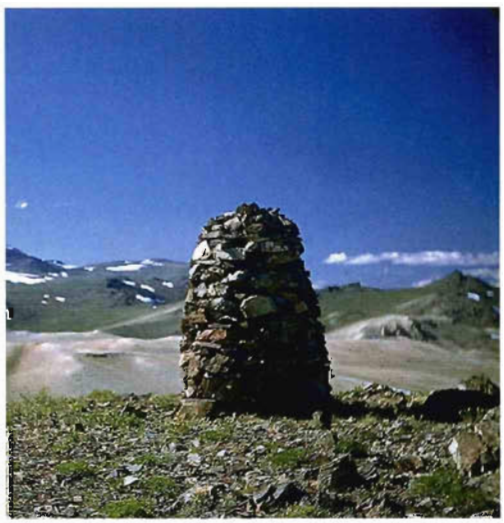
Mountain climbers and most physiologists had long recognized that sea level residents were much more likely to succumb to acute mountain sickness (e.g., lethargy, nausea, weakness, headache) by passively going to elevations above 10,000 feet in altitude —as by airplane or vehicle, rather than by physical climbing— Discomfort could be generally avoided by several days of working or hiking at an intermediate altitude of 9,000-10,000 feet before proceeding further. People, of course, vary considerably both in their susceptibility to mountain sickness at 10,000 feet, and in the severity of symptoms. But generally some mild distress is common if one simply drives from 4,000 feet (e.g., from Bishop) to 10,000 feet in one day.

Travelling directly to the 12,500 foot level was another matter. Persons wholly unacclimatized to the higher altitudes were often quite ill for several days at Mt Barcroft. So, short-time stays at Crooked Creek were the rule, and it was not as if there weren't pleasant enough things to do there, like day hikes to Cottonwood Canyon or Blanco Bluff. These activities would greatly facilitate the needed adaptations to higher altitude, as will be discussed later.

7- Above 10,000 ft., Sheep Mountain



(Above) Sheep herders grazed their animals here during Spring; note dying bristlecone forest at upper left. *(Below, right)* Rock cairn built by sheep herders.



(Above, left) Spring storm clouds form over White Mountain peak as men wait for pick up; Mt. Barcroft to left.

8. Mt. Barcroft Construction Begins

You probably wouldn't have hired this construction crew to build your house! Everything was financed on a shoe-string budget, and our most valuable pieces of equipment were the even then ancient "cherry picker" crane and dump truck, gleaned from Navy surplus equipment. The Mt. Barcroft construction team comprised: Thomas Hanson, David Wiltsie, Kenneth Jackson, Patrick Hannon, Peter Miljanich, Jack Schooley, Carl Cramer, David Jensen, and me—all Berkeley graduate students; Alan Bassham and Fred Schaefer, Berkeley post-docs; and Jack Shriber. Dr. Sherburne F. Cook, professor of physiology —and to everyone including, I suspect, his wife and children as well, "Dr. Cook"— dug trenches alongside the rest of us. He, too, was one of the construction crew. Several other members of ONRU-2, and visitors from the Berkeley and Davis campuses, contributed a day's work, sized things up, and as quickly departed.

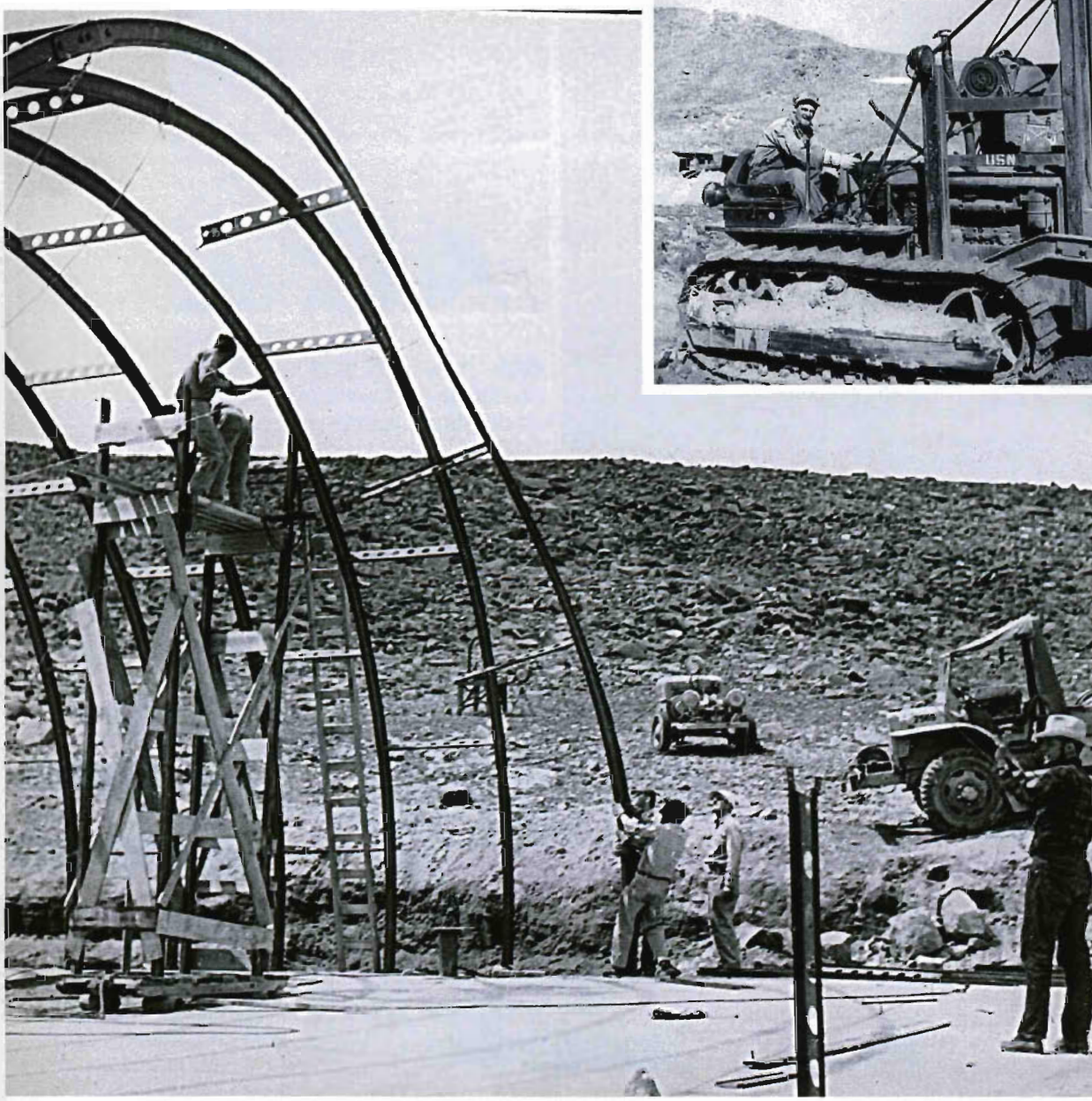
(Above) Ken Jackson —standing in a makeshift bucket affixed to the end of the cherry picker—attaches cross struts to the metal arches of the Quonset building.

(Right) Tom Hanson, at the left, and I take turns hand digging —and blasting—the pit to hold underground fuel storage tanks.

9. Day's Work, Day's Pay

Eve Moreland was Business Operations Officer for WMRS, but she remained at the Berkeley campus of the University of California (UCB). Eve bore the brunt of financial paperwork, and Elaine Lis, Nello's research assistant in Berkeley was often sidetracked, as well, —preparing grants and reports with Eve 32 hours straight, at one count!

Paul Manis, long-time operations manager for WMRS, had joined the enterprise in winter of 1950, along with Jack Shriber and Tex Baska. Paul stayed at Crooked Creek, where he coordinated the logistics of supplying equipment and supplies to the Barcroft construction crew. The crew comprised thirteen of us, plus Bob Choate and Bill Munch. Jack had joined us for summer construction, while Tex and Elmer Buelow had remained at Crooked Creek to ferry equipment between the two locations. At the end of the year, Elmer returned to the completed Barcroft laboratory where he continued as resident caretaker during 1951-1954.



(Top) Bill Munch on skip loader.

(Bottom, far right) Bob Choate supervises as we erect the Quonset building's supporting ribs.

10. Road Gang

Completion of the Mt. Barcroft laboratory before the first Fall snow proved daunting for all of us —a largely novice crew. Construction was directed by our taskmaster, Robert Choate, a brand new civil engineer about our age. Bob treated us like day laborers, and he managed rather thoroughly to make our lives miserable, while we —a cocky team of World War II veterans— undoubtedly made his life just as miserable.

(Left) Pete Miljanich in bucket, Dr. Cook on ladder, attach corrugated plates to ribs.

(Right) Tom Hanson surveys largely completed rib structure, before plates are attached.

(Above right) Jack Shriber

(Left) Al Bassham, Ken Jackson, Jack Schooley, and Pat Hannon (in leather jacket).

11. Laboratory Completion

(Above, left to right) An unusually clear view of Campito, Paiute, and Sheep mountains. The laboratory *(in the foreground at right)* sits on the southeast flank of Mt. Barcroft, at 12,500 feet.

During summer construction, Dr. Cook was usually doing his best to dampen down a variety of mutinous complaints, aimed at Bob, Nello, or our alcoholic cook (whose cooking was miserable). By summer's end, most of our construction crew were so fed up that rarely if ever again did they visit. With a defiant "take this job and shove it" expression, we blew up the outhouse with three sticks of C-3 military explosive, just before boarding vehicles to leave the mountain *(left)*.

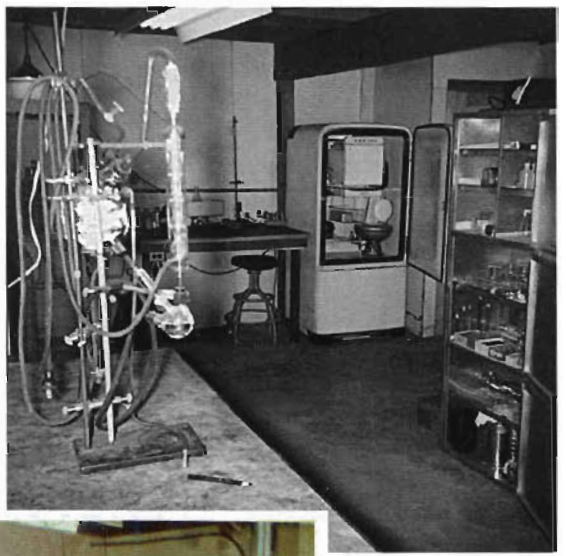
Nevertheless, we had all worked diligently. We had completed the two-story Quonset structure on schedule, and we left a facility endowed with hot and cold running water, flush toilets, heating, and other living amenities. Before winter set in, in 1951-1952, I returned to Mt. Barcroft, set up a rat colony, and commenced my graduate research in the new facility.

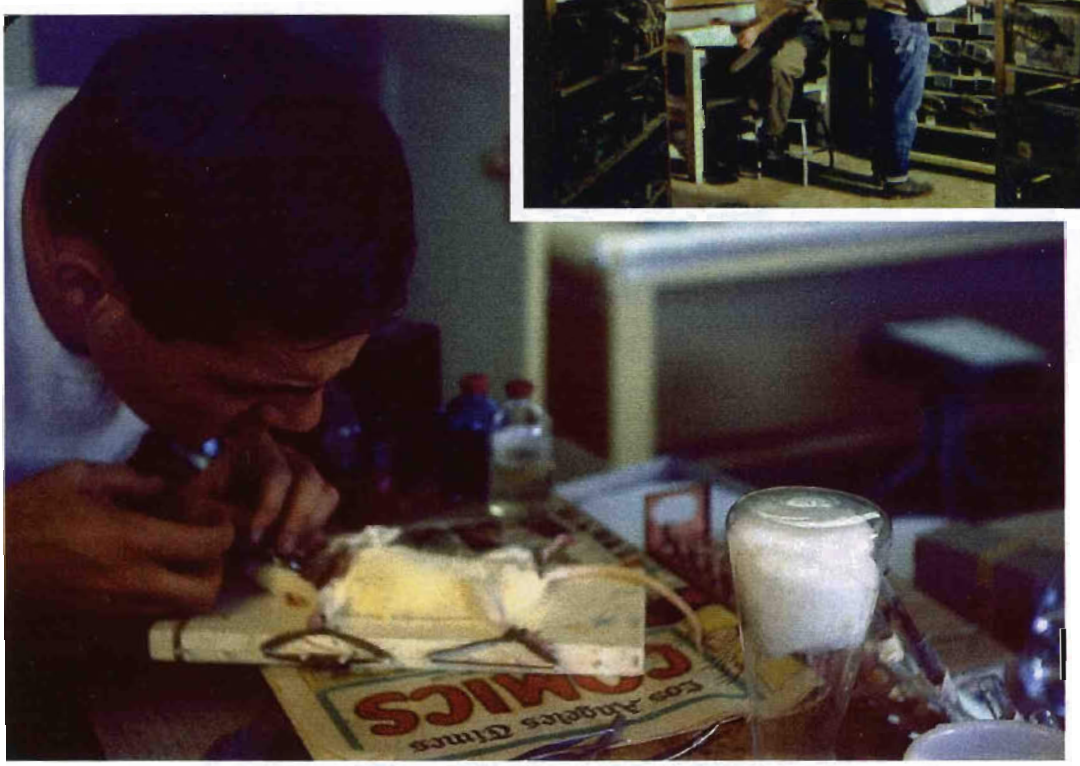
12. Mt. Barcroft Research Begins

Immediately following completion of the 12,500 foot Barcroft facility —today, named the Nello Pace Laboratory— I set up equipment and began the first project at Barcroft. My work was a part of a larger and then major program dealing with multiple aspects of high altitude acclimatization. A year or two later, Nello recruited Ralph Kellogg, a newly appointed assistant professor at Berkeley, who was interested in investigating the respiratory and blood chemistry adaptations that facilitated high altitude acclimatization.

For my work, I set out to determine what factors, if any, might induce an increase in the muscle pigment, myoglobin, that binds oxygen. This molecule has among its properties that of maintaining oxygen content within the muscle cell, and it does so at lower oxygen partial pressures, compared to the rather similar blood pigment, hemoglobin. At an altitude of 12,500 feet, one might expect to find a much higher content of oxygenated myoglobin in muscle than at sea level. Of course, this is only one of a whole set of adaptations —physiological and biochemical—that make high altitude acclimatization possible.

During the next several years at Barcroft, I bred rats through the fourth generation, performed surgery, carried out the biochemical isolations, and determined myoblobin content of muscles under varied exercise conditions at 12,500 feet —for the first time, one was enabled to do some fairly sophisticated laboratory procedures in a region normally wholly unsuitable for such work.





(Top) One of three outfitted laboratories inside the Barcroft building. Note the propane fired Servel refrigerator at the right. When needed, electricity was powered up from a large and noisy diesel electric generator setup, in the garage.

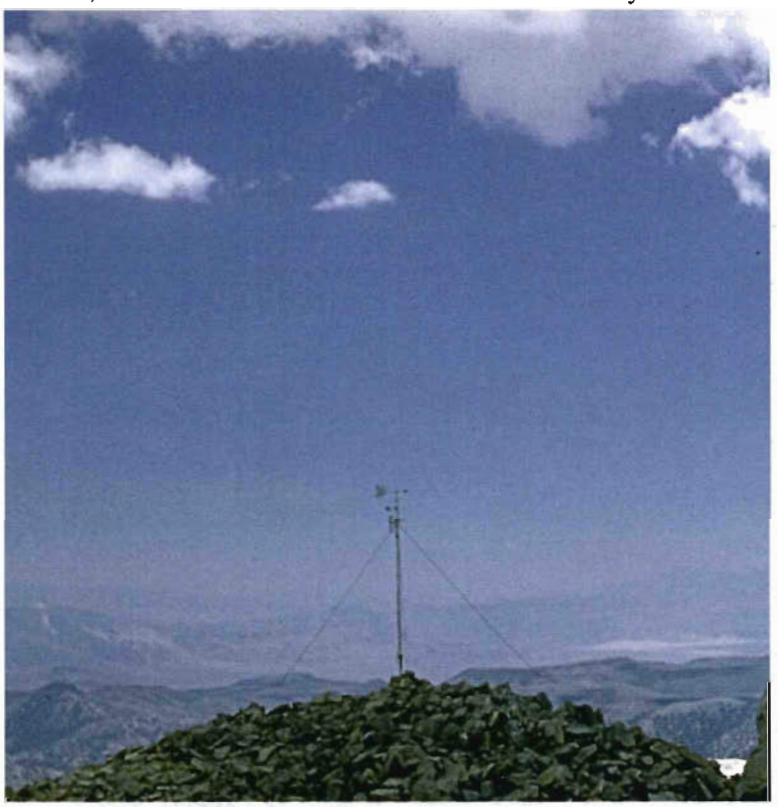
(Middle —clipping from unidentified periodical) Peter Miljanich checks up on the rat colony.
I am updating records.

(Bottom) An anesthetized rat is being cannulated prior to perfusion with saline solution.

13. Hypobaric Experience

High altitude acclimatization research was an outgrowth of my earlier military experience. In WW II, I had served as a Navy hypobaric chamber technician, where my main duties were to put on scare shows (under medical supervision) for indoctrinating Navy aviators on the dire consequences of disregarding oxygen at high altitude. At the time, pilots usually flew unpressurized aircraft at 12,000-15,000 feet, where hypoxic symptoms like loss of judgement first appear. They might ascend to 25,000 feet, from time to time, where blackouts would be a near certainty. Since "real" men then expected to get by without supplementary oxygen, loss of life and aircraft had become significant issues.

Typically, I would take a small group of aviators with me inside a large, refrigerated vacuum chamber. While breathing oxygen, we would ascend to a pressure altitude of 35,000 feet, as the chamber temperature was dropped to stratospheric temperature (-65 F°). Then, we would attempt to recreate situations in which hypoxic blackouts, "bends," frostbite, impaired judge-



(Top right) Evening lab work, in this case myoglobin spectophotometry.

(Top left) Meteorological sensors on the promontory to the East of Barcroft laboratory. Nevada's dry mountain ranges are visible in the background.

(Lower left) Morning meteorological data collection, in the "clean" lab. Bill Roach succeeded Elmer Buelow and was the resident maintenance person for the ensunmg 12 years.

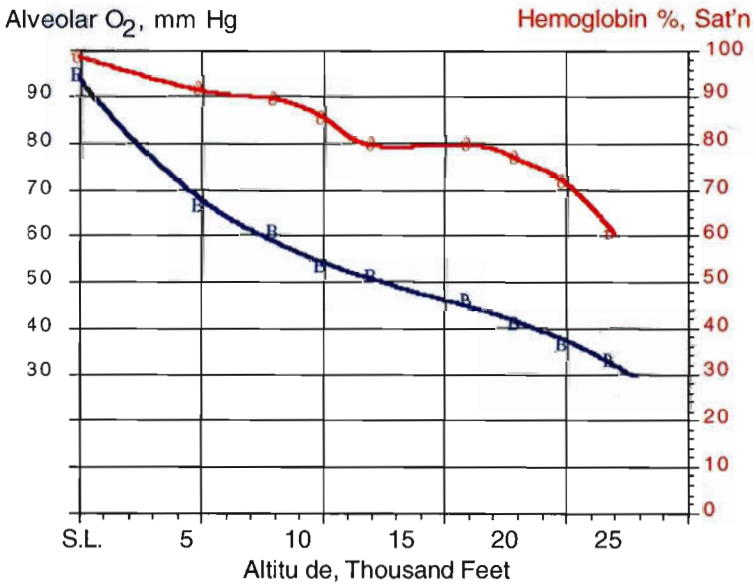
14. Acclimatization Research

ment, or other acute symptoms might occur. Among my experiences was a striking experiment initiated by Dr. Charles S. Houston, an early mountain climber on the Himalayan peak, K2. The experiment demonstrated an induced respiratory acclimatization to 22,000 foot pressure altitudes, and was carried out at the close of WW II.

Charlie, who was then a Navy physician, had persuaded several volunteers to gradually ascend to a pressure altitude of 30,000 ft over a 30-day period. We used the Navy's then largest hypobaric chamber, at Pensacola, FL. During the 30 day period, four men lived in the chamber while its interior pressure was gradually decreased. The four slept, worked out on a stationary bicycle, and functioned reasonably well to a pressure altitude of 25,000 feet. Night-time breathing, mental acuity, fatigue, and appetite remained fairly normal.

Above 25,000 feet, their ability to function quickly deteriorated without supplementary oxygen. During the 30-day period, I carried materials in and out via the air lock. Had I not worn an oxygen mask when entering, I might have been brain-dead in about 10 minutes. The impression was dramatic, and as indicated in the box below, it more or less crystallized my later interest in pursuing research on the high altitude acclimatization —a complex layered process, to be discussed.

ONR maintained its interest in high altitude acclimatization by funding a broad program of basic research on the specific physiological and biochemical processes and sequential changes common to protracted exposure to high altitude.



At about 12,000 feet, the oxygen partial pressure in the lung drops to about one half of its sea level value (*blue graph, at left*). Nevertheless, the oxygen saturation of blood hemoglobin remains relatively high, with only a 20% deficit compared to its sea level value (*red graph, at left*). A variety of mechanisms (respiration rate, blood hemoglobin concentration, blood circulatory rate, etc.) act synergistically to maintain a smaller deficit in oxygen content delivered to tissues via the blood. At 12,000 feet, the 20% deficit is significant in that it may adversely affect mental acuity. However, it is usually small enough to not too seriously affect one's capacity for physical work.

Long term, the myoglobin concentration in muscles also increases, further contributing to one's physical ability to cope with the oxygen deficit. The myoglobin increase is accentuated by heavy physical work.

From a strictly military viewpoint, the possibility that acclimatization might be stimulated through artificial means —if not by actual sojourn at high altitude—seemed appealing, too; i.e., aviators might be protected from sudden, accidental loss of cabin pressure if partially acclimatized.

Drs. Harve Carlson and Freeman Quimby of ONR were sponsors throughout '50-'56. Somewhat unwitttingly, though, Freeman and Harve were also dragged into the operational aspects of the Mt. Barcroft laboratory —I say "unwittingly," because I do not think either one of them was fully prepared for the next six year's roller coaster ride of Nello's making.

15. Winter Life

Getting about in winter was always a problem in the '50s. Snow on the exposed mountain slopes along the way to Barcroft, as with Crooked Creek, tended to be more like permafrost than snow. As we had no snow removal equipment, our main transportation means were snowshoes or one of the two "weasels" (surplus military snow tractors). The weasels were notoriously unreliable. They usually walked off their tracks when driven at an angle on the slopes —often several times each trip— and required heavy work to reseat a track on its idler pulley. We *always* carried snowhoes with us for backup.

At Barcroft, we used Bob Symons' ski rescue service, in Bishop, on rare occasions, but flying was otherwise too expensive. Bob was a rather unique character —an expert glider pilot, who had set a national glider record and earned his living rescuing injured skiers from the high Sierras. His especially outfitted small plane was equipped with pivoting wheels for rocky surfaces and dual skis on each strut. Hydraulically lowerable, the skis were used to land, on snow, although for the well exposed saddle above Mt. Barcroft, he sometimes flew an ordinary plane. He delighted in swooping off the mountain canyons, much like a glider.

During the first two years of winter operation, there were seldom more than two people resident at Barcroft. Heating fuel was stockpiled in underground storage tanks; communication was by somewhat unreliable short wave radio between Barcroft and Crooked Creek; and, power was supplied when needed by the monster sized diesel electric generator or propane. Elmer even brought to the mountain an audio setup with good records. As long as sufficient food and fuel had been laid in for winter, living at the Barcroft laboratory could be fairly comfortable. We were, however, rather vulnerable to unforseen accidents, as time would prove in 1951 and later on at least three fairly serious occasions.

Injured Man Rescued Frid
By Ski Plane on White Mts.

The small ski-equipped plane owned by Bob Symons, Bishop flying service operator, was instrumental in rescuing Burt Vaughn, a University of California employe, last Friday afternoon atop the wind swept high altitude laboratory on the White mountains.
Word was received from Symons late Friday morning that the man had slipped and fallen into a 10 foot hole in which he and another employee had been working and had severely injured himself. Dr. J. Lloyd Mason accompanied Symons in the small snow going plane, and despite the lack of sufficient snow landed near the upper camp.
It was discovered that the man had suffered a dislocated shoulder and was unable to move. After treating the man's injuries he was transferred to a Weasel and taken down to the plane. It was soon discovered that the many rocks sticking up through the snow had damaged the skis considerably but, with a little oil on the runners, the plane again took off and returned to the Bishop airport where an ambulance was waiting to take him to the hospital. Symons returned to the mountain station and pi Dr. Mason.

(Clockwise from top left —Clippings from 1951-1952; newspapers unknown) Pete Miljanich with crowbar and Burt Vaughan in weasel; Bob Symons and passengers landing on plateau above Barcroft lab..

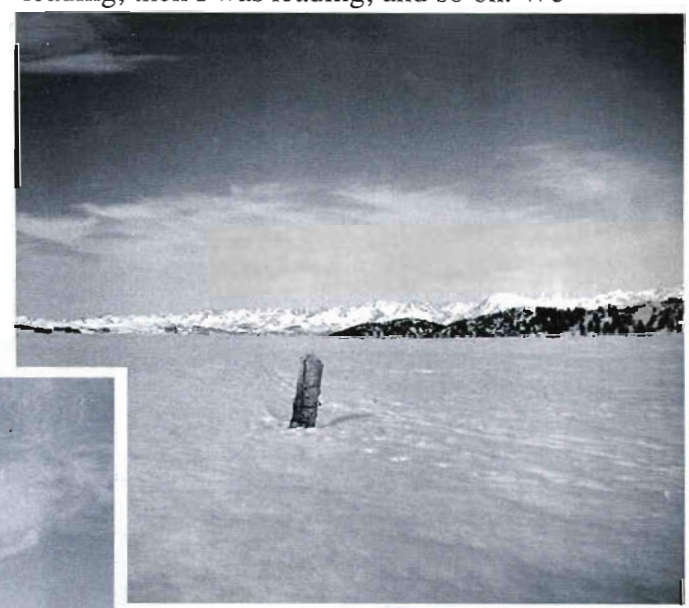
16. Rescue

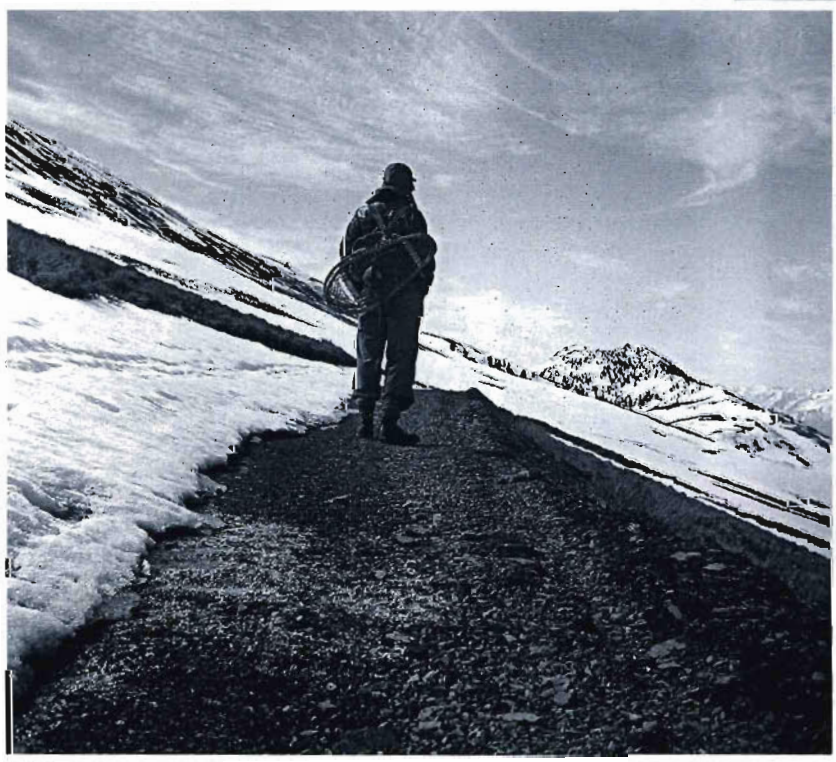
Winter of 1951-1952 had brought particularly severe snow and ice to the White Mountains, as it had throughout the Sierra Nevada range en route. At Berkeley one winter morning, we heard a terse message from Crooked Creek, by short wave radio: "No Food. No equipment. Quitting!" Evidently the Barcroft Laboratory had been abandoned and the Crooked Creek station was about to be abandoned. Knowing very little else, Nello, I, and Henry Wilson, a visiting associate from England, immediately departed for Bishop. In Bishop, Nello's efforts to arrange road clearance to Crooked Creek met with no success.

Failing to secure county help, we travelled on to Westguard Pass, arriving mid-afternoon. At the roadway turnoff, Nello returned to Bishop to arrange air drops of food at the now isolated Crooked Creek station, while Henry and I headed for Crooked Creek —snowshoes on our backs and more hikers than winter mountaineers. At sundown, on showshoes, we reached the steep 20% grade leading to Sage Hen Flat, a climb of about 3 miles that we had earlier christened "Studebaker Flat," (for obvious enough reasons). To this point, we managed to stay ahead of a black thunderhead, but by nightfall, the clouds socked in tight.

Our guideposts on the iced over slopes were occasional crests of the outside road edge. They were largely buried and made for extremely slow going. From our hiking speed six miles back, I estimated that we would reach Crooked Creek *before* sundown, not by nightfall. Clearly, we had misjudged the bad weather impact. I won't forget our depressed feelings at that point. Henry asked me to join him in prayer, after which we agreed that we had "a good way to go." We left unspoken the fear that we had probably over-estimated our prowess.

Crusted snow & mush? —Pure misery! Henry had lagged behind me for the past hour; now he was leading; then I was leading; and so on. We extended 10 minute breaks to 20 minute breaks each hour then reverted, changed from snowshoes to bare boots on ice then back again to snowshoes. On snowshoes, we broke through mush to our thighs at Sage Hen Flat. Finally, two agonizing miles further, we reached Crooked Creek station late at night, having travelled twenty-two miles on hoof.





(Above) On crest above Sage Hen Flat.

(Left) Near sundown, looking back toward Westguard Pass; Sierra Nevada flank is barely visible in background at mid-right.

17. Mutiny!

At Crooked Creek station, Henry and I encountered a hotbed of resentment. Elmer, Tex Baska, Jack Rose, and another fellow were steaming with anger over Berkeley staff's failure to come up with funds for laying in winter supplies. Paul Manis, at the time, was staying in an office in Bishop. An ultimatum had been sent from the mountain top: Barcroft laboratory had in fact been abandoned, and the Crooked Creek station was to be abandoned the next day.

(Above) Half-buried at Crooked Creek station.

WMRS' resident staff had truly reached the breaking point. They were underpaid. They worked in inadequate, ragged winter clothing; supplies were limited, and most of the surplus equipment, like the two weasels, was just too unreliable. Snow travel? —Elmer, for travel between stations, usually had to depend on makeshift wood skis tied with baling wire to his work boots. I carried my own snowshoes, as did Henry, and the backup resource included only two more pairs bought privately and kept at Crooked Creek.

Frankly, I don't think I felt much different from these guys. I had worked with them, knew them, and we had all experienced the same problems and complaints. No operational support, whatever, had come from the university, itself, and when financial expenditures were needed, Nello used research funds, typically stalling as long as possible. His genius had been selling a dream, certainly not administering a field operation.

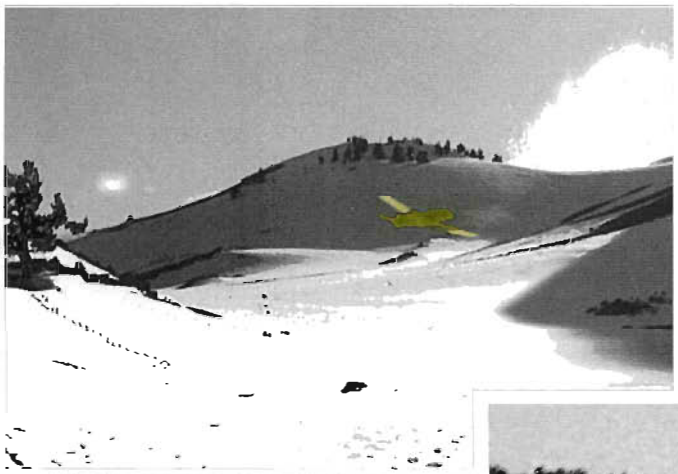
(Right) Respite following our 20 mile snowshoe trek; Elmer Buelow & Henry Wilson, in armchair.

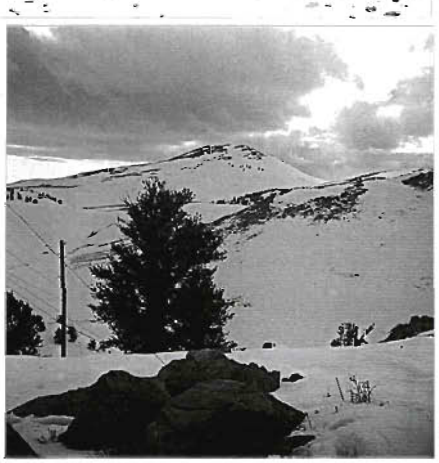
In truth, the Berkely staff probably did not have the needed funds, since operational support had been cobbled together from various research grants and military surplus

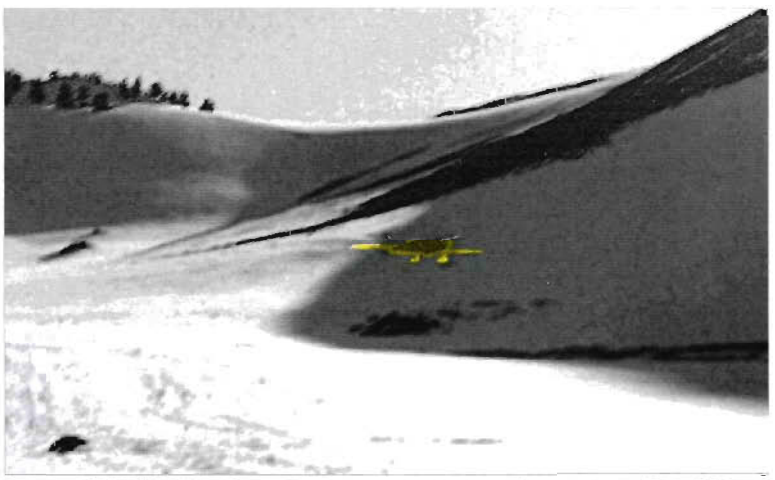
(Far right) Burt Vaughan; What, now?

18. Air Drop

equipment, rather than as a line item for operational support. Meanwhile, at Berkeley, Eve Moreland was frantically getting out grant revisions, new grants, and whatever else it took to bring in the emergency funds needed during this very severe winter.







Back at Crooked Creek, Elmer agreed to hang in for another two days. Air dropped food supplies would then arrive, as previously arranged by Nello with Bob Symons' ski plane rescue service. Bob's plane did arrive on time, scattering supplies all over the icy plateau fronting the Crooked Creek building. We and the company dog spent the morning retrieving cans, boxes, and sacks of food.

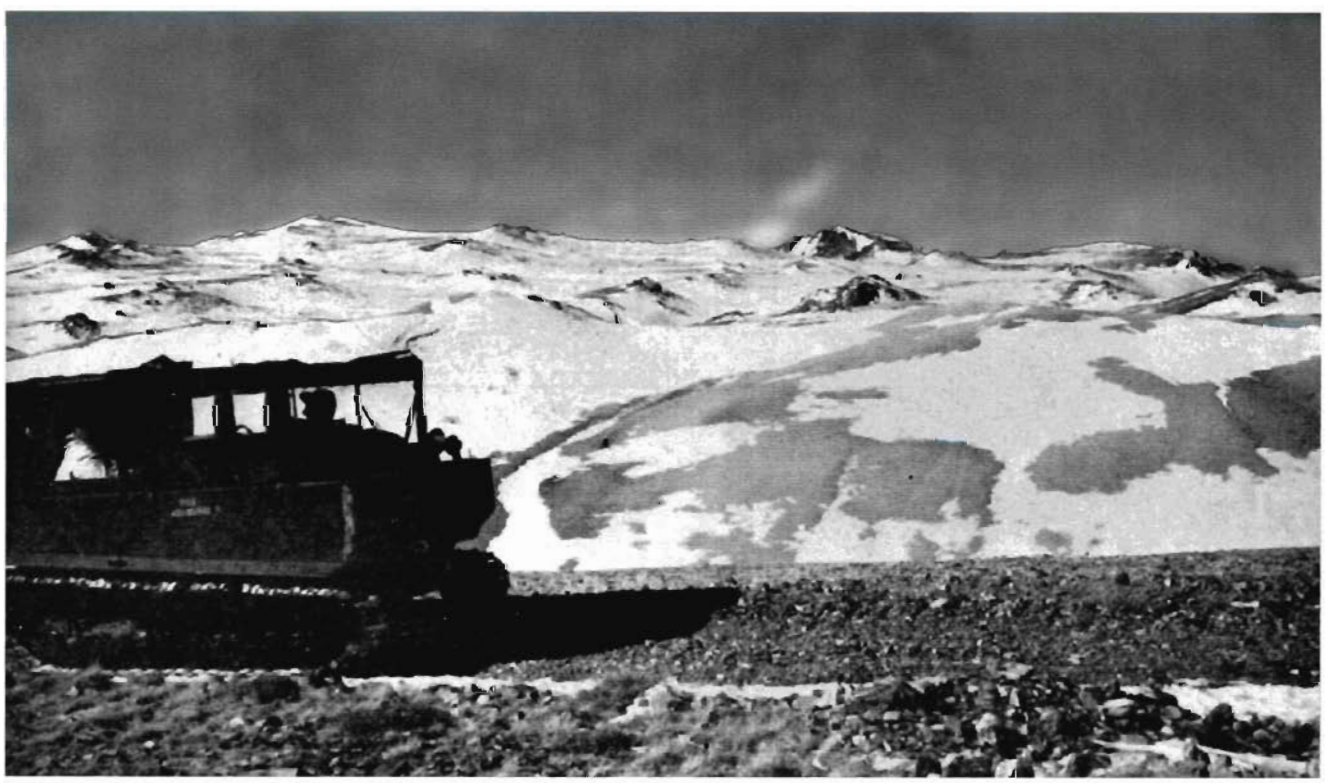
Irregardless, several other staff members pulled out, leaving me, Henry, and Elmer with the replenished supplies and little else. We mulled over what to do about the abandonment of the Mt. Barcroft laboratory and awaited return of one of the two weasels, which at best would help us avoid making the trek entirely on snowshoes.

19. Back to Barcroft

Later in the week, Henry and I reached the Mt. Barcroft laboratory —9 miles above— where we found Elmer's terse note posted on the door: "No food. No fuel. Quitting!" The door was wide open; snow was blowing inside; the diesel fueled stoves were cold; and, the water pipes had burst. Worse, the two-year old animal colony that I had set up for my acclimatization studies had frozen to death —a really depressing setback. Yet, I guess I understood the staff's anger, and there wasn't much else to do but barricade the door and return to Crooked Creek.

At Crooked Creek, two other staff member had returned from Owens Valley, and Elmer was taken to Bishop's hospital for treatment of a frost bitten foot. Henry and I rested for a couple of days and tried to shore up morale. The station was undermanned, the two weasels had sprung their tracks, and nothing more could be done at Mt. Barcroft until late Spring when the snow thinned. Returning to Berkeley, we found Eve again sandbagged, this time explaining and preparing affidavits to various state authorities —just how did injury and improbable accidents like these happen to people nominally employed by the university for research?

Difficult winters were a way of life for several years. In 1952, the Barcroft laboratory was again isolated —although not abandoned. This time, Nello and I attempted a straight climb by weasel from the East side of Sheep Mountain, but we ended up simply churning snow. Facing a whiteout, we were forced to retreat to an emergency cabin, below 10,000 feet. Once again, the most practical transport was on hoof, as happened again, for a third time, when station people found themselves stranded outdoors. .



[Photo appearing in unidentifiable periodical , "Fortnight," dated April 1957]

20. Transition, 1953-1954

After numerous near-catastrophes during the two years following completion of Barcroft laboratory, living there had stabilized fairly well by 1953, and adequate supplies had been laid in for the ensuing winter. Summer season for the next two years was particularly busy with visitors and certainly becoming more enjoyable professionally.

Visiting research staff usually shared their interests, and the relative lack of distractions on this isolated mountain led to many interesting after dinner discussions —on astrophysics, meteorology, wildlife biology, poultry reproduction, respiratory acclimation, mountaineering —you name it! We all pitched in on the communal work, learned a lot outside our main fields of study, and also learned how to put on some pretty good meals! Although rarely there, I suspect that this was exactly the kind of fellowship Nello had envisioned.

As Fall of 1953 approached and fewer visitors were on hand, we relied more on staff support. A procession of quite unreliable people ensued —invariably hired at low wages— for staffing Crooked Creek and Barcroft facilities. Several were fired for alcoholism, game poaching, and other offenses. Paul Manis was then spending a great deal of time in Bishop, recuperating from a heart attack, and Elmer Buelow was forced to spend quite a bit of his time keeping the lid on at Crooked Creek. Meanwhile, Nello had departed on trips, first to Korea then to Makalu in the Himalayas of Nepal, Nominal oversight was left with Professor Sherburne Cook at Berkeley with Carl Cramer as interim Officer-in-Charge of ONRU-2.

Those of us working at Barcroft had by now become quite experienced mountaineers, and we were well prepared for winter. Dave was completing his doctoral dissertation on the population cycling of White Mountain deer. He and his wife, Pat, had secured a home nearby in Bishop, and, as his taxidermy business waned during Fall, he would spend more time on the mountain. Doug Powell, another wildlife biologist, was also regularly visiting Barcroft.

Given the staff support situation, had several of us not been there throughout winter, we very much feared repetition of the earlier Barcroft abandonment with research setbacks. So, my family came to Bishop, and our families —weather permitting— stayed days at a time at the Barcroft laboratory.

While Nello generally frowned on women intruding on what he saw as a male preserve —only once did he bring Eve, Elaine, or other female members of the Berkeley support staff to Crooked Creek for overnight stays— in fact, this was not the first time spouses of researchers had stayed at Barcroft over Nello's protests. As it was, our families constituted the only competent resident support team on site, at the time. They contributied and helped in numerous ways, while Dave, Doug and I were able to make considerable research progress before our Navy support ended.

Comparatively benign weather conditions held through October, as weather forecasts would confirm each morning by short wave radio. At that point and evidently thinking we would overwinter, Dr. Cook summarily ordered me to remove all families from the mountain. Many months later, when Nello returned from Nepal, I had expected to be thoroughly chewed out. Nothing further was said except for one wry, passing reference to "Burt's women on the mountain." In a way this, too, was vintage Nello —ONRU-2 and the help it made possible had disbanded by October 1953, and I guess Nello was relieved that the WMRS enterprise hadn't blown apart during his winter absences.

(Above; from rear left) Elmer Buelow, Burt Vaughan, Douglas Powell, David Wiltsie, Pat Wiltsie, Artis Vaughan, and visiting canine)

21. Stark Beauty

(Above) A clear morning reveals the striking beauty of the southern flank of White Mountain peak. On foot from Barcroft, I began earlier in the morning to avoid afternoon bad weather.

(Below) Eastern scarp of the Sierra Nevada range, seen here from White Mountain peak. The floor of Owens Valley lies about 10,000 feet below; the town of Bishop is toward the green area beyond the picture's left edge.

The best parts of White Mountain are the unobstructed scenic vistas from higher elevations. Its beauty definitely got into my blood stream. And, the deep blue sky, cottonwood canyons below, dramatic cloud patterns, startling topographic detail —the night sky, too— were more than enough reasons to spend all the time I could spare for exploring. I did not pass up many opportunities!

22. "Summer in the Mountains" Revisited

In June 1956, on my return from McMurdo Sound, Antarctica, I joined Ralph Kellogg, who was setting up a laboratory inside the newly constructed Summit building. There, we would carry out a series of respiratory acclimatization studies, at 14,246 feet, on ourselves and on several volunteers.

We watched as Bob Symons' ski-plane landed passengers on the plateau just below the switchbacks leading up to the peak. Don Badger, Joe Dailey, and Fred Hencken —three Berkeley graduate students recruited by Nello— deplaned on this pile of rock complete with fishing rod, hiking boots, and summer camp gear! Again, Nello's familiar line echoed in our ears —"$200 and a summer in the mountains!"

These guys then found themselves confined for twenty days to bare rock, perhaps a hundred feet in diameter on the very top of White Mountain's 14,246 foot peak. (Before returning to Berkeley, we relented, letting them spend several days' fishing at lower elevations.)

(Above) Lunch break; Joe, Don, and Ralph (taking snapshot).

(Left) Joe, Burt, and Don

22

29 July 56 Busy day today. Weather cleared sufficiently for us to have lunch in the front "patio". This was unusual. Typically weather obscures by noontime.

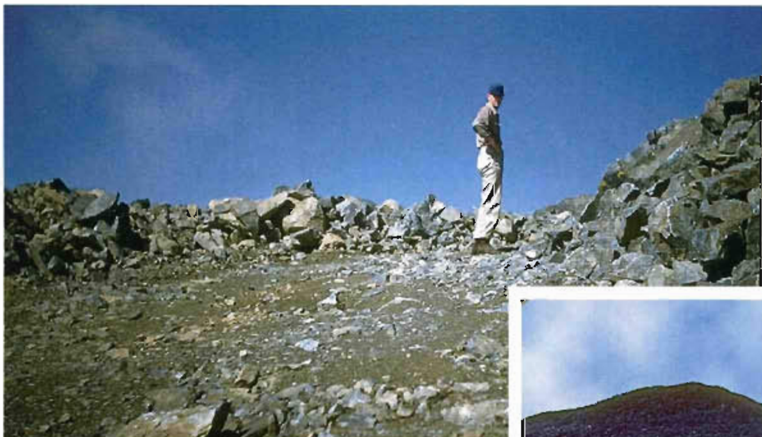
RK & I worked outdoors for several hours, I soldering ground connections from stovepipe to roof, RK concreting in shutter ~~holdopens~~ hold-opens.

ran the tests on each other (i.e. O.B tested Daily)

O.B. has a hypersensitive arm from so many needle sticks, and has complained about it.

I walked for about 1 hour, stripped to the waist to enjoy the sunshine, between tests this noon. Snow drifts below the first two Y turns were a good 15' high, still.

(Above) Diary page from 1956.

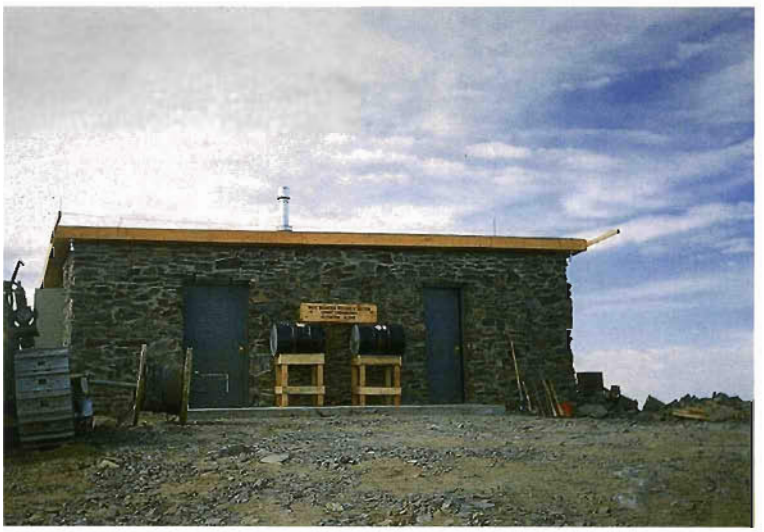


(Left) With four of us confined to the peak, in summer of 1956, Don Badger makes a noontime escape along the road-bed just below the peak.

(Right) Even during summer, the switchbacks leading to White Mountain peak were unsuitable for anything but a heavy duty 4-wheel drive vehicle. The edges dropped off thousands of feet on either side of the saddle—shown in foreground— and dense clouds often formed unexpectedly, making the switchbacks rather treacherous. Fuel and equipment were hauled to the summit with considerable difficulty.

24. Living at 14, 246 ft.

White Mountain peak as seen from the upper flank of Mt. Barcroft sometimes could seem deceptively benign. But in as little as two hours' time, afternoon weather would change dramatically, especially from the plateau just above Mt. Barcroft at about 13,000 ft., to White Mountain's 14, 246 ft. summit. Usually, a fierce wind started up around 4:00 PM; clouds loomed rather unexpectedly; and, the bone dry, electrified air crackled with corona discharge off anything metallic.



(Above) The masonry and concrete Summit Laboratory, on White Mountain peak's summit. It was built by a commercial contractor in 1956. Diesel fuel drums at the doors [!] provided fuel for inside heating. We also had to regularly haul up fuel for a monster sized diesel electric plant (adjacent) that gobbled up about 2½ gallons per hour .

(Below) Diary page from 1956

20

26 July 1956 J.P. Ran plateau tests on each other (i.e. RK and CV) for this day. Subjects time essentially free.

27 July 1956 Continued as above. Yesterday we ran O_2 + 290 O_2-CO_2 tests which are time consuming (about 1½ hrs each) Today we completed plateau series on each other with 58 O_2-CO_2 and 110 O_2-CO_2 tests which are quite short, (20 minutes).

Tremendous lightning storm today, continuing into the nite. Our aerial discharged repeatedly; the mountain side within 1000 ft. was struck on several occasions, and we kept indoors. Doug Powell has told us about feeling ground currents.

25. The Plan

Our studies at the Barcroft and Summit laboratories constituted parts of a comprehensive and rather ambitious research plan. Several different physiological systems were known to come into play as one successfully acclimatized to high altitude *(below right)*, and we hoped to pinpoint their timing, relative importance and interplay —features that were not very well delineated at the time.

At the Barcroft laboratory, respiratory changes on ourselves as subjects were rather borderline, in regard to heightened sensitivity to carbon dioxide. For this reason, Ralph Kellogg decided to move our efforts to the just completed Summit laboratory, in anticipation of more definitive results. He was also the key person in keeping us on course in various aspects of the overall plan.

Ralph had assumed responsibility for electrolyte balance and ventilatory studies, and I, having now completed myoglobin studies, was preparing to study hypoxic stimulation of the carotid and aortic chemoreceptors. Nello, meanwhile, had committed to completing studies on stimulation of erythropoiesis, while also continuing as *de facto* research director. Others at Berkeley would pick up on other phases of the project.

(Below) Plan as envisioned in 1955.

Acclimatization Study Plan

Immediate Accomodation —Neurological

Increased ventilatory response
Hypoxic stimulation of respiration by chemoreceptors in the aortic and carotid bodies
Increased cardiac output (blood circulation)

Other Short-Term Changes —Electrolytes

Increased sensitivity of the brain to carbon dioxide
Reduced buffering capacity of the blood to carbon dioxide
Increased hematocrit (red cell fraction of the blood) via electrolyte shifts

Longer Term Changes —Cellular/Hormonal

Increased production of circulating red blood cells (erythropoietic stimulation)
Increased muscle concentrations of myoglobin, cytochrome, and other cellular constituents

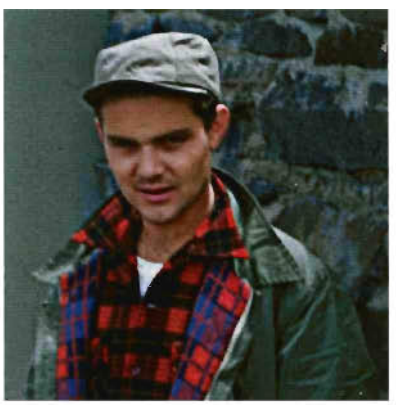
The research plan obviously implied a continuity and long term commitment from everyone. Given Nello's other responsibilities and propensity for extemporizing, the plan as a whole proved quite unrealistic. Our mutual relationships were soon marred by wrangling over unfinished tasks, particularly when Nello infrequently appeared at Barcroft.

(Left) Determining ventilatory (respiratory) response to carbon dioxide; Ralph Kellogg is checking standardizations of gas mixtures, inside the Summit laboratory (14, 246 ft).

26. Winding Down

(Above) Preparations for measuring ventilatory response to carbon dioxide, Don Badger seated

(Right) Joe Dailey, perennially good natured at the Summit



As events materialized following 1955, Ralph continued independently, publishing numerous papers on respiration and acid/base balance throughout the next decade. In the Fall, having completed my commitments at the Summit laboratory, I resigned and entered an entirely new line of research. My parting with Nello was anything but amicable.

At the Summit Laboratory, I was unaware of mounting disillusionments at Berkeley, too. Elaine Lis had resigned; Eve and several others were planning to do so by Spring semester and had announced their intentions. Back in Berkeley in the midst of these matters, I told Nello one evening that I intended to seek another position. I had had my fill!

During my intervening trip to the Antarctic, surgical preparations that I had completed earlier (for the chemoreceptor studies) had not been kept alive. Furthermore, my salary advancement as a post-doc had been delayed nearly one year —undoubtedly because of the usual WMRS financial problems. We exchanged some sharp words. Later in the week, Nello asked me to reconsider. Asking if it was money I wanted, he followed me out of his office, pulling dollar bills from his pockets. Such "Godfather" memories are colorful, and certainly familiar enough. This time, however, several years passed before we spoke to each other again.

27- Changing Times

During the 1950-1956 period, Nello had managed contracts approaching sixty thousand dollars per year —perhaps seven times as much as full professors doing research at UCB were accustomed to, at the time. Despite poor management skills, he could certainly sell the dream, and none of us who worked with him ever doubted that ability.

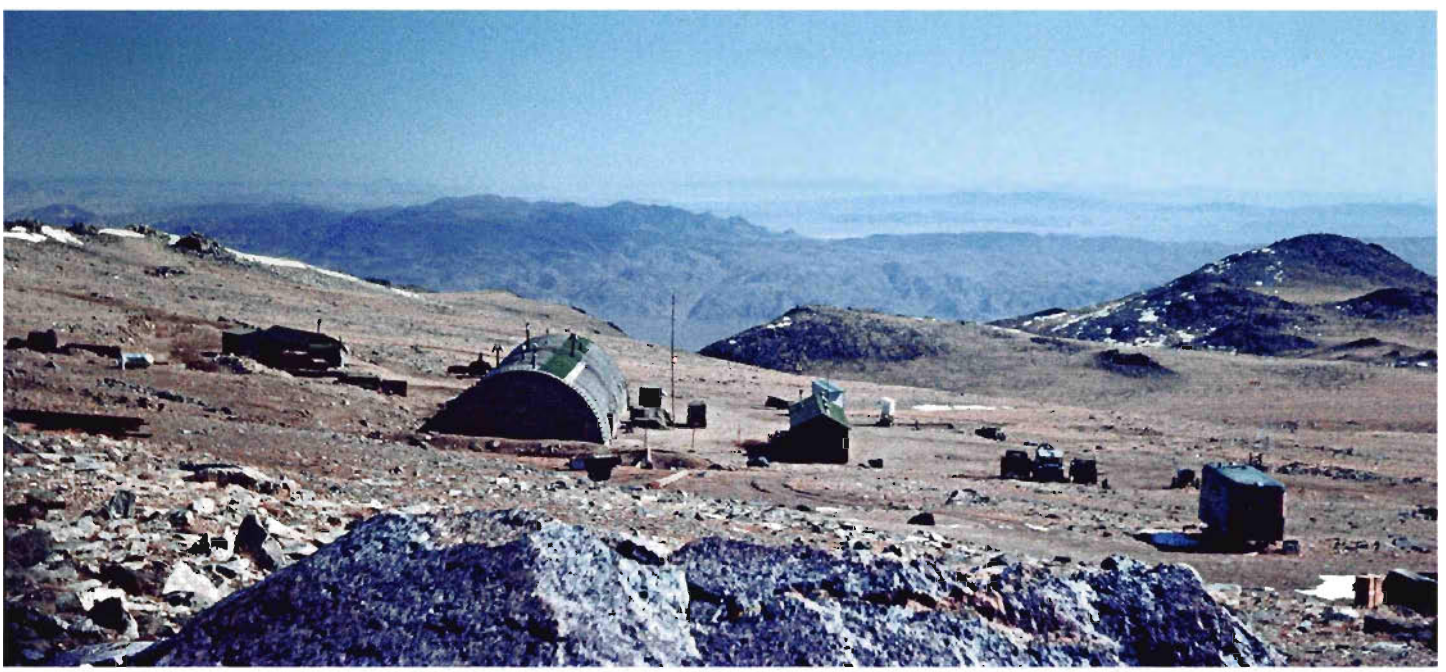
Several years later —with a new job and Ph.D. well in hand, and feeling somewhat cynical after my White Mountain experiences— I was listening one evening as Nello described our adventures to the Naval Reserve group. Almost without thinking, I felt myself being transported away on a wave of fresh enthusiasm! So, I have no doubt whatever that our ONR colleagues boarded the same roller coaster, would bend rules from time-to-time, and would eventually become as exasperated as were any of us by Nello.

And in due course during late '56 or possibly '57, Freeman Quimby of ONR visited me while I was working at the U. S. Naval Radiological Defense Laboratory. He had long supported basic research, but this time he was seeking advice from scientists who had worked previously at White Mountain for an impending decision to close out funding.

Freeman said that funding for WMRS programs had placed him in an extremely vulnerable position because published studies from WMRS then had been few compared to expenditures for other large ONR programs of the time. I did feel that running such an operation without university institutional funds for operations had created an extremely difficult situation for everyone, and that research should continue. Nevertheless, ONR did cut funding. At this point, many of us were off Nello's payroll, and he was able to keep WMRS open by developing other grant and contract support.

Looking back, Nello was a true visionary in establishing WMRS, and this quality of his extended to other areas of our relationship, as well. Quite apart from financial support for several years of graduate work, I am particularly indebted for his foresight in insisting on an intensive and wide-ranging graduate study program. It prepared me very well for future positions. It might have been great if we could have continued the acclimatization research. Regardless, times had clearly changed.

Interestingly, one will find in a current status report that well over a thousand studies involving the use of WMRS have been published over the past forty-five years ("WMRS 1995"). An even larger number of visiting scientists, staff scientists, and students have been involved at WMRS, as well. Clearly, many people have bought into Nello's dream. making it a continuing reality.



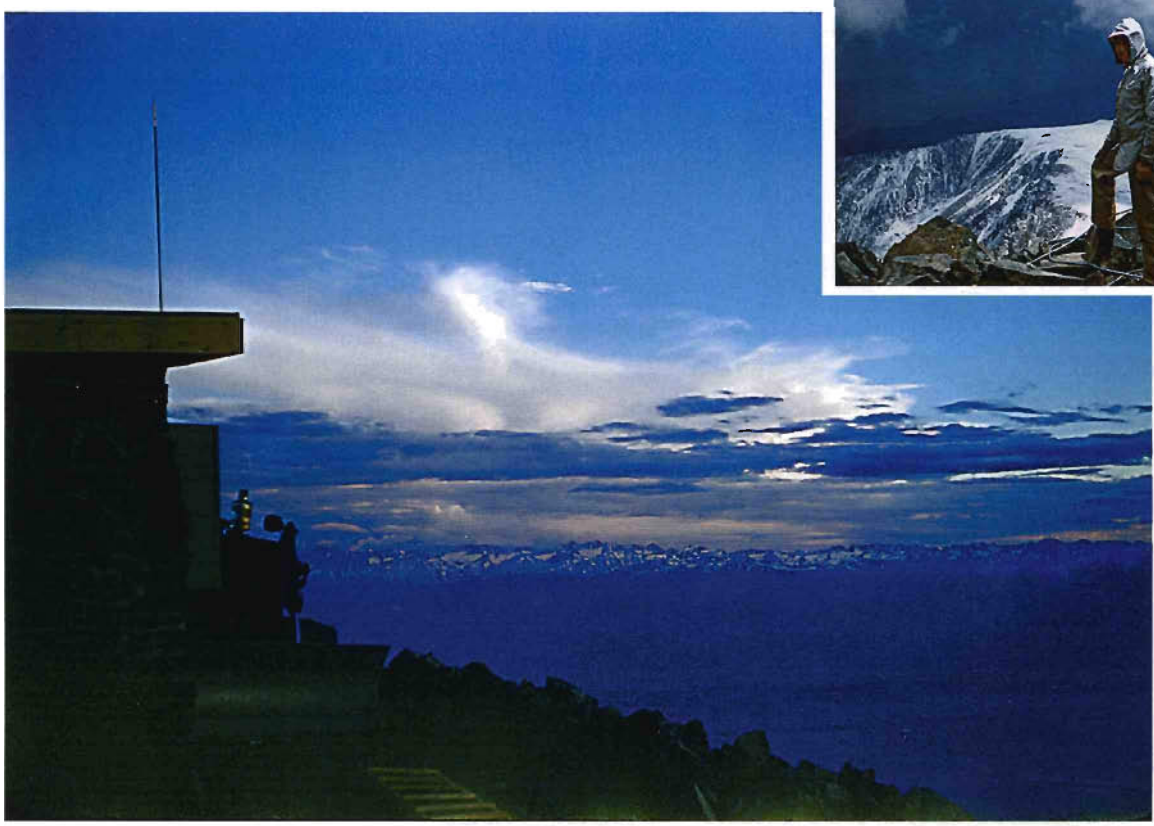
(Above) Early '60s picture. Laboratories were now connected by power line to commercial electric utilities. Looking East from the Mt. Barcroft laboratory toward the dry mountain ranges of Nevada.

28. Taking Leave—Pellisier Flats

Disappointments aside, the incredible beauty of the White Mountains remains unforgettable, and I could not resist taking these parting pictures.

Looking North from the Summit Laboratory, Pellisier Flats *(at left)* are visible as a green shallow slope just beyond the snow covered spine in the foreground, and accessible only on foot.

(Right) Eastern view from the rear of the Summit Laboratory; Ralph Kellogg in foreground.



(Left). Looking West at nightfall from the summit of White Mountain. The snow tipped 13,000-14,000 foot scarp of California's Sierra Nevada mountain range glimmers above midnight blue of the valley below.

29. Epilogue

I am particularly grateful to Jack Shriber, Eve Moreland, Elaine Lis, and Muriel Johnston, of the former ONRU-2, as well as to Frank Powell, currently Director of WMRS, and David Trydahl, the on-site manager, for their encouragements and assistance. I also thank: Bradley Westbrook, archivist at the Berkeley library of the University of California (UC); Russell Schoch, editor of California Monthly for copyright permission; and to Lisa Allred, Attorney General, Washington State University, for researching pertinent copyright issues.

Nello Pace continued as director of WMRS until his retirement in 1977. After 1958, the UC Regents began to contribute maintenance support to the WMRS facility, as a university-wide institution. Management responsibility for WMRS passed to UC Los Angeles in 1997, and in 1995 to UC San Diego. Paul Manis remained as site manager of WMRS until 1963, and on his death, bestowed an endowment for student aid at WMRS. Regrettably, Elmer Buelow, having lost his position at the Mt. Barcroft laboratory in 1954, died by his own hand shortly after leaving.

Those of us most closely associated with building and establishing the Barcroft and Summit laboratories moved on shortly after 1956. Dave Wiltsie, continued wildlife studies in the White Mountains, after founding a successful taxidermy business in Bishop that catered to seasonal hunters. Eve Moreland and Jack Shriber entered private business, as well, while Tom Hanson entered covert government service after a brief return to Berkeley. Ken Jackson, Dave Jensen, Carl Cramer, and Elaine Lis, all retired after long careers as university professors. Al Bassham and Fred Schaffer retired as senior scientific staff at Berkeley, and I, thoroughly hooked on the natural sciences, retired after twenty years as division manager for environmental sciences at Pacific Northwest National Laboratory. My earliest mentor, Charles Houston, continues publishing on high altitude acclimatization and maintains a large reference database on the subject (website: http://www.wmrs.edu/high_altitude/Default.htm)

For many of us, the 1950-1956 period was a time of extraordinary and exciting experiences instigated by Nello. Like him, we were then rather youthful. Idealistic and certainly not as sophisticated in the ways of the world as we would have preferred to believe, we each made our share of misteps. Our feelings working with Nello —or for him, depending on viewpoint— were certainly complicated. Nevertheless, he was a visionary and stimulating personality. Most of us are indebted to him in many ways, perhaps not all of which we realized at the time. An unbridled character, Nello left an enduring legacy for our successors at WMRS, as well.

—Burt Vaughan