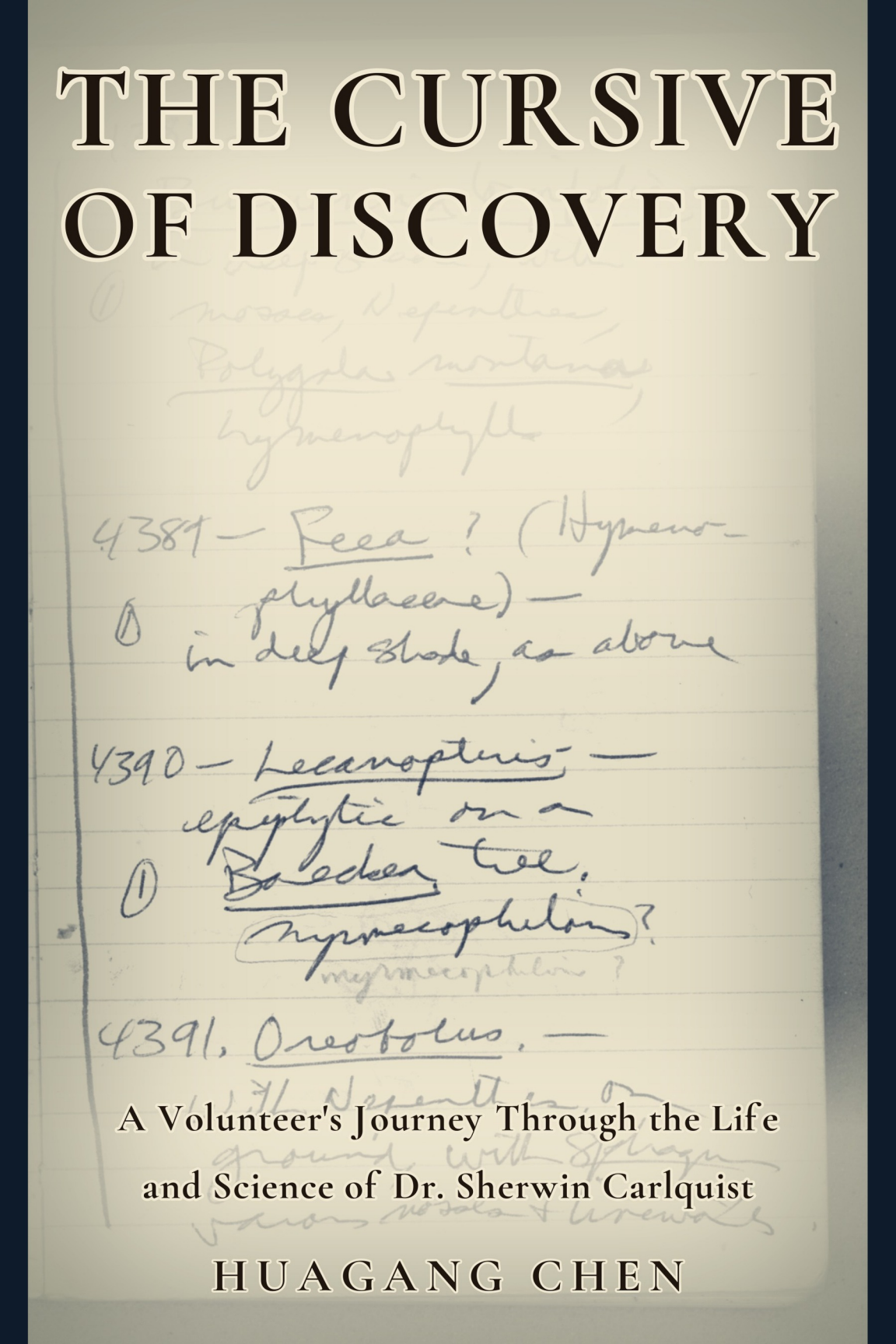
THE CURSIVE OF DISCOVERY



A Volunteer's Journey Through the Life and Science of Dr. Sherwin Carlquist

HUAGANG CHEN

Dr. Sherwin Carlquist was one of the great botanists of his century: the scientist who explained how plants crossed thousands of miles of open ocean to reach and remake the Hawaiian Islands, who could read the life of a plant in the grain of its wood, and who photographed and filmed the living world from the rainforest floor to the electron microscope. He filled nineteen field notebooks by hand, in a fast and beautiful cursive, across fifty years and six continents. Then he died, six months before the grant that would finally honor his life's work.

Huagang Chen never met him. A retired scientist and a volunteer, he spent hundreds of hours at his own desk, decoding that difficult handwriting one word at a time, so a stranger's discoveries would not be lost. And somewhere in the work he understood something: Carlquist had written his notes to his own future self, and now, decades later, Huagang had become the reader those notes were waiting for.

The Cursive of Discovery is the story of that meeting across time: a patient volunteer and a patient genius, a hand hard to read because the mind behind it was so full. It is a book about islands and evolution and the plain joy of noticing, and about a quiet truth: a nineteen-cent notebook, filled one careful line at a time, can hold a lifetime of wonder. For young scientists, nature lovers, and anyone who believes that patient attention is its own kind of discovery.

Huagang Chen

THE CURSIVE OF DISCOVERY

THE CURSIVE OF DISCOVERY

✦

A Volunteer's Journey Through the Life and Science of Dr. Sherwin Carlquist

HUAGANG CHEN

First edition

Set in Georgia.

For the volunteers who learn to read a stranger's hand, and for Dr. Carlquist, who wrote it all down for whoever came next.

You collected this earlier.

From a Sherwin Carlquist field notebook, written to his future self

CONTENTS

Nineteen Notebooks

✦

The breakfast dishes are done and the house has gone quiet. I sit down at my own desk, in my own home in Arlington, Texas, with two screens standing side by side in front of me, and I open a dead man's notebook.

A photograph of the author at his desk, one screen holding a scanned notebook page, the other his transcription. (Photograph to be supplied by the author.)

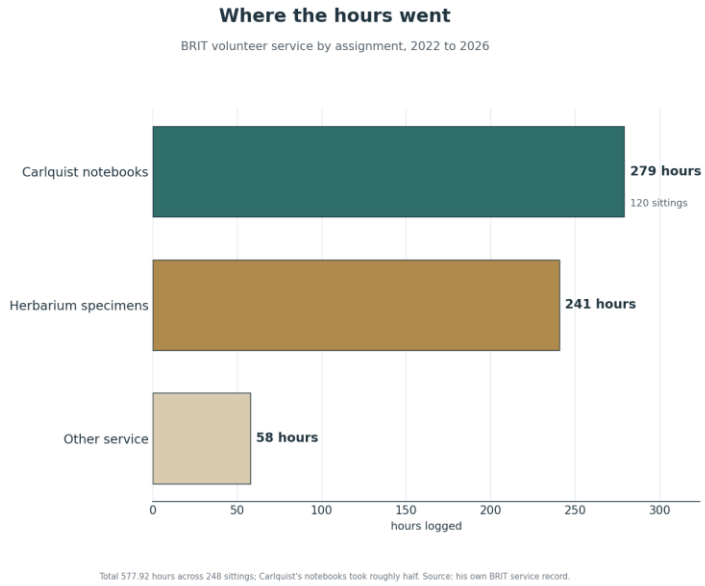
Not the notebook itself. That is in a climate-controlled room about twenty-five minutes up the road, in Fort Worth, in an archival box, handled with more care than I would handle my own passport. What I open is a scan of it, page by page on my screen, photographed by someone else's patient hands so that people like me can work from home. But the effect on a person is not so different. The paper has gone the color of weak tea. There are freckles of foxing along the margins. The ink from the reverse side shows through faintly, so that every page is really two pages competing for your attention. And running across all of it, line after line after line, is the handwriting of a man I never met and never will.

I am a volunteer. I want to say that plainly at the start, because everything in this book follows from it. I am not a botanist. I spent my working life as a pharmaceutical scientist, most of it in eye care, and when I retired I found I still wanted something to do with my mornings that used the part of my mind that likes hard problems. So I signed up at the Fort Worth Botanic Garden, and through the garden I came to the Botanical Research Institute of Texas, which everyone there simply calls BRIT, and BRIT had a job that almost nobody wanted.

Huagang Chen, a volunteer at the Fort Worth Botanic Garden.

There were nineteen field notebooks, all handwritten, and someone had to read them.

In a long career as a scientist I had never once kept track of my own hours. A salaried man in a laboratory does not punch a clock, and I never had. This volunteer work was the first time in my life I kept a record of my own time, and I did it myself, at my own desk at home: the moment I sat down and the moment I stood up, noted on a slip of paper and entered later into the log the project kept for us. I was never clocking in at that building. The hours were mine, counted by me, in my own house. When I added them up recently the number came to something over five hundred and seventy, though not all of it was this. A great deal of it was other work at the same institution, transcribing pressed plant specimens in the herbarium, which I took up when the notebooks wound down and kept at for a long time after. Some was the ordinary volunteer work I had started with, in the greenhouses and at the front desk, before I had ever heard the name Carlquist. There was also, later still, a separate project, translating Chinese into English, which is a story for another day. But the largest single part of it, close to half, was this: something like two hundred and seventy-nine hours, across a hundred and twenty separate mornings, spent right here, at this desk, in this chair, with the coffee going cold beside me, reading him. My wife would come through and see the same screen she had seen an hour before and ask whether I had made any progress. Some mornings the honest answer was one word. Not because I had spent the hour on that one word. I had learned not to do that. I would give a hard word a minute, and if it would not come I would go on and let the line fill in around it and come back to it later. But some mornings, when I stood up, that one recovered word was the whole of what I had to show for the morning, and I had learned to be content with it.



Where the hours went. Close to half of my volunteer time went to Carlquist's notebooks, and almost as much to transcribing pressed specimens in the herbarium. The rest was the garden work I started with.

I would like to tell you about that word, and about the man who wrote it, and about what happened to me somewhere in the middle of all those hours. But first you have to see what I was looking at.

The heavenly script

The first time I opened one of his notebooks I thought there had been a mistake.

I do not mean the handwriting was ugly. That was the strange part. It was beautiful. It ran in a fast, forward-leaning cursive, the loops all consistent, the pressure even, the lines marching down the page with the confidence of a man who never once stopped to wonder whether he would be able to read it later. In Chinese we have an expression for writing you cannot make out. We call it 天

书, tianshu, heavenly script, meaning the writing of heaven, meaning: not for mortals. That was my first thought. Beautiful, and not for me.

An hour would go by and I would have perhaps a third of a page. Sometimes less. I would sit there staring at eight or nine letters, absolutely certain they were a word, absolutely unable to say which word.

So I learned to work the way you work any stubborn problem, which is to say from the outside in. I had two screens side by side on the desk: the scanned page open on one, my own typing on the other. I would find the words I could read and use them as walls. A date. A number. A place name I recognized. Then I would guess at the shape of the thing in the middle. Then I would take my guess to the botanical dictionary the project had given us, which lived in a tab on the second screen, always a glance away, and see whether any real plant name in this world matched the shape my eyes were insisting on. Then I would take it to Google and see whether that plant had any business growing where he said he was standing.

Very often it did not, and I would start again.

I want to be honest about the beginning: it was discouraging. I would finish a morning and think, at this rate I will be dead before this notebook is. There is a particular kind of tiredness that comes from failing at something small over and over. I did not know yet that I was learning. That is the thing nobody tells you about a difficult hand. You are not decoding it letter by letter forever. You are building, somewhere below the level of thought, a model of one specific person's way of moving a pen. And once that model is built, the same page that defeated you in March opens for you in June like a door that was never locked.

But in the beginning it was slow, and I was slow, and there were mornings I sat down mostly out of stubbornness.

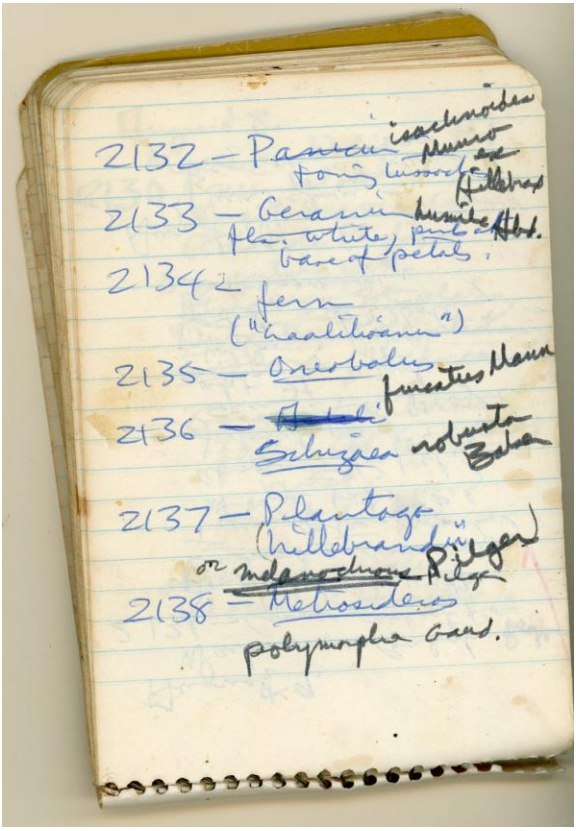
I had one advantage, and it was not a scientific one. Many years ago, as a young man in China during the Cultural Revolution, I was not permitted to attend an ordinary high school. I was sent to a technical school instead, to learn to repair automobiles. I took an entire truck apart there, until not one part was joined to another, and then I put it back together as a working truck. People have sometimes said to me that this was a detour away from science. I have come to think it was the beginning of it. When you have once understood how a whole system fits together, bolt by bolt, you stop being frightened of complicated things. You learn that a mess is only a mess until you find the order inside it, and that finding the order is mostly a matter of not leaving.

A page of difficult handwriting is a system. It has parts. The parts fit together in a particular way, always the same way, because one hand made all of them.

So I did not leave.

What is actually on the page

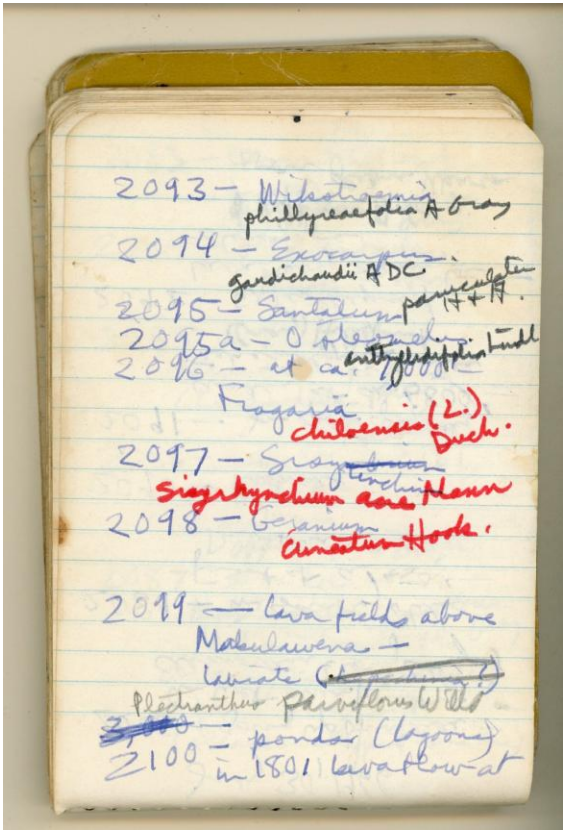
If I put one of the hard pages in front of you, you might not immediately see the problem. Let me show you what I mean.



This is what "notoriously difficult" looks like. A page I had to learn to read one crushed word at a time.

The trouble is not sloppiness. The trouble is density. Every specimen gets a number, a name, a place, and a description, and he is writing all of that in the field, often standing up, sometimes in rain, always in a hurry to get to the next plant. So he compresses. The scientific name of a plant carries an author abbreviation after it, the shorthand for whichever botanist first published that name. Gaud. for Gaudichaud. Hbd. for Hillebrand. R.Br. for Robert Brown. F.Muell. for Ferdinand von Mueller. He writes these as tiny superscripts, crammed into whatever space is left at the end of a line, in letters perhaps a millimeter and a half tall.

Then there is the second layer. Years later, back in a herbarium with a microscope and a stack of reference specimens, he would go through the same notebook and correct himself. A plant he had called one thing in the field turns out, on examination, to be something else. So the new name goes in over the old one, in red ink or in pencil, sometimes with an arrow, sometimes just wedged into the gap above the line.

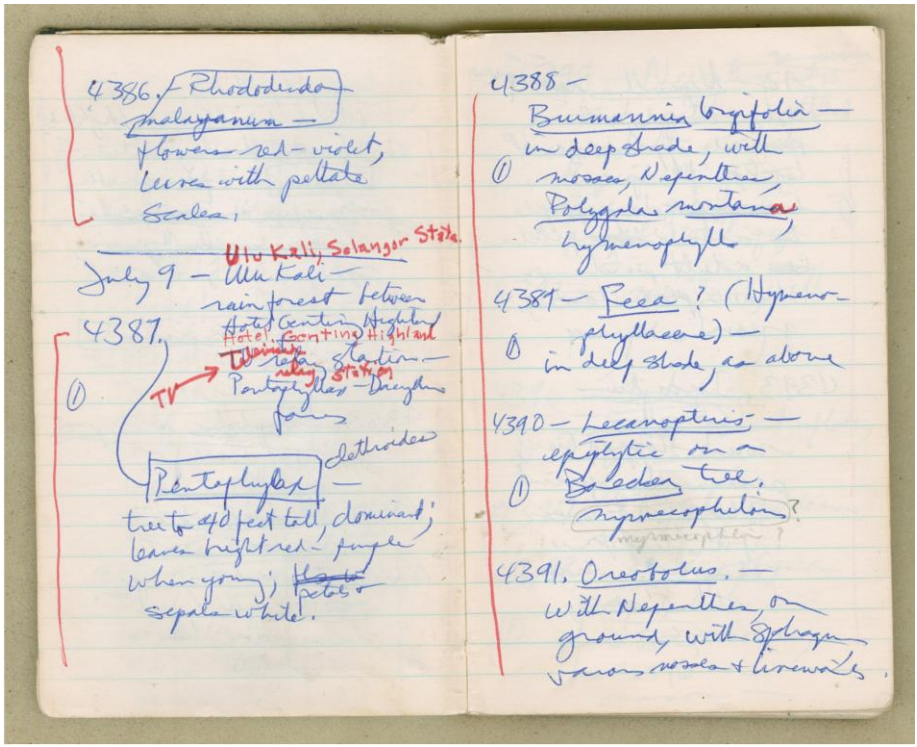


Which mark came first? Blue in the field, red years later. The page keeps its own history.

For a transcriber this is a genuine puzzle, and not only a visual one. You have to decide what the record is. Is the record what he thought that morning on the mountain, or what he concluded four years later at a bench? The answer, which the archive is very

firm about, is both, and you must keep them separate, and you must not quietly improve him. His first word stays his first word.

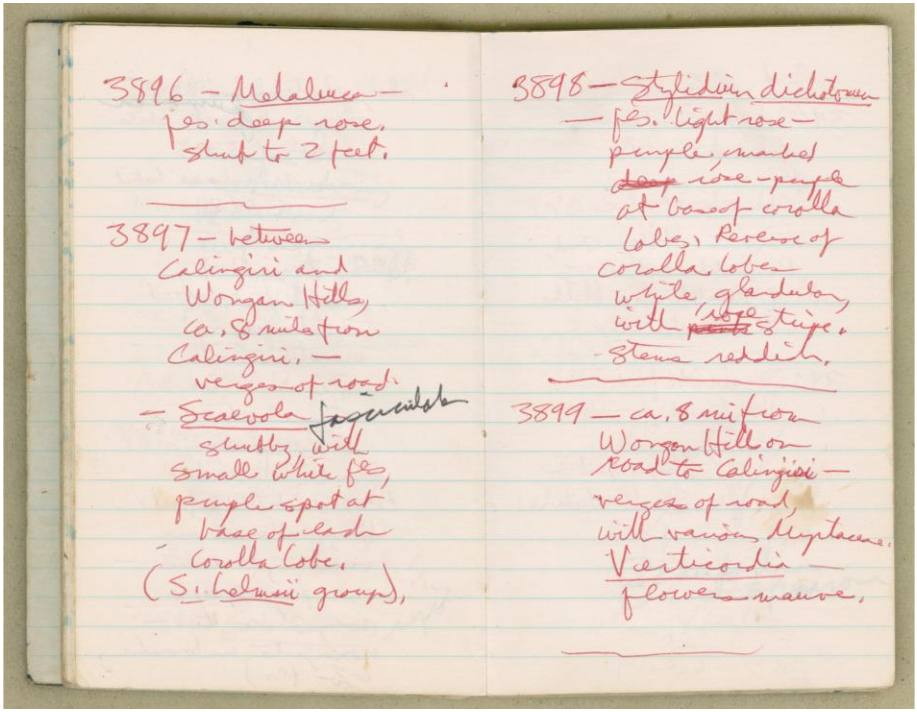
And then, just when you have your rules straight, you discover he has a private color system.



Once you see it, the colored scribble becomes a code. Red for where he stood, blue for what he found.

In the Malaysian notebooks from 1973, the red ink is not corrections at all. Red is places. Ulu Kali. Genting Hotel. Penang Island. He is using color the way a good engineer uses color on a drawing, to separate two kinds of information that would otherwise tangle. Nobody wrote this convention down anywhere. Nobody had to. It was his notebook, for his eyes.

There are pages that go almost entirely red, and they are, in their way, handsome.



A page nearly all in red. The notebook as its own kind of art.

At the front of the notebooks he sometimes left a key to his own shorthand, which is the closest thing a transcriber gets to a gift. UCU meant ultra close-up, a photographic term. CU meant close-up. K'bosch was Kirstenbosch, the great botanical garden at the foot of Table Mountain in South Africa. A double mark meant inches. A number with a single mark after it, like 2800', meant feet above sea level. The first time I found one of those key pages I sat back in my chair and laughed out loud, because it felt exactly like a man leaving a note on the kitchen table for someone who would arrive later.

A page from the front matter of one of the notebooks, where he set down his own abbreviations. His key to reading him. (Plate to come from the Sherwin Carlquist Collection.)

Not every page survived the fifty years in good order. One of the Hawaii notebooks took water somewhere along the way, and

parts of it were rewritten over the damage, ink over stain, so that reading it is like listening to a recording with weather on the tape.

A water-damaged notebook page from Hawaii, 1967, rewritten over the ruined text. The cursive of discovery, literally. (Plate to come from the Sherwin Carlquist Collection.)

One line, two ways

Here is the clearest way I know to show you how hard this hand can be.

Some notebooks were transcribed more than once, by different volunteers at different times, and the versions do not always agree. That sounds like a failure of the process. I have come to think it is the most honest thing in the whole archive.

There is a line in Notebook 17, from his New Caledonia work, that one pass rendered like this:

> *metrooidear + Panaberia? Hegin as ore goes*

You can feel the transcriber fighting. The question mark is a person admitting they are not sure. It looks like gibberish because it is a careful record of gibberish, which is what that line looked like to a reader who had not yet built the model of his hand.

A later, slower pass recovered it:

> *Metrosideros + Pancheria begin as one goes*

Metrosideros and *Pancheria* are two genera of trees. He is noting where they start to appear as you climb. The sentence is completely ordinary. It is a botanist telling himself what grows at what elevation. But between the first reading and the second lies everything I want you to understand about this work: the difference is not intelligence, and it is not effort. It is familiarity. The second reader had spent enough hours inside his handwriting to know that his lowercase g dips a certain way, that

his capital M sometimes loses its first stroke when he is moving fast, that "begin as one goes" is a phrase he uses.

When a line like that finally comes apart in your hands, the feeling is out of all proportion to the size of the thing. Four words. And I would get up and walk around the house.

That was when I stopped thinking of the difficulty as an obstacle. The hand is hard to read because the mind behind it was fast and full. He was not writing badly. He was writing at the speed of his own attention, which was considerable, in conditions that did not allow for penmanship. Every crammed superscript is a man refusing to lose a piece of information he had walked a long way to get.

I have never been able to look at those pages the same way since.

There is a second thing that happens, and it took me longer to notice. When you transcribe someone for hundreds of hours, you begin to hear them. Not their voice, exactly. Their pace. He wrote in short bursts when the walking was hard and in long, easy runs when he had a table and a lamp. He underlined when something surprised him. Only a handful of times, in fifty years of notebooks, did he use two exclamation marks, and every time I stopped and read the line over, because a man that economical does not do that lightly.

And once you can hear a person, you cannot help behaving as though they are in the room. I would find myself saying, out loud, in an empty house: no, that is not an r.

Nobody warns you that this is what archival work does. It is not lonely. It is the opposite of lonely, in an odd and slightly haunted way.

I should say that I was never working entirely alone, even at that desk. Nothing I typed was final, and there were other people at other desks doing the same thing. But that is the next chapter. In this one it is still just me and the page.

The man whose hand this is

I should tell you a little about him, though the whole of this book is really the telling.

Dr. Sherwin Carlquist was one of the significant botanists of the last century. He was American, born in Los Angeles in 1930. He earned his doctorate and then spent something close to fifty years in the field, on six continents and a great many islands, studying how plants get to remote places and what happens to them once they arrive. He wrote books that changed how his colleagues thought. He took photographs, more than a hundred thousand of them, in a way I will come to later because it deserves its own chapter. He taught. He died in December of 2021.

Dr. Sherwin Carlquist. The man whose hand this is, and whom I never met.

That last fact matters more than it should, and I will come back to it.

For now, I want to stay with the smaller thing, which is that a man spent five decades filling nineteen notebooks with numbered plants, one at a time, and then the notebooks sat in boxes, and the boxes came to Texas, and I sat down at my desk one morning in 2023 and started to read them.

I never met him. I want to keep saying that, because it is the strange fact at the center of my experience. I know how he abbreviated Kirstenbosch. I know that he underlined when he was excited and that he used two exclamation marks only a handful of times in fifty years. I know the way his hand tightened when he was writing in the cold. I know none of the things you would learn about a person in five minutes of conversation.

And yet I would not say I did not know him.

Let me put it another way. If you handed me a page of writing from any of the nineteen notebooks with the date and the place torn off, I could probably tell you roughly when in his life he wrote it, and whether he was comfortable or cold, and whether he was seeing something he expected or something that startled him. I could not tell you his politics or what he ate for breakfast. I know the part of a person that shows up in their work when nobody is watching, which is a narrow slice of a life, and a real one.

There is a Chinese habit of thought I grew up with, which is that you show respect to a teacher you never met by taking their work seriously. You do not have to have shaken a man's hand to owe him careful attention. For most of two years, this was the form my respect took: getting his words right, and not improving them.

The notes were written to someone

This is the part I have thought about most, and the part that changed the work for me from a task into something else.

A few weeks in, I noticed something about the way he wrote to himself. He did not write "I collected this." He wrote, quite often, in the second person. He was giving instructions. Not to a reader, and not to a colleague. To himself, later.

> *you collected this earlier between Denmark + Mt. Barker … Look at S. glaucum in herbarium to see what 'typical' glaucum is.*

Denmark and Mount Barker are towns in Western Australia. He is standing in a field with a plant in his hand, and he is telling the man he will be in six months, back at a microscope in California, what to go and check.

Once you notice it, you find it everywhere.

You will have to check specimens, of course, but…

your non-sensitive new species (Esperance, Cranbrook)

And this one, which stopped me for a long minute:

tussock vegetation near riverside where in 1962 you photographed the beautiful red-fruited Coprosma

He is standing in New Zealand. He is remembering a photograph he took five years earlier at that same riverside, and he is reminding his future self to connect the two. The notebook is not a record of what happened. It is a set of messages sent forward in time, from a man to the only reader he completely trusted, which was himself, later.

Here is the thing about messages sent forward in time. They assume the reader arrives.

He died before he could be that reader. Not all at once, of course. He was a working scientist into his last years and he answered a great many of his own questions. But there are messages in those notebooks that were never collected. Instructions to check a specimen he never got back to. A note to look again at a population he never saw again. A plant he wanted to think about more.

And then, decades later, a retired pharmaceutical scientist in Arlington, Texas, sat down with a botanical dictionary and started reading them one word at a time.

I do not want to make more of this than it is. I did not go and check *S. glaucum* in a herbarium. I am not a botanist and the instructions were not written to me. But I read them. Somebody finally read them. When he wrote "you," the "you" turned out, after everything, to be me, sitting in a quiet house on the other

side of the world from Mount Barker, forty and fifty and sixty years late, doing my best.

I found I could not treat it as data entry after that.

I have tried since to work out why it moved me the way it did, and I think it is this. A man writing "I saw" is making a record. A man writing "you will have to check" is making a promise. He is assuming a future in which he is still curious, still working, still able to walk up that slope again. Every one of those sentences is a small act of confidence in his own tomorrow. There are hundreds of them, across fifty years, and the whole set of them together is the most hopeful thing I have ever read.

And some of the promises came due after the man was gone.

But I have come to believe that this is the ordinary way it works, and not a tragedy. Most of what any of us leaves is collected by strangers, later, in conditions we did not imagine, and put to uses we would not have guessed. The only part we control is whether we wrote it down clearly enough to be collected at all.

He wrote it down clearly. That is the joke of the beautiful, impossible hand. It looked like a wall and it was actually a door.

And it runs in both directions, which is the part I did not expect. Because I was leaving notes too. When I ran into something a later reader would stumble on, I would put in a short bracketed note of my own. There is a place where he uses the old symbols for male and female flowers, the ones you see on a biology worksheet, and I stopped and explained what they were, in plain words, for the next reader. There is a place where he abbreviates a national monument to four letters and I spelled it out. There is a place where he wrote March 23, 1988, and the whole surrounding page is plainly 1989, and I did not correct him,

because that is not what we do. I wrote a small note beside it, a question rather than a fix: should the year be 1989?

A screen of the transcription showing the volunteer's own bracketed notes, left in the record for the next reader. (Plate to come from the transcription record.)

That is the whole shape of this book in one small mark. A man leaves careful notes for whoever comes after. Somebody comes after, much later than anyone intended, and reads them, and leaves careful notes of their own for whoever comes after that.

Fifteen that became nineteen

I promised you the tangled labels, and they are worth the detour, because they are the best example I have of the way confusion in this work eventually turns into clarity.

When I started, I was told there were nineteen notebooks. The catalog said nineteen. The index in front of me listed Field Notebook 1 through Field Notebook 19. Simple enough.

Then I opened the covers.

The notebook I had been handed as number 17 said, in the archive's own labeling, "Field Notebook 17 (prev. 14)." Number 16 had been 13. Number 11 had been 8. Number 9 had been 6. That is a tidy pattern, three added to each. But then number 5 had previously been 18, which fits no pattern at all, and for a while I was convinced I had misread it.

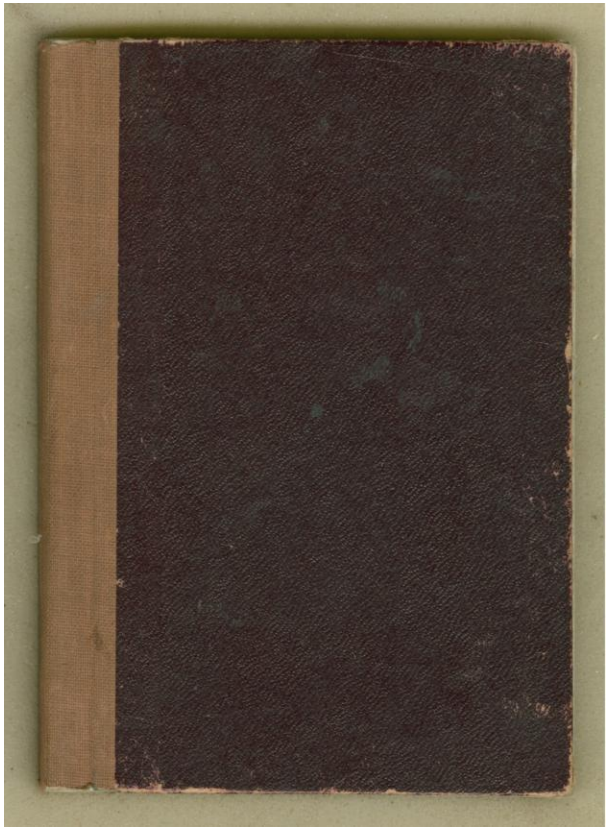
I had not misread it. What I was looking at was history.

For years the collection held roughly fifteen of his field notebooks. Then, in August of 2024, another group of his material came across from Rancho Santa Ana, the California botanic garden where he had worked for decades, and was formally added to the collection here. Some of it was field notes;

some was material that had been kept separately. Once it arrived, the whole set had to be renumbered into a single clean sequence from one to nineteen, and the notebooks that had already been numbered under the old scheme got new numbers on top of their old ones.

So the nineteen notebooks were never nineteen separate books that had always sat in a row. They are fifteen that became nineteen: an old count, plus a later arrival, folded together and renumbered so that a person coming to the collection today can read them in order without knowing any of this.

I find that I like the number for exactly that reason. Nineteen is not a fact of nature. It is the number of pieces a life's work broke into, after the boxes and the moves and the decades, and then the number somebody chose so that the pieces could be put back in an order that made sense.

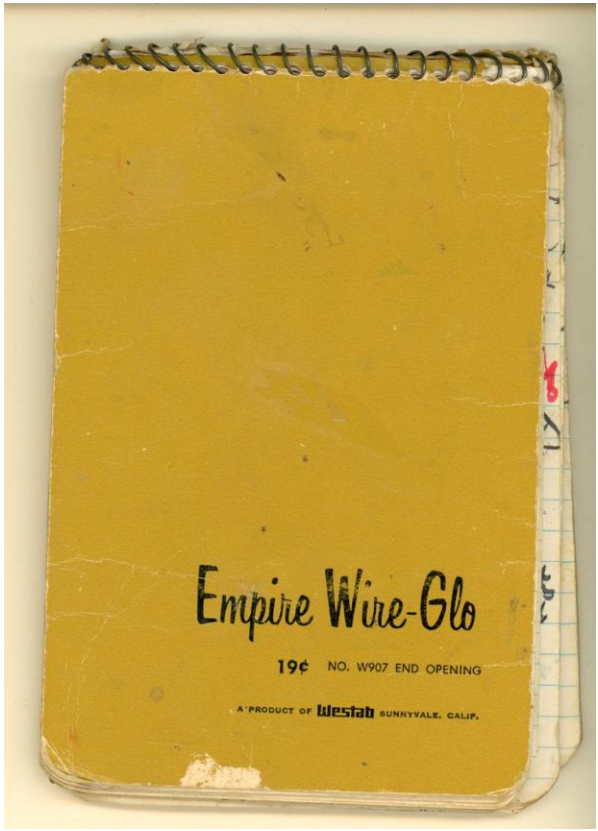


Nineteen notebooks, no two quite alike. A drugstore pad sits in the same collection as clothbound field books.

Of the nineteen, I worked through six myself: four I transcribed and two I checked behind another volunteer. Others took the rest, because the work passed between hands. I will tell you about those hands in the next chapter, because they deserve it. What I want to leave you with here is smaller and more personal.

Nineteen cents

The very first notebook I want you to see is not the most beautiful one. It is the cheapest.



Nineteen cents. Empire Wire-Glo, No. W907, a product of Westab, Sunnyvale, California.

That is a drugstore spiral pad. The kind a child buys for school with change from a pocket. The price is printed right on the cover, nineteen cents, and the company that made it is printed there too, a paper company in Sunnyvale, California, that has not existed for a very long time.

Inside it is a season of the sort of observation that ends up in scientific books. This one is Hawaii, and the year is 1966.

That date is the part that stops me. In 1966 he was thirty-six years old and no longer an unknown. He had already published the book that made his name. He could have carried anything he liked into the field.

He carried a drugstore pad that cost nineteen cents.

I keep coming back to it when people ask me why any of this matters. We have an idea, I think, that important science happens in expensive rooms. Some of it does. But a great deal of what we know about how plants reached the islands of the world was first written down by a man crouching in the dirt with a nineteen-cent notebook, filling it one numbered plant at a time, because the notebook was not the point. The attention was the point. The notebook only had to be good enough to hold it.

He never stopped working that way. The very first of the nineteen, the notebook numbered one, goes back to 1951, when he was twenty-one and interested in a group of yellow-flowered California plants that most people would walk past without a glance. Nobody had given him a grant. Nobody was going to read it. He started numbering anyway, and fifteen years later, with a reputation and a readership, he was still buying the cheapest paper on the rack.

Everything that came after, the books, the awards, the fifty years of walking, is built on somebody being willing to write down number one and then keep going.

He did not write for me. He wrote for the man he would be in six months, at a microscope, needing to remember exactly which slope this came off and whether the fruits were red.

But the notes outlasted the man, which is the ordinary miracle of writing things down. He wrote it down for whoever came next.

And it turned out to be me.

I did not deserve it and I did not expect it and I am not sure I was the right person for the job. What I had was time, and a stubborn streak, and a habit from a long career of not putting a

number down until I was sure of it. Some mornings that was enough for a page. Some mornings it was enough for one word.

The word was usually the name of a plant. It was usually a plant I had never heard of, growing on an island I will never visit, noticed by a man who has been dead since the winter of 2021.

I would get it right, and I would sit there at my desk, the two screens still glowing, and I would be so pleased.

The Hallways of BRIT

✦

I have been describing a desk. A lamp, a screen, one hand meeting another across seventy years of paper, and a morning in which a good result is a single word.

That is true, and it is not the whole picture. Behind the notebook on my screen there is a building in Fort Worth, and behind the building there is a quiet machine of care that has been running for years, staffed almost entirely by people I have never met. I was one small moving part in it. I did not understand the size of the thing until I had been working for months, and when I did understand it, my sense of what I was doing changed again.

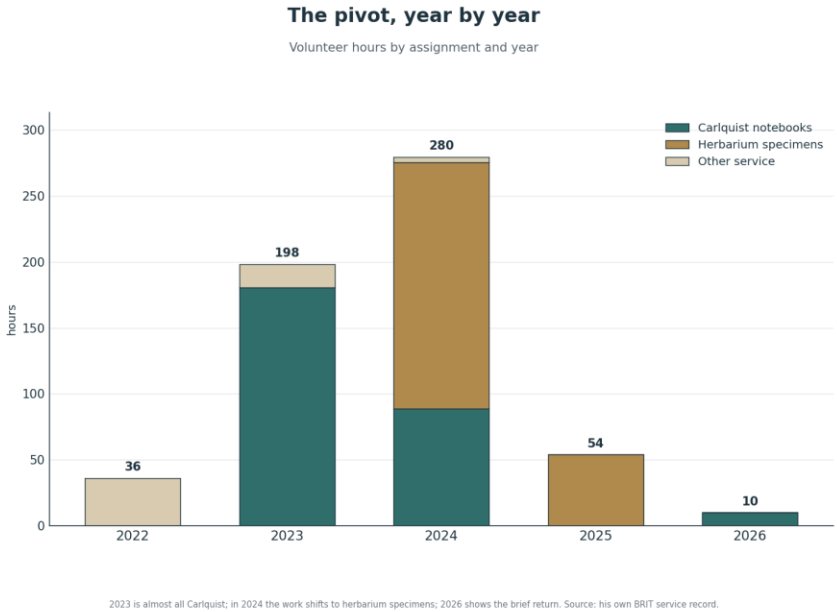
I had thought I was reading a man's notebooks. I was actually taking one shift in a relay that started before me and will finish after me.

A garden and an institute

The place is called the Botanical Research Institute of Texas. Everyone says BRIT, as one word, and I will do the same from here on.

BRIT is a research institution: a herbarium, a library, an archive, a working staff of botanists. It sits joined with the Fort

Worth Botanic Garden, and the two are close enough in practice that a volunteer signing up at the garden can end up working on either side. That is exactly what happened to me. I went to the garden because I have loved plants since I studied traditional medicine as a young man in Guiyang, and because a retired man needs somewhere to put his attention. I signed up in the autumn of 2022, and for the first half a year I did the ordinary work of a new volunteer. I greeted visitors at the door. I worked in the begonia greenhouse and in the one they call Rolling Hills. I helped decorate the garden for the holidays and lent a hand at the plant sales. The name Carlquist meant nothing to me yet. Then, in the spring of 2023, someone mentioned there was a collection that needed reading, and asked whether I had the patience for difficult handwriting, and I ended up in the archive almost by accident, and stayed for years.



My volunteer mornings, counted year by year. The notebooks filled 2023 and the first half of 2024. Then I moved to

the herbarium and stayed at it, and came back to Carlquist once more at the start of 2026.

The collection had come a long way to get there. Dr. Sherwin Carlquist worked in California for most of his life, at the Claremont colleges and at the botanic garden associated with them. That is where the notebooks were written up, where the slides were filed, where the specimens were pressed. When a scientist's working life ends, all of that has to go somewhere, and where it goes is not a small question. Some collections are split. Some sit in a basement. Some are quietly lost.

His came to Texas, and was given an address: `BRIT-A-AR003`. That string is not decoration. It is the archive's way of saying: this exists, it is ours to keep, and anything in it can be found again.

I like that more than I can easily explain. My whole career was in a regulated industry, where a thing that is not documented did not happen. To see a man's fifty years given a permanent identifier felt familiar, and it felt like a kind of promise.

What is actually in the boxes

Let me give you the size of it, and then let me put the numbers away, because numbers are the worst way to feel something.

There are roughly fifty-two banker boxes. There are about a hundred and twenty-five thousand catalogued images. The specimen numbers in the notebooks run from one to just under sixteen thousand.

Now here is what those numbers mean, which is the part worth holding on to.

The nineteen notebooks are the words. About a hundred and twenty-five thousand photographs are the pictures. Sixteen thousand numbered plants are the things themselves, most of them also pressed flat and dried and filed in a cabinet somewhere.

It is one man's fifty years of looking, split into three forms and stored in a room, waiting.

When I try to imagine it physically I do not picture a spreadsheet. I picture a wall. Boxes stacked to a height above my head, each one heavier than it looks, each one holding some thousands of small transparent squares that a man held up to a window one at a time, decades ago, to see whether the picture had come out.

A person cannot hold that. A person can hold one page. That is why the work is done the way it is done, by many people, in small pieces, over years.

There is a particular feeling that comes over a volunteer somewhere in the first month, and I think everyone who has done this kind of work knows it. You are given a task that is clearly finite. Nineteen notebooks. That is a number. You could count to nineteen before your coffee cooled. And then you open the first one and discover that a single notebook holds several hundred pages, and a single page holds a dozen entries, and a single entry can hold you up for twenty minutes, and the arithmetic that had seemed friendly turns and looks at you.

The only cure I ever found for that feeling was to stop looking at the whole and start looking at the line. Not the notebook. Not the page. The line in front of me. It is the same trick a long-distance walker uses, and the same one I used through the hardest stretches of my career: the far end of the work is not your business this morning. This morning's business is this line, read correctly.

Somebody, at some point in the history of that building, must have looked at fifty-two boxes and had exactly this thought and decided to start anyway. That decision is the reason there is anything to write about.

One saltine box at a time

Here is the part that gave this chapter its name.

Every image in the collection has two addresses. It has the address it was born with, which describes where it physically sat when it arrived: which banker box, which slide box inside that, which slide inside that. And it has a new address, which describes where it lives now: which flat box, which small inner box, which slide.

The staff call those small inner boxes saltine boxes, because that is roughly what they look like, a flat cardboard box about the size of a sleeve of crackers. It is not a scientific term. It is the kind of word that grows inside a working building.

The reason for the second address is that the first one was never meant to last. Banker boxes are office supplies. The cardboard is acidic, the lids warp, and the boxes were packed by whoever was packing that week, in an order that made sense at the time and to nobody since. So the collection is being moved, physically, box by box, out of the boxes it arrived in and into archival housing built to last a century, and every single item is being given its permanent address as it goes.

The rehousing: how each image moves from its original banker-box address to its permanent archival one, one saltine box at a time.

One saltine box at a time. That is the actual pace of it.

When people picture archival work I think they picture a discovery: a lost letter, a sealed room. Most of it is this instead. It is moving a small flat box from one shelf to another and writing down, carefully, where you put it. It is unglamorous in a way that I found I respected enormously, because I have spent my life around processes where the unglamorous step is the one that keeps everything else from being worthless.

The hallways of that building are lined with a record being given somewhere permanent to live.

The grant that came too late

I want to tell you a hard thing now, and then I want to leave it alone, because it does not need any help from me.

For years this collection sat, valuable and mostly unread, the way a great many collections sit. Doing something with it properly, digitizing the photographs, transcribing the notebooks, connecting the pieces so that scientists anywhere could use them,

takes money. Real money, the kind that comes from a national funding agency after a long application and a longer wait.

That money came. The National Science Foundation approved a project built around this collection, close to a million dollars, shared with the California garden where he once worked, to do the work properly at last. The award even carries its own number, 2133562, the way the collection does.

It was approved about six months after Dr. Sherwin Carlquist died. He died on the first of December, 2021.

He never knew. He spent fifty years filling those notebooks, and the decision that his life's work would be properly preserved and opened to the world arrived roughly half a year after he was past caring about anything.

I have turned this over many times at my desk. I do not think it is a scandal; grants take the time they take, and everyone involved was doing their job. I think it is simply the ordinary shape of things, and the ordinary shape of things is sometimes very hard.

What I will say is this. The project honors him now. Every hour any of us put in was, in a small way, a message sent backward to a man who could not receive it. He would have liked knowing. He did not get to know. So the work is the only form the telling can take.

There is a version of this story that is only sad, and I have decided not to tell it that way, because I do not think it is accurate. Consider what actually had to be true for that grant to be written at all. Somebody had to know the collection was worth close to a million dollars of public money. Somebody had to be able to say what was in it, and why a scientist in another country would want it. That knowledge did not appear from nowhere. It existed

because the man himself had spent fifty years making a record so orderly that its value could be argued for after he was gone.

He made the case without knowing he was making it. Every numbered plant was a sentence in an application he never saw.

And the reason his collection came to a well-run institution instead of a basement is the same reason: an orderly record is easy to want. A disorderly one is a burden, and burdens get lost. His care in 1958 is the reason there was a project in 2022.

That is not consolation. It is just the mechanism, and I find the mechanism steadying.

A relay of strangers

The notebooks are full of Carlquist. They are also, if you look, full of us.

Because the transcription passed between hands, and because the archive's rules require you to record what you did, the working text carries small markers that were never meant to be read as anything but housekeeping. You are moving through a long notebook, deep in the plants of Western Australia, and you come across a line in square brackets that has nothing to do with botany:

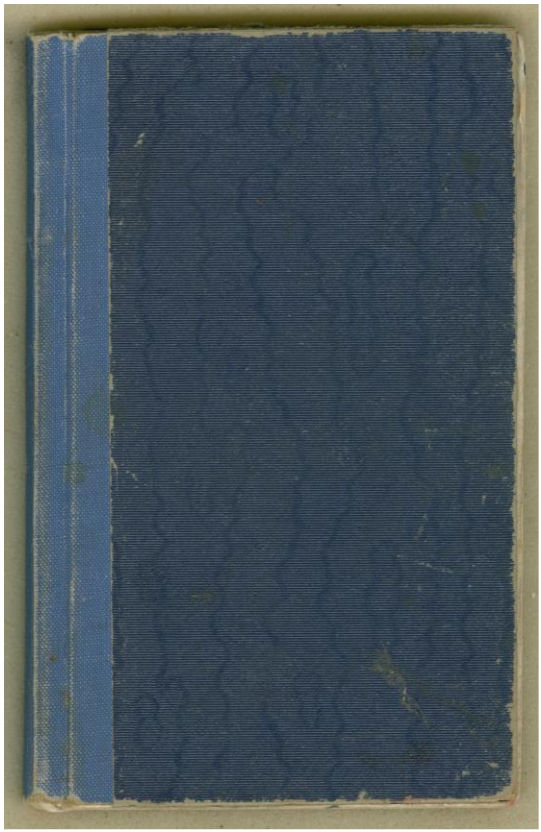
> *[Jason Best stopped here 2023 November 17]*

Somebody sat where I sat. He got to that line on a Friday in November and then his day ended, or his semester ended, or the notebook was handed to someone else, and he did the courteous thing and said so.

There is another one, further in, that I recognize immediately, because I wrote it:

> *Huagang Stopped at page 87 / 190*

Eighty-seven of a hundred and ninety. Not quite halfway. I remember nothing specific about that day. I remember the shape of a hundred days like it.



The notebooks passed from hand to hand for two years. Every volunteer who stopped mid-notebook left a mark saying where, so the next one would not have to guess.

A screen of the working transcription showing two stopping-marks months apart, one volunteer's and then another's. (Plate to come from the transcription record.)

The people running all this deserve their names as much as the notebooks do, and I can give you some of them. Krishna Shenoy, the project's archivist, led it, and was the one who first sat us down and walked the volunteers through the whole thing:

what the collection was, where it had come from, and the rules we were to keep. About ten of us listened that morning, and I was one of them. Ana Niño, the librarian, has kept the effort moving ever since, organizing a changing handful of volunteers month after month so that the reading never quite stopped. There were never many of us. Fewer than ten at any one time, coming and going as people do: a semester ends, a family needs you, a health problem arrives, and someone new logs in and picks up at page eighty-seven. A few of us stayed a long while. Glenn Butler was the first to sit down to these notebooks, before the rest of us arrived, and he gave them a great many hours. Julie Miller stayed to the end of them, and did the patient checking as often as the first reading.

None of us were botanists, as far as I know. We were retired people and students and practicum workers who had some hours and did not mind hard reading.

And the work was checked, and then checked again. This matters, and it is the part I would most want a young reader to notice. Nothing any one of us transcribed was taken on trust. The reading of a single notebook went through three sets of hands. One person transcribed it, typing the handwriting into text. A second, the checker, read that text against the original scan line by line and marked what the first had gotten wrong. Then a third did a final skim across the whole thing, looking for what the first two had missed together. Transcriber, checker, final reader, and then we would trade the roles and do it again on the next book.

I did all three jobs at one time or another. Of the nineteen, I worked six of them: four I typed out myself, and two I read behind somebody else's typing. The one I typed as number twelve had started life as number nine, before the collection was renumbered into a single clean run. The books were all different lengths, some only a dozen pages, one of them the hundred and ninety whose page eighty-seven I stopped at above.

And none of it happened in that building. I never once went in to do this part. I sat at my own desk at home, the scans reaching me over the internet and my finished pages going back the same way, into a shared folder the project kept, where whoever was coordinating could see what was done and what was still waiting for hands. A whole quiet machine, run out of a dozen separate houses by people who were mostly never in the same room.

We came in to the garden itself only now and then, every couple of weeks, for a working meeting. A room at the garden center, a few of us around a table, someone bringing a dish to share, the coordinators walking us through a new step and answering the questions that had piled up. Then everyone went home again to the real work. I want to be plain about that, because it is easy to picture me at a desk inside the archive: I was not. The building held the collection. The reading happened in our houses.

I recognized this immediately, because it is how a laboratory works. In my career, no result was real until a second person had tried and failed to break it. I had not expected to find the same discipline among a handful of volunteers reading old handwriting at their desks, but there it was, and it is the reason the transcription can be trusted at all.

So the chain runs like this. A man writes a note to his own future self. He dies. Some years later a funding agency decides the notes matter. A librarian recruits a few strangers. One stranger reads a page and hands it to another stranger, who checks it. And what comes out the far end is a text that a scientist in Kenya or New Caledonia can search on a screen.

In the first chapter I told you the notebooks were written by one hand to one reader. That was true of the writing. It is not true of the saving. The saving took a whole chain of strangers keeping

a dead man's record legible, and I was one link, and not the most important one.

Two labors, side by side

There were really two volunteer efforts running in that building, and I want to keep them straight, because they are easy to confuse and only one of them was mine.

Mine was the notebooks: reading handwriting into text.

The other was the pictures. Somebody has to look at each of those photographs and record what it shows, where it was taken, when, and which plant is in the frame. A hundred and twenty-five thousand times. That work has its own written instructions, its own conventions, its own volunteers.

I have read those instructions, and one line in them made me laugh out loud in recognition:

> *Watch the clock!*

Which is the sound of an institution that knows exactly how easy it is to lose a whole morning to one interesting slide. I lost many mornings that way, on my own side of the building, to one interesting word.

But there is another line in the same instructions that I have thought about ever since, and it is the closest thing this archive has to a moral:

> *Our goal is not to translate the information to current-day standards and nomenclature… Use the name that Carlquist applies.*

Read that again, because it is doing something unusual.

Plant names change. They change constantly, as scientists work out that two things called one name are really two species,

or that a name published in 1867 has priority over the one everybody has been using. A great deal of what Carlquist wrote in 1958 is, by today's rules, out of date. It would be easy, and it would feel helpful, to quietly modernize him as we go.

The archive says no. Use his name. Use his word. If he was wrong, he was wrong in a way that is part of the record, and the record is the point.

I do not think I properly understood the ethic of an archive until I read that line. We were not there to produce a corrected, improved, current version of Sherwin Carlquist. We were there to make sure that what he actually wrote could still be read in a hundred years. Fidelity, as institutional policy.

It is also, when you think about it, the same courtesy he showed his own future self. He did not clean up his first impression either. He wrote down what he saw, and then, years later, wrote the correction beside it and let both stand.

This rule had a practical effect on my mornings that I did not anticipate. It meant I was not allowed to be helpful.

My whole instinct, trained by decades of technical work, was to fix things. I would see a name I knew had been superseded and my hand would want to update it. I would see an obvious slip of the pen and want to smooth it out. The rule says: no. Type what is there. If you believe there is an error, you may say so, in a bracket, in your own voice, clearly marked as yours, and then you leave his word standing.

I found this humbling in a way that took me a while to appreciate. It is a discipline of not-improving, and it runs against everything a working scientist is trained to do. But it is the only rule that makes an archive worth having. The moment we start tidying the dead, we lose the ability to know what they actually

thought, and what they actually thought is the only thing we came for.

One number, three records

Now let me show you the thing that turns this collection from a pile into a machine, because it is the most satisfying piece of engineering in the whole archive and it is simple enough to explain in a paragraph.

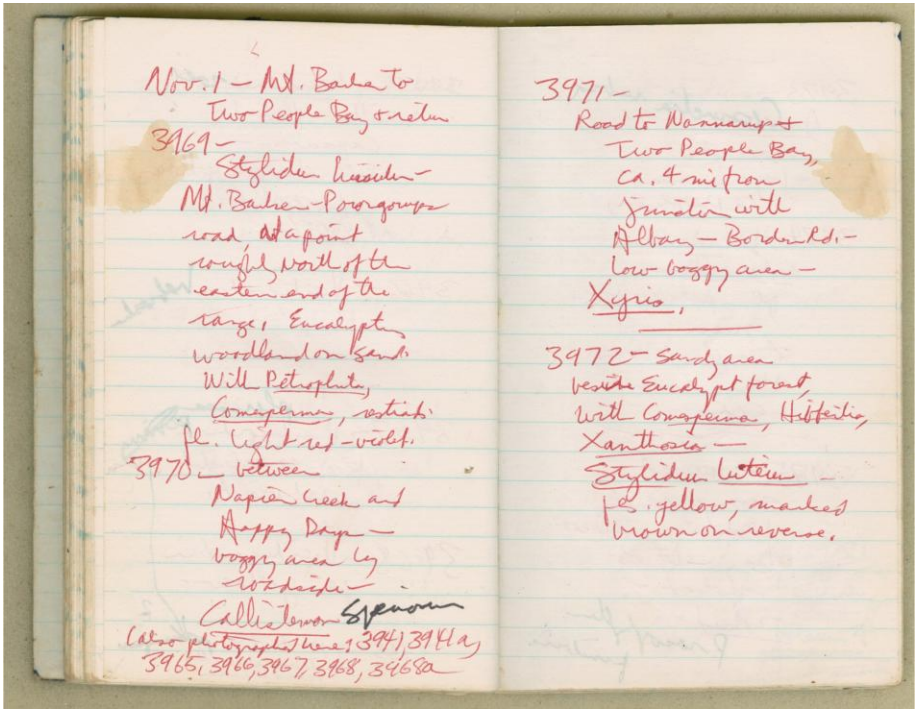
When Carlquist collected a plant, he gave it a number. Not a name, a number, running in a single sequence across his entire working life: one, two, three, and so on, up past fifteen thousand. That number went in the notebook next to the description.

When he photographed that same plant, the number went with it. The slide carries the collector's number.

And when he pressed and dried a piece of that plant and sent it to a herbarium, the number went on that sheet too.

So there is one key, and it is just the number. Match the number on a slide to the number in a notebook, and you know exactly what that photograph shows, where it was taken, on what day, and what the man who took it was thinking when he took it. Match it to the pressed specimen, and you can go look at the actual plant, seventy years later, under a microscope.

Botanists call it the collector's number. In the archive's terms, the collector number on the slide and the specimen number in the notebook are the same number: **Collector# = Specimen#**. One key, three records: the words, the picture, and the plant itself.



His notebook points straight at his slides. "Also photographed here 3964, 3965 … 3968a." Those numbers are the key that reunites his words with his photographs.

That line, in his hand, is the whole system in miniature. He is telling his future self: there are pictures of this one, and here is where to find them.

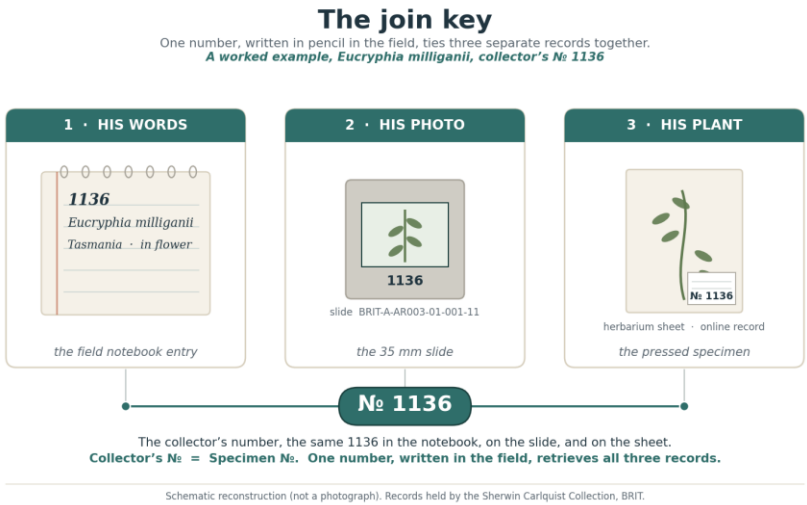
Here is a real case, worked through, because I find it more convincing than any explanation.

There is a slide in the collection with the identifier `BRIT-A-AR003-01-001-11`. On its own it is a small square of film in a box. But it carries a collector's number: 1136. Take 1136 to the notebooks and you find the entry. The plant is *Eucryphia milliganii*, a small tree from Tasmania. Take the same number to the online herbarium database, and there is the pressed specimen, with its own record, viewable from anywhere in the world.

A slide, a sentence, and a dried plant, separated for decades in different rooms and different states, joined back together by one number a man wrote in pencil in the field.

That crossing of states is not incidental. It is why the grant reached across two of them. A great many of his pressed plants stayed in California, at the garden where he spent his career, while a great many of his photographs came here to Texas. For decades that meant a plant and its own picture could sit two states apart, in separate institutions, effectively strangers to each other. The number ends the estrangement. The project has already reunited nearly three thousand of them this way, a photograph in Texas matched back to its specimen in California by the collector's number the two of them share, and every match is one more plant made whole.

That is the book's recurring figure, and I will use it often from here on: his words, his photo, his plant.



One number, three records: his words, his photograph, and the pressed plant itself, tied together by the collector's number he wrote in the field. Find the number and you find all three.

I should be honest about how much of this actually works today. The answer is: a small fraction, and growing. Of the hundred and twenty-five thousand image records, only something like five to seven percent are complete enough right now to make that three-way join automatically. Certain trips join cleanly. Tasmania does. The Canary Islands in 1967 do. His early Australian work does. The enormous South African run from 1973 has the rows entered but many of the fields still empty, so for now those photographs are pictures without their words.

That gap is the whole job. It is what the grant was for. It is what the volunteers are for. Every notebook page any of us transcribed makes a few more photographs joinable, forever.

I want to be precise about why that is worth anyone's morning, because "digitizing an archive" sounds like filing, and it is not filing.

A photograph without its number is a pretty picture of a plant. It might be one of two hundred similar species. You cannot publish from it, you cannot compare with it, and you certainly cannot use it to answer a question about how that plant got to that island. The same photograph with its number attached becomes evidence. It has a date, a place, an elevation, a named collector, and a written description of what the plant was doing when it was found. It can be lined up beside a specimen collected by somebody else in 1890 and a specimen collected by somebody else in 2019, and now three people across a hundred and thirty years are working on the same question together.

That is the difference a transcribed line makes. It is the difference between a picture and a fact.

Somebody has to sit down and make that difference, one line at a time, and nobody is going to be famous for it.

The work is not finished

I want to end this chapter where the archive actually is, which is in the middle.

The boxes are still being moved. The photographs are still being tagged, one at a time, by people at screens. The training milestones for the current round of workers run into 2026. There are still notebook pages that nobody has read since the man who wrote them.

A row from the picture inventory: an image file, and beside it Carlquist's own caption, transcribed. Six thousand six hundred and sixty-five such rows are ready to view today. (Plate to come from the Sherwin Carlquist Collection.)

That is not a failure. That is what a serious effort looks like from the inside at any given moment. Nobody is going to finish this collection in a burst of inspiration. It will be finished the way the hallway is walked, one saltine box at a time, by strangers, most of whom will never be thanked by name.

So the picture I would like to leave you with is not a treasure discovered. It is a cart in a hallway with a few boxes on it, waiting for tomorrow morning, and somewhere in Texas or California or wherever the next volunteer happens to live, a person who will log in after breakfast and pick up at the page where somebody else stopped.

Island Dreams and Evolutionary Wonders

✦

By the time I had been at this for a year, I could read most of his handwriting at something like a normal pace. And that is when the real surprise arrived, because I stopped fighting the letters and started noticing the sentences.

A field notebook is not a diary. There is no reflection in it, no weather report unless the weather matters to a plant, no mention of whether he was lonely or tired or glad. It is a list. Number, name, place, height, color, condition, and on to the next. Fifteen thousand nine hundred and fifty times.

And yet, if you read enough of them, something comes through the list. He is not simply cataloguing. He is arguing with the landscape. Every entry is a small answer to a question he is carrying around, and the question, in one form or another, for fifty years, was this: how did you get here, and what happened to you after you arrived?

That question turns out to be one of the great questions in biology. This chapter is about what he found, told as well as a retired formulator with a dictionary can tell it. I had to look most of it up. That is part of why I want to explain it to you, because I remember exactly how it felt not to know.

Two thousand miles of nothing

Start with Hawaii, because Hawaii is where his thinking started.

The Hawaiian Islands are the most isolated group of islands on Earth. From the nearest continent it is somewhere over two thousand miles of open Pacific. They are young, geologically speaking. They rose out of the sea floor as volcanoes, sterile, black, and empty. There has never been a land bridge. There never was a time you could have walked there.

And yet when the first people arrived, those islands were covered in plants, and something like ninety percent of them grew nowhere else in the world.

That is a genuine puzzle, and when Carlquist began his career it was not settled. Some serious scientists believed there must once have been land connections, ancient continents now sunk, highways of dry land that let plants and animals simply walk and spread. It is an appealing idea. It is also, we now know, wrong.

The alternative sounds almost silly when you first hear it, which is why it took a great deal of evidence to make it respectable. The alternative is that they arrived one at a time, by luck, across the open ocean.

Think about what that actually requires. A seed has to leave one place, cross two thousand miles of salt water, arrive alive on a bare volcanic island, land somewhere it can grow, and then, in most cases, manage to reproduce with no partner of its own kind anywhere within two thousand miles. The odds against any particular seed are enormous. But the ocean has been there for millions of years, and enormous odds and enormous time are two different things. If a successful arrival happens once every twenty or thirty thousand years, the islands fill.

How do they cross? Three ways, mostly. Some ride the wind: spores and dust-fine seeds get lifted into high air currents and come down wherever the air lets them go. Some ride the sea: fruits with air pockets and waterproof coats float for weeks and stay alive. And a great many ride the birds. A migrating bird eats a fruit in one place and passes the seed, undamaged, days later in another. Or a seed with a hook or a coat of mud sticks to feathers or feet and travels for free.

Botanists call this **long-distance dispersal**, and Carlquist made it his life's theme. He examined the seeds and fruits of Hawaiian plants and asked, of each one, which method it must have used, and whether its nearest relatives elsewhere in the world had the same equipment. He assembled the case one plant at a time until the sunken-continent explanation was no longer needed. His book *Island Biology*, published in 1974, is the summary of that argument, and it changed how his field thought about islands.

He never stopped thinking in these terms. There is a line in one of his notebooks, written about a plant on a perfectly ordinary continental hillside, that made me smile when I finally decoded it, because you can hear a man who has spent his life on one idea seeing it everywhere:

> *a good example that long-distance dispersal works within a continent*

Even at home, he was watching seeds travel.

What I admire about the way he made the argument is that it is not a clever theory. It is bookkeeping. If a plant crossed the ocean on the wind, its seeds should be small and light, and its nearest relatives should be plants with small light seeds. If it floated, the fruit should be buoyant and able to survive weeks in salt water, and somebody should be able to test that in a tank,

which people did. If it came on a bird, it should have a hook or a sticky coat or a fruit that a bird would eat, and its relatives elsewhere should be plants that birds carry.

So for each Hawaiian plant group he asked which method the equipment implied, and then checked whether the answer was consistent with where its relatives lived. Do that a few times and you have an anecdote. Do it for the whole flora, plant family by plant family, for years, and you have an argument that a sunken continent is not needed to explain anything.

There is a lesson in that which has nothing to do with botany. The sunken-continent idea was more exciting. It had lost worlds in it. The dispersal explanation is a long list of small verifiable questions about seed coats. The unexciting one turned out to be true, and the only way anyone could show it was by being willing to do the boring version of the work for a very long time.

One arrival, many descendants

Now for the second half of the puzzle, which is what happens after the seed lands.

Picture that island again: young, bare, and empty. In a mature place like a continent, every possible way of making a living has already been taken. There is something eating every kind of leaf, something growing in every kind of soil, something occupying every layer from the forest floor to the canopy. A newcomer has to fight for a foothold.

On a new island, nobody is there. All the ways of making a living are vacant. And the one lucky founder that arrives and survives has all of them available to its descendants.

So over a long enough time, the descendants of that single arrival begin to differ from one another. Some end up in the wet forest and grow tall and soft-leaved. Some end up on dry lava and

grow small and tough. Some become shrubs, some become vines, some become something that looks like a small tree. Given enough generations of this, one ancestor has become many species, each shaped for a different life, all of them found nowhere else on Earth.

That process is called **adaptive radiation**, and Hawaii has one of the finest examples anywhere. Carlquist spent years on it.

The star of it is a group of plants called the silversword alliance. On the high volcanic summits of Maui and the Big Island, on ground that is essentially bare cinder, in thin cold air, there grows a plant that looks like nothing else in the world: a perfect sphere of narrow, sword-shaped leaves, coated in silver hairs so dense the whole plant shines. The Hawaiians call it ʻāhinahina, the gray-gray. It sits there, slowly, for years and years. Then, once, it sends up a flowering stalk taller than a person, blooms, sets seed, and dies.

His notebook, characteristically, gives it two dozen words:

to 6 feet, misty rain much of time

This is where the key I described in the last chapter stops being an idea and becomes something you can hold.

That line has a number beside it. The number is on a slide in a box in Fort Worth, and it is on a pressed specimen in a cabinet. So the silversword is not just a sentence in a dead man's handwriting. It is a sentence, plus his photograph of the actual plant on the actual mountain that morning, plus the dried plant itself, which a botanist can still put under a microscope today. Three records of one plant, made by one man on one day, scattered for fifty years into three different kinds of storage, and pulled back together by a number written in pencil.

His words, his photo, his plant.

A silversword on the summit cinder of Haleakalā, and the notebook line that names it. (Plate to come from the Sherwin Carlquist Collection.)

Once I understood that, my own job looked different again. Every line I typed correctly was not just a line. It was a set of keys, handed back to whoever wanted to open those other two boxes.

Here is what makes it more than a strange plant. The silversword's closest relatives are not other silver mountain plants. They are ordinary, unglamorous, yellow-flowered California plants called tarweeds, the kind that grow along roadsides and dry hills on the mainland. A tarweed ancestor made the crossing, long ago, probably as a sticky seed on a bird. Its descendants, over millions of years, became the silverswords on the summits, and also the *Dubautia*, which are shrubs and trees and even vines spread across wet forest and dry scrub at every elevation of the islands.

One arrival. Dozens of descendant species. Almost every kind of life a plant can lead, all of them cousins.

The same story runs through the Hawaiian lobeliads, a group whose names fill page after page of his notebooks: *Clermontia*, *Cyanea*, *Trematolobelia*, *Rollandia*. It is one of the largest such radiations known in plants anywhere, and much of it is now rare or gone.

I want to note something here that I will come back to at the end of this book. Carlquist's very first field notebook, from 1951, when he was twenty-one years old, is largely about tarweeds. Ordinary yellow California roadside plants. He was still working on their island cousins half a century later. But that is a story for the last chapter.

There is one more thing to say about islands, and it is the sad half. A radiation like the lobeliads takes millions of years to build

and can be dismantled in a century or two. Island plants evolve without the pressures a continent applies. They lose defenses they no longer need. They exist in small numbers on small areas. And then goats arrive, or pigs, or a weed from somewhere else that grows faster, and a lineage that spent five million years becoming itself is gone in a few decades.

A great many of the plants in these notebooks are now rare, and some of what he collected cannot be collected again. That is not a sentimental point. It is a practical one, and it is the reason people are still working through those pages today. Sometimes his entry, with its date and its elevation and its plain description of how common the plant was on that slope, is the best record anyone has of a population that no longer exists.

He was writing a census without knowing that some of it would become a memorial.

Reading a plant's life in its wood

I should mention the other half of his scientific life, because it ran alongside the islands the whole way and it explains a great many of the entries that puzzled me at first.

All over the notebooks, attached to ordinary-looking specimens, are little notes about keeping a piece of the stem. A sample kept. A voucher for research in wood anatomy. Something to be pickled, which turns out to mean preserved in fluid rather than dried, so the soft tissue survives. For a long time I did not understand why a man interested in island plants kept sawing off bits of twig in the Australian desert.

Here is why. If you cut a stem thin enough to see through and put it under a microscope, you are looking at a plant's plumbing: the tiny tubes that carry water up from the roots. Those tubes vary. Some plants have wide ones, which move a lot of water

quickly and are wonderful until a drought comes, when a wide tube is prone to filling with an air bubble and failing. Some have narrow ones, which are slower but far safer. There are patterns in how the tubes are grouped, how thick the surrounding fibers are, how the whole structure is arranged.

And those patterns are not random. They record the conditions the plant evolved to survive. A botanist who knows what to look for can slice a twig and tell you a good deal about the climate that shaped it.

That field is called **wood anatomy**, and Carlquist became one of its leading figures. His *Comparative Wood Anatomy*, published in 1988, gathered a career of it. It is also, quietly, an island argument: island plants often show wood patterns you do not see in their mainland relatives, because the island rewrote the rules they were living under.

So the man crouching in a dry Australian scrub with a saw is doing the same work as the man on the Hawaiian summit. He is asking a plant what happened to it.

Plants that do impossible things

I said this chapter would have wonder in it, and here is where I keep the promise. Because along the way, in the places his work took him, he kept meeting plants that a person simply does not believe until they are shown.

Some of the plants he could not stop photographing. You do not quite believe them until you are shown.

Consider a leaf that has stopped being a leaf and become a trap.

On the slopes of Mount Kinabalu, in Borneo, grow the pitcher plants. The giants of the group live in a band of cool, wet mountain forest a few thousand feet below the summit, and Carlquist worked his way up through them. A pitcher plant grows an ordinary leaf, and then at the tip of that leaf it grows something else: a jug. The jug has a slippery waxy rim, a lid, a pool of liquid at the bottom, and a sweet smell. An insect comes for the smell, loses its footing on the rim, falls in, cannot climb the slick walls, and is slowly digested.

Why would a plant do such a thing? Because the soil there is poor. Mountain soils, leached by constant rain, hold very little nitrogen, and nitrogen is what a plant needs to make proteins.

Roots cannot get it out of that ground. So these plants get it from animals instead. They are not monsters. They are plants solving a soil problem with the only nitrogen available, which happens to be walking around on six legs.

Kinabalu has the giants of the family. *Nepenthes rajah*, with the largest pitchers of any species, big enough to hold a couple of litres of fluid. *Nepenthes villosa*, and *Nepenthes lowii*, and a natural hybrid between two of them that his notebook records in his usual shorthand as Rajah crossed with Villosa. They are, in person, apparently astonishing. You read about them for years and then you see a photograph and understand why he climbed.

The strangest part came out only recently, and it is the opposite of the monster story. The largest of these giants, including the rajah and the lowii in his notebook, do not mainly eat animals at all. A small tree shrew, or on the highest ground a mountain rat, climbs up to lick a sweet secretion from under the lid, and while it feeds it leaves its droppings in the bowl. The plant is not a trap for the shrew. It is a toilet for it, and the droppings are the fertilizer. The pitcher is shaped and spaced to fit the animal exactly. The soil would not give up its nitrogen, so the plant went and found a partner who would.

A giant pitcher plant of Mount Kinabalu: a leaf remade into a trap. (Plate to come from the Sherwin Carlquist Collection.)

Then there is the flower that gave me the strangest afternoon of the whole project.

In the same Borneo notebook, a specimen number and a name: *Rafflesia*. I did not know what that was. I looked it up, and then I sat back from my desk.

Rafflesia holds the record for the largest single flower on Earth. A full-grown bloom can be close to a meter across, thick and rubbery, mottled red and cream. It smells of rotting meat,

which is not an accident; the smell brings carrion flies, and the flies do the pollinating. And here is the part that took me a moment to accept: the plant has no leaves. No stem. No roots. Nothing green anywhere, no ability to feed itself at all. For most of its life it exists only as threads growing inside the tissue of a jungle vine, stealing what it needs, invisible. Then, once, it pushes a bud out through the vine's bark, and the bud swells for months, and opens into that enormous flower, and rots away within a week.

Rafflesia in Borneo: the largest single flower on Earth, and a parasite with no leaves at all. (Plate to come from the Sherwin Carlquist Collection.)

I should add one caution, because I got it wrong myself at first and had to correct my own notes. *Rafflesia* holds the record for the largest single flower. It is not the tallest bloom in the world; that title belongs to a different plant, the titan arum, whose towering structure is really a dense cluster of many small flowers rather than one. Both smell terrible, and for the same reason, which is probably why I confused them.

He collected odd, parasitic, difficult plants all his life. *Cassytha*, a leafless vine that lives off other shrubs. *Hydnora*, which spends nearly its whole existence underground. A desert parasite in the American southwest that the local people called sand food. There is a pattern to what draws a mind, and his was drawn to plants that had abandoned the ordinary way of being a plant and found some other way to live.

And in Western Australia, there are the trigger plants, which botanists call *Stylidium*: small, innocent-looking flowers with a column that is under tension, like a set mousetrap. An insect lands, touches the trigger, and the column swings over in a fraction of a second and slaps a load of pollen onto its back.

Carlquist filmed them doing it, which is a story that belongs in the next chapter, and he spent years working out how they do it, which is a story for later still.

Islands that are not in the sea

The idea I have found most useful from all of this, the one I have thought about at odd moments ever since, is that an island does not have to be surrounded by water.

An island is really just a place that is cut off. If a population cannot easily leave and outsiders cannot easily arrive, then whatever happens there happens on its own, and the results can be strange.

A mountaintop is an island. The cold alpine zone on a high peak is separated from the next high peak by miles of warm lowland that an alpine plant can no more cross than a land plant can cross the ocean. Scientists call these sky islands, and the same evolutionary logic applies.

Mount Kenya is the example that stopped me. It sits almost exactly on the equator, and it is high enough that its upper slopes are freezing every single night of the year and thawing every single day. Nothing about that combination is ordinary. And the plants that live there are correspondingly extraordinary: giant groundsels, relatives of an ordinary little daisy-family plant, that grow as thick-trunked trees. His notebook gives one of them the plain descriptor:

> *tree to 18 ft*

Beside them grow giant lobelias, tall columns of packed leaves that trap water in their centers and freeze solid overnight without dying. The same family that gives us small blue garden flowers, grown to the size of a person, on a mountain on the equator, because nothing was there to stop them.

New Guinea's alpine meadows tell a similar story. So, in another way, do the cushion plants of New Zealand. On exposed ground there, several completely unrelated plants have all arrived at the same solution: a dense, low, rock-hard dome, packed so tightly that the wind cannot get into it. They are not cousins. They came at that shape independently, because in that place, that shape is what works. Botanists call this convergence, and it is one of the most persuasive things in biology, because it shows that evolution is not simply random drift. Put similar pressures on different lineages and they will find their way to similar answers.

An island, in this sense, is a natural experiment that has already been run. You do not have to do anything except go there and read the result carefully. Which is precisely what he did, for fifty years, with a notebook.

And so, in a different way, does the place that matters most for the end of this chapter.

New Caledonia is an island in the southwest Pacific, and it is not a young volcanic island like Hawaii. Its rock is old, a fragment left over from the breakup of the ancient southern supercontinent. But the island itself spent a long stretch of its history under the sea, and when it re-emerged it came up bare. So its plants did what the Hawaiian plants did: they arrived, across water, and then had a very long time to themselves. Much of the ground they landed on is what geologists call ultramafic, or serpentine: strange soil, rich in metals like nickel that most plants find poisonous.

The result is a flora found nowhere else, holding lineages that have died out or dwindled everywhere they still have competition. Giant southern conifers, *Araucaria* and *Agathis*, the family that includes the Norfolk Island pine, stand there in more species than

anywhere on Earth. Pitcher plants grow on the metal-rich ground.

I like that this is the same story as Hawaii and not a different one. An old rock and a young rock, an ocean either way, and in both cases the plants had to cross it.

Carlquist went there in 1978. He filled a notebook.

The plainest line in the book

I want to show you one entry from that notebook, and then I want to tell you what it took me a while to understand about it.

The entry is completely ordinary. It has the same shape as thousands of others. A number, a name, a shrub, its height, the color of its fruit, a note on how common it was and at what elevation.

> *Amborella trichopodes — Fountain-shaped shrub to 20 feet … Fruits red — no flowers at this season. Quite common between 1,000–2,000 feet.*

That is it. A fountain-shaped shrub, twenty feet, red fruits, no flowers just now, fairly common on the middle slopes. He wrote it, gave it a number, and moved on to the next plant.

The Amborella entry in his own hand. (Plate to come from the Sherwin Carlquist Collection.)

Now here is what nobody on Earth knew in 1978.

Every flowering plant alive today, and there are something like three hundred thousand species of them, is descended from a common ancestor. Every rose, every oak, every blade of grass, every apple blossom, every silversword on the summit of Haleakalā, all of it, one family. For a very long time nobody could work out which living plants sat closest to the base of that family

tree, because the fossils are poor and the flowers of the earliest plants are long gone.

Then, around 1999, molecular biology got good enough to compare the DNA of plants across the whole group and build the tree from the inside out. And the answer, confirmed and reconfirmed since, was a small shrub found only in the wet forests of New Caledonia.

Amborella trichopoda is the sister of all other flowering plants. Its lineage split off before every other branch. It is the closest living relative we have to the ancestor of every flower in the world.

It was, and is, a plain shrub about twenty feet tall with red fruit, quite common between one and two thousand feet.

I want to be careful here, because it would be easy and false to make this into a story about a man discovering something. He did not discover it. He could not have. The tools that revealed what that plant was did not exist for another twenty years, and when they did, the work was done by other people in laboratories using methods he never used. He walked past the oldest branch on the flowering-plant tree and wrote it down like any other bush, because in 1978 that is exactly what it was: any other bush.

What he did do was record it honestly, and completely, and with a number, so that it could be found again.

That is the thing I did not expect this work to teach me. The plainest line in the whole notebook, the one that gave me no trouble at all, the one I typed in about forty seconds on an ordinary Tuesday, was hiding the biggest thing in the book. And there was no way for him to know, and no way for me to know, and the only reason anyone knows now is that a man in a wet forest wrote down what he saw without deciding in advance which parts would matter.

There is a detail I find almost funny, and I mean that with affection. His entry spells the name trichopodes. The accepted spelling is *trichopoda*. That is the kind of small slip a man makes writing fast in a wet forest, and under the rules I described earlier I was not permitted to correct it. So the archive now holds, in a transcription I typed myself, a slightly misspelled name for the most evolutionarily significant plant in the collection.

I like that more than I can justify. It is the sound of an ordinary working day.

The sequel, for anyone who wants it: in 2013 a large team published the complete genome of *Amborella trichopoda*, because if you want to understand what the first flowering plants were like, this is the closest living thing to ask. There are laboratories on several continents that keep it growing. It has become one of the most studied plants on Earth.

None of that was visible from the roadside in 1978. What was visible was a fountain-shaped shrub with red fruit, and a man who wrote it down.

I have thought about that a great deal since. I will come back to it at the end.

What the notes were really for

So this is what the list is, when you have read enough of it.

Number 15559 is a shrub in New Caledonia. Number 1136 is a small tree in Tasmania. Somewhere in the Hawaiian notebooks is a silver rosette on a volcano, and in the Borneo ones a jug that eats insects and a flower that smells of death, and on a mountain in Kenya a groundsel grown into a tree. Each of them is four lines of fast handwriting and a number.

And running underneath all of it, page after page, decade after decade, is one man's answer to one question: how did you get

here, and what happened to you after you arrived. The seeds crossed the water. The descendants split and took up every available life. The isolated places, whether they are in the sea or on a peak or on a strange metal soil, run the experiment where you can see it.

He could read that story off a hillside. I find that more impressive than any single discovery, because a discovery is a moment and this was a way of seeing that he carried every day for fifty years.

I should admit what all of this did to me personally, since I have been claiming that a person can learn from these notebooks and it would be poor manners not to report my own case.

I trained in pharmacy, in a tradition that begins with plants and then leaves them behind for the molecule. For most of my working life a plant was a source of a compound. I could not have told you why there are so many species of anything, or what an island had to do with it.

Now, when I walk in the mornings, I look at the ordinary weeds along the sidewalk in Arlington and I find myself asking his question without meaning to. How did you get here. What happened to you after you arrived. There is a plant near the corner with a seed that sticks to my shoe, and I know exactly what that seed is doing, and I know that it is a strategy millions of years old and that it works so well it once populated an ocean's worth of islands.

That is what a good scientist actually leaves behind. Not only the findings. A way of looking that other people can pick up and use, long after he is gone, on plants he never saw, by a road he never walked.

The Artist-Scientist

✦

There is a question I did not think to ask for most of my first year, and once I asked it the whole collection changed shape for me.

How do we know what he saw?

He wrote four lines about a shrub in a wet forest in New Caledonia. Four lines is not very much. It gives the height and the color of the fruit and the elevation, and then he is gone up the road to the next plant. If those four lines were all that survived, we would have his conclusion and none of his evidence.

But they are not all that survived. Because almost every time Sherwin Carlquist wrote down a plant, he also photographed it.

The number, when I first came across it, seemed like a mistake in the spreadsheet. The collection at BRIT holds something on the order of **a hundred and twenty-five thousand catalogued images**.

That is not a man who took pictures of his fieldwork. That is a man for whom photography was half the work.

A hundred and twenty-five thousand times

Let me try to give that number a shape, because I have found that numbers this size go straight through a person without touching anything.

Most of it is color transparencies, the kind of small square slide you hold up to a window or drop into a projector. There are tens of thousands of black and white negatives as well. The frames come in three sizes: a great many small four-centimeter squares, a large body of six-by-six centimeter medium format, and some thousands of ordinary thirty-five millimeter.

A note for anyone who has only ever taken photographs with a telephone. A positive, which is what a slide is, shows you the true colors directly when light passes through it. A negative reverses everything, light for dark and color for its opposite, and has to be printed before a human can read it. He shot enormous quantities of both, and developed a great deal of it himself.

I would like you to hold the physical reality of this for a moment. Every one of those images had to be composed, exposed, carried home undeveloped through customs and heat and humidity, processed, mounted, labeled, and filed. There was no reviewing the shot on a screen. You did not know whether you had it until weeks later, often after you had left the continent where the plant was growing.

So he shot generously, and he shot carefully, and he wrote the numbers down.

I want to put one more frame around the number, because a hundred and twenty-five thousand is easy to say and hard to feel.

Suppose you decided to look at all of them. Give each image five seconds, which is barely enough to register what it shows and nowhere near enough to read a label. Work eight hours a day at it

without a break, five days a week. You would be at it for well over a month, doing nothing else, just watching his pictures go by. Give each one half a minute, long enough to actually see it, and you are into your sixth month.

That is one man's supply of looking. And he did not merely take them; he kept them in order, in numbered boxes, cross-referenced to the notebooks, for half a century, through moves between institutions and the ordinary chaos of a life.

I have worked in laboratories where keeping six months of data tidy was considered an achievement.

There is a line in the South African notebooks, attached to a strange parasitic plant called *Hydnora africana* that spends nearly its whole life underground, that told me more about his working method than any essay could:

> *For other details, refer to my photographs.*

Read that as a scientist. He is not saying "I also took some pictures." He is saying: the written description is the summary, and the photographs are the record. Go and look at those if you want to know what this plant actually was.

The notebook is the index. The pictures are the evidence.

It also explains something that had puzzled me for months at my desk. His written descriptions are often shorter than I expected from a man of his reputation, and occasionally they are almost curt. I had wondered whether he was rushing, or whether the detail simply lived in his head.

Neither. He was not writing the full description because he had already taken it, with a lens, in better detail than a sentence could manage. The brevity is not carelessness. It is division of labor between two instruments.

The weight he was willing to carry

I said a large part of the collection is medium format, and I want to explain why that matters, because it is the detail that convinced me he was serious.

A normal film camera makes a picture about twenty-four by thirty-six millimeters. A medium-format camera like a Hasselblad makes a square negative six centimeters on each side. That is a much larger piece of film, and the difference is not subtle: with that much surface, you can enlarge the image a great deal and still see fine detail. The hairs on a leaf. The texture of a seed coat. The individual scales on a fern frond.

The cost is that the camera is heavy, the lenses are heavy, and a roll gives you around a dozen exposures before you have to reload.

Now picture carrying that up Mount Kinabalu, or across a desert, or onto a subantarctic island, along with the plant press, the specimen bags, the notebook, and the food. Twelve frames at a time, and every frame chosen.

I am not a photographer. But even I can see what that trade tells you. He wanted the detail badly enough to carry the weight for fifty years.

I have seen a photograph of his kit laid out for the record, the lenses in a row with a ruler beside them for scale, the way you would document any set of instruments. It is not a small amount of glass. Lenses of different lengths for different distances, and the close-up gear for the work at a hand's width from a flower. Each piece is weight, and each one is a decision made in advance about what he might need that day and what he was willing to carry to have it.

His cameras and lenses, laid out and measured. Every one of them is weight somebody carried up a mountain, chosen against the plants he expected to meet.

And he planned the pictures the way he planned everything, in writing, in the notebook, to himself. On one page, in among the specimen entries, there is a small list he set down under a heading addressed to his own future self: photos at night. A reminder, written in advance, of the shots that could only be made after dark, when the light would be his to arrange instead of the sun's. It is the same second-person habit as the rest of the notebook. He was briefing the man he would be that evening on what not to forget.

And the care extended past the exposure. The collection contains glass-plate positives, slides in metal mounts, prints he made himself. As a young man, too poor to afford anything else, he is said to have spent a Christmas holiday sleeping on the floor of a herbarium darkroom so he could keep working. That story

may be polished by retelling, but the collection makes it easy to believe.

His photographic vocabulary is baked so deeply into his science that it turns up as shorthand in the botany. In the notebooks he writes UCU for an ultra close-up, CU for a close-up, and OCU for a variant of his own. Those abbreviations sit in the middle of ordinary specimen entries as though they were measurements, which, in his mind, they were:

> *Photographed at K'bosch Nov 2 — OCU's plus sunlight close-ups of Sorocephalus 4924, Protea convexa 4922.*

K'bosch is Kirstenbosch, the great botanical garden under Table Mountain. That is a man scheduling his light.

There is also a stray note in the collection, not from a notebook at all, that I found oddly moving. It is a message he left for somebody at an exhibit, arranging to come and photograph plants before the display was taken apart:

> *I can't be here at 4PM — it may be 6PM or later before I can get here to collect plants from the exhibit for photographing. If you wish to break the exhibit down before then, could you save for me…*

A man rearranging his evening around the chance to photograph a plant properly. That is the whole personality in three sentences.

There is a practical reason the photographs matter so much in botany, and it took me a while to appreciate it.

When a botanist collects a plant, the specimen gets pressed flat and dried. That is the standard method and it works: a well-pressed specimen lasts centuries, and herbarium cabinets around the world are full of plants collected in the seventeen hundreds that are still perfectly usable.

But pressing costs you things. It costs you color, almost entirely. A brilliant red fruit turns brown. It costs you three-dimensional shape, which for something like a pitcher plant is most of the point. It costs you the way the plant actually sat on the ground, whether it sprawled or stood, whether it grew alone or in a mat. And it costs you the whole living context: the light it grew in, the rock it grew on, the insect that was visiting when he arrived.

A photograph keeps exactly the things a press destroys.

So the two methods together are much stronger than either alone, and he knew it, which is why the same number goes on both. The dried specimen preserves the anatomy you can dissect. The photograph preserves the plant as an organism in a place. Neither is the record. The pair is the record.

This is the sort of thing that seems obvious once said and was not at all obvious to me, coming from a discipline where a compound is a compound wherever you find it.

A medium-format frame from Tenerife, 1967: the giant bugloss on the slopes of El Teide. (Plate to come from the Sherwin Carlquist Collection.)

The thing a photograph cannot hold

Now the part that stopped me, when I finally understood what I was reading.

In Western Australia grow the trigger plants, which I mentioned in the last chapter: the small flowers with a column held under tension, which fires when an insect lands and slaps pollen onto its back. The motion takes a fraction of a second. It is, by all accounts, too fast for a person to be sure of what they saw.

A still photograph cannot record it. You can photograph the column cocked, and you can photograph it fired, and you have

two pictures and no answer. What is missing is exactly the part in question: how it moves, how fast, through what path, and what happens to the insect in the middle of it.

So he brought a movie camera.

In the notebooks from around Darwin in 1978, among the specimen entries, is a note that he shot movie film of one of the trigger-plant species. Four rolls. And in the archive today, in banker boxes numbered thirty-one and thirty-five and thirty-nine, there are actual reels of motion picture film.

I have not seen them. Almost nobody has. Old film needs specialist handling and transfer before it can be viewed safely, and that has not happened yet. Somewhere in those boxes there is very probably a few seconds of a flower firing, filmed in the field in the tropics almost fifty years ago, by a man who wanted to see the motion badly enough to carry a second camera.

A single frame of a trigger plant firing, from his own motion film. (Frame to come; the film survives in the collection.)

I keep thinking about the decision behind those four rolls. He did not need a movie camera to publish a paper. He needed it to actually see the thing. The tool followed the question, which is the correct order and much rarer than it sounds.

I recognized something of my own working life in that, and it is the reason this chapter is the one I felt most at home in.

I am not a photographer the way he was. But I have carried a camera on enough mornings to know a little of what he was after.

In formulation work you spend a great deal of time trying to observe a process that will not hold still to be observed. A drug releasing from a particle over hours. A film forming as a coating dries. You cannot simply look; the event is too slow, or too fast, or happening inside something opaque. So a large part of the job is inventing a way to see it: sampling at intervals, staining something so it shows up, finding an instrument that responds to the thing you care about.

Anyone who has done that kind of work will recognize a man carrying a movie camera into the tropics for a flower that moves too fast. He was not being thorough. He was being blocked, and he found a way around the block.

The difference between a good scientist and a merely competent one is very often just this. The competent one reports

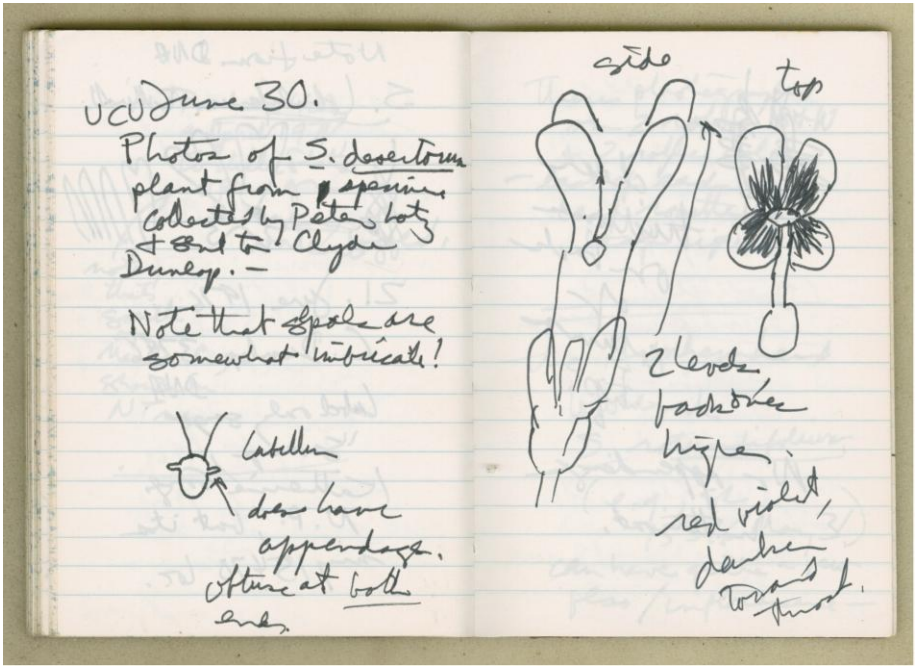
that the thing could not be observed. The good one goes and gets a different camera.

Not a chisel, a pencil

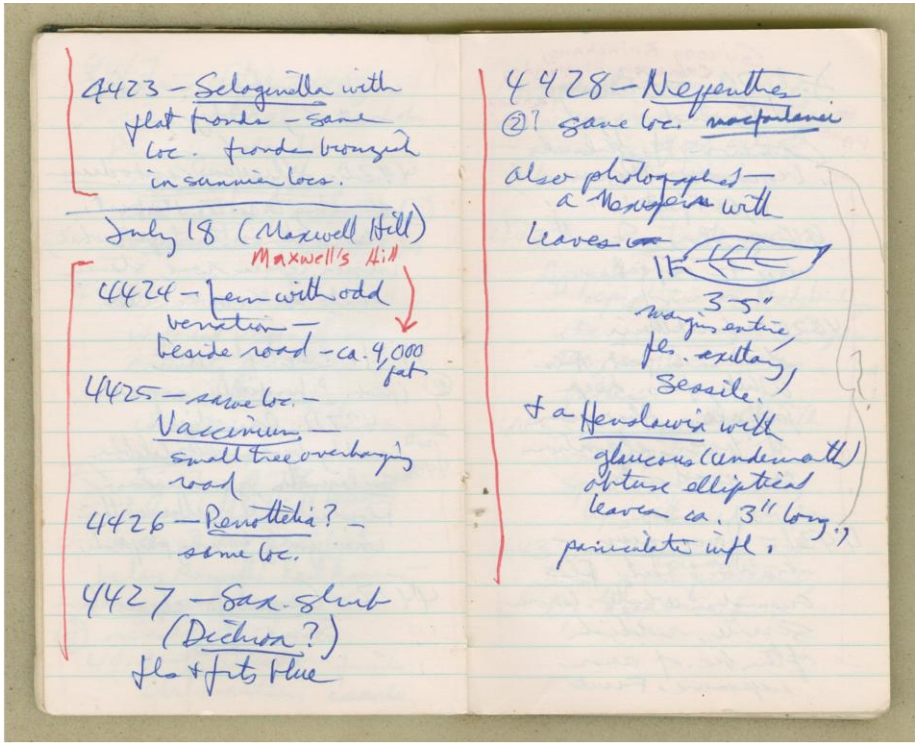
There is one more instrument in his hands, and it is the one I did not expect.

He drew.

All through the notebooks, wherever words were slower than a line would be, there is a small quick sketch: a flower shown from the side and then from the top, a leaf with its veins and its measurements, a fern frond, the toothed rim of a moss capsule, the odd little appendage on a seed, the cross-section of a five-angled fruit.



Side and top, the throat hatched in, and a note on the color beside it. A few sure lines and the thing is explained.



Where a drawing said it faster than a sentence, he drew.

These are not decorative. Look at what the sketch does that the sentence cannot: it holds shape and proportion and the relationship between parts, all at once, in the time it takes to write two words.

And here is the connection that took me a year of reading his handwriting to see.

The thing that makes his cursive so hard to read is speed. The letters run together because the hand is moving fast, keeping up with a mind that has already gone on to the next observation. That same fast hand, given a pencil and a shape instead of a word, produces a drawing that is quick and sure and correct.

It is one instrument doing two jobs. The fluency that cost me hundreds of hours is the same fluency that made these little drawings possible. I spent a long time thinking of his hand as an

obstacle. It was never an obstacle. It was an unusually good hand, being used at full speed.

He also drew maps. There are hand-drawn distribution maps in the back pages of some notebooks, showing where a species had been found, dot by dot across a region. And in the slide collection there are photographs of his own drawings and maps, which means at some point he set a drawing on a table, lit it, and photographed it, so that a diagram could travel in the same box as the plants.

Those maps deserve a moment, because of what making one actually involves.

Today you would type coordinates into a computer and the dots would appear. He had a pen, a base map, and his own accumulated records, and every dot on the page is a place he or somebody else physically stood with a plant in hand. The map is drawn from the notebooks. It is his own five years or fifteen years of walking, compressed onto one page, so that he could look at the shape of the whole distribution at once and ask why it stops where it stops.

That is what a scientist is doing when they make a picture of their data. They are trying to see a pattern that no single observation contains. He had to make his by hand, at a desk, at the back of the notebook, at the end of a season.

I found several of those pages while transcribing, and they were among the few times I stopped and simply looked instead of reading. There is nothing to transcribe on a map. It is just a man's summary of where a plant lives, drawn carefully, in a notebook that cost him almost nothing.

The whole living scene

If you go through the picture inventory expecting only plants, you will be surprised, and this surprise is the one I would most like to pass along.

He photographed a black swan. A walking-stick insect. A thorny devil, which is a small spiny Australian lizard that looks like something invented for a children's book. Honeyeaters and sunbirds at flowers. In one caption, a cheerful list: cockroach, frog, jewel bugs, stream and landscape.

At first I read this as a scientist relaxing, taking holiday snapshots between the real work.

I no longer think that is what it is. Consider the sunbird at the flower. A sunbird at a flower is not a bird photograph. It is the pollination photograph. It is the answer to the question of how that plant's pollen gets from one individual to another across a valley, which is one of the central questions of island biology, because a plant that arrives on an island without its pollinator has a serious problem.

The lizard, the insects, the stream, the landscape: these are the plant's world. A botanist who photographs only the plant has recorded an object. A botanist who photographs the plant's visitors, its neighbors, its weather and its ground has recorded a life.

A sunbird at a flower: not a bird photograph, a pollination photograph. (Plate to come from the Sherwin Carlquist Collection.)

He photographed carvings in New Zealand, and paper maps, and landscapes from aeroplane windows. He had a traveler's eye as well as a scientist's, and I do not think the two were separable

in him. The habit was simply to look, and then to make a record of having looked.

There is a category of his subjects that a young reader will enjoy knowing about, because it shows a definite personal taste rather than a survey.

He was drawn, over and over, to plants that do something. Sundews, whose leaves are covered in sticky red-tipped hairs that curl slowly around a trapped insect. Bladderworts, which carry tiny underwater traps that suck in prey faster than the eye can follow. Pitcher plants. Trigger plants. Parasites of every description, including the one the desert peoples of the American southwest called sand food, which grows almost entirely buried with a single fleshy head at the surface.

You could work a whole career in botany without photographing any of these. Most plants stand still and photosynthesize and are, to be honest, not visually dramatic. He kept finding the ones that move, trap, cheat, or steal.

I think there is something in that beyond taste. The plants that do something odd are the plants whose problems are visible. A sundew makes the nitrogen problem legible; you can see the solution happening. A parasite makes the cost of independence legible by having abandoned it. If you are a man trying to understand what pressures shape a plant, the dramatic species are not entertainment. They are the cases where the pressure has left a mark you can photograph.

The photograph is half the record

I explained a key two chapters ago: every plant he collected got a number, and that same number rode along onto every slide he shot of it.

At the time I described it as a system, which is accurate and slightly bloodless. Standing in the middle of this chapter, I can put it better.

The number means that the four dry lines in the notebook and the photograph of the living plant are the same document. Neither is complete. The words tell you what he understood; the picture tells you what he was looking at when he understood it. Put them together and, seventy years later, you can stand approximately where he stood.

The three records of one plant, side by side: the line in his hand, the frame he shot, and the pressed specimen. (Composite plate to come.)

His words, his photo, his plant. The photograph is not an illustration of the record. It is half of it.

As small as it goes

The last instrument is the one that shows how far he was willing to push.

In the collection there are sixteen frames labeled as electron microscope images of a plant called *Balanops*.

A scanning electron microscope does not use light. It sweeps a very fine beam of electrons across the surface of a specimen and builds a picture from what comes back. Because electrons behave differently from light, it can resolve things far too small for any ordinary microscope: the sculpted surface of a single pollen grain, the breathing pores on the underside of a leaf, the texture of a seed coat at a scale where a human hair would be a fallen tree.

So follow the line of his attention. The naked eye on a hillside in Western Australia. The close-up lens, a hand's width from a flower. The medium-format camera, carried up a mountain for the sake of detail. The movie camera, brought out for a motion

too fast to see. And the electron beam, resolving a surface too small for any ordinary microscope to reach.

That is one continuous reach, a single question asked at five magnifications: what is actually there, and how would I know?

Sixteen frames of a single Balanops *specimen under the electron beam, the far end of his reach. (Plate to come from the Sherwin Carlquist Collection.)*

Sixteen frames of one thing, at that magnification, is not idle curiosity either. At that scale you are seeing a surface no human eye has ever directly seen, and one image can mislead you badly, because you cannot tell an artifact of the preparation from a real feature. Sixteen frames is a man checking.

The care is identical at every scale. Twelve exposures of a hillside, four rolls of a moving flower, sixteen frames of a single specimen under the beam. It is the same person, doing the same thing, with progressively stranger equipment.

I have known plenty of good scientists. What I recognize in this collection is something slightly different from intelligence, and rarer. He did not trust himself to remember, so he wrote it down. He did not trust the writing to be enough, so he photographed it. He did not trust the photograph to hold the motion, so he filmed it. He did not trust his eye to reach the surface texture, so he put it under an electron beam.

Every instrument in this chapter is a way of not fooling himself.

I want to say one plain thing about the word artist, since it is in the title of this chapter and I have been circling it.

I do not think he was a scientist who happened to have an artistic hobby. That framing is too tidy and it is the wrong way round. The photographs are not beside the science. They are the

science, done with a lens instead of a pen, and the drawings are the science done with a pencil, and the film is the science done at twenty-four frames a second.

What we call art and what we call science overlap almost completely at the point where both of them mean: look at the actual thing, carefully, for longer than is comfortable, and then make an honest record of what is there.

He was very good at that. He was good at it with words, and better at it with a camera, and he did it for fifty years without anyone standing over him making him do it. Nobody checks whether you photographed the sunbird. Nobody knows if you skipped the awkward frame or did not bother with the drawing. Those choices happen alone, in the field, and they are the whole difference between a record somebody can use in seventy years and a record that is merely adequate.

The evidence that he made the harder choice, over and over, is sitting in fifty-two boxes in Fort Worth.

And every one of those hundred and twenty-five thousand frames had to be made somewhere. Not in a studio. On a mountain, in a swamp, on a reef, in a desert, at the end of a road that ran out.

There is a photograph I have never seen and think about anyway. Somewhere in those boxes is the first frame of the first roll he ever shot in the field, of some plant on some California hillside in the early nineteen fifties, taken by a young man who had no idea he was starting anything.

Footprints Across Remote Lands

✦

Every one of those photographs had to be taken somewhere.

That sounds like an obvious remark, and I made it to myself in an obvious way, sitting at my desk one morning with a page of Western Australian specimens in front of me. Then I looked at the page again and the obvious remark turned into something else. This entry was written by a man kneeling on sand nine thousand miles from where I was sitting. The one below it was written the same afternoon, a few miles further along a track that may not exist any more. He had walked there, in the heat, carrying a plant press and a heavy camera, and he had stopped and written this down, and then he had gone on.

The notebooks are not only a record of plants. They are a record of a body, moving across the world, for fifty years.

Once I started reading them that way I could not stop. The place names pile up like the board in an airport. Kalgoorlie. Nikko. Kirstenbosch. Teleki Valley. Kota Kinabalu. Melpomene Cove. Some of them I had never heard of. Some of them I had to look at three times because I could not believe a botanist had been there with a notebook.

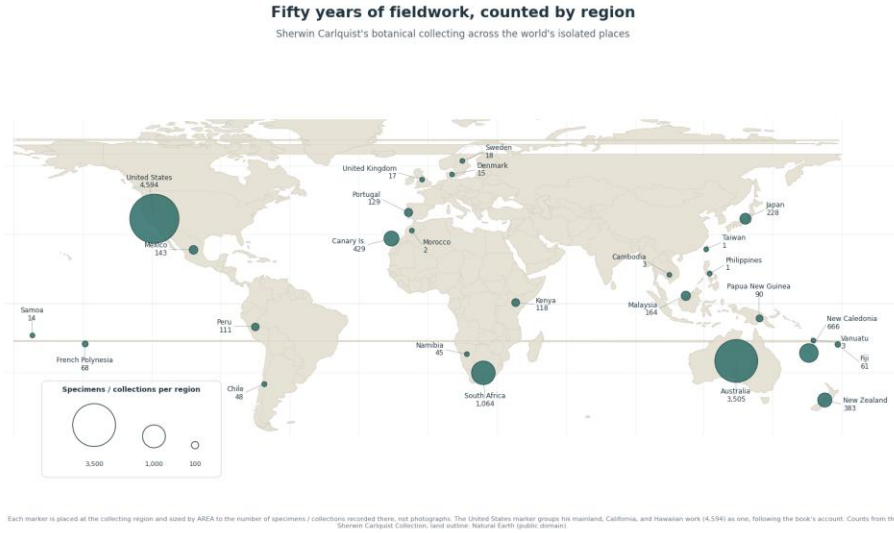
This chapter is the walking.

A life measured in place names

The collection's own records make it possible to see the shape of his fieldwork, because the pictures are counted by region and the count follows the years he spent.

Australia is the largest by a long way, something near twenty-four thousand images, with Western Australia dominating. Then the United States, around fifteen thousand, which is his California base and his Hawaiian work together. South Africa, more than nine thousand, almost all of it from a single extraordinary stretch in 1973 and 1974. Japan, over six thousand. New Caledonia, around four thousand. Malaysia, nearly three thousand, which is Borneo and the peninsula. Kenya, several hundred. New Zealand, the Canary Islands, Mexico, Fiji, Papua New Guinea, Thailand, Namibia, Puerto Rico. And Taiwan, where he worked in May of 1963, around Taipei and Sun Moon Lake.

I have made a map of all this for the book, a marker over every country he worked in, sized to how much he collected there. It counts the plants he gathered, the numbered specimens, and not the photographs, which run to many times more. But it shows the shape of a life at a glance: the great weight of it in Australia and the American west, and the small single marks, one visit each, over places like Taiwan and Morocco.

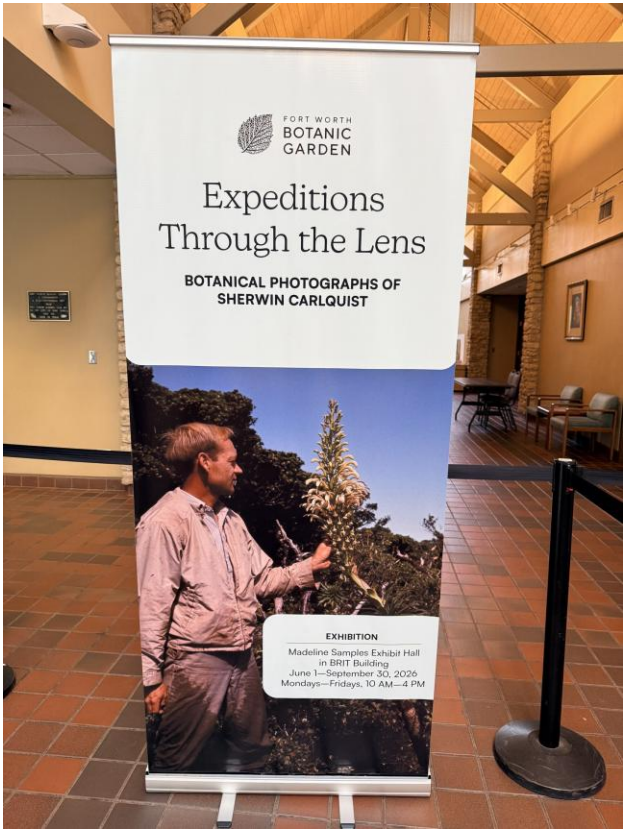


Where his numbered plants came from, counted by the specimens he collected in each place. His photographs of those places number far more. One man, fifty years, six continents.

His East Asian work is Taiwan and Japan. In Japan he was in Nikko, on Okinawa, at Mount Unzen, and out on the Bonin Islands, which are volcanic and isolated and exactly the kind of place his mind went. In June of 1982 he botanized at Hiroshima and at Nagasaki, and made no remark about it in the notebook beyond the plants, which is either restraint or simply the habit of a man whose notebook was for plants.

I have read the place names often enough now that they have stopped being a list and become a kind of weather. Anywhere isolated. Anywhere a plant might have arrived by accident and then had to make a life. Islands in the sea, islands on mountaintops, islands of strange soil in the middle of a continent. He went where the experiment had already been run.

Let me take you to five of those places, in his order, with his notebook open.



Sherwin Carlquist as a young man in the field, beside a giant lobelia. He tracked plants like this one from mountain to mountain, wherever the cold had made them strange.

Guadalupe Island, April 1958

He is twenty-eight years old.

Guadalupe is a volcanic island off the Pacific coast of Baja California, well out to sea, and in 1958 getting there meant a boat and a plan. The notebook records the trip almost hour by hour, which is unusual for him and tells you he knew it mattered.

They leave San Diego. They come in at the island and overnight near a spring. The next day he climbs Mount Augusta, up through a grove of cypress that grows nowhere else on Earth,

and works his way down a canyon full of juniper. There is a camp the party calls Lobster Camp. Later they sail around to Melpomene Cove, and out toward a rock offshore called Isolete Negro, and anchor.

Reading it, you can feel a young man having the time of his life and refusing to let it show in the prose.

What does show is the accounting. At one point he does a small piece of arithmetic in the margin: the last specimen number of the trip minus the first, which comes to fifty plants collected. He is checking his own work, the way a person does at the end of a shift.

Fifty plants. It is not a large number. But he was twenty-eight, and he had a boat and an island and a notebook, and what he was actually establishing on that trip was not a collection. It was a habit: go to the isolated place, walk up the mountain, write down everything, count it at the end.

He kept that habit for the next fifty years.

There is one more thing worth noticing about Guadalupe, and it is sad. The island's famous cypress grove and its other endemic plants had been chewed for a century by feral goats, and much of what he saw was already the remains of something larger. He was recording a flora that was in trouble. A good deal of his life's collecting turned out to be like that, though he could not always have known it at the time.

Mount Kenya, July 1967

This is the scene that made me put my coffee down.

Mount Kenya sits almost exactly on the equator. It is also seventeen thousand feet tall, which means its upper slopes do something no ordinary place does: they freeze solid every single night of the year and thaw again every single day. There is no

summer and no winter to speak of. There is only a nightly winter and a daily summer, over and over, forever.

He went up the Naro Moru Track in July of 1967 and camped at Klarwill's Hut, at nearly fourteen thousand feet, in the Teleki Valley.

Now, plants cannot leave. They cannot go inside at night. So the plants of that valley have had to solve a problem that almost nothing else in the world faces, and the solutions are so strange that the first European visitors sent home descriptions nobody believed.

His notebook, in its flat way, records them. There is a groundsel there, a relative of the small daisy-family weeds that grow in any garden, and on that mountain it has become a tree. He notes it as a shrubby tree to eighteen feet. It has a thick woolly trunk and a rosette of huge leaves at the top, and at night the plant closes those leaves over its own growing point to protect it from freezing.

Beside it grow giant lobelias, the same family as the small blue flowers people plant in window boxes, here standing as tall columns with a hollow center that fills with water. The water freezes at the surface at night and the ice acts as a blanket for the living tissue underneath.

And in the bog nearby, he writes, the ground is frozen at night.

There is one more line in that stretch that I like more than any of the botany. He notes that sunbirds, which he calls by their scientific family name, were seen visiting the flowers.

Fourteen thousand feet, on the equator, in a valley where the ground freezes every night, a man is watching which birds come to which flowers, and writing it down.

That is the sky island I described earlier, seen from the inside. The cold summit is cut off from every other cold summit by miles of warm lowland, so its plants have been evolving in isolation as surely as if they were on a rock in the middle of an ocean. Carlquist did not have to be told this. He was standing in it.

Giant groundsels and lobelias in the afroalpine zone of Mount Kenya, around fourteen thousand feet. (Plate to come from the Sherwin Carlquist Collection.)

I have tried to imagine the physical experience and I cannot really. He was thirty-seven. The air at that height holds a bit more than half the oxygen it does at sea level. He was carrying a press, a camera, and specimen bags, and sleeping in a hut, and getting up the next day to do it again.

The Cape, 1973

In August of 1973 he arrived in South Africa and stayed until December, and in those four months he did the densest collecting of his life.

The Cape has a plant community found nowhere else, called fynbos, which grows on nutrient-poor sandy soils and packs an astonishing number of species into a small area. Table Mountain alone holds more plant species than some entire countries. For a botanist interested in how plants make a living in hard conditions, it is one of the great places on Earth.

He worked Skeleton Gorge and Nursery Gorge on Table Mountain. He worked the coast around Hermanus and Rooi Els, and the reserve at Fernkloof, and the valley at Jonkershoek. He was at Kirstenbosch, the botanical garden under the mountain, often enough that it earns its own abbreviation in his shorthand.

But the reason this scene stays with me is not the plants. It is that he was not alone.

The notebooks from those months are full of other people. There are entries collected with Jon Williams and with Hugh Taylor. And there is a name that appears again and again: Elsie Esterhuysen.

I had never heard of her. I looked her up, the way I looked up everything, and found that she is something close to a legend in South African botany, a collector of extraordinary energy and skill who spent decades in those mountains and gathered a staggering number of specimens, many of them species new to science. She did not hold a senior post. She walked, and she collected, and she was very good at it.

His notebook records one specimen as collected by Elsie Esterhuysen, a new record for the Ceres Division, which is the plain administrative way of saying: she found this plant somewhere nobody had recorded it before, and here it is.

There is another entry from that season that I think about often. A plant, noted in his hand, not collected for about sixty years.

Somebody gathered that species around 1913. Nobody found it again through two world wars and everything that followed. And then on an ordinary working day in 1973, two people walking in the right gully with their eyes open picked it up again.

There is a plant that carries Elsie Esterhuysen's name, because a botanist named a species after her, and it appears in his notebook too, filed among the others without ceremony.

Fynbos on the slopes above the Cape, where four months of 1973 produced some of the densest collecting of his life. (Plate to come from the Sherwin Carlquist Collection.)

A word about what fynbos actually is, because the name will be new to most readers and the plants are worth knowing.

It is a shrubland: tough, small-leaved, often spiky, growing on sand so poor in nutrients that a farmer would despair of it. Three groups dominate. The proteas, with their huge architectural flower heads, which are what most people picture when they think of South African plants. The ericas, which are heaths, hundreds of species of them, most of them small-flowered and fine-leaved. And the restios, which look like rushes and are the group that gives fynbos its particular texture.

The whole community is adapted to burn. Many of the plants need fire to release their seed or to clear the ground for a new generation, and the cycle of burning and regrowth is not a disaster there, it is the mechanism.

This is the sort of place that rewards a man who reads wood and water. A plant living on poor sand in a summer-dry climate that periodically catches fire has solved several serious engineering problems, and the solutions are visible in its anatomy if you know how to slice it.

Which is exactly why he spent four months there and came home with more than nine thousand photographs.

What that season taught me about the work is that fieldwork is not a solitary heroic activity, whatever the photographs suggest. It is a community of careful people, most of them not famous, who know their ground and share it with visitors, and whose names survive mostly in other people's notebooks.

Hawaii, again and again

There is one destination that does not fit the pattern of a single great expedition, because he kept going back to it for more than thirty years.

His Hawaiian fieldwork runs from 1953, when he was twenty-three, through to the mid-1980s. He was there in the fifties,

several times in the sixties, again in the seventies and once more in the eighties. No other place in the collection has that shape.

The reason is that Hawaii was the question. Everything I described about long-distance dispersal and adaptive radiation, the whole argument of his working life, is an argument about how that flora came to exist. You do not settle a question like that in one visit. You go back with a new idea and check it against the plants, and then you go back again with the objection somebody raised, and check that too.

So the Hawaiian notebooks are a record of a man returning to the same islands across three decades with progressively better questions. The silverswords on the summits. The lobeliads in the wet forest, one of the largest plant radiations known anywhere. The crater rims and the lava flows and the rain-soaked ridges.

The trip that first took him there, in 1953, was paid for by his mother as a birthday present. He was a young man with an interest and no money, and somebody who loved him bought him a ticket to the place that turned out to hold his life's work.

I find that detail almost unbearably ordinary and important. A great deal of what we call a career is one person deciding to fund somebody's curiosity before there is any evidence it will amount to anything.

Western Australia, the long campaign

Before the desert crossing there is a body of work that the numbers alone would tell you about, if you looked at them: Australia is the largest region in his collection, and inside Australia it is the southwest corner that dominates.

There is a reason, and it is the same reason as always. The southwest of Western Australia is one of the great isolated floras of the world. It is cut off from the rest of the continent by desert,

it has not been glaciated or drowned, and its soils are among the oldest and poorest anywhere. Old, poor, and isolated is the recipe for extraordinary numbers of species found nowhere else, and that corner of Australia has them by the thousand.

He went in 1962 and again in a major campaign in 1967, and kept returning.

The notebooks from those trips are full of the plants that part of the world is famous for. Kangaroo paws, with their furred tubular flowers. The trigger plants, in dozens of species, which became one of the long obsessions of his career. Carnivorous plants: the Albany pitcher plant, which is not related to the Borneo pitchers at all but has arrived at the same trap independently, and the rainbow plants with their sticky glandular leaves, and sundews everywhere. He worked the Stirling Range, and Cape Le Grand on the south coast, and the strange limestone spires of the Pinnacles.

Somewhere in that country, in front of a plant in the genus *Grevillea*, this careful and unemotional man wrote:

> *amazing Grevillea!!*

Two exclamation marks. I mentioned earlier that in fifty years of notebooks I found only a couple of instances, and this is one of them. He is standing in front of something so good that the shorthand breaks down.

I have never seen the plant he was looking at. The *Grevillea* of Western Australia include some of the most elaborate flowers in the world, all curled styles and brushes of red and orange. Whatever was in front of him that day, it got through.

The hazards, recorded flatly

Field science is dangerous in ways that do not make it into papers, and his notebooks record the danger in exactly the same voice they record leaf measurements, which is what makes it funny and slightly alarming.

In Hawaii in 1967 he was working around a volcanic crater, and noted:

> *Dangerous cliffs of crater at Aloi — about to break off!*

That is a man standing on ground he has just judged to be actively unsafe, writing it down, and, one assumes, collecting the plant anyway.

In New Zealand he came to the Franz Josef Glacier, where the ice comes down almost into rainforest, and recorded, with what I read as pure delight:

> *Vegetation around Franz Josef Glacier is almost entirely Coriaria shrubs!*

One exclamation mark. He is at a glacier, in temperate rainforest, and what he wants noted is the surprising dominance of one shrub.

He also worked far south, in the subantarctic, on islands where the weather is famously vile and the landing is the hardest part of the trip. And there is an incident reported from his Hawaiian work in the mid-1960s, when a party he was with was left for several days on a low coral atoll in the northwestern Hawaiian chain because the boat crew could not find the island again on the way back. It is eight feet high. In a swell, from a distance, it disappears.

None of this appears in the notebooks as adventure. It appears as conditions, in the same handwriting as everything else, and then the specimen entries resume.

Across the Nullarbor, 1974

Then there is the crossing, which is the one that makes me shake my head.

In 1974 he drove from Kalgoorlie in Western Australia out across the Nullarbor Plain and up into the Gibson and Great Victoria Deserts, and the notebook logs it by the mile.

Cocklebiddy. Rawlinna. Warburton. Giles. Between the named places are the entries that give the flavor: sixty-seven miles north of Cocklebiddy. A hundred and seventy-two miles east of Warburton, toward a feature called the Schwerin Mural Crescent.

I want you to sit with those distances. Not sixty-seven miles between towns. Sixty-seven miles north of a roadhouse, into country with no road worth the name, to collect a plant.

The Nullarbor is a limestone plain so flat and so treeless that its name means, in cobbled-together Latin, no trees. Beyond it the desert country carries spinifex, a spiky hummock grass that grows in rings, and desert oaks, and low escarpments the Australians call breakaways where the flat land suddenly drops. He notes red granite standing out of sand dunes. He notes the vegetation changing as the soil changes, which is the whole point of driving that far.

At Giles there is a meteorological station, one of the most remote in the world, and by the record he was there for the release of a weather balloon and jotted down the names of the staff. A handful of people living in the middle of an enormous nothing, sending a balloon up into the sky twice a day so that the rest of the country can have a forecast.

And underneath the adventure, the reason for it: he was cutting wood.

This is where a great many of the stem samples came from, the ones I mentioned earlier, kept for the microscope. If you want to understand how a plant's plumbing responds to drought, you go where drought is the whole story, and there is nowhere on Earth more suited to that question than the Australian interior. The material he collected on that crossing fed into the comparative wood work that occupied him for decades.

So it was not a road trip that happened to include some botany. It was a wood-anatomy campaign that required a desert.

There is a detail in those pages I want to put in front of a young reader specifically, because it is the least glamorous thing in this whole chapter and it is the thing that makes the rest of it worth anything.

He recorded where he was to the mile.

Not "in the desert." Not "west of Warburton." A hundred and seventy-two miles east of Warburton, toward a named feature. Sixty-seven miles north of a roadhouse. In country where one stretch of spinifex looks exactly like the last stretch of spinifex for a day's driving in every direction, he kept track of his own position, continuously, so that every plant he cut would carry a real location.

Do you know how easy it would have been to write "Gibson Desert" and be done? Nobody would ever have checked. The specimen would still have looked fine in a cabinet.

But a specimen labeled "Gibson Desert" is nearly useless for the questions that matter now. You cannot go back to it. You cannot ask whether that population still exists, or whether the species has moved as the climate has shifted, or how it relates to the population ninety miles away. The precision he maintained while exhausted, in the middle of nowhere, in 1974, is what makes those specimens usable by scientists who were not born yet.

That is the whole discipline in one habit. Write down exactly where you were, even when nobody is watching and it costs you something.

Desert oaks and spinifex in the country between Warburton and Giles, 1974. (Plate to come from the Sherwin Carlquist Collection.)

Borneo and New Caledonia, 1978

Nineteen seventy-eight was his great tropical year, and it produced two of the scenes I would most want a young reader to have in their head.

In July he was on Mount Kinabalu in Borneo. Kinabalu rises to over thirteen thousand feet straight out of tropical forest, so climbing it takes you from steaming lowland jungle to alpine rock in a couple of days. His notebook records work up around eleven thousand feet, and the road between the park headquarters and the first power station, and *Gunnera* growing on the wet road cuts, which is a plant with leaves big enough to shelter under.

On the cool wet slopes below that, in the mossy mountain forest, are the giant pitcher plants I described earlier, the ones that trap and digest insects to get the nitrogen the soil will not give them. Lower still, down in the warm forest at the mountain's foot, he encountered *Rafflesia*, the enormous parasitic flower that smells of rot. One mountain, and he walked up through several worlds to get to the top of it.

I have to remind myself, when I read those pages, that he did not go there to see marvels. He went because Kinabalu is an island. Not surrounded by water, surrounded by lowland heat, with a summit flora cut off from every other summit flora in Southeast Asia. Everything strange about its plants follows from

that isolation, and he was there to record the strangeness carefully enough that somebody could later explain it.

Then he crossed to New Caledonia.

I described that island earlier. It is an old rock, long ago a fragment of the southern supercontinent, that spent a long stretch of its history under the sea and came up bare, so its plants had to arrive across water the way Hawaii's did. Its soil is full of metals that most plants cannot tolerate, and its forests hold plants that grow nowhere else on Earth.

The notebook follows him along the road between La Foa and Canala, through low dry forest on serpentine soil. He is collecting steadily. Shrubs, trees, the odd tolerant things that grow on that poisoned-looking ground.

And somewhere along that road he stopped at a fountain-shaped shrub about twenty feet tall, with red fruit and no flowers that season, and wrote it down.

I have already told you what that shrub turned out to be, and I am not going to tell it again here, because the point of this chapter is where he was standing, not what we learned afterward. Where he was standing was a hot roadside on a metal-rich hill, at the end of a long year of travel, doing what he had done ten thousand times before.

The serpentine country of New Caledonia, where a plain roadside shrub turned out to sit on the first branch of the whole flowering-plant family tree.

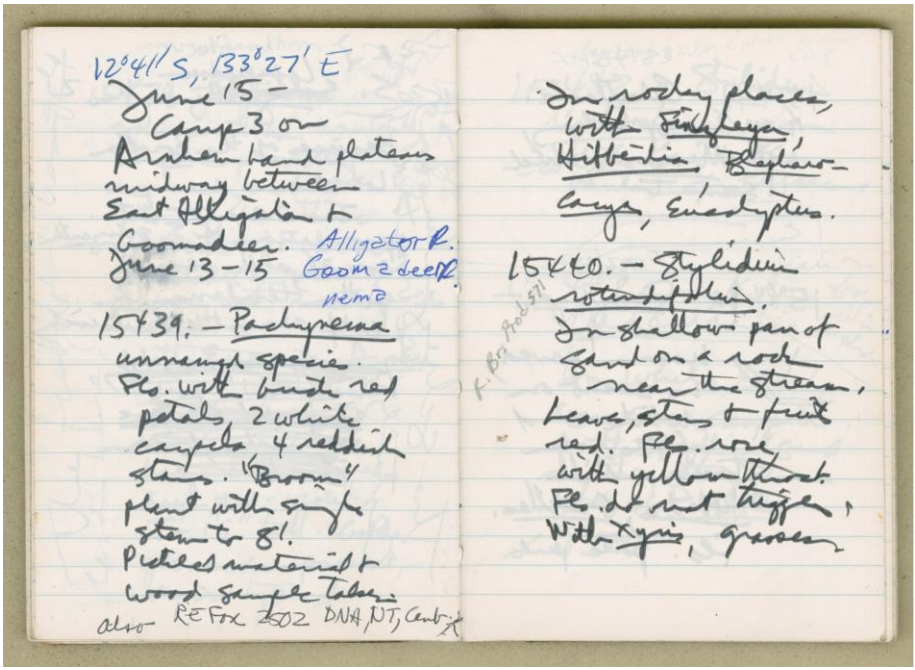
Arnhem Land, 1978

The last scene is the most remote.

Arnhem Land is in the far north of Australia, a vast area of sandstone plateau, escarpment, and floodplain. In 1978 he went

in with a local botanist named Clyde Dunlop, who knew the country. The notebook begins that stretch with a plain, companionable line: on the twenty-fourth of May, Clyde Dunlop shows him a lagoon at Berrimah.

Then they go further in, and the entries change character. The camps are no longer named after places. They are fixed by coordinates.



Twelve degrees forty-one minutes south, one hundred thirty-three degrees twenty-seven minutes east. Camp 3, on the plateau. At the far edge of the map, the record stayed exact.

That page is one of my favorites in the whole collection, and it is worth explaining why. There is no landmark to name. So he gives the position in degrees and minutes, and a camp number, and gets on with the plants. Anybody, ever, can stand exactly where he stood.

The same pages carry Deaf Adder Creek and Magela Creek, and notes about photographing at night, and the record of the movie film of the trigger plants that I described in the last chapter. That filming happened here, in this camp, in this heat.

There is an entry that records a collection made opposite what he writes as the sacred mountain, in quotation marks. He does not explain further and he does not intrude. A man working on somebody else's country, noting that a place has meaning that is not his to describe.

And then, near the end of the stretch, a line that tells you everything about how far in they were:

> *Then pick-up by helicopter.*

That is the logistics of real remoteness. You do not drive out. Somebody comes and gets you.

He was forty-eight years old.

I should say plainly what the helicopter means, because it is easy to read past. It means the party was somewhere a vehicle could not reach and a person could not comfortably walk out of. Everything they needed went in with them and stayed with them. There was no resupply and no changing your mind. If the plant press filled up, that was the end of collecting until pickup.

People sometimes imagine field botany as a gentle occupation, a man with a magnifying glass and a straw hat. Some of it is. And some of it is being set down on a sandstone plateau in the tropical north of Australia with a finite amount of water and a date for extraction.

The curiosity that never switched off

I said this chapter is about the walking, and I want to close it by naming what I actually see when I read these pages one after another.

It is not toughness, exactly, though he was clearly tough. It is that the attention never switched off.

At fourteen thousand feet with a headache from the altitude, he noticed which birds visited which flowers. A hundred and seventy-two miles east of Warburton, he recorded the exact mileage. On a plateau reachable only by helicopter, he wrote the latitude and longitude in degrees and minutes. In four months in the Cape, he kept the names of the people he was walking with, so that the record would show whose eyes had actually found the plant.

None of that is required. A tired person in a hard place does the minimum, and nobody would ever have known. He did the full version, in a swamp, at altitude, in a desert, for fifty years.

And there is one entry, from much later and much closer to home, that I keep as a small gift. Driving in eastern California on Highway 395, between Lee Vining and Bishop, he stopped and collected a plant two miles south of a pass called Sherwin Summit.

Sherwin Carlquist, collecting at Sherwin Summit. He does not remark on it. He writes the locality the way he writes every locality, exactly, and moves on.

Highway 395 at Sherwin Summit, where the collector and the mountain happened to share a name. (Plate to come from the Sherwin Carlquist Collection.)

I like to think he noticed and enjoyed it privately and saw no reason to put a joke in a scientific record. That would be in

character. A private pleasure, kept out of the record, because the record was for the plants.

What the walking was for

Here is what I understand now that I did not understand when I started.

The photographs and the pressed plants and the numbered entries are the visible half of the work. The invisible half, the part that does not survive in any box in Fort Worth, is what it cost to be in those places at all: the boat to Guadalupe, the hut at fourteen thousand feet, the four months of Cape gullies, the miles of desert track, the helicopter at the end of the plateau.

There is no shortcut in this. You cannot collect the plants of a remote island from a library. Somebody has to go, and be uncomfortable, and pay attention anyway.

I have thought about the arithmetic of it more than once. Fifty years of fieldwork, on six continents and a long list of islands, in an era before satellite phones and reliable maps and easy flights. Every trip had to be funded, planned, permitted, and survived. Equipment had to be carried in and specimens carried out, through customs, in heat, without refrigeration. Film had to come home undeveloped and intact.

And at the end of every one of those days, tired, in a hut or a tent or the back of a vehicle, he had to sit down and write it up. That is the part nobody photographs. The walking is romantic. The writing-up, every single evening, for fifty years, is not romantic at all, and it is the only reason any of the walking still exists.

I know a little about that, in a much smaller way. Hundreds of hours at a desk is not an adventure either. It is the same kind of hours, spent on the other end of the same record.

That is why the field notebook is the object at the center of this book, and not the published papers. The papers are the conclusions, cleaned up and defended. The notebook is the man in the place, at the moment, cold or hot or tired, writing down what is actually in front of him because he will not be back.

A hundred and seventy-two miles east of Warburton, in country where one stretch of spinifex is the last stretch of spinifex for a day's drive in every direction, he wrote down exactly where he was standing. Then he went on to the next plant.

Lessons from the Micro-World

✦

We left him on a sandstone plateau in the far north of Australia, waiting for a helicopter.

Now I want to open the same notebook he was carrying at that camp, a few pages further on, and show you what happens when the specimen entries stop.

Because they do stop, occasionally. Every so often, in the middle of a run of numbered plants, the list breaks off and the handwriting changes character. The lines get closer together. The margins fill. Little diagrams appear. And for two or three pages, a man who has spent the day collecting sits down in the heat and argues with himself.

Those pages are the reason I wanted to write this chapter. A published scientific paper shows you a finished conclusion, defended, with the doubts sanded off. It is the polished object. What almost nobody ever sees is the thinking that produced it: the guess, the botched attempt, the correction, the better question.

I have seen it. It is in the notebooks, and it is the most human material in the entire archive.

Arguing with the book

The first thing that surprised me was how freely he disagreed with published authorities, and how young he was when he started.

In the South African notebooks there is a plant in a family he knew well, and beside it, in the ordinary flow of the entry, a verdict:

> *Ecologically + morphologically quite different from other Penaeas, don't believe Dahlgren's monograph.*

A monograph, for anyone who has not met the word, is the definitive treatment of a plant group: one scholar's comprehensive account of every species, how they relate, how to tell them apart. It is the reference everyone else uses. Writing "don't believe" beside one is not a small remark.

Elsewhere he writes that a population obviously upsets the present taxonomy of a species complex. In the Australian notebooks he notes that something is contrary to a published illustration by another researcher.

When I first read these I thought: this man has some confidence. Then I kept reading, and I understood that I had the tone wrong.

He is not dismissing anyone. In the same stretch of pages where he questions that illustration, he writes about the same researcher:

> *Erickson p. 200-201, says both are sensitive. This is an important account because she observed what others didn't.*

He cites her page numbers. He calls her account important. He says plainly that she saw something other people missed. And

then, where the plant in front of him does not match her drawing, he says so.

That is not ego. That is a man who takes the literature seriously enough to check it against the actual plant, and who then reports what he found, whichever way it comes out. He credits where the evidence supports credit and disagrees where it does not, and the two are the same act.

I have worked in enough laboratories to know how rare that combination is. It is easy to defer to everything published. It is easy to dismiss it all. Doing the work to know which parts are right is the hard middle path, and it costs the most time.

There is also a quiet lesson in there for a young person, and I want to make it explicit because I would not have understood it at twenty.

A published book is not a verdict. It is somebody's best account, made with the evidence they could reach, and it is meant to be checked. The whole system depends on people going out to the actual plant and comparing it with what the book says. When the two disagree, that is not a scandal or an embarrassment. That is the system working exactly as intended.

But it only works if the person in the field is willing to write down the disagreement, in plain words, where somebody will find it. Most people are not. It feels presumptuous, particularly when you are young and the author of the monograph is eminent. It is much more comfortable to assume you have made a mistake and say nothing.

He said something. In pencil, in a notebook, in a gully in South Africa, decades before anybody would read it.

The experiment that failed

Now the set-piece, which is the finest thing in the notebooks.

Arnhem Land, mid-1978. He is interested in the trigger plants, the small flowers whose column snaps over in a fraction of a second to slap pollen onto a visiting insect. He wants to understand the mechanism: what sets it off, and what happens afterward.

He is staying at the house of the local botanist who has been showing him the country. There are trigger plants there, and a garden sprinkler, and the flowers are wet.

So he tries to trigger them.

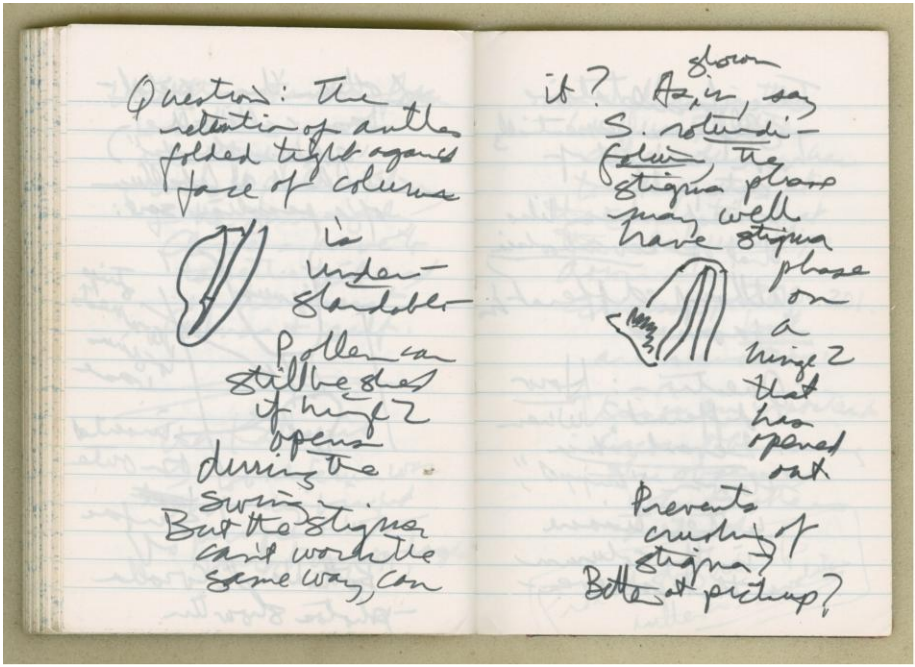
And he cannot. He touches them, and nothing happens. He records the failure without any drama at all, noting simply that his attempts had no success, as his film shows. He was filming the attempt, which is worth pausing on: he set up a movie camera to record an experiment he then failed to perform.

Then, while he is taking still photographs, one of the flowers goes off on its own.

Now, here is where an ordinary person, myself included, would write down "sprinkler must have interfered" and go to dinner. Here is what he writes instead. He asks whether a stimulus can be retained. That is, whether a flower can be touched, not fire immediately, and then discharge later, holding the trigger somehow in between.

Look at what has happened in the space of a paragraph. A failed experiment has turned into a real question about the physiology of the plant, and the question is a better one than the experiment was going to answer.

A field notebook page from Arnhem Land, 1978, where the specimen list gives way to two pages of reasoning and a pair of diagrams.



"But the stigma can't work the same way, can It?" The published paper shows the answer. This is the question, in his hand, with the plant drawn beside it.

That page is the one I would put on the cover of this chapter if I could. Read what he is doing on it. He observes that the anthers stay folded tight against the face of the column, and works out that this is understandable, because pollen can still be shed if a particular hinge opens during the swing. Then he stops himself:

> *But the stigma can't work the same way, can It?*

The capital letter in the middle of "It" is his, and it is the sound of a hand moving fast. Then, immediately, two possible answers, offered as questions rather than claims: does the arrangement prevent the stigma from being crushed? Is it better at picking pollen up?

He does not know. He says so. He writes the alternatives down and draws the column twice so he can look at it.

That is what thinking actually looks like, and it almost never survives into print.

I want to point out one more thing about that failed sprinkler experiment, because it connects to everything in the previous chapter.

He was filming it.

He did not set up a camera to document a success. He set it up because the event he wanted to study happens too fast to be sure of, and a film would let him look again. Which means that when the experiment failed, he still had a record of the failure, and he could review it, and the note in the notebook says as much: no success, as the movie shows.

The camera was not there to illustrate the science. It was part of the apparatus. In the last chapter I called his seeing an instrument, and this is the proof: the same eye that made a hundred and twenty-five thousand photographs was being used here as a measuring device in a live experiment.

Seeing carefully was not how he presented his findings. It was how he got them.

Two plants, one trick

A little earlier in the same run of pages there is a moment of pure delight that I have read many times.

He has plants in a container at very high humidity, and he notices water beading at the tips of glandular hairs. And something connects:

> *Hydathodes! – of course hairs which do this have been reported before… nothing mysterious now about Drosera using the same trick!*

A hydathode is a pore through which a plant pushes out liquid water, as distinct from evaporating it. You have seen the result on a summer morning: those beads along the edge of a leaf that look like dew but are actually the plant's own water, forced out.

Drosera is the sundew, the little carnivorous plant whose leaves are covered in stalked hairs, each tipped with a glistening drop that traps insects.

And in one line he has connected them. The sundew is not doing anything magical to produce its sticky drops. It is using a known mechanism, one already described in ordinary plants, put to a different use.

The exclamation mark is the point. That is a man alone in a hot room in northern Australia having a genuinely good afternoon.

It is also, if you look at the shape of it, exactly how understanding usually arrives. Not as a revelation out of nowhere. As a recognition: I have seen this before, somewhere else, in something unrelated, and it is the same thing. The insect-trapping sundew and the ordinary leaf weeping water on a summer morning turn out to be running the same machinery. Nothing new had to be invented for the carnivore. An existing part was repurposed.

That is very often how evolution works, and it is very often how a person works out a problem. You do not need a new idea. You need to notice that two old ideas are the same idea.

He could only make that connection because he had spent decades looking closely at very ordinary plants as well as spectacular ones.

Designing an experiment, and then attacking it

Immediately after, he starts planning how to test the question properly, and this passage is the one I would give to any young person who wants to know what science actually is.

First the design:

> *Experiments in which jars are inverted over plants in flower should be done (watch out, however, you can't trigger by mistake).*

Put a jar over a flowering plant, keep the air inside saturated, and see what the column does. Sensible. And already, in parentheses, the practical warning: be careful, because putting the jar on may set the flower off, and then you have destroyed the very thing you were measuring.

Then, having designed it, he turns around and attacks his own design.

He notes that if humidity is always at one hundred percent, the anthers will not open properly in the first place, which means the experiment would be measuring the wrong thing entirely. The jar that creates the condition he wants to study also creates a second condition that ruins the measurement.

So he proposes fixes. Keep the plants in a screenhouse and apply the jar only at night, so the confound is limited. Or drop the whole approach and use a pipette to place a single drop of water directly at the tips of the column, which tests the same idea without changing the air at all.

Design, critique, revise, alternative. Four moves, alone, in a notebook, in a camp, with nobody grading him.

I do not think it is possible to explain the scientific method better than by watching somebody do that, and I have no intention of explaining it further. That is what it is. It is not a

formula on a poster. It is the habit of arguing with your own good idea before somebody else has to.

What the "you" was for

And now I can tell you the thing that took me nearly two years of reading to understand, and which changed how I saw the whole archive.

In the first chapter I showed you how he wrote to himself in the second person. You collected this earlier. You will have to check the specimens. At the time, and for a long while after, I read those lines as a kind of intimacy: a solitary man keeping himself company in the field, speaking gently to the person he would be later.

That reading is not wrong. But it is not what the "you" was doing.

Look at it here, in the middle of the reasoning:

> *You'll have to find a way of testing how this great efficiency in seed set is achieved in Stylidium.*

That is not company. That is an instruction. He has found something he cannot resolve in the field with the equipment in his hands, and rather than let it go, he writes it forward, as a task, to whoever is in a position to do it. Usually that meant himself, six months later, at a bench in California. Sometimes it meant himself ten years later. And in some cases, as it turns out, it meant nobody at all, because the man died before he got back to it.

The parenthetical warning is the same thing in miniature. Watch out, however, you can't trigger by mistake. He is briefing a future experimenter on a mistake he has already made once.

The second person is not sentiment. It is a working scientist's way of holding open a question he cannot close today, in a form specific enough that somebody could actually pick it up.

I sat with that for a while when I finally understood it. Because it means the notebooks are not a record of completed work. They are, in part, a list of unfinished business, written in the imperative, addressed to a reader.

And the reader, in the end, was a retired man in Texas with a botanical dictionary, who could type the instruction accurately and could not carry it out.

That is not nothing, though. I could not do the experiment. But I could make sure the instruction still existed, in searchable text, where somebody who can do the experiment will find it.

The discipline of not overclaiming

There is one more habit in these pages that I have come to admire more than any of the clever ones, and it is the opposite of clever.

He was capable of restraint at exactly the moment restraint costs the most.

Somewhere in the same Australian material, looking at a group of plants that will not sort themselves neatly into species, he can see that something interesting is going on. The populations blur into each other. Any botanist would feel the pull: this could be a new species, or a case that overturns somebody's classification, or the beginning of a paper.

Here is what he writes:

> *This situation is very tantalizing, but should merely be described for what it is – a polymorphic species breaking up…*

Read that carefully. He admits the pull. He uses the word tantalizing, which is a confession that he wants it to be more than it is. And then he says: describe it as what it is, not as what would be exciting.

I have been in rooms where that sentence was needed and nobody said it. In pharmaceutical work you see promising early data all the time, and the temptation to describe a hopeful result as a finding is enormous, because careers and funding and simple human enthusiasm all push the same direction. The discipline of writing down the boring accurate version, in your own private notebook, where nobody would ever have caught you, is a kind of integrity that does not get medals.

There is a companion line from the same body of work, much blunter, which reads almost like a motto:

> *vegetative habit divergence is everything.*

A whole career's worth of judgment compressed into five words, written to nobody.

Wrong in his own handwriting

There is a counterweight to all this that I would not want to leave out, because without it he becomes a plaster saint and he was not one.

The same man who wrote "don't believe Dahlgren's monograph" also wrote, about his own work:

> *No 3230–3329! (numbering error)*

And elsewhere, about a group of his own determinations:

> *[these 5 names OK, but may have been mixed – check!]*

He made mistakes. He mis-numbered a run of specimens. He suspected he had mixed up five names and could not be sure. And

in both cases he did the same thing: he wrote it down, in the same ink, on the same page, where it would be found.

He did not go back and quietly fix the record so he would look better. He flagged his own uncertainty for the next person.

I have a particular feeling about those lines, because I did the same thing on the other side of the same page. When I found a date in his notebook that could not be right, I did not correct it. I put a small bracketed question beside it and left his word standing.

Two men, forty years apart, neither of whom ever met the other, doing exactly the same small honest thing: marking a doubt so the next reader would know where to look.

That is not a coincidence of temperament. It is what the work requires, and both of us were taught it by the work.

Patience, which is the whole method

The last thing to say about how he thought is the least dramatic and the most important.

Threaded through every notebook, in every country, for fifty years, are little notes attached to ordinary plants. A wood sample kept. A voucher taken for research in wood anatomy. Something set aside to be preserved in fluid rather than dried.

Hundreds upon hundreds of times.

Wood anatomy, as I said earlier, is the study of what a plant's internal plumbing can tell you about the life it led. Doing it means collecting a stem, preserving it, sectioning it thinly enough to see through, staining it, mounting it, examining it under a microscope, and comparing it with hundreds of others. One specimen might take an afternoon. The scientific value comes

only from the comparison, which means the work is worthless until you have done it a great many times.

There is a run in his American work, on a group of desert shrubs, that goes on for something like a decade across several states. He kept going back for more material, year after year, because the question needed more cases than any one trip could supply.

That decade of sawing and sectioning and squinting is what became *Comparative Wood Anatomy* in 1988.

In the last chapter I described the endurance it took to be in those places at all: the altitude, the desert, the helicopter. This is the other endurance, and it is the one that is genuinely hard to imagine sustaining. Nobody writes an adventure story about a man at a microscope in the ninth year of a project, comparing his four-hundredth stem section.

But that is where the science was.

The field notebook and the microscope slide are the same discipline in two settings. One numbered plant at a time, done ten thousand times, by a person who did not get bored and did not decide that this one probably did not matter.

I want to say something about that phrase, because it is the closest thing I have to a conclusion about him.

Every large piece of work is made of a very great number of small acts that are individually skippable. Any one stem section could be left out and the book would still be written. Any one specimen could be labeled "Gibson Desert" instead of a precise mileage and nobody would notice for forty years. Any one evening in a camp could be spent resting instead of writing up.

The quality of a life's work is decided almost entirely in those moments, and always privately.

This is not a comfortable thought, because it means there is no single decision that makes somebody like him. There is no year he became a great botanist. There is only a very long series of ordinary evenings in which he did the full version instead of the adequate one, and the sum of those evenings is fifty-two boxes in Fort Worth that scientists will be using for the next century.

I have found this idea useful in my own life, late as it is to be discovering it. I spent hundreds of hours on a transcription that nobody was checking closely and that would not carry my name. There were mornings when a difficult page could have been left with a guess in it and the file would have looked complete.

The reason not to do that is the same reason he did not do it. Somebody is going to rely on this later, and they will not know which parts you rushed.

The record of the thinking

The archive at BRIT has a rule I mentioned earlier, and I understand it much better now than when I first read it. Volunteers are instructed not to modernize him. Where a name has changed, we keep his. Where he was wrong, we keep the wrong thing and note it.

When I started, I thought that rule was about historical accuracy, which it is. Now I think it is about something larger.

His voice was the method. The self-address, the argument with the monograph, the botched experiment written up as a question, the flagged numbering error, the restraint of describing a tantalizing situation as merely what it is rather than what he hoped it might be. None of that is style laid on top of the science. It *is* the science. Strip it out to make a clean modern record and you would still have the specimen data, and you would have lost

the only surviving evidence of how a first-rate mind actually worked.

That is why they keep his words. Not out of sentiment. Because the thinking is the part that teaches.

And this is what I keep coming back to, at the end of two years of mornings.

He could have written down the answers. Plenty of scientists do; the notebook holds the result and the reasoning stays in the head, where it dies with the man. He wrote down the questions. He wrote down the failed attempt at the sprinkler, and the guess about a retained stimulus, and the two possible reasons the stigma might be arranged as it is, and the experiment that would not work, and the better experiment that might, and the five names he was not sure about.

He wrote down the part he had not finished.

He wrote it down for whoever came next.

I do not think he had any particular person in mind. I think it was simply his habit, the way he did the work, and the habit turned out to be a kind of generosity that outlived him by decades.

What he handed forward was not a set of conclusions. It was a way of working: pay attention, argue with your own idea, admit what you do not know, mark your errors where somebody can find them, and be patient beyond what seems reasonable.

That is the inheritance. It is not a set of facts about plants. It is a way of holding a question: patiently, honestly, in writing, where somebody else can pick it up after you have put it down.

And an inheritance is only real if somebody actually takes it up.

A Call to the Next Generation

✦

To finish, I want to go back to the beginning. Not the beginning of my work, but the beginning of his.

Notebook one. The year is 1951. The handwriting is the same handwriting, already fast, already leaning forward, but a little larger and a little less compressed, the way a young person's hand often is.

He is twenty-one years old.

And what he is doing, page after page, across the hills and roadsides of California, is collecting tarweeds.

I should tell you what a tarweed is, because the answer matters. It is a small plant in the sunflower family, usually yellow-flowered, often sticky, with a resinous smell that some people find unpleasant. It grows on dry ground, on road cuts, in the kind of neglected margin nobody photographs. In late summer, when most things have finished, the tarweeds are still going, dusty and unglamorous.

Nobody would call it a beautiful plant. Nobody would build a career on it.

A twenty-one-year-old is walking around California in 1951 filling a cheap notebook with them, one after another, with their numbers and their localities and their heights and the color of their rays.

If you had met him that summer and asked what he was doing, and he had told you, you would have thought: what a strange thing to care about.

I have a soft spot for that first notebook, and I think I know why.

When I was a young man in China, I was not permitted to go to an ordinary high school, and I ended up in a technical school learning to repair automobiles. Taking apart a truck engine was not a prestigious thing to be doing. Nobody looking at that workshop would have said, there is the beginning of a scientific career. It looked like a detour, and for years I thought of it that way.

It was not a detour. It was where I learned that complicated things are made of parts, and that the parts can be understood one at a time, and that patience is usually the whole trick.

So when I look at a twenty-one-year-old crouching by a California road with a sticky yellow weed and a cheap notebook, I do not see a boy wasting his summer. I recognize the posture. He is doing the unglamorous thing that turns out later to have been the foundation.

You almost never know at the time. That is the difficulty and, I have come to believe, the mercy of it.

What the weed turned out to be

Fifty-two years later, in 2003, he published a book about tarweeds.

It is called *Tarweeds and Silverswords*, and it is about the connection between that dusty California roadside plant and the most spectacular plants in the Hawaiian Islands.

I described the silverswords earlier: the rosettes of silver, sword-shaped leaves that grow on bare volcanic cinder high on Haleakalā and Mauna Kea, that sit for years and then send up a single flowering stalk taller than a person and die. They are among the most photographed plants in the world. When people talk about the wonders of island evolution, the silverswords are usually the picture.

The silverswords are tarweeds.

Not similar to tarweeds. Descended from them. Some ancestor of the California tarweeds crossed more than two thousand miles of open Pacific, almost certainly as a sticky seed carried on a bird, and landed on a young volcanic island with every way of making a living unoccupied. That is the long-distance dispersal I described in the third chapter. What followed is the adaptive radiation: the descendants of that one arrival split and changed until they had become the silverswords on the summits and the shrubs and trees and vines of the wet forests and the dry slopes below.

The plain weed the boy was chasing in 1951 is the mainland key to one of the most beautiful evolutionary stories on Earth.

A California tarweed beside a Hawaiian silversword: the roadside plant a twenty-one-year-old could not stop collecting, and the island descendant it explains. (Plates to come from the Sherwin Carlquist Collection.)

I want to be careful not to make this sound like destiny. He did not know in 1951 that the tarweeds would lead there. He was not being far-sighted. He was twenty-one and interested in a group of plants that most people ignored, and he followed the

interest for fifty years, and the interest turned out to have a very large room on the other side of it.

That is the shape of a great many real careers, and it is nothing like the shape people expect. There was no moment of vision. There was a young man with a cheap notebook and an odd enthusiasm, and then five decades of not putting it down.

I would like young people to hear this in particular, because the version of a scientific life that reaches them is usually the version with the moment in it: the falling apple, the flash in the laboratory, the single brilliant idea that changes everything. Those stories are mostly tidied up afterward, and they do a quiet kind of harm, because they suggest that if no lightning has struck you by twenty, you were not chosen.

Nothing struck him. He liked a weed nobody liked and he kept at it until he understood something nobody had understood.

The island-hopper comes home

There is one more arc in the notebooks, and it is the one that moves me most.

Think about where this man had been. A wooden boat to Guadalupe Island at twenty-eight. Fourteen thousand feet on Mount Kenya, in a valley that freezes every night on the equator. Four months in the gullies of the Cape. A thousand miles of desert track between Kalgoorlie and Giles. The alpine zone of Mount Kinabalu. A sandstone plateau in Arnhem Land with a helicopter coming for him. In his late fifties he was still going out, to Namibia, to Borneo again, and to a subantarctic island in the far southern ocean where the weather is bad enough that landing is the hard part.

His fourteenth field notebook spans the years from 1988 to 2012.

It opens on those last great expeditions. And then, gradually, the entries change. The far islands stop. The localities get closer to home. And for the last decade of that notebook, from about 2003 to 2012, he is recording plants in his own garden in Santa Barbara.

Same numbering. Same format. Same careful notes on habit and flower and fruit.

The greatest island-hopper of his generation, in his seventies and eighties, going out into his own backyard with a notebook and writing down what was growing there, exactly as he had done on a New Caledonian ridge thirty-five years before.

The last pages: a notebook that opens on subantarctic islands and closes in a Santa Barbara garden. (Plate to come from the Sherwin Carlquist Collection.)

I have thought about those pages a great deal. It would be easy to read them as a sad diminishment, a great traveler reduced to his own yard. I do not think that is right, and I do not think he experienced it that way.

The way of seeing never switched off. That is all those pages say. The radius shrank because bodies age and knees fail, and the attention stayed exactly the same size. He did not need a remote island to be interested. He needed a plant, and there were plants in the garden.

If you want to know whether somebody loved the work itself, as opposed to the travel or the reputation, look at what they do when the travel stops.

There is a second reason those garden pages matter, and it is practical rather than sentimental.

A person who has spent fifty years looking at plants on six continents and a long list of islands knows things that never get

written into a paper. Where to stand. What time of day the flower opens. Which detail to check first. That knowledge lives in the hands and the eyes and it is very difficult to transmit.

The garden notebook is that knowledge still being exercised, at eighty, on a shrub by a fence. He is not collecting for a project any more. He is looking, because looking is what he does, and writing it down, because that is the other half of looking.

I find that I want young people to see those pages more than I want them to see the photographs of the expeditions. The expeditions are the part that looks like an adventure film. The garden is the part that tells you what the man actually was.

The meaning that came late

Now let me close the story I opened in the third chapter, the one about the plain roadside shrub in New Caledonia.

He collected it in 1978. He wrote down its height, the color of its fruit, the fact that it had no flowers that season, and how common it was on that stretch of hillside. He gave it a number and moved on. Nothing about the entry is remarkable, and I typed it in less than a minute.

Around 1999, two decades later, molecular biology revealed that this shrub sits at the base of the entire flowering-plant family tree. It is the sister lineage to all other flowering plants: the closest living relative of the common ancestor of every flower on Earth.

He could not have known. The methods did not exist. Nobody on the planet knew in 1978.

Here is the thing I keep turning over. His entry is not diminished by his not knowing. It is *useful* precisely because of how he made it. He wrote down what was actually there: the height, the fruit, the elevation, the abundance, on that date, at that place, with a number attaching it to a photograph and a

pressed specimen. He did not decide in advance which observations would matter. He recorded the ordinary and the extraordinary in exactly the same way, because in the field you cannot tell which is which.

And so, when the meaning finally arrived twenty years later, there was a record waiting for it.

I said in the first chapter that I was decoding his handwriting. I have come to think that word is wrong. I was not decoding it. I was receiving it.

Because here is the mirror, and it took me most of two years at that desk to see it.

Carlquist recorded a plant whose meaning he could not reach, and a later generation found the meaning because his record was honest and complete.

And Carlquist himself left nineteen notebooks whose meaning he could not complete, because he died. And a handful of strangers at their own desks, a grant that arrived six months too late, a librarian named Ana and a colleague of hers, a man called Jason Best who stopped on a Friday in November, and a retired pharmaceutical scientist in Arlington, Texas, went through them one line at a time so that a future generation could find what he could not.

He did for a plant what we did for him. Receiving carefully and forwarding carefully are the same act. That is the whole thing. That is what I would like you to take from this book.

And it is not finished. I want to be honest about that, because it would be a nicer ending if I could tell you the work was done.

It is not. Of the enormous collection of photographs, only a small fraction are yet linked to the notebook entries that explain them. There are film reels in boxes that have never been

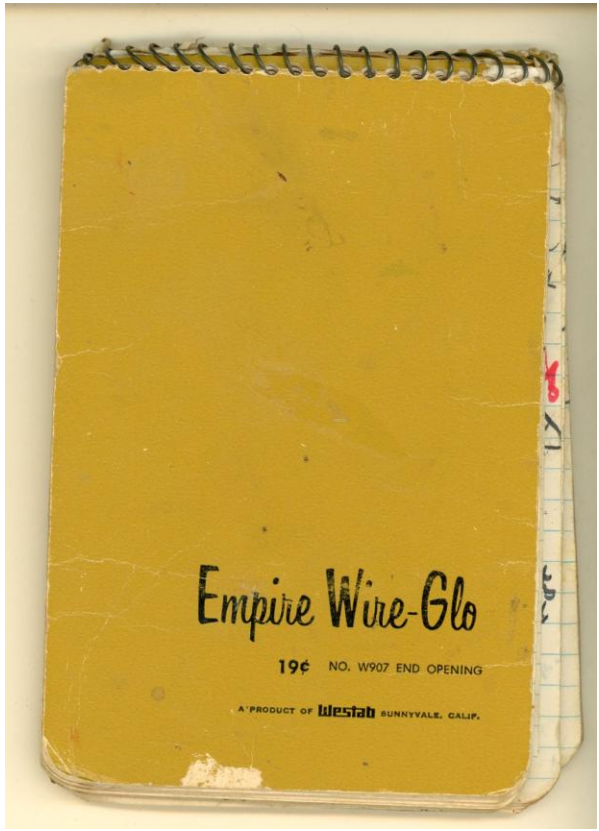
transferred and never viewed. There are pages of that handwriting that nobody has read since he wrote them. The training milestones for the current round of volunteers run on into the coming year, and after that there will be another round.

Somebody will finish it. Probably several somebodies, most of whom have not yet heard of Sherwin Carlquist, some of whom are children right now.

That is not a failure of the project. That is simply what a serious record is: something too large for the person who made it, handed along.

Nineteen cents

Let me put the object back on the table.



Empire Wire-Glo, No. W907, a product of Westab, Sunnyvale, California. The price is printed on the cover.

Everything in this book came out of notebooks like that one. The argument that explained how a whole island flora arrived across two thousand miles of ocean. The comparative wood work that took a decade of sawing and sectioning. The tarweed obsession that became a landmark fifty years on. The plain entry that turned out to name the earliest branch still living on the flowering-plant tree.

It is worth noticing what he did not have. No satellite navigation. No digital camera, no reviewing the shot, no second chance if the film was ruined. No search engine to check a name against. No way to send a photograph to a colleague and ask. He had paper, a pen, a camera he had to carry, and his own eyes, and

the discipline to use them the same way on a bad day as on a good one.

I am not going to pretend that money and equipment do not matter in science. They do. But they are not where the work begins, and a young person who believes the work begins with equipment will wait a long time for permission that never comes.

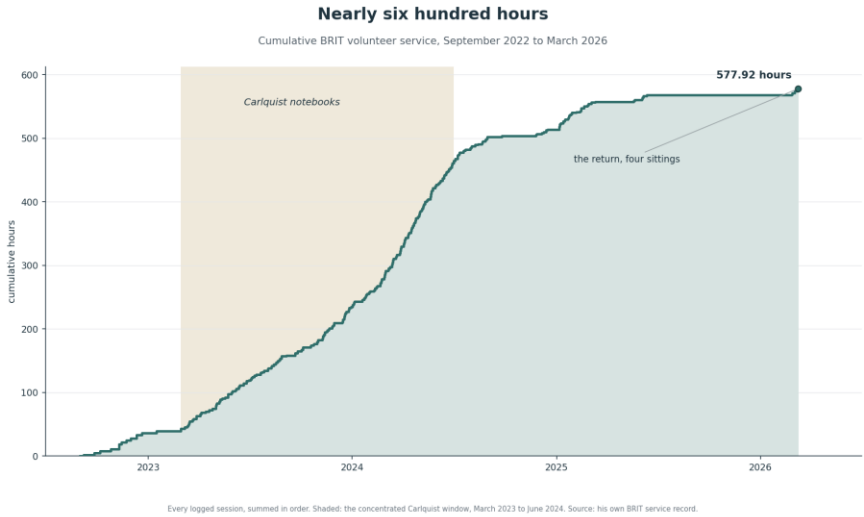
The price is right there on the cover for anybody to read.

I have kept thinking, through all of this, about who the book on my shelf is really by.

A scientific career looks, from outside, like a series of publications with one name on them. From inside a set of field notebooks it looks completely different. It looks like a mother buying a young man a trip to Hawaii for his birthday because he was interested in plants. It looks like Clyde Dunlop showing a visitor a lagoon outside Darwin. It looks like Elsie Esterhuysen walking a Cape gully and finding a species nobody had recorded there. It looks like a helicopter pilot arriving on the right day.

And then, decades later, it looks like a librarian organizing volunteers, and somebody named Jason Best stopping at a line on a Friday afternoon, and a retired formulator in Texas typing a plant name he had to look up three times.

None of us could have done what he did. He could not have done it without any of us either. That is not a moral about teamwork. It is just an accurate description of how a body of knowledge actually comes into existence: unevenly, across generations, through the hands of people who never meet.



My logged hours, adding up over three and a half years. The shaded stretch is the notebook work, close to half the whole, from the spring of 2023 to the middle of 2024, with a short return at the very end.

For whoever comes next

So here is the sentence this book has been walking toward.

He wrote it down for whoever came next.

That is what those nineteen notebooks are. Not a monument, not an archive in the grand sense, and certainly not something he prepared for posterity. A working man's daily record, made accurately because accuracy was the job, and left behind because that is what happens to everything we make.

For a long time nobody came. The notebooks sat in their boxes through his last years and past his death in December of 2021. The grant that would finally fund the work was approved about six months later, when he was no longer there to be told.

And then people came. Not famous people. A coordinator, a librarian, a few students, a handful of retired volunteers with time

and patience. We came sixty and seventy years after some of those pages were written, and we sat down in our own homes and started reading a stranger's handwriting one word at a time.

I was one of them. When he wrote "you," across all those decades, the "you" eventually turned out to be an immigrant grandfather in Texas who had to look up almost every plant name he encountered.

And now I have written this down, which makes me, in my small way, another man leaving a record for somebody he will never meet.

Which brings me to you.

Now, you

I do not know who you are or what you love.

You may be fifteen and already certain that you want to be a scientist. You may be forty and wondering whether it is too late to become serious about something. You may not care about plants at all. Carlquist's subject was botany, and mine, for most of my life, was the chemistry of medicines, and neither of those has to be yours. The thing I am describing is not a field. It is a way of paying attention, and it works on anything: on a machine, on a language, on a river, on a neighborhood, on people and how they live together. Science knows no borders, and neither does careful attention. It belongs to all of us.

I also want to say something to the reader who is quite sure none of this applies to them, because they are not clever enough, or not young enough, or did not go to the right school, or are not the sort of person who does science.

I was not the sort of person who does this either.

I came to it at nearly seventy, with no botanical training whatever, in my second language, from a career in an entirely different field. On my first mornings I could not read a single line of that handwriting. There was every reason to conclude that this work was for someone else, someone better prepared, and to leave it alone.

What I had was time and stubbornness. That turned out to be enough, because the work did not require brilliance. It required somebody to actually sit down and do it, repeatedly, for a long time, and to care about getting it right when nobody would have known the difference.

A great deal of the world's necessary work is like that. It is waiting for somebody ordinary who is willing.

Here is what I have learned from hundreds of hours inside another man's handwriting, offered to you for whatever it is worth.

Pick the thing you cannot stop looking at, even if other people find it dull. Especially if they find it dull. The tarweeds were dull, and nobody told him they were important. They became important because somebody looked at them for fifty years.

Write down what is actually there, not what you were hoping for, and not the tidied version. Write it down when you are tired and nobody is checking, because that is the only version that will still be true in fifty years.

When you are unsure, say so, in words, where someone can find it later. When you are wrong, mark it in your own hand rather than quietly fixing it. Both of those feel like weakness and both of them are the opposite.

Be patient past the point that seems reasonable. Most of what is worth understanding takes longer than anyone tells you, and

the people who find things are very often just the ones who did not stop.

Learn from the people already doing it, and give them credit by name. He cited the page numbers of a researcher he disagreed with and said plainly that she had seen what others missed. He wrote down the name of the local botanist who showed him a lagoon. Nobody made him do either.

And write it down for whoever comes next, even though you will not meet them, and even though you cannot know which of your plain, ordinary observations will turn out to be the important one. You are not able to know that. Neither was he. That is exactly why you record all of it carefully.

You do not need permission and you do not need money. You need something you love enough to look at closely, and a cheap notebook, and the will to use it honestly.

That is all he had, on a California roadside, at twenty-one, in 1951.

One last thing, and then I will stop.

Every morning for two years I sat down after breakfast in a quiet house and opened a page of a stranger's handwriting, and most mornings it went slowly, and some mornings I got one word. On the good days a line that had been nonsense for a week came apart in front of me and turned out to be a man describing a shrub on a hillside in 1967, and I would sit back in my chair, alone at my desk in Texas, and be as pleased as I have ever been about anything.

I am telling you this because I want you to know that the thing I am recommending is not a duty. It is one of the great pleasures available to a person, and it is almost free, and hardly anybody takes it up.

Somewhere near you there is something growing, or running, or breaking down, or changing, that nobody has looked at properly. It is probably close by, and probably plain, and probably the sort of thing people walk past. That is usually where the unexamined things are.

Go and look at it. Write down what you see.

Somebody will be glad you did. You will almost certainly never meet them.

A Postscript: Fort Worth, 2026

✦

I did not plan to end this book anywhere but at my desk. In the late winter of 2026, as I was trying to finish it, I went back to the notebooks for four more mornings, the way he kept going back to his islands, and found I was not quite done with them. And then, in the summer, they did something I had not expected. They came out of their boxes and went up on a wall.

A hundred and twenty mornings with his handwriting. Thick in 2023, thinning through 2024, and then four quiet mornings at the start of 2026, while this book was being written.

The Botanical Research Institute of Texas put on an exhibition. They called it Expeditions Through the Lens:

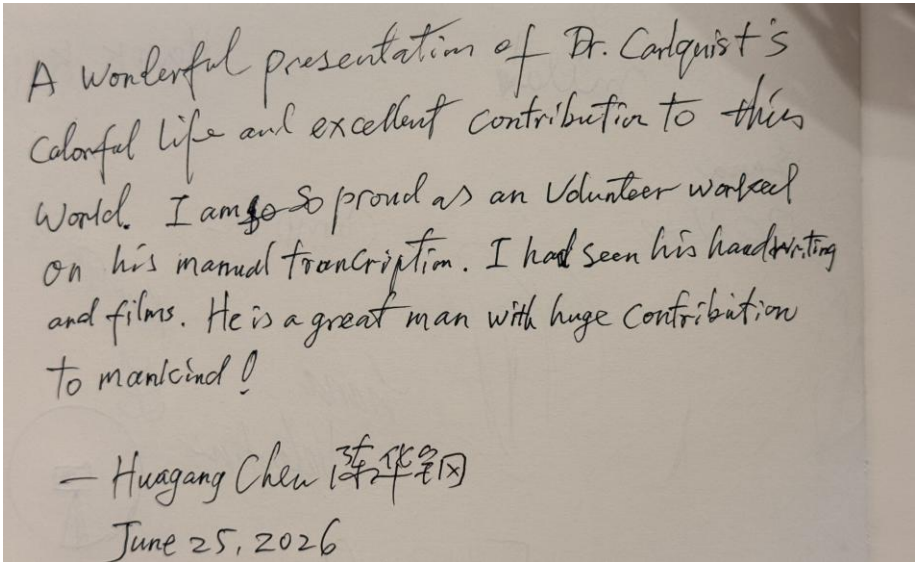
Botanical Photographs of Sherwin Carlquist, and they hung it in the Madeline Samples Exhibit Hall, in the BRIT building itself, from the first of June to the end of September. For four months, anyone who walked in off the street could see his photographs, printed large and lit properly, in the same building where the notebooks live and where, for two years, I had sat reading his hand.

I want you to feel what that is. For most of half a century those pictures were small squares of film in numbered boxes, held up to a window one at a time by the man who took them, and then filed away. I had known them only as scans, as the other half of a record I was piecing back together on a screen at home. To stand in front of them, printed and on a wall, in their real color, at the size he must have seen them in his mind, was to meet the work in its own body for the first time.

The grant I told you about, the one that came six months too late, paid for a great deal of the work behind those walls. He never saw it. He never knew the collection would be preserved, or funded, or shown to anyone. And yet there it was, his life's looking, finally looked at, by strangers who had never heard his name until that morning and would carry it out with them when they left.

The exhibition did one more thing that I only understood while standing in it. All through this book I have described his recurring figure, his words and his photograph and his plant, three records of one thing joined by a number. On those walls the figure was made real. The photograph he took, beside the notebook line, beside the pressed plant from the herbarium. The thing I had been reassembling one entry at a time, somebody had reassembled at the scale of a room, so that a child could walk past and take in the whole of it at a glance.

I went on the twenty-fifth of June. There was a guest book near the door, the kind every exhibition keeps, and I stood at it for a while before I wrote anything. Then I picked up the pen and left a few lines in my own hand, in my own imperfect English, about how proud I was to have read his handwriting and seen his films, and what a great man he was, and how much he had given to the world.



My own note in the exhibition guest book, the summer of 2026. For two years I read his hand. That morning I left mine, in a book that someone I will never meet will open.

I have thought since about what I was actually doing at that little table by the door. For two years a dead man's handwriting had been coming toward me across the decades, one word at a time, and I had been receiving it. And there, in the guest book, I was doing the other half of it. I was setting something down, in my own hand, on a page I would not see again, for a reader I would never meet, on the ordinary assumption that somebody would come after me and open it.

That is the whole of what I have been trying to say, and it turned out to be a thing a person can do with a pen in an afternoon, in the same building where all of it began for me.

I hope somebody reads my few lines one day, the way I read his. I hope they cannot quite make out one of the words, and have to sit with it a while. And I hope that when it finally comes clear, they feel what I felt: that a stranger took the trouble, and that the trouble was a kind of gift.

ABOUT THE AUTHOR

Huagang Chen is a retired pharmaceutical scientist. Born in Anshan, China, he studied traditional medicine as a young man in Guiyang, holds a master's degree, and spent twenty-four years in eye-care research and development. When he retired to Arlington, Texas, he began volunteering at the Fort Worth Botanic Garden, where he was asked to help read a dead botanist's handwritten field notebooks. He gave hundreds of hours to it, at his own desk, one word at a time. He wrote this book because he believes a life as devoted and as selfless as Sherwin Carlquist's should not stay in boxes, and because what he learned at that desk belongs to anyone, in any field, who is willing to look closely. Science, he likes to say, knows no borders.