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Strahler's *Physical geography*, New York: Wiley (1951; 1960; 1969; 1975)

Figure 1. Arthur Strahler on a field trip, *c.* 1950 (photo by V. Miller, courtesy of Alan Strahler)

I Introduction

In the United States, and elsewhere, the years after the second world war brought a huge increase in the number of university students. Most of the students were male, and many had served in the armed forces and had developed an interest in geography. For beginning students of physical geography, the choice of textbooks was limited, however. In the USA, the most widely adopted text was *Physical elements of geography* by Vernor C. Finch and Glenn T. Trewartha of the University of Wisconsin (Finch and Trewartha, 1949).

The premise of Finch and Trewartha's text was that 'careful, systematic, direct observation and description are preliminary to and necessary for any classification and explanation that may follow' (Finch and Trewartha, 1949: 2). The results were predictably turgid. The section on landforms, for example, contains chapters on 'plains of stream degradation', 'plains of stream aggradation', 'glaciated plains', 'plains in dry climates', 'the shore features of plains', 'plateaus', 'hill lands', and 'mountains'. It is probably reasonable to assume that this form of extended description and classification must have been tedious to teach, and to learn.

It was against this background that Arthur Strahler, a young instructor at West Point and Columbia University, perceived a need for a better textbook, one that reflected a more scientific analytical approach to the subject, and one that presented the material in a more interesting manner. The result was the 1951 publication of *Physical geography*.

Strahler's *Physical geography* has gone through many incarnations since it was first published. A second edition appeared in 1960, the third in 1969, and the fourth in 1975. Several

other versions of the book have since appeared. The 2005 edition of *Physical geography: science and systems of the human environment*, co-authored with the original author's son, Alan Strahler, still contains material from the 1951 edition. It continues to define the canon of introductory physical geography in North America and elsewhere.

II The book

The first edition of *Physical Geography* was probably written in the period 1948–50, a time in which Strahler was also involved in the research that would revolutionize twentieth-century geomorphology (Strahler, 1950a; 1950b; 1952a; 1952b). At the same time, he also had a very heavy teaching load and actively sought out additional teaching responsibilities. From 1941 to 1957, he was appointed to teach in the University Extension Program in geology, and summer session geology from 1942 until 1947. The extension classes were often quite large, with 75 or more students (N. Timoffeef, personal communication).

Strahler's approach to the material was different from that of Finch and Trewartha insofar as he adopted a more analytical and scientific approach (Table 1). As part of a broader approach to geography, rather than purely physical geography, the Finch and Trewartha text references the work of Sauer and Hartsthorne (Finch and Trewartha, 1949: 5). In contrast, Strahler's preface mentions the inspiration of Tarr, Salisbury, and De Martone, and describes physical geography as, 'a body of basic principles of earth science, selected with a view to including primarily the environmental influences that vary from place to place over the earth's surface' (Strahler, 1951: 1). As a geologist by background and academic affiliation, he was unencumbered by existing paradigms in physical geography. He could literally rewrite the textbook, and that is exactly what he did.

One of the most striking contrasts with the Finch and Trewartha text was Strahler's use of diagrams that were more analytical than descriptive. His drawings of the polyconic projection, for example, were not based on a simple grid depiction of the projection as in Finch and Trewartha (1949: 528), but instead he took the projection apart and stuck it back together again (Strahler, 1951: Figure 2.14). By relying on sketches rather than photographs, he was also able to show what a valley looked like before, during and after glaciation (Strahler, 1951: Figure 13.2). His depiction of great circles is masterfully simple: a photograph of two hands holding a piece of string across a globe (Strahler, 1951: Figure 1.7). Most of the figures had very brief captions. The figures usually spoke for themselves.

A trained and gifted amateur artist, he drew and inked many of the block diagrams himself (Alan Strahler, personal communication). Other diagrams were drawn by his Columbia colleague, Erwin Raisz. In this endeavor, he acknowledged the role of another Columbia colleague, Armin K. Lobeck, whose method for the construction of block diagrams (Lobeck, 1924) helped him quickly produce a large number of such diagrams. The simpler line drawings were produced by the publisher, based on sketches provided by the author (Alan Strahler, personal communication). More than a dozen of the illustrations were acknowledged as the work of W.M. Davis. In fact, some geomorphologists may be surprised at the amount of Davisian geomorphology contained within the book. However, Strahler was no enemy of the Davisian scheme, and towards the end of his life commented that his 1950 *Annals* paper (Strahler, 1950b) had 'been grievously misconstrued as a denouncement of the fundamental validity of the Davisian denudation "cycle"' (Strahler, 1992).

Given Strahler's impact on the quantitative revolution in geography (see Tate *et al*., 2004) it is also perhaps surprising that there is little quantitative geomorphology in the first two editions of *Physical geography*. Although Strahler included quantitative material in his graduate

Table 1. Comparison of the Finch and Trewartha textbook chapter headings with those of the first two editions of Strahler's *Physical geography*

Finch and Trewartha (1949)	Strahler (1951)	Strahler (1960)
The field of geography: its content, method and point of view	I: THE EARTH AS A GLOBE	I: THE EARTH AS A GLOBE
The Earth: its shape, planetary relations, and representation on maps	Form of the Earth; the geographic grid	Form of the Earth; the geographic grid
	Map projections	Map projections
A: THE ELEMENTS OF WEATHER AND CLIMATE	Illuminations of the globe	Illuminations of the globe
Air temperature (including insolation)	Time	Time
Atmospheric pressure and winds	Moon and tides	Moon and tides
Atmospheric moisture and precipitation		
Air masses, fronts and storms	II MAPS and LANDFORMS; ROCKS AND STRUCTURES	II THE WEATHER ELEMENTS
	Planimetric maps	Weather elements and air temperature
B: CLIMATIC TYPES and THEIR DISTRIBUTION	Topographic maps	Air pressure and winds; global circulation
The tropical rainy climates	Introduction to landforms	Ocean waves, currents and ice
The dry climates	Rocks and the Earth's crust	Moisture, clouds and precipitation
The humid mesothermal climates	Weathering, mass wasting, and ground water	Cyclonic storms, air masses, weather fronts
The humid microthermal climates	Landforms made by streams	
Polar climates and highland climates	The cycle of landmass denudation	III CLIMATE and SOIL
	Landforms made by glaciers	Climates and their classification
C: PROCESSES CONCERNED WITH THE	Landforms made by waves	Equatorial and tropical climates
ORIGIN OF LANDFORMS	Landforms made by wind	Middle-latitude climates
Earth materials and tectonic processes	Coastal plains, horizontal strata, and domes	Polar, arctic and highland climates
The agents and processes of gradation	Folds, faults, and fault blocks	The soil
	Crystalline masses and volcanic forms	The great soil groups
D: LANDFORMS		
Plains of stream degradation	III WEATHER AND CLIMATE; NATURAL	IV LANDFORMS
Plains of stream aggradation	VEGETATION AND SOILS	Introduction to landform study
Glaciated plains	Weather elements and air temperature	Rocks and their structures
Plains in dry climates	Air pressure, winds, and ocean currents	The Earth's crust
The shore features of plains	Moisture, clouds and precipitation	Water in the soil and rock
Plateaus	Storms and weather analysis	The wasting of slopes
Hill lands	Climates and their classification	Runoff
Mountains	Climates controlled by equatorial and tropical airmasses	Landforms made by streams
	Climates controlled both tropical and polar airmasses	The cycle of land-mass denudation
E: EARTH RESOURCES	Climates controlled by polar and Arctic airmasses; highland climates	Landforms made by waves and currents
Water resources of the land	The soil	Landforms made by wind
The biotic resource: original vegetation cover	The great soil groups	Coastal plains, horizontal strata, domes
and associated animal life		Folds, faults, and fault blocks
Soils: their nature and classification		Crystalline masses and volcanic forms
The great soil groups of the world		
The mineral fuels		
Ores and other economic minerals		

seminars, his classroom experience was that most first-year students could not assimilate it or were not interested (N. Timoffeef, personal communication). However, quantitative geomorphology does appear as a new chapter in the greatly expanded third edition of 1969, written after he had left Columbia and become a full-time textbook author.

The new quantitative geomorphology chapter pulled no punches. There were several graphs redrawn from his research papers showing data and regression lines for specific drainage basins. Mathematical statements were made regarding the geometric series laws that relate stream order to the number of streams, length of streams, basin area and stream slopes, with worked examples, and there were explanations of sigma and exponents. Strahler noted that 'the sciences of climatology and hydrology, closely linked with geomorphology, progressed from the very outset by quantitative statements ... Historically, then, geomorphology until recently has followed a course of action quite different from related sciences of climatology and hydrology' (Strahler, 1969: 454).

Unfortunately, the new quantitative geomorphology chapter did not complement Strahler's qualitative explanations of phenomena in other chapters. Although he made major pioneering contributions to quantitative geomorphology, Strahler remained a supporter of qualitative Davisian analysis for his entire career, and despite his comments on the quantitative nature of climatology, it must be said that much of the success of the climatology chapters arises from his analytical but qualitative explanations.

Perhaps surprisingly, much of Strahler's pride in achievement was not in the sections on geomorphology, but rather that on climate classification (Alan Strahler, personal communication). Recognizing the sterility of Koppen's empirical classification based on temperature and precipitation data, Strahler developed a much more analytical approach to classification, based on air mass source regions and movement. The approach was qualitative, but for the third edition Strahler quantified the concept using a 'thermohyet diagram' to relate precipitation and temperature (Strahler, 1969: 230). The idea of thermohyet diagrams as a proxy for air mass characteristics was further developed by his student John E. Oliver (Oliver, 1970). Essentially a pedagogic tool, the classification was never published by Strahler in a refereed journal, and has not been widely adopted outside Strahler's book and its successors. However, the classification can still be warmly recommended to any instructor who has faced learner resistance to Köppen's classification.

Strahler's topically classified bibliography at the end of all the editions is unmatched in terms of scope. The bibliography almost entirely consists of peer-reviewed literature, but he was very good at identifying shorter, more readable papers. It is doubtful whether many of these papers were read by the majority of students, but they do give a sense of authority that is missing in many current textbooks. Quite possibly they were more useful to the instructor than to the students, and even today the bibliography serves as an effective guide to classic research literature, especially in geomorphology.

The book evolved through the four editions from 1951 to 1975 as Strahler continually changed the arrangement of chapters. The second edition had a complete rearrangement of the material (Table 1). In addition to the quantitative geomorphology chapter, the third edition also had new chapters on vegetation. Biogeography was completely absent in the first two editions, and the impetus to introduce this may have come from new competing texts that did include this material (eg, McIntyre, 1966). Although Strahler had no claim to being an expert in the field, the new biogeography chapters were well researched and comprehensive, helped by his acquaintance with the prominent ecologist, Pierre Dansereau, who held a joint appointment in botany and geography at Columbia

(M. Woldenberg, personal communication). The fourth edition introduced new chapters on hydrology, as well as new material on environmental impacts and radiation budgets.

Strahler was also a pioneer in the production of supplementary materials for texts, producing sets of 35 mm slides for sale by Wiley (Thorne, 1952), literally assembling each of the slide sets himself (Alan Strahler, personal communication).

III Impact

Reviews of the original 1951 book were excellent. Writing in the *Geographical Review*, Anastasia van Burkalow of Hunter College noted that 'Professor Strahler's skill in exposition is matched by his skill in drawing simple line diagrams that nevertheless are unusually graphic' (van Burkalow, 1952). In the UK, W.G.V. Balchin's review in the *Geographical Journal* was also enthusiastic about the diagrams (Balchin, 1952). Even John Leighly, in his otherwise depressing 1955 *Annals* account of 'What has happened in physical geography', said 'It is a hopeful sign that one of our best publishing houses has issued an expensively produced textbook bearing the simple title "Physical Geography", whose author frankly invokes the great books by Salisbury and Tarr as his models' (Leighly, 1955).

However, it was Richard F. Logan's review in *Science* that now seems the most perspicaceous from a historical perspective (Logan, 1952). 'This text presents a thorough and refreshingly new approach to the study of physical geography', wrote Logan. 'This book will serve excellently as a text for a course in physical geography, conducted along rigorous scientific lines. It is the sort of book that adds prestige to geography in the eyes of our scientific colleagues.' If this was Strahler's aim, then the book can surely be seen as not just a textbook, but as a quiet and effective manifesto for a new scientific basis for physical geography. Written around the same time as his papers on the statistical analysis of slopes (Strahler, 1950a; 1950b), the book reinforced the message of Strahler's research, albeit at an introductory level. This manifesto became more explicit with the inclusion of quantitative geomorphology in the third edition.

IV Why was it so successful?

Several factors probably contributed to the success of the book. The book was certainly needed in the early 1950s. However, the biggest factor in the continuing success of the book was Strahler's ability to explain complex material in a logical manner. This facilitated clear instruction in a way that students could understand.

The development of materials for his courses was probably the impetus for the textbook, and his course preparations were meticulous. As an instructor, he always went into the lecture room one hour before the lecture. He would make sure that the board was washed. He would then create an outline of the lecture on one board, and then draw all the diagrams that he needed on the other boards. He was ambidextrous, and the diagrams were immaculate, accurate, and quickly drawn. Teaching Assistants were given detailed instruction on exactly how any materials were to be laid out (R. Hordon, personal communication; N. Timoffeef, personal communication).

The lectures were very organized, and filled with lots of information. He did not walk around, nor did he wave his arms. He would not be distracted from the subject material, never expressed personal opinions outside of the subject to hand, and only rarely would a very dry joke emerge. He spoke in a fairly monotone voice, and once told Stanley Schumm that he avoided showing any emotion because he wanted to avoid any impression of bias in his presentations. Students who enjoyed physical geography probably enjoyed his lectures. Others must have found them a challenge. In fact, some students photographed the blackboard and did not bother attending the lecture (N. Timoffeef, personal communication).

It may be surmised from the above that Strahler's commitment to teaching probably arose from his interest in the subject. The logic of his explanations applied, regardless of the students. However, the textbook, particularly the preface of the first edition, does reflect the demographic characteristics of his students, who were mostly young men. Among his students at the time when he was developing materials for the book were many from the West Point Military Academy. His experiences with the West Point students were particularly influential, and colour the cold war rhetoric in the 1951 first edition:

> The preparation of this book has been carried out under the constant realization that our nation faces a great test of military and political strength in the developing conflict with the forces of world communism. With the outcome of this struggle very much in doubt it may be reasoned that any form of education that will strengthen our ability to win a major war must be pursued vigorously while time remains ... Physical geography can provide the fundamental understanding of earth science needed for intelligent strategic and tactical military planning: it can provide in advance the explanation for rigorously prescribed techniques learned in the haste of accelerated military training programs.

Although this rhetoric jars with modern academic sensibilities, Strahler's remarks must, of course, be placed in the context of the time. It is likely that some of the book was developed from teaching materials from his West Point courses (Alan Strahler, personal communication), and in the early 1950s the US Defense Department provided scholarships to a large number of students (M. Woldenberg, personal communication). However, the military context was reduced in the second edition (Strahler, 1960), and is absent in later editions.

V Conclusion

Strahler's book was successful for the following reasons.

(1) The environment was right. The textbook market was rapidly expanding, and the existing leading textbook was seriously deficient. Subsequently, for many years there was no serious competition.
(2) The book was very well written and presented. Strahler took complex concepts, and produced simple, logical, and persuasive explanations. He was willing to use appropriate published sources, but was unconstrained by existing explanations if he found them unsatisfactory. He was a genius who did not allow his own ego to get in the way of the material.
(3) His explanations were very visual. He was a master draftsman, skilled at the art of producing block diagrams, and also a pioneer in the use of supplementary visual materials. He wrote well, but he knew the value of good illustrations.
(4) He was an instructor, not just a textbook writer. Leaving the quantitative material out of the early editions was probably a good idea, and he knew that because he had previously tried to incorporate the material into his undergraduate lectures with little success.
(5) The book evolved with the discipline. Although material was recycled from edition to edition, the 1975 edition is a very different book from that of 1951. The changes from edition to edition were substantive, and both reflected changes in the discipline and also influenced the way that it was taught.
(6) His reputation as a researcher gave the book credibility. Even bearing in mind that most of his influential research was completed by the late 1950s, his reputation continued to grow well into the 1970s, as the quantitative paradigm grew in dominance.

It is certainly unusual for a textbook to have such a long life, and perhaps the argument can be

made that Strahler's *Physical geography* has defined the scope of introductory physical geography at the expense of innovation. The past few years have seen massive growth in geographical hydrology and biogeography. More geographical research is now being published in hydrology than in climatology. Yet, recent editions of Strahler and Strahler (2005), and of similar texts, such as Christopherson (2006), and McKnight and Hess (2008) continue to stress the atmosphere over the hydrosphere, and biogeography is still relegated to a chapter or two.

Despite the continuing success of textbooks based on Strahler's model, some recent textbooks have started a process of deconstruction that may ultimately allow the development of a new view of introductory physical geography. The textbook by de Blij *et al*. (1993), for example, contains 52 short chapters, and a new text by Arthur Strahler's son, Alan Strahler (Strahler and Merali, 2008), uses hundreds of double-page spreads to cover the material. Perhaps the time has come to emulate, rather than imitate, Arthur Strahler's extraordinary achievement.

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