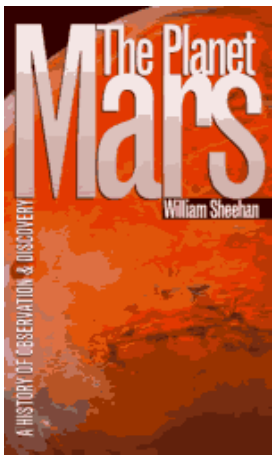


The Planet Mars: A History of Observation and Discovery

William Sheehan

Chapter 9
Opposition 1909

In July 1907, G. V. Schiaparelli wrote a remarkable letter to Vincenzo Cerulli in which he considered the view of a printed page from various distances. He noted that in a first stage, A, the vision is confused and the page appears as a gray square; at a next stage, B, this view is replaced with a vision of geometrical lines; at a third stage, C, one suspects breaks and irregularities; finally, at stage D, one is able to read the individual letters. The relevance of this to the observation of Mars, Schiaparelli wrote, is that

> the first observers of Mars, to 1860, lived in stage A. Since this epoch, Secchi, Kaiser, and Dawes came near to stage B, finding some lines. . . . In the years after 1877 the view produced in me and others was stage B---a vision apparently complete and accurate of single and double lines on the planet. Now, thanks to you [Cerulli], we are entering stage C; the naive faith in the regularity of the lines is shaken, and we have the prospect of yet another stage, D, in which the appearance of lines will resolve into forms of a different order---closer to the true structure of the Martian surface. But will this, then, be the final truth? No; for of course as optics continue to improve, the process will proceed to other stages of vision, or illusion. My thanks to you for the progress you have realized along this stairway.[1]

It is hard to believe that anyone capable of such penetrating analysis would retreat again into the realm of error and illusion, and yet Schiaparelli did just that after studying Lowell's 1907 photographs of Mars. So, apparently, did Cerulli himself. Schiaparelli wrote to E. M. Antoniadi in 1909: "The polygonations and geminations for which you show so much horror (and, with you, so many others) are a proved fact, against which it is needless to dissent. Dr. Cerulli was convinced some weeks ago. I have shown him a series of fine photographs obtained by Mr. Lowell in July, 1907; he was able to see the doubling of the Gehon, the Ganges and several others."[2]

Schiaparelli was now an old man, but he was still active; he observed the planet at the next opposition of 1909. In June 1910, however, he suffered a stroke, and he died in Milan on July 4. His last recorded utterances about Mars, in May 1910, show that he had returned to his long-held views. "I am of the opinion," he summed up, "that the geometrical and regular lines (the existence of which is still disputed by many) teach us nothing at present in regard to the probability or improbability of intelligent beings on the planet. However it would be worthwhile were someone to collect everything . . . that can reasonably be said on the subject. And from this viewpoint, I hold in high esteem the noble-minded endeavours of Mr. Lowell . . . as well as his very perceptive arguments on the matter."[3] He thus died, as he had for so long lived, an agnostic concerning the meaning of the canals and the question of Martian life, though toward the end he was leaning heavily toward Lowell's views.

Though they had nipped Schiaparelli's skepticism in the bud, Lowell's photographs failed to overcome the hardened opposition of W. W. Campbell, Lowell's longtime nemesis and now the director of the Lick Observatory. Campbell wrote to George Ellery Hale at Mount Wilson:

> You have of course noticed that Lowell, the past year or two, has been making much ado in public, and in many matters quite unprofessionally. I have occasionally thought of putting my finger publicly on the weak points, but have serious doubts as to the usefulness of such an unpleasant undertaking. I do not believe that either his photographs or Todd's record any markings on Mars that have not been conceded to exist by experienced observers of the planet for twenty-five years past; and which can be seen with a six-inch telescope better than they have been photographed. . . . I think Lowell and Todd are going to be a trial to sane astronomers. . . . My question is just how far they should be allowed to go before somebody steps on their rope.[4]

In addition to his photographic evidence of canals, Lowell was also touting the spectrographic discovery of water vapor on the planet. During January 1908 the air at Flagstaff had been exceptionally dry, and V. M. Slipher had obtained photographs of the spectrum of Mars which seemed to indicate that the "a" band indicating water vapor (near wavelength 7,150) was strengthened relative to that in the Moon's spectrum. Lowell sent copies of Slipher's plates to the *Encyclopaedia Britannica,* telling Slipher that there "they are sure to go `thundering down the ages'---as Prof. [E. S.] Morse would say---bumping at every obstruction."[5] But Campbell, who had found no definite evidence of water vapor from Mount Hamilton in 1894, was skeptical of this pronouncement as well, telling Hale: "From the first, I have had no confidence in their reported evidence of water vapor, and these spectrograms do not change my opinion. The critical band lies just in the beginning of the region where Slipher's plates fall off exceedingly rapidly in sensitiveness, and we all know very well that in such regions the apparent contrasts may vary widely from the truth, both on the original negatives and the photographic copies."[6] Campbell himself carried out an arduous expedition to the summit of Mount Whitney (elevation 14,495 ft, or 4,418 m) in late August and early September 1909 in order to obtain spectrograms with Mars close to the Earth and next to the Moon in the sky. The result was negative, thus confirming his 1894 observations. Campbell did not claim that there was no water vapor in the Martian atmosphere at all, only that "any water vapor . . . must have been much less extensive than was contained in the rarified and dry air strata above Mount Whitney."[7] His result would stand the test of time; not until 1963 were very minute traces of water definitively detected in the Martian atmosphere.[8]

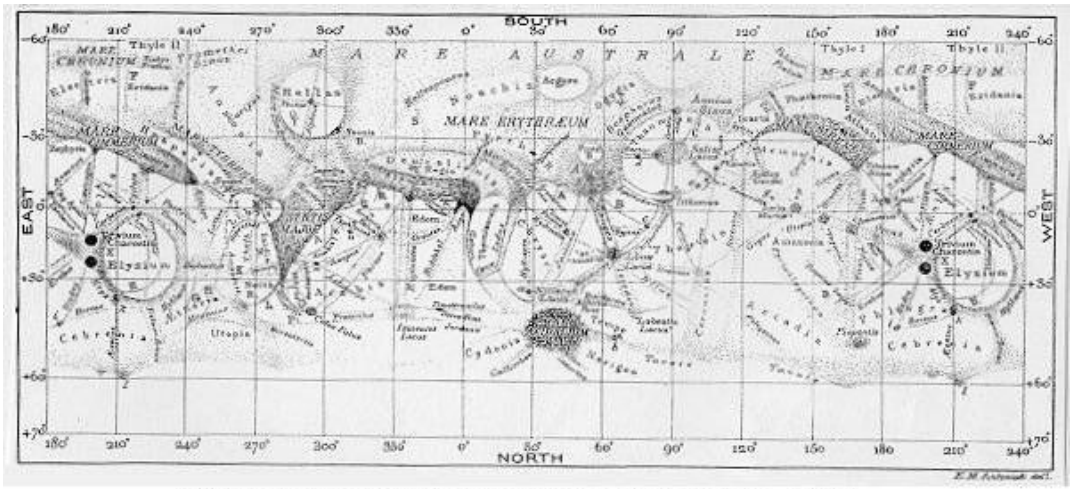
As in 1894, Campbell's negative spectroscopic observations in 1909 created relatively few headlines, at least compared with the visual observations of the planet, which again grabbed most of the attention. By the next time Mars was close to the Earth, Lowell had hoped to have a larger telescope to turn toward it---at least in part to combat the allegation that no large telescope had ever shown the canals. At first he had considered buying another refractor, possibly as large as 50 inches (1.27 m), but the cost estimates proved sobering even to Lowell, and he began "reflecting on the reflector"---this despite having only a few years before declared that "reflectors should be shunned; alluring though they be. . . . [F]or planetary detail they are well-nigh worthless."[9] He discussed plans for an 84-inch (2.14-m) reflector with George W. Ritchey, the brilliant telescope maker then at Mount Wilson, but finally contracted for a more modest 40-inch (1.02-m) reflector with the Clark firm, at that time headed by Carl A. R. Lundin.[10] But Lowell had reflected too long, and the telescope was not ready in time for the September 1909 opposition. In any case, it failed to perform up to expectations, largely because of disastrous seeing brought about by Lowell's novel but ill-advised decision to mount it below ground level.

Lowell was not the only astronomer who hoped to turn a large telescope on Mars in 1909. Eug&#65533;ne Michael Antoniadi (fig. 15), who used the "Grand Lunette"---the 33-inch (83-cm) Henry refractor at Meudon Observatory---to obtain some of the most remarkable views of the planet ever obtained in the prespacecraft era, was another.

Of Greek descent, Antoniadi was born in Constantinople (now Istanbul) in 1870. His interest in astronomy was awakened early. By his late teens he was already observing with a 3-inch (76-mm) refractor at Constantinople and on the island of Prinkipio in the Marmara Sea, and had begun submitting his drawings to the Soci&#65533;t&#65533; Astronomique de France (founded by Camille Flammarion in 1887) and the British Astronomical Association. Antoniadi was a remarkably talented draftsman, and his drawings attracted immediate attention; Flammarion was so impressed that he invited Antoniadi to visit him at Juvisy in 1893, and promptly hired him as an assistant.[11]

E. M. Antoniadi

For a modest salary of 300 francs a month, Antoniadi was expected to observe six nights a week, usually with Flammarion's fine 9-inch (23-cm) Bardou refractor, and to copy all his observations into the official records of the observatory. Antoniadi would leave his residence in Paris, travel to Meudon, and ascend to the observatory by means of a tower so that he could reach the dome without having to pass through Flammarion's private quarters. Mars was the chief interest of both men. Flammarion, who had just published the first volume of his classic *La Plan*[illegible]*te Mars,* regarded himself as the greatest living authority on the planet, and in 1896 Antoniadi had become the director of the Mars Section of the British Astronomical Association (BAA).



British Astronomical Association map of Mars, 1896

In the 1890s, Antoniadi collaborated with Flammarion on several canal-filled maps of the planet (fig. 16). At this time he was convinced of the canals' objective reality. However, his successive Mars Section reports to the BAA show a gradual change in viewpoint. In his report for 1896--97, he noted that "the canals were seen by all the working members of the section invariably,"[12] with Antoniadi himself, who sighted 46 canals, ranking as the third most prolific canalist behind Percy Molesworth and Rev. T. E. R. Phillips. Phillips, observing for the first time with a 9.5-inch (24-cm) reflector, went so far as to say: "My experience of Martian observation this winter has led me to believe that Mars is not nearly so difficult an object as is commonly supposed, and that many of the canals are easy."[13] Antoniadi's experience was somewhat different; at Juvisy he found that "the canals are very difficult objects, visible only in rare glimpses." He added that "but for Prof. Schiaparelli's wonderful discoveries, and the foreknowledge that `the canals are there'," he would have missed three quarters at least of those seen.[14] Nevertheless, though convinced in general of the canals' objective existence, he already found it prudent to throw out the work of at least one embarrassingly prolific enthusiast, C. Roberts, who despite using only a 6.5-inch (16-cm) reflector recorded no less than 134 canals on his highly stylized drawings. Antoniadi explained: "It was thought safer to avoid introducing uncertain data in the general excellence of the section's work, and not overcrowd our already crowded chart with the most daedelian network ever devised."[15] Incidentally, even Roberts's efforts were surpassed by those of the quixotic Serbian astronomer Spiridion Gop_evi_, or Leo Brenner as he called himself, whose 1896--97 map based on observations made with a 7-inch (18-cm) refractor shows 164 canals, including no less than 18 radiating from the small dark spot called Trivium Charontis. Moreover, Brenner claimed to have detected 34 canals using a tiny 3-inch (76-mm) refractor![16]

Antoniadi's next report (1901), on the results of the 1898--99 opposition, includes the following comment: "Notwithstanding the natural skepticism of many scientific men, every opposition brings with it its own contingent of confirmations of Schiaparelli's discovery of linear markings, apparently furrowing the surface of the planet Mars. The difference between objective and subjective in the daedelian phenomena presented by these appearances will be the work of future generations. But the value of the great Italian results will be everlasting."[17] His qualifications were justified, for by now he had become convinced that the geminations---certainly the most sensational of the "great Italian results"---were illusions, the result of focusing errors or mere eye fatigue. (He later retracted this particular theory, but there has never been much doubt that they were an optical effect, apparently involving some kind of astigmatism in the observer's eye---I must admit that I have never seen a fully convincing explanation.) Moreover, his confidence in the whole network had been badly shaken by the "discovery" by Lowell and his assistants of what Antoniadi referred to as "subjective" linear markings on Mercury, Venus, and the Jovian satellites. Whereas in 1898 Antoniadi had stated that "despite the skepticism of several

eminent authorities, I do not hesitate to say that the famous canals of Mars have a true objective existence," by 1902 he characterized his position as "agnostic."[18]

The decisive event had come with his break with Flammarion in that same year, 1902. Antoniadi had just married Katharine Sevastupulo, who belonged to one of the leading families in Paris's Greek community. She may have had independent means. In any case, the marriage was good for Antoniadi; he had frequently suffered from poor health toward the end of his association with Flammarion, but after his marriage his health began to improve. (One suspects that some of his complaints, at least, were psychosomatic; Maunder's wife, Annie, complained that Antoniadi worried too much.)[19] For a while Antoniadi considered becoming an Englishman, but at last he decided to remain in France; he and Katharine found an apartment on the Rue Jouffroy, in one of the most expensive districts in Paris, and there they remained for many years.

One detects a sea-change in Antoniadi's view of the Martian canals after his departure from Juvisy. He still hesitated to place them into the same category as the disputed Lowellian markings on Venus and Mercury, pointing out that "the hard line-likeness of the `canals' is almost sure to be experienced by painstaking observers of the planet; and this circumstance cannot be treated lightly as illusive."[20] Nevertheless, in order to avoid "the possibility of our representation of Mars [being] profaned by doubt," Antoniadi took a decisive step in his Mars Section report on the 1903 opposition.[21] In addition to the customary canal-filled chart that provided a summary of all submitted observations, he prepared another version from which all the canals had been carefully expunged. Maunder wrote of this radical departure: "We seem to have returned to the pre-Schiaparellian age. . . . Is it a retrogression or an advance? . . . Either way we may take it as marking an epoch; for it is practically the first time for five-and-twenty years that a chart of Mars has appeared in which the canal-system was not predominant. Even should it be condemned as unscientific, it would still have an historic importance as marking the growing strength of a reaction."[22]

Over the next several years Antoniadi gave up much of his astronomical work, instead concentrating on an intensive study of the architecture of the Mosque of Saint Sophia in Constantinople that eventually led to the publication of a three-volume work on the subject. Not until 1909 were his abilities as an observer and astronomical artist fully reawakened, when he appeared on the stage to play the greatest role of his life. Henri Deslandres, the director of the Meudon Observatory, placed the Grand Lunette---then, as now, the largest refractor in Europe, and the third largest in the world---at his disposal for the favorable opposition.

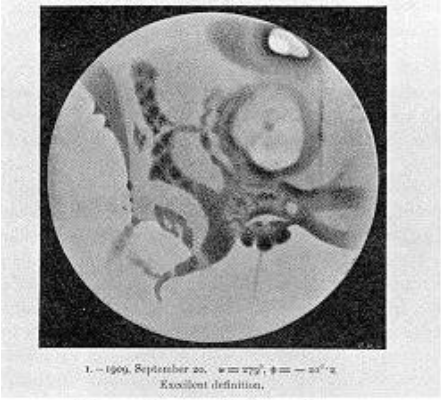
Even before Antoniadi was given this great opportunity, he was already studying Mars with his own 8.5-inch (22-cm) reflector. In August, he found the markings on the planet unusually pale, an aspect he attributed to a veil of "pale lemon" haze. "As far as the outlines of the markings are concerned," he added, "Mr. Lowell's maps are the most accurate ever published."[23] Antoniadi wrote to Lowell shortly before he started work with the Grand Lunette, and by return post received some advice. "I am glad that you are to use the Meudon refractor," Lowell said, but then enjoined him to "remember that you will have to diaphragm it down to get the finest details. Even here we find 12 to 18 inches [30--46 cm] the best sizes."[24]

At Flagstaff, Lowell had found it generally necessary to stop down his 24-inch refractor by means of a diaphragm, usually to 12 to 16 inches. This, he maintained, was because of the presence of eddies in the air, which caused blurring of the images when the full aperture was used. Indeed, he had a valid point; these eddies do exist, and they vary in size from millimeters to tens and even hundreds of meters---the largest of them naturally produce the greatest variations in refractive index, and since a larger telescope samples larger and stronger areas of turbulence, the blurring that Lowell wrote about is quite real.[25] Moreover, there was another advantage to using a diaphragm. All large lenses, including Lowell's own, which has perhaps the finest optical figure of any lens ever made, suffer seriously from chromatic aberration. This causes a planet as seen against a dark sky background to be surrounded with an obnoxious magenta or purplish haze, which is highly deleterious to the perception of fine details. Diaphragming reduces this bothersome effect. I have used the Lowell refractor myself, and based on my experience suspect that the reduction of chromatic aberration, rather than the fact that Lowell was viewing through a narrower, less turbulent light path, accounts for most of the advantage he found in stopping down to 12 to 16 inches.

Before this letter arrived, Antoniadi had already had his first chance with the Grand Lunette, which does not seem to have been equipped with a diaphragm at the time. Though Antoniadi had earlier conceded the superiority of the "ideal

The Meudon Observatory near Paris

definition" at Flagstaff, in practice he found conditions at Meudon more favorable than he had expected. The building housing the Grand Lunette (fig. 17) stands on the edge of a high terrace; to the east there is a sheer drop to the Meudon Park below, so that the seeing is generally very good for objects to the east of the meridian---even objects that are low and rising. To the west there is no such drop, and air currents from the ground exert more deleterious effects, with the result that the seeing often deteriorates rapidly as objects approach the meridian. Under the conditions most apt to bring favorable seeing---with Mars to the east and rising---Antoniadi, on September 20, 1909, made his first observations with the Grand Lunette. There was a temperature inversion that night over Paris; the air had arranged itself into stratified layers that remained stable for seven hours, allowing images of Mars that were simply glorious. It is supremely ironic that Antoniadi's first views of the planet with the large instrument were to prove the best of his career. "The first glance cast at the planet on September 20 was a revelation," he wrote. "The planet appeared covered with a vast and incredible amount of detail held steadily, all natural and logical, irregular and chequered, from which geometry was conspicuous by its complete absence." A "maze of complex markings" covered the south part of Syrtis Major, which was then approaching the central meridian; the deserts of Libya and Hesperia appeared shaded, and Mare Tyrrhenum looked "like a leopard skin."[26] He described the land between Syrtis Major and Hellas as being "like a green meadow, sprinkled with tiny white spots of various sizes, and diversified with darker or lighter shades of green."[27] He later told Lowell that after he got over his initial excitement at the "bewildering" amount of detail visible, "I sat down and drew correctly both with regard to form and intensity all the markings visible. . . . However, one third of the minute features I could not draw; the task being beyond my means."[28]



Drawing of Mars by E. M. Antoniadi, 1909

Five days after these breathtaking views of the planet, Antoniadi wrote excitedly to W. H. Wesley, secretary of the Royal Astronomical Society, "I have seen Mars more detailed than ever, and I pronounce the general configuration of the planet to be very irregular, and shaded with markings of every degree of darkness. Mars appeared in the giant telescope very much like the Moon, or even like the aspect of the Earth's surface such as I saw it in 1900 from a balloon at a great height (12,000 feet)."[29] He continued to observe and draw the planet (fig. 18). He pointed out to Lowell that "the tremendous difficulty was not to *see* the detail, but accurately to *represent* it. There, my experience in drawing proved of immense assistance."[30] Again he emphasized that the detail he was seeing was not in the least geometric; it was highly irregular and completely natural in appearance. "Bewildering" was the word he would use again and again in describing it.

Antoniadi made all of these observations using the full aperture of the 33-inch refractor. In Lowell's view, this was a problem, and he somewhat perversely dubbed "best" the one drawing Antoniadi had marked "tremulous definition." This drawing showed canals, which Antoniadi insisted appeared only by glimpses when the seeing was poor. The other drawings showed the planet as it had looked in seeing that Antoniadi ranked as "moderate," "splendid," and "glorious," but Lowell dismissed these as "not so well defined," and he reminded Antoniadi once again of the blurring problem with large telescopes: "This is the great danger with a large aperture---a seeming superbness of image when in fact there is a fine imperceptible blurring which transforms the detail really continuous into apparent patches. On the other hand, a bodily movement often coincides with the revelation of fine detail. The subject we have carefully investigated here and all of our observers recognize it."[31] Antoniadi politely but firmly disagreed: "I understand from your letter that you consider my knotted Mare Tyrrhenum as due to blurring; but I beg to call your attention to the fact that I was holding steadily this knotted structure; and that two days ago, I found this particular knotted appearance confirmed by photography."[32] Henceforth he became a vigorous advocate of the crushing superiority of large telescopes for visual planetary work.[33]

Antoniadi was a skilled observer. On the other hand, the Meudon telescope suffers from chromatic aberration no less than the Lowell instrument---indeed more so, on account of its greater size. In such an instrument---and this I can say from personal experience---the image of a bright planet like Mars is awash in an obnoxious haze of magenta or violet light.

Lowell's suggestion of a diaphragm was not as unreasonable as Antoniadi obviously thought it, though even better would have been the use of a yellow filter to absorb some of the extraneous unfocused light. And yet there is no arguing with Antoniadi's results, and here, at least, there can be no doubt: with the Meudon instrument, Antoniadi was able to make out faint tones and subtle colors on the planet that were inaccessible in smaller instruments.

In general, Antoniadi found the best seeing at Meudon on nights when it was foggy and quiet. But he enjoyed few nights with perfect seeing---he later estimated only one night in fifty. On most evenings the image was "more or less boiling," but during the less agitated moments of the boiling image the large aperture revealed more than a smaller one would have done. Indeed, good images were "preceded by a period of slight rippling of the disk, very detrimental to the detection of fine detail. The undulations would then cease suddenly, when the perfectly calm image of Mars revealed a host of bewildering details."[34]

Such was his experience on the nights of October 6 and November 9, when he enjoyed brief periods of excellent definition in which he grasped the true character of the Martian deserts. "The soil of the planet then appeared covered with a vast number of dark knots and chequered fields," he wrote, "diversified with the faintest imaginable dusky areas, and marbled with irregular, undulating filaments, the representation of which was evidently beyond the powers of any artist. There was nothing geometrical in all this, nothing artificial, the whole appearance having something overwhelmingly natural about it."[35] In the desert known as Amazonis he had held some of this detail for ten to twelve seconds at a time. Instead of the "hideous lines" that were wont to appear in brief glimpses under conditions of indifferent seeing, he made out "a maze of knotted, irregular, chequered streaks and spots." Even held thus steadily, the features were so complex that Antoniadi despaired of drawing them, though he provided Lowell an impressionistic sketch of what he had seen. There is a striking similarity between this sketch and the *Mariner 9* and Viking imagery, the resemblance of the pattern of windblown streaks around cratered terrain to Antoniadi's sketch being highly suggestive of the real structure of the surface on this part of the planet.

With regard to the canals, Antoniadi believed that, in some cases, there was at least some objective basis to their fleeting apparitions. The Jamuna, which to Schiaparelli had appeared on June 9, 1890, as a narrow line with a breadth of 0.04" of arc, appeared in the Grand Lunette as "nothing like a regular band . . . but rather the mere irregular border of a weak halftone."[36] Other canals were similarly found to consist of "winding, irregular knotted streaks, or broad irregular bands, or groups of complex shadings, or isolated dusky spots, or jagged edges of half-tones."[37] Antoniadi thus felt that his work had provided a partial vindication of Schiaparelli's observations, but he thought otherwise of the Lowellian spiderwebs---those he regarded as absolutely illusory.

After the 1909 opposition, Mars retreated through a cycle of less favorable oppositions, which finally bottomed out with that of 1916. Lowell observed the planet extensively in 1911, 1913--14, and 1916, with both his 24-inch (61-cm) refractor and his newly unveiled 40-inch reflector, but found nothing to cause him to change his views. Meanwhile, he had begun to make plans for the next series of favorable oppositions, which would come in the early 1920s. Among other projects he hoped to mount a joint expedition with the French astronomer Ren" Jarry-Desloges to the Atacama Desert in Chile. But it was not to be. Lowell's colorful career was cut short on November 12, 1916, by an intracerebral hemorrhage. Shortly before his death, he summed up his final views about Mars:

> Since the theory of intelligent life on the planet was first enunciated 21 years ago, every new fact discovered has been found to be accordant with it. Not a single thing has been detected which it does not explain. This is really a remarkable record for a theory. It has, of course, met the fate of any new idea, which has both the fortune and the misfortune to be ahead of the times and has risen above it. New facts have but buttressed the old, while every year adds to the number of those who have seen the evidence for themselves.[38]

We now know from Earth-based charge-coupled device (CCD) images (see chapter 15) and spacecraft photographs that Antoniadi was more or less right and Lowell was wrong. There are no genuine canals on Mars. Schiaparelli, Lowell, and countless others were victims of the "Grand Illusion": under certain conditions of observation, the really complex Martian details appear as a r"seau of fine lines.

Ultimately, the solution to the canal mystery belonged more to the realm of perceptual psychology than to astronomy. The canals were seen by glimpses; they were fragmentary perceptions. To quote Antoniadi, who had seen many of them, as both single and double lines, at Juvisy: "A glimpsed object is not as certain as an object held steadily, and, however

self-evident or trite such a remark may be, yet it is a very important one to make."[39] The periods when a large wavefront of uniform refractive index passes across the telescope aperture typically last on the order of a fraction of a second. Thus, the best seeing often occurs by what Percival Lowell once called "revelation peeps." The effect is exactly like that produced by a tachistoscope, a device used by perceptual psychologists since the turn of the century to study what takes place during interrupted or brief perceptions. The planetary observer waits for the tachistoscope flash, and waits with an expectant mind---just as Sir Ernst Gombrich listened to weak and static-filled radio transmissions during World War II; the interpretation is of "whiffs" of information coming over the airwaves (or in this case light waves). What appeared to many observers as canals and oases was actually the brain's shorthand rendering of what the eye vouchsafed to it in glimpses obtained through telescopes with modest apertures. But there was a further stage along what Schiaparelli had described as the ascending stairway of perception, the stage Antoniadi rendered in the sketches and maps he made with the Grand Lunette. Instead of lines and dots, the characteristic markings appeared as winding, knotted, irregular bands, jagged edges of halftones, and sooty patches. In turn, Antoniadi's view of the planet was itself a tentative---and blurred---vision of what would later be revealed when spacecraft visited the planet and sent back images of the surface.

The canals have been disproved, but they will never be forgotten. They will always remain an important chapter in the history of Martian exploration, not least because of the literature they inspired. Beginning with H. G. Wells's interplanetary invaders and Edgar Rice Burroughs's eerie invocations of Barsoom, the canals and the dying world they were supposedly meant to save inspired much of our early science fiction---and there, at least, they will live on.[40] Moreover, observers, especially those using small instruments, will continue to have fleeting glimpses of the canals from time to time---tantalizing Lowellian moments.

| Next Chapter | Table of Contents | Home Page |

The University of Arizona Press, 2/2/97 2:15PM