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Invasion by Washing Water

D. R. BARBER

Photographic plates contain gelatine as well as silver salts. At a British Observatory the gelatine appears to have attracted unusual phenomena inviting even more unusual conclusions.

In these days of carefully standardized development and lavishly equipped dark-rooms supplied with sterilized mains water, spoilage of photographic material during processing is negligible. In particular, damage to plates, films, or papers caused by bacterial contamination of the water-supply is almost unheard of.

Against such a background the mysterious series of bacterial "events" that occurred at the Norman Lockyer Observatory, Sidmouth, between the years 1937 and 1961 may well raise remarkable questions.

At this hill station in S.E. Devon, England, some 600 feet above sea-level, no mains water-supply is available. Formerly the sole supply for photographic purposes was of rain-water collected from the roofs and cupolas of the observatory buildings. But since 1938, spring water, pumped from low-level collecting pits and filter-bed to a high-level storage tank near the main buildings, has replaced the rain-water supply entirely. On this account alone, processing conditions at the observatory would be regarded as primitive, judged by modern commercial standards.

THE SIDMOUTH EVENTS, 1937-1961

In this 25-year period, no less than six unique events were observed at intervals ranging from 1 to 11 years. Each was marked by the unexpected appearance in rain and spring water of very large concentrations of an extremely rapid gelatine-liquefying organism. When present at maximum concentration, this micro-organism caused major damage to photographic material during the brief interval ($\frac{3}{4}$–1 hr.) between washing and drying the processed plates, or films. The liquefaction of the gelatine base was so rapid that its progress could often be followed visually.

The plate defects produced by the micro-organism were characteristic for each of the outbreaks, namely a distinct "pitting" of the gelatine/silver layer, with clearing of the silver grains at the centre of each pit and their re-distribution around its walls. This resulted in a relatively clear and nearly circular spot surrounded by a narrow zone of higher photographic density. Individual pits varied in diameter from about 0·05 to 0·25 mm. On a severely attacked plate scores of these tiny defects might be visible under low (x 15) magnification, and at higher magnifications a detailed structure could be discerned.

The first appearance of the unusual micro-organisms occurred in the summer of 1937, and activity continued into the autumn of that year. As a result, a total of 32 photographic records of stellar spectra, and other astronomical objects, was damaged to an extent that made them useless for accurate measurement. A recrudescence of activity followed in each of the summers of 1938, 1939 and 1940, and further plate damage resulted, though on a smaller scale. By 1941, all signs of the ultra-rapid liquefying organisms had ceased; only the indigenous slow-acting (*Bacillus fluorescens*) organisms now remained. (These local micro-organisms are quite incapable of liquefying photographic gelatine under normal processing conditions, even when present in high concentrations.)

Subsequent to this first event the precaution was taken to discontinue the use of rain-water (collected off the cupola roofs) in processing photographic material, a practice followed from the observatory's inception.

FURTHER OUTBREAKS

No further trouble from bacterial activity was experienced until, quite suddenly in September 1948, a batch of negatives again showed unmistakable signs of attack similar to those occurring in 1937–1941. Because of a rapid fall in both air, and water temperatures towards the end of the month, the outbreak was short-lived; and by the end of October activity had died out. However, this brief event produced a level of attack of similar magnitude to that observed during the first "invasion."

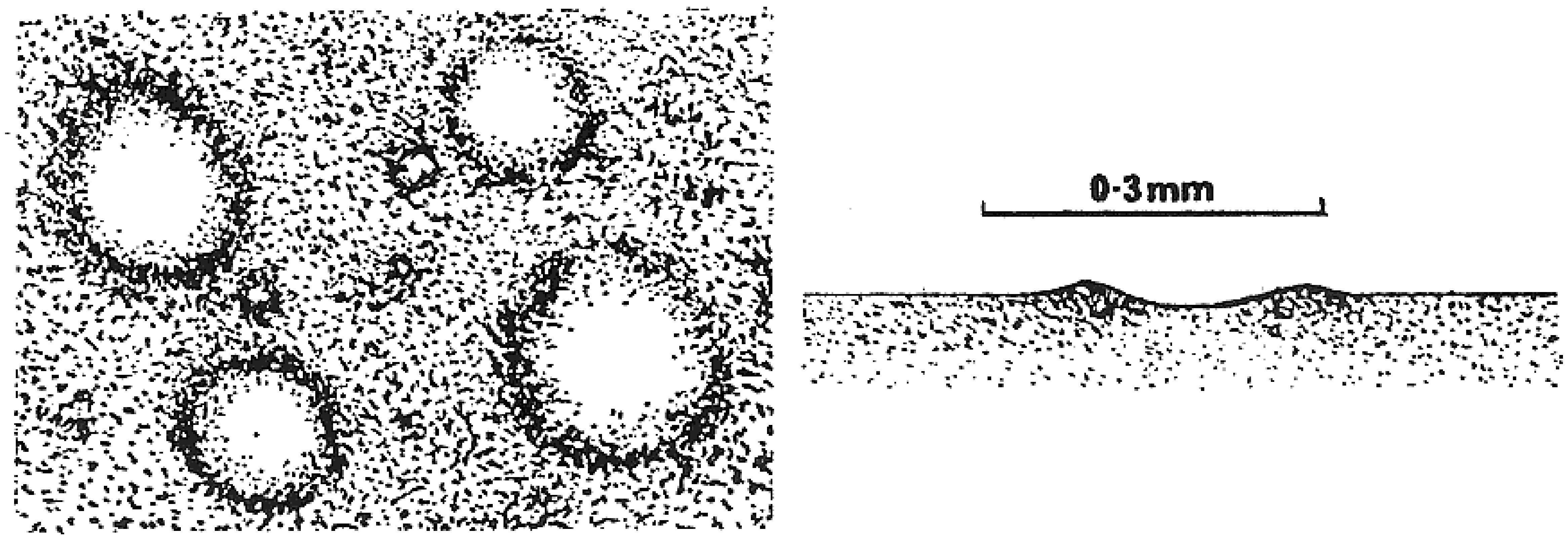
Following the 1948 outbreak, the further precaution ,was taken of disinfecting all water used for photographic purposes. Since this procedure made the detection of subsequent outbreaks from plate examination virtually impossible, a routine water-sampling programme was initiated. The tests were designed specifically to isolate the ultra-rapid liquefying organisms, if present in the raw water-supply—they were carried out at the Area Laboratories of the National Agricultural Advisory Service, Ministry of Agriculture, Fisheries and Food. For the separate identification of both abnormal, and normal strains, samples were incubated at 15°C on nutrient gelatine, and "spot" counts made after 24 and 48 hours respectively after inoculation.

Another long period of bacterial inactivity now ensued, and not until July 1956 did the third event suddenly occur. This outbreak developed very rapidly, and it was again marked by a very high degree of bacterial activity which, however, had died out by the beginning of August. It was notable as being the first occasion on which the unusual water-borne liquefiers were accompanied in both early, and late stages of the event by a very high concentration of air-borne "yeast-like" organisms also capable of rapidly attacking exposed and moist gelatine plates. In point of fact the air-borne organisms easily out-numbered the water type; and it was from the presence of the former that major plate damage resulted. This outbreak was revived, with a second sharp peak of activity, in the late summer of 1957.

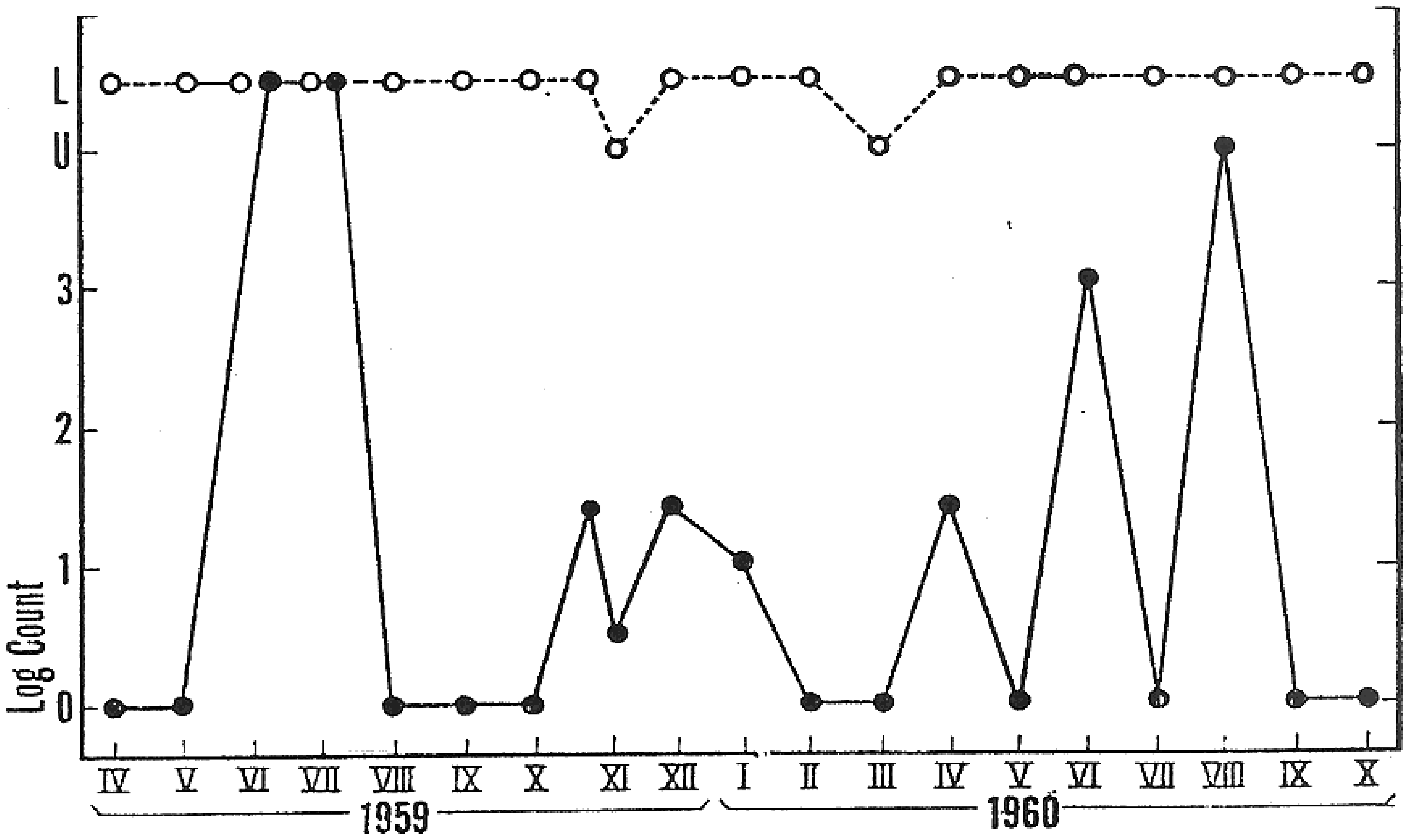
A fourth short-lived invasion of water-

BACTERIAL ACTION PATTERNS

After attack by the ultra rapid gelatine liquefying micro organisms, a processed emulsion showed typical crater like rings with an eroded central zone (left). *The crater structure is also visible in a transverse section through a single defect* (right)*—here at a magnification of about 70×. Silver grains removed from the central areas amass at the edges of the "crater".*



Plots of log counts of gelatine liquefiers recorded during 1959 and 1960 outbreaks. The white circles represent the normal strain (48 hour incubation period) and the black points the ultra rapid strain (24 hour incubation). The level L represents complete liquefication, the level U partial liquefication where no count is possible.



borne organisms was noted in May 1958, and, in 1959, a fifth event—with two distinct spells of activity occurred. The first of these was in the summer months and was short-lived; whilst the second (autumnal) outbreak lasted longer. In both, the concentration of ultra-rapid liquefiers was low. No major damage to photographic material deliberately exposed to attack was noted.

A sixth event—the last of the series of major outbreaks—appeared in the summer of 1961. Activity was moderately intense, although short-lived, and limited once again to water-borne micro-organisms.

BACTERIOLOGICAL INVESTIGATIONS

The potency and rapidity of attack shown by the micro-organisms associated with each of the six events just described together with their intermittent appearance in the local fresh-water supply, made it obvious that the organisms responsible for the damage to photographic material represented a species or strain quite different from that indigenous to the locality.

Moreover, their presence in the photographic plate defects had been confirmed quite early in the investigation by direct staining of the damaged area with weak methylene blue. This simple test revealed the gelatine-liquefying activity to be of a bacillary nature, as was later confirmed microscopically and culturally.

Subsequent to these earlier tests, numerous attempts at identification, some successful and others not so, were commenced in the summer of 1937, continuing thereafter as opportunity availed. Following the 1937 outbreaks, initial studies of the micro-organism were made by members of the Ministery of Agriculture, Fisheries and Food staff at Seale Hayne Agricultural College, Newton Abbot. These were later transferred to the National Agricultural Advisory Service Laboratories, Staplake Mount, Starcross. The various tests applied clearly demonstrated the intermittent presence in the observatory's water-supply of a phenomenally-rapid liquefying strain of *Bacillus* (*Pseudomonas*) *fluorescens liquefaciens*, typed independently by the Lister Institute, and hitherto unrecognized in terrestrial fresh-water types. Because of its extremely rapid action on moist gelatine, and also its complete tolerance of very high concentrations of the normally toxic silver salts[1], the bacterium did not conform with the behaviour pattern already known for the normally-present fresh-water liquefiers.

Later (in 1948), identical organisms were isolated both from water samples and from sections of processed photographic emulsion. From these, pure cultures were successfully obtained, and typed. The results confirmed the 1937 findings, namely, that the responsible bacterium was of quite abnormal type.

Further field work and laboratory tests followed the events of 1956 and 1958 with the assistance of members of the Dairy Bacteriology, and Veterinary Investigation Service staffs at Staplake Mount, Starcross.

AIR-BORNE ORGANISMS

The 1956 invasion followed a somewhat different pattern to that observed in 1937, and 1948. On this occasion the appearance of the ultra-rapid liquefying organisms in the water-supply was preceded (approx. 4 days) by an invasion of extremely rapid air-borne liquefiers having a yeast-like structure. These were first detected in a sample of rain-water collected on July 19. Subsequent to this date very large numbers of the yeast-like organisms were present in the air throughout the main building of the observatory. Exposed nutrient gelatine plates were attacked with great rapidity, and numerous defects in all respects similar to those observed before appeared. The same yeast-like organisms were later found, along with the ultra-rapid *B. fluorescens* type, in water samples taken daily from July 23 to 25. The highest concentration of air-borne contamination was noted between July 25 and 27. Nutrient gelatine plates exposed in the laboratory on these dates were visibly attacked within 20 minutes of exposure, and completely liquefied within an hour. By July 31, the air-borne organisms had disappeared, although water samples continued to indicate their presence up to mid-September. By the end of that month the first phase of the attack was over. A second period of reduced activity commenced in late July 1957, continuing until the end of October.

Several attempts were made at Starcross to propagate pure cultures of the yeast-like organism, but none was successful. It was not possible, therefore, to identify the responsible species.

In the remaining events of 1959/1961, activity, as demonstrated by the liquefaction tests, was again confined to water-borne *B. fluorescens* type organisms: no further invasions of air-borne micro-organisms have been observed.

One further point remains to be discussed. Of the six events reported, Nos. 1, 3 and 5 showed a revival of bacterial activity in the summer months of the year following the primary invasion. This fact may possibly be of fundamental importance in any attempt to establish the origin of the "foreign" micro-organisms, for it is known that the indigeneous fresh-water strain of *B. fluorescens* is not a spore-forming organism. Any carry-over of activity from one season to the next will thus be unexpected. Hence, from the repeated occurrence of multi-peaked outbreaks of bacterial activity in the three events the particular organisms in question was probably either a spore-forming, or other-wise highly-resistant strain. Though closely resembling *B. fluorescens* under the microscope, the abnormal liquefier differed from it in several important aspects. This conclusion will again be referred to in a later section.

A plot of log concentration versus date for both normal, and ultra-rapid liquefying organisms during the severe outbreak that commenced from June 1959 onwards (page 203), shows two distinct periods of enhanced activity, namely June–September 1959, and July–August 1960, when the concentration of the abnormal micro-organisms was so high as to be uncountable on culture plates incubated for the standard period of 24 hours. By contrast, during the whole period, the concentration of the indigenous strain of *B. fluorescens* remained remarkably constant.

WHERE DO THEY COME FROM?

The factual evidence already presented raises several very pertinent questions:

—Is the observed activity of this abnormal liquefier wholly consistent with that expected from a study of known terrestrial strains?

—Why do these micro-organisms show such high tolerance to toxic silver salts in sharp contrast to the reactions of known types?

—If the bacteria are indeed extra-terrestrial, what is the likely source?

An American suggestion that the virus responsible for endemic influenza outbreaks emanated from the planet Venus, led to a fresh examination of the 1937/1948 Sidmouth data, and also to a search among the large collection of spectrograms obtained at Sidmouth prior to 1937 for earlier evidence of bacterial attack. As a result of the latter, two earlier outbreaks—one probable event in 1930, and a second well-determined occasion in 1932—were discovered.

Next, all the available data was analysed in relation to solar activity, and planetary configurations, in particular those of Venus. The results were so unexpected that it was thereupon decided to await further experimental data before attempting any possible explanation. However, a prediction based on the preliminary analysis, that a particularly favourable occasion would fall in the summer of 1956, given a near dated geomagnetic storm, was fulfilled by the event of July 23. And, as it transpired, no less than five more outbreaks were re-

COINCIDENCE OF CONJUNCTIONS, GEOMAGNETIC STORMS AND BACTERIAL EVENTS

Sequence 1		2		3		4		5	
Date	*Events*	*Date*	*Events*	*Date*	*Events*	*Date*	*Events*	*Date*	*Events*
7/2/1926	g	20/4/1929	—	1/7/1924	—	10/9/1927	g	24/11/1922	—
5/2/1934	(b)	18/4/1937	g, b	29/6/1932	g, b	8/9/1935	g	22/11/1930	g (b)
2/2/1942	—	15/4/1945	—	26/6/1940	g, b	6/9/1943	g	20/11/1938	—
31/1/1950	g	13/4/1953	g, b	24/6/1948	g, b	3/9/1951	g (b)	17/11/1946	—
28/1/1958	g, b	10/4/1961	g, b	21/6/1956	g, b	1/9/1959	g, b	15/11/1954	—

The dates are inferior conjunctions of Venus (the planet lying between Sun and Earth). g=concurrent geomagnetic storm; (b)=suspected bacterial event; b=confirmed bacterial event.

corded between 1948 and 1961. Thus it has been possible to extend the original analysis to include this additional evidence.

The final results are summarized in the table above. They amply support the conclusions reached from the preliminary investigation, namely that *each recorded presence of the abnormal micro-organisms* in the local water-supply, or on processed photographic material, *coincided* (with a single unconfirmed exception) *closely in date with an inferior conjunction of Venus and a major geomagnetic storm.* Data for the six major events are summarized in the table on page 207.

This remarkable association of events appears all the more striking when it is realized that, of a total of nine bacterial invasions between 1922 and 1961, only one instance of a suspected outbreak (limited to a single affected spectrogram, with one doubtful defect) fell close in date to an inferior conjunction unaccompanied by a near-dated geomagnetic storm.

By contrast, there were no less than seven occasions in this period when, with equally close conjunction and storm dates, no outbreak of bacterial activity followed. However, this apparent paradox may be readily resolved, without recourse to ad hoc assumptions, from a consideration of the relevant astronomical data.

The planet Venus has a synodic period[2] of 1·6 years. Thus between every fifth similar conjunction an interval of almost 8 years will elapse. In consequence, the dates of either inferior, or superior conjunctions fall naturally into five distinct sequences with all dates in each sequence occurring at approximately the same time of year. Three of these sequences (Nos. 1, 4 and 5) are associated with autumn and winter months, while two (Nos. 2 and 3) fall in spring and summer. Thus the latter may be expected to favour a bacterial event if only because weather and temperature conditions at such times are likely to be more favourable. Indeed, it would seem that the prevalent meteorological pattern for the locality will be of major importance in determining whether or not an outbreak is likely to occur. That this is so is confirmed by the observations, since of the seven occasions when an outbreak was imminent but did not occur, none fell in the spring and summer months. Moreover, local weather conditions preceding each of the six major events exhibited a similar pattern marked by a period of precipitation immediately prior to the onset of bacterial activity, and a wind direction which remained predominantly northerly during the interval between geomagnetic storm and bacterial events.

This latter observation suggests that a northerly surface air-stream is required to transport the air-borne micro-organisms to the locality whence they are brought to ground by rainfall. Indeed, this is what might be expected if the "foreign" bacteria are initially injected into the earth's upper atmosphere together with the solar particles that, at such times, enter the auroral belt some 800 miles north of south-west England. Furthermore, the observed mean interval of time between storm and bacterial events, namely 55 days (below) is compatible with a drift velocity for the cloud of bacteria of about 15 miles per day—a value sufficiently realistic to support the above hypothesis.

THE VALIDITY OF SPECULATION

Much of what has already been said—notably the suggested mode of transporting the cloud of bacteria from Venus to the earth via a solar particle stream—is highly speculative. Nevertheless, it is to the credit of the suggestions just made that the observed facts—presented here it is believed for the first time—are not inconsistent with the idea of an extra-terrestrial origin of the "foreign" micro-organisms.

Even so, whilst it is not impossible that these strange bodies come from somewhere outside of the earth or its atmosphere, it should be stressed that certain difficulties emerge from such a line of argument. It is equally possible that some alternative explanation of the Sidmouth events would prove more satisfactory. But, to the author's knowledge, no such explanation exists.

So we can regard the long-continued

INTERVALS BETWEEN GEOMAGNETIC STORMS AND BACTERIAL ACTIVITY

Event		Date of Onset	Degree of Bacterial Activity	Inf. Conj. Date	Nearest Geomagnetic Storm	Time Lag (Days)
1	a b c	1937 June 5 1938 Aug. 31 1939 Feb. 6	Water-borne infection very severe in first phase, less severe in recurrent outbreaks. Long continued activity.	1937 April 18	1937 April 24–25* 26–27	41
2		1948 July 26	Severe.	1948 June 24	1948 May 21–22	66
3	a b	1956 July 23 1957 July 28	Water-borne infection preceded by air-borne yeast like organisms. Very severe in initial stages.	1956 June 22	1956 May 23–25	61
4		1958 May 8	Relatively slight and short lived.	1958 Jan. 28	1958 Feb. 11*	57
5	a	1959 June 17	Moderate and short lived.	1959 Sep. 1	1959 May 11–12*	35
	b	1959 Nov. 2	Slight but long continued.		Sep. 3–4	59
6		1961 June 21	Moderately severe; short lived.	1961 April 10	1961 April 14–15	67

*Signifies "great" geomagnetic storm.

observations of sporadic damage to processed plates and films, as described, as presumptive evidence of the occasional presence in rain-, and spring-water of viable bacteria capable of attacking gelatine with extraordinary rapidity. Perhaps they may be of extra-terrestrial origin. The latter statement rests mainly on the remarkable association found between invasions of the "foreign" organisms, inferior conjunctions of the planet Venus, and severe geomagnetic storms; and also on their complete tolerance to highly toxic silver salts in contrast to the lethal effects of these same salts on normal types of gelatine-liquefying bacteria. Furthermore, the invading organisms showed strong fluorescence in ultra-violet light, a reaction that might well be of positive survival value on passage through free space.

Notwithstanding all this favourable evidence, definite confirmation of a spatial origin for these living bacteria must clearly be sought in a direct observation of organisms, similar in all respects to those described here, whilst in transit between Venus and the earth. This could doubtless be made from an orbiting satellite vehicle; but until data of this kind is available the origin of the mysterious invading bodies must remain unknown.

Finally, there is the not unnatural question: "why have there been no reports of similar happenings in other localities?" The only answer is that very few instances of conditions at all similar to those experienced at the Norman Lockyer Observatory are likely to be found elsewhere. Indeed, had photographic work at Sidmouth wholly followed conventional practice, it is safe to infer that the "foreign" invaders would not have been spotted.

For the benefit of the science fiction addict it may be worth remarking that such a bacterial invasion—if that is the true explanation—is an infinitely more elegant way of interplanetary travel than all the marvels of modern rocketry. A wider implication of this idea however may raise fundamental questions of the very origin of life on this or any other particular planet.

The author records with pleasure his sincere thanks to several professional colleagues of the Advisory Services of the Ministry of Agriculture, Fisheries and Food, at first stationed at Seale-Hayne Agricultural College, Newton Abbot, and later at Staplake Mount, Starcross, Devon, for their sustained interest and collaboration during the long-term investigations.

Factual data obtained directly from cultural, and gelatine-liquefaction tests, etc., which they made are quoted here with the permission of the Deputy Directors of these Services (Veterinary Investigation, and Dairy Bacteriology) of the Ministry.

The author wishes to thank also the Observatory attendant, Mr. A. J. Denner, for his invaluable help in collecting the numerous water samples required for the routine tests.

[1]None of the large number of photographic plates attacked by the micro-organism showed any selective action with respect to photographic density. Frequency of attack, as judged by "pitting", appeared quite similar in the densest silver deposits to that found in the fog background (clear zone) of the plate.

[2]The synodic period is defined as the interval of time elapsing between successive inferior, or superior conjunctions of the planet with the Sun. At inferior conjunction, Venus lies between Sun and Earth.