example, consider a computer. No one would dispute that a power supply is essential. Even for a perfectly efficient computer, thermodynamics tells us that it takes at least $kT \ln 2$ energy units to erase a bit, where T is the temperature and k is the Boltzmann constant. But the need for power tells us nothing about what makes a laptop different from a washing machine. To understand how a computer works, and what it can and cannot do, requires the theory of computation, which is a logical theory that is disconnected from thermodynamics. The power supply can be designed by the same person who designs them for washing machines.

The key point is that, although the second law is necessary for the emergence of complex order, it is far from sufficient. Life is inherently an out-of-equilibrium phenomenon, but then so is an explosion. Something other than non-equilibrium thermodynamics is needed to explain why these are fundamentally different. Life relies on the ability of matter to store information and to implement functional relation-

ships, which allow organisms to maintain their form and execute purposeful behaviours that enhance their survival. Such complex order depends on the rules by which matter interacts. It may well be that many of the details are not important, and that there are general principles that might allow us to determine when the result will be organization and when it will be chaos. But this cannot be understood in terms of thermodynamics alone.

Understanding the logical and physical principles that provide sufficient conditions for life is a fascinating and difficult problem that should keep scientists busy for at least a millennium. Thermodynamics clearly plays an essential part, and it is appropriate that the authors stress this — many accounts of the origin of life are easily rebutted on this point. But it isn't the principal actor; just one of many. The others remain unknown. ■

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worked in a UK institute and at the World Health Organization (WHO). He repeatedly asserts that these illegals provided the Soviet Union with "significant" information.

Kouzmanov does provide some information on his agency's work. He describes how Westerners were targeted for recruitment by the KGB, and discusses the recruitment process and the means whereby data collected by agents and illegals were transported from the West to the Soviet Union. These procedures have previously been described by defectors and students of the Soviet intelligence system, and Kouzmanov's book adds little to the story already in the public domain. Disappointingly, it provides almost no information on how the KGB transformed the data into intelligence, and how this was then used.

According to Kouzmanov, individuals were deployed in the West and given numerous objectives related to spying on national programmes. For example, he describes a husband-and-wife team who, while operating a mock medical practice in Germany, were told by the KGB "to establish the locations of all NATO installations; their command personnel...air-force bases, and cruise-missile and rocket sites". It is doubtful that two individuals could accomplish all this. And Kouzmanov's explanation that the KGB placed agents in the WHO to obtain information about the "development of vaccines against the most dangerous human and animal viral diseases" seems rather lame, given that anyone could obtain this information simply by telephoning WHO representatives.

The author further alleges that around 1980 a KGB agent was placed inside the US Army Medical Research Institute of Infectious Diseases at Fort Detrick, Maryland, and that another agent was employed by an unnamed British institute (probably the National Institute for Biological Standards and Control, which was not engaged in biodefence). What did these agents do? Did they provide information about US and UK defensive efforts that might be used by the Soviet bioweapons programme? Did they inform their superiors that neither country actually had an offensive programme? Perhaps they provided information on the development of vaccines that might have been useful to the Soviet defensive programme?

In fact, Kouzmanov provides little information on the accomplishments of these and other agents in the biological field. Nor does he identify the Soviet research institutes with which the KGB allegedly collaborated in an effort to create more potent bioweapons, despite the fact that many of them are known today to Western security and academic communities.

Kouzmanov describes himself as a biophysicist with a microbiological background, so it is surprising how many technical mistakes he makes. For example, he misidentifies the bacteria *Bacillus anthracis* and *rickettsiae* as viruses, and misspells agents such as *Francisella tularensis* and *Yersinia pestis*.

Russia's secret weapons

Biological Espionage: Special Operations of the Soviet and Russian Foreign Intelligence Services in the West

by Alexander Kouzmanov

Greenhill: 2005. 192 pp. £12.99, \$19.95

Jens H. Kuhn, Milton Leitenberg & Raymond A. Zilinskas

In 1992, President Boris Yeltsin admitted that the former Soviet Union had supported a secret biological-warfare programme, in violation of the Biological Toxin and Weapons Convention, which the Soviet Union ratified in 1975. Some of the researchers and officials who operated the programme, such as Ken Alibek, Igor Domaradskii and Serguei Popov, have provided personal accounts that shed light on the clandestine system. However, the compartmentalization and secrecy so prevalent in the former Soviet Union mean that such accounts describe only a fraction of the nation's bioweapons programme. Almost nothing is known about the biological-warfare activities of the Soviet ministries of defence, health and agriculture, the security agencies and the national academies.

As a result, any new information on the roles of these agencies in the Soviet bioweapons programme is welcomed by those who are concerned about whether Russia is continuing with its bioweapons programme. This is the backdrop to the publication of a book by Alexander Kouzmanov, a former KGB agent, who claims to provide new and important information about the role of the KGB in the Soviet bioweapons programme. So, what do we learn from it?

Kouzmanov describes himself as a former employee of the top-secret Department 12 of

IMAGE
UNAVAILABLE
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REASONS

In the dark: the bioweapons programme run from KGB headquarters has remained largely secret.

Directorate S, the elite inner core of the KGB First Chief Directorate, which was responsible for operations abroad. One of the responsibilities of this department was to oversee 'illegals' — Russian intelligence operatives masquerading as Western nationals. Illegals were deployed to spy on Western biodefence activities, procure microbiological agents of interest for Soviet bioweapons research and development, and to perform acts of bioterrorism and sabotage. Kouzmanov was a case handler for several illegals, including some that allegedly

Some of Kouzminov's claims are reiterations of stories that have been told before and have yet to be substantiated. For example, he alleges that the Soviets used *B. anthracis* and *F. tularensis* against German troops in the Second World War — an often-repeated story that has not been verified but has been discounted by microbiologists on the basis of epidemiological analyses. Kouzminov also asserts that Soviet agents obtained marburgvirus samples by exhuming victims of the first recorded outbreak of marburgvirus disease in Germany in 1967. But documentation of the official exchange of marburgvirus strains between German and Soviet microbiology institutes is publicly available.

Other claims, especially those in the final chapter, seem bizarre. If Kouzminov is to be believed, almost every outbreak of a new or

emerging infectious disease in the past 15 years — including the outbreak of foot-and-mouth disease in Britain in 2001 and the severe acute respiratory syndrome (SARS) pandemic in 2003 — may have been either a deliberate bioweapons attack or an accidental release of a genetically engineered microbe from a bioweapons facility. He also implies that the causative agents of hantavirus pulmonary syndrome were genetically engineered specifically to attack Native Americans. That allegations such as these would be made by a professional scientist in the face of a huge body of literature that seems to contradict them is astonishing.

It seems surprising that an insider can write a book about the special operations of Soviet foreign intelligence services in the West and provide so little about their achievements. At

best, *Biological Espionage* is the personal memoir of a former Soviet employee who writes about the practices of Soviet and Russian intelligence agencies in the biological field but provides little evidence of their accomplishments. Why was it written in the first place? If not to inform, then perhaps to misinform? ■

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Surface tensions

A reinterpretation, using damaged photographs, of a failed attempt to fly to the North Pole.

Colin Martin

Danish artist Joachim Koester recalls an ill-fated attempt to reach the North Pole by hydrogen balloon in his film installation at the 2005 Venice Biennale, *Message from Andrée*. It was inspired by the story of Swedish engineer Salomon August Andrée, whose balloon, optimistically named *The Eagle*, crash-landed in July 1897 a few hundred kilometres north of the Norwegian island of Spitsbergen, three days after taking off from Danes Island.

Andrée and his companions — another engineer, Knut Frænkel, and a physicist, Nils Strindberg — trekked across pack ice for three months, but failed to reach Franz Josef Land before the onset of winter. They died on White Island in mid-October. Their bodies and equipment were not found until August 1930, when an account of their misadventure, based on Andrée's diaries and Strindberg's notebooks, was published as *With the Eagle to the Pole*.

Strindberg had taken more than 100 pictures, using photographic plates with an expiry date of 1 January 1898. Remarkably, the exposed plates survived for 33 years and photographs were printed from them. Some, showing the aeronauts beside their damaged balloon and scenes from their trek, were re-touched to remove surface marks and were reproduced in the best-selling book.

Historians studying the photographs in the Andrée museum at Gränna also ignored this superficial layer of 'visual noise'. But Koester has used it to reinterpret the archive, by re-photographing many images with a 16-mm camera and producing a short

sequence of animated film. "If language defines our world, the black dots and light streaks on the photographs can be seen as bordering on the visible...pointing to the twilight world of what can be told and what cannot be told," he explains.

The jerky, random movements of the surface marks do not provide a definitive narrative, but Koester's film hints at the men's subconscious uncertainty, contrasting their innermost thoughts with the stoic 'public' thoughts conscientiously recorded in their journals.

In a catalogue essay on Koester's artistic response to the tragedy, Anders Kreuger characterizes nineteenth-century polar exploration as "a theatre of vanity and

GRÄNNA MUSEUM

Joachim Koester uses surface damage to photographic plates (left) to tell the tale of Salomon August Andrée's failed balloon flight to the North Pole.

delusion", inspired as much by Jules Verne's imagination as any defined scientific purpose. In retrospect, the notion of inexperienced aeronauts taking off into the Arctic wilderness in a hard to manoeuvre balloon, dependent on a strong southerly wind for their progress, seems foolhardy at best.

During their arduous trek across the pack ice, Strindberg coped psychologically by making endless lists: of the meals they ate, the equipment they carried, and, most poignantly, their ideas for improving future expeditions. In contrast, the incoherent short phrases and single words of Andrée's last diary entries have an abstract quality matched by Koester's film. The film, which can be seen in the Danish Pavilion at the Venice Biennale until 6 November, shifts the focus of Strindberg's images from the intentional to the accidental, reconfiguring a photographic narrative into a powerful affirmation of human endeavour in adversity. Colin Martin is a London-based writer.