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Detta fax består av _____ sidor, försättsbladet inräknat. Vid felaktig överföring var god ring telefonnr ovan. / This fax contains 4 *pages, this page included.*
Please call the telephone number above if [illegible] in the transmission.

13/8 - 93

Dear Matt,

Thank you very much for your kind and rapid help!

I tried to get the information you asked for from FOA, today. Unfortunately, the people who know about it are travelling and/or on vacation! I will try again next week. In the mean time I send you a couple of pages from the small FOA booklet on BW, in case you do not have it available. If you so wish I could send you a copy of the whole booklet by mail next week. (Excuse the bad copies, but I had not a good copier available. Hope they suffice, though!)
I will in any case send you a copy of the SIPRI article on bio technology, which Tamas Bartfai, Bo Ryberg and I have written, if you have not already obtained the latest SIPRI yearbook. I would very much appreciate your views on it, if you have the time, some time.
All the best!

/Johan

AUG 16 1993

FOA orienterar

om

This is the fourteenth of a series of publications presented by Försvarets Forskningsanstalt (FOA) (The Swedish National Defence Research Institute) in June 1986 and deals with

Biological Warfare Agents

This publication is a special issue translated into English of one number of a popularized series concerned with research fields of interest to the Swedish Defence.

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Åke Bovallius
Director of the NBC Department
The Swedish National Defence Research Institute (FOA):

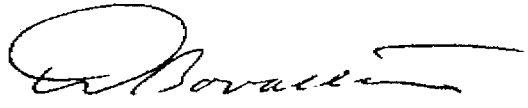
Biological Warfare Agents

During the 1960's and 1970's the NBC weapons (Nuclear, Biological and Chemical Weapons) – and especially B-weapons – attracted little attention in Swedish defence planning. As a result knowledge of biological warfare agents was reduced both within the total defence as well as to the general public in Sweden, a state of affairs which led in turn to inadequate protection against these so-called unconventional weapons.

Of the NBC weapons the biological (B) are probably the least known. Nuclear (N) weapons, especially, but also chemical (C) warfare agents have featured far more prominently in the media and international debate. There are international agreements prohibiting the use (1925), the development, manufacturing and storage (1975) of B-weapons and the agreements have been signed by more than 100 states. But the conventions contain no agreements on control procedures because it is very difficult to verify preparations for the use of BW agents even on a relatively large scale. This creates uncertainty as to how the conventions are observed and as to whether BW agents in some form or other might in any case be used in a future war. This uncertainty has led to rumours and claims that countries have access to, or are using, B-weapons in covert form. Generally, however, it has proved impossible to verify or refute accusations of this kind. The microbiological, biomedical and genetical sciences have undergone rapid development in recent years, creating new possibilities of using B-weapons as well as improving the means of protection against them.

In Sweden – which neither possesses nor intends to acquire B-weapons – The Swedish National Defence Research Institute (FOA), Department No. 4 at Umeå, has been entrusted with the responsibility for observing developments in the field of B-weapons and of contributing to improved protection.

More than 20 years have elapsed since FOA issued information on B-weapons in this series of publications (BC warfare agents, 1964). Since then much has happened in this field, unfamiliar to so many people, and there is good reason to present up-to-date information. In this series we endeavour to issue information in a straightforward and simple fashion, but without making any concessions with regard to accuracy and reasonable coverage. We try to avoid unnecessary difficulties in the text and we supplement with illustrations to facilitate comprehension. I trust that this publication will be of assistance to those who need or desire to obtain a survey or general knowledge of BW agents and of protection against them.



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Contents

FRONT COVER: Portrait of a merchant, detail of the left wing of the Darmstadt Madonna altarpiece, oil on limewood panel, about 1526, by Hans Holbein the Younger (1497

B-weapon	
Tularemia bacteria	0.000 000 000 000 3 g
CW-agents	
Nerve gas	0.000 1 g
Botulinum A toxin	0.000 000 3 g
(from the bacterium Clostridium botulinum)	

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micro-organisms it is sometimes necessary to resort to methods other than freeze-drying. Storage durability varies between micro-organism and storage methods. The limited period of storage can involve a problem, but the simple cultivation technique permits the required quantity to be produced within a very short time.

Control and inspection of B-weapon production

The truly large plants for the cultivation of micro-organisms can be difficult to keep secret due to numerous highly-qualified staff and the extensive equipment required. If continuous cultivation can be utilized, the demand with respect to the size of the plants is reduced and thereby the risk of discovery. The existing possibility of control is direct inspection on site, a condition which the powers negotiating on the limitation of arms could not agree on. Small scale production and storage is practically impossible to check.

o-organisms.

mainly for bacteria which produce spores.
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the higher temperatures but involves the death

y method, complicated and costly
ing and drying, a method offering great advanta-
irulence and viability can take place after some

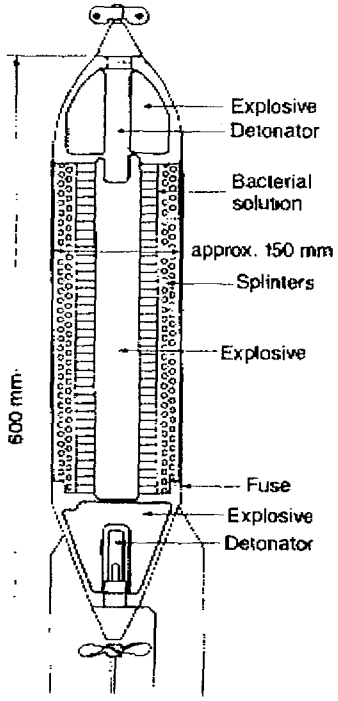
Dispersion and Propagation

Biological weapons can assume liquid or powder form for dispersion in many different ways. Independently of the scale of a B-attack, different methods of dispersion can be utilized. In the first instance B-weapons can be dispersed via the air and foodstuffs/water, but also via insects and infected materials. In cases when the B-weapon gives rise to an infectious disease this can be spread further, e.g. from person to person.

Dispersion in the atmosphere

The B-weapon can be dispersed by means of a spray unit or by the detonation of the container.

Example of a biological bomb. The drawing shows a type known as the Ishi bomb.



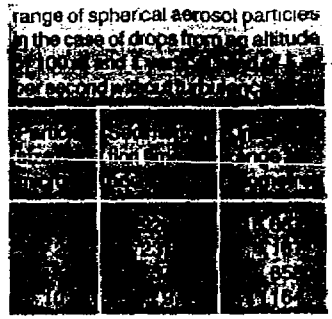
Spray units can be found in or dropped from aircraft, helicopters, missiles, robots and ships. Aerosol generators for sabotage use – including self-actuating types – can be camouflaged in small containers such as hair spray containers, fountain pens, cigarette lighters, etc.

When the B-weapon is dispersed by means of an explosion, many different kinds of weapon carriers can be used. Some examples are artillery shells, flying bombs and land mines. For dispersion in the atmosphere the ideal method is a fine-particle aerosol cloud containing living micro-organisms. To cause infection by inhalation the particle size should be 1–5 µm.

In the case of liquid aerosol created by an explosion the particle sizes are not homogeneous. Furthermore, some of the micro-organisms are destroyed by the heat and the pressure wave from the explosion. Nevertheless dispersion by explosion can cause a sufficient number of infection doses. With a spray unit it is simpler to obtain drops or particles of a specific size. Spraying – mainly of liquid aerosols – also causes damage to certain proportion of the micro-organisms.

Particle size and meteorological factors in addition to the nature of the terrain influence the propagation of the aerosol outdoors. Indoors it is mainly the ventilation pattern which is of importance. In both cases the aerosol is diluted in the course of time.

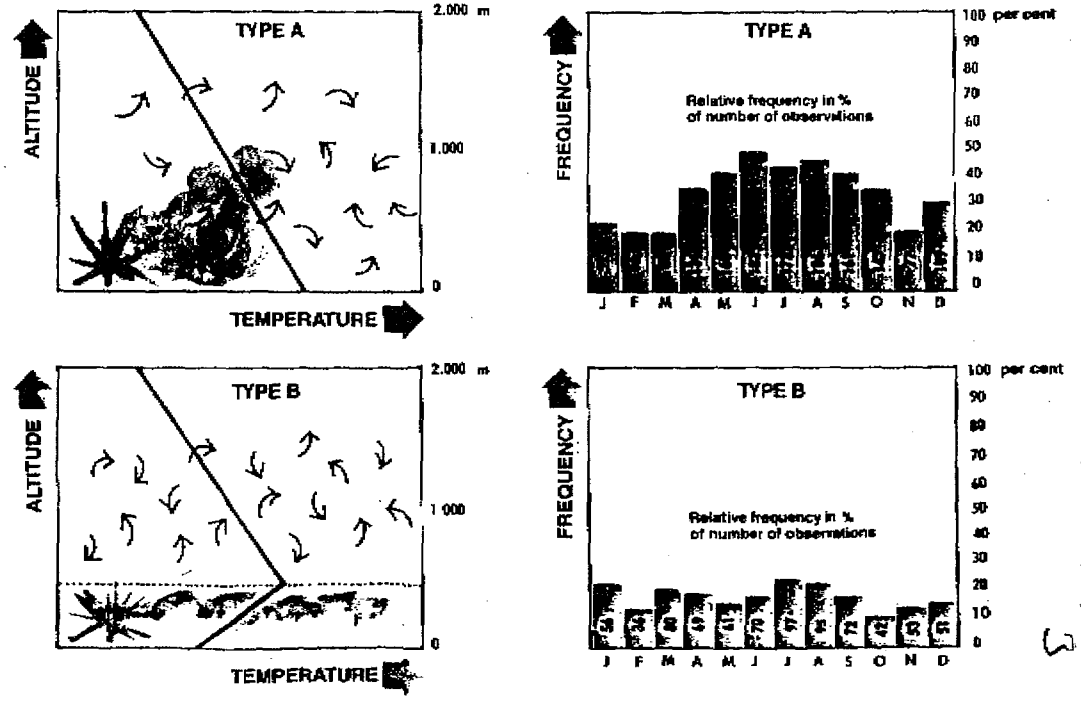
The rate of fall of microbiological aerosols is generally very low. The particles therefore follow the prevailing air currents and outdoors it is thus the meteorological conditions – atmospheric layers, wind force, the direction of the wind, turbulence, etc. – which determine how the aerosol is transported.



Rate of fall of aerosol particles.

The behaviour of the aerosol is dependent on the vertical air temperature gradient. When the atmospheric layers are unstable the particles are swept up to relatively high altitudes. The dilution

Frequency of unstable (A) and stable (B) layers in the atmosphere. (After S B Nordström, MVC.)

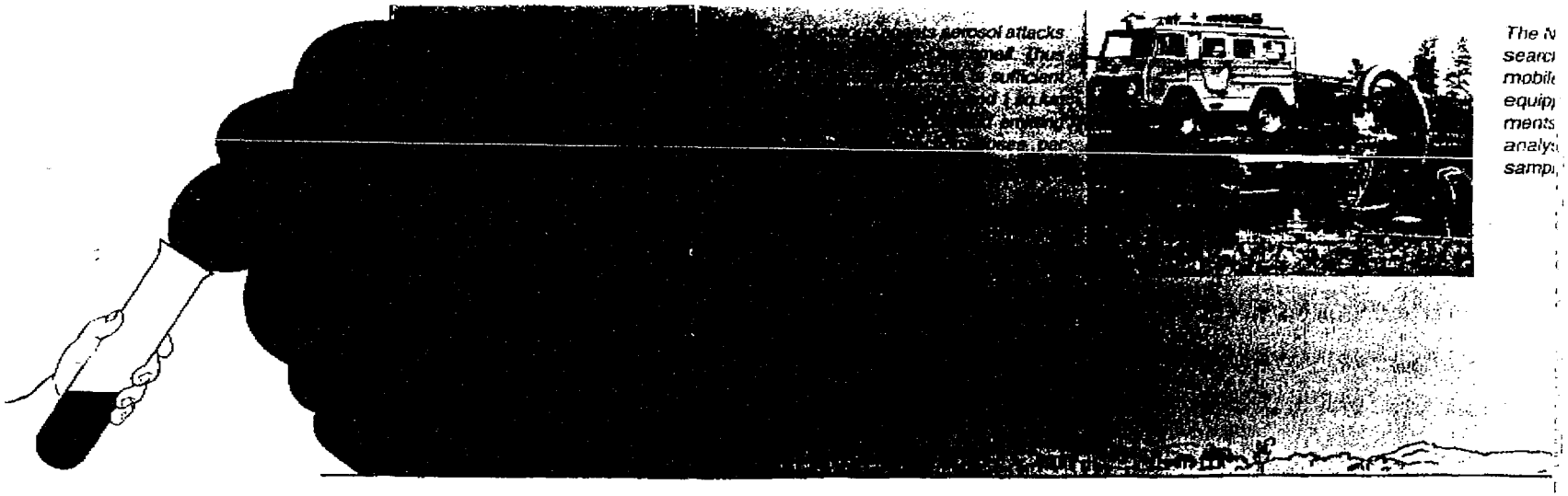


of the aerosol is rapid and the concentration diminishes swiftly in relation to the distance from the source of dispersion. This type of layer structure is most prevalent during the day time in summer. When the layers are stable the particles remain collected and the concentration is higher. This type of structure is most usual at night in clear weather and little wind (see figure on previous page).

The meteorological situation thus varies during the 24-hour period, for which reason the time of dispersion is of great importance.

The landscape also influences propagation. Flat open countryside is more favourable to propagation than hilly regions. In valleys, bogs and over water surfaces the aerosol can linger after the aerosol cloud itself has passed. In forests and built-up areas only a part of the cloud penetrates while the greater part passes above or to the side. If, on the other hand, the aerosol is dispersed at ground level in forests or in densely built-up areas, the cloud can remain in position and be effective during longer periods.

To begin with, houses and buildings provide some protection against a drifting aerosol, but if it should seep in, it can remain inside for a relatively long period. This means that a person who remains indoors during a B-attack and fails to ventilate properly after the aerosol cloud has drifted past, can inhale as much infectious agent as if he had remained in the open air throughout the attack.



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Micro-organisms which are dispersed via aerosol can be deposited on surfaces. Materials, premises, foodstuffs, water and terrain can be dangerously infectious long after the attack itself. In the case of transports across exposed terrain micro-organisms can be swept upwards and again become airborne. These secondary aerosols can once again cause infections.

The micro-organism's chances of survival in the atmosphere are mainly dependent on its capacity to tolerate sunlight (UV radiation) and to resist drying. Some can survive for decades, e.g. the spore-forming bacterium *Bacillus anthracis* (anthrax), whereas other micro-organisms have survival periods of only a few minutes. Indoors the micro-organisms are not affected to the same extent by the environmental factors mentioned above, something which can raise the risk of infection. The survival possibilities for micro-organisms can be greatly increased if they are enclosed in protective substances (micro-incapsulation).

Theoretical calculations indicate that in a large-scale aerosol attack B-weapons can be spread over large land areas. Small local attacks can result in the efficient spreading of infections in limited areas.

For large releases the micro-organisms can be transported long distances. In 1969 the Swedish National Defence Research Institute registered raised concentrations of micro-organisms in the atmosphere. With the aid of simulat the weather making soil an of dispersion with the Black nection with a

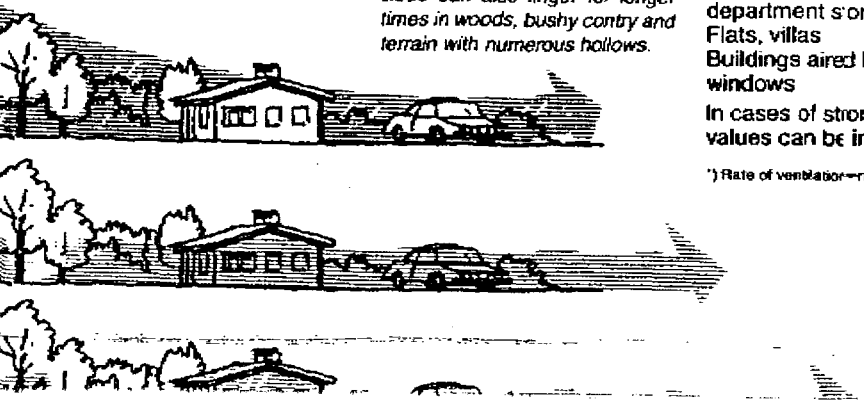
In buildings and vehicles the effects of a drifting aerosol cloud are delayed. In time the cloud penetrates — somewhat diluted — and remains there for a long time. For this reason the dosage can amount to the same value as without a delay. The aerosol cloud can also linger for longer times in woods, bushy contry and terrain with numerous hollows.

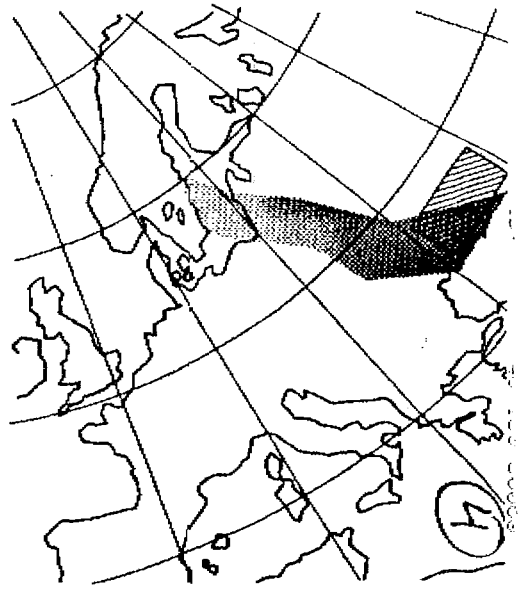
Examples showing how the rate of ventilation*) can vary in different types of buildings.

Type of premises	Rate of ventilation
Public buildings with good ventilation, shops, department stores	2—3
Flats, villas	0.2—0.7
Buildings aired by open windows	6—11

In cases of strong winds these values can be increased tenfold.

*) Rate of ventilation=rate of change of air per hour.





Dispersion calculations show the transport route for fine sand which fell on a number of places on the east coast of Sweden some years ago. The grey rectangle indicates the area along the Black Sea where sandstorms were reported during the period in question.

Dispersion via foodstuffs

A B-attack via foodstuffs can be launched in many ways. Because most micro-organisms are sensitive to heat, it is likely that the attack would take place via rect consumption. Important points of attack are to be found in the production, distribution and consumption cycles, e.g. butchers, dairies, fresh goods

food is serv able for disp are those wh humans via t These inclu *Shigella sp.*, *Campylobac* Contrary t