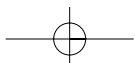
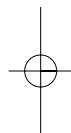
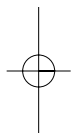


Chemical and Biological Warfare



Chemical and Biological Warfare

A COMPREHENSIVE SURVEY FOR THE CONCERNED CITIZEN

ERIC CRODDY

WITH CLARISA PEREZ-ARMENDARIZ AND JOHN HART

C

Copernicus Books
An Imprint of Springer-Verlag

© 2002 Springer-Verlag New York, Inc.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher.

Published in the United States by Copernicus Books,
an imprint of Springer-Verlag New York, Inc.
A member of BertelsmannSpringer Science+Business Media GmbH

Copernicus Books
37 East 7th Street
New York, NY 10003
www.copernicusbooks.com

Library of Congress Cataloging-in-Publication Data

Croddy, Eric

Chemical and biological warfare : a comprehensive survey for the concerned citizen / Eric
Croddy with Clarisa Perez-Armendariz and John Hart.

p. cm.

Includes bibliographical references and index.

ISBN 0-387-95076-1 (alk. paper)

1. Chemical warfare. 2. Biological warfare I. Title.

UG447.C755 2001

355'.34—dc21

2001054929

Manufactured in the United States of America.

Printed on acid-free paper.

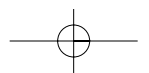
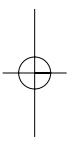
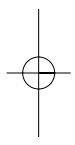
9 8 7 6 5 4 3 2 1

ISBN 0-387-95076-1

SPIN 10771289

Contents in Brief

PART ONE: GAS, BUGS, AND COMMON SENSE	I
Chapter 1: The Fog of War	3
Chapter 2: Who Has These Weapons?	19
Chapter 3: Threats and Responses	63
 PART TWO: CHEMICAL AGENTS	 85
Chapter 4: Basic Concepts	87
Chapter 5: Chemical Warfare: A Brief History	127
Chapter 6: Control and Disarmament	169
 PART THREE: BIOLOGICAL AGENTS	 191
Chapter 7: Basic Concepts	193
Chapter 8: Biological Warfare: A Brief History	219
Chapter 9: Control and Disarmament	237
Chapter 10: Vaccination and Biological Warfare	249



Contents

PREFACE	XVII
ACKNOWLEDGMENTS	XIX
INTRODUCTION	XXI
<i>How This Book Is Organized</i>	XXII
PART ONE: GAS, BUGS, AND COMMON SENSE	I
Chapter 1: The Fog of War	3
GAS AND BUGS	5
CBW, Briefly Defined	6
THE UTILITY OF CBW AGENTS	7
Making the Enemy “Suit Up”	7
Leaving a Large Footprint	8
Implying a Threat	9
ACQUISITION	9
<i>Obtaining CW Precursors</i>	10
<i>The Development of BW Programs</i>	10
<i>Dual-Use Technologies in BW</i>	12
Production	12
<i>CW Agent Production</i>	12
<i>BW Agent Production</i>	13
WEAPONIZATION	14
CW Weapon Design	14
Weaponizing BW Agents	16

DELIVERY	16
Dispersal	16
Atmospheric Conditions	17
<i>Wind Speed and Turbulence</i>	18
<i>Heat</i>	18
 Chapter 2: Who Has These Weapons?	 19
THE SUPERPOWER AND FORMER SUPERPOWER	21
The United States	21
<i>Chemical Weapons</i>	21
<i>CW in World War II</i>	23
<i>CW During the Cold War</i>	24
<i>Current Status of US Chemical Weapons</i>	28
<i>Biological Weapons</i>	30
<i>The Post-World War II Era and the Korean War</i>	30
Russia and the Former Soviet Union	31
<i>Chemical Weapons</i>	32
<i>The Russian Federation in the 1990s</i>	33
<i>Biological Weapons</i>	34
THE MIDDLE EAST	36
Iraq	36
<i>Chemical Weapons</i>	36
<i>The Gulf War (1990–1991)</i>	36
<i>Iraqi VX</i>	39
<i>Biological Weapons</i>	40
Iran	42
<i>Chemical Weapons</i>	42
<i>Biological Weapons</i>	43
Syria	43
<i>Chemical Weapons</i>	43
<i>Biological Weapons</i>	45
Egypt	46
<i>Chemical Weapons</i>	46
<i>Biological Weapons</i>	47
Libya	48
<i>Chemical Weapons</i>	48
<i>Operation at Tarhunah</i>	48
<i>Biological Weapons</i>	49
Israel	49
<i>Chemical Weapons</i>	49

<i>Biological Weapons</i>	49
EAST ASIA	50
North Korea	50
<i>Chemical Weapons</i>	50
<i>Suspected CW Arsenal</i>	51
<i>Biological Weapons</i>	52
South Korea	53
China (PRC)	54
<i>Chemical Weapons</i>	54
<i>Biological Weapons</i>	56
Taiwan	56
OTHER PLAYERS	57
South Africa	57
<i>Chemical Weapons</i>	57
<i>Biological Weapons</i>	58
Cuba	58
SUB-STATE ACTORS	58
Chapter 3: Threats and Responses	63
A NEW KIND OF WARFARE	63
The First World Trade Center Bombing	64
Aum Shinrikyo	64
Taking the Toll	66
MEDICAL THREATS AND RESPONSES	67
Anthrax	67
<i>The Disease</i>	68
<i>Anthrax as a Weapon</i>	68
<i>Treatment and Vaccination</i>	69
Smallpox	70
<i>The Disease</i>	70
<i>Smallpox as a Weapon</i>	70
<i>Vaccination</i>	71
CIVIL DEFENSE THREATS AND RESPONSES	72
The Chemical Industry	72
<i>Bhopal</i>	73
Densely Populated Spaces	74
Water Supplies	74
Crop Dusts	79

Food Security	80
DETECTION	80
PART TWO: CHEMICAL AGENTS	85
Chapter 4: Basic Concepts	87
WHAT CHEMICAL WEAPONS ARE NOT	88
WHAT CHEMICAL WEAPONS ARE	88
Properties	89
Delivery Systems	90
BASIC CLASSES OF CW AGENTS	92
Choking Gases (Lung Irritants)	92
<i>Chlorine</i>	93
<i>Phosgene</i>	95
<i>Diphosgene</i>	96
<i>Chloropicrin (or Chlorpicrin)</i>	96
<i>Ethylchlorarsine</i>	97
<i>Perfluoroisobutylene (PFIB)</i>	97
Blister Agents (Vesicants)	98
<i>Mustard (Sulfur)</i>	98
<i>Nitrogen Mustard</i>	102
<i>Lewisite</i>	102
<i>Phosgene Oxime ("Nettle Gas")</i>	103
<i>Phenyldichlorarsine (PD)</i>	104
Blood Agents	105
<i>Hydrogen Cyanide: Instrument of the Shoah</i>	105
<i>Cyanogen Chloride</i>	108
<i>Arsine (Arseniuretted Hydrogen)</i>	108
<i>Carbon Monoxide</i>	108
<i>Hydrogen Sulfide ("Sour Gas")</i>	109
Nerve Agents (Toxic Organophosphates)	109
<i>Nerve Agent Proliferation</i>	111
<i>Dynamics of Nerve Agent Poisoning</i>	111
Incapacitants: Psychoactive Chemicals in War	112
<i>Belladonna, or Glycolate Alkaloids</i>	113
<i>3-Quinuclidinyl Benzilate (BZ)</i>	113
<i>Ergot and Lysergic Acid Diethylamide (LSD)</i>	114

<i>Mescaline and Its Derivatives (Phenyl Ethylamines)</i>	I16
<i>Methaqualone</i>	I16
Harassing or Riot-Control Agents (RCAs)	I16
<i>Lacrimators (Eye Irritants)</i>	I18
<i>Sternutators</i>	I21
<i>Vomiting Agents</i>	I22
<i>Banned RCAs</i>	I22
Herbicides	I23
Obscurant Smokes	I24
Napalm	I24
Malodorous Concoctions and Masking Agents	I25

Chapter 5: Chemical Warfare: A Brief History	I27
---	-----

FROM GREEK FIRE TO THE <i>FLAMMENWERFER</i> . . .	I28
--	-----

The Nineteenth Century	I31
The Dawn of Organic Chemistry	I33
From the <i>Flammenwerfer</i> to the Livens Projector:	
The Buildup to War	I36
<i>The Livens Projector</i>	I38
<i>Chemistry That Changed the World</i>	I40

WORLD WAR I	I42
--------------------	-----

The Chlorine Attack at Ypres	I43
Mustard Enters the War	I44
Weapons Used and Abandoned	I46

THE AFTERMATH: PERSPECTIVES ON CHEMICAL WARFARE	I48
--	-----

Tukhachevsky and the War Against the Peasants	I50
The Wushe (Paran) Incident):	
The First Use of Chemical Weapons in Asia?	I52
Ethiopia: 1935–1936	I52

WORLD WAR II	I53
---------------------	-----

The Sino-Japanese War	I54
United States and CW Policy	I55
Churchill and Chemical Weapons	I55
The Bari Incident	I59

FROM KOREA TO THE GULF WAR	I60
-----------------------------------	-----

Allegations of Chemical Warfare in Korea	I60
Yemen: 1963–1967	I61
Southeast Asia: 1965–1975	I61

Iran-Iraq War: 1980–1988	162
<i>Agents Used Against the Kurds by Iraq</i>	164
<i>Iranian Chemical Weapons Development</i>	164
Lessons from the Gulf War	166
<i>Khamisayah and Sarin Release in the Gulf War</i>	167

Chapter 6: Control and Disarmament 169

HISTORICAL PRELUDES	169
Early Twentieth Century Negotiations	169
<i>The Hague Conferences</i>	170
<i>The Washington Arms Conference</i>	172
<i>The 1925 Geneva Protocol</i>	173

THE CHEMICAL WEAPONS CONVENTION (CWC)	175
Controlling Agents and Precursors	177
Scheduling Agents and Precursors	177
<i>Schedule 1 Agents and Precursors</i>	177
<i>Schedule 2 Agents and Precursors</i>	178
<i>Schedule 3 Agents and Precursors</i>	179
Declarations and the CWC	179
<i>Export Controls</i>	180
<i>The Australia Group</i>	180
Verification of Compliance	181

MONITORING AGENTS AND THEIR PRECURSORS	182
<i>Monitoring of CW Agents (Schedule 1)</i>	182
<i>Monitoring of CW Precursors (Schedule 2)</i>	183
<i>Monitoring of Commercial Chemicals (Schedule 3)</i>	183
Proliferation Signatures	183
Challenge Inspections	184
Managed Access	185

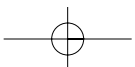
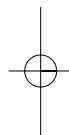
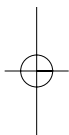
DESTRUCTION OF CHEMICAL WEAPONS	186
Not in My Backyard	186
The Destruction and Conversion of Facilities	188
Brain Drain in the Former Soviet Union	188

PART THREE: BIOLOGICAL AGENTS 191

Chapter 7: Basic Concepts	193
BIOLOGICAL WARFARE AGENTS	196
THE NATURE OF INFECTIOUS DISEASE	198
The Germ Theory of Disease	198
The Advent of Modern Microbiology	199
The Airborne Origin of Infectious Disease	200
DIFFERENTIATING AMONG PATHOGENS	200
Bacteria	200
The Rickettsiae	200
Viruses	201
Bioaerosols	202
BIOLOGICAL WARFARE AGENTS	204
Bacteria	205
<i>Anthrax</i>	205
<i>Plague</i>	206
<i>Tularemia</i>	207
<i>Glanders</i>	207
<i>Q-Fever</i>	208
<i>Cholera</i>	208
Viruses	209
<i>Smallpox</i>	209
<i>Hemorrhagic Fever Viruses</i>	210
<i>Venezuelan Equine Encephalitis (VEE)</i>	211
<i>Foot-and-Mouth Disease</i>	212
Biological Toxins	213
<i>Mycotoxins</i>	213
<i>Fungi (Molds)</i>	214
<i>Botulinum Toxin</i>	214
<i>Staphylococcal Enterotoxin Type B (SEB)</i>	215
<i>Ricin and Saxitoxin</i>	216
<i>Trichothecene Mycotoxins (T2)</i>	216

BIOREGULATORS	217
PROTOZOA	217
Chapter 8: Biological Warfare: A Brief History	219
BIOLOGICAL WEAPONS IN ANCIENT TIMES	219
Biological Warfare in the New World	220
BIOLOGICAL WARFARE IN MODERN TIMES	222
World War I	222
The Geneva Protocol of 1925	223
Japanese BW, 1932–1945	224
THE UNITED STATES BW PROGRAM	226
Development Phase: 1939–1950	226
The Post-World War II Era and the Korean War	229
US Testing Activities, 1951–1969	231
SOVIET BIOLOGICAL WEAPONS: 1919–1989	233
The Soviet Renaissance (1973–1989)	233
The Biopreparat Complex	235
BW in Russia Today	235
Chapter 9: Control and Disarmament	237
HISTORY	237
Summary of the BTWC	238
The Review Conferences	240
1980	240
1986	243
1991	243
1997	244
THE BTWC TODAY	245
THE FUTURE OF THE BTWC	248

Chapter 10: Vaccination and Biological Warfare	249
DISEASE AS DETERRENCE	249
Smallpox, Variolation, and the First Vaccines	250
<i>Jenner's Vaccinia</i>	253
Typhus and DDT	255
MODERN MILITARY VACCINATIONS	256
Typhoid and the Boer War (1899–1902)	257
Yellow Fever as a BW Threat	257
Japanese B Encephalitis and the War in the Pacific	258
Botulinum and D-Day	259
Plague and the Vietnam War (1965–1975)	259
Botulinum Toxoid and the Gulf War (1991)	260
Vaccinating for Anthrax in the Twenty-First Century	261
<i>Historical Development</i>	261
<i>The Current Controversy</i>	263
NOTES	267
SELECT BIBLIOGRAPHY	293
INDEX	295



Preface

As these lines are being written, firemen, police officers, and a host of other rescue workers are still trying to save victims of the terrorist attacks on the World Trade Center and the Pentagon. Even without precise counts of the dead and wounded in Pennsylvania, Virginia, and New York, we can already conclude that this attack was a signal event of mass destruction, with the outcome certain to make it the deadliest single terrorist act ever committed against United States citizens. The number who died in the attacks and the 100-minute aftermath will almost certainly exceed the number of American armed forces killed at Pearl Harbor, or on D-Day. But these victims of terror were, by and large, civilians, people going about their business. And the instruments of their death, the murder weapons, were not, until yesterday, considered weapons at all.

It is always hard, but especially under these circumstances, to talk about weaponry, the tools of war and terror. What can these new weapons be compared to? How can they be described? The US Department of Defense categorizes the most deadly kinds of armaments as “weapons of mass destruction,” or WMDs, and defines them as “capable of a high order of destruction . . . of being used in such a manner as to destroy large numbers of people.”* This does not tell us much. How does one define “a high order of destruction” and “large numbers of people”? Timothy McVeigh, who was responsible for bombing the Alfred P. Murrah Federal Building in Oklahoma City in 1995, was indicted on US federal charges for using a WMD, a truckload of improvised explosives. In the blast, 168 people were killed—again overwhelmingly civilians, men, women, and children going about their business.

Was McVeigh charged with using a WMD because 168 is a large enough number? Is this or a number near it the dividing line between an ordinary act of savagery and one in which we call the killers’ implements weapons of mass

* Department of Defense, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: Joint Chiefs of Staff/US Government Printing Office, Joint Pub 1-02: March 23, 1994): p. 412.

destruction? Chemical and biological armaments have the potential to kill huge numbers of people, many times the number killed by McVeigh's bomb. And certainly it seems to make sense that the US Department of Defense categorizes them as WMDs. But is it not true that almost any weapon, even the machetes used in Rwanda in 1994, can be used to perpetrate horrors on an unspeakable scale?

The term "weapons of mass destruction"—probably coined in 1956 by the Soviet Red Army Marshal Georgi Konstantinovich Zhukov (known as "the hero of Stalingrad")—has, like any defining or categorizing word, its shortcomings. It explains some things, but goes only so far. The arms expert Ken Alibek, whom we shall meet later in this book, suggests that a better name for biological armaments might be "mass casualty weapons," since their object is to inflict human injury but not to destroy buildings or property. Distinctions like these are grim—but they are also useful. They help us refine and sharpen our sense of things. They help us face up to and describe in words what otherwise may be overwhelming, confusing, frightening. And of course trying to face up to facts and describe events—no matter how horrible they may be—is the first step toward understanding.

My wish is that readers will take up this book in that spirit. Studying weaponry and warfare and disarmament isn't just a challenging and stimulating intellectual discipline for its own sake. The stakes are much too high for that. Its aim instead is to help us understand a long-standing aspect of human behavior, a force in human history, that seems capable of devising new tools of destruction that we may have to face at times and in places where we least expect them—in a pair of towers above a great harbor, in offices at the heart of our vast and powerful military establishment, and in a quiet country field in southwestern Pennsylvania.

Eric Croddy
Monterey, California
October 23, 2001

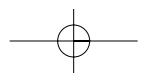
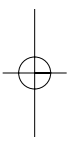
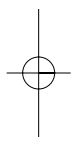
Acknowledgments

The Monterey Institute, Center for Nonproliferation Studies, would like to thank the Ploughshares Fund for their generous support of this project. Any views expressed herein are solely those of the author, and not necessarily those of the Ploughshares Fund or the Monterey Institute.

I would personally like to thank the following people, all of whom were instrumental in making this book happen. First, I want to thank Jonathan B. Tucker, the director of the Chemical and Biological Weapons Nonproliferation Program at the Monterey Institute, who initiated this project and Clarisa-Perez Armendariz and John Hart who made strategic contributions towards the development of the text. I also wish to thank other colleagues at the Monterey Institute were always there for me when I needed assistance or scholarly advice: Jason Pate, Diana McCauley, Gavin Cameron, Kathleen Vogel, Gary Ackerman, Kimberly McCloud, Raymond Zilinskas, Amy Sands, Tim McCarthy, Mari Sudo, Dan Pinkston, Amin Tarzi, Michael Barletta, Gaurav Kampani, Sonia Ben Ouagrham, Fred Wehling, Yuan Jing-Dong, Evan Medeiros, Lisa Burns, Phillip Saunders and Clay Moltz. Dr. Anthony T. Tu has been most helpful, and I am privileged to have his friendship as well as expertise. Martin Hugh-Jones has been most patient with my inane questions from time to time. My good friends and scholars at the National Chengchi University in Taiwan, Yuan I and Arthur S. Ding have taught me a great deal about East Asian proliferation issues, and Jean-Pascal Zanders has been a wealth of wisdom and a dear friend. Thanks also go to my colleagues and Monterey Institute of International Studies graduates Ken Palnau, Anisha Lal, Anjali Bhattacharjee, Matt Osbourne, Tim Ballard, Faith Stackhouse, Garvey McIntosh, and Jason Evans for their invaluable support in developing the book. My dear friend Al J. Venter has made important contributions to my thinking about a number of issues discussed here. Special thanks go to the excellent editorial staff at Copernicus Books for really making it all happen and to Michael Hennelly for his invaluable advice. Our appreciation goes to Pernacca Sudhakaran, Ewen Buchanan, and the excellent staff at the UN photo laboratory for their dedication and generous use of photographs. There are many others who would prefer to remain anonymous, but I want to thank them as well.

A big thank you to my family for their love and support.

Any errors, committed or otherwise, are solely my responsibility.



Introduction

Why study chemical and biological warfare (CBW)? At the very lowest level, the topic lends itself to morbid curiosity. The scale on which “bugs and gas” can be used to kill people, and the way in which they cause death, can make for gruesome reading. Then there is the matter that these weapons are considered, rightly or wrongly, to be abominable, and those who wish to confirm that opinion will find in studying CBW plenty to abhor. Readers in these two categories are likely to be disappointed by what they will find in this book.

Fear is another motive for study. One can hardly read the paper or listen to the news today and not, sooner rather than later, hear reports about the belligerent nations, repressive regimes, and terrorist organizations that have access to, or are working on the development of, these weapons. The mere existence of CBW armaments, we are told, poses a significant threat to the stability of international order. Even if one believes that the nuclear stand-off between superpowers—the Balance of Terror that characterized the Cold War—is a thing of the past, we now have a whole new cast of characters to worry about. They are less well understood than our old adversary the Soviet Union, and less predictable. They operate as states (or sometimes “rogue states”), but also in the shadows, in league with networks of terrorists, global criminal enterprises, and splinter groups representing every conceivable type of fanaticism. And they will, it is almost certain, push us into a whole new kind of decades-long war. For readers arriving with this point of view, I hope this book will serve as a kind of corrective.

It is not my belief that CBW armaments are benign, or that states and sub-state organizations are not wishing for or even planning chemical or biological attacks against the United States and the rest of the industrialized world. I am not someone who places great faith in the good will and sober judgment of, say, Saddam Hussein. In fact, if I were a betting man, I would put my money on the likelihood that we *will* see chemical or biological weapons attacks in the not-too-distant future. But where this book perhaps differs from some more popular discussions of the topic is in its argument, in its underlying theme, that biological and especially chemical attacks of any magnitude are extremely difficult to plan, develop, execute, and fund. Certainly it is true that a fanatical cult

could release nerve agent on a crowded subway car, as happened in Tokyo in March 1995. And the ultimate splinter group, a single deranged individual, may be perfectly capable of killing, injuring, or incapacitating large numbers of individuals in any number of ways chemical or biological. If you add to these all the belligerent major powers, rogue states, and oppressive regimes worldwide (and factor in their client terrorist organizations as well), you can imagine no end of mischief—gas attacks, reservoir poisonings, anthrax outbreaks, and so forth. But what we have to do is dwell less on nightmare scenarios and try to learn—as calmly and clearly as possible—what CBW agents are, how they work, who has used them in the past, and what is being done to limit their proliferation. Fear may be a good motivator, but it is not, as far as I can tell, an aid to understanding.

How This Book Is Organized

This book is divided into three major parts. In Part I, “Gas, Bugs, and Common Sense,” there is a brief introduction to and definition of CBW (Chapter 1), including descriptions of why and how nation-states and “sub-states” (for example, terrorist organizations) develop chemical and biological weapons. Chapter 2 then lists, in a fairly straightforward manner, the nations that have CBW capabilities, along with brief descriptions of the particular agents they possess. In Chapter 3, we take a look at some of the threats we’re likely and unlikely to face.

Part II is focused on chemical weapons. In Chapter 4, there are rather extensive descriptions and discussions of more than fifty of the best-known CW agents. Chapter 5 is a history of chemical warfare from ancient times to the present. And Chapter 6 discusses in detail the workings of the 1992 Chemical Weapons Convention (CWC), by all accounts one of the most effective international treaties written. (But not, as the chapter makes clear, without its limitations.) Included in the chapter is a lengthy discussion of the extremely difficult matter of verification, and the highs and lows of the international community’s relationship with Iraq, an unwilling signer of the accord.

Part III, which more or less mirrors Part II, focuses on biological agents and weapons, with Chapter 7 describing more than forty biological agents in detail. Chapter 8 focuses on BW armaments in history, again covering a broad span. Chapter 9 covers the Biological Weapons and Toxins Convention of 1972 (BWTC), a work of the best intentions but not much good effect. (The success of the CWC and the comparative ineffectiveness of the BWTC are discussed in some detail.) Finally, a whole chapter (Chapter 10) is devoted to the issue of vaccinations and biological warfare.