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Microbial Survival in the Environment

Bacteria and Rickettsiae Important in Human and Animal Health

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Preface

This book is a collection of data on the tenacity in the environment of bacteria and some rickettsiae important in medicine and veterinary medicine. These data are of fundamental importance to physicians, veterinarians, epidemiologists and others when, in their practices, they are confronted with epidemics of contagious diseases or outbreaks of foodborne illnesses. At such times prompt answers are often needed to limit the problem, and thus to protect the public's health. Since data needed for such a purpose are widely distributed in the international scientific literature, the occasional desperate literature search is likely to miss some of the information that is available. This book seeks to fill that void. It lies in the nature of a compilation such as this is that it can never be totally complete. The compilation requires continual up-dating to include new information, and some currently acceptable information may have to be corrected as new data become available. However, most of the information in this compilation will never be out-of-date. The authors are always thankful for suggestions from others.

Collection of the data in this book resulted from, first, several decades of studying the literature, and, second, literature searches made by the Institut für Dokumentationswesen in Frankfurt a.M., the Biomedizinische Datenbank of Hoechst A.G., the Dokumentationsstelle für Veterinärmedizin in West Berlin, the Deutsches Institut für medizinische Dokumentation und Information in Cologne, the Institute for Scientific Information in Philadelphia, and MEDLARS of the National Library of Medicine in Washington, D.C. We are grateful to these organizations for their help in providing information and references for use in this book. This compilation contains some data obtained at the turn of the century; only such early data are included as were thought to be reliable. For example, when *Vibrio cholerae* and *Yersinia pestis* were discovered, there was much more interest in their survival in the environment than there has been in later decades. Hence, to provide information about these bacteria, data from early experiments were included.

Data on the survival of bacteria in the environment are biological data. They result from the influence of many factors on the microorganism. Kind of bacterium, age, stage of growth, and nutritive conditions during growth influence results as much as do environmental factors which either enhance or retard growth or survival of the organism. Hence, the usefulness of the data becomes greater if the conditions under which they were obtained are accurately and completely described. We have attempted to do this as far as it was possible within

the limitations both of the size of this book and the contents of the original reports.

As an environmental factor, we have included the substrate in or on which a given bacterium was found or grown. Also included are the common physicochemical factors such as low temperatures, high temperatures, irradiation, drying, pressure and water activity, all of which impinge on the substrate. Included with the substrates are the avertebrates (fleas, flies, mosquitoes, etc.) which are of importance as cyclical or acyclical carriers of certain bacteria. However, the effects of disinfectants and sanitizing agents are not included.

A major section of the book provides information about genera and species of bacteria, which are arranged in alphabetical order and are named according to the 8th edition of *Bergey's Manual of Determinative Bacteriology*. Data for each bacterial species are also arranged alphabetically, according to substrate. Information for each substrate is, as far as possible, again arranged alphabetically, according to physicochemical factors. Also, in this section, reference is made regularly to the two other sections of the book, tabular material and commentaries, where additional information can be found.

The tabular section provides results of experiments arranged in tables. Such experiments generally dealt with more than one bacterial species. It did not seem appropriate to incorporate these data into the section on individual species of bacteria; to do so would have resulted in needless repetition of experimental methods used by the investigators.

The section on commentaries provides information on how bacterial behavior is influenced by (1) general physicochemical factors, and (2) the surroundings in which a given bacterium is found. This section also includes information on the growth and death of pathogenic bacteria when they are in the soil or water.

The reader of this book can obtain the desired information in two ways. If the reader is interested in the survival of a certain bacterial species in or on one of several different substrates, then the section of the book which contains information arranged according to genus and species of bacteria should be consulted. Should the reader be interested in knowing about the survival of different bacteria on or in a single substrate, the index section should be consulted and here the reader will be guided to the desired information in other sections of the book.

Finally, we express our gratitude to the staff of Springer Verlag for the care and painstaking efforts needed to convert our manuscript into this book.

EILHARD MITSCHERLICH
ELMER H. MARTH

Units and Abbreviations

Contents

I Special Part

Bacteria Considered in Alphabetical Order

Vide Index

Acholeplasma granularum

Significance and Habitats. A common inhabitant of the nasal cavity of swine. Frequently isolated from acute synovitis lesions of swine (COTTEW and LEACH 1969).

Growth Limits. Temperature: Vide Table 1.

	Culture
	Survival time
In fluid culture or in lesion material at ..... −25° C	several years
(SWITZER 1969).	

Acholeplasma laidlawii

Significance and Habitats. Saprophyte, but also isolated from the genital tract and nasal cavity of cattle, nasal cavity of swine, oral cavity of man and sinus of chicken (FREUNDT 1974).

Growth Limits. Temperature and hydrogen ion concentration: Vide Table 1.

Vide Table 6, p. 725.	**Air**
A. laidlawii was isolated from the barn air of a cattle herd (JASPER et al. 1974).	

Acinetobacter calcoaceticus

Significance and Habitats. Present in soil and water and frequently isolated from healthy and diseased animals and man. Pathogenicity uncertain but probably of some significance in otherwise debilitated individuals (LAUTROP 1974c).

Ionizing Radiation Resistance	**Culture**
Pure cultures of two strains in plate count broth or trypticase soy broth were quick-frozen in a dry ice-alcohol bath and treated with various doses of a ^{60}Co source to give a 7- to 8-log cycle reduction in population	D value 405–814 krad
(WELCH and MAXCY 1975). Vide p. 719	
Moist Heat Resistance	
Pure cultures of three strains in plate count broth or trypticase soy broth were heated at ..... 65° C	D value 4.5–6.7 min
(WELCH and MAXCY 1975). Vide p. 710.	
Growth occurs on trypticase soy agar with 2.5% NaCl (4 of 4 strains) and 6.5% NaCl (3 of 4 strains) (WELCH and MAXCY 1975). Vide p. 730.	**Salt**

Actinobacillus equuli syn. *Shigella equirulis*

Significance and Habitats. Causes suppurative lesions especially in the kidneys and joints of foals and piglets and endocarditis in pigs. Also occurs in normal horses in the mouth,

tonsillar region and the intestinal tract. Not pathogenic for rabbits, guinea pigs or rats (PHILLIPS 1974).

Growth Limits. Temperature: Vide Table 1.

	Culture
	Survival time in d
In slant agar cultures stored at ..... room temperature	
in the dark	21
exposed to sunlight	< 5
(STREITFERDT 1932). Vide p. 716.	
In gelatin stab cultures	90–120
(DIMOCK et al. 1928, quoted from STREITFERDT 1932).	
Growth occurs in milk (STREITFERDT 1932).	**Milk**
	Paper
	Survival time
In drops of broth cultures dried on filter paper	< 24 h
(STREITFERDT 1932).	

Actinobacillus lignieresii

Significance and Habitats. Pathogenic for cattle and sheep. Found in granulomatous lesions of the upper alimentary tract of cattle particularly in the tongue. Associated with suppurative lesions in the skin and lungs of sheep. Has been described as an etiological agent in disease in man and in the dog (PHILIPS 1974).

Growth Limits. Temperature: Vide Table 1.

	Culture
Cultures should be transferred every few days (WILSON and MILES 1964).	

	Pus
	Survival time
In pus in sealed tubes	30–60 d
(WILSON and MILES 1964).	

Actinobifida dichotomica

Significance and Habitats. Implicated in farmer's lung disease. Isolated from soil, mushroom compost but not hay (LACEY 1971).

Growth Limits. Temperature: Vide Table 1.

Moist Heat Resistance – Spores	**Buffer**
	D value
Spores of *A. dichotomica* heated in 0.001 M phosphate buffer (pH 7)	
in a thermostatically controlled oil bath at ..... 100° C	71 min
(CROSS 1968). Vide p. 710, 728.	

Actinomyces bovis

Significance and Habitats. Causes actinomycosis in cattle. Similar infections have been described in swine, horses and other animals but the species involved have not been described adequately (SLACK 1974).

Growth Limits. Temperature: Vide Table 1.

	Culture
	Survival time in d
In pure cultures at ..... room temperature	10–14
on Dorset's egg medium in the ..... ice chest	21–28

(WAKSMAN 1961).

Actinomyces eriksonii

Significance and Habitats. Has caused pulmonary and subcutaneous abscesses in man, isolated from sputum and tonsillar crypts (SLACK 1974).

Growth Limits. Temperature: Vide Table 1.

Actinomyces israeli

Significance and Habitats. Causes human actinomycosis and occasionally infections in cattle. The source of infection is endogenous, as the normal habitat is the oral cavity of man including tonsillar crypts and dental calculus (SLACK 1974).

Growth Limits. Temperature: Vide Table 1.

	Culture
	D value
Tubes with peptone-broth (pH 7.0) were inoculated with 14-d-old organisms of four strains of *A. israeli* and stored in the dark at .... 21° C	4.3–5.9 d

(SCHAAL 1970a).

	Survival time
In cultures stored at..... 37° C	7–28 d

(WILSON and MILES 1964).

	Glass
Desiccation Resistance	
	Survival time
Dried on glass and kept in the dark	49 d

(WILSON and MILES 1964). Vide Table 105, p. 722.

	Salt
	D value
Tubes with 0.9% physiological saline solution (pH 7.1) were inoculated with 14-d-old organisms of four strains of *A. israeli* and stored in the dark at ..... 21° C	0.48–1.93 d

(SCHAAL 1970a). Vide p. 730.

Tubes with twice-distilled water and tap water (nitrate 48 mg l^{-1}; chloride 76 mg l^{-1}; sulfate 140 mg l^{-1}; entire hardness equivalent to 270 mg CaO l^{-1}; free CO_2 35 mg l^{-1}; fixed CO_2 115 mg l^{-1}; calcium 145 mg l^{-1}; magnesium 35 mg l^{-1}; pH 7.1) were inoculated with 14-d-old organisms of four strains of *A. israeli* and stored in the dark	**Water**
at ..... 21° C.	D value in d
In distilled water	0.7–2.6
in tap water	1.0–2.6

(SCHAAL 1970a). Vide p. 738.

Actinomyces naeslundi

Significance and Habitats. Human infection has been reported. Habitat is oral cavity of man including tonsillar crypts and dental calculus (SLACK 1974).

Growth Limits. Temperature: Vide Table 1.

Actinomyces odontolyticus

Significance and Habitats. Isolated from deep dental caries in man but the relationship of this organism to the disease has not been established. Normal habitat is the oral cavity of man (SLACK 1974).

Growth Limits. Temperature: Vide Table 1.

Actinomyces viscosus

Significance and Habitats. Pathogenicity for man has not been established. Isolated from the oral cavity of hamsters, rats and man (SLACK 1974).

Growth Limits. Temperature: Vide Table 1.

Aegyptianella pullorum

Significance and Habitats. Causative agent of aegyptianellosis in birds (MITSCHERLICH and WAGENER 1970).

A. pullorum is transmitted by *Argas persicus*. Transovarial transmission occasionally occurs in the ticks (KREIER and RISTIC 1974b).	**Ticks**

Aerococcus viridans

Significance and Habitats. May be pathogenic for lobsters. Has been isolated from human infections of the urinary tract and from endocarditis (EVANS 1974). Causes the greenish discoloration of pickled and cooked meats, such as ham products (INCZE 1964).

Growth Limits. Temperature, hydrogen ion concentration: Vide Table 1.

Moist Heat Resistance. A. viridans organisms incubated at 30° C for 24 h in yeast infusion broth were heated at different temperatures in ham infusion containing 1.1% salt, pH 6.5. Five tubes were inoculated for each exposure time. At ..... **Culture**

	D value in min
55° C	19.86–22.37
60° C	6.67–10.08
65° C	2.42– 2.68
70° C	1.34– 1.50

(INCZE 1964). Vide p. 710.

Growth occurs at 10% NaCl. Vide p. 730. **Salt**

(EVANS 1974).

Alcaligenes faecalis

Significance and Habitats. Isolated from feces, abscesses related to intestinal tract, occasionally blood stream. Generally considered non-pathogenic (BORMAN et al. 1948).

Growth Limits. Temperature: Vide Table 1.

Oil: Vide Table 43, 44, p. 730. **Fats**

Cockroaches and Flies. A. faecalis was isolated from the hind gut of the American cockroach *Periplaneta americana* (BITTER and WILLIAMS 1949), and from the intestinal tract of city-caught flies (TORREY 1912 quoted from STEINHAUS 1947). **Insects**

Vide Table 318, p. 738. **Water**

Anaplasma centrale

Significance and Habitats. Agent of benign bovine anaplasmosis (MITSCHERLICH and WAGENER 1970).

A. centrale is transmitted by *Boophilus decoloratus* and *Haemaphysalis cinnabarina punctata*. Transovarial transmission occurs in both ticks (MITSCHERLICH and WAGENER 1970). **Ticks**

Anaplasma marginale

Significance and Habitats. Agent of malignant bovine anaplasmosis (MITSCHERLICH and WAGENER 1970).

Blood from a calf with 40% of its erythrocytes parasitized with *A. marginale* was collected into acid-citrate-dextrose solution. The cells were separated by centrifugation and suspended 50% (v/v) in 6% dimethylsulfoxide made isotonic with 0.85% NaCl. Samples (10 ml) of this suspension were immediately frozen at a rate of −2° C per min. When −25° C was reached, the blood was rapidly lowered to −79° C in a dry ice-alcohol mixture and then transferred to a liquid nitrogen storage unit at ..... −196° C **Blood**

Survival time
4.3 years (n.f.t.)

(LOVE 1970).