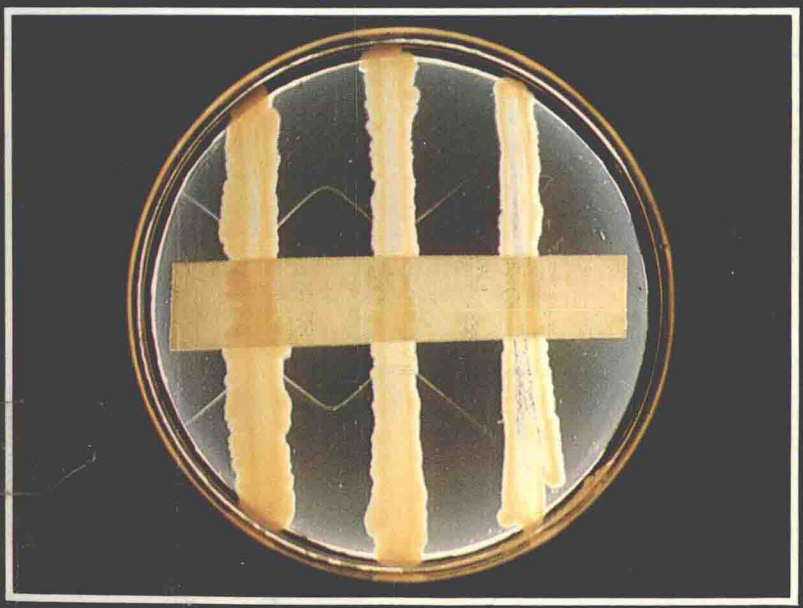
A Colour Atlas of

Microbiology

R. J. OLDS

INTERNATIONAL EDITION



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R. J. OLDS

Animal Health Officer (Bacterial Diseases).
Food and Agriculture Organisation
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Many people have kindly contributed material for me to photograph. Eighty of the photographs are of primary plate cultures and other materials collected by my friends in the Public Health Laboratory Service at Cambridge. For this I am particularly indebted to Dr G R E Naylor and Dr Joan Boissard, each of whom also made many helpful suggestions during the preparation of the text, and to Dr H W K Fell, whose contributions appear in both bacterial and fungal chapters. Dr J Marks, Tuberculosis Reference Laboratory, Cardiff, contributed specimens for 24 photographs of mycobacteria. Specimens for 38 photographs of fungi were obtained from workers at the Mycological Reference Laboratory, London, through the courtesy of the late Dr I G Murray and Dr D W R Mackenzie; Miss Christine Philpot and Mr A G Proctor have been most helpful. Fifty-two specimens were prepared by our technical staff, Mr A H Westley, Mrs Lesley Allinson and Miss Julie Matthews, and 15 by undergraduates in this department. Most of the media were prepared by Mr J F Stevenson and his staff. Each of these groups have contributed so much that itemised acknowledgement would be excessively detailed, yet quite inadequate to express the value of their association.

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I am indebted to Dr G R E Naylor and the Public Health Laboratory Service for permission to publish **272** and **273**, and to Dr R M Fry for his

critical comments on much of the text. My wife's help has taken diverse forms – technical, clerical and critical. The publishers have been most helpful and patient.

It is a pleasure to acknowledge the assistance of all of these persons and to record my thanks for their contributions.

To my parents

Contents

Preface: Materials and Methods

Most of the procedures were those of Cruickshank (1969). Hartley's digest broth was used as the basis for digest agar and blood agar. Media were designated A or B according to whether they were made in the Public Health Laboratory or in the Department of Pathology, Cambridge. Some slight colonial differences were found consistently on media made in the two laboratories. Colonies essentially similar to those on blood agar A can be grown on blood agar made with Columbia agar (Baltimore Biological Laboratory; Oxoid Limited). Methods other than those of Cruickshank (1969) are mentioned in the following paragraphs.

The procedures of Cowan and Steel (1965) were used for the preparation of potato medium, and for tests for decarboxylases, Frazier's method for hydrolysis of gelatin, Hugh and Leifsen's method for oxidation or fermentation of carbohydrates, lecithinase, levan and dextran formation, nitratase, phenylalanine, phosphatase and starch hydrolysis tests.

Media and methods for the growth of mycobacteria were described by Marks (1972), and for fungi by Collins and Lyne (1970).

Fluid thioglycollate medium, TCBS agar and triple sugar iron agar were produced by Difco Laboratories; bacitracin and optochin sensitivity discs, multodiscs and sensitest agar by Oxoid Limited.

For other materials and methods see: Anderson *et al* (1931) for McLeod's heated blood tellurite agar; Bühlmann *et al* (1961) for the decomposition of acetamide test; Crowle (1961) for the Amido Schwarz stain; Gershman (1963) for the motility-sulphide medium; Gridley (1953) for his fungal stain; Lacey (1954) for his pertussis medium with antibiotics; Lautrop (1960) for his urease test; Mackie and McCartney (1953) for Kirkpatrick's flagella stain; Preston and Maitland (1952) for their flagella stain; Preston and Morrell (1962) for their Gram stain; Walker *et al* (1971) for fluorescent antibody staining; Wheeler *et al* (1965) for the TRIFF stain; and Whittlestone (1969) for mycoplasma media.

Glossary: Some Common Synonyms

The first name listed for each organism is used in this book. The other names are cross-referenced in the index.

Acinetobacter anitratum: Achromobacter anitratus, Cytophaga anitratum, Moraxella glucidolytica.

Actinobacillus aprophilus: Haemophilus aprophilus.

Bordetella bronchiseptica: Alcaligenes bronchisepticus, Brucella bronchiseptica.

Bordetella parapertussis: Acinetobacter parapertussis.

Campylobacter fetus: Vibrio fetus.

Citrobacter ballerup: Ballerup-Bethesda Group, *Salmonella ballerup.*

Citrobacter freundii: Escherichia freundii, Colloides anoxydana.

Clostridium chauvoei: Clostridium feseri.

Clostridium welchii: Clostridium perfringens.

Corynebacterium haemolyticum: Corynebacterium pyogenes var. *humanis.*

Enterobacter aerogenes: Aerobacter aerogenes (motile strains).

Enterobacter cloacae: Aerobacter cloacae, Cloaca cloacae.

Fusobacterium fusiforme: Fusiformis fusiformis, Bacteroides fusiformis.

Gonococcus : *Neisseria gonorrhoeae.*

Klebsiella aerogenes: Aerobacter aerogenes (non-motile strains).

Klebsiella pneumoniae: Friedländer's bacillus.

Meningococcus : *Neisseria meningitidis.*

Micropolyspora faeni: Thermopolyspora polyspora.

Moraxella: includes *Mima polymorpha* var. *oxidans.*

Mycobacterium intracellulare: Battey bacillus.

Neisseria mucosa: Diplococcus mucosus.

Nocardia madurae: Actinomadura madurae, Streptomyces madurae.

Paracoccidioides brasiliensis: Blastomyces brasiliensis.

Pasteurella septica: Pasteurella multocida.

Phialophora pedrosoi: Fonsecaea pedrosoi, Hormodendrum pedrosoi.

Pneumococcus : *Diplococcus pneumoniae, Streptococcus pneumoniae.*

Pseudomonas aeruginosa: Pseudomonas pyocyanea.

Pseudomonas mallei: Acinetobacter mallei, Loefflerella mallei, Malleomyces mallei, Pfeifferella mallei, the glanders bacillus.

cont.

Pseudomonas pseudomallei: Loefflerella whitmori, Malleomyces pseudomallei, Pfeifferella whitmori, Whitmore's bacillus.
Salmonella arizona: Arizona group, *Paracolobactrum arizona Salmonella* subgenus III.
Salmonella paratyphi B: Salmonella schottmülleri.
Staphylococcus albus: largely synonymous with *Staphylococcus epidermidis.*
Staphylococcus aureus: Staphylococcus pyogenes.
Streptobacillus moniliformis: Actinobacillus muris, Streptothrix muris ratti.
Streptococcus, Group A : *Streptococcus pyogenes.*
Group H : *Streptococcus sanguis.*
Group K : *Streptococcus hominis, Streptococcus salivarius.*
Thermoactinomyces vulgaris: Micromonospora vulgaris.
Trichophyton sulphureum: Trichophyton tonsurans var. *sulphureum.*
Vibrio cholerae: Vibrio comma.
Yersinia pestis: Pasteurella pestis, the plague bacillus.
Yersinia pseudotuberculosis: Pasteurella pseudotuberculosis.

Introduction

This atlas is intended primarily for students of microbiology in the medical and paramedical sciences. It should also meet some needs of laboratory workers and of student technicians in microbiology. Its purpose is to illustrate the appearances of bacteria and fungi as they are seen at the laboratory bench.

Each photograph is accompanied by essential explanatory text. The clinical significance of the result illustrated is seldom mentioned. If it is not obvious it can be found in standard textbooks to which it is assumed that the student has access. Each caption includes a statement of the magnification represented by the printed photograph. Where possible these magnifications are comparable with those most used in the laboratory. Thus, photomicrographs of bacteria are reproduced at x1000, colonies of bacteria at x6 – a magnification readily obtained with a hand lens, and petri dish and fungal tube cultures at about x1.

Standard methods were used for photomicrography. For macro-photography one or more of the methods illustrated in **1** to **4** were used. Details of media and other materials and methods will be found in the preface.

Most of the commonly encountered bacteria and fungi are illustrated. Some of the less common organisms are shown as well. These have been selected for one or more of the following reasons: they may be dangerous pathogens, in which case it seems better to expose the student to a photograph then to a live culture; they may be sufficiently similar to a dangerous pathogen to represent a better organism for student study than the pathogen itself; they may illustrate some germinal point in the development of microbiology, such as the L-forms of *Streptobacillus moniliformis.*

Virtually all features which may be used in the characterisation of a micro-organism are likely to vary with the medium on which it is grown. As media become more standardised this source of variation between laboratories is becoming reduced. Within any one laboratory standardisation of media by strict quality control and evaluation is essential for the skilled examination of cultures. Apart from variability resulting from variation in culture media, one can expect differences between strains within a bacterial or fungal species. The art of the bacteriologist or the mycologist is his recognition at a glance of features which may not be

described adequately by the written word. It is hoped that this colour atlas has a part to play in the development of this art.

Clues to the source and methods of spread of infection in a community may come from any quarter. Probably the most fruitful source is colony morphology, because it is promptly available and because the colony has manifold features, any one of which may provide the clue. Other sources are unusual biochemical properties or patterns of antibiotic sensitivity. Any one of these may be just as useful as an epidemiological marker as phage-, bacteriocin- or sero-type which are deliberately and painstakingly sought for the purpose.

Key


= lamp with hemispherical reflector


= lamp with cylindrical reflector

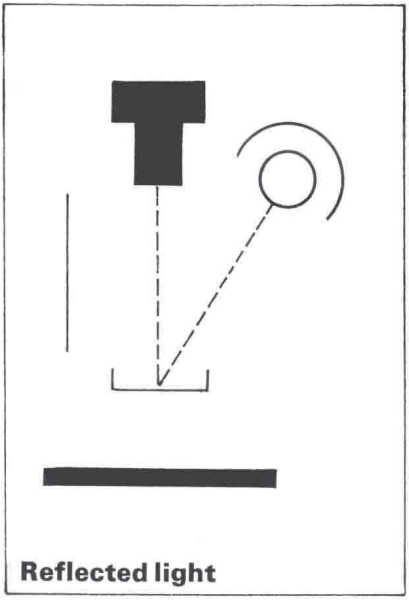

= subject


= camera


= black background

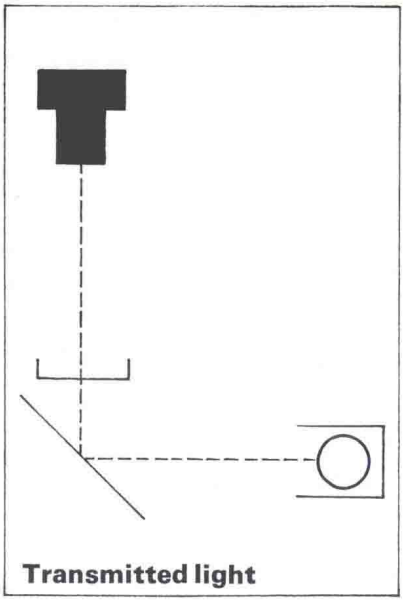
= white background or reflector

1



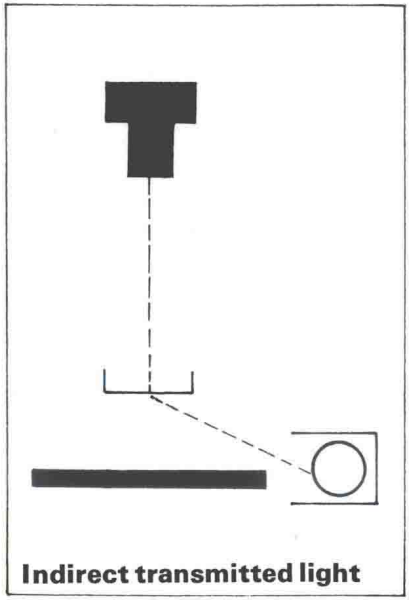
Reflected light

2



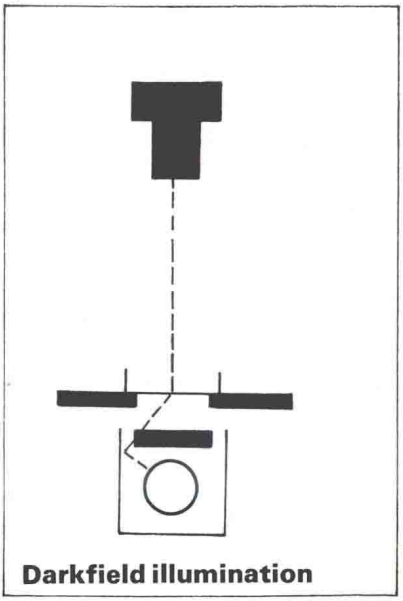
Transmitted light

3



Indirect transmitted light

4



Darkfield illumination

Bacteria: Macroscopic Appearances

This section depicts a range of colony morphology on a fairly standard set of media. The object is to give guidance in examining colonies and to illustrate the main features, rather than to depict standards by which the identity of an unknown can be established. Each bacteriologist must establish his own standards for his own media. The photographs should help him do this, but they cannot render the process unnecessary.

The photographs are intended to replace the detailed verbal descriptions of colonies found in many textbooks. Therefore the caption does not include a long description. Sometimes the characteristics of a colony can be stated briefly by noting its resemblance to some well-known object, as for example, when a pneumococcal colony is described as a 'draughtsman' or 'chequer'. These terms have proved very useful to practising bacteriologists, and a number of them are used in this section.

There is no adequate photographic substitute for the actual examination of colonies if the student is to appreciate the three-dimensional structure of the colony. However, something of this structure will be appreciated if he scans the photograph from top to bottom, and notices how the incident light illuminates colonies at the top of the picture where the light is almost over the colony, and then examines colonies near the bottom where the angle of illumination is flatter. Thus, although the plate remains still in the photograph, by viewing various colonies, he can obtain some impression of what he sees when looking at one colony and moving the plate.

Some preliminary examples

It may be useful to study a few selected examples first. In examining a photograph, particular note should be made of how the lamp is imaged on the surface of the colony : a smooth colony will produce a sharp image (**5**) ; if the surface is matt, the image will be less sharp (**10**) ; if the surface is quite rough, no image will be seen (**48**). The image of the lamp also gives some idea of the elevation of the colony : in a smooth

convex colony an undistorted view of the lamp will be seen (**111**) ; a conical colony will produce a triangular image (**26**) ; if the elevation is irregular, the image will be distorted accordingly (**86**).

The edge of the colony may be entire (**5**) or it may have some degree of irregularity. The most irregular edges are found on rough-surfaced colonies (**45**). How the edge of the colony slopes down to the medium, i.e., the elevation at the edge, is a most distinctive feature of some colonies. Compare for example the 'shorelines' of the three colony types in (**72**.)

By transmitted light a colony may appear transparent, i.e. water clear (**106**), translucent or opaque (small and large colonies in **66** respectively). Colony colour should not be assessed by transmitted light except when specifically looking for the distinctive colours shown by many species by indirect transmitted light (**66**). Otherwise, the colour of a colony is best appreciated by diffuse reflected light, but because diffuse lighting understates colony shape it has not been used in this atlas.

Most colonies have a butyrous (buttery) consistency ; this is appreciated by manipulating the growth with a wire. Some colonies fracture when touched, others stick to the wire (**22**) or appear like gum (**91**).