

The history of *Pseudomonas extorquens*  
In commemoration of the 20th anniversary of the death  
of Professor Kazimierz Bassalik

LUDMILA BASSALIK-CHABIELSKA

Institute of Genetics and Animal Breeding, Polish Academy  
of Sciences, Jastrzębiec, 05-551 Mroków, Poland

(Received: November 13, 1979)

Abstract

On the 20th anniversary of the death of Professor Kazimierz Bassalik it is just the time to relate the story of the bacterial strain *Pseudomonas extorquens* isolated by him in 1913. The history of investigations on these bacteria in recent years is discussed. Attention is called to the lack of the description of the species *extorquens* in the latest edition of Bergey's Manual of Determinative Bacteriology (1974) and in Palzeroni's monograph (1978).

Professor Kazimierz Bassalik died on the 27th of June, 1960. He was one of the founders of the Polish Botanical Society and for 17 years chairman of the Warsaw Division. For 10 years he was deputy chairman and chairman of the Society. Since 1930 he was editor of the main organ of the Polish Botanical Society, *Acta Societatis Botanicorum Poloniae*. In 1951 he was elected Honorary Member of the Polish Botanical Society.

Prof. Bassalik specialised in plant physiology and general microbiology in its widest sense. His investigations, or those performed under his guidance, on the role of the soil microflora in making accessible to plants mineral components from insoluble compounds, particularly phosphorites, and his studies on the decomposition in the soil of insoluble oxalic acid salts gained world priority. For those who are interested in the development of science the history of the "oxalate" bacteria isolated by Bassalik should be instructive.

The first fundamental and extensive study of Bassalik on *Pseudomonas extorquens*, a bacterium utilising oxalates as the sole source of carbon, was published in 1913 in "Jahrbücher für wissenschaftliche Botanik". Bassalik isolated the "oxalate" bacteria in Switzerland and it is

there that he described in detail their morphological and physiological properties. In the discussion concerning their taxonomy he mentions that, according to the systematic key of Fischer, this new species should be classified in the genus *Bactrinium*, according to Migula — in the genus *Pseudomonas*. Bassalik further reached the conclusion that, in view of the chaos prevailing at the time in systematics, it would be best to name the microorganism "simply" *Bacillus*. The bacteria were rod-shaped of  $1.5 \times 3 \mu\text{m}$  dimensions, they were straight or slightly curved and Gram-negative. The rods did not form endospores, they were motile and had one polar flagellum, three times the length of the cell. The colonies on agar medium were pink to red in colour. The bacteria utilised oxalates rapidly and completely. It should be reminded that this was the first bacterial strain with this property to be described. The end product of oxalate oxidation by the microorganisms found in their medium was only carbon dioxide. Bassalik suggested the possibility of three metabolic pathways in the utilisation of oxalates: 1) oxalic acid is reduced to glyoxalic acid, 2) oxalic acid is degraded to formic acid and carbon dioxide and 3) oxalic acid is oxidised with the release of carbon dioxide which is further reduced and utilised for synthesis of cellular material. The third hypothesis was so unusual at the time (20 years before the paper of Wood and Werkman in 1935 on carbon dioxide utilisation by heterotrophic bacteria) that Alfred Fischer, head of the Department in which Bassalik worked did not allow for the publication of his paper in 1909 so that it appeared only after Fischer's death. Bassalik demonstrated, moreover, that malonate, succinate, oxamide, mesoxalate, glyoxalate, formaldehyde, methanol and ethanol can be sources of carbon for these bacteria.

After I World War Bassalik brought the strain *extorquens* from Basel to Warsaw. It was included in the Warsaw University collection, and in spite of passaging on agar did not change its properties. It perished during the war. In 1948 an identical strain was isolated from the soil in the Botanical Garden of the Warsaw University. According to the systematics of Bergey's Manual of Determinative Bacteriology (1948) the strain was named *Pseudomonas extorquens*. Under this name it is kept in the collections, the American one ATCC and the British one NCIB. In 1960 Brisou, a French specialist in the field of systematics of the family *Pseudomonadaceae*, took interest in the strain *extorquens* (Bassalik et al., 1960). In view of the properties of this strain and mainly of the pigment produced by it he classified it in the family *Pseudomonadaceae*, tribe *Chromobactereae*, genus *Flavobacterium*, species *extorquens*.

Quayle called attention in 1961 to the fact that various authors described under different names related bacteria metabolising methanol.

This compound as a new source of readily accessible protein was becoming more and more interesting. Prompted by the suggestion of Quayle, Stocks and McCleskey (1964) compared the strains isolated by them as well as *Pseudomonas methanica* Harrington and Kallio, *Pseudomonas* AM1 Peele and Quayle, *Pseudomonas* PRL-W4 Kaneda and Roxburgh and *Protaminobacter ruber* den Dooren de Jong and proved that they hardly differ from the strain *extorquens* Bassalik. Stocks and McCleskey stressed the priority of the name *extorquens* as the name of the species in relation to a number of the names introduced later for the strains isolated again of the same bacteria. The latter authors considered as condition further taxonomic studies on the genera *Vibrio* and *Pseudomonas* before the generic name *Vibrio* introduced for the species *extorquens* suggested by Bhat and Barker in 1948 or eventually, the name *Pseudomonas* proposed by Janota in 1950 could be confirmed. In English literature the generic name *Pseudomonas* is preserved for the species *extorquens*. For instance Downs and Harrison published in 1974 "Studies on the production of pink pigment in *Pseudomonas extorquens* NCIB 9399 growing in continuous culture". The pink pigment produced by *extorquens* is, according to the above mentioned authors, an oxo-carotenoid related to rhodoxanthin. Higgins et al. used, in 1976, *Pseudomonas extorquens* for modern comparative studies on the metabolism of methanol-utilisers.

Although many detailed investigations on *Pseudomonas extorquens* Bassalik have been published, it is not included among the documented species described in the latest edition of Bergey's Manual of Determinative Bacteriology (1974). This species is only mentioned there as existing. Neither was *Pseudomonas extorquens* taken into account in the monograph of Palleroni "The *Pseudomonas* Group" published in 1978. In the preface to Bergey's Manual (1974) five main critical remarks to the earlier editions are mentioned. Among them that "the Manual contains descriptions (often incomplete and based on old literature) of organisms no longer available for detailed study by modern methods, and that since the publication of Index Bergeyana much of the synonymy duplicated information readily available elsewhere". The above mentioned remarks taken into consideration caused many improvements to be introduced into the latest edition of the Manual. On the other hand, some valuable new species which were a true gain of natural science lost the position which they deserve, and what more, the research effects of some scientists who contributed a great deal to the development of world microbiology were partly disregarded.

On the occasion of the reminder of one of the first studies of a searcher of high merit for the development of plant physiology and micro-

biology (Bassalik-Chabielska, 1978) wish is expressed that the species *extorquens* be included in future publications concerning the modern systematics of the genus *Pseudomonas*.

## REFERENCES

- Bassalik K., 1913. Über die Verarbeitung d. Oxalsäure durch *Bacillus extorquens* n. sp., Jahrb. f. wiss. Botanik 53: 255-302.
- Bassalik K., Janota-Bassalik L., Brisou J., 1960. Etude sur *Flavobacterium extorquens* (ex *Pseudomonas extorquens*). Annales Inst. Pasteur 98: 165-169.
- Bassalik-Chabielska L., 1978. Kazimierz Bassalik (1879-1960). Postępy Mikrobiologii 17: 21-22.
- Bhat J. V., Barker H. A., 1948. Studies on a new oxalate decomposing bacterium, *Vibrio oxalaticus*. J. Bacteriol. 55: 359-368.
- Bergey's Manual of Determinative Bacteriology 1948 — 1st ed., 1974 — VIIIth ed., Williams Wilkins Co., Baltimore.
- Downs J., Harrison D. E. F., 1974. Studies on the production of pink pigment in *Pseudomonas extorquens* NCIB 9399 growing in continuous culture. J. Appl. Bacteriol. 37: 65-74.
- Higgins I. J., Knowles C. J., Tonge G. M., 1976. Enzymic mechanisms of methane and methanol oxidation in relation to electron transport systems in methylotrophs: purification and properties of methane oxygenase. In Microbial Production and Utilization of Gases, Ed. H. G. Schlegel, G. Gottschalk, N. Pfennig, Göttingen. Akademie der Wissenschaften. E. Goltze.
- Janota L., 1950. Przebieg zużywania kwasu szczawowego przez *Pseudomonas extorquens* Bassalik w zależności od początkowej liczby komórek. Med. Dośw. Mikrobiol. 2: 131-132.
- Palleroni N. J., 1978. The *Pseudomonas* Group. Patterns of Progress. Meadowfield Press Ltd. Bushey, England.
- Quayle J. R., 1961. Metabolism of  $C_1$  compounds in autotrophic and heterotrophic microorganisms. Ann. Rev. Microbiol. 15: 119-152.
- Stocks P. K., McCleskey C. S., 1964. Identity of the pink-pigmented methanol-oxidizing bacteria as *Vibrio extorquens*. J. Bacteriol. 88: 1065-1070.
- Wood H. G., Werkman C. H., 1935. The utilization of  $CO_2$  by the propionic acid bacteria in the dissimilation of glycerol. J. Bacteriol. 30: 323.

### Historia *Pseudomonas extorquens*

#### W dwudziestą rocznicę śmierci profesora Kazimierza Bassalika

#### Streszczenie

W dwudziestą rocznicę śmierci prof. Kazimierza Bassalika przedstawiono historię szczepu bakterii *Pseudomonas extorquens* wyizolowanych przez niego w 1913 roku. Omówiono historię badań tych bakterii do lat ostatnich. Zwrócono uwagę na brak opisu gatunku „*extorquens*” w ostatnim wydaniu Bergey's Manual of Determinative Bacteriology (1974) oraz w książce monograficznej Palleroniego (1978).