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## **BURKHOLDERIA- AN EMERGING BACTERIUM WITH CLINICAL SIGNIFICANCE**

**BHARTI P\***

Department of Biotechnology, SUS College of Research and Technology, Tangori, Mohali,  
Punjab- 140306

\*Corresponding author: E Mail: [bharti\\_pratibha@yahoo.com](mailto:bharti_pratibha@yahoo.com); Phone: +91 9872261100

### **ABSTRACT**

A new genus *Burkholderia* was derived from the genus *Pseudomonas* only about two decades ago. There are only a very few reports on the diversity of *Burkholderia* species. The species belonging to genus *Burkholderia* have been found to possess excellent metabolic capability, enabling them to feed on numerous substrates. Moreover, the physiological versatility of *Burkholderia* gives it the potential to survive in diverse habitats ranging from soil, water, plants to even humans. Members of the genus *Burkholderia* are among a few unicellular bacteria that have been given due importance in the recent past owing to its pathogenic potential. They exhibit broad significance as environmental and clinical pathogens and pose a great risk to the environment including plants, animals and human beings. Thus they are a significant concern from the biotechnological viewpoint. The present article highlights the emergence of *Burkholderia*, addition of new species to the genus, its characteristics and distribution. The present review also incorporates a wide plethora of the diseases caused by less exploited, yet highly pathogenic *Burkholderia* species.

**Keywords: Biopesticides, Bioremediation, Niches, Pathogenic, *Pseudomonas***

### **INTRODUCTION**

A new genus comprising of diverse microorganisms have been derived from *Pseudomonas*, and have become a bacteria with potential importance owing to its tremendous properties and effects. *Burkholderia* are probably the most abundant, environmentally adaptable inhabitants of [1] soil, plants, animals and water [2, 3, 4]. The

microorganisms belonging to *Burkholderia*, occupy a wide range of ecological niches because of vast array of metabolic activities which imparts them the potential to feed on a variety of substrates [4, 5].

Moreover, various species belonging to this genus are opportunistic pathogens [6] found in the hospital environments [5] and are responsible for various fatal illnesses. This review focusses on the physiological, environmental and pathogenic characteristics of newly emerged organisms belonging to *Burkholderia*.

### ***Burkholderia***

#### **Taxonomy**

The genus *Burkholderia*, comprises of bacteria that were previously recognized and named as members of 'non-flourescent Pseudomonads' [7]. The taxonomic heterogeneity of the genus *Pseudomonas* as revealed by the earlier work [8] led to the gradual dissection of the genus over the following decades [9] and its classification into nine additional genera: *Burkholderia*, *Stenotrophomonas*, *Comamonas*, *Acidovorax*, *Brevundimonas*, *Shewanella*, *Methylobacterium*, *Sphingomonas* and *Ralstonia* [10]. Based on the phenotypic characteristics, 16S rRNA sequence [11], DNA-DNA homology values, cellular lipid and fatty acid composition [12], a new genus

*Burkholderia* is proposed for the RNA homology group II of genus *Pseudomonas* [13, 14, 15, 16] while *Pseudomonas* sensu stricto was restricted solely to homology group I [17]. Genus *Burkholderia* falls in the beta subclass of proteobacteria, while *Pseudomonas* belong to the gamma subclass [4, 5, 6]. The genus name '*Burkholderia*' was assigned in recognition of the pioneering work of Walter Burkholder of Cornell University [18].

According to the present scientific classification, *Burkholderia* belongs to the Kingdom: Bacteria, Phylum: Proteobacteria, Class: Beta-Proteobacteria, Order: Burkholderiales, Family: Burkholderiaceae and Genus: *Burkholderia*. The genus *Burkholderia* was created [15] and as classification of bacteria evolved over time and as improvements in molecular tools for bacterial identification occurred, various members were accommodated in the genus. It is functionally a remarkably diverse genus [19] and according to current taxonomy, contains 44 validly described species [20] with *B. cepacia* as the type species. On the basis of plant associated characteristics, cellular lipids, fatty acid composition, phenotypic characteristics [21], chemotaxonomic characteristics, DNA-DNA hybridization data [15], rRNA-DNA

hybridization data and the sequences of 5S and 16S rRNA [13], 7 species of *Pseudomonas* RNA homology group II were transferred to the new genus *Burkholderia* [15, 22] including *P. cepacia* [23], *P. mallei* [24], *P. pseudomallei* [25], *P. caryophylli* [26], *P. gladioli* [27], *P. picketsii* [28] and *P. solanacearum* [29]. In 1994, *P. plantarii* [30] and *P. glumae* were transferred to the genus *Burkholderia* [13]; also two new species *B. vietnamiensis* [31] and *B. vandii* [13] were proposed in the genus. On the basis of the phenotypic and genetic characteristics, *P. cocovenenans* [21] is transferred to the genus *Burkholderia* as *B. cocovenenans* combination novel. The species (*Pseudomonas*) *andropogonis* (=woodsii) was transferred to the genus *Burkholderia* [31]; in addition, (*Pseudomonas*) *pyrroconia* proved to be one of the members. New isolated species belonging to *Burkholderia* and found to be closest neighbour of *B. caryophylli* based on 16S rDNA included *B. glathei* and *B. phenazinium* comb. nov. (earlier, *Pseudomonas* sp.). Another new *Burkholderia* species named *B. graminis* sp. nov. was proposed [32], referring to its habitat, the rhizosphere of grasses. Other species have also been proposed for addition to this genus [31] and hence renamed (Figure 1).

### Metabolic Characteristics

Over the past two decades, research on *Burkholderia* species has been steadily expanding [34]. Among the many characteristics of *Burkholderia* (Table 1), the strains have the ability to use a wide range of organic compounds as carbon and energy sources [15]. Members of the genus *Burkholderia* serve as good candidates for bioremediation [4] thus preventing adverse effects to the environment [35]. They act as biopesticides due to its capability of degrading numerous low molecular mass organic compounds including aromatics, halogenated derivatives and various recalcitrant organic residues [14] for eg. constituents of crude oils and ether derivatives used as gasoline additives are found to be degraded by *Burkholderia* isolates [36].

### Habitat

The genus *Burkholderia* is a heterogeneous group with extraordinary nutritional and physiological versatility, a property which enables it to colonize a surprisingly wide range of ecological niches [19] with extreme conditions such as soil [2], plants, animals and water [4, 5, 19]. *Burkholderia* are probably the most abundant, environmentally adaptable [1] soil and plant-associated bacteria [34] that are very efficient root colonizers [38]. Since 1990 members of the

genus *Burkholderia* have been widespread in the rhizosphere of various crops worldwide [39] including *Burkholderia pickettii* and *Burkholderia solanacearum* which are among the most frequently isolated groups from sweet corn roots and cotton roots [40]. Indeed, *Burkholderia* species can be free-living in the rhizosphere [41] as well as epiphytic and endophytic [19, 2], and is capable of nitrogen fixation [42], thus contributing in plant growth promotion [4].

### Disease

Several species belonging to the genus *Burkholderia* are clinically relevant, opportunistic pathogens [43] found in the hospital environments [5] that commonly inhabit the respiratory tract of human beings [19, 4]. Various species belonging to the genus cause a wide range of disease in plants, animals as well as humans (Table 2).

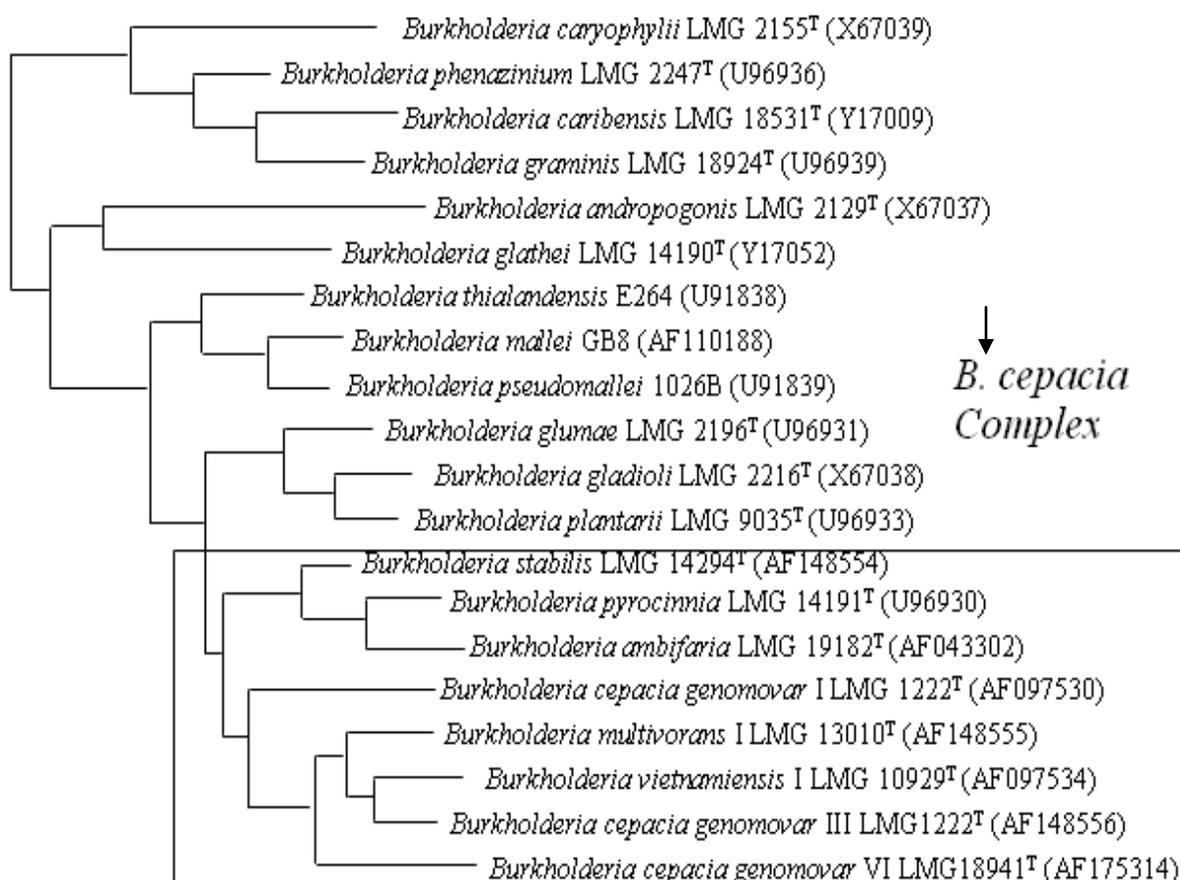


Figure 1: Neighbour-joining phylogenetic tree (showing the position of various *Burkholderia* sp. based on the 16S rDNA sequence comparisons); Bar: 5% sequence dissimilarity [33]

Table 1: Main characteristics of the genus *Burkholderia* [37]

Properties	Observation
Morphology	Gram negative, straight or slightly curved rods
Growth	Non-sporeformers, grows on Nutrient and MacConkey agar
Genome	Large with 2-4 circular replicons
Oxygen requirement	Aerobic
Growth temperature	10 °C to 45 °C
Catalase	Positive
Urease	Positive
Voges Proskauer test	Negative
Methyl Red test	Positive
Nitrate deoxidizing test	Negative
Fermentation of substrates: D-glucose, D-mannose, fructose, galactose, mannitol, glycerin, glycerol, inositol, sorbitol, gluconate	Positive
Fermentation of substrates: Lactose, maltose, sucrose, starch, glycogen, L-sorbate, methyl alpha-D-mannoside, methyl alpha & beta-D-glucoside, D-turanose, methyl beta-D-xyloside, D-arabinose, melezitose and inulin	Negative
Fatty acid composition	3-hydroxyhexadecanoic acid (C16:0 3-OH) and 2 forms of phosphatidylethanolamine (PE) possessing 14:0, 3-OH 14:0 and 3-OH 16:0

Table 2: Major diseases caused by *Burkholderia* species

Causative agent	Disease	Reference
<i>Burkholderia gladioli</i>	Pneumonia and septicaemia associated with chronic granulomatous disease; Respiratory tract infections, septicemia, abscesses, osteomyelitis, adenitis and lymph node infections with cystic fibrosis; Protracted keratitis complicated with corneal ulcers	[44,45]
	Otitis media in immunocompromised mice.	[46]
<i>B. gladioli</i>	Panicle blight symptoms on rice; Wilt and crown rot in lisianthus; Leaf spot and soft rot of orchids	[47]
<i>B. gladioli</i> pathovars <i>gladioli</i> , <i>alliicola</i> , <i>agaricola</i> and <i>cocovenenans</i>	Leaf and corn disease in <i>gladioli</i> and <i>irises</i> ; Onion slippery skin and bulb rot; Soft rot and cavity disease in the mushroom <i>Agaricus bitorquis</i> ; Production of lethal toxins responsible for severe food poisoning in China	[48]
<i>B. cepacia</i>	Cardiac cirrhosis, cellulitis, endocarditis, urinary tract infections, intravenous bacteremias, wound infections, life-threatening pulmonary infections, chronic granulomatous disease, cystic fibrosis, vertebral osteomyelitis in intravenous drug abusers, life-threatening sepsis and foot-rot	[4, 49]
<i>B. cepacia</i>	Onion-bulb rot and sour skin	[19]
<i>B. cenocepacia</i>	Vaginal infection with myeloma and chronic hepatitis C	[50]
<i>B. mallei</i>	Glanders in animals like horses, mules and donkey characterized with pneumonia, bacteremia, pustules and even death	[51]
<i>B. pseudomallei</i>	Melioidosis (whitmore disease) in man and animals associated with abscesses, chronic pneumonia and septic shock; Necrotizing fasciitis; Cellulitis with multiple abscesses; Aortic aneurysm	[51, 52]
<i>B. thailandensis</i>	Pneumonia and septicaemia	[53]
<i>B. andropogonis</i>	Leaf spot of jojoba, brown leaf spot of citrus, leaf spot of velvet bean, black spot on orchids, blight of golden cane palms and stripe disease of sorghum	[54]
<i>B. phytofirmans</i>	Root associated disease in onion	[3]
<i>B. plantarii</i>	Seedling blight in rice	[19]
<i>B. glumae</i>	Panicle blight symptom on rice	[47]
<i>B. graminis</i>	Root associated disease in wheat	[19]
<i>B. caryophylli</i>	Wilt, stem crack and rot of carnation and bacterioses of onion	[19]

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