Aeromonas shigelloides (Bader) Ewing et al.: a Proposal That It Be Transferred to the Genus *Vibrio*

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A comparison of the data now available on the microorganism variously called C27, *Aeromonas shigelloides*, *Pseudomonas shigelloides*, *Pseudomonas michigani*, *Plesiomonas shigelloides*, and *Fergusonia shigelloides* suggests that this organism fits best into the generic description of *Vibrio* and accordingly should be transferred to this genus as *Vibrio shigelloides* (Bader) comb. nov.

In 1947, Ferguson and his co-workers isolated a motile enteric organism, thought at that time to belong to the *Enterobacteriaceae*, which contained a major somatic antigen of *Shigella sonnei*, phase I; they later described this organism in detail as C27 (10). Since then, organisms similar to or identical with C27 have been isolated by various workers, mainly from clinical materials in man and animals (1, 2, 5, 12, 16-18, 24).

The taxonomic position of this interesting organism has also been the subject of numerous publications, the most important of which are those by Sakazaki et al. (17), Ewing and Johnson (8), Ewing et al. (7), Habs and Schubert (13), Sebald and Véron (19), and Eddy and Carpenter (6).

Early workers (10, 18) clearly considered it to be an anaerogenic, motile paracolon, and Ferguson and Henderson (10) reported C27 to be "apparently amphitrichous." Most workers now agree that the organism is a polar flagellated, gram-negative rod, oxidase- and catalase-positive, which ferments carbohydrates and which could be placed in either the genus *Aeromonas* or the genus *Vibrio*.

Bader (2) had shown that organisms he had isolated from dog feces possessed a major antigen of *Shigella sonnei* and were polarly flagellated, and he proposed the name *Pseudomonas shigelloides* for these organisms, mainly because they were gram-negative rods with lophotrichous flagellation, fermented glucose anaerogenically, failed to ferment lactose, but reduced nitrate to nitrite. The clear differentiation between *Pseudomonas* and *Aeromonas* was not then understood, and Bader's assignment of

the organism to the genus *Pseudomonas* was justified. Sakazaki et al. (17), in a study of 22 strains including Ferguson's original C27 cultures, confirmed that the organism was lophotrichous but proposed the name *Pseudomonas michigani*. Meantime, work was proceeding on the differentiation of the polarly flagellated gram-negative bacilli, usually classified as belonging to *Pseudomonas*, *Aeromonas*, or *Vibrio* (20-22). Ewing and Johnson (8), on the basis of the mode of attack on sugars—fermentative as against oxidative (15)—and of the result of the cytochrome oxidase test [a modification of the Gaby and Hadley (11) technique], concluded that the C27-type organisms should be placed in the genus *Aeromonas*. Subsequently, Ewing et al. (7) confirmed their opinion that C27 should be considered an aeromonad and suggested that, since the name *Pseudomonas shigelloides* for the C27 organism of Bader (2) was validly published, the specific epithet *shigelloides* should have precedence over the specific epithet *michigani* in the name *Pseudomonas michigani* Sakazaki et al. 1959. Ewing et al. (7) did not discuss the possible assignment of the C27 organism to the genus *Vibrio*.

In 1962, Habs and Schubert (13) compared several of Bader's C27 strains. They confirmed that on the basis of flagellation and other morphological grounds, these organisms belong to the family *Pseudomonadaceae* and within this family to the tribe *Pseudomonadeae*. They excluded them from the genera *Pseudomonas*, *Xanthomonas*, and *Acetobacter* because they decomposed glucose anaerobically and from the genera *Protaminobacter*, *Alginomonas*, *Mycoplasma*, *Zoogloea*, and *Halobacterium*—all of which fail to attack glucose. *Zymomonas*,

Azotomonas, and *Photobacterium* were also thought to be excluded, leaving only *Aeromonas*.

Experience with the genus *Aeromonas* led Habs and Schubert (13) to define the latter as consisting of organisms which were polarly flagellated, gram-negative rods, which attacked glucose anaerobically, with or without gas formation, and which possessed a series of exoenzymes (proteolytic, lipolytic, and amylolytic). The uniformity of the genus *Aeromonas* thus defined would be lost by including within it the C27 organism, *Pseudomonas shigelloides*. Moreover, Habs and Schubert exclude them from the genus *Vibrio* mainly on morphological grounds—the cells were not strictly comma-shaped, although several strains, but not all, were sensitive to the vibriostatic agent 0/129. Accordingly, they proposed a new genus, *Plesiomonas*. Meantime, Sebald and Véron (19) had been examining the guanine plus cytosine (GC) ratio of the deoxyribonucleic acid of a series of named *Vibrio*, *Aeromonas*, *Pseudomonas*, *Moraxella*, and *P. shigelloides* strains and found that the values for the latter were about 51%, and so different from that found in the genera *Pseudomonas* (64%) and *Aeromonas* (60%), that they proposed a new genus, *Fergusonia*.

Eddy and Carpenter (6), in a further study on *Aeromonas*, including C27 strains, concluded that the C27 group could possibly be included in a new family, *Vibrionaceae*, as the genus *Plesiomonas*, but that further discussions of the genera and specific subdivision of the new family must await clarification of the relationship of *Vibrio* to *Aeromonas* and of their internal relationships.

Véron (23) has similarly proposed that *Plesiomonas shigelloides* be included, with the genera *Vibrio* and *Aeromonas*, in the family *Vibrionaceae*, a family which should be clearly distinguished from the family *Spirillaceae* and composed of strict aerobes or microaerophiles.

Morphologically, organisms in the genus *Plesiomonas* seldom show the comma-shaped rod so characteristic of *Vibrio cholerae*, the type species of the genus *Vibrio*. However, other members of the genus, such as *V. fischeri* and *V. anguillarum*, are often very much less comma-shaped than *V. cholerae*, and exclusion from the genus on such morphological grounds as suggested by Habs and Schubert (13) would appear to be doubtful. Moreover, the possession of lophotrichous flagellation as opposed to the single polar flagellum of *V. cholerae* is not sufficient to exclude it from the genus, because *V. fischeri* has also been shown to be lophotrichous (14). Also, possession of the lysine and ornithine decarboxylases and failure to produce alkaline reaction in arginine medium are not constant features of *Vibrio* species as asserted by Habs and Schubert (13). Thus, in our hands *V. anguillarum* and *V. costicola* are both positive in arginine but negative in lysine and ornithine, whereas *V. fischeri* is positive only in lysine (14).

It is our contention that the anaerogenic fermentation of carbohydrates, the sensitivity of many strains to the vibriostatic agent, 0/129, and the values of the GC content, being much lower than those reported for *Aeromonas* but within the top range for *Vibrio*, all support the suggestion that the C27 organism is closer to the genus *Vibrio* than to the genus *Aeromonas*. An Adansonian analysis involving over 100 features of C27 and a large number of both named strains and fresh isolates of species from the genera *Aeromonas* (including *A. formicans*), *Vibrio* (including *V. parahaemolyticus* and luminous vibrios), and *Pseudomonas* showed that C27 had a similarity value of generally 70 to 80% to the genus *Vibrio*, but generally less than 60% to the genus *Aeromonas* (4).

On the basis of the evidence presented, it is concluded that the organism originally named *Pseudomonas shigelloides* is closer phenotypically to the genus *Vibrio* than to *Aeromonas*, and accordingly we propose it be included in the genus *Vibrio* as *Vibrio shigelloides* (Bader) comb. nov.

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