Proposal That *Flavobacterium breve* Be Substituted as the Type Species of the Genus in Place of *Flavobacterium aquatile* and Emended Description of the Genus *Flavobacterium*: Status of the Named Species of *Flavobacterium*

Request for an Opinion

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It is requested that the Judicial Commission issue an Opinion rejecting the name *Flavobacterium aquatile* (Frankland and Frankland) Bergey et al. 1923 as a nomen dubium. Because this species is the type species of the genus *Flavobacterium*, the Judicial Commission is also requested to issue an Opinion designating *Flavobacterium breve* (Lustig) Bergey et al. 1923 as the new type species of *Flavobacterium*. The description of the genus *Flavobacterium* Bergey et al. 1923 is also herein emended. The proposed taxonomic or nomenclatural status of all known previously described species of the genus *Flavobacterium* is indicated in appendixes to this paper.

Proposed rejection of *Flavobacterium aquatile* (Frankland and Frankland) Bergey et al. 1923 as the type species of *Flavobacterium*. *Bacillus aquatilis* Frankland and Frankland 1889, isolated from well water of the chalk area of Kent, was designated the type species of the genus when *Flavobacterium* was created in 1923 by Bergey et al. (9). However, in designating *F. aquatile* the type species, they described it as motile and peritrichous (9), a character contrary to that recorded in the original description of *Bacillus aquatilis* (32). This discrepancy suggests that Bergey et al. (9), in selecting the type species of *Flavobacterium*, may have examined peritrichous strains which they identified as *F. aquatile*, but which in fact did not belong to this species.

No type strain was designated for *Bacillus aquatilis*, and apparently none of the strains on which the original description of the species was based is extant. Several cultures reputed to be reisolates of *F. aquatile* were studied by Weeks (79), who found that "Cultures F39 and F36, though very different one from the other, present cultural characteristics which are superficially similar to those of the Franklands' *B. aquatilis*. It will be shown, however, that F39 is not a true bacterium. . . ." The fact that two very different cultures, one of which was subsequently identified as a species of *Sporocytophaga*, fitted the original description of *B. aquatilis* (32) illustrates the meager and ambiguous

nature of that description. Furthermore, Weeks (79) observed that culture F36 only " . . . corresponds generally in its properties to those given for *F. aquatile*" and noted certain discrepancies between the characters of culture F36 and those given in the Franklands' original description of *B. aquatilis*. The colonies of culture F36 on nutrient gelatin were not composed of radiant bundles of threads, and the cells showed no movements that could be called oscillatory. Although Weeks (79) chose to discount the differential importance of these two characteristics, his arguments for doing so were based mainly on the imprecise and sometimes equivocal nature of the original description of *B. aquatilis* as given by the Franklands (32). However, one could argue equally well that these two characteristics should be given due consideration. Indeed, the original description of the species (32) as displaying oscillatory movements and filaments up to 17 μ m in length indicates that the organism described was probably a cytophaga or a flexibacter and not a flavobacterium at all (55). A culture of *F. aquatile* was deposited by Weeks in the American Type Culture Collection (ATCC) under the number ATCC 11947 with the strain designation Taylor F36 (1) (subsequently referred to herein as such). There is some confusion in the literature regarding the date of isolation of strain Taylor F36. Weeks and Breed (82) stated that it was isolated in 1941 whereas Weeks (79) implied that the strain was

isolated in the early 1950s. Weeks and Beck (81) stated that their culture of "strain Taylor" was isolated in 1952, which was presumably the correct date of isolation. It has been stated in support of accepting strain Taylor F36 as a reisolate of *F. aquatile* that the strain was isolated by E. W. Taylor from the same chalk well in Kent from which Frankland and Frankland originally isolated *B. aquatilis* (71). However, because 63 years elapsed between the original description of *B. aquatilis* and the supposed re-isolation of the species in 1952, it would seem unlikely that E. W. Taylor could have known the exact location from which the Franklands isolated *B. aquatilis* or, if he did, the possibility of ecological changes affecting the location cannot be excluded.

The status of strain Taylor F36 was that of a lectotype [sic] according to Sneath and Skerman (71), who noted: "Clearly this strain, F36, should be made the official neotype." However, to our knowledge strain Taylor F36 has never been clearly and formally proposed as the neotype strain of *F. aquatile*, although it has become generally accepted as such (80) but never challenged until now. It is our opinion that the original description of *B. aquatilis* is too meager and incomplete for the certain assignment of strains to the species and that strain Taylor F36 cannot in any case be definitely ascribed to the species in view of its characteristics which Weeks (79) recorded to be at variance with the original description of the species.

The main cause of dissatisfaction with *F. aquatile* strain Taylor F36 as the only acceptable reference strain of the species is evidence that it might be an atypical cytophaga. Follett and Webley (31) reported that the cell wall characteristics of the strain were similar to those of *Cytophaga johnsonii*, whereas Mitchell et al. (59) observed that the strain actively swarmed when the cultures were incubated for prolonged periods at 15°C. Gliding cellular motility in the strain was later demonstrated by Perry (65) using a novel microscopic technique. He (65) suggested that *F. aquatile* could be given the status of a nomen dubium because it was uncertain from the Franklands' original description (32) whether *B. aquatilis* was nonmotile or a glider. J. Henrichsen (personal communication) did not agree that strain Taylor F36 was able to glide and believed that the movements observed by Perry were attributable to some other phenomenon. There is other evidence that the strain would be misplaced in either *Cytophaga* or *Flexibacter*. Hayes (36) found that strain Taylor F36 was ungrouped and was not similar to typical cytophagas in a numerical phenetic analysis. He proposed that *F. aquatile* should not be retained

as the type species of *Flavobacterium* because it did not demonstrate what he considered to be the essential characteristics of that genus. In addition, Callies and Mannheim (21) reported that strain Taylor F36 contains ubiquinones and therefore is different from the flavobacteria and cytophagas which have a low guanine plus cytosine (G+C) content in their deoxyribonucleic acid (DNA) and which have menaquinones as their sole respiratory quinones.

F. aquatile was an unfortunate choice as the type species of *Flavobacterium* because the species is currently represented by only one strain which is of uncertain taxonomic affinities. McMeekin and Shewan (55) consider that a fuller species description is required and that attempts should be made to isolate further strains of the organism. However, we reject such an approach because on their own admission (55) "... retention of *F. aquatile* as the type species is of doubtful value and will continue to present difficulties." The consequences of retaining the species should be considered. If strain Taylor F36 is subsequently proved to be a cytophaga and becomes established as the neotype of *Flavobacterium aquatile*, then the species would probably have to be classified with species of *Flexibacter*. Because the name *Flavobacterium* was published before *Flexibacter*, the former would take priority, all of the current species of *Flexibacter* would become species of *Flavobacterium*, and a new genus would have to be erected to accommodate the remaining currently known species of *Flavobacterium*. Acceptance of strain Taylor F36 as a strain of *F. aquatile* could thus result in causing more widespread taxonomic confusion than already exists in the genus *Flavobacterium*.

In consideration of the foregoing, we request that the Judicial Commission issue an Opinion rejecting the name *Flavobacterium aquatile* (Frankland and Frankland) Bergey et al. 1923 as a nomen dubium as has been previously suggested (65).

Proposal that *Flavobacterium breve* (Lustig) Bergey et al. 1923 be designated the type species of *Flavobacterium*. *F. breve* was included in the original description of the genus *Flavobacterium* and apart from *F. aquatile* was the only original species retained by Weeks (80) in section I of the genus. We believe that *F. breve* would be a more appropriate choice than *F. aquatile* as the type species of *Flavobacterium*. A neotype strain (NCTC 11099) has been proposed for *F. breve*, and the description of the species has recently been revised (41). It is more typical of a group of similar bacteria widely placed under the genus name than is *F. aquatile*, and there are more strains of this species avail-

able for study: at least 10 strains have now been identified in our laboratory, and these include three further reference cultures of *F. breve* deposited in culture collections—NCTC 11162, NCTC 11163, and ATCC 14234. The original description of *F. breve*, like that of *F. aquatile*, was rather meager, and none of the strains on which the original description was based are extant. However, when the description of *F. breve* was revised (41) on the basis of subsequent isolates, there were no consistent discrepancies between these isolates and the original description given by Lustig (53) and there was no evidence of affinity to the cytophagas, a fact confirmed by L. Perry (personal communication). Of those species listed below in Appendix I, only *F. meningosepticum* contains strains on which the original description of the species was based. *F. balustinum*, *F. meningosepticum*, and *F. odoratum* were excluded as candidates to replace *F. aquatile* as the type species because they were not species included in the genus when the genus description was originally published (9). Therefore we request that the Judicial Commission issue an Opinion designating *Flavobacterium breve* as the new type species of the genus *Flavobacterium*.

Emendation of the description of the genus *Flavobacterium* Bergey et al. 1923. The main criteria for including a species in the genus *Flavobacterium* as originally described by Bergey et al. (9) were the formation of yellow- or orange-pigmented colonies on culture media and the ability to produce acid weakly from carbohydrates. Because *Flavobacterium* was based on so few characteristics, the genus was taxonomically heterogeneous from the beginning and was considered by Weeks (80) to be an uncertain taxonomic concept. As originally described, the genus contained gram-negative species that were peritrichous, polarly flagellated, or nonmotile as well as some gram-positive species. The degree of heterogeneity in the genus was subsequently reduced by excluding species in which strains were either polarly flagellated (8) or definitely gram-positive (82). As defined by Weeks (80), the genus also excluded species which showed gliding or swarming on culture media. It was divided into two sections: section I contained nonmotile species with the G+C content of their DNA in the range of 30 to 42 mol% (low-G+C-content strains) and section II contained species that were either nonmotile or motile and peritrichous but that had G+C contents in the range of 63 to 70 mol% (high-G+C-content strains).

The definitions of *Flavobacterium* given in the various editions of *Bergey's Manual of Determinative Bacteriology* were not necessarily generally accepted. In the view of Ferrari and

Zannini (30), gram-positive strains should not be excluded because of the variability in the Gram reaction of some species. Brisou (16) proposed that the nonmotile species be placed in a new genus called *Empedobacter* and retained the peritrichous strains in *Flavobacterium*, although at that time the G+C contents of strains to be included in the former genus were not known. Another approach was to view the nonmotile, low-G+C-content strains of *Flavobacterium* as probable cytophagas (59), typical cytophagas being strains that exhibited true gliding motility and spreading growth (25). Although evidence to support this approach was reported by Perry (65), the interpretation of his observations has been questioned by other workers, notably J. Henrichsen (personal communication) and McMeekin and Shewan (55). Further evidence of the overlap between *Flavobacterium* and *Cytophaga* was provided by Christensen (24), who concluded from a comprehensive phenotypic study that *F. pectinovorum*, a so-called atypical cytophaga, was identical with *C. johnsonae*. However, not all *Flavobacterium* species should necessarily be regarded as misplaced cytophagas because cellular movements by non-flagellated bacteria are sometimes difficult to demonstrate and to interpret (25, 56). Hayes (36) and McMeekin et al. (57) showed in phenetic analyses that although there were few unequivocal distinguishing tests, typical cytophagas were generally distinguishable from nonmotile, nongliding strains with low G+C contents. Hayes (36) believed that the latter should be retained in *Flavobacterium*, whereas gram-negative, nonmotile or motile and peritrichous, high-G+C-content species of *Flavobacterium* could possibly be reclassified in *Empedobacter*. More recently, Callies and Mannheim (21) found that flavobacteria either possessed ubiquinones or menaquinones as their sole respiratory quinones and proposed that the genus *Flavobacterium* should be restricted to those low-G+C-content strains containing ubiquinones, thus resembling *F. aquatile*.

Various gram-negative, nonmotile, nongliding, nonspreading, low-G+C-content strains from soil and water (35, 36, 60), food products and processing plants (4, 36, 52), and human clinical specimens and the hospital environment (44, 60, 61, 66, 76, 77) have been identified as flavobacteria. Few of these isolates were ascribed to species, possibly because of the inadequate definition of *Flavobacterium* and the lack of suitable reference strains. We believe, therefore, that the description of *Flavobacterium* given by Weeks (80) should be emended. Various strategies for the taxonomic revision of flavobacteria were discussed by McMeekin and Shewan (55),

and their conclusion with regard to *Flavobacterium* was: "5. Low % GC non-motile, non-gliding organisms represent the majority of Gram negative yellow pigmented strains and should be allocated to the genus *Flavobacterium*..." This view agrees with ours, and it is one that has apparently been increasingly adopted in recent years by microbiologists in various fields. From the standpoint of medical microbiology, we believe it is important that the name *Flavobacterium* be conserved for the gram-negative, nonmotile, nongliding, non-spreading strains with low G+C contents; otherwise well-described and medically important species such as *F. breve*, *F. meningosepticum*, and *F. odoratum* might have to be reclassified. It does not seem advantageous at present to transfer these species, for which there are designated type strains, to other relatively poorly understood genera such as *Cytophaga*, *Empedobacter*, or *Flexibacter*, or, alternatively, to create a new genus for these species.

Accordingly the following emended description of the genus *Flavobacterium* is proposed. This description is based primarily on our results (40-42, 45, 61-63) for clinical isolates. However, to avoid a bias towards isolates of clinical origin, the results of Hayes (36, 37) are also taken into account because several of Hayes' strains corresponded to species recognized in our laboratory and were isolated from a variety of nonclinical sources. Likewise, we have also included results from Callies and Mannheim (21) on the respiratory quinones.

Flavobacterium Bergey et al. emend. Cells vary in shape from rods to near coccid forms; long rods often develop in liquid media. Non-motile. Do not glide or spread (swarm) on a nutrient agar medium. Endospores not formed. Gram negative.

Growth on solid media is typically pigmented (yellow to orange), but some strains may be nonpigmented. The pigment hue may vary with the growth medium and the incubation period. The degree of pigmentation may be more pronounced at lower temperatures (15 to 20°C), and daylight may be required for the development of maximum pigmentation. The pigments are nonfluorescent and are insoluble in growth media; they are generally presumed to be carotenoid. Colonies are typically translucent (occasionally opaque), circular, convex or low convex, smooth and shiny with entire edges.

Chemoorganotrophic. Generally not fastidious, but some cultures may prove difficult to maintain following primary isolation. NaCl is not required at concentrations in excess of 10% (wt/vol).

Metabolism is respiratory. Menaquinones are

the sole respiratory quinones. Aerobic; unable to grow anaerobically in an atmosphere of pure hydrogen (they may grow anaerobically in the presence of 7% [vol/vol] carbon dioxide and consequently may be mistaken for facultative anaerobes). Neither acid nor gas is produced from carbohydrates in peptone water or broth media. Those strains dissimilating glucose do so oxidatively with the production of acid only, and then only when the concentrations of peptone in the test media are low. Other carbohydrates most frequently attacked are fructose, glycerol, maltose, and trehalose.

The temperature range for the growth of environmental isolates is usually 0 to 30°C, clinical isolates grow at 37°C, and in some species strains grow at 42°C.

Generally actively proteolytic, the majority of strains digest casein and liquefy gelatin. Extracellular deoxyribonuclease is produced by most strains. Tributyrin is often hydrolyzed. Catalase, oxidase, and phosphatase are produced. Citrate is not utilized. Amino acids, supplementary growth factors, or both, particularly aneurine or biotin, may be required for growth. Indole is often produced in small amounts (a sensitive technique is necessary to demonstrate this character). Agar is not digested.

Widely distributed in soil and water. Commonly found in food such as raw meats (including poultry), vegetables during commercial processing, and dairy products. Occur in the hospital environment and in human clinical material. Some strains are pathogenic for man and other animals, while others are probably opportunist pathogens.

The G+C content of the DNA ranges from 31 to 40 mol%.

Status of previously described species of *Flavobacterium*. During our reappraisal of the characteristics of the genus *Flavobacterium*, a comprehensive list was prepared of the names of all of the described species of *Flavobacterium*. Certain species (Appendix I) are acceptable under the proposed redescription of the genus *Flavobacterium*. Other species are excluded from the genus *Flavobacterium* because they either are of unknown status and there are no extant reference strains (Appendix II) or do not conform to the emended description (Appendix III). In Appendix IV are listed the species that were originally placed in *Flavobacterium* but were later transferred to other genera. Appendix V contains species names which are not validly published according to the Bacteriological Code (46).

Although *Flavobacterium devorans* (Zimmermann) Bergey et al. 1923 is included in Appendix III because there is a reference strain for

the species—ATCC 10829—this strain has recently been found by E. Yabuuchi, E. Tanimura, A. Ohya, I. Yano and A. Yamamoto (Abstracts of the XII International Congress for Microbiology, Munich, p. 90, 1978) and E. Falsen (personal communication) to belong to *Pseudomonas paucimobilis* (39). Consequently it is possible that someone might cause confusion by suggesting that *P. paucimobilis* is a junior synonym of *F. devorans* and then proposing the new combination *Pseudomonas devorans* for *P. paucimobilis*. We would formally challenge any such proposal because the original description of *F. devorans*, like that of *F. aquatile*, is meager and incomplete so that unequivocal identification of strains of the species, based on the original description as reference, is not possible. Also, ATCC 10829, which Yabuuchi et al. (Abstracts of the XII International Congress for Microbiology, p. 90, 1978) found to be motile by means of a single polar flagellum, does not conform neatly either to the description of the

species given by Weeks (80), wherein it is claimed to be peritrichous, or to the original description of the species (83). Zimmermann (83) described *Bacillus devorans* as being extremely motile whereas, motility is difficult to demonstrate in strains of *P. paucimobilis*, as the name is intended to show. *B. devorans* colonies on gelatin were said to be only yellowish-gray, whereas colonies of *P. paucimobilis* are clearly deeply yellow pigmented (39; Yabuuchi et al., Abstracts of the XII International Congress for Microbiology, p. 90, 1978). We endorse the statement by Yabuuchi et al. (Abstracts of the XII International Congress for Microbiology, p. 90, 1978) that: "Unless the authentic strain of the original describer for *F. devorans* or any isolate in conformity with the original description for the species is found, the name *Flavobacterium devorans* should not be retained further." We therefore consider that *F. devorans* should not be on the Approved Lists of Bacterial Names when they are published on January 1, 1980.

APPENDIX I

The following appear to be acceptable as species of *Flavobacterium*.

Species	Type or reference strains	Reference
<i>Flavobacterium balustinum</i>	NCTC 11212 = La 724 ^a	Harrison 1929 (34)
<i>Flavobacterium breve</i>	NCTC 11099 NCTC 11162 NCTC 11163 ATCC 14234	Lustig 1890 (53)
<i>Flavobacterium meningosepticum</i>	NCTC 10016 = ATCC 13253 (serotype A) NCTC 10585 = ATCC 13254 (serotype B) NCTC 10586 = ATCC 13255 (serotype C) NCTC 10587 (serotype D) NCTC 10588 (serotype E) NCTC 10589 (serotype F)	King 1959 (44)
<i>Flavobacterium odoratum</i>	NCTC 11036 = ATCC 4651 NCTC 11179 = ATCC 29979 NCTC 11180	Stutzer and Kwaschnina 1929 (75)

^a We have examined this strain in our laboratory and have found that it corresponds to the herein emended description of the genus *Flavobacterium*. We are preparing a revised description of the species, and we will be proposing a neotype strain for the species. Abbreviations: ATCC, American Type Culture Collection, Rockville, Md.; NCTC, National Collection of Type Cultures, London, England.

APPENDIX II

There are no known extant reference strains for the following species which have been placed in the genus *Flavobacterium*. The status of these species is therefore unknown. It is possible that some of these species could be excluded from the genus *Flavobacterium* on characteristics given in their original descriptions. However, in view of the lack of reference cultures, we suggest that these names should not appear on the Approved List of Bacterial Names, which becomes effective on January 1, 1980. Accordingly we have neither examined the original descriptions nor given references. Names and citations are taken from Index Bergeyana (19).

- F. aestumarina* (ZoBell and Upham) Brisou 1955
- F. amocontactum* ZoBell and Allen 1935
- F. amylum* Morris 1946
- F. androstendionicum* Ercoli and Molina 1944
- F. annulatum* (Chester) Bergey et al. 1923
- F. antenniforme* (Ravenel) Bergey et al. 1923
- F. aromaticum* (Pammel) Bergey et al. 1923
- F. aurantinum* (Hammer) Bergey et al. 1923
- F. aurescens* (Ravenel) Bergey et al. 1923
- F. boreale* (Lundestad) Bergey et al. 1930
- F. brunneum* (Copeland) Bergey et al. 1923
- F. butyri* Bergey et al. 1923
- F. carbonilicum* Molina and Ercoli 1944
- F. ceramicola* (Lundestad) Bergey et al. 1930
- F. cerevisiae* (Fuhrmann) Bergey et al. 1923
- F. chitinochroma* (Hock) Brisou 1955
- F. chlorum* Steinhaus 1941
- F. decidosum* (Wright) Bergey et al. 1923
- F. delesseriae* (Lundestad) Bergey et al. 1930
- F. diffusum* (Frankland and Frankland) Bergey et al. 1923
- F. dormitator* (Wright) Bergey et al. 1923
- F. droebachense* (Lundestad) Bergey et al. 1930
- F. flavotenuis* Schrire 1928
- F. flavum* (Fuhrmann) Bergey et al. 1923
- F. fucatum* Harrison 1929
- F. fulvum* (Zimmermann) Bergey et al. 1923
- F. gelatinum* Sanborn 1930
- F. granulatum* Ferrari and Zannini 1958
- F. (Halobacterium) maris-mortui* [sic] Elazari-Volcani 1940
- F. halohydrium* ZoBell and Upham 1944
- F. halophilum* Bergey et al. 1930
- F. iniquum* Stapp 1940
- F. invisible* (Vaughan) Bergey et al. 1923
- F. kornii* (Chester) Hauduroy et al. 1953
- F. lacunatum* (Wright) Bergey et al. 1923
- F. lutzii* (Brown) Brown and Heffron 1929
- F. marinum* Harrison 1929
- F. matzoonii* (Chester) Bergey et al. 1923
- F. meningitidis* Hauduroy et al. 1937
- F. moribificans* (Migula) Bergey et al. 1930
- F. neptunium* ZoBell and Upham 1944
- F. ochraceum* (Zimmermann) Bergey et al. 1923
- F. orchiditis* [sic] Sherwood, Irwin, and Marts 1933
- F. ovale* (Wright) Bergey et al. 1923
- F. peregrinum* Stapp and Spicher 1954
- F. plicatum* (Copeland) Bergey et al. 1923
- F. polysiphoniae* (Lundestad) Bergey et al. 1930
- F. pruneaeum* [sic] Sanborn 1930
- F. racemosum* (Zettnow) Bergey et al. 1923
- F. radiatum* (Zimmermann) Bergey et al. 1923
- F. rhodomelae* (Lundestad) Bergey et al. 1930
- F. schirokikhii* (Jensen) Bergey et al. 1923
- F. sinuosum* Ferrari and Zannini 1958
- F. stolonatum* (Adametz and Wichmann) Bergey et al. 1923
- F. tabidum* Kimata 1942
- F. tremelloides* (Tils) Bergey et al. 1923
- F. turcosum* (Zimmermann) Bergey et al. 1923
- F. ustilagophagum* [sic] Cercos 1948
- F. vadosa* [sic] (ZoBell and Upham) Brisou 1955
- F. vaginale* Hosoya and Onoda 1954
- F. vitarumen* Bechdel, Honeywell, Dutscher, and Knutsen 1928
- F. xanthochrus* [sic] (ZoBell and Upham) Brisou 1955

APPENDIX III

The following species, until now assigned to *Flavobacterium* and for which there are extant reference strains, are excluded from the genus because they do not conform to the description of the genus *Flavobacterium* as it is herein emended. Culture collection accession numbers are quoted for reference cultures (ATCC = American Type Culture Collection, Rockville, Md.; CCEB = Czechoslovak Collection of Entomogenous Bacteria [Institute of Entomology], Prague, Czechoslovakia; NCMB = National Collection of Marine Bacteria, Torry Research Station, Aberdeen AB9 8DG, Scotland; CCM = Czechoslovak Collection of Microorganisms, J. E. Purkyně University, Brno, Czechoslovakia; NCIB = National Collection of Industrial Bacteria, Aberdeen, AB9 8DG, Scotland; ETH = Mikrobiologisches Institut, Eidgenössische Technische Hochschule, CH-8006 Zürich, Switzerland; NCTC = National Collection of Type Cultures, Central Public Health Laboratory, London NW9 5HT, England; La = International Center for Information on and Distribution of Type-Cultures, CH-1000 Lausanne 17, Switzerland).

Species	Present generic status or reason for rejection (from original description if no reference is given), or both
<i>F. acidificum</i> Steinhaus 1941 (74) (ATCC 8366; type strain)	Motile. Reference culture gram positive (80)
<i>F. acidurans</i> Millar 1973 (58) (ATCC 27383; type strain)	DNA base composition is 66.3 mol% G+C
<i>F. arborescens</i> (Frankland and Frankland) Bergey et al. 1923 (9) (ATCC 4358)	Reference culture gram positive; DNA base composition is 71 mol% G+C (80)
<i>F. aurantiacum</i> (Frankland and Frankland) Bergey et al. 1923 (9) (CCEB 304)	Motile. Peritrichous and "Gram labile" according to CCEB records
<i>F. buccalis</i> (Chester) Bergey et al. 1923 (9) (University of Surrey 401)	DNA base composition is 51.1 mol% G+C (NCTC unpublished data)
<i>F. capsulatum</i> Leifson 1962 (47) (ATCC 14666; type strain)	DNA base composition is 63 mol% G+C (59)
<i>F. caudatum</i> (Wright) Bergey et al. 1923 (9) (NCMB 1499)	Reisolated in 1919 by Conn (26), who described it as motile and transferred it to <i>Pseudomonas</i>
<i>F. dehydrogenans</i> (Arnaudi) Arnaudi 1942 (2) (ATCC 13930)	Gram positive. DNA base composition is 72 to 74 mol% G+C (80)
<i>F. denitrificans</i> (Jensen) Bergey et al. 1923 (9) (CCM 1950)	Motile
<i>F. devorans</i> (Zimmermann) Bergey et al. 1923 (9) (ATCC 10829)	Motile. DNA base composition is 69 mol% G+C (80). Reference strain identified as <i>Pseudomonas paucimobilis</i> (Yabuuchi et al. Abstracts of the XII International Congress for Microbiology, Munich, p. 90)
<i>F. enalia</i> [sic] (ZoBell and Upham) Brisou 1955 (15) (ATCC 23821 <i>Alteromonas haloplanktis</i>)	Motile by means of several flagella at each pole
<i>F. esteroaromaticum</i> (Omeliński) Bergey et al. 1930 (10) (ATCC 8091)	Reference strain is gram positive; DNA base composition is 69 mol% G+C (80)
<i>F. extorquens</i> (Bassalik) Bassalik, Janota-Bassalik and Brisou 1960 (3) (NCIB 9399)	Polarly flagellated
<i>F. ferrugineum</i> Sickles and Shaw 1934 (70) (ATCC 13524)	DNA base composition is 48.6 mol% G+C (NCTC unpublished data; cf value of Weeks, 42.6 mol% G+C [80])
<i>F. flavescens</i> (Pohl) Bergey et al. 1923 (9) (ATCC 8315)	Motile. Reference strain is gram positive; DNA base composition is 71 mol% G+C (80)
<i>F. halmephilum</i> Elazari-Volcani 1940 (B. Elazari-Volcani, Ph.D. thesis, the Hebrew University, Jerusalem, Israel, 1940) (ATCC 19717)	DNA base composition is 49.7 mol% G+C (21)
<i>F. harrisonii</i> (Buchanan and Hammer) Bergey et al. 1923 (9) (ATCC 14589 <i>Erwinia herbicola</i>)	Peritrichous
<i>F. heparinum</i> Payza and Korn 1956 (64) (ATCC 13125)	Motile. DNA base composition is 45.6 mol% G+C (65)
<i>F. indoltheticum</i> Campbell and Williams 1951 (22) (ATCC 27950, type strain)	Peritrichous
<i>F. lactis</i> (Grimm) Bergey et al. 1923 (9) (ETH 4078)	Peritrichous
" <i>F. lucescoloratum</i> " (unpublished name) (ATCC 17964)	Gram variable and motile, according to ATCC records
<i>F. lutescens</i> (Migula) Bergey et al. 1923 (9) (2611 Brisou)	DNA base composition is 65 mol% G+C (80)
<i>F. marinotypicum</i> ZoBell and Upham 1944 (84) (ATCC 19260, type strain)	Peritrichous

APPENDIX III—Continued

Species	Present generic status or reason for rejection (from original description if no reference is given), or both
<i>F. marinovirusum</i> ZoBell and Upham 1944 (84) (NCMB 563)	Peritrichous
<i>F. oceanica</i> [sic] (ZoBell and Upham) Brisou 1955 (15) (NCMB 558)	Motile by means of a single flagellum at one or at each pole
<i>F. oceanosedimentum</i> Carty and Litchfield 1978 (23) (ATCC 31317)	DNA base composition is 67.5 mol% G+C
<i>F. okeanokoites</i> ZoBell and Upham 1944 (84) (CCM 320)	Peritrichous
" <i>F. oxydans</i> " (unpublished name) (ATCC 21245)	Gram positive and probably a <i>Corynebacterium</i> sp. according to ATCC records
<i>F. pictorum</i> Brisou, Tysset, and Jacob 1960 (17) (La 730)	Motile
<i>F. resinovorum</i> Delaporte and Daste 1956 (27) (ATCC 12524)	Peritrichous
<i>F. rigense</i> Bergey et al. 1923 (9) (F18 Weeks)	Peritrichous
<i>F. sewanense</i> (Kalantarian and Petrosian) Bergey et al. 1934 (7) (La 734)	DNA base composition is 66.7 mol% G+C (NCTC unpublished data)
<i>F. solare</i> (Lehmann and Neumann) Bergey et al. 1923 (9) (NCMB 692)	Gram-positive according to NCMB records
<i>F. suaveolens</i> Soppeland 1924 (72) (ATCC 958)	Peritrichous. Reference strain is gram positive and has a DNA base composition of 70 mol% G+C (80)
<i>F. tirrenicum</i> Marini and Spalla 1964 (54) (ATCC 15997)	Motile
<i>F. trifolii</i> (Huss) Bergey et al. 1923 (9) (ATCC 14537 <i>Erwinia herbicola</i>)	Polarly flagellated
<i>F. uliginosum</i> ZoBell and Upham 1944 (84) (ATCC 14397)	Agarolytic
<i>F. xanthium</i> [sic] (Zettnow) Bergey et al. 1930 (10) (ATCC 8375)	Polarly flagellated

APPENDIX IV

The following species, for which there are extant reference strains, were originally assigned to *Flavobacterium*, but have since been transferred to other genera by various authors. These species are excluded from the genus because they do not conform to the description of the genus *Flavobacterium* as it is herein emended. Culture collection accession numbers are quoted for reference strains (for abbreviations, see head of APPENDIX III)

Species	Present generic status or reason for rejection (from original description if no reference is given), or both
<i>F. acetylicum</i> Levine and Soppeland 1926 (49) (ATCC 953, ATCC 954)	Gram positive. <i>Brevibacterium</i> Breed 1957 (13)
<i>F. coeliacum</i> (Gray and Thornton) Bergey et al. 1930 (10) (ATCC 17041, type strain)	Gram positive. <i>Nocardia</i> Waksman and Henrici 1948 (78)
<i>F. fecale</i> Bergey et al. 1930 (10) (NCTC 11036, proposed neotype for <i>F. odoratum</i>)	Illegitimate, junior synonym of <i>F. odoratum</i> (40)
<i>F. fermentans</i> (von Wolzogen Kühn) Bergey et al. 1934 (7) (NCTC 8049, neotype of <i>A. hydrophila</i>)	Polarly flagellated. Junior synonym of <i>Aeromonas hydrophila</i> Stanier 1943 (73)
<i>F. fuscum</i> (Zimmermann) Bergey et al. 1923 (9) (<i>B. fuscum</i> : ATCC 15993; <i>F. fuscum</i> : ATCC 14233, ATCC 25310)	Gram positive. <i>Brevibacterium</i> Breed 1953 (12)
<i>F. (Halobacterium) cutirubrum</i> [sic] (Lochhead) Elazari-Volcani 1940 (B. Elazari-Volcani, Ph.D. thesis, the Hebrew University, Jerusalem, Israel, 1940) (CCM 2088)	Subjective synonym of <i>Halobacterium salinarum</i> (33)
<i>F. (Halobacterium) halobium</i> [sic] (Petter) Elazari-Volcani 1940 (Ph.D. thesis) (CCM 2090)	Polarly flagellated (33), requires added NaCl in concentrations in excess of 10% (wt/vol); transferred to <i>Halobacterium</i> by Elazari-Volcani 1957 (29)
<i>F. (Halobacterium) salinarum</i> [sic] (Harrison and Kennedy) Elazari-Volcani 1940 (Ph.D. thesis) (CCM 2084)	Two flagella, one at each pole. Requires added NaCl in concentrations in excess of 10% (wt/vol); transferred to <i>Halobacterium</i> by Elazari-Volcani 1957 (29)

APPENDIX IV—Continued

Species	Present generic status or reason for rejection (from original description if no reference is given), or both
<i>F. (Halobacterium) trapanicum</i> [sic] (Petter) Elazari-Volcani 1940 (Ph.D. thesis) (NCMB 767)	Requires added NaCl in concentrations in excess of 10% (wt/vol); transferred to <i>Halobacterium</i> by Elazari-Volcani 1957 (29)
<i>F. helvolum</i> (Zimmermann) Bergey et al. 1923 (9) (ATCC 11822)	Gram positive. <i>Brevibacterium</i> Lochhead 1955 (50)
<i>F. lasseuri</i> Bergey et al. 1930 (10) (ATCC 12983)	Illegitimate, junior synonym of <i>Pseudomonas lemonnierii</i> (Lasseur) Breed 1948 (11)
<i>F. maris</i> Harrison 1929 (34) (ATCC 21111)	Gram positive. <i>Brevibacterium</i> Breed 1953 (12)
<i>F. pectinovorum</i> Dorey 1959 (28) (ATCC 19366, type strain)	Subjective synonym of <i>Cytophaga johnsonae</i> (24)
<i>F. piscicida</i> Bein 1954 (5) (ATCC 15251)	Peritrichous. <i>Pseudomonas</i> Buck, Meyers, and Leifson 1963 (20)
<i>F. proteus</i> Shimwell and Grimes 1936 (69) (ATCC 12841)	DNA base composition is 48 mol% G+C (67); <i>Obesumbacterium</i> Shimwell 1963 (68)
<i>F. pseudomallei</i> (Whitmore) Bergey et al. 1930 (10) (ATCC 15682)	Motile. <i>Pseudomonas</i> Haynes 1957 (38)
<i>F. rhenanus</i> [sic] (Migula) Bergey and Breed 1948 (6) (CCM 298)	Motile. Subjective synonym of <i>Erwinia herbicola</i> (48)
<i>F. rhenii</i> (Chester) Bergey et al. 1923 (9) (<i>F. rhenanum</i> CCM 298)	Illegitimate, junior synonym of <i>Flavobacterium rhenanum</i> (Migula) Bergey and Breed 1948 (6)
<i>F. salmonicolor</i> (den Dooren de Jong) Bergey et al. 1930 (10) (ATCC 19149)	Gram positive. <i>Nocardia</i> Waksman and Henrici 1948 (78)
<i>F. sulfureum</i> Bergey et al. 1923 (9) (ATCC 19098)	Gram positive. <i>Brevibacterium</i> Breed 1957 (13)
<i>F. synxanthum</i> (Ehrenberg) Bergey et al. 1923 (9) (ATCC 9890, suggested neotype)	Flagellated. <i>Pseudomonas</i> Breed 1948 (14)
<i>F. zettnowii</i> Bergey et al. 1923 (9) (ATCC 8375 <i>P. xanthe</i>)	Illegitimate, junior synonym of <i>Pseudomonas xantha</i> Zettnow 1915 (19)

APPENDIX V

The following names of species of *Flavobacterium* are considered to be not validly published according to the rules of the Bacteriological Code (46).

<i>F. nubilum</i>	(Frankland and Frankland) Jensen 1934 (43)
<i>F. thermophilum</i>	Loginova, Userbayeva, and Egorova 1978 (51)

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REPRINT REQUESTS

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