Plasmids		
pAK22	pBBR-based plasmid. Expression of genes under the control of the T7 promoter. kan^R	(1)
mamU-GFP	pAK22 derivative used for MamU-GFP expression	This work
Upper_fliC	pAK22 derivative used to express *fliC* under its native regulatory region	This work
Upper_*fliC*$_{T207C}$	pAK22 derivative used to express T207C FliC mutant off of its native regulatory region	This work
Upper_*fliC*$_{T210C}$	pAK22 derivative used to express T210C FliC mutant off of its native regulatory region	This work
pAK31	pBBR-based plasmid. PIR-dependent ORI. Integration on the chromosome of PIR^- strain to generate deletion mutants. kan^R	(1)
Del_fla	pAK31 derivative used to delete *fliC*	This work
Oligonucleotides		
Name	Sequence	In plasmid
5-mamU-Eco	ggGAATTCatgcgcatcgcggcgatcatc	mamU-GFP
3-mamU-Bam	ggGGATCCtttgggcaccagcatgggt	mamU-GFP
5-Hind-upper-0684-inf	cgaggtcgacggtatcgatAAGCTTctcccaccaagaaaaaggtg	Upper_fliC
3-Spe-0684-inf	gcggtggcggccgctctagaACTAGTTTAACGGAACAGCGACAGG	Upper_fliC
0684-a	ggACTAGTgctgaagctgggcaagtt	Del_fliC
0684-b	CCCATCCACTAAATTTAAATAgaagtaagggtgacgtcagacat	Del_fliC
0684-c	TATTTAAATTTAGTGGATGGGgatcctgtcgctgttccgttaa	Del_fliC
0684-d	ggACTAGTgaagccgaattcctcgtg	Del_fliC
T210C-F	ccGCGACCGCGCTGTGCTCGGGTACCTACACC	Upper_*fliC*$_{T210C}$
T210C-R	GGTGTAGGTACCCGAGCACAGCGCGGTCGCgg	Upper_*fliC*$_{T210C}$
T207C-F	CGCCGGCaccGCGTGCGCGCTGacgTCGG	Upper_*fliC*$_{T207C}$
T207C-R	CCGAcgtCAGCGCGCACGCggtGCCGGCG	Upper_*fliC*$_{T207C}$

Table S1 : Plasmids and oligonucleotides used in this study.

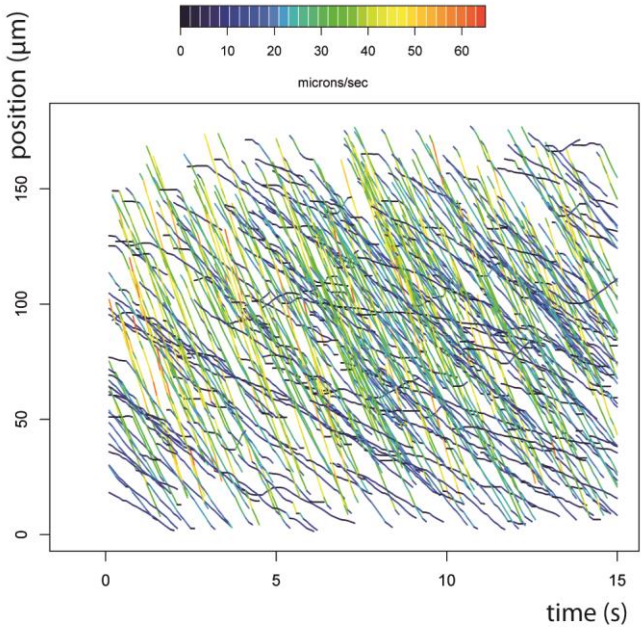

Figure S1: Motility behaviors of AMB-1 cells. The traces shown here are representative of the 586 cells analyzed. Only four hundred of the traces are shown for clarity purposes. The graphs describe the position of each cell (y axis: distance in µm) in function of time (seconds). Instantaneous speed are represented by color-coded fragments.

Supplemental movies:

Movie S1: AMB-1 cell body rotates as a right-handed helix. Video recording showing an AMB-1 cell swimming parallel to the applied magnetic field and spontaneously reversing swimming direction. Phase contrast microscopy. 40X objective.

Movie S2: AMB-1 flagella can rotate in the clockwise and counter-clockwise directions. Video showing an immobile AMB-1 cell which two flagella are fluorescently labeled. The flagellum on the right alternates between being deployed outward (CCW) and folded about the cell body (CW). 100X objective. Exposure time: 80 ms.

Movie S3: One polar motor can alternate between two rotation directions. Video showing two AMB-1 cells that are attached to a glass slide coated with anti-FliC antibodies. The cell movement is due to the rotation of the flagellum which is attached to the slide.

Movie S4: AMB-1 flagella adopt two characteristic patterns of fluorescence. Video showing an AMB-1 swimming downward which leading flagellum (bottom) rotates about the cell body (*parachute*) and lagging flagellum (top) is deployed outward (*tuft*). 100X Objective. Exposure time: 80 ms.

Movie S5: AMB-1 lagging flagellum rotates in the counter-clockwise direction. Video parameters were slowed down to 10 frames per second so as to visualize the lagging flagellum rotation direction. 100X objective. Exposure time: 80 ms.

Movie S6: AMB-1 runs can be interrupted by short pauses. Video showing an AMB-1 cell belonging to the motility group 2 (pauses). The labeled cell swims performs a north-bound run, from the right to the left. 60X objective. Exposure time: 100 ms.

Movie S7: AMB-1 reversals are accompanied by the simultaneous change in both flagella direction of rotation. 100X objective. Exposure time: 100 ms.

Movie S8: AMB-1 tumbling is caused by the asymmetric rotation of the flagella. 100X objective. Exposure time: 80 ms.

References:

1. **Komeili A., Vali H., Beveridge TJ, Newman DK.** 2004. Magnetosome vesicles are present before magnetite formation, and MamA is required for their activation. Proc Natl Acad Sci U S A. Mar **16**;101(11):3839-44.