

Supplementary material for

“A general model of locomotion of brittle stars with a variable number of arms”

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This PDF file includes:

captions for Videos S1, S2 (p. 1)

Figs S1–S5 with captions (pp. 2–5)

Video S1. Locomotion of a five-armed individual of the brittle star *Ophiactis brachyaspis*. Quantitative analysis of this trial is presented in Fig. 3. Resultant values are schematized in row 3 of column 3 (red point symbol) in Fig. S1.

Video S2. Locomotion of a six-armed individual of the brittle star *Ophiactis brachyaspis*. Resultant values are schematized in row 1 of column 1 (black circle symbol) in Fig. S2.

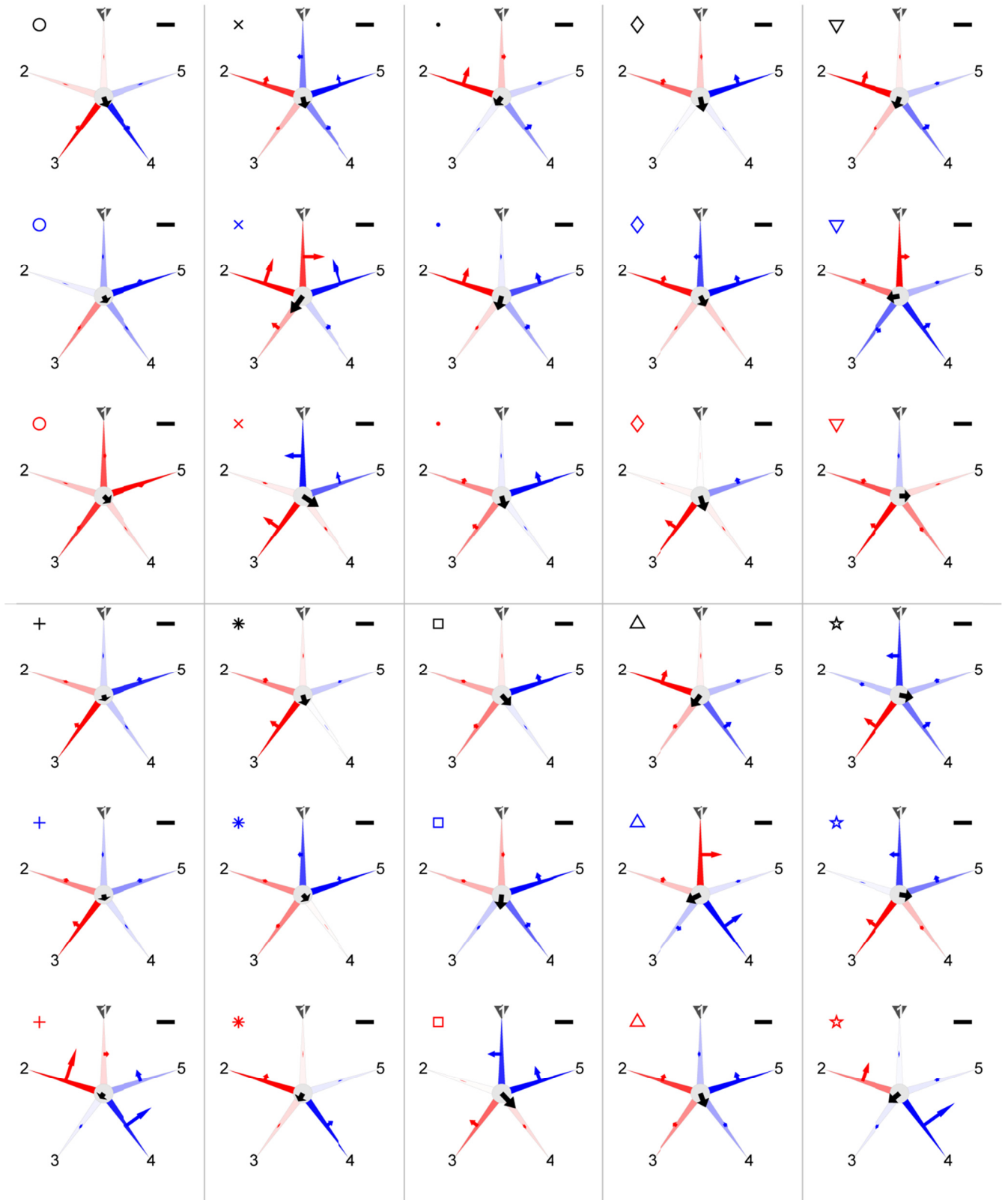


Fig. S1. Trial-by-trial locomotion of five-armed brittle stars (*Ophiactis brachyaspis*). Three trials per individual were analysed in 10 individuals, which are partitioned by grey lines. Black arrows at the disks represent moving distance (S ; c.f. Fig. 2) by length and moving direction (Θ ; c.f. Figs 2, 3) by angle. Arms with negative/positive values for the tendency of being left or right rowers (B_a ; c.f. Figs 2, 3) extend blue-leftward/red-rightward arrows, respectively, with the arrows' length corresponding to $|B_a|$. In each panel, the arm with the maximum $|B_a|$ is coloured with the darkest blue/red, while the other arms show lighter blue/red corresponding to the relative values to the maximum. Scale bars represent 20 mm for S and 50 for B_a . Symbols correspond to those in Fig S5. The trial in row 3 of column 3 (red point symbol) is shown in Video S1.

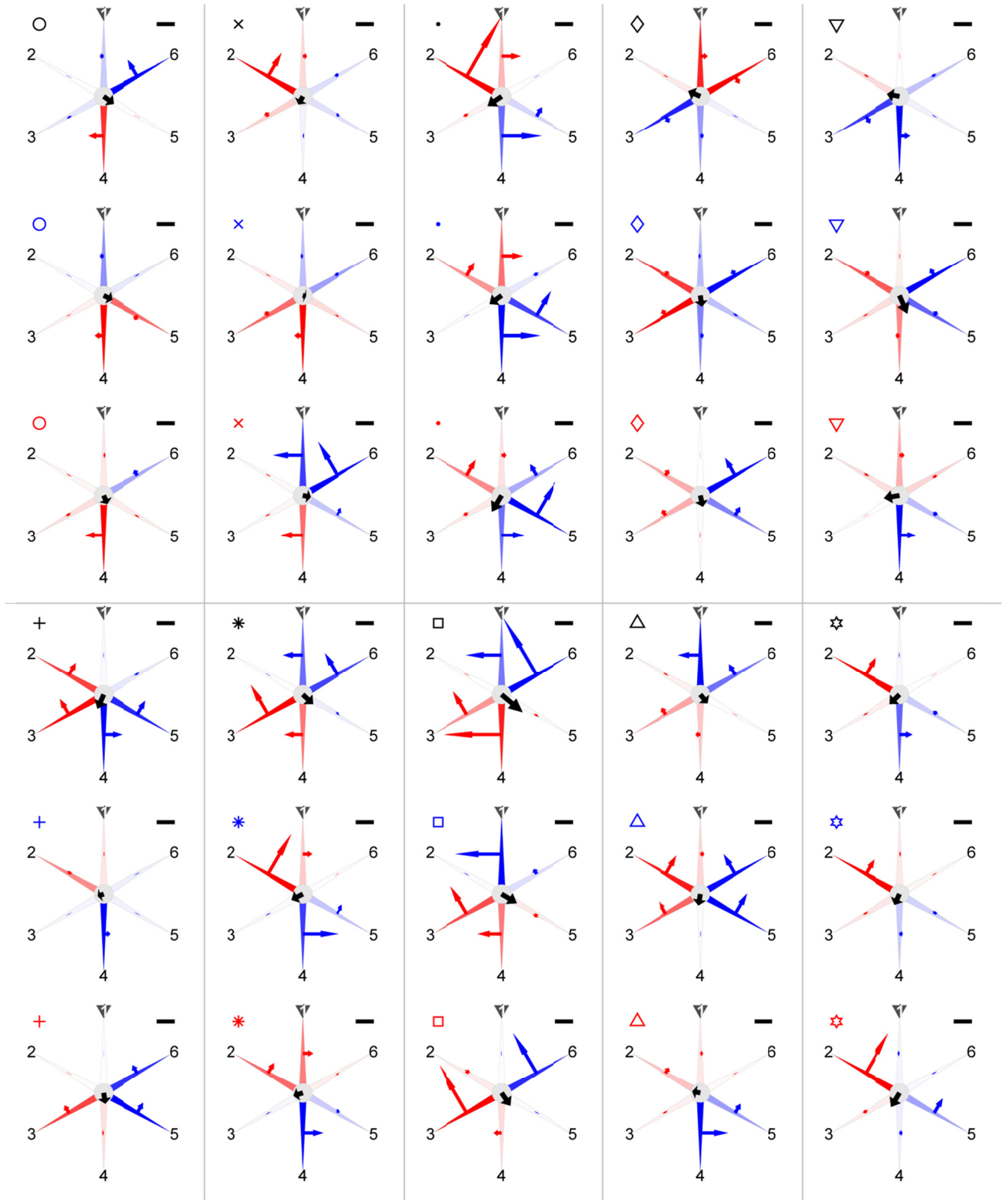


Fig. S2. Trial-by-trial locomotion of six-armed brittle stars (*Ophiactis brachyaspis*). Three trials per individual were analysed in 10 individuals, which are partitioned by grey lines. Results are shown as in Fig. S1. The trial in row 1 of column 1 (black circle symbol) is shown in Video S2.

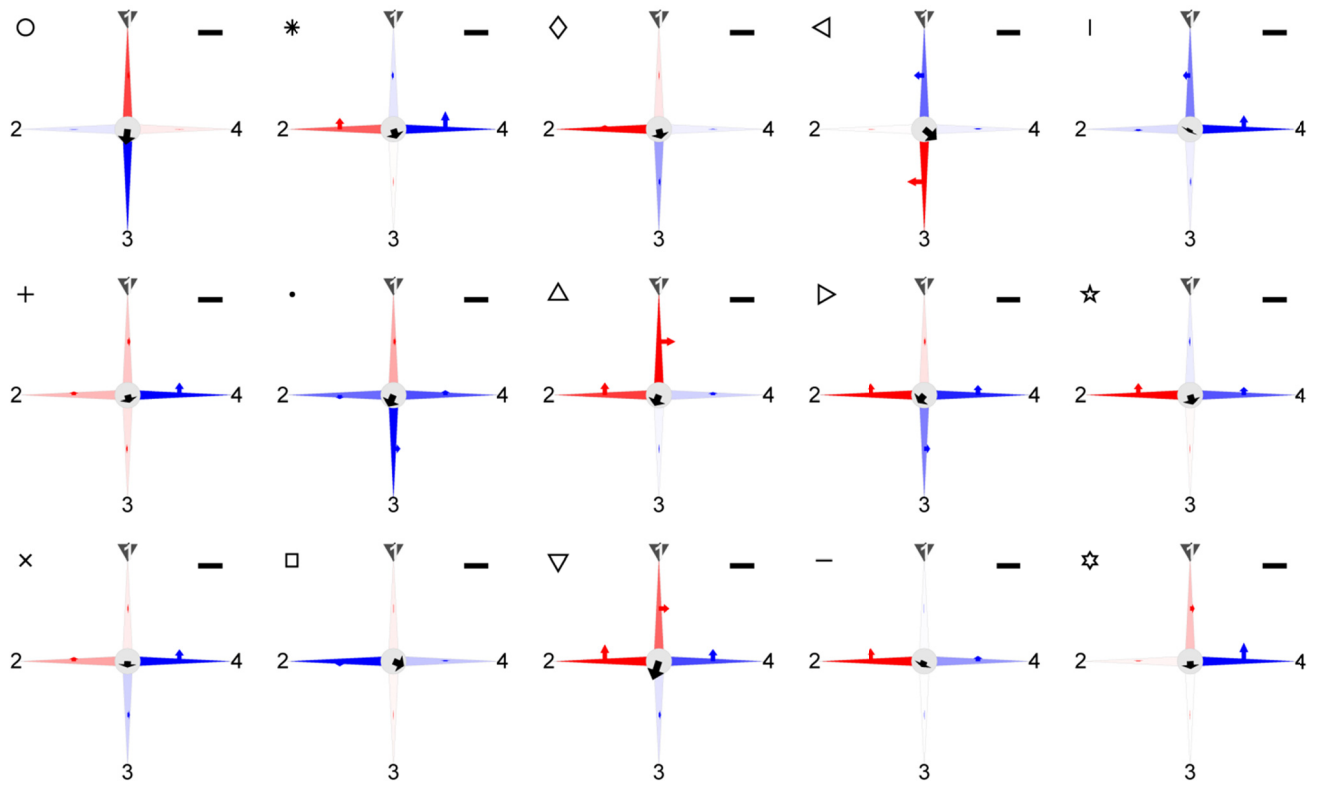


Fig. S3. Trial-by-trial locomotion of four-armed brittle star (*Ophiactis brachyaspis*). Fifteen trials were analysed in one individual. Results are shown as in Fig. S1.

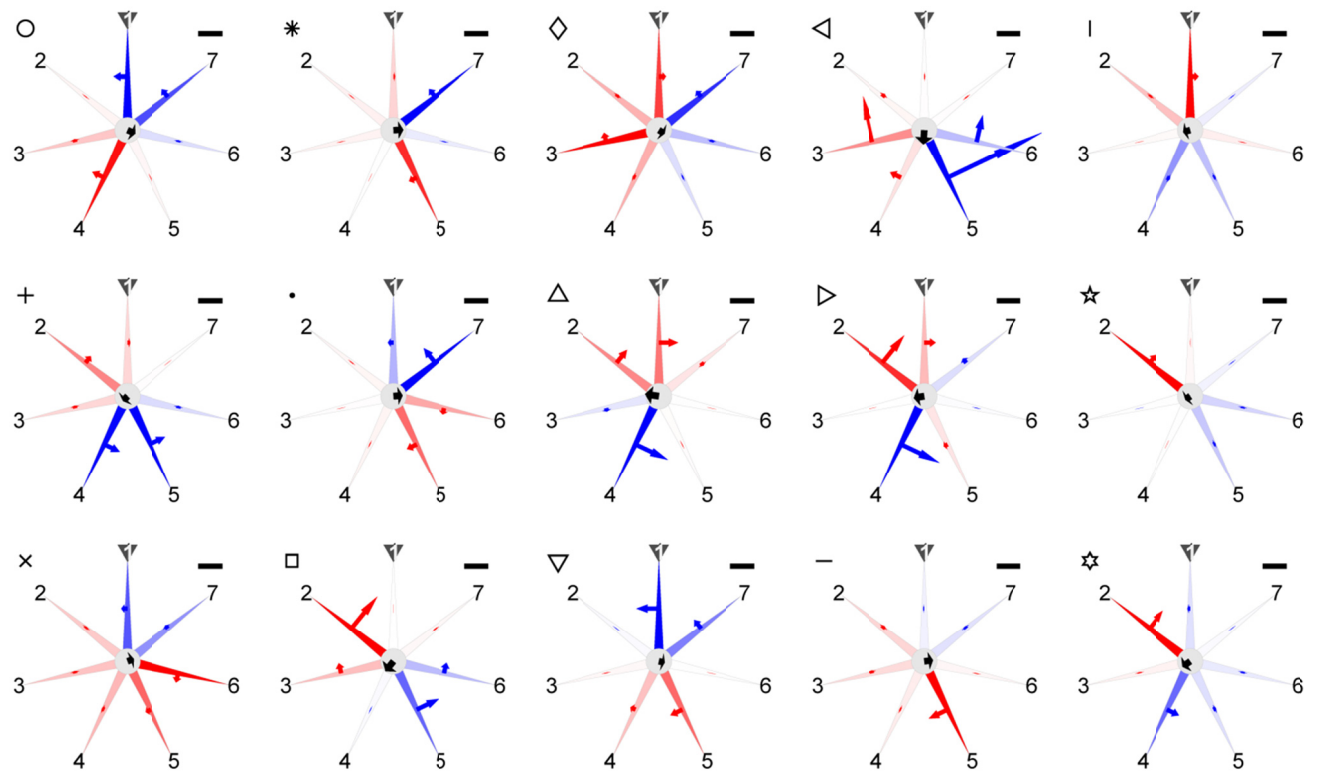


Fig. S4. Trial-by-trial locomotion of seven-armed brittle star (*Ophiactis brachyaspis*). Fifteen trials were analysed in one individual. Results are shown as in Fig. S1.

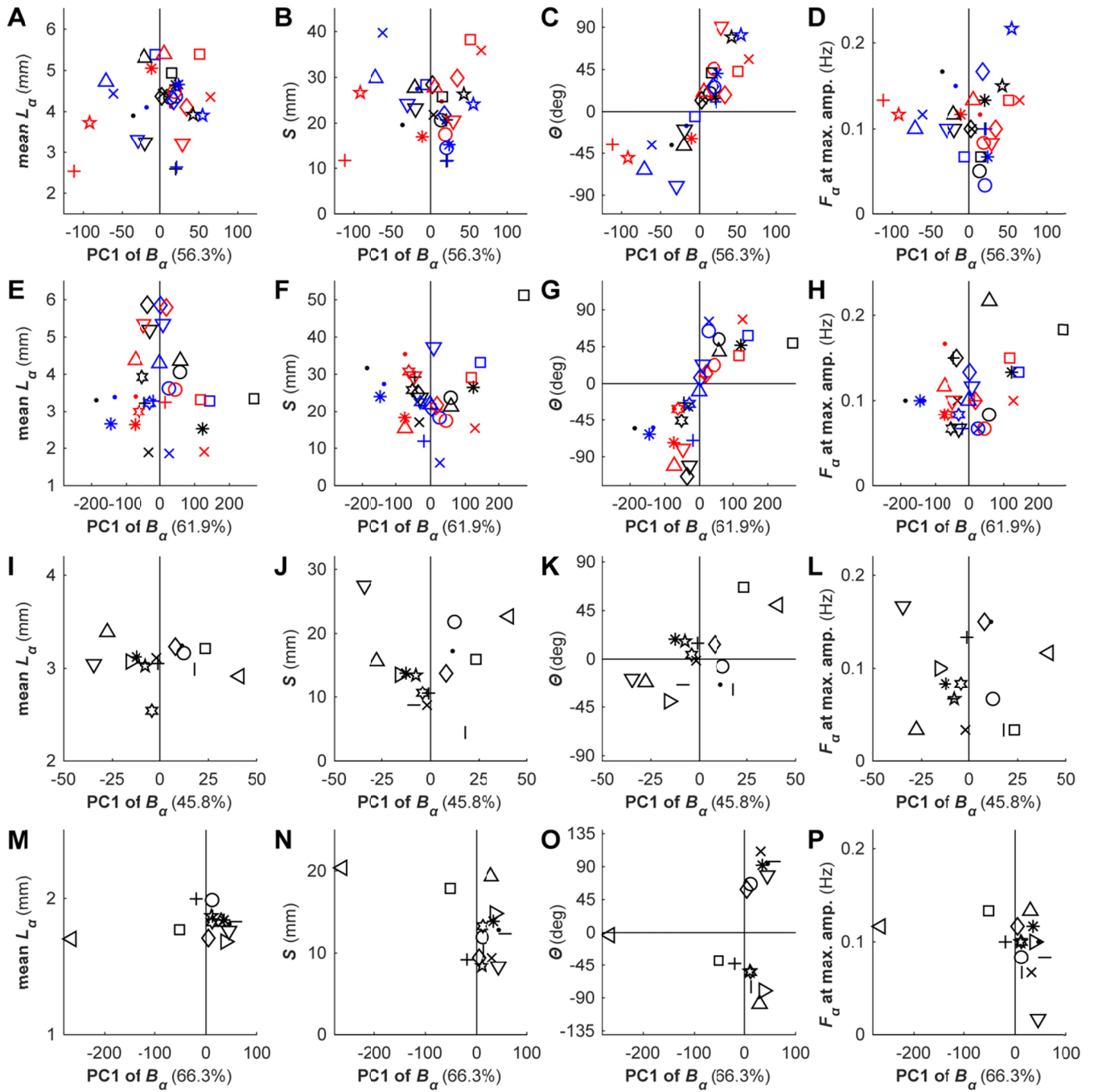


Fig. S5. Scatter diagrams of measurements for locomotion of brittle stars (*Ophiactis brachyaspis*). A–D: five-armed case (10 individuals, 30 trials). E–H: six-armed case (10 individuals, 30 trials). I–L: four-armed case (one individual, 15 trials). M–P: seven-armed case (one individual, 15 trials). Horizontal axes represent the first principal component (PC1) of all arms' tendency of being left or right rowers (B_α ; c.f. Figs 2, 3) in each trial, which was obtained using the principal component analysis (PCA); parenthesized percentages indicate the contribution rates of PC1 to the total variances. Vertical axes represent the followings: A, E, I, M, mean of all arm lengths (L_α) in each trial; B, F, J, N, moving distance (S ; c.f. Fig. 2); C, G, K, O, moving direction (θ ; c.f. Figs 2, 3); D, H, L, P, frequency (F_α) of the arm with the maximum amplitude in each trial. Symbols correspond to those in Figs S1–S4. Trials in the same five- or six-armed individual are indicated by the same shape of symbols while black, blue, and red colours represent three trials. Linear correlation is obvious between B_α and θ in the five- and six-armed cases (C, G), which is consistent with model evaluation in the main text. PC1 in the seven-armed case would be strongly biased by the outlying trial with left triangle symbols (M–P).