

Supplementary materials to the paper "Synchronisation and collective swimming patterns in fish *Hemigrammus bleheri*"

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Movie S1 Video recording of the startup of an experiment. A pair of fish are initially at rest in the test section and they are observed to rapidly arrange in a typical swimming pattern as soon as a flow velocity is imposed in the swimming channel.

Movie S2 Sequence of the different synchronisation patterns of a fish pair. S-IP: synchronised in phase; NS: non synchronised; S-OP: synchronised out-of-phase.

TABLE I. Characteristic distance

Fish Pairs	Flow velocity																			
	2.7cm/s		4.1cm/s		5.5cm/s		6.8cm/s		8.2cm/s		9.6cm/s		11cm/s		12.3cm/s		13.7cm/s		15cm/s	
	l	d	l	d	l	d	l	d	l	d	l	d	l	d	l	d	l	d	l	d
Pair1	0.04	0.58	0.02	0.65	0.14	0.40	0.18	0.43	0.10	0.46	0.10	0.59	0.13	0.59	0.10	0.49	0.22	0.62	0.08	0.49
Pair2	0.21	0.55	0.08	0.50	0.22	0.62	0.07	0.63	0.11	0.73	0.13	0.81	0.10	0.60	0.07	0.60	0.07	0.68	0.04	0.60
Pair3	0.14	0.40	0.07	0.47	0.10	0.60	0.34	0.47	0.35	0.68	0.48	0.53	0.37	0.61	0.29	0.69	0.46	0.70	0.35	0.49
Pair 4	0.38	0.61	0.18	0.59	0.03	0.67	0.04	0.72	0.08	0.78	0.08	0.78	0.03	0.57	0.04	0.74	0.06	0.67	0.05	0.65
Pair5	0.10	0.63	0.08	0.62	0.22	0.63	0.04	0.75	0.15	0.52	0.03	0.52	0.14	0.77	0.21	0.62	0.10	0.68	0.04	0.61
Pair6	0.01	0.39	0.02	0.43	0.01	0.40	0.11	0.74	0.07	0.46	0.08	0.41	0.09	0.54	0.02	0.63	0.01	0.78	0.01	0.78
Pair7	0.35	0.57	0.32	0.55	0.22	0.55	0.40	0.44	0.22	0.48	0.37	0.55	0.49	0.61	0.39	0.61	0.28	0.61	0.33	0.68

TABLE II. Number of flapping cycles used for calculating asynchronous and synchronous phase

Fish Pairs	Flow velocity									
	2.7cm/s	4.1cm/s	5.5cm/s	6.8cm/s	8.2cm/s	9.6cm/s	11cm/s	12.3cm/s	13.7cm/s	15cm/s
Pair1	55	60	64	68	74	80	81	83	88	89
Pair2	55	69	71	67	68	72	78	85	91	98
Pair3	55	63	67	69	71	75	85	90	94	100
Pair 4	58	64	67	69	72	80	86	88	96	95
Pair5	55	62	67	71	75	85	89	93	98	101
Pair6	69	80	86	82	98	102	104	102	113	117
Pair7	66	68	70	79	80	81	81	87	97	94

TABLE III. Fish length ratio

Fish Pairs	L1/L2
Pair1	1.11
Pair2	1.10
Pair3	1.0
Pair4	0.98
Pair5	1.0
Pair6	0.94
Pair7	1.0

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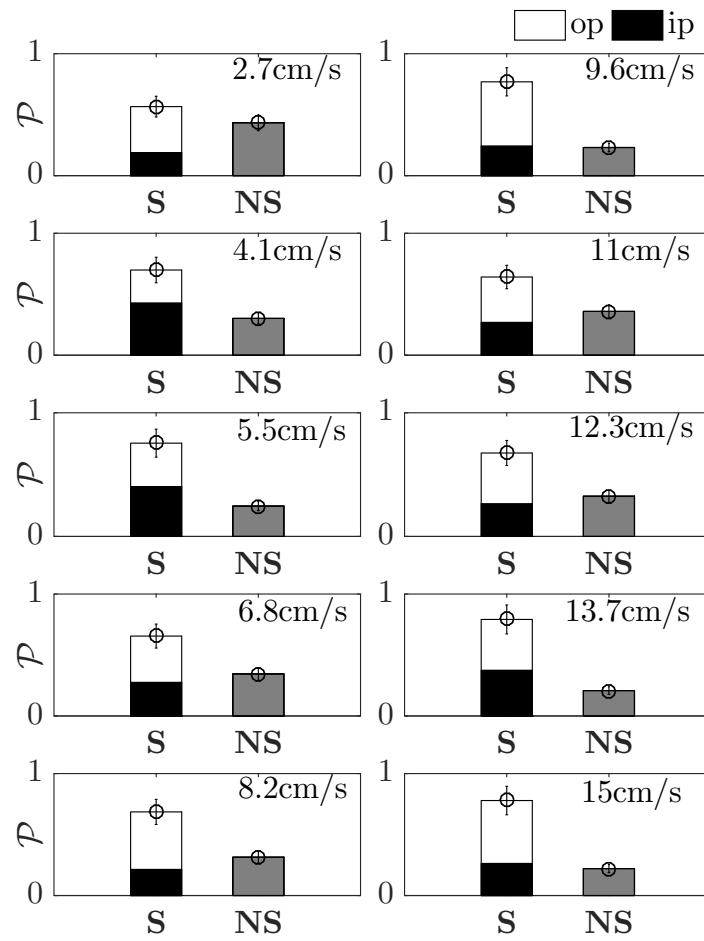


FIG. 1. Probability histograms of synchronization of fish pair 1 at different flow velocities. The mean body length of pair1 is 33 mm. The ratio of body length of two fish($L1/L2$) is 1.11, where $l1$ is body length of top fish and $L2$ is body length of bottom.

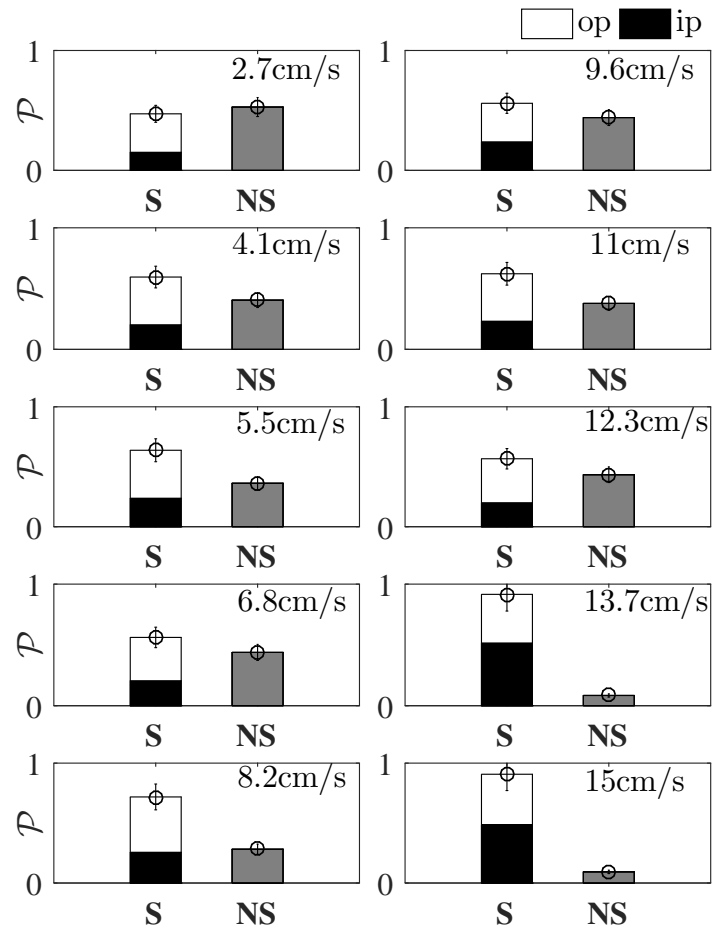


FIG. 2. Probability histograms of synchronization of fish pair 2 at different flow velocities: The mean body length of pair2 is 28 mm. The ratio of body length of two fish($L1/L2$) is 1.10, where $l1$ is body length of top fish and $L2$ is body length of bottom.

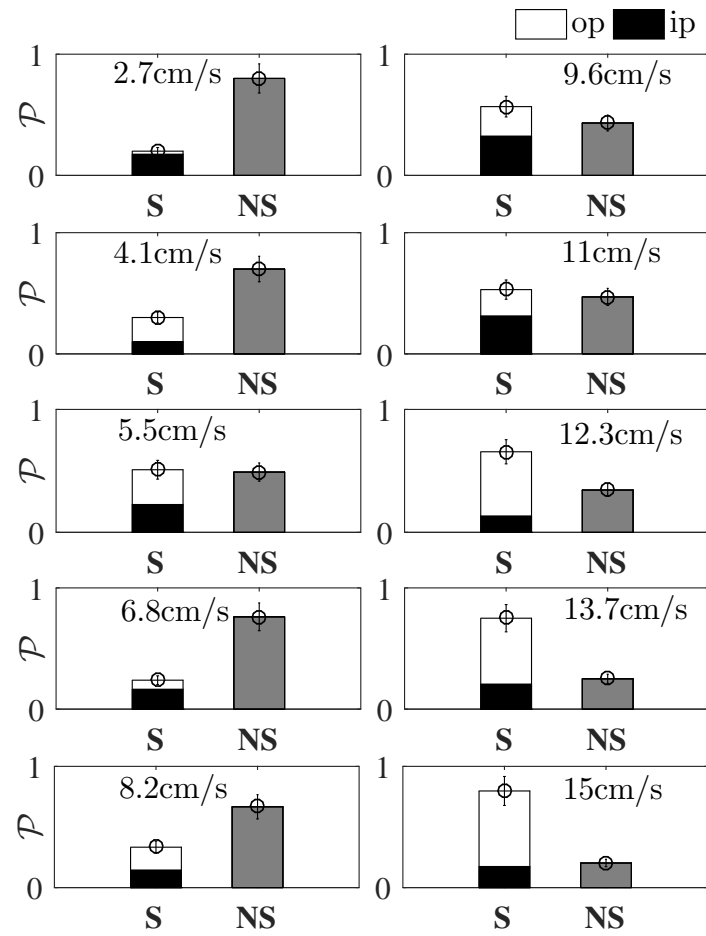


FIG. 3. Probability histograms of synchronization of fish pair 3 at different flow velocities. The mean body length of pair3 is 30 mm. The ratio of body length of two fish($L1/L2$) is 1.0, where $L1$ is body length of top fish and $L2$ is body length of bottom.

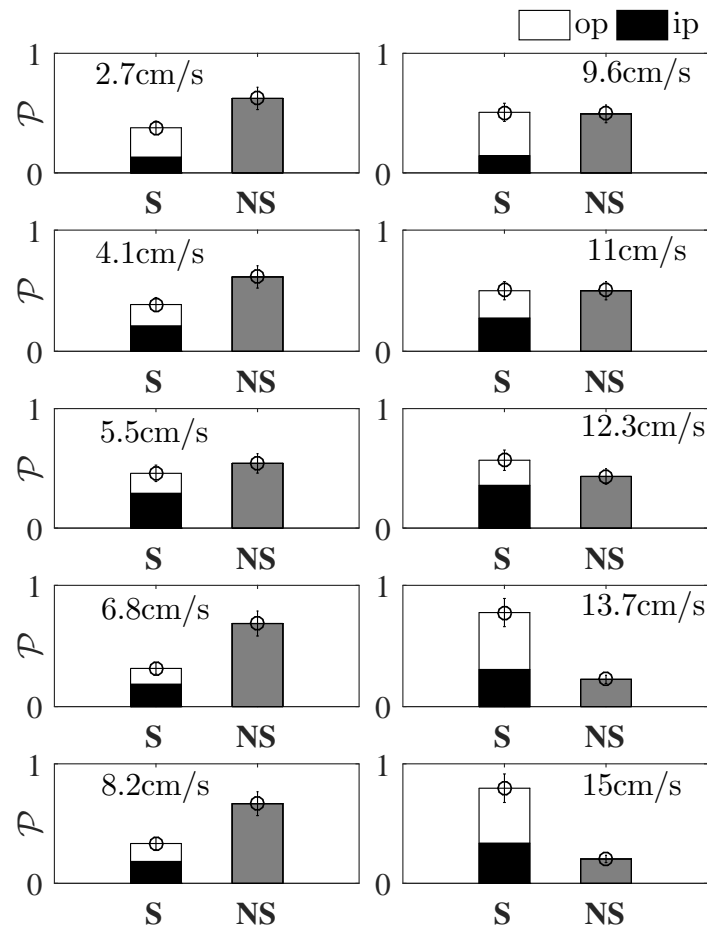


FIG. 4. Probability histograms of synchronization of fish pair 4 at different flow velocities. The mean body length of pair4 is 30 mm. The ratio of body length of two fish($L1/L2$) is 0.98, where $L1$ is body length of top fish and $L2$ is body length of bottom.

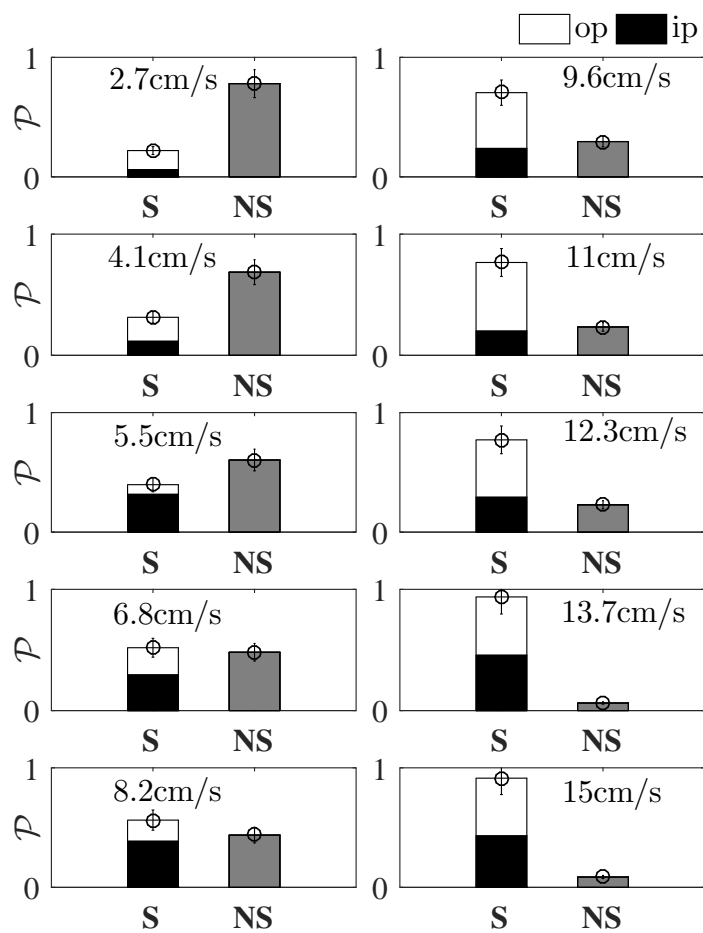


FIG. 5. Probability histograms of synchronization of fish pair 5 at different flow velocities. The mean body length of pair5 is 29 mm. The ratio of body length of two fish($L1/L2$) is 1.0, where $L1$ is body length of top fish and $L2$ is body length of bottom.

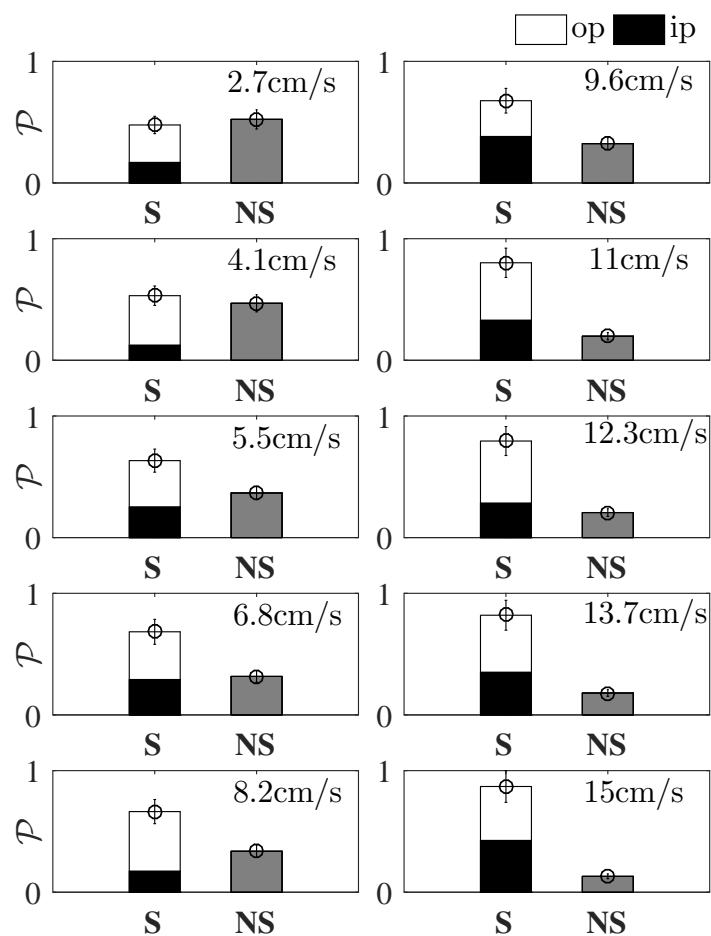


FIG. 6. Probability histograms of synchronization of fish pair 6 at different flow velocities. The mean body length of pair6 is 34 mm. The ratio of body length of two fish($L1/L2$) is 0.94, where $L1$ is body length of top fish and $L2$ is body length of bottom.

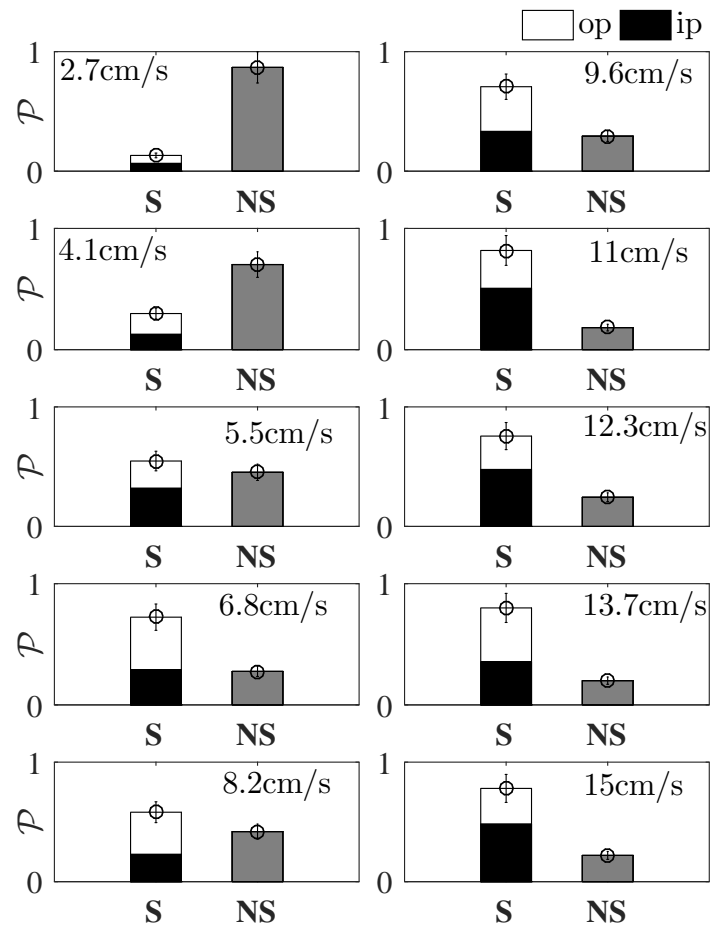


FIG. 7. Probability histograms of synchronization of fish pair 7 at different flow velocities. The mean body length of pair7 is 31 mm. The ratio of body length of two fish($L1/L2$) is 1.0, where $L1$ is body length of top fish and $L2$ is body length of bottom.