Table S8 (parts A, B, C). Muscle functions based on muscle moment arms and co-occurrence of activation and kinematics.

Behaviors: WAIR = wing-assisted incline running, AF = ascending flight. Kinematics: DEP = depression, ELEV = elevation, RET = retraction, PROT = protraction, PRO = pronation, SUP = supination, FLEX = flexion, EXT = extension, ADD = adduction, ABD = abduction; DS = downstroke, US = upstroke. Superscripts: A = adult model (>100 days), J = juvenile model (18-20 days), B = baby model (7-8 days); if no superscript, kinematic rotation occurs in all models. Text color, potential function column: black = consistent w/ previously suggested function, red = inconsistent w/ previously suggested function; blue = no previously suggested function; bold = main function. Cell color, right column: green = DS muscle or muscle not active during DS-US transition, blue = US muscle, active during DS-US transition. **: biarticular muscle. *: not tested here (digit kinematics).

A

	Muscle	EMG timing (colored lines = WAIR simulations, Adult, Juvenile, or Baby model; gray bars = AF, from Dial	Moment arms (Adult solid Baby small dash) + tin simulated; AF from Dial 1 (from Heers	Potential function based on moment arms and phys x-sectional area (Table 2) (black: consistent with previous data, blue: no previous data, red: inconsistent with previous data)		Relative importance (average % torque from Table 2)		Reason for discrepancy with previous work (Dial 1992, Poore 1997, Biewener 2011, Berg & Biewener 2012) on flight?		Suggested function based on moment arms and co- occurrence of EMG and kinematics; green = downstroke muscle, blue = upstroke muscle	
		1992)	WAIR	AF	WAIR	AF (adult only)	WAIR	AF (adult only)			
	Pectoralis	0.4 Pectorals 0.1 0.0 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	## NOTIONALE ** TOTAL	Garage 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	DEP RET or PROT PRO	same	97-100 52-59, 19-24 73-79	96 51, 13 76	Consistent		decelerate ELEV -> DEP; PROT -> RET; decelerate SUP -> PRO
	Supracoracoideus	0.5 d	0.20 0.20 0.20 0.20 0.20 0.35	### Open Control of the Control of t	ELEV PROT SUP	same	54-75 67-74 84-91	50 80 72		Consistent	decelerate DEP + RET + PRO -> ELEV + SUP
	Coracobrachialis posterior	0.4 Corrodorchistis protestor of the pro	BIS DESCRIPTION OF THE PROPERTY OF THE PROPERT	(A) 0.10 0.10 0.10 0.10 0.10 0.10 0.10 0.1	ELEV or DEPJ RET SUP or PRO	mainly DEP RET SUP or PRO	x, x 10-23 4-12, x	x 19 38, x	WAIR kinematics: humerus kept elevated -> ELEV instead of DEP		DEP (AF) or opposes DEP (AF, WAIR); decelerate PROT -> RET; PRO or opposes PRO
	Coracobrachialis anterior	Very low activation	COMMONMONIA NT 40 60 80 100	Star states to the star state to the star state to the star state to the star state to the star star star star star star star star	DEP or ELEV PROT SUP or PRO ^B	same	x, x x x, x	x, x x x	No previou	isly suggested functions	does not seem to contribute much — mainly stabilization
SHOULDER	Subcoracoideus	5.0coracoldeus 5.0coracoldeus 0.15 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05	Section 100 to 1	### OLD	ELEV or DEPJ RET PRO or SUPBJ	ELEV or DEP RET PRO or SUP	x, x 6-11 x, x	x, x 9 x, 16	No previously suggested functions		opposes DEP; decelerate PROT -> RET; mainly PRO
10HS	Latissimus dorsi	1.00 + Latisamus dors 0.5 0.5 0.5 0.1 0.4 0.1 0.2 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	DEC 0.2 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	ELEV RET PRO or SUP	same	8-23 14-26 x, x	19 12 x, x	No previou	isly suggested functions	opposes DEP -> ELEV; decelerate PROT -> RET
	Scapulohumeralis caudalis	Scapabhymenals countils 0.4 Scapabhymenals countils 0.3 0.1 0.0 20 40 Magazinate (KCycky) 100	Marina Ma	## Parameter Par	ELEV or DEPBJ RET or PROT PRO	same	4-21, x 17-22, 5-30 17-30	24 18, 14 21	WAIR kinematics: humerus very retracted -> PROT instead of RET		oppose DEP ^A -> ELEV ^A (esp. WAIR); RET -> oppose RET -> PROT; mainly PRO or oppose PRO
	Subscapularis	0.055 Subsceptures 0.050 0.03 0.03 0.03 0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	ELEV Mainly RET PRO	ELEV RET PRO	x x x	X X X	Disagree w/ previous work: muscle pulls "down", but elevates an already elevated humerus		does not seem to contribute much: opposes DEP; decelerate PROT -> RET; decelerate SUP (AF) -> PRO
	Deltoideus major	0.4 Destroidence magazi 0.2 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	BASE 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	0.00	ELEV PROT or RET ^{BJ} SUP	ELEV PROT PRO or SUP	4-6 3-5, x x	7 x x, x	WAIR kinematics: humerus very retracted -> PROT instead of RET		decelerate DEP -> ELEV; opposes RETA -> PROTA (WAIR); decelerate PRO -> SUP (WAIR), or opposes long axis rotation (AF)
	Tensor propatagialis brevis	Tentor procuraçadas 0.2 0.2 0.0 0.0 0.0 0.0 0.0 0.	### No. 10	BE 100 000 000 000 000 000 000 000 000 00	DEP or ELEV PROT or RET ^B SUP or PRO ^B	same	x, x 7-12, x 5-6, x	x, x 9 x	cannot account for the r	functions (at shoulder); note that SIMM ole of the propatagialis in tensing the propatagium	ELEV ^A (WAIR) or DEP (AF), stabilization; PROT (WAIR) or opposes RET (AF) SUP or opposes PRO (AF)
	Scapulotriceps	0.3 - Superiorcept (out) Superio	### ### ### ### ### ### ### ### ### ##	40 miles in a service in a serv	ELEV RET PRO or SUPBJ	same	4-7 5-11 x, x	7 x x		Consistent	opposes DEP -> ELEV; RET ~ no long axis rotation

Table S8 (parts A, B, C). Muscle functions based on muscle moment arms and co-occurrence of activation and kinematics.

Behaviors: WAIR = wing-assisted incline running, AF = ascending flight. Kinematics: DEP = depression, ELEV = elevation, RET = retraction, PROT = protraction, PRO = pronation, SUP = supination, FLEX = flexion, EXT = extension, ADD = adduction, ABD = abduction; DS = downstroke, US = upstroke. Superscripts: A = adult model (>100 days), J = juvenile model (18-20 days), B = baby model (7-8 days); if no superscript, kinematic rotation occurs in all models. Text color, potential function column: black = consistent w/ previously suggested function, red = inconsistent w/ previously suggested function; blue = no previously suggested function; bold = main function. Cell color, right column: green = DS muscle or muscle not active during DS-US transition, blue = US muscle, active during DS-US transition. **: biarticular muscle. *: not tested here (digit kinematics).

	EMG timing (colored lines = WAIR simulations, Adult, Juvenile, or Baby model; gray bars = AF, from Dial 1992) Moment arms (Adult solid lines, Juvenile large dash, Baby small dash) + timing of activity (WAIR, simulated; AF from Dial 1991 & 1992) + kinematics (from Heers et al. 2016)		Potential function based on moment arms and phys x-sectional area (Table 2) (black: consistent with previous data, blue: no previous data, red: inconsistent with previous data)		Relative importance (average % torque from Table 2)		Reason for discrepancy with previous work (Dial 1992, Poore 1997, Biewener 2011, Berg & Biewener 2012) on flight?	Suggested function based on moment arms and co- occurrence of EMG and kinematics; green = downstroke muscle, blue = upstroke muscle		
		1992)	WAIR	AF	WAIR	AF (adult only)	WAIR	AF (adult only)		
	Tensor propatagialis brevis	Tentor processgales 0.2 Tentor processgales 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0	THEOR POWER PARKETS IN THE PARKETS I	# Company	FLEX ADD ^{BJ} or ABD PRO	FLEX ADD or ABD PRO	39-49 15-16, 19-24 47-55	37 17, 33 53	Consistent; note that SIMM cannot account for the role of the propatagialis in tensing the propatagium	FLEX (AF) or opposes FLEX (WAIR); mainly opposes ADD and ABD (WAIR, AF); PRO or opposes SUP
	Biceps brachii	0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6	100	Motion 1 100 100 100 100 100 100 100 100 100	FLEX ADD or ABD ^B PRO or SUP ^A	same	22-32 6-7, x 5-17, 5	32 9 6, 19	Consistent	opposes EXT, or FLEX (AF) ADD or opposes ABD; SUP (AF) or opposes PRO (AF)
	Scapulotriceps	Scapularinceps (solid) Scapularinceps (solid) Rummericops (solid) Superiority (solid) Sup	SONATION	Motion	EXT ADD SUP or PROB	EXT ADD SUP or PRO	29-43 6-11 11-26, x	41 9 8, 8	Consistent	opposes FLEX, or EXT (WAIR); ADD or opposes ABD; opposes PRO -> SUP
	Humerotriceps	Scapulatriceps (salid) Namericiceps (salid)	Seaton shelded to the	Meson plants of the plants of	EXT ADD PRO ^A or SUP	same	33-48 10-14 x, 4-21	45 12 7, 6	Consistent	EXT (AF) -> opposes FLEX; ADD or opposes ABD SUP or opposes PRO (AF)
	Brachialis	0.20 Brachels 0.15 0.00 0 40 60 80 100 Wingstrote (Ncycle)	Station and statio	fluino estados proprios de la companya del companya del companya de la companya d	FLEX or EXTB ADDBJ>A SUPBJ>A	same	x, x x x	x x x	No previously suggested functions	opposes EXT -> FLEX; opposes PRO
ELBOW	Pronator sublimis, profundus	1.0 Provider politicular subdimus 0.8 Provider subdimus 0.0 O O O O O O O O O O O O O O O O O O	# Gastra production 100 10	(B) 0.00 - 1	FLEX or EXT ^{AB} ADD SUP	FLEX ADD SUP	8-18, x 42-58 3-41	12 46 44	Disagree: activated during PRO but actually stabilizes against PRO; misnomer from human anatomy. Bird position left, human position right.	P. profundus: mainly EXT; P. sublimis: FLEX or opposes EXT mainly ADD; opposes PRO, or SUP (AF)
	Entepicondylo- ulnaris	0.6 f	0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05	Feetin	EXT ^{BA} or FLEX ^{BJ} ADD SUP	same	x, x 7-12 14-21	x 7 20	No previously suggested functions	EXT; ADD or opposes ABD; opposes PRO
	Supinator	0.2	Station and statio	Marian Parameter	FLEX or EXTB ABD SUP or PROBJ	same	x, x 5-10 x, x	x 12 x	Consistent; PRO in B and J models is only brief and occurs when the muscle is not activated	FLEX ABD or opposes ADD
	Anconeus	0.8 - Anconsus 0.8 - Anconsus 0.8 - Anconsus 0.8 - Anconsus 0.9 - Anconsus 0.9 - Anconsus 0.9 - Anconsus 0.9 - Anconsus Norganists (Noycks) 80 100	100	100 - 100 -	FLEXAJ>B or EXTB ABD PRO	same	x, x 25-32 22-39	x 28 33	No previously suggested functions	FLEX; ABD or opposes ADD; opposes SUP
	Flexor carpi ulnaris**	Flexor carps 0.4 10 10 10 10 10 10 10 10 10 1	6 Case of Case	School of the state of the stat	FLEX ^J or EXT ADD SUP	same	x, 11-26 8-11 21-36	13 7 18	No previously suggested functions (at elbow)	EXT -> opposes FLEX; ADD or opposes ABD; opposes PRO, or SUP
	Extensor metacarpi radialis**	0.8		0.10 0.00 0.00 0.00 0.00 0.00 0.00 0.00	FLEX ABD PRO or SUP	same	9-16 26-38 x, x	11 27 x	No previously suggested functions (at elbow)	FLEX or opposes EXT; ABD or opposes ADD
	Extensor digitorum communis**	0.3 -	### ##################################	Miscon - Mis	FLEX or EXT ^B ABD PRO	same	x, x 5-8 x	x 6 x	No previously suggested functions (at elbow)	mainly ABD
	Extensor carpi ulnaris**	0.5 0.4 Extensor carpli unions 0.2 0.4 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	Share	Mean	FLEX or EXT ^B ABD PRO	same	x, x 7-9 x	x 10 x	No previously suggested functions (at elbow)	ABD, or opposes ADD

B

Table S8 (parts A, B, C). Muscle functions based on muscle moment arms and co-occurrence of activation and kinematics.

Behaviors: WAIR = wing-assisted incline running, AF = ascending flight. Kinematics: DEP = depression, ELEV = elevation, RET = retraction, PROT = protraction, PRO = pronation, SUP = supination, FLEX = flexion, EXT = extension, ADD = adduction, ABD = abduction; DS = downstroke, US = upstroke. Superscripts: A = adult model (>100 days), J = juvenile model (18-20 days), B = baby model (7-8 days); if no superscript, kinematic rotation occurs in all models. Text color, potential function column: black = consistent w/ previously suggested function, red = inconsistent w/ previously suggested function; blue = no previously suggested function; bold = main function. Cell color, right column: green = DS muscle or muscle not active during DS-US transition, blue = US muscle, active during DS-US transition. **: biarticular muscle. *: not tested here (digit kinematics).

С	Muscle	Juvenile, or Baby model; (from Heers et al. 2016) gray bars = AF, from Dial		Potential function based on moment arms and phys x-sectional area (Table 2) (black: consistent with previous data, blue: no previous data, red: inconsistent with previous data)		Relative importance (average % torque from Table 2)		Reason for discrepancy with previous work (Dial 1992, Poore 1997, Biewener 2011, Berg & Biewener 2012) on flight?	Suggested function based on moment arms and co- occurrence of EMG and kinematics; green = downstroke muscle, blue = upstroke muscle	
		1992)	WAIR	AF	WAIR	AF (adult only)	WAIR	AF (adult only)		
	Flexor carpi ulnaris**	Feror cary 0.4 0.2 0.2 0.2 0.2 0.3 0.4 0.60 0.100	100 00 00 00 00 00 00 00 00 00 00 00 00	1	FLEX or EXT ^J ADD or ABD ^J PRO or SUP ^{AB}	FLEX ADD or ABD PRO or SUP	89-99, x 22-53, 8-87 46-64, 8-25	94 37, 69 27, 65	Consistent; EXT moment in J small and brief	FLEX or opposes EXT; ADD or opposes ABD; PRO or opposes SUP
	Flexor digitorum sublimis, profundus	Finer digitorum podinodo (ostid) Plesor digitorum audieno (osted) Plesor digitorum audieno (osted) O d d d d d d d d d d d d d d d d d d d	######################################	1	EXT ^{BJ} or FLEX ^A ADD PRO or SUP ^B	EXT or FLEX ADD PRO	11-15, x 38-64 17-83, 29	x 52 35	No previously suggested functions (at wrist); main function may be to ADD phalanges (FLEX in human anatomy)	EXTBJ, opposes FLEX, FLEXA, opposes EXTA; mainly opposes ABD; PRO or opposes SUP
	Ulnimetacarpalis ventralis	EMG very low	BOATO 20 40 60 80 100	Manufacture (1)	FLEX or EXT ADD or ABD ^B PRO or SUP ^{AB}	same	4-60, x 4-6, x 8-32, 13-20	6, x x 17, 80	No previously suggested functions	does not seem to contribute much during WAIR: FLEX; ADD
WRIST	Extensor metacarpi radialis**	1.0 Extensor metacarps 1.0	1	100 0.00 0.00 0.00 0.00 0.00 0.00 0.00	EXT ADD or ABD ^{AB} PRO ^J or SUP	EXT ADD or ABD PRO or SUP	59-67 11-36, 21-24 14-31, 65-79	60 23, 12 50, 58	Consistent	EXT, also opposes FLEX; ABD or opposes ABD (WAIRJ, AF); SUP or opposes PRO
	Extensor digitorum communis**	0.1	#fination and additional ad	figure - separation of separat	EXT ADD ^J or ABD PRO ^{BJ} or SUP	EXT ADD or ABD PRO or SUP	3-6 x, 28-30 x, 8-10	5 x, 24 x, x	Consistent - ADD moment in J brief and does not occur when muscle is activated. Should also ABD phalanges (EXT in human anatomy)	mainly opposes FLEX; mainly opposes ADD; SUP or opposes PRO
	Extensor carpi ulnaris**	0.1	# flates	### ### ### ### ### ### ### ### ### ##	EXT ADD ^J or ABD PRO ^{AB} or SUP ^B	same	3-9 x, 33-52 6-14, x	8 34 8	Some texts say EXT, some say FLEX; activated during wrist flexion but actually serves to stabilize wrist - tendons of Extensor digitorum communis and Extensor carpi ulnaris pass through retinaculum on distal ulna, preventing flexion	EXT but mainly opposes FLEX ABD but mainly opposes ADD; PRO but mainly opposes SUP
	Extensor pollicis longus	EMG very low	60 0.15 0.00 0.00 0.00 0.00 0.00 0.00 0.0	Section Sect	EXT ABD ^{AB} or ADD ^{J>BA} PRO ^J or SUP	same	3-16 8, x x, 6-57	16 7, 8 9, 32	No previously suggested functions (at wrist); main function may be to extend pollex*	does not seem to contribute much to wrist movement during WAIR: EXT or opposes FLEX; ABD or opposes ADD; opposes PRO
	Extensor indices longus	EMG very low	1	Manual Ma	EXT or FLEX ^B ADD ^J or ABD PRO ^J or SUP	same	3-7, x x, 9-13 x, 10-38	6 23 7	No previously suggested functions (at wrist). Should also ABD interphalangeal joints* (EXT in human anatomy)	does not seem to contribute much to wrist movement during WAIR: EXT or opposes FLEX; ABD or opposes ADD; opposes PRO