

Cambridge University Press

978-0-521-06495-8 - Mechanics and Physiology of Animal Swimming

Edited by Linda Maddock, Quentin Bone and Jeremy M. V. Rayner

Index

[More information](#)

Index

	<i>page</i>
acantharians	14-19
crawling form (<i>litholophus</i>)	17, 24-26
inflation-deflation of cell surface	19
acanthopterygian fish swimming biology	53
acceleration reaction, cephalopods	30-31
accelerators, gait specialization	55, 56-57
actinopterygians	53-56
evolutionary patterns	53
activation	
cycle and strain cycle, fish muscles	99
maximal, myosin	91
aerotaxis <i>see</i> oxygen-taxis	
amiaiform fish	56
ammoniacal fluids in cephalopods	29
amoebae	18
<i>Anas</i> sp. <i>see</i> ducklings (mallard)	
<i>Ancistroteuthis lichtensteini</i> , investigations	36-43
<i>see also</i> cephalopods	
angelfish	56, 60
anguilliform fish	
body dynamics	122-126
EMG	117-118
lateral oscillations	100
Mauthner cells	57
<i>see also</i> lamprey	
<i>Anhinga melanogaster</i> <i>see</i> darter fish	
Archimedes' principle	152
axopodia	17, 23-25

	page
<i>Bacillus subtilis</i>	3-12
bacteria, functional patterns	3-12
bulk consumption time, T	9
concentration-convection pattern	5
convection patterns	4
functional patterns, oxygen concentration	4-5
gravitational potential energy	10
mean upward swimming speed	10
nitrogen effects	8
oxygen consumption	8
swimming velocity	9
viscous power dissipation	11
visibility of variations in concentration	12
<i>see also</i> protists	
balistiform locomotion	35
baupläne (body forms)	
ichthyosaurs	134
Mesozoic marine reptiles	134
mosasaurs	134
plesiosaurs	134
BCF swimming (body and caudal fin undulation)	47, 50, 57-60
biomechanics, thunnids	73-74
body and caudal fin undulation	47, 50, 57-60
body dynamics, anguilliform	122-126
body movements, timing of EMG and muscle strain	114-118
boundary gradient, oxygen concentration	9
bubbles/gas chambers, protists	16
bulk consumption time, T , bacteria	9
buoyancy, various substances	152
buoyancy regulation	
air-breathing tetrapod	151-156
Archimedes' principle	152
dolphin	155
evolutionary strategies	159-161
gastroliths	161
genomic adaptation to	14-17
hydrostatic <i>vs</i> hydrodynamic	156-157
penguins	161, 165
plesiosaurs, gastroliths	141, 160-161
protists	14-20
sea otter	160
sea snake	156
work done during dive and	157-159

Index 233

page

burst-and-coast behaviour	50
burst-and-coast swimming, carp	88, 89
calcium channels, in ciliary beating	21
carangiform swimming	100-110
caudal fin	106-107
characteristics	110
cardiovascular physiology, thunnids	72-73
carp	
burst-and-coast swimming	88, 89
escape response	79-83
fibre types	87-88
V/V_{max}	86-91
mechanical properties of red muscle	89
muscle	
electromyograms	116
red and white muscle	85
red muscle performance	78-83
muscle temperatures	88
power output during tail beat, slow myotomal muscle	108
vs scup, swimming speed	88-91
caudal fin	106-107
height/width ratio, ichthyosaurs	136
caudal musculature replaced by tendons, thunnids	110
caudal peduncle, thunnids	61
cell concentration-driven convection plumes	6
cell contraction	18
cephalopods	
acceleration reaction	30-31
costs of transport	42
evolution	29
fins	27-43
clapping	35
fin-jet interactions	37-42
fins-first swimming	40-42
form and function	32, 33
lift generation	32-34
loiginid fin dimensions, velocities and forces	37
paired lateral	32
propulsive waves	35
scaling of fins, transport costs	36-37

	page
cephalopods (continued)	
flying in air	35
hatchlings, independent movement	36
hyponome	31
jet-fin interactions	37-42
jet propulsion	29-31
mechanoreceptors	31
planktonic and mesopelagic, ammoniacal fluids	29
reversal of direction	40-42
<i>Sepia</i> , Froude efficiency	30
swimtunnel, kinematic variables	38
translational movement	32
cetaceans see whales	
chelonian, freshwater, buoyancy	156
ciliary function	20-24
ciliates	
ciliary function	20-24
peritrich ciliates	14-16, 19
tintinnids	17
types	21
cod	
maximum oscillatory work <i>vs</i> fish length, fast muscle fibres	104
work-loop power output	102
computational models, fish, swimming biology	59
computed tomography, centra measurements, ichthyosaurs	136-137
concentration-convection pattern, bacteria	5
concentration, visibility of variations in, bacteria	12
contractile organelles	18-19
contraction-relaxation cycles	19-20
convection	
patterns, bacteria	8
<i>vs</i> diffusion	10
<i>Coryphaena hippurus</i> see dolphin	
costs of transport, cephalopods	42
cottiform fish	55, 57
coupled oscillators, spinal cord, lamprey	121-122
crawling form (<i>litholophus</i>), acantharians	17, 24-26
critical swimming velocity	
elasmobranchs	67
salmonids	67
cross-bridges, myosin	76, 92
cruising and sprinting gaits	54-55, 56-57

Cambridge University Press

978-0-521-06495-8 - Mechanics and Physiology of Animal Swimming

Edited by Linda Maddock, Quentin Bone and Jeremy M. V. Rayner

Index

[More information](#)**Index** 235*page*

curvature and bending moment	112-113
curvature, waves of and muscle strain	113-114
<i>Cyprinus carpio</i> see carp	
cytoskeleton, protists	13
darter, buoyancy regulation	155
deep-sea fish (rattails)	118
density	
fresh and sea-water	152
minimizing and air quantity, ichthyosaurs	159-160
tissues	152
design, fish muscular system	75-97
diatoms	16, 18
diffusion <i>vs</i> convection	10
dinoflagellates	14-16, 18, 19, 22
helical swimming pattern	23
diodontiform fish	56
direction reversal, cephalopods	40-42
dissection, penguin	173-192
diving, work done during	157-159
dogfish see elasmobranchs	
dolphin	
Amazon, limb proportions	137
bottlenose	
buoyancy regulation	155
hydrodynamic efficiency	146
manoeuvrability	60
ducklings	
energy conservation	193-204
formation movement	
metabolic results	198-201
transport costs	201-202
vorticity benefits	203
imprinting on decoy	196-198
efficiency, hydrodynamic, dolphin	146
elasmobranchs	
critical swimming velocity	67
evolutionary patterns	53
gaits	53
hovering and station-holding	57

	page
elasmobranchs (continued)	
physiology	65-68
shark heart function	65-66
swimming performance and respiration	66-68
electromyograms (EMG)	85, 112-113
and kinematics, saithe	105-107
anguilliform fish	117-118
carp	116
lamprey	115-118
mackerel	114-115
saithe	114-115, 117-118
salmonids	116
scup	116, 117-118
timing, body movements and muscle strain	114-118
energetics , thunnids	68-69
energy conservation , ducklings	193-204
<i>Enhydra lutris</i> <i>see</i> sea otter	
escape response , carp	79-83
esociform fish	55
evolution	
cephalopods	29
fish muscular system	96-97
penguins	164-165
evolutionary patterns	
actinopterygians	53
elasmobranchs	53
evolutionary trends , fish swimming biology	51-53
experimental measurements , ducklings	196
fast muscle , superficial, saithe	105
fast (white) and slow (red) muscle fibres	78-83, 100-103
fibre types , carp	87-88
fin-jet interactions , cephalopods	37-42
fins	
as muscular hydrostats	28
cephalopods	27-43
fins-first swimming	40-42
form and function	32, 33
lift generation	32-34
loliginid fin dimensions, velocities and forces	37
paired lateral	32
propulsive waves	35
scaling of fins, transport costs	36-37

Cambridge University Press

978-0-521-06495-8 - Mechanics and Physiology of Animal Swimming

Edited by Linda Maddock, Quentin Bone and Jeremy M. V. Rayner

Index

[More information](#)

Index

237

page

	<i>page</i>
fins-first swimming	40-42
fish, fossil history	51-53
fish, muscular system	75-97
activation cycle and strain cycle	99
components, variation	76
design constraint	76-78
summary of steady-state design constraints	91
V_{max} and V/V_{max}	83-91
design (fibre orientation and myofilament lengths)	83
evolution, activation-relaxation rate adjustments	96-97
fast (white) and slow (red) muscle fibres	78-83, 100-103
dogfish, slow / speedy swimming	112
curvature and bending moment	112-113
electromyograms	85, 112-113
gait specialization	49-50
red <i>vs</i> white fibres	49-51
role of fast muscle fibres, locations along body	104-110
speed swimming requirements	100-102
gear ratio	76
lateral muscle timing and EMG activity	111-118
lateral oscillations	100-110
length change and stimulation pattern, defining parameters	92-96
mechanical properties of muscle, non-steady-state	91-96
myofilament overlap	78-83
myotomal muscle, <i>in vitro</i> simulations of <i>in vivo</i> activity patterns	99-110
scaling effects	103-104
unique features	76
fish, swimming biology	45-62
amiiform fish	56
anguilliform fish	56-57
comparisons with squid swimming	27-43
computational models	59
cottiform fish	57
environmental factors and gait compression	58-59
formation movement	194-196
gait specialization	47-50
accelerators	55, 56-57
body and caudal fin undulation (BCF swimming)	47, 50, 57-60
burst-and-coast behaviour	50
cruising and sprinting gaits	54-55, 56-57
evolutionary trends	51-53
factors defining	48

Index

	page
fish, swimming biology (<i>continued</i>)	
gait specialization (<i>continued</i>)	
gait expression variations among fish	51-59
hovering and station-holding	47-49, 57
manoeuvrers	55-56
median and paired fin propulsors (MPF swimming)	48-50
ontogeny	57-58
propulsors	47
recruitment sequence	50-51
suppression	53-57
swimming performance range fractionation	46-51
utility	51
heat flux	71
historical overview	112
lamprey	119-132
manoeuvrability and agility	60-62
minimum turning radius	60
muscle strain	
body movements, timing of EMG	114-118
waves of curvature	113-114
ontogeny and size	57-58
oricariids	57
physiology of pelagic fish	63-74
pitching and rolling	60
pleuronectiform fish	57
seahorses	60
sprint speed, maximum	60
stability control	61-62
thunnids	60
caudal peduncle	61
flagellar beating	20-24
types	22
flight apparatus and wings, penguins	169-173
fluid density, and particle concentration	12
fluid mechanics, lamprey swimming biology	119-132
flying fish, flying squid	35
flying in air, cephalopods	35
foraminiferans	14
form and function, fins	32, 33
formation movement	193-204
ducklings	196-204
experimental measurements	196
predictive models	195-196
vorticity, and relative velocity	194-195, 203

Cambridge University Press

978-0-521-06495-8 - Mechanics and Physiology of Animal Swimming

Edited by Linda Maddock, Quentin Bone and Jeremy M. V. Rayner

Index

[More information](#)**Index** 239*page*

- fossil history, fish 51-53
 Froude efficiency, *Sepia* 30
 functional patterns, bacteria 3-12

Gadus morhua see cod

- gait expression variations among fish 51-59
 gait specialization
 fish muscular system 49-50
 fish swimming biology 47-50

gaits

- body and caudal fin undulation (BCF swimming) 47, 50, 57-60
 definition 46
 elasmobranchs 53
 median and paired fin propulsors (MPF swimming) 48-50
 see also fish, swimming biology

gas chambers/bubbles, protists 16

gastroliths

- buoyancy control 161
 plesiosaurs 141, 160-161

gear ratio, fish muscular system 76

generation of locomotor pattern, spinal cord, lamprey 120-122

genomic adaptation to buoyancy regulation, protists 14-17

gradient, boundary, oxygen concentration 9

gravitational potential energy, bacteria 10

hatchlings, independent movement, cephalopods 36

heart function, elasmobranchs 65-66

heat flux 71

helical swimming pattern, dinoflagellates 23

helioflagellates 23

heliozoans 24

historical overview, fish swimming biology 112

hovering and station-holding 47-49, 57

hydrodynamics

- anguilliform swimming 127-132
 characteristics, penguins 167-173
 efficiency, dolphin 146
 small particles 14

hyponome

- cephalopods 31

- Nautilus* 31

	page
ichthyosaurs	
baupläne	134
caudal fins (height/width ratio)	136
comparisons with other marine reptiles	143-147
minimizing density and air quantity	159-160
swimming	135-138
<i>Illex coindetii</i>	
investigations	32-43
<i>see also</i> cephalopods	
<i>Illex illecebrosus</i> , investigations	32-43
imprinting, ducklings	196-198
inflation-deflation of cell surface, acantharians	19
insects, generation of extra lift	35
jet-fin interactions, cephalopods	37-42
jet propulsion	
cephalopods	29-31
<i>Nautilus</i>	31
kinematics	
cephalopods	38
mackerel	112-113
saithe	112-113
salmonids	72
thunnids	71-72
<i>Lactotoria</i> sp., manoeuvrability	60
lamprey	
anguilliform body dynamics	122-126
hydrodynamics	127-132
square-wave motion	127-129
EMG	115-118
spinal cord	
chain of coupled oscillators	121-122
generation of locomotor pattern	120-122
swimming biology	119-132
<i>see also</i> anguilliform fish	
lateral fins, paired, cephalopods	32
lateral muscle timing and EMG activity	111-118
lateral oscillations	100-110
anguilliform fish	100
thunnids	100

Index

241

page

length change and stimulation pattern, defining parameters	92-96
lift generation	
cephalopods	32-34
fins	32-34
insects	35
limb proportions, dolphin	137
lipid droplets, protists	16-18
lobopods 18	
locomotor pattern, spinal cord, lamprey	120-122
lolinid fin dimensions, velocities and forces	37
<i>Loligo</i> spp. <i>see</i> cephalopods	
mackerel	
EMG	114-115
kinematic analysis	112-113
manoeuvrability	
and agility, fish	60-62
dolphin	60
salmonids	60
thunnids	60
manoeuvrers, fish	55-56
Mauthner cells, anguilliform fish	57
maximal activation, myosin	91
mechanical properties of muscle	
carp red muscle	89
non-steady-state	91-96
scup	92-97
mechanoreceptors, cephalopods	31
median and paired fin propulsors (MPF swimming)	48-50
Mesozoic marine reptiles	133-149
baupläne	134
taxa and statistical comparison	146
metabolic costs, salmonids	69
metabolic rate, salmonids	69
metabolic results, ducklings	198-201
microtubules, axoneme	20-21
minimum turning radius, fish	60
models, predictive, ducklings	195-196
mosasaurs	
baupläne	134
comparisons with other marine reptiles	143-147
swimming	138-139

	page
movement, translational, cephalopods	32
MPF swimming (median and paired fin propulsors)	48-50
muscle	
carp	85, 88, 116
myofilaments, overlap	78-83
slow myotomal muscle, carp	108
strain, fish	113-118
temperatures, carp	88
muscular hydrostats, fins as	28
muscular system, fish	75-97
activation cycle and strain cycle	99
components, variation	76
design	
constraint	76-78
summary of steady-state design constraints	91
V_{max} and V/V_{max}	83-91
design (fibre orientation and myofilament lengths)	83
evolution, activation-relaxation rate adjustments	96-97
fast (white) and slow (red) muscle fibres	78-83, 100-103
curvature and bending moment	112-113
dogfish, slow / speedy swimming	112
electromyograms	85, 112-113
gait specialization	49-50
red vs white fibres	49-51
role of fast muscle fibres, locations along body	104-110
speed swimming requirements	100-102
gear ratio	76
lateral muscle timing and EMG activity	111-118
lateral oscillations	100-110
length change and stimulation pattern, defining parameters	92-96
mechanical properties of muscle, non-steady-state	91-96
myofilament overlap	78-83
myotomal muscle, <i>in vitro</i> simulations of <i>in vivo</i> activity patterns	99-110
penguin	185-191
scaling effects	103-104
unique features	76
myonemes	18-19, 19
myosin	
cross-bridges	76, 92
maximal activation	91
<i>Myoxocephalus scorpius</i> <i>see</i> sculpin	

Cambridge University Press

978-0-521-06495-8 - Mechanics and Physiology of Animal Swimming

Edited by Linda Maddock, Quentin Bone and Jeremy M. V. Rayner

Index

[More information](#)**Index**

243

*page**Nautilus*

- hyponome 31
- jet propulsion 31
- locomotion 31
- comparisons with squid swimming 28, 29

Navier-Stokes equation 130

Negaprion sp., *see also* elasmobranchs

nitrogen effects, bacteria 8

Odonus sp., manoeuvrability 60

ontogeny, fish swimming biology 57-58

oricariids 57

oscillators, chain of coupled, spinal cord, lamprey 121-122

oscillatory cycles, saithe 107

oxygen concentration

- bacteria, functional patterns 4-5

- boundary gradient, calculation 9

- conservation, consumption and transport equation 8

oxygen consumption, bacteria 8

oxygen consumption rates, salmonids 68

oxygen-taxis 6-7

pachystostosis, sirenians 160

paired lateral fins, cephalopods 32

pattern

- convection, bacteria 8

- functional and oxygen concentration, bacteria 4-5

- helical swimming, dinoflagellates 23

pectoral girdle, penguin 173-185

pelagic fish physiology 63-74

Pelamis platurus *see* sea snake

penguins 163-192

- adaptation to aquatic life 191-192

- buoyancy 165

- buoyancy regulation, gastroliths 161

- dissection 173-192

- muscle system 185-191

- pectoral girdle, *articulatio humeralis* and *humerus* function 173-185

- evolution and taxonomy 164-165

- hydrodynamic characteristics 167-173

- flight apparatus and wings 169-173

- trunk 167-169

	page
penguins (<i>continued</i>)	
physical constraints and principle of thrust generation.....	164-167
subaquatic flight strokes	141
swimming kinematics	164-166
swimming posture	168
perch, shiner, pectoral fin efficiency	146
performance, swimming	
and respiration, elasmobranchs	66-68
range fractionation	46-51
peritrich ciliates	14-16, 19
phaeodarians	16, 18
physical constraints, penguins	164-167
physical models, self-propulsion	26
physiological regulation of buoyancy, protists	16-18
physiology	
elasmobranchs	65-68
pelagic fish	63-74
thunnids	68-74
pitching and rolling, fish	60
plesiosaurs	
baupläne	134
buoyancy control, gastroliths	141, 160-161
comparisons with other marine reptiles	143-147
swimming	139-143
pleuronectiform fish	57
pliossaurs	142-143
comparisons with other marine reptiles	143-147
plumes, speed of descent, formula	12
<i>Pollachius virens</i> see saithe	
polycystines	14-16
power output during tail beat, carp slow myotomal muscle	108
power output, relative maximum, saithe	106
power requirements, salmonids	101
predictive models, ducklings	195-196
propulsive waves, cephalopod fins	35
propulsors	47
protists, marine planktonic	13-16
acantharians, crawling form litholophus	17, 24-26
buoyancy regulation	
genomic adaptation to buoyancy	14-20
physiological regulation of buoyancy	16-18
crawling forms litholophus	17, 24-26
cytoskeleton	13

Cambridge University Press

978-0-521-06495-8 - Mechanics and Physiology of Animal Swimming

Edited by Linda Maddock, Quentin Bone and Jeremy M. V. Rayner

Index

[More information](#)

Index

245

	<i>page</i>
protists (<i>continued</i>)	
gas chambers/bubbles	16
lipid droplets	16-18
swimming behaviour	20-26
<i>see also</i> acantharians; actinopterygians; amoebae; bacteria; ciliates; diatoms; dinoflagellates; phaeodarians; polycystines; radiolarians; spasmonemes; sphaerellarians	
pulsella, defined	23
pusules	18
radiolarians	18
radius of turning, fish	60
recruitment sequence	50-51
red and white muscle	
carp	85
fibres in fish	78-83, 100-103
red muscle performance, carp	78-83
red <i>vs</i> white fibres	49-51
relative maximum power output, saithe	106
relative velocity, ducklings	194-195
reptiles, Mesozoic marine	133-149
respiration, elasmobranchs	66-68
respirometry	
fish, swimming biology	63-74
thunnids	63-74
volume	64-65
reversal of direction, cephalopods	40-42
Reynolds number	
cilia and flagella	21
defined	14, 129-130
fish swimming	62
<i>Rhinecanthus</i> sp., manoeuvrability	60
rolling and pitching, fish	60
rowing movement, axopodia	24, 25
saithe	
electromyography and kinematics	105-107
EMG	114-115, 117-118
kinematic analysis	112-113
relative maximum power output	106
single tail beat	109
strain and force records, oscillatory cycles	107
superficial fast muscle	105
work-loop power output	102

salmonids	
critical swimming velocity	67
EMG	116
kinematics	72
manoeuvrability	60
metabolic rate	69
oxygen consumption rates	68
power requirements	101
standard metabolic costs	69
station-holding	57
scaling effects, fish muscular system	103-104
scaling of fins, transport costs, cephalopods	36-37
<i>Scomber scombrus</i> <i>see</i> mackerel	
sculpin	
fast and slow muscle fibres	101
work-loop power output	102
scup	
EMG	116, 117-118
mechanical properties of muscle	92-97
slow fibres	102-103
swimming speed	88-91
swimming speed, <i>vs</i> carp	88-91
V/V_{max}	90-91
work-loop power output	102
during oscillatory contractions	96
<i>Scyliorhinus</i> sp. <i>see</i> elasmobranchs	
seahorses	60
sea lion, plesiosaur-like swimming	140
sea otter, buoyancy regulation	160
sea snake, buoyancy regulation	156
self-propulsion, physical models	26
<i>Sepia</i> <i>see</i> cephalopods	
<i>Seriola</i> , manoeuvrability	60
<i>Seriola</i> , yellowtail	60
sharks <i>see</i> elasmobranchs	
single tail beat, saithe	109
sinking speed, Stokes' equation	14
SIO water tunnel	63-74
sirenians, pachystostosis	160
skate swimming analysis	34-35
'slipstreaming'	194
slow fibres, scup	102-103

Index

247

page

slow (red) and fast (white) muscle fibres	78-83, 100-103
spasmonemes	14-16, 18-19
speed swimming requirements of muscles	100-102
sphaerellarians	14
spinal cord, lamprey	120-122
sprinting and cruising gaits	54-55, 56-57
sprint speed, maximum	60
square-wave motion, lamprey swimming	127-129
squid <i>see</i> cephalopods	
stability control	61-62
startle responses, fish	46-47
station-holding, salmonids	57
steady-state design constraints, fish muscular system	91
<i>Stenotomus chrysops</i> <i>see</i> scup	
Stokes' equation, sinking speed	14
strain and force records, oscillatory cycles, saithe	107
striated flagellar roots	18-19
subcortical fibrillar layers	18-19
superficial fast muscle, saithe	105
suppression of swimming	53-57
swimming	
ichthyosaurs	135-138
plesiosaurs	139-143
swimming behaviour, protists	20-26
swimming biology, fish	45-62
amiiform fish	56
anguilliform fish	56-57
comparisons with squid swimming	27-43
computational models	59
cottiform fish	57
environmental factors and gait compression	58-59
formation movement	194-196
gait specialization	47-50
accelerators	55, 56-57
body and caudal fin undulation (BCF swimming)	47, 50, 57-60
burst-and-coast behaviour	50
cruising and sprinting gaits	54-55, 56-57
evolutionary trends	51-53
factors defining	48
gait expression variations among fish	51-59
hovering and station-holding	47-49, 57
manoeuvres	55-56

	page
swimming biology, fish (<i>continued</i>)	
gait specialization (<i>continued</i>)	
median and paired fin propulsors (MPF swimming)	48-50
ontogeny	57-58
propulsors	47
recruitment sequence	50-51
suppression	53-57
swimming performance range fractionation.....	46-51
utility	51
heat flux	71
historical overview	112
lamprey	119-132
manoeuvrability and agility	60-62
minimum turning radius	60
muscle strain	
body movements, timing of EMG.....	114-118
waves of curvature	113-114
ontogeny and size	57-58
oricariids	57
physiology of pelagic fish	63-74
pitching and rolling	60
pleuronectiform fish	57
seahorses	60
sprint speed, maximum	60
stability control	61-62
thunnids	60
caudal peduncle	61
swimming kinematics, penguins	164-166
swimming performance and respiration, elasmobranchs	66-68
swimming posture, penguins	168
swimming speed, scup	88-91
swimming velocity, bacteria	9
swimtunnel, kinematic variables, cephalopods	38
<i>Symplectoteuthis oulaniensis</i>	
investigations	32-43
<i>see also</i> cephalopods	
taxonomy and evolution, penguins	164-165
teleosts <i>see</i> carp; cod; mackerel; saithe; salmon; sculpin; scup; thunnids	
tetraodontiform fish	56
<i>Tetrasomum</i> sp., manoeuvrability	60
thermoregulation, thunnids	70-71
thrust generation, penguins	164-167

Index

249

page

thunnids

caudal musculature replaced by tendons 110

lateral oscillations 100

manoeuvrability 60

physiology 68-74

 biomechanics 73-74

 cardiovascular 72-73

 energetics 68-69

 kinematics 71-72

 thermoregulation 70-71

 respirometry 63-74

thunniform swimming 110

Thysanoteuthis rhombus 42

 see also cephalopods

tintinnid ciliates 17

tractella, defined 23

translational movement, cephalopods 32

transport costs

 cephalopods 42

 ducklings 201-202

Triakis sp. 65

 see also elasmobranchs

trunk, penguins 167-169

tuna see thunnids

turning radius, fish 60

upward swimming speed, bacteria 10

V/V_{max} , fibre types, carp 86-91

velocities and forces, loliginid fin dimensions 37

velocity, critical swimming, elasmobranchs 67

viscous power dissipation, bacteria 11

visibility of variations in concentration, bacteria 12

vorticity, and relative velocity, ducklings 194-195

vorticity benefits, ducklings 203

waves of curvature, muscle strain 113-114

Weis-Fogh mechanism 35

whales

 caudal fins (height/width ratio) 136

 minimizing density and air quantity 159-160

Cambridge University Press

978-0-521-06495-8 - Mechanics and Physiology of Animal Swimming

Edited by Linda Maddock, Quentin Bone and Jeremy M. V. Rayner

Index

[More information](#)

250

Index

- | | |
|--------------------------------------|-------------|
| wings, penguins | 169-173 |
| work-loop technique | 100,102-104 |
| work-loop power output | |
| saithe | 102 |
| scup | 102 |
| work, maximum oscillatory, cod | 104 |