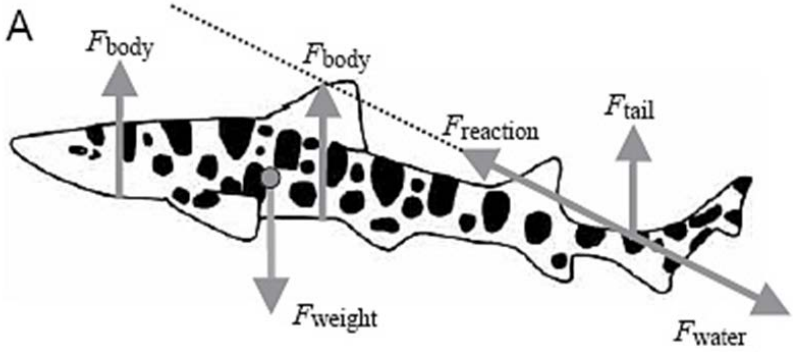
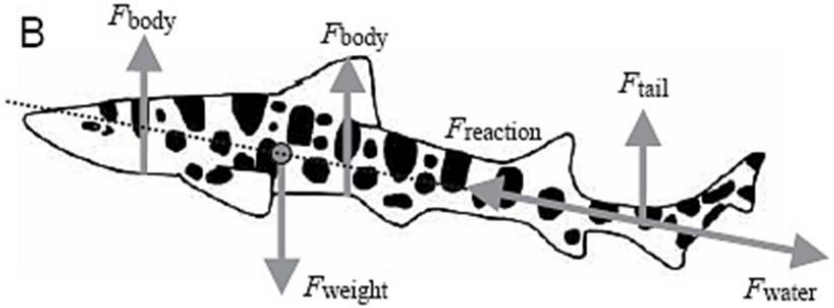
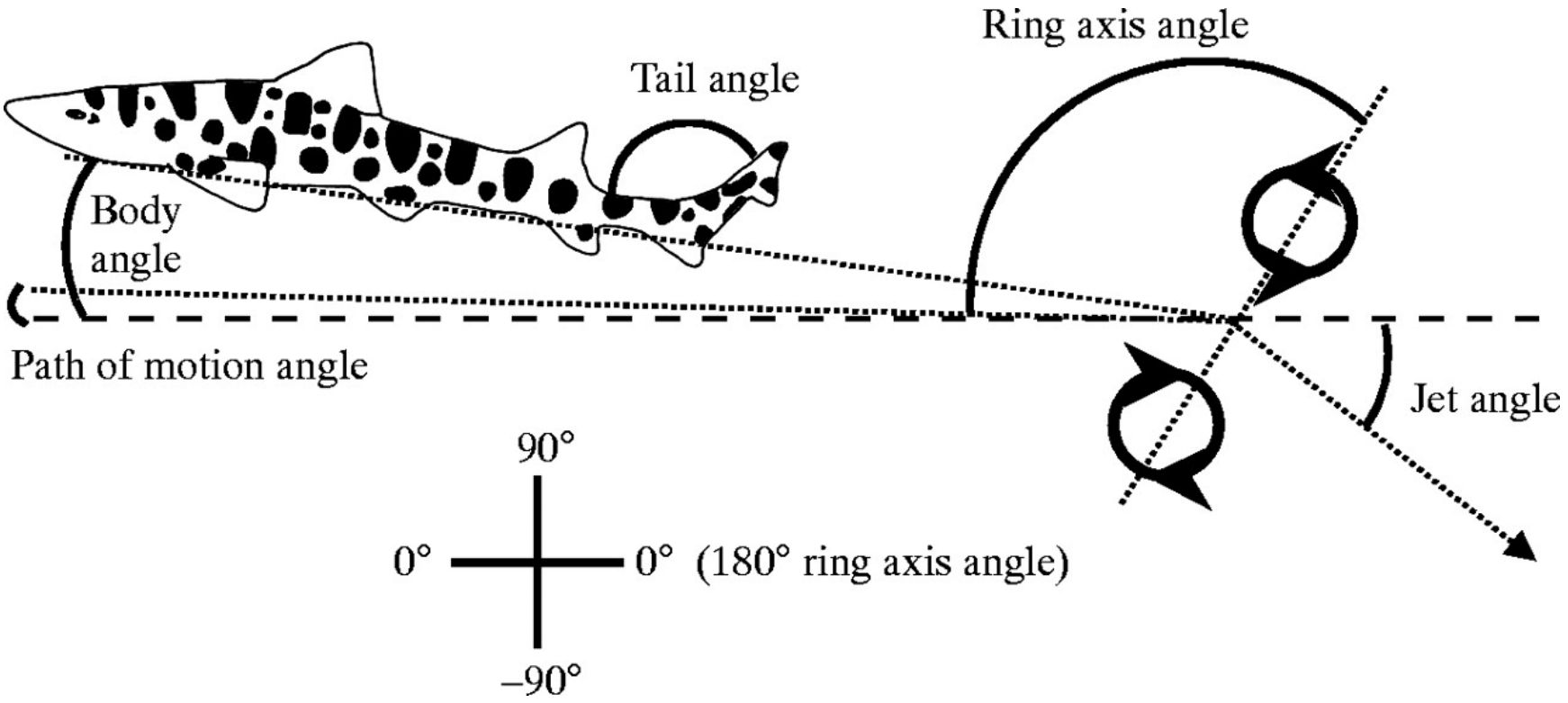
Swim or Sink


A
F_{body}
F_{body}
$F_{reaction}$
F_{tail}
F_{weight}
F_{water}

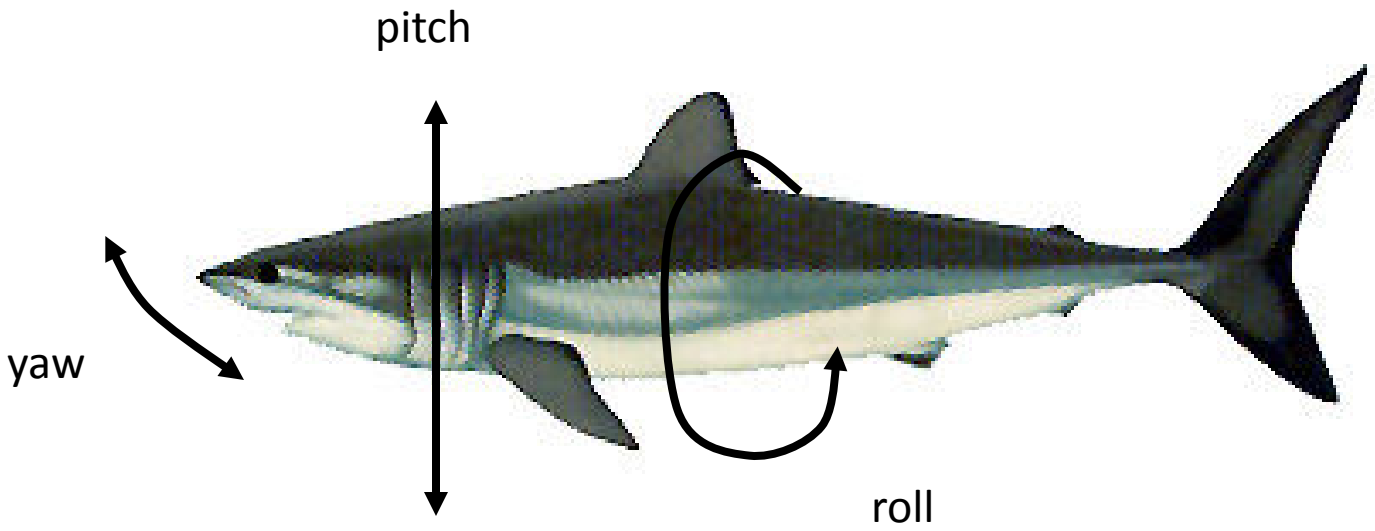

B
F_{body}
F_{body}
F_{tail}
$F_{reaction}$
F_{weight}
F_{water}

Role of Heterocercal Tail

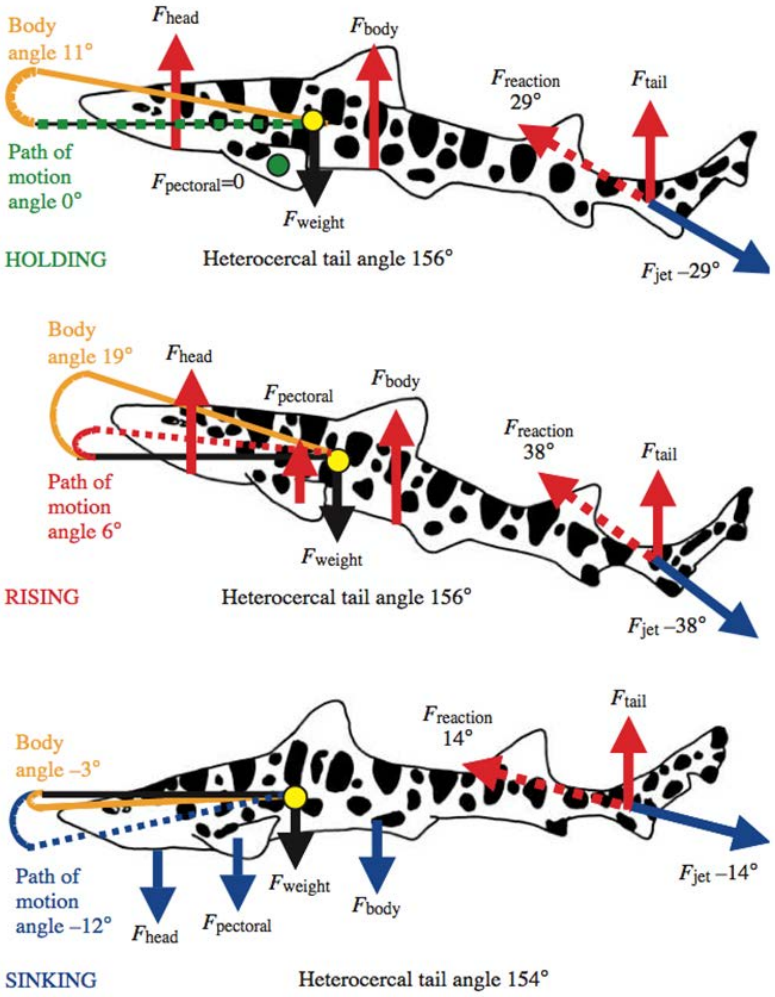


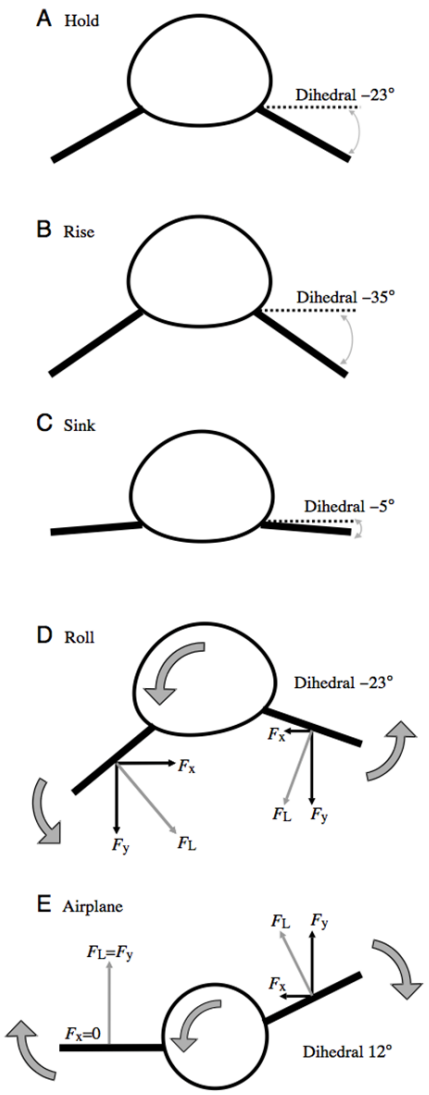
Homocercal tail function?

Role of fins

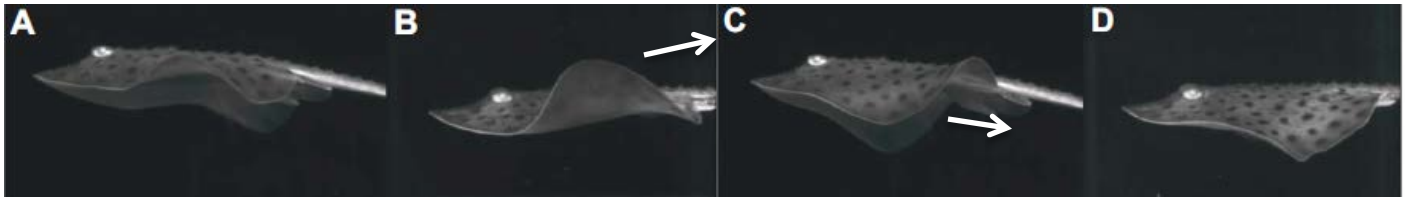


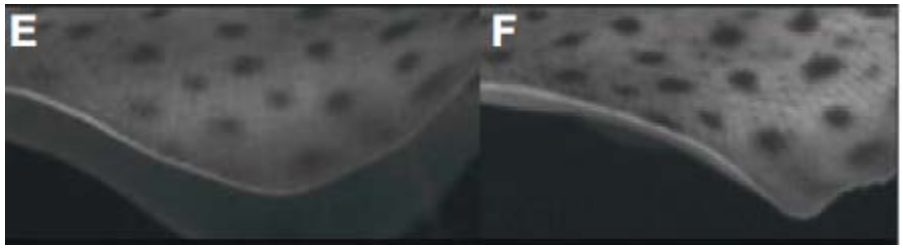
Role of Pectoral Fins: Leopard shark example

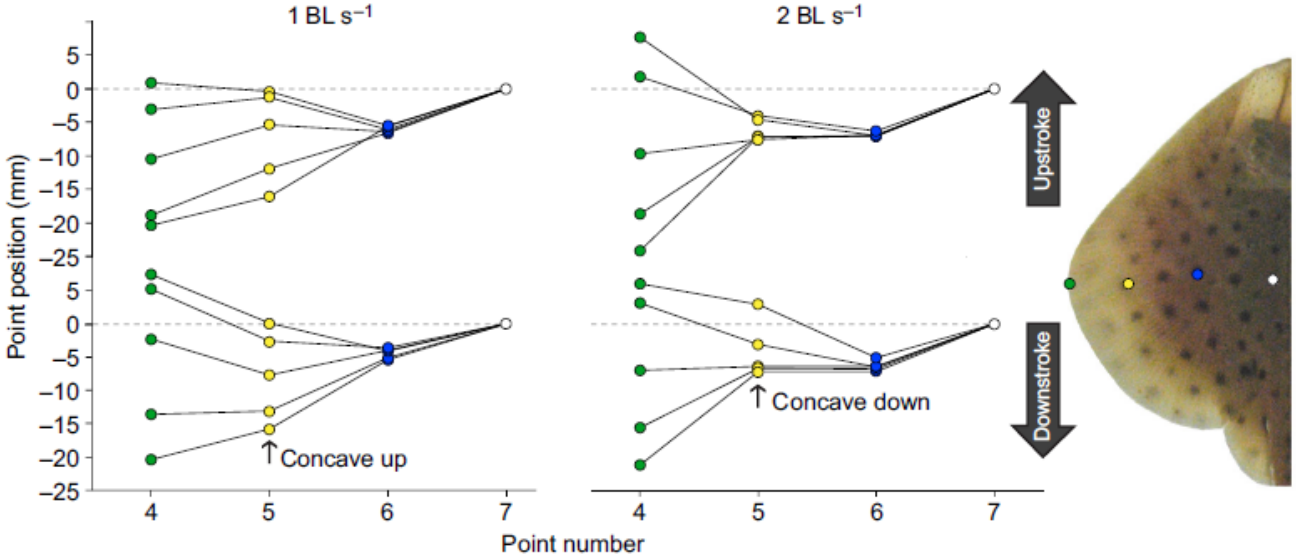




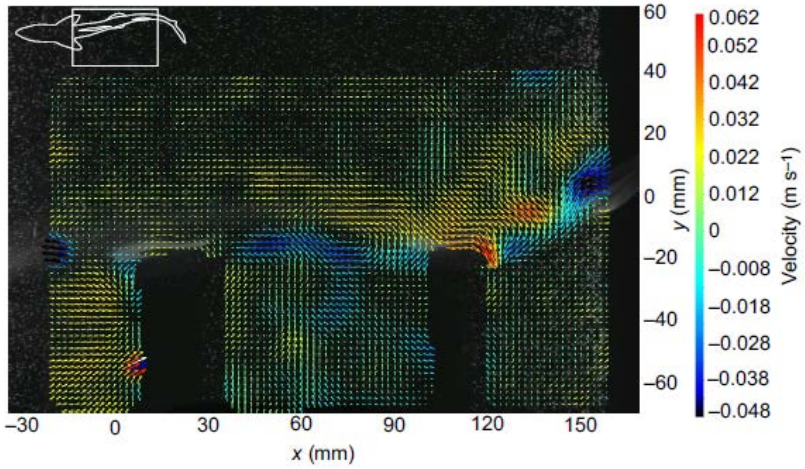
Role of Pectoral Fins: Little skate example

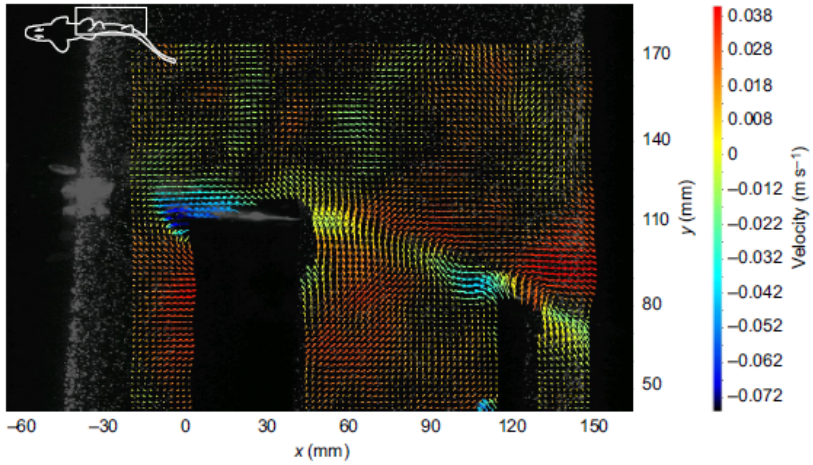






Role of Dorsal Fin





‘Pure muscle’

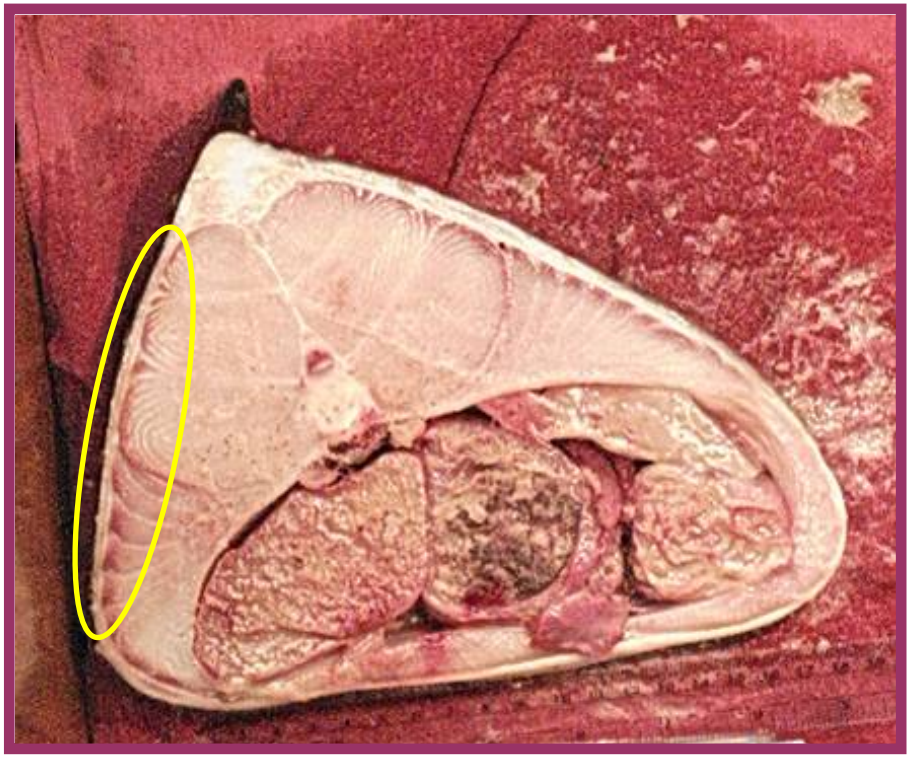
~95% of muscle in body used for swimming
~50% of body mass devoted to swimming muscles (humans ~35% skeletal muscle)

Swimming muscles

- White muscle (~45-50% of body mass)
  - Larger fibers
  - Fast twitch
  - Poorly vascularized
  - Anaerobic (glycogen)
  - Burst swimming
  - Low endurance
  - More powerful (5x red muscle)

- Red muscle (<5% of body mass)
  - Smaller fibers
  - Slow twitch
  - Well vascularized
  - Aerobic (lipid, fatty acid, glycogen)
  - Sustained swimming
  - High endurance
  - Less powerful

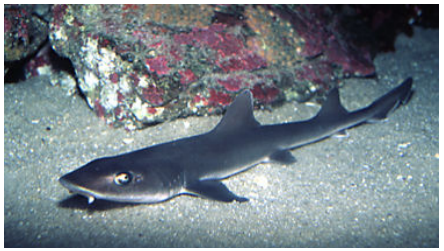
blue shark



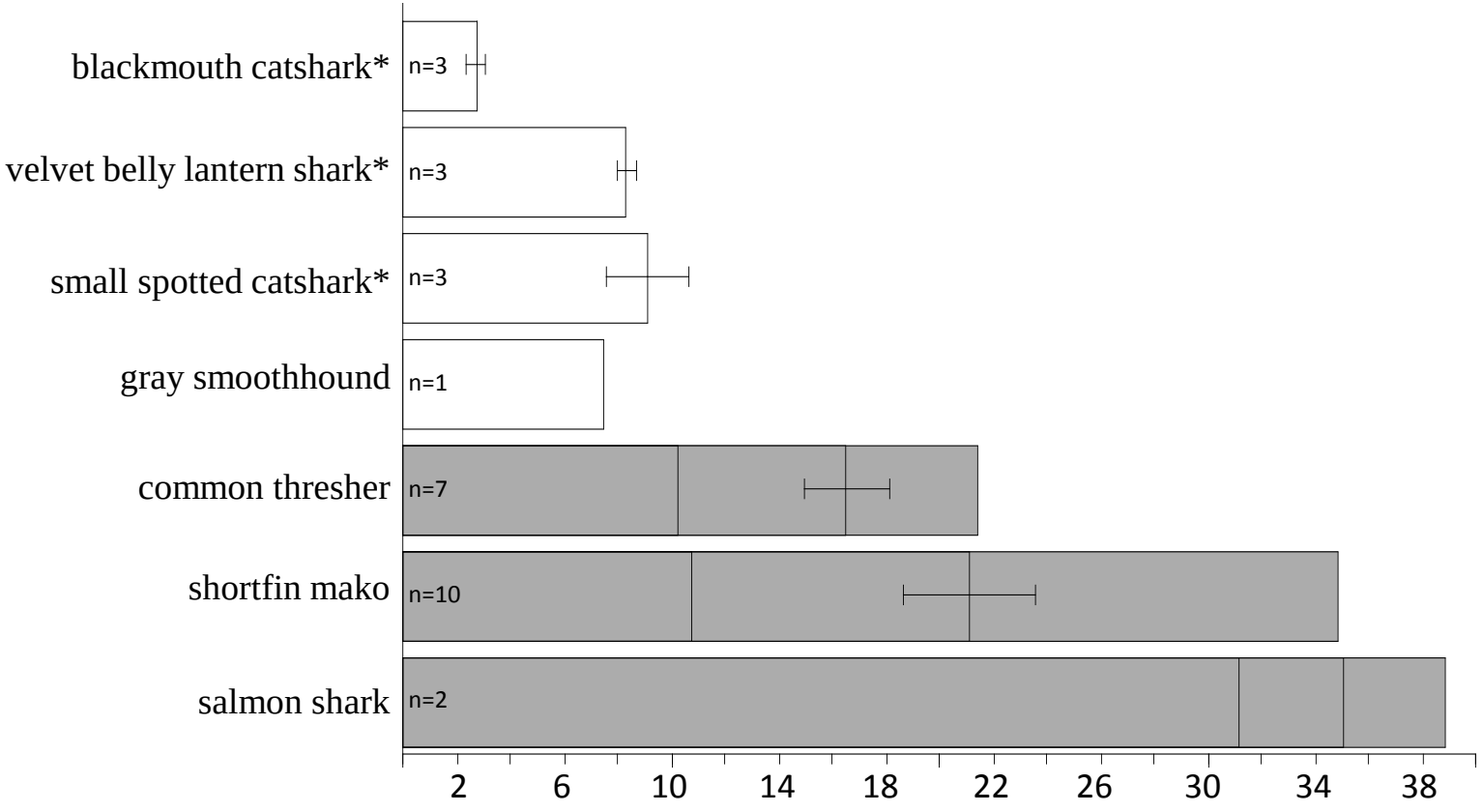
blackmouth catshark

velvet belly lantern shark

small spotted catshark



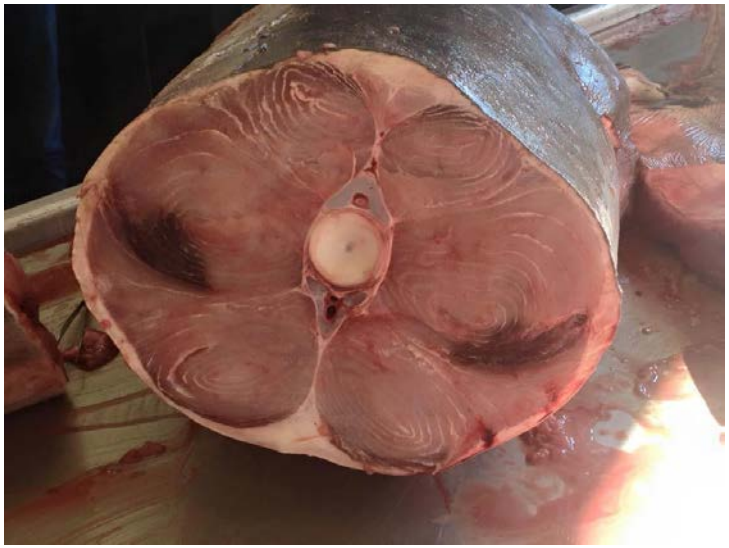
gray smoothhound

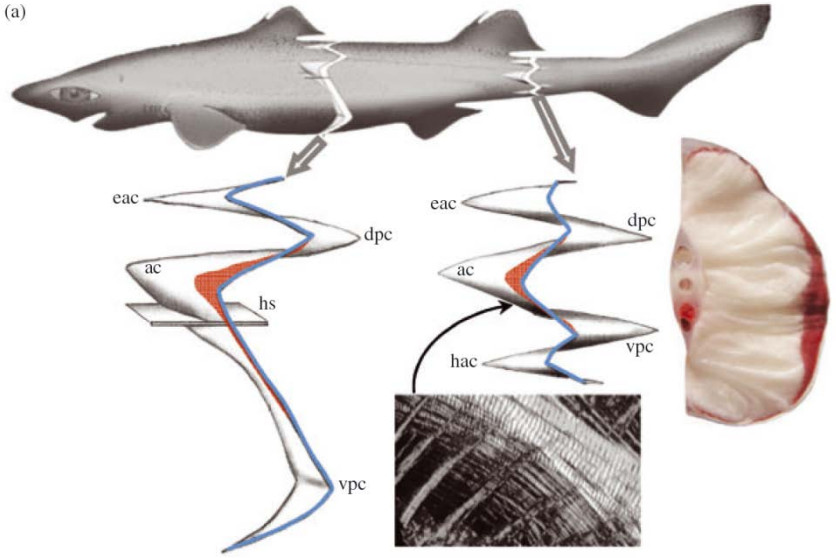


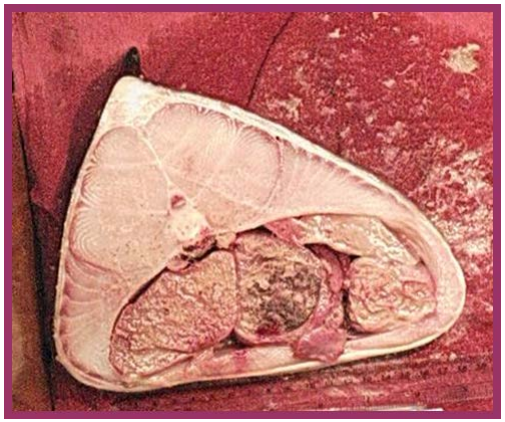
*Kryvi *et al*. (1981)

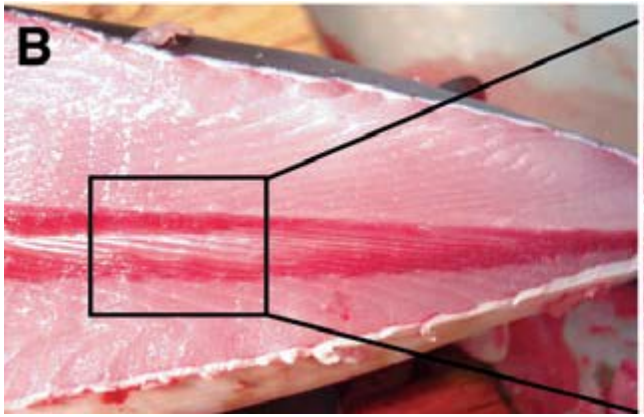
values = mean ± SEM

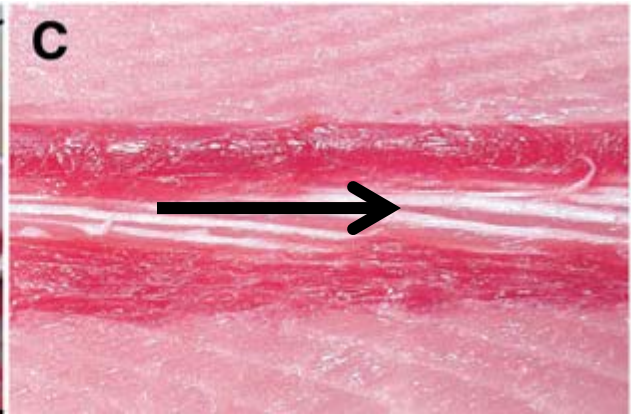
Muscle (myomere) orientation





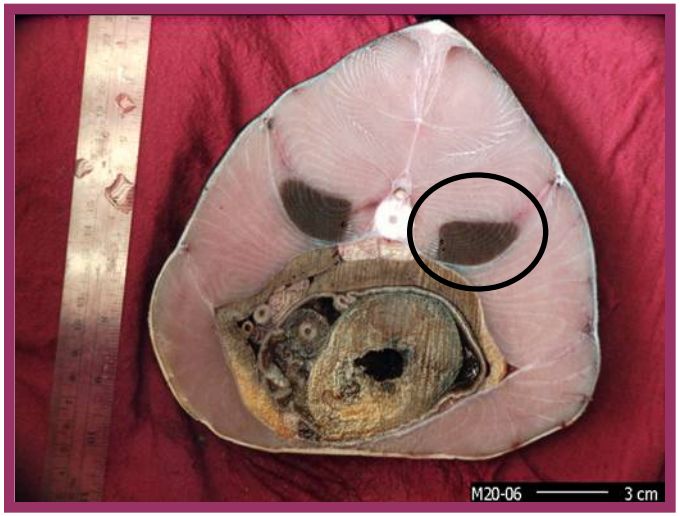




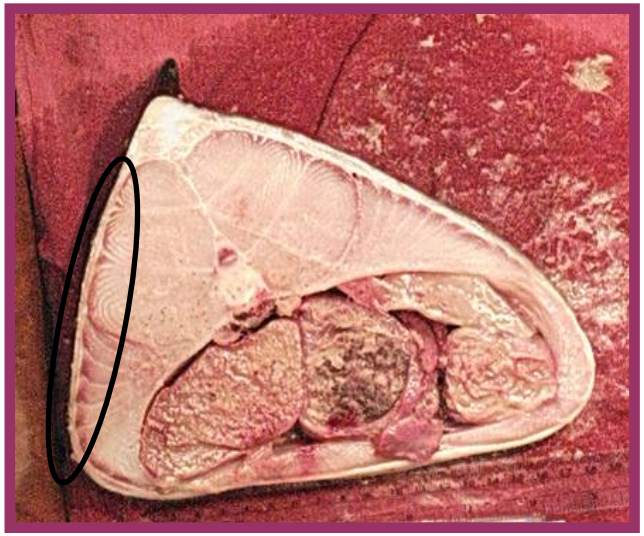


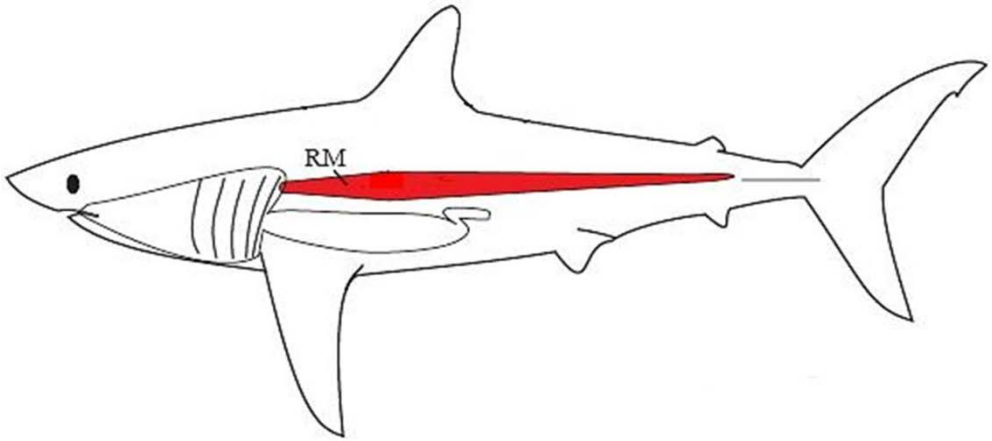
Different red muscle position

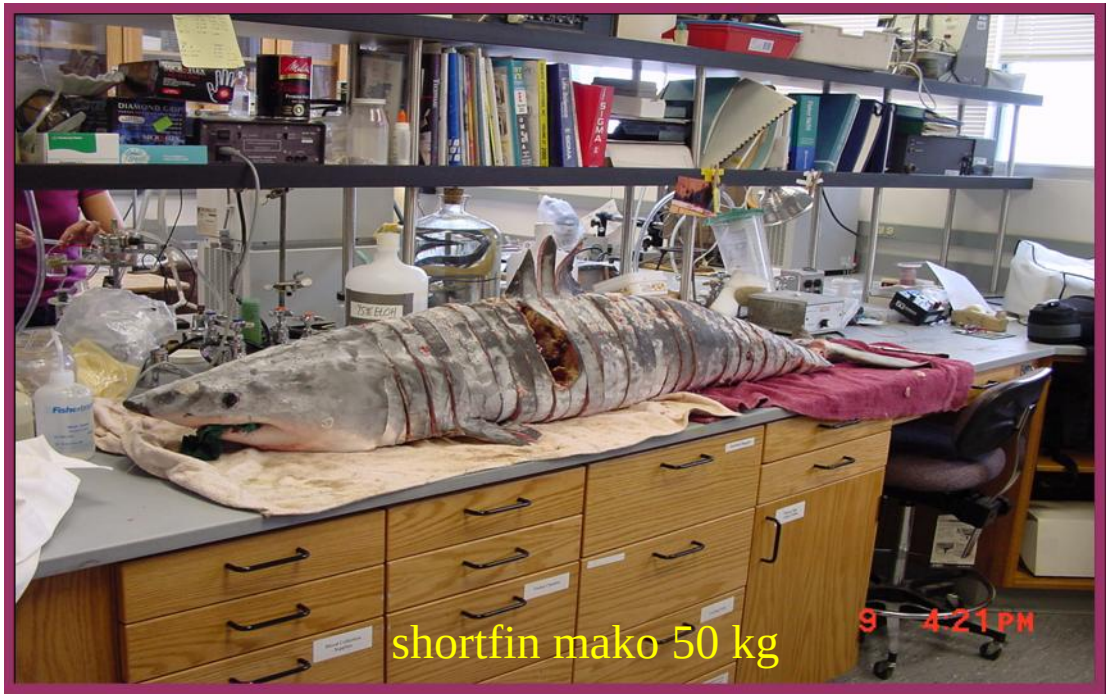
mako shark

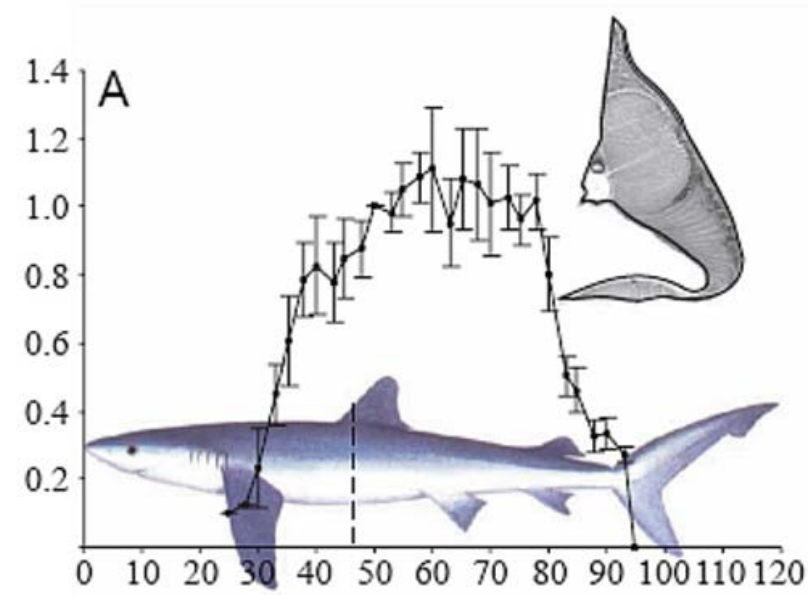


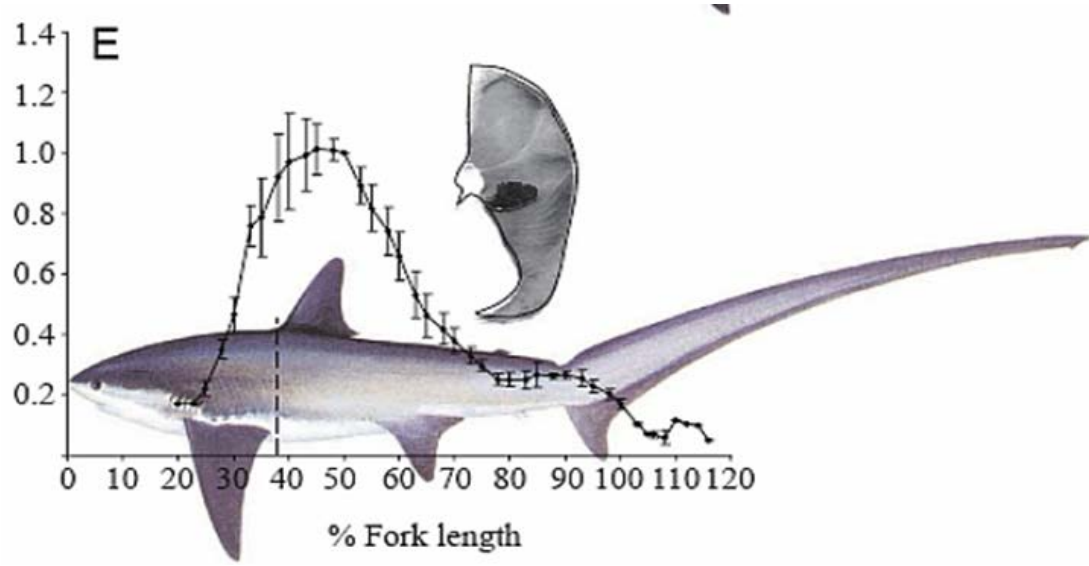
blue shark

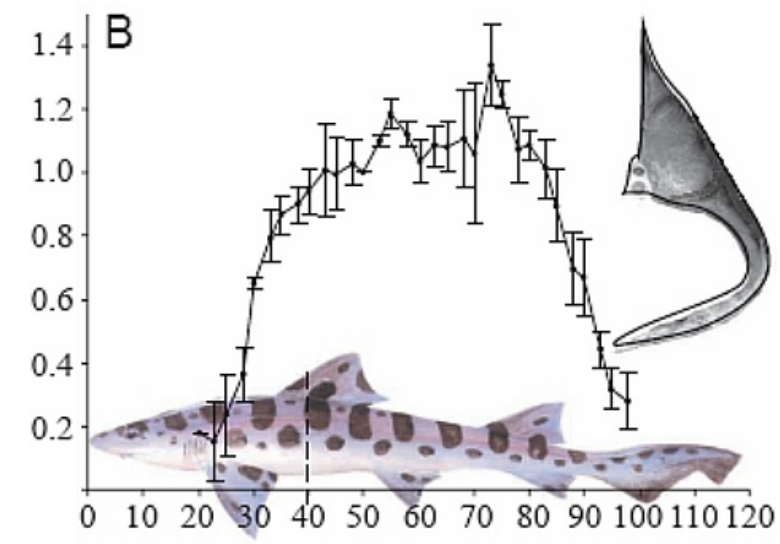


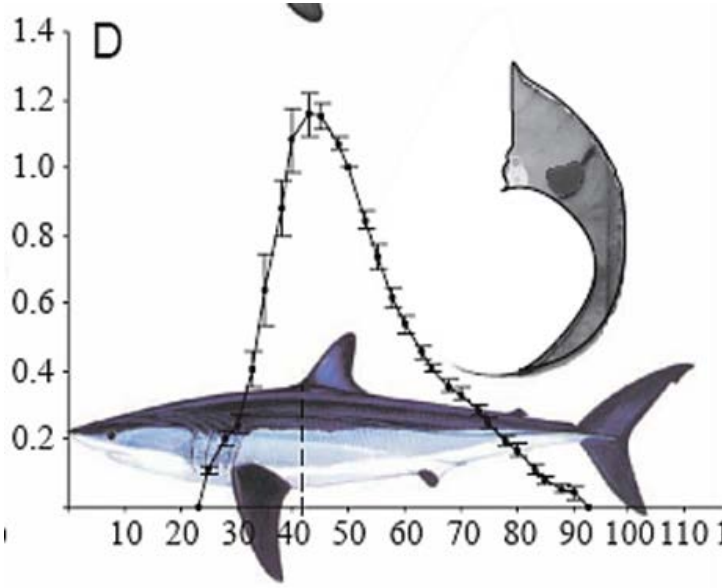



shortfin mako 50 kg
9 4:21PM

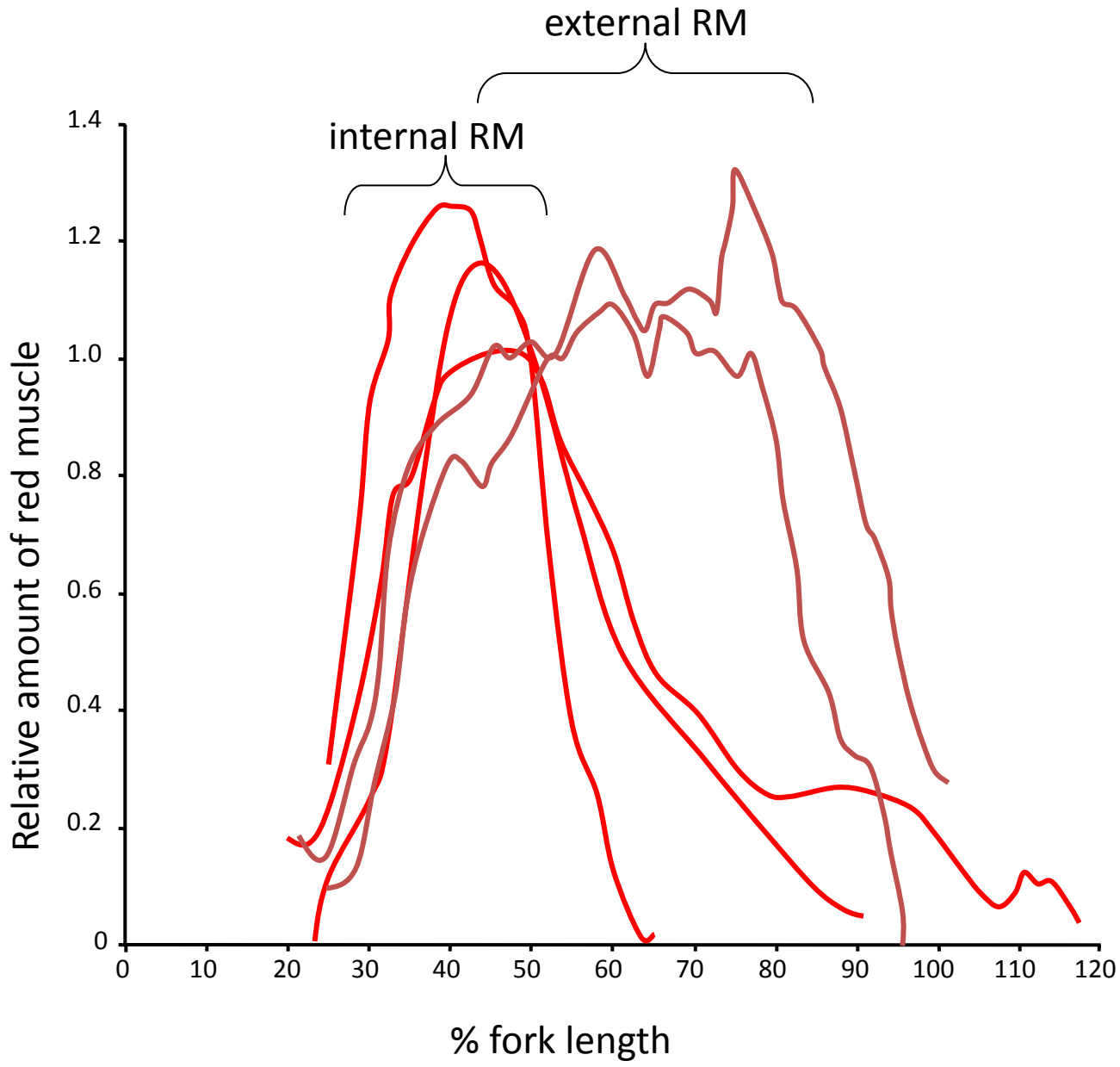






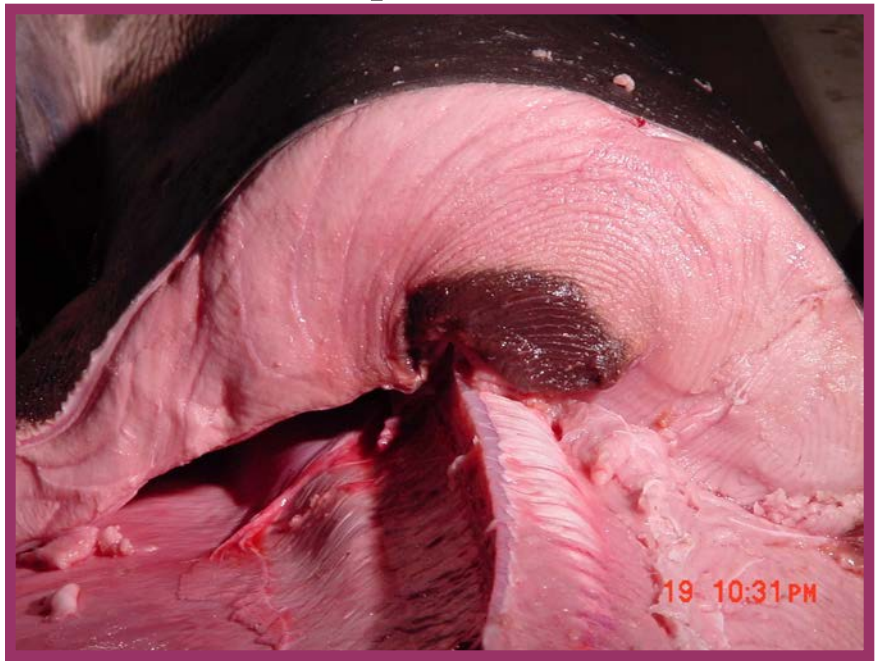


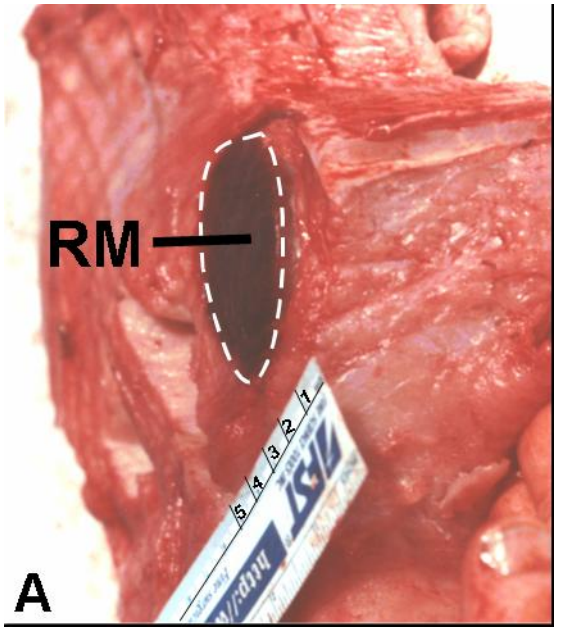
(Bernal et al., 2003)

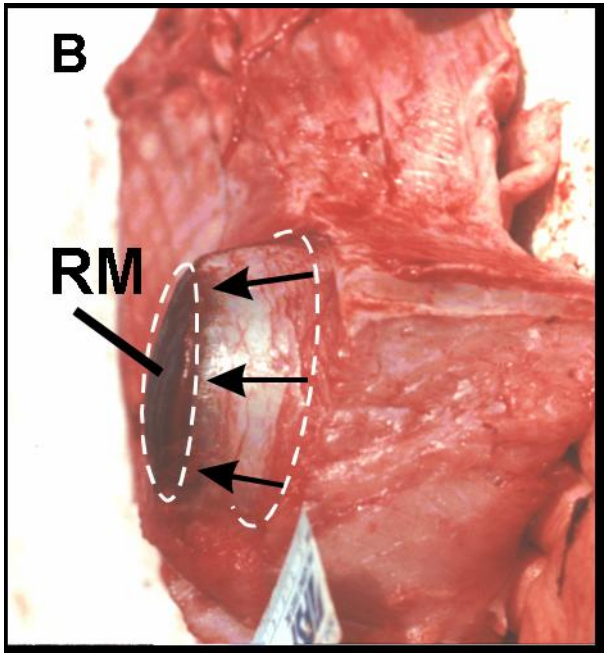


values represent the mean for each species

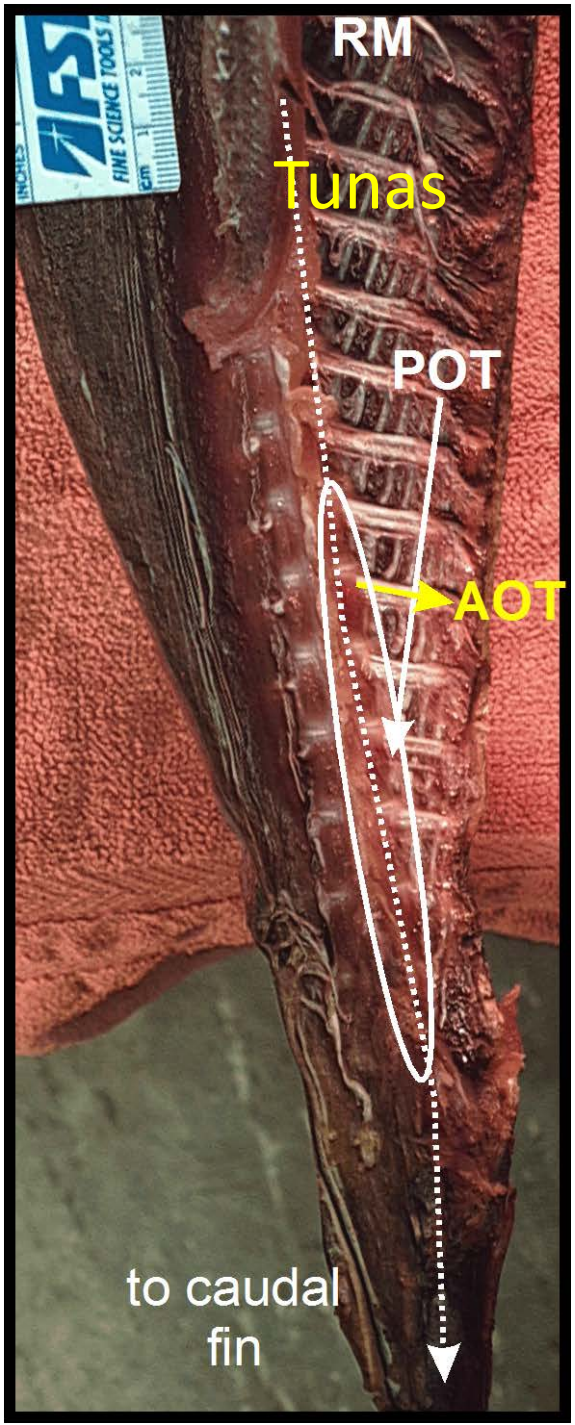
The red muscle is free
to move within the body and can
thus move in a piston-like fashion

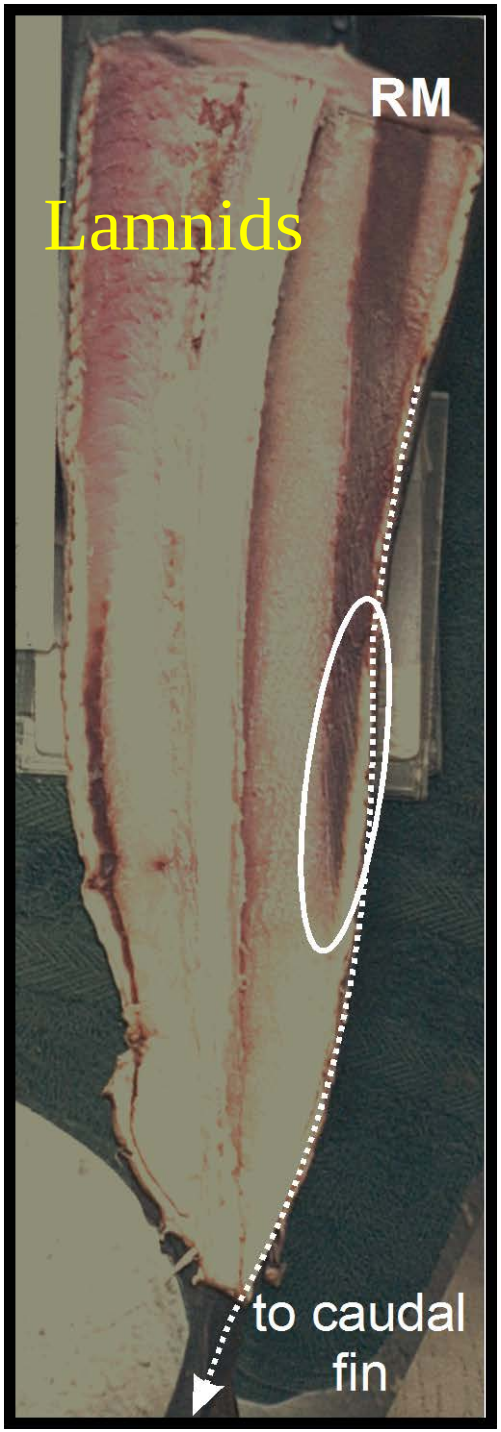


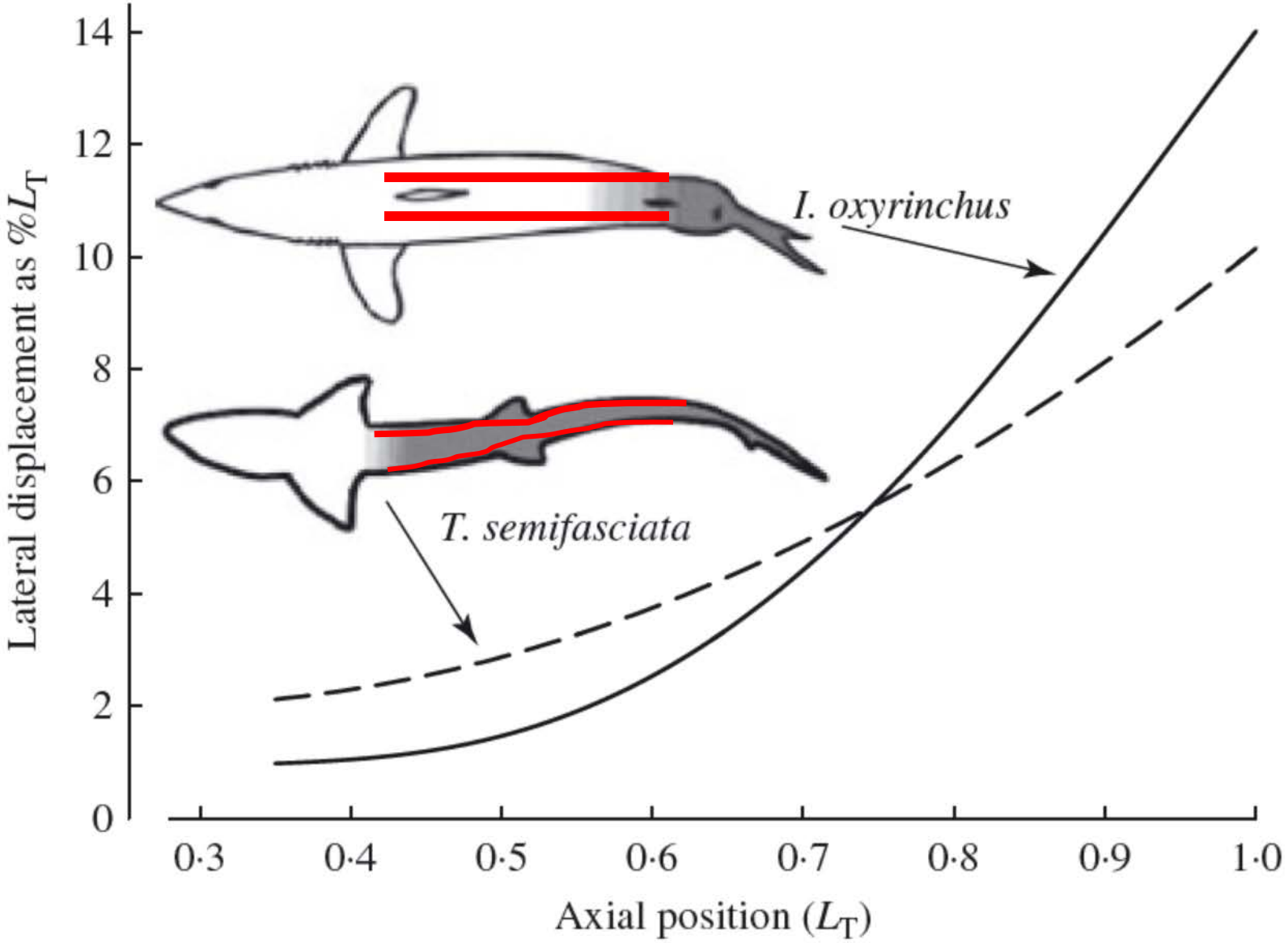




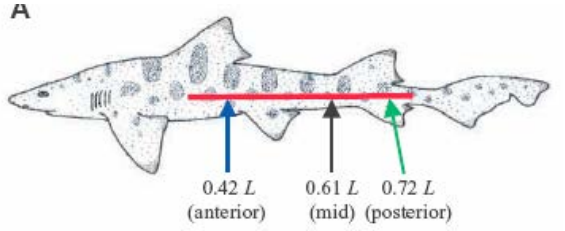
Force transmission to the tail

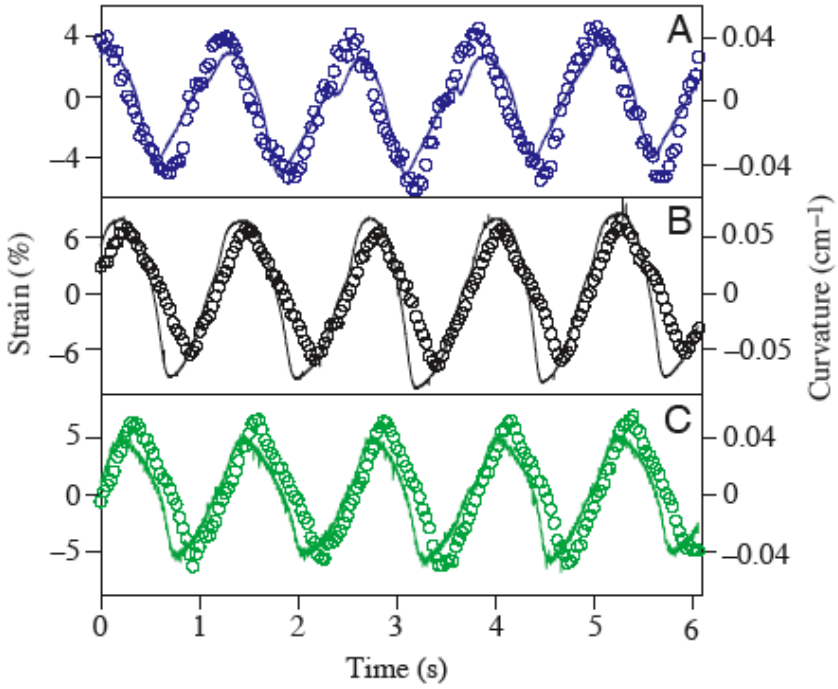




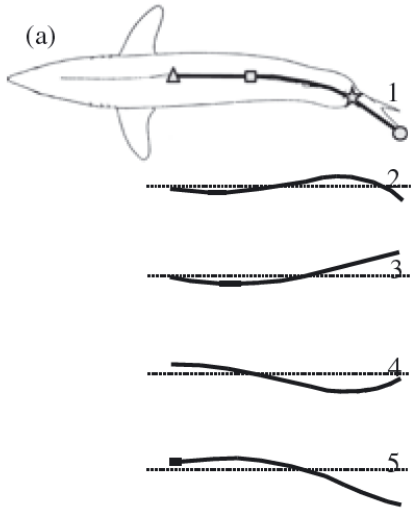

14
12
10
8
6
4
2
0
Lateral displacement as %L_T
0·3
0·4
0·5
0·6
0·7
0·8
0·9
1·0
Axial position (L_T)
I. oxyrinchus
T. semifasciata

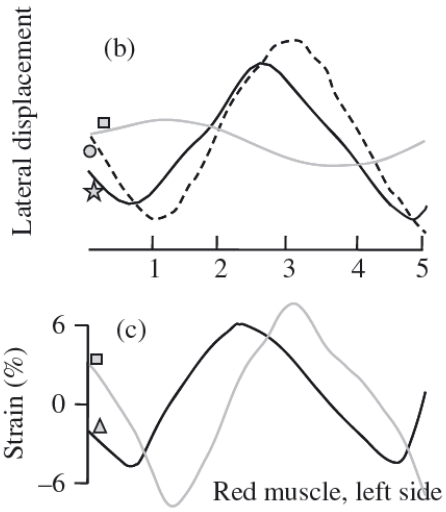
leopard shark





Mako shark





Swimming speeds

- Generally 0.3 – 0.4 BL/s (<2.0 m/s)
- Burst: ~1 – 6.5 BL/s (5-9 m/s)
  - Duration of 5 – 10 seconds
- Most increase speed by increasing tail beat frequency
- Escape response = ‘C start’ (high body bending)