

dragonflies & damselflies

understanding an insect order by three essential facts

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Anisoptera
2940 sp.

Zygoptera
2740 sp.

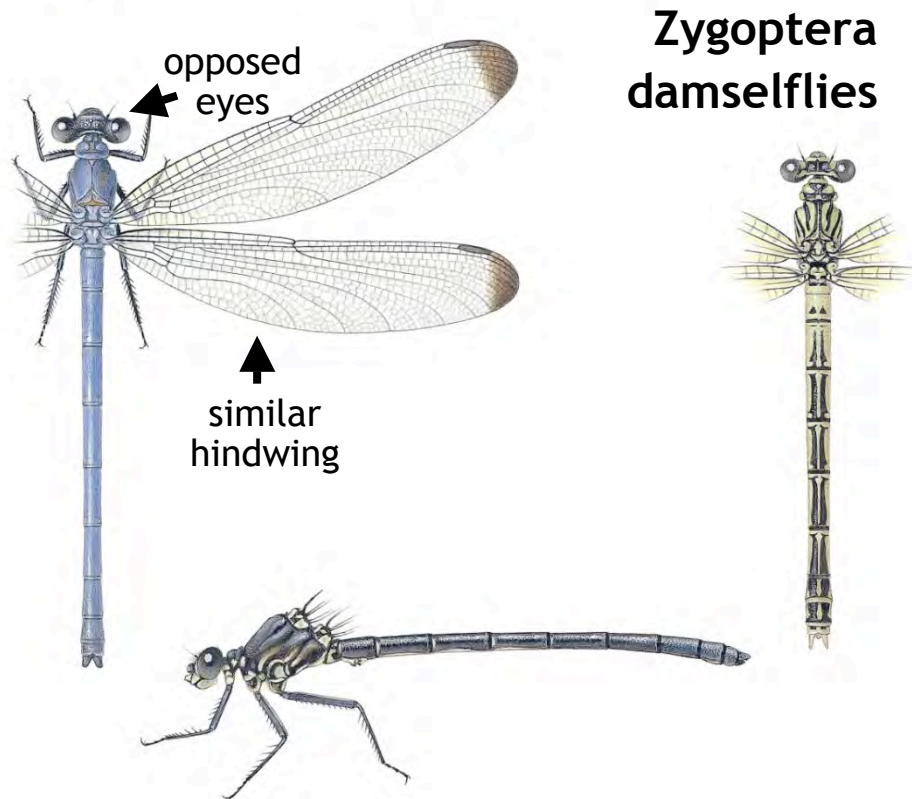
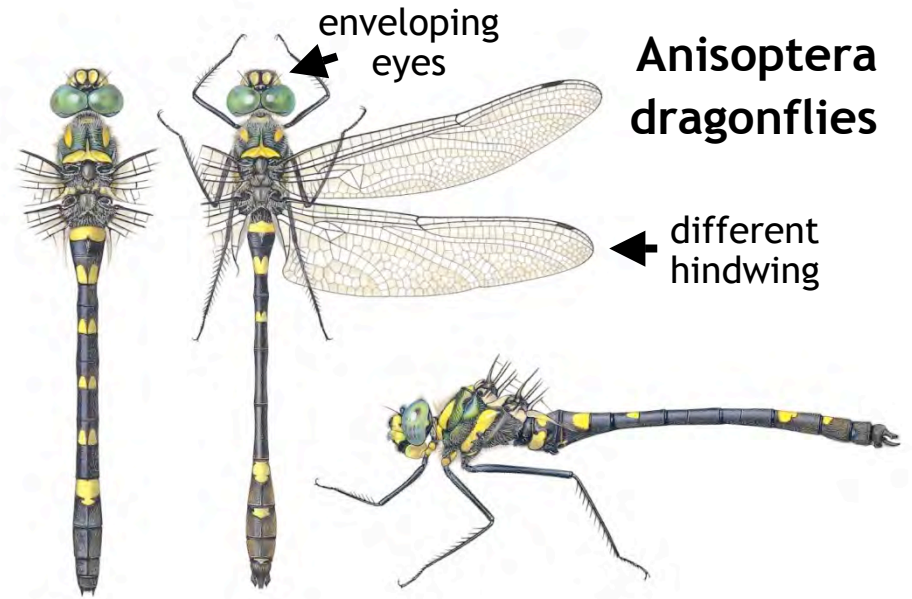
fact one

5680 species in 2 suborders

20,000 Orthoptera; 160,000

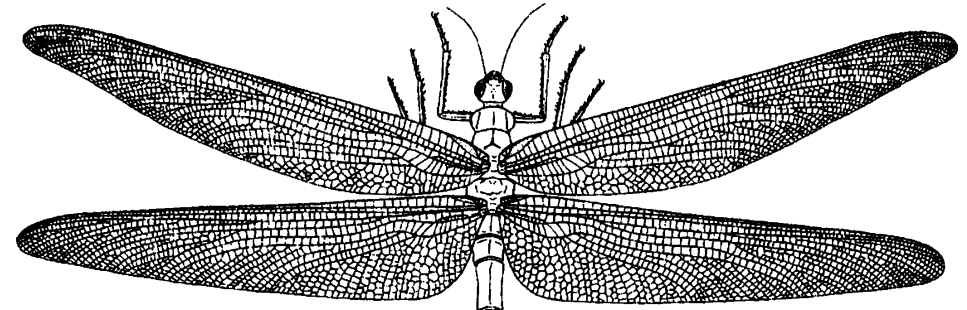
Lepidoptera; 100,000s of

Coleoptera & Hymenoptera



65	Caenozoic	Tertiary	largely modern odonate fauna, currently relictual groups distributed globally	angiosperms	first humans	
145	Mesozoic	Cretaceous			extinction ammonites dinosaurs etc	
220		Jurassic	origin of Zygoptera and Anisoptera	gymnosperms	first placental mammals	
250		Triassic			first birds	
280	Palaeozoic	Permian	reign of giant dragonflies	ferns, lycopods, horsetails	first mammals rise dinosaurs	
320		Carboniferous			<i>Kennedyia fraseri</i> first true odonate	extinction trilobites etc
380		Devonian			<i>Delitzschala</i> oldest winged insect	first reptiles
			<i>Rhyniella</i> oldest insect		first amphibians	

evolution of Palaeoptera

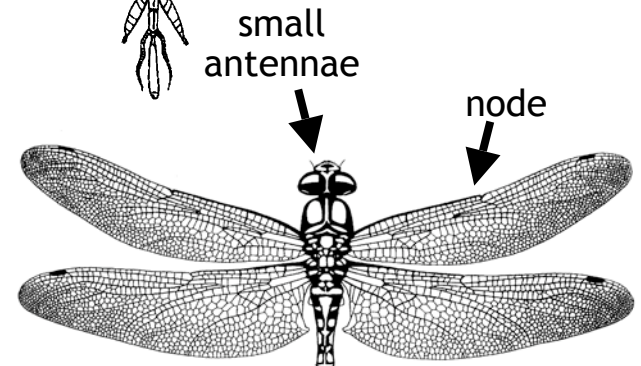


wingspan 15-70 cm

Namurotypus sippeli
Meganisoptera
Protodonata

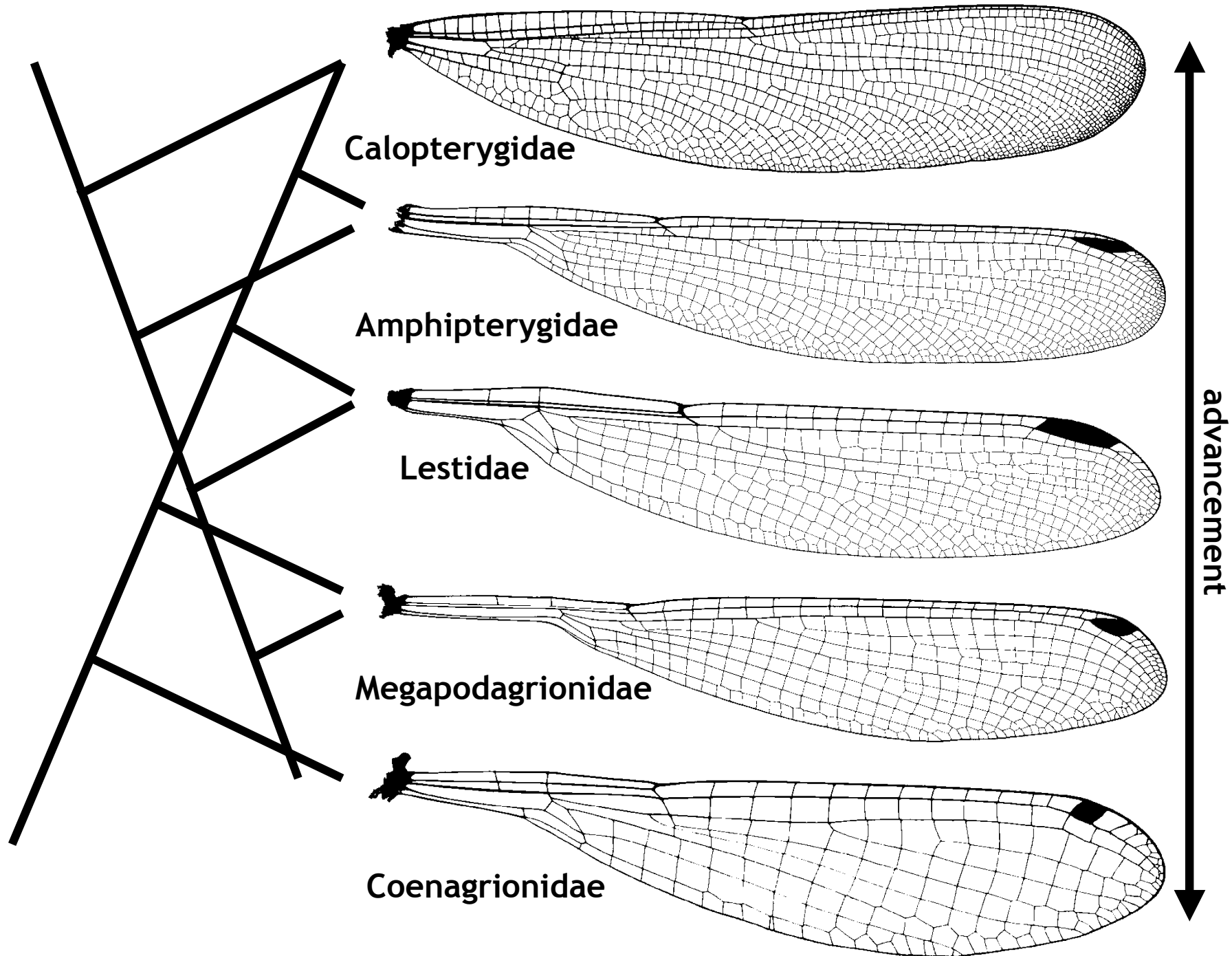


Ephemeroptera



Aeshna cyanea

unsegmented gripping cerci

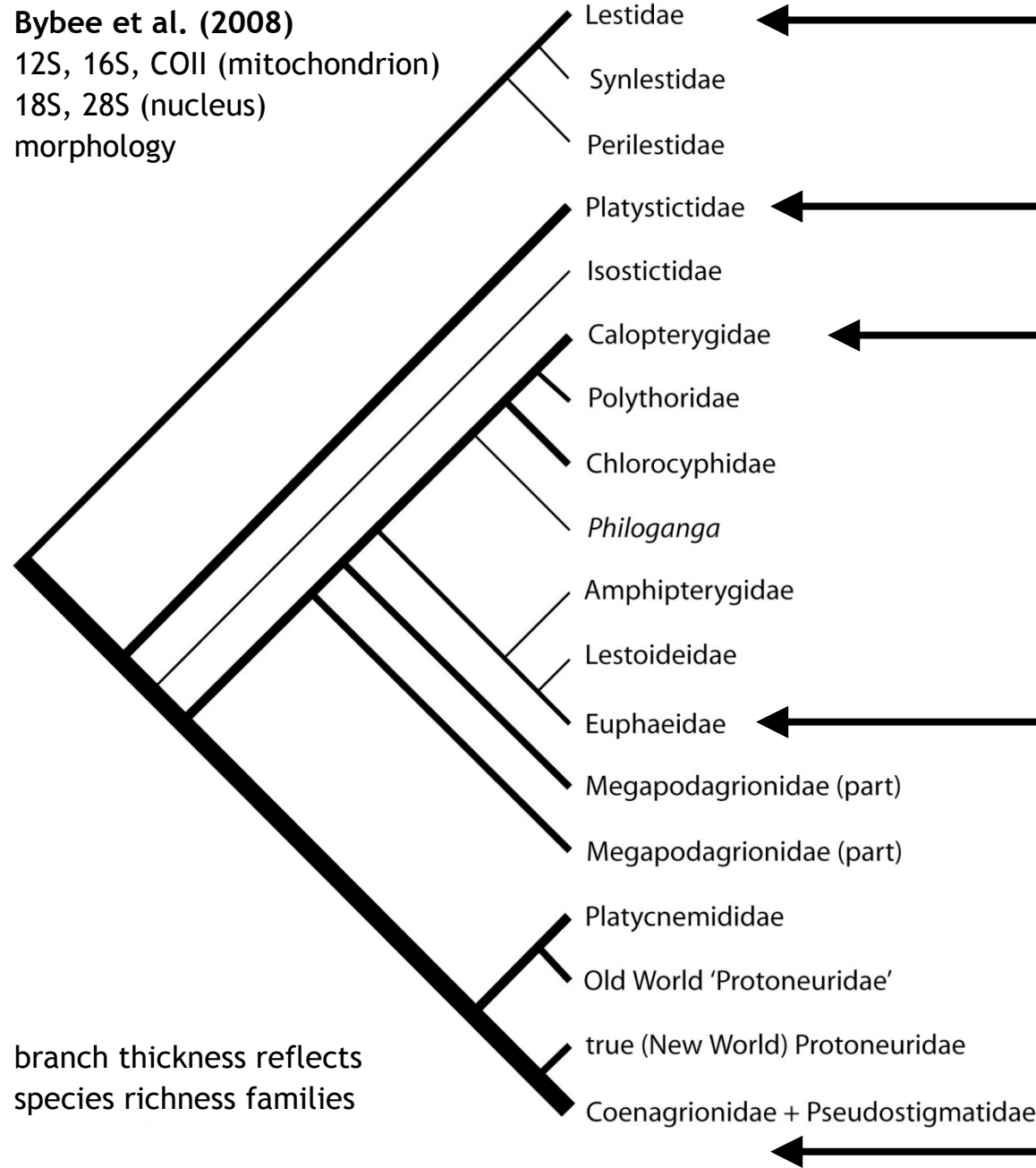


Bybee et al. (2008)

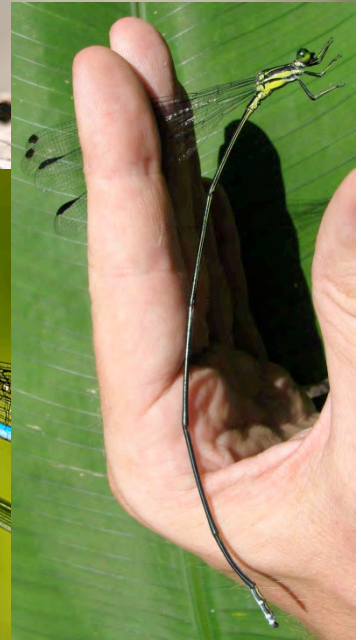
12S, 16S, COII (mitochondrion)

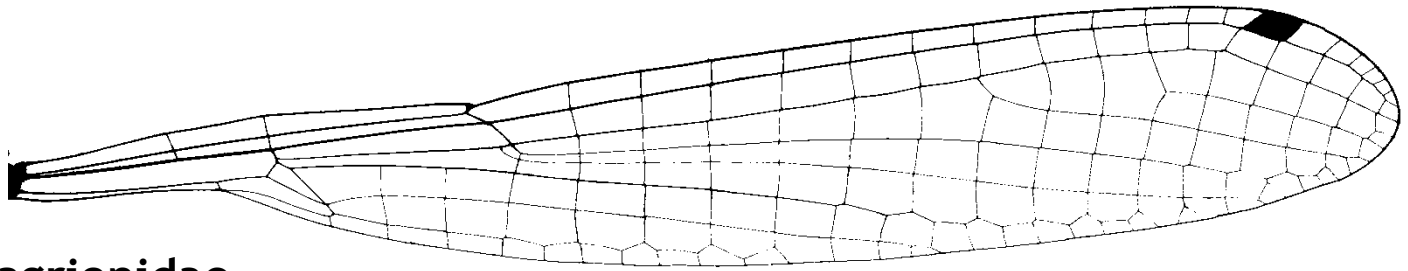
18S, 28S (nucleus)

morphology

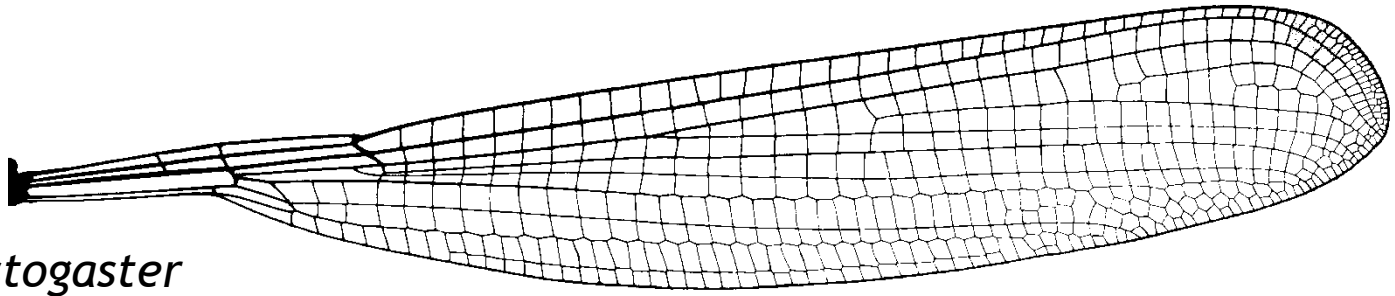


branch thickness reflects
species richness families

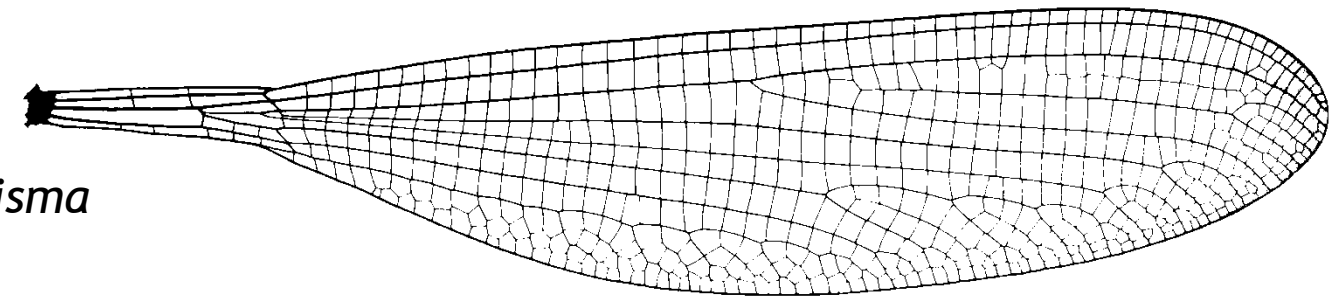




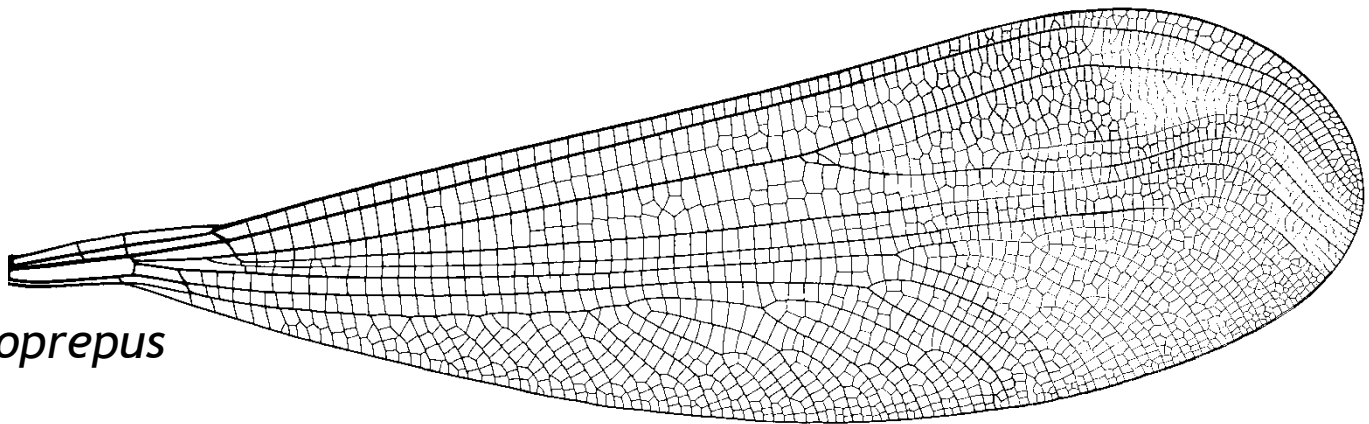
Coenagrionidae



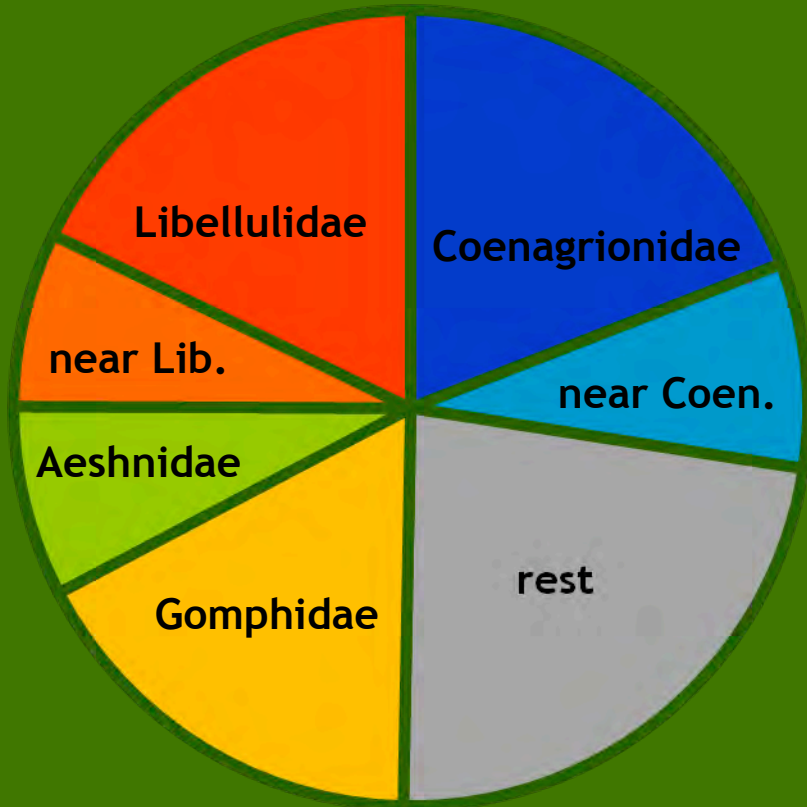
Mecistogaster



Anonisma



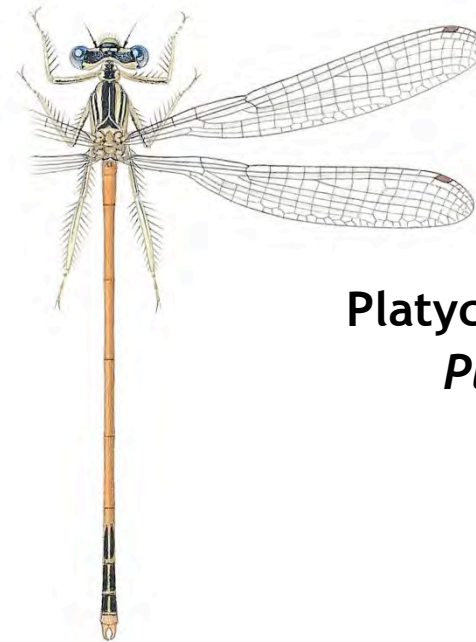
Megaloprepus



Odonata
Zygoptera
dominated by
Coenagrionoidea



Coenagrionidae
Erythromma



Platycnemididae
Platycnemis



Calopterygidae
Sapho



Synlestidae
Chlorolestes



Platycnemididae
Chlorocnemis

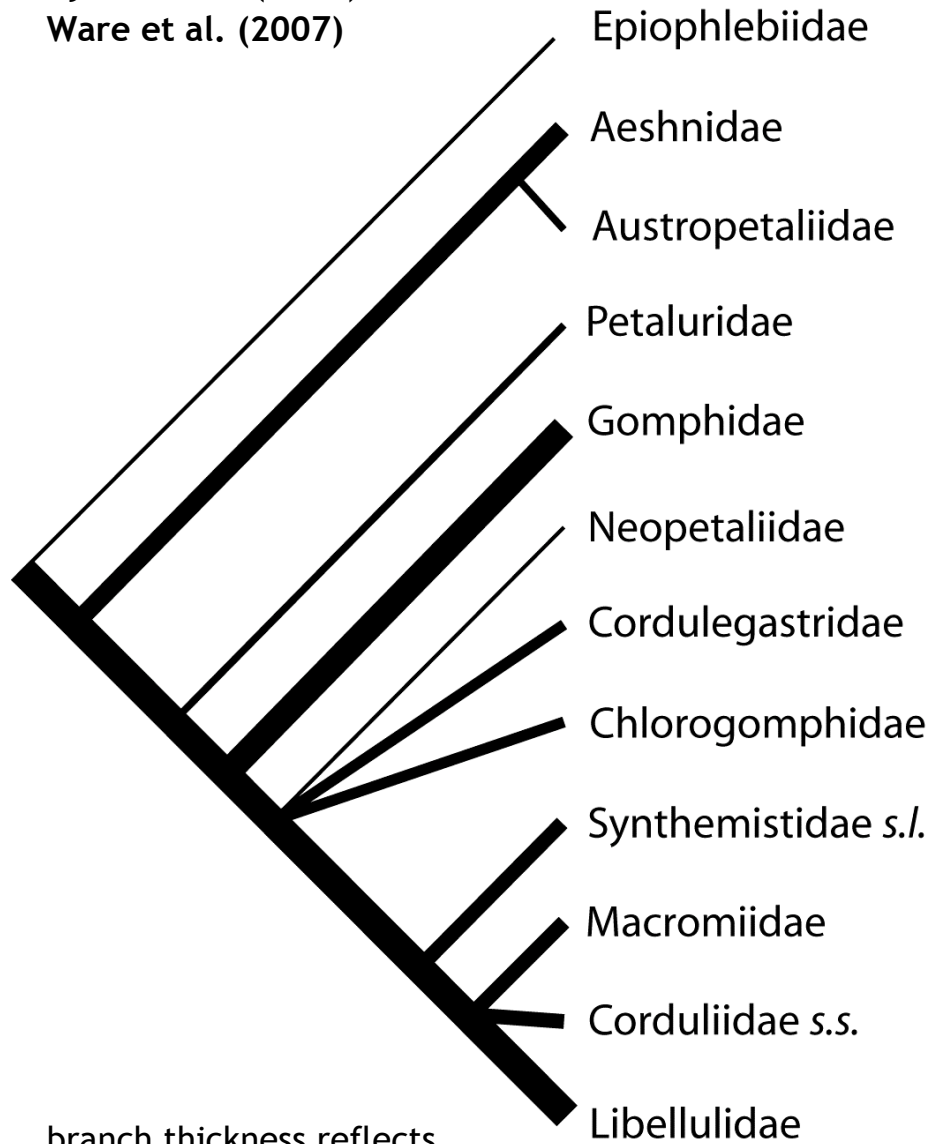


Megapodagrionidae
Philosina

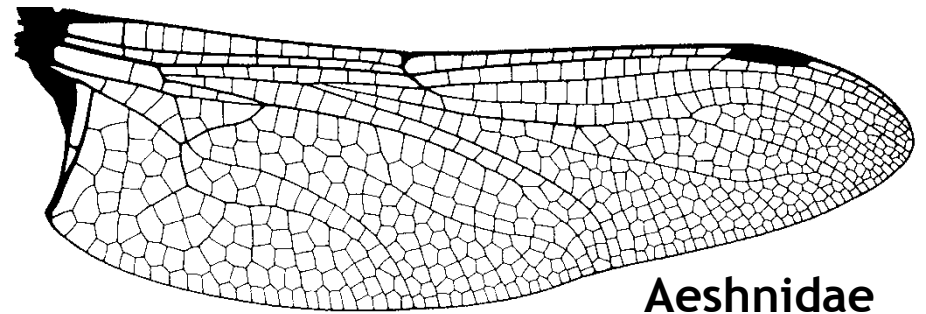


Euphaeidae
Euphaea

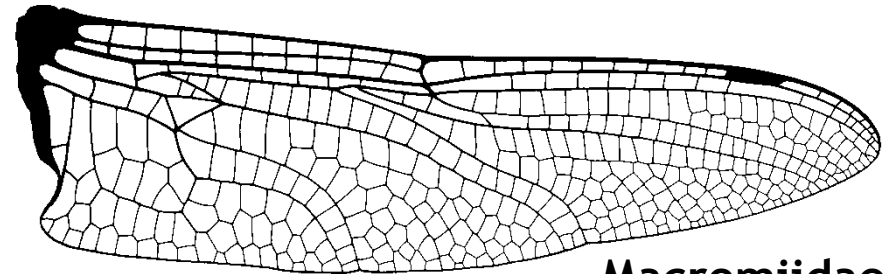
Bybee et al. (2008)
Ware et al. (2007)



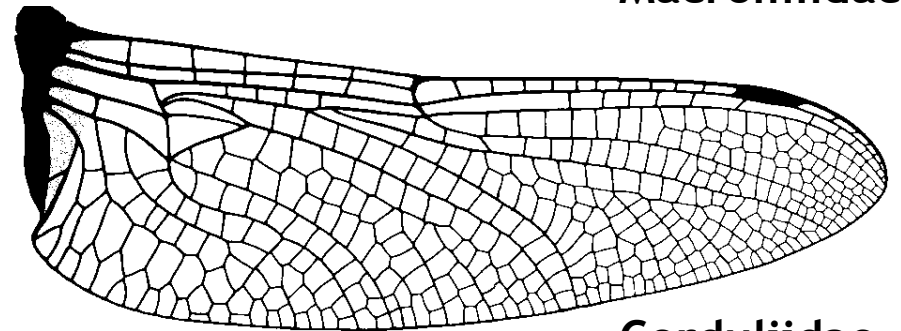
branch thickness reflects
species richness families



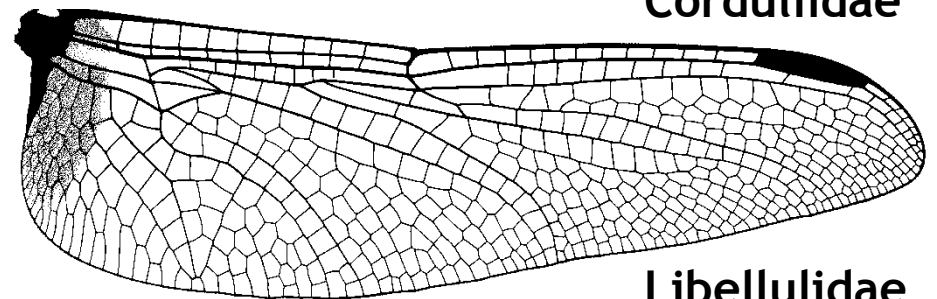
Aeshnidae



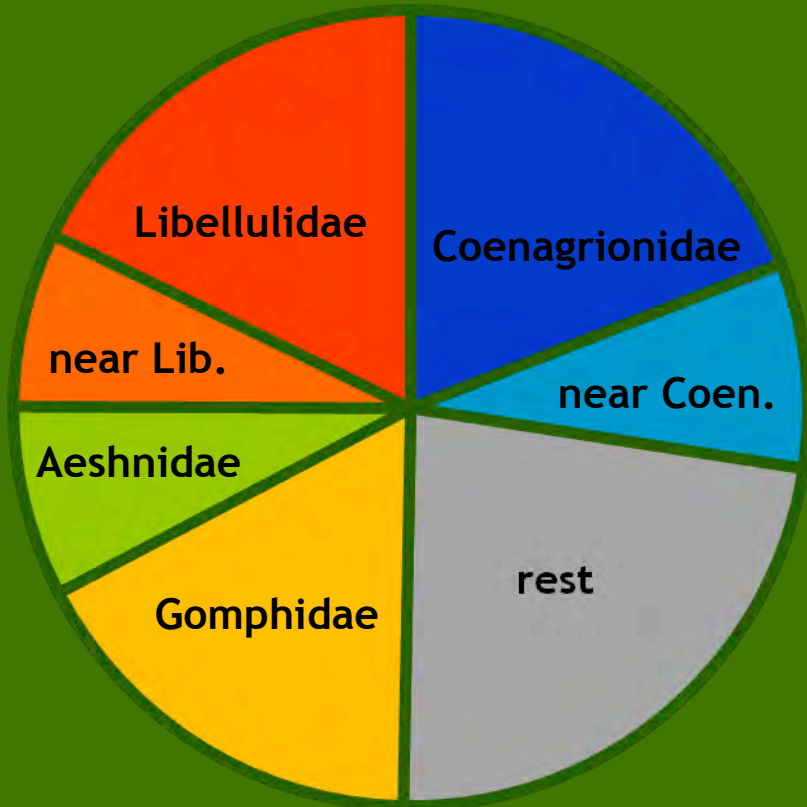
Macromiidae



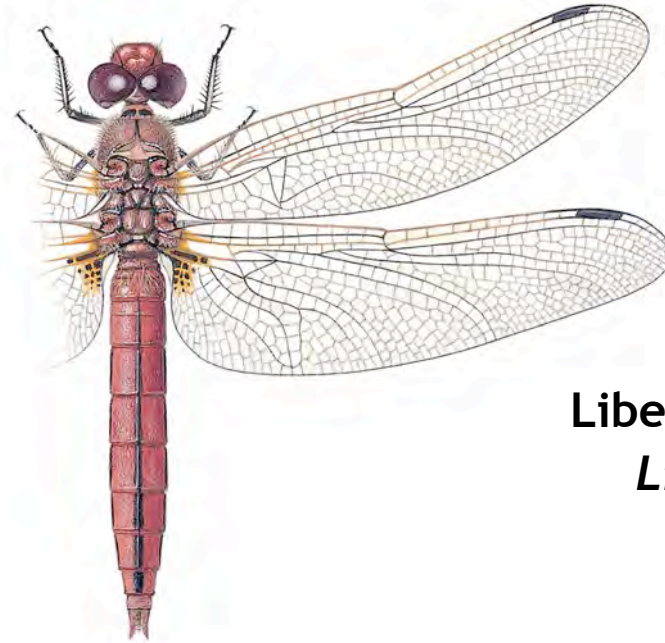
Corduliidae



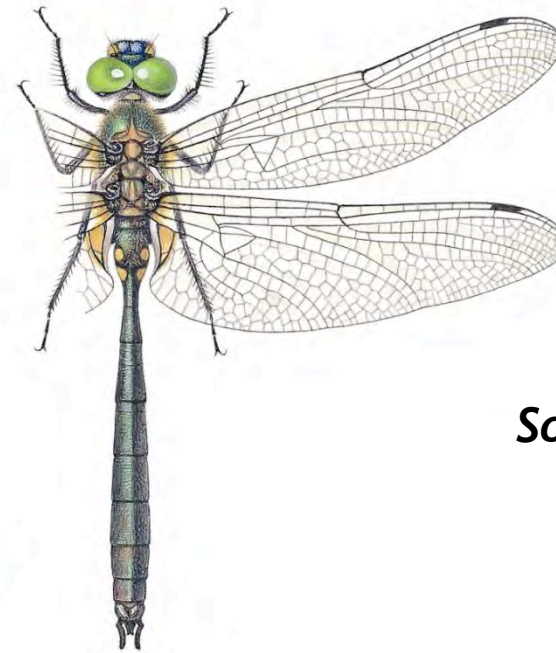
Libellulidae



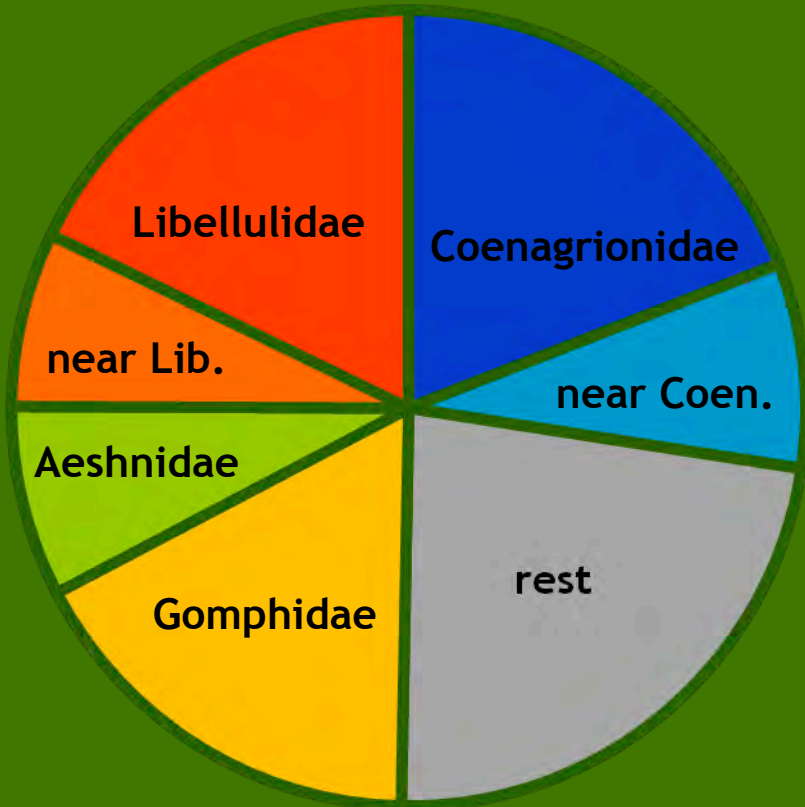
Odonata
Anisoptera
dominated by
Libelluloidea



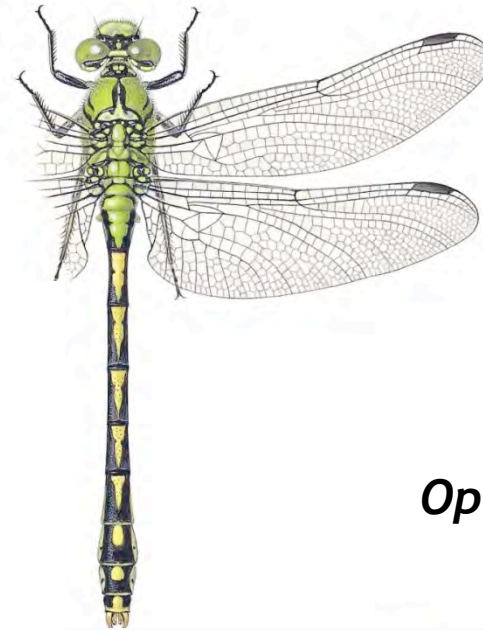
Libellulidae
Libellula



Corduliidae
Somatochlora



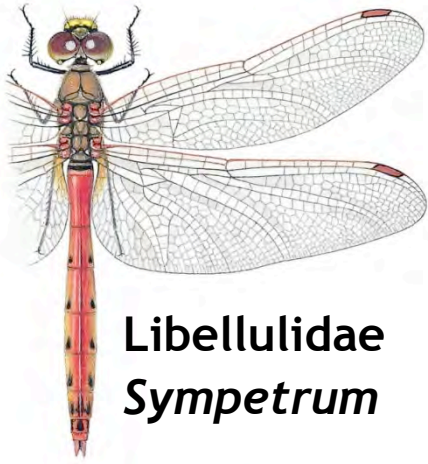
Odonata
Anisoptera
“Aeshnoidea”



Gomphidae
Ophiogomphus



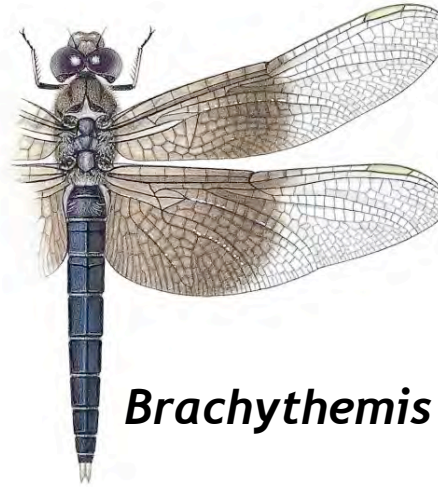
Aeshnidae
Aeshna



Libellulidae
Sympetrum



Leucorrhinia



Brachythemis



Acisoma



Corduliidae
Epitheca



Cordulegastridae
Cordulegaster



Aeshnidae
Caliaeschna



fact two

all are amphibious predators
hunting in land and water




larva: built for growth




odonate apomorphy:
labial mask of larva





clasper
Aeshnidae
Aeshna



sprawler
Libellulidae
Leucorrhinia

larval ecological types



burrower
Gomphidae
Gomphus



Coenagrionidae
Enallagma



Anisoptera
Aeshnidae
Aeshna



Zygoptera
Lestidae
Lestes

Anisoptera
Aeshnidae
Aeshna



epiproct and paraprocts
form shutter of rectum,
with rectal gills



Zygoptera
Lestidae
Lestes

epiproct and paraprocts
form lamellae that
function as gills

Anisoptera
Aeshnidae
Aeshna



rapid expulsion of
water from rectum
for jet propulsion

strike of labium
in 0.005 seconds
(3x as fast as mantis)

Zygoptera
Lestidae
Lestes





emergence



exuviae

adult: built for reproduction

flight

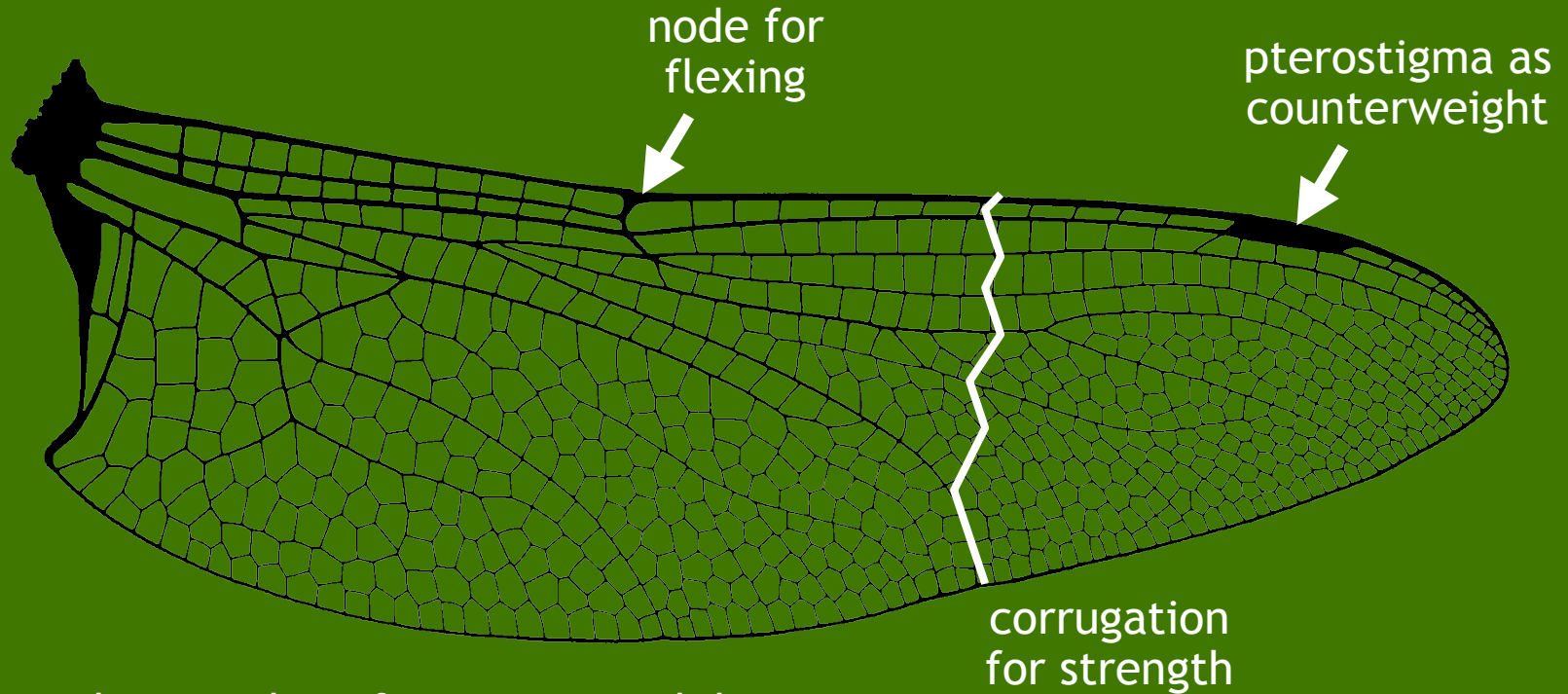
two pairs of wings
two compound
eyes, each of up to
29,000 ommatidia



vision



odonate wing and flight



independent stroking for maneuverability

	<i>Calopteryx</i>	<i>Lestes</i>	<i>Anax</i>	mosquito
beats/second	15	33	38	1000
km/hr	8	10	>36	
mm/beat	175	45	250	

flight modes



percher
Zygonoides



flier
Zygonyx



glider
Pantala

black pigment
in cuticle



black pigment
under trans-
parent cuticle



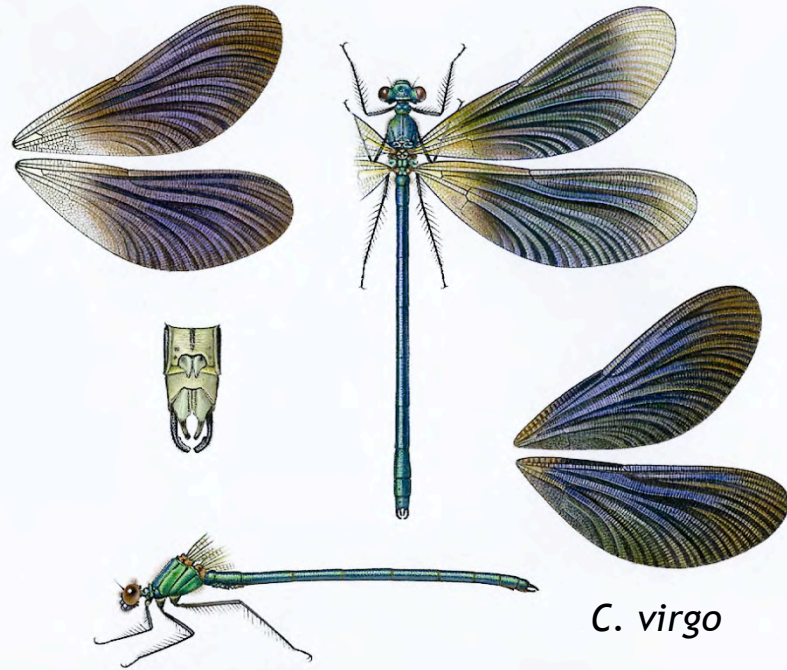
adult coloration.

red, blue, yellow and
green pigments in
living cells



red pigment +
pruinosity
= violet

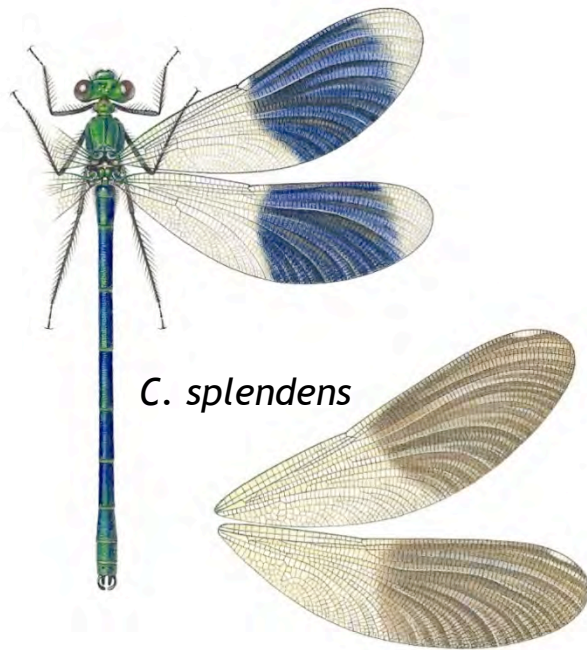




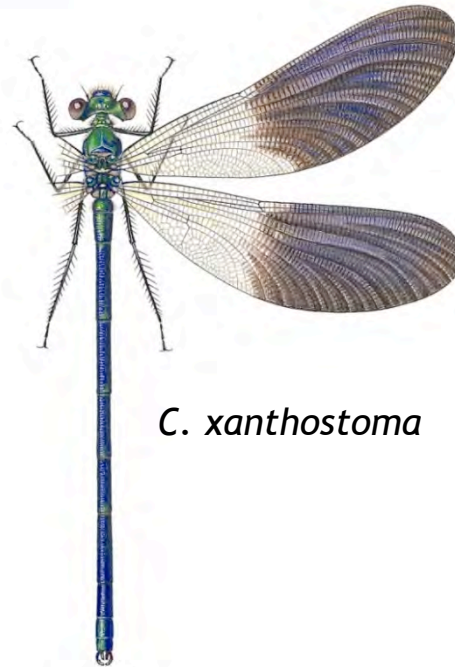
C. virgo



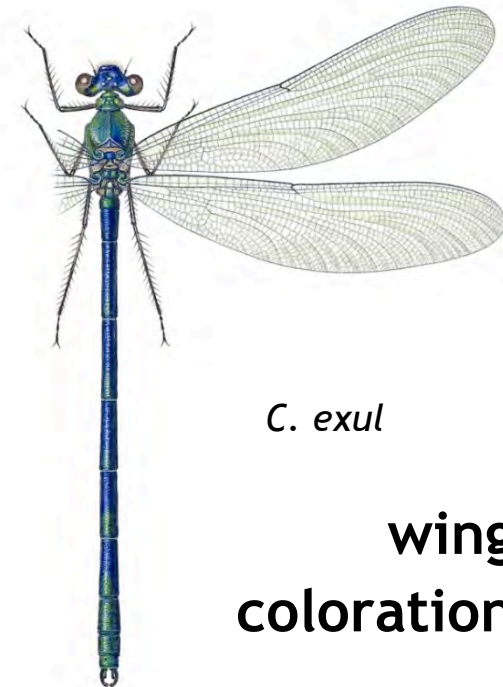
C. haemorrhoidalis



C. splendens



C. xanthostoma



C. exul

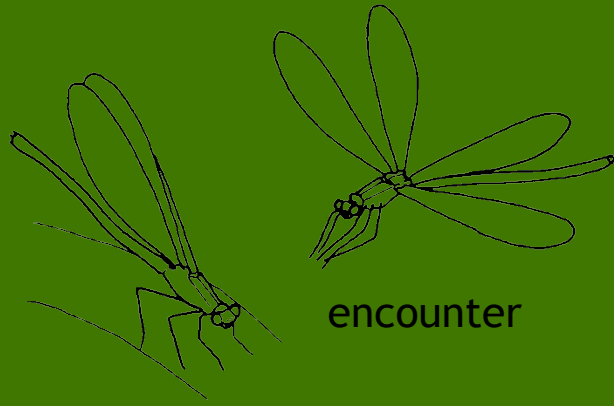
wing
coloration



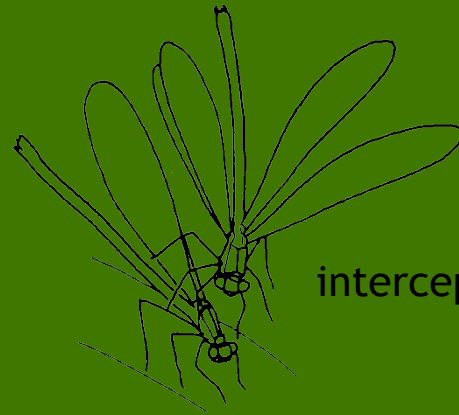
fact three

unique reproduction

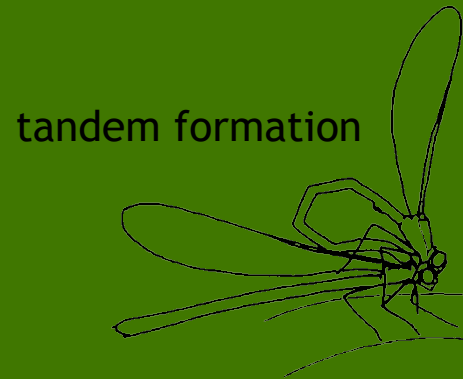
indirect insemination and delayed fertilisation



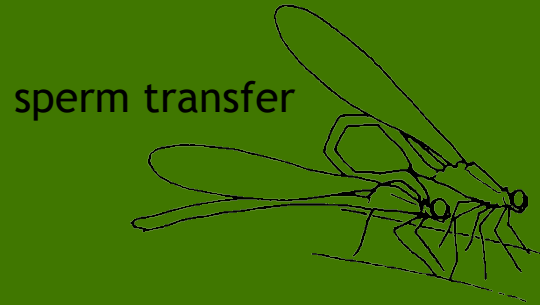
encounter



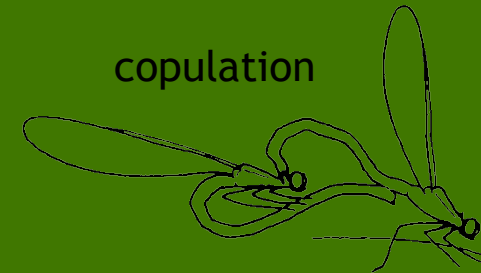
interception



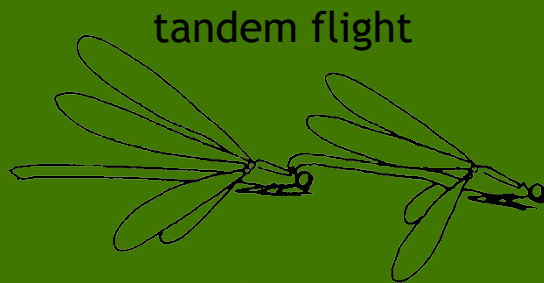
tandem formation



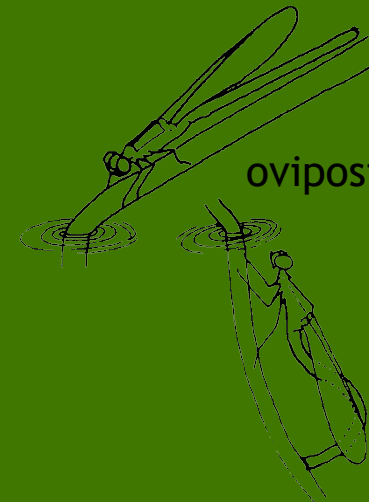
sperm transfer



copulation



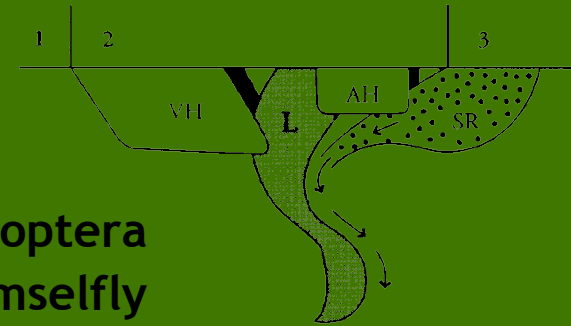
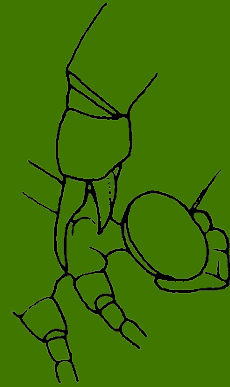
tandem flight



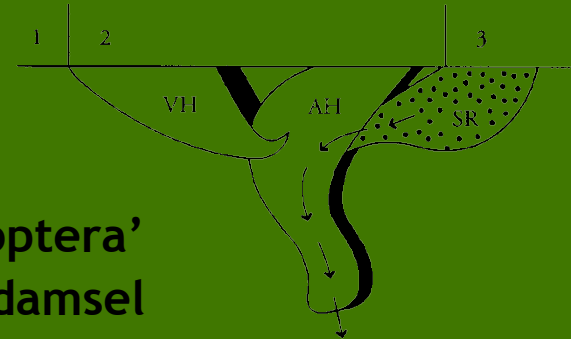
oviposition

reproductive behaviour

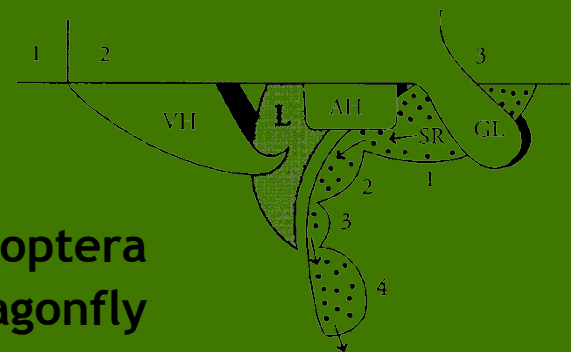
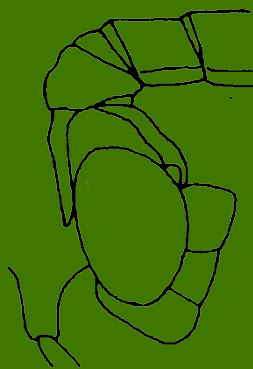
tandem grip and sperm transfer



Zygoptera
damselfly



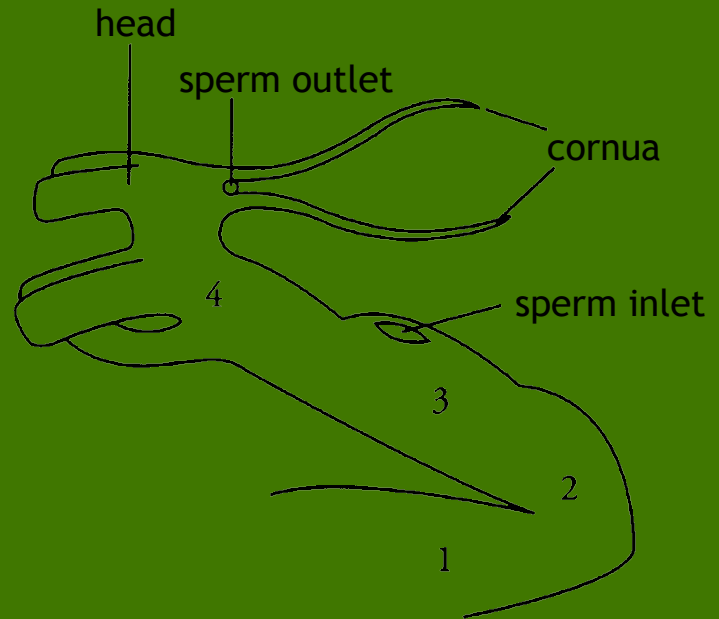
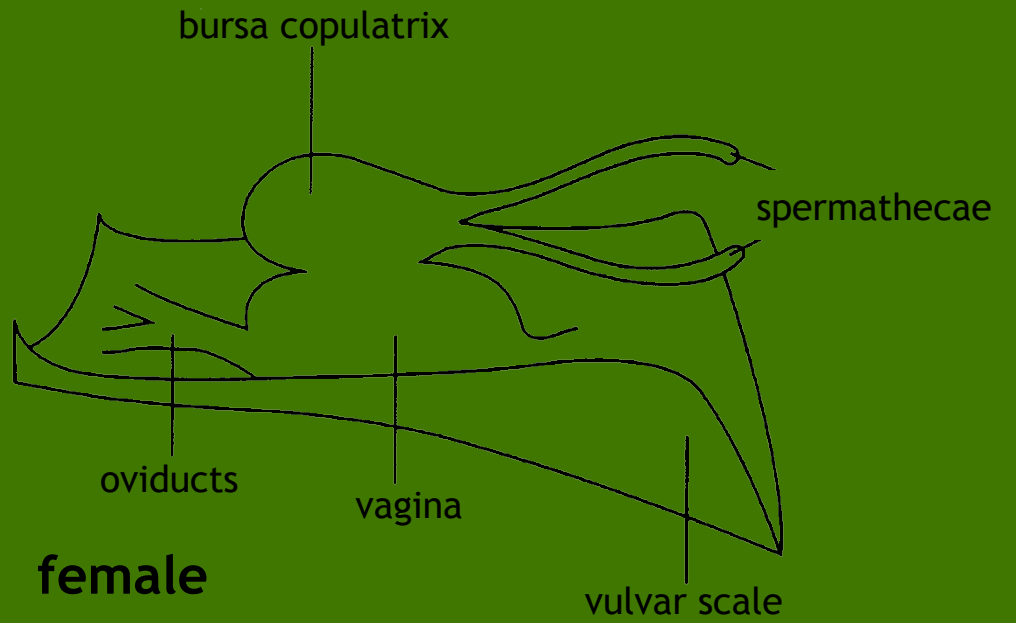
'Anisozygoptera'
dragon damsel



Anisoptera
dragonfly



sperm transfer, storage, removal





indirect insemination

unique secondary genitalia in Odonata
modified male palps in spiders
externally in wingless insects

delayed fertilisation

enables sperm competition, forces mate guarding

