An Introduction to Crayfish

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Crayfish expert?

- Astacology
  - Greek *astakos* meaning "lobster"
- Astacologist?

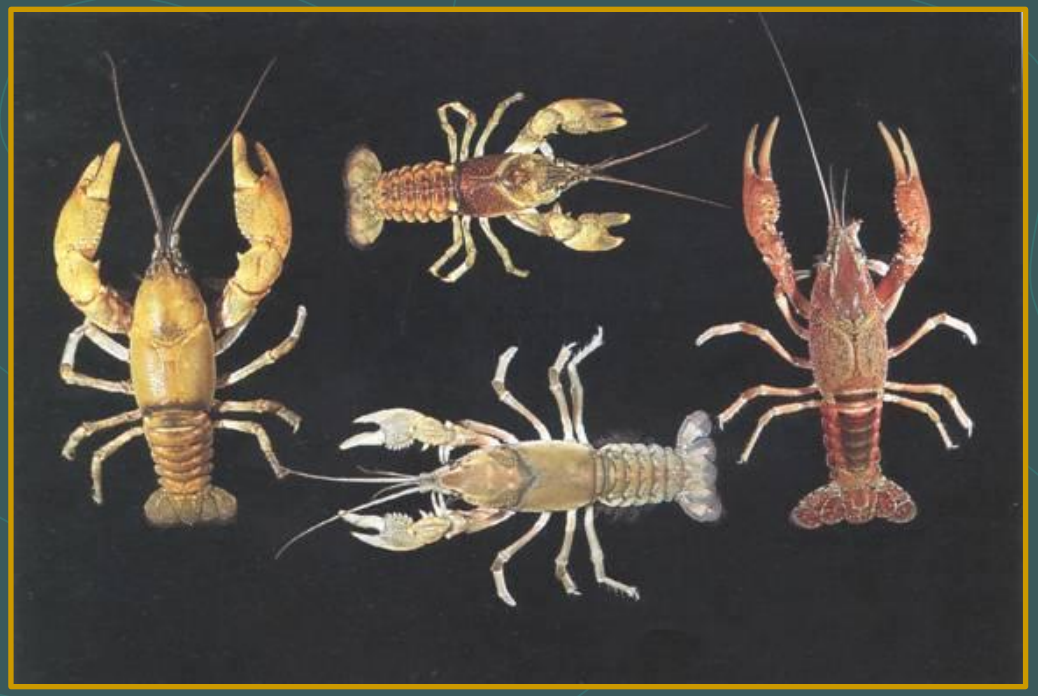
Agenda

- What is a crawdad?
- Classification
- Distribution
- Morphology
- Life history
- Habitat
- Ecology
- Conservation status

Orconectes harrisoni (belted crayfish)

Goals

…To better understand and appreciate crayfish and their role in ecosystems…



Information sources

- Scientific literature
- MDC research data
- Casual observations

Procambarus clarkii (red swamp crayfish)

Orconectes punctimanus (spothanded crayfish)

Etymology: crayfish or crawfish?

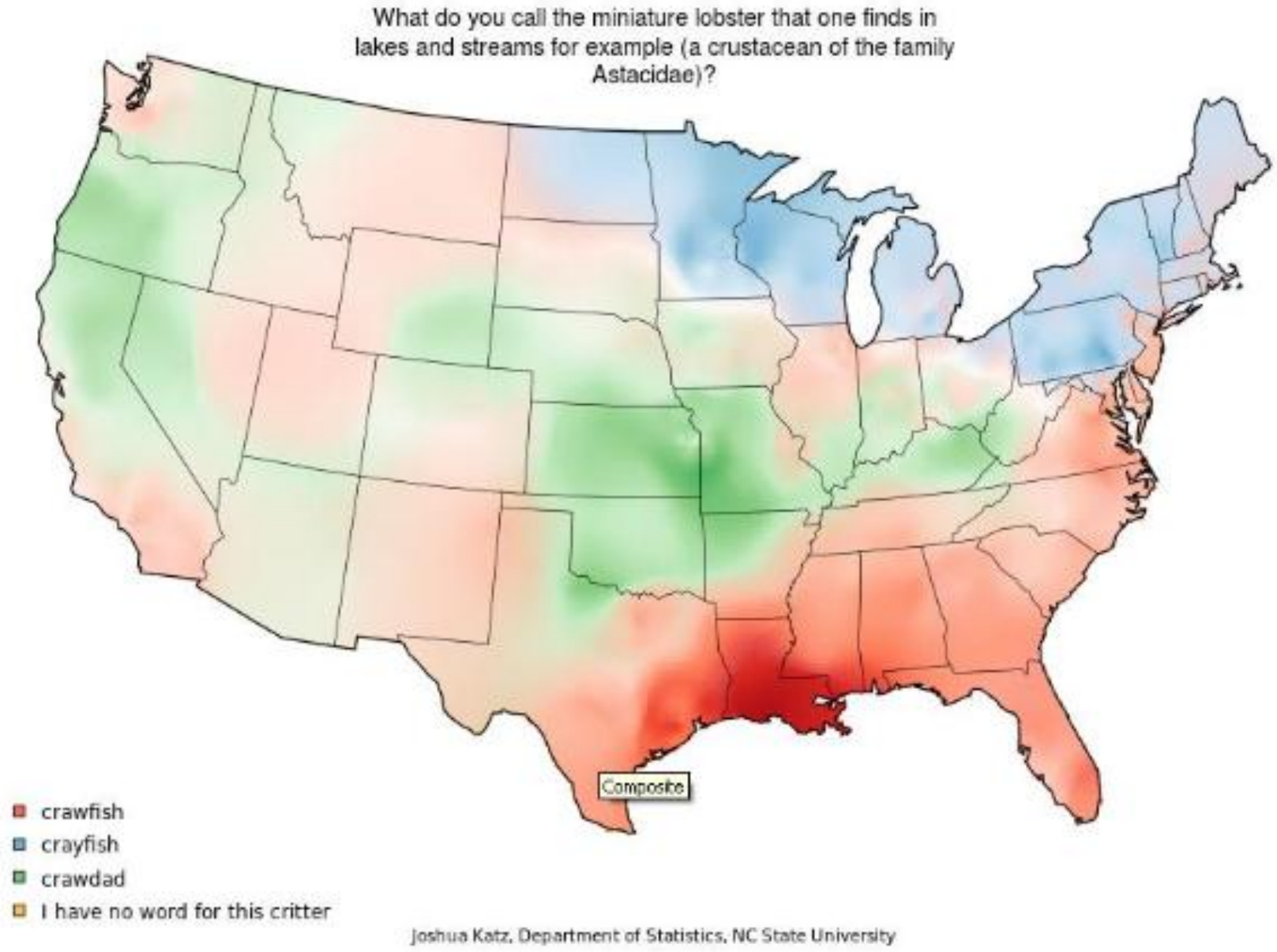
- Old High German “Krebiz”
  - Edible crustacean
- Old French speakers → “crevise”
- British → “crey-fish”
- Modern English → “crayfish” & “crawfish”
- Craw“dad”?
  - Southern → Grumpy old man?
- Dialect is dependent on locality

Dialect surveys (Burt Vaux 2005, Josh Katz 2013)

- What do you call the miniature lobster that one finds in the lakes and streams, for example (a crustacean in the family Astacidae)?

Orconectes peruncus
(Big Creek crayfish)

4. "I Have No Words For This Critter." 'Nuff said




Crayfish

What is a crawdad?

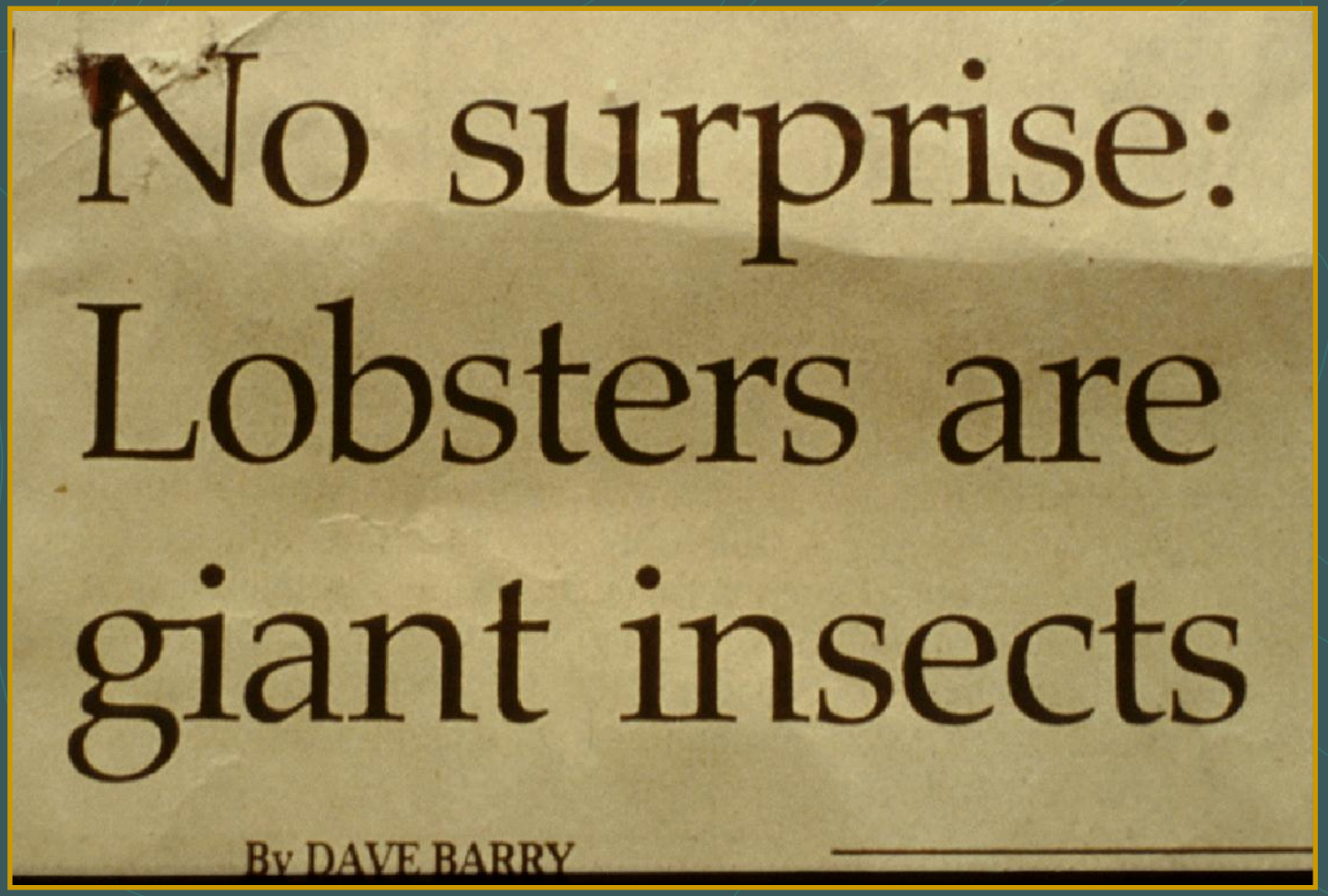
- “Common and lowly as most may think the crayfish, it is yet so full of wonders that the greatest naturalist may be puzzled to give a clear account of it.”
  - Roesel von Rosenhof in Huxley’s *The Crayfish, an Introduction to the Study of Zoology* (Huxley 1880)

Procambarus sp.

What is a crawdad?

- Crawdad is something I put on a hook
- Crawfish is something I eat
- Crayfish is something I study

Classification



Higher classification

Phylum Arthropoda

Subphylum Crustacea

Order Decapoda

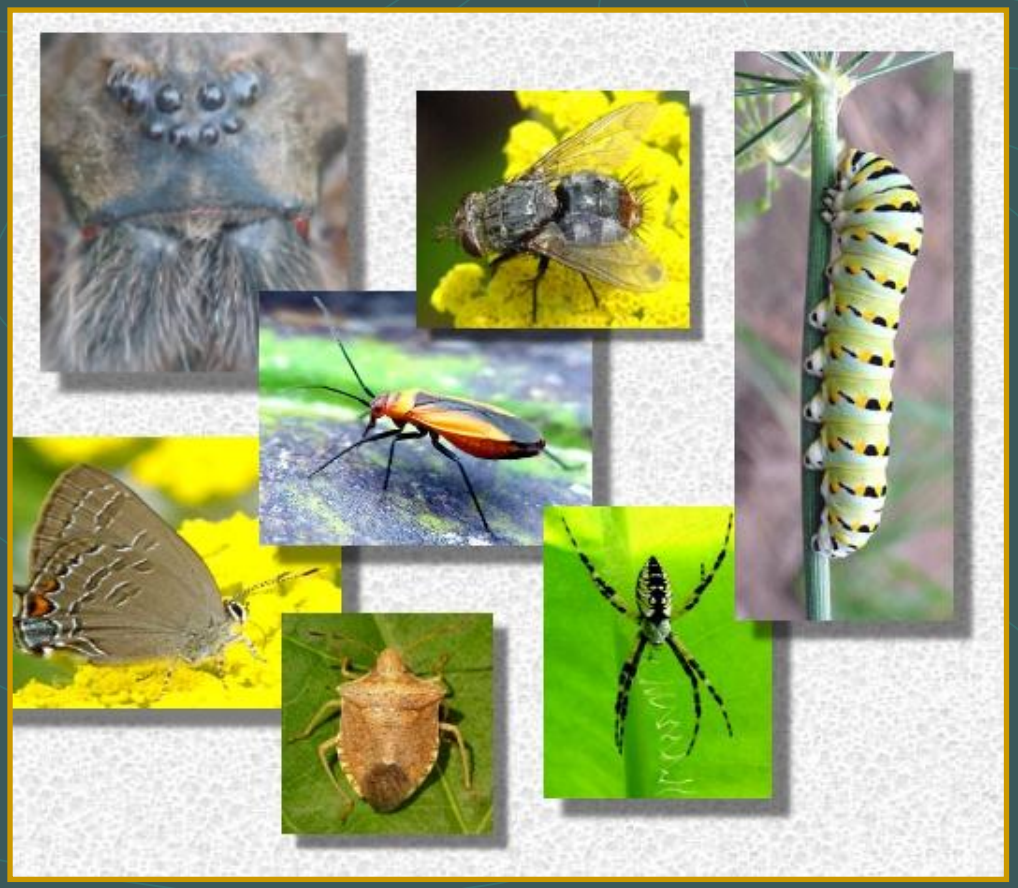
Family Astacidae

Family Cambaridae

Family Parasticidae

Phylum: Arthropoda

- Segmented bodies and appendages



Subphylum: Crustacea

- Paired mandibular jaws, maxillae, 2 pr. antennae

Order: Decapoda (10 legs)

- Characteristics
  - Terminal claws on first 3 pr. appendages
  - Branchial chamber enclosed by carapace
- Includes
  - Shrimps
  - Spiny Lobsters
  - Crabs
  - *Astacidea* (or Superfamily *Astacoidea*)

Decapods are good eats!

North American crayfish families

- Astacidae – Eurasian origins
- Cambaridae – North American origins
  - Cambarellinae – *Cambarellus*
  - Cambarinae – all other genera

Cambarellus puer (Cajun dwarf crayfish)

Family: Astacidae (North America)

- 1 genus: *Pacifastacus*
- 5 species
- 2 possibly extinct
- *P. leniusculus* with 3 subspecies
- All west of the Rocky Mountains

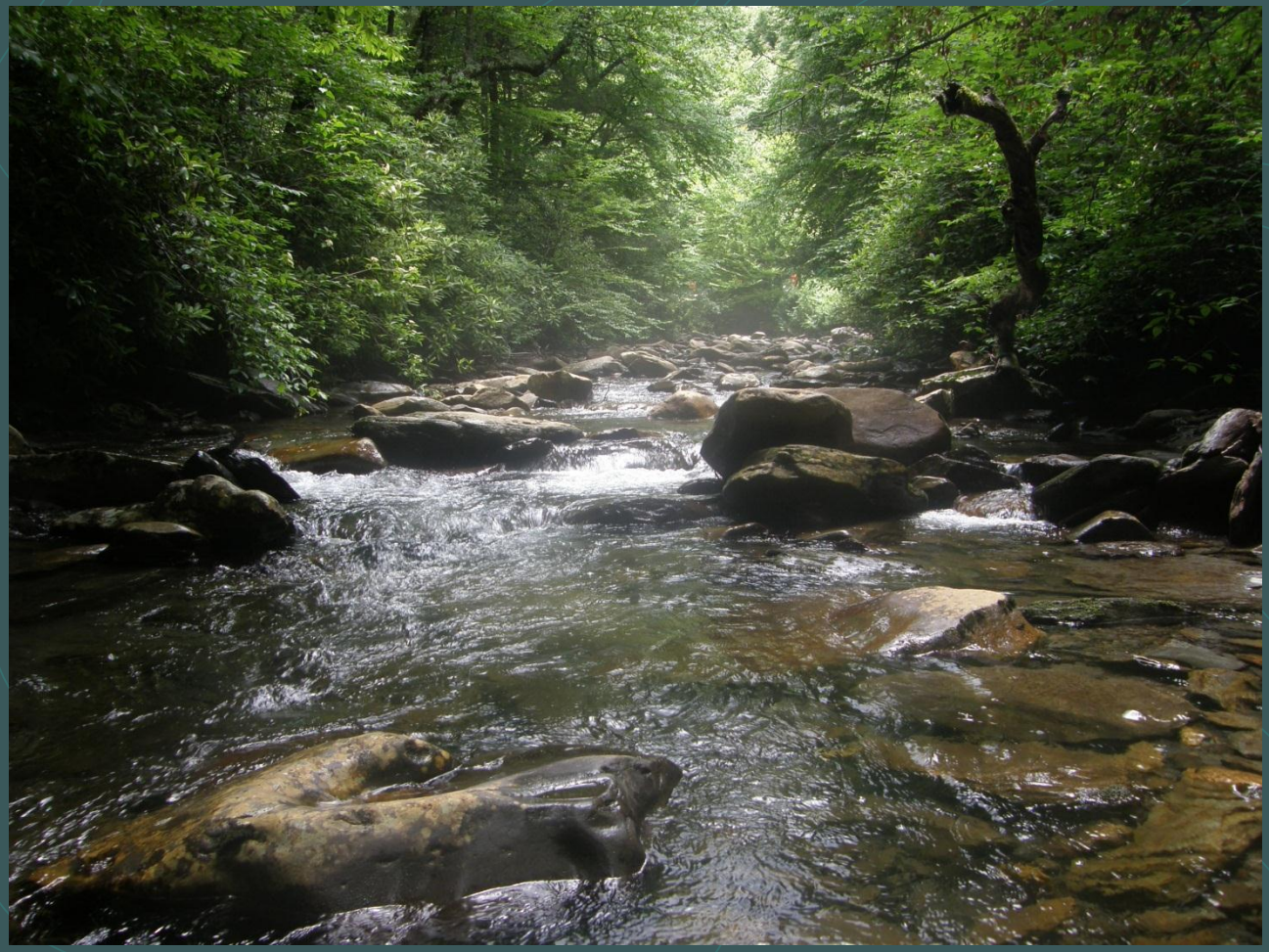
Pacifastacus l. leniusculus (Signal crayfish)

Family: Cambaridae (North America)

- 2 subfamilies (Cambarellinae, Cambarinae)
- 12 genera
- Approximately 375 species/subspecies
- Central and eastern in distribution
  - Mostly east of the Rockies
  - Southern Canada into Mexico

Procambarus gracilis
(grassland crayfish)

Crayfish distribution

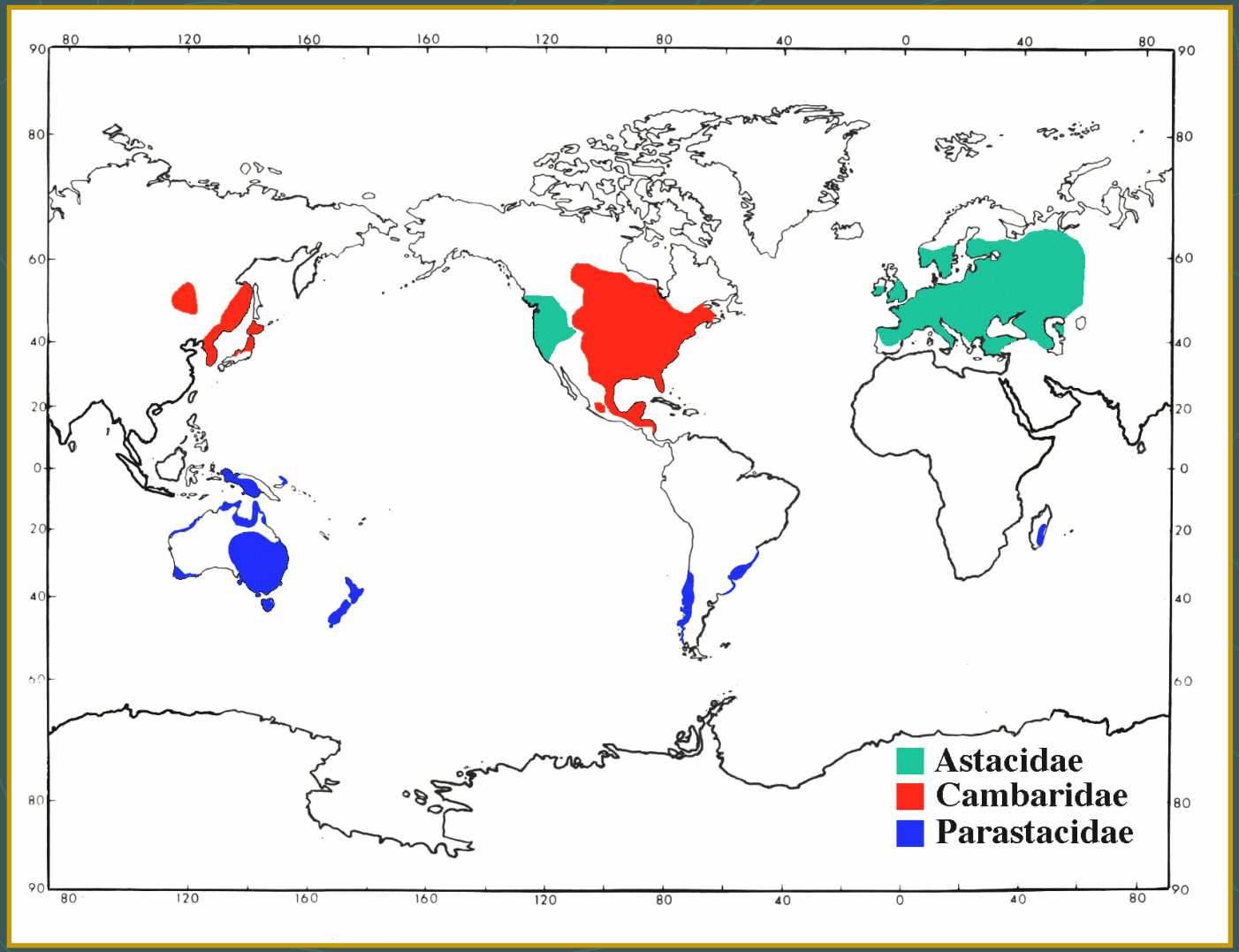


Crayfish distribution

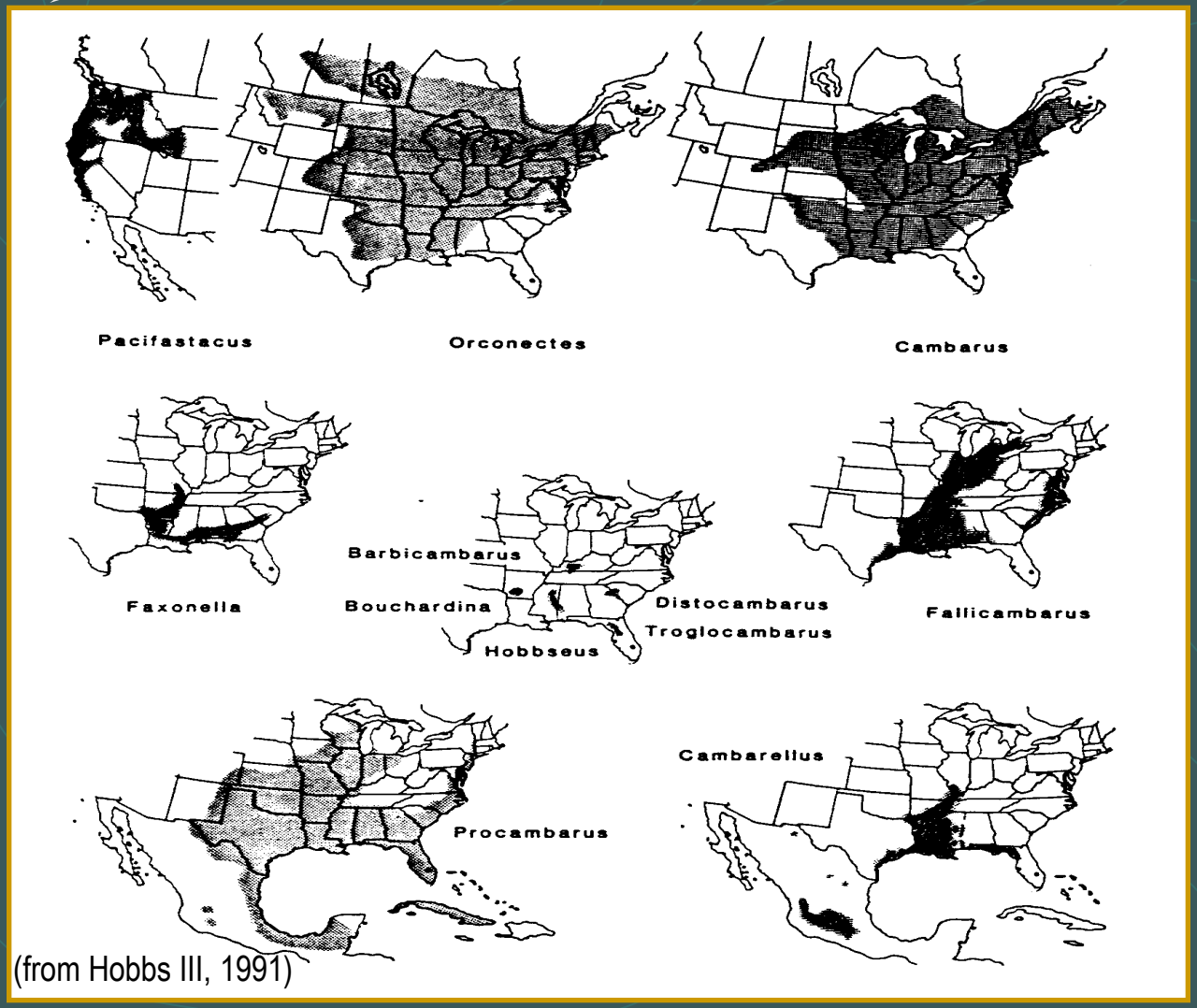
- 650 species/subspecies worldwide
- Over 380 recognized species in N. America
  - Most of these east of Rocky Mountains
  - Several more in Mexico (49) and Cuba (4)
  - “Crayfish Hub”
- Two North American hubs
  - Cumberland Plateau
  - Ozark Plateau

Cambarus hubbsi
(Hubbs’ crayfish)

Distribution of extant crayfish families



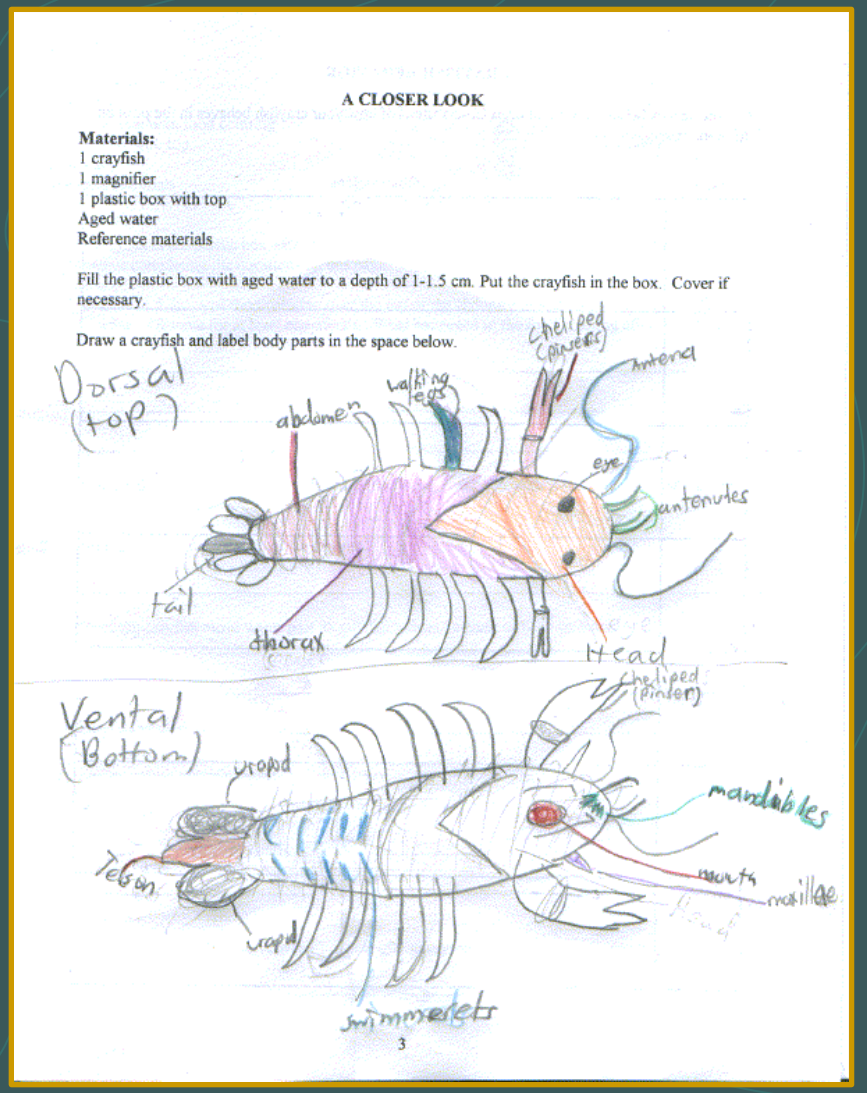
North American distribution



(from Hobbs III, 1991)

Morphology

- Exoskeleton – molting
- 10 legs – chelae for defense/mating
- Antennae – locate food/predators
- Gills
- Fan-shaped tail – escape
- Stalked compound eyes



A CLOSER LOOK

Materials:
1 crayfish
1 magnifier
1 plastic box with top
Aged water
Reference materials

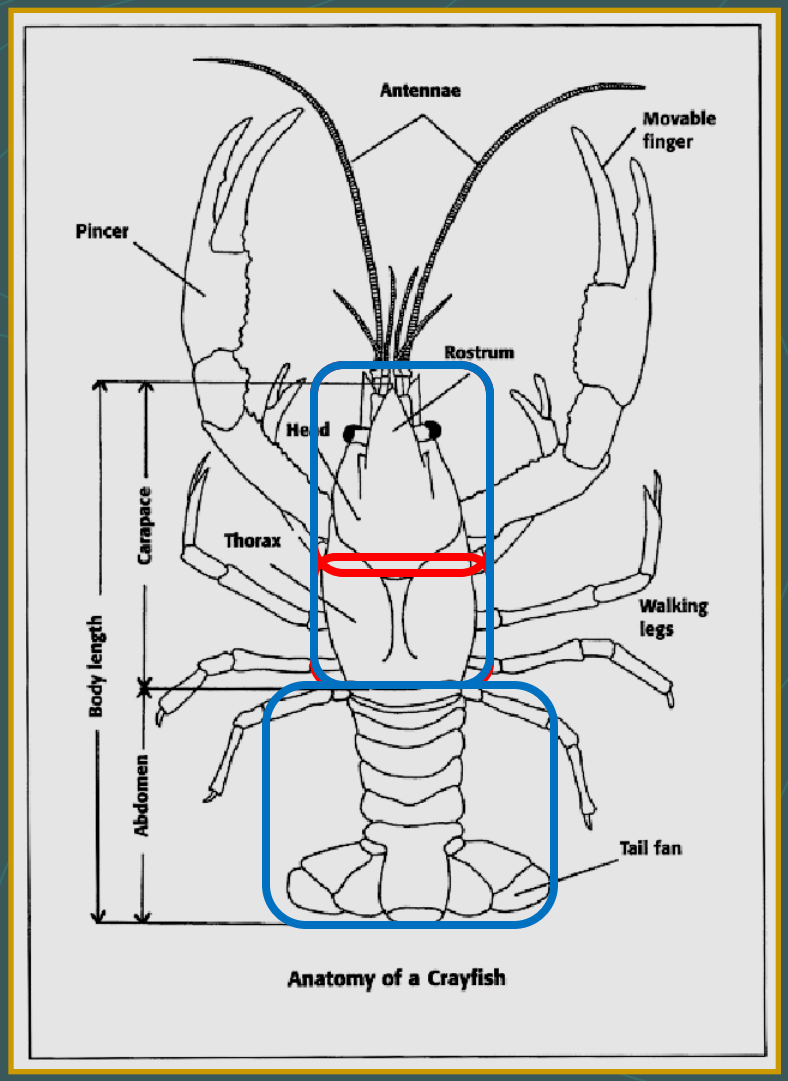
Fill the plastic box with aged water to a depth of 1-1.5 cm. Put the crayfish in the box. Cover if necessary.

Draw a crayfish and label body parts in the space below.

3

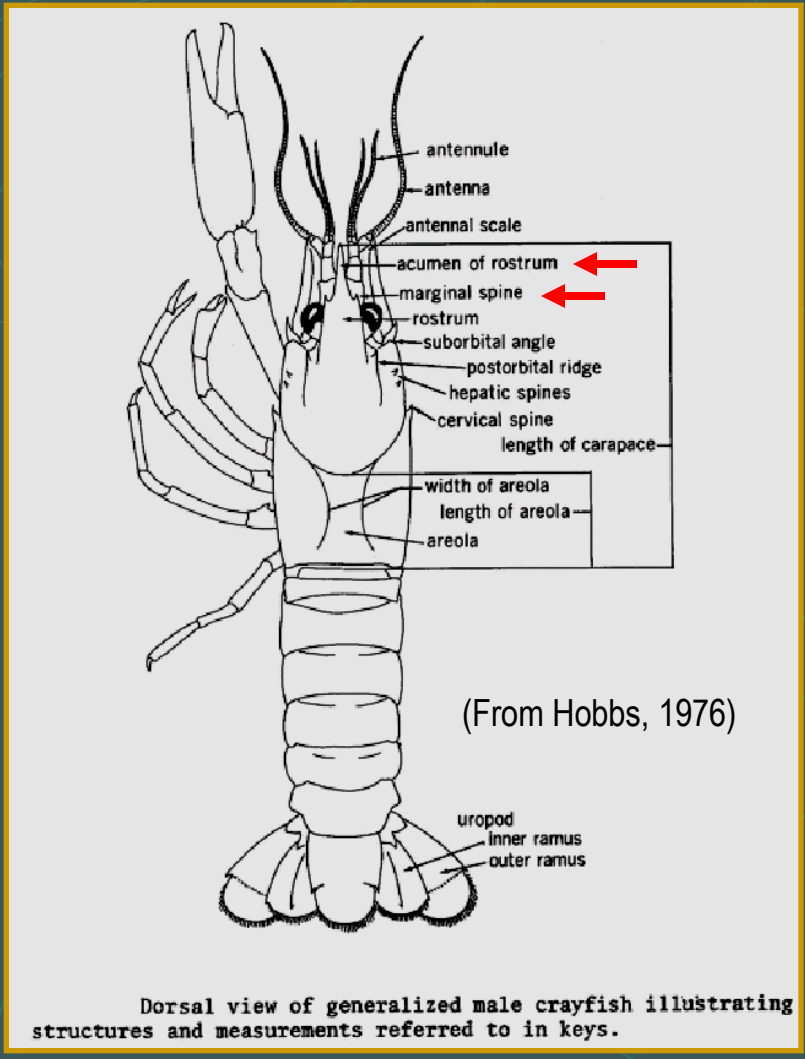
Morphology

- Body divided into two main regions
  - Cephalization (covered by carapace)
    - Head
    - Thorax
  - Abdomen



Appendages of the head

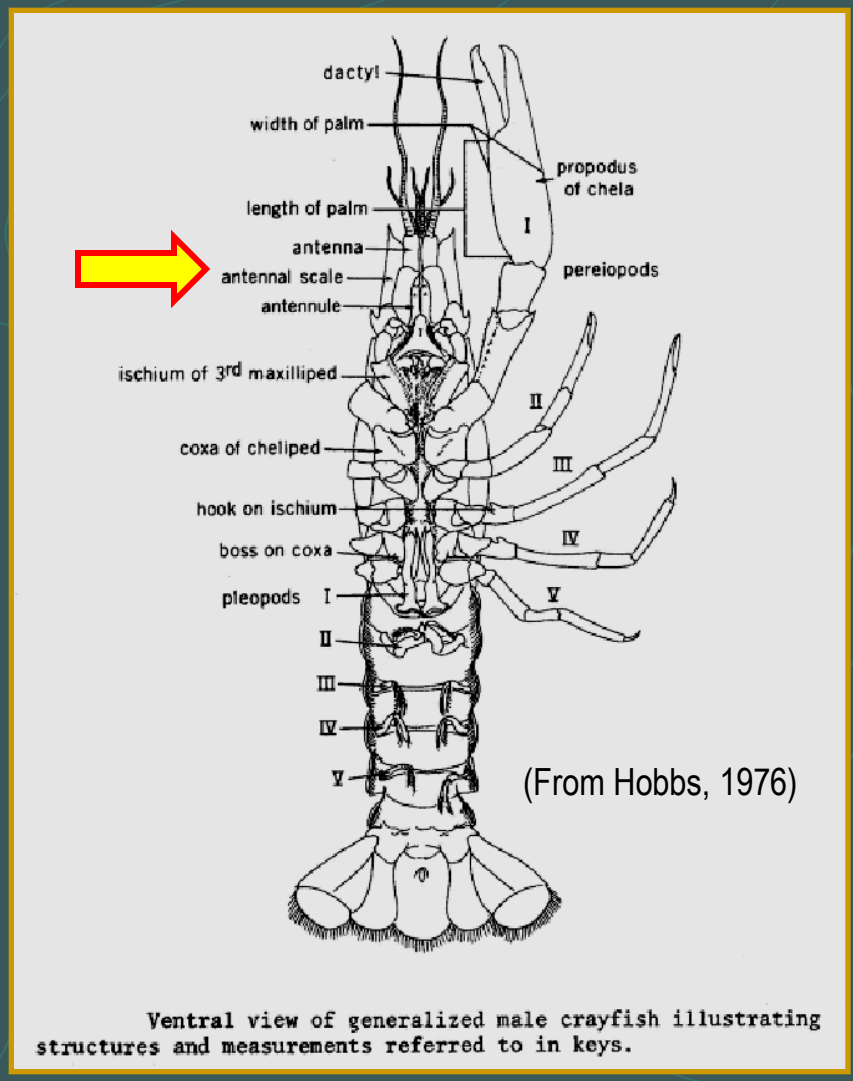
- Two pair of antennae
  - Sensory
  - 1st pair - Antennae
  - 2nd pair – Antennules
- Rostrum
  - Acumen
  - Marginal spine



Dorsal view of generalized male crayfish illustrating structures and measurements referred to in keys.

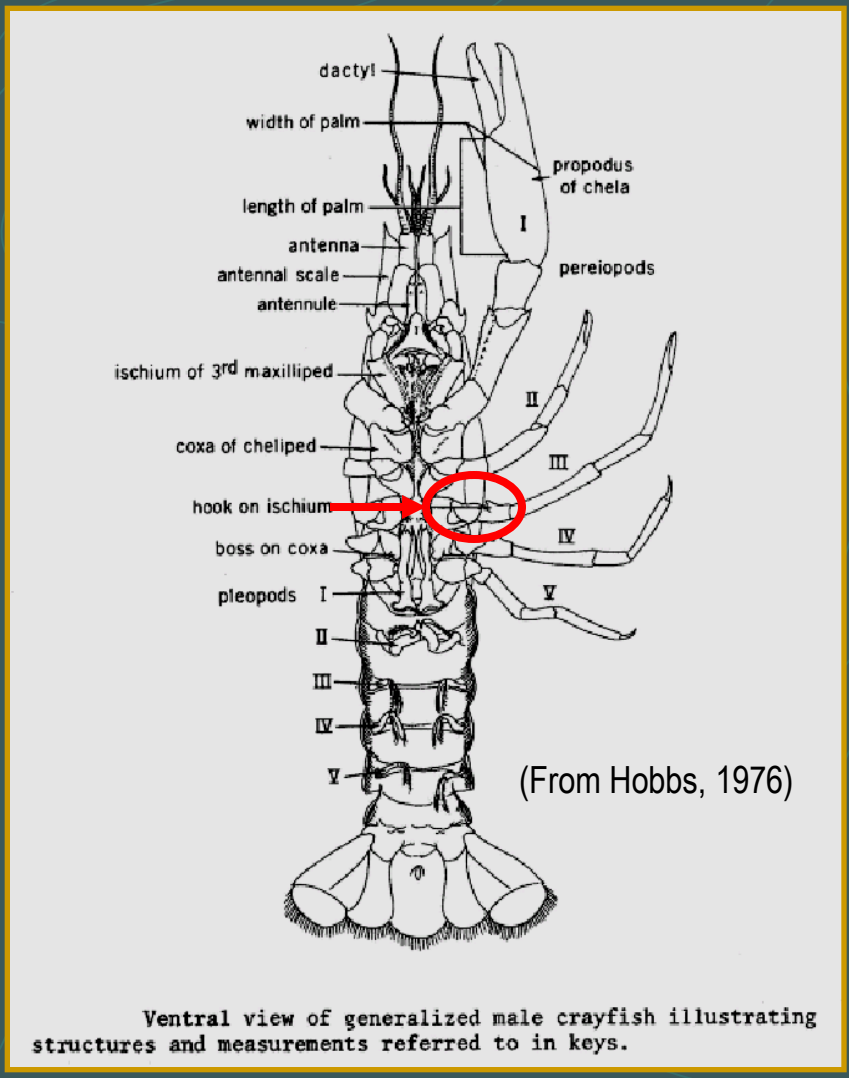
Appendages of the head

- Mouthparts
  - 1 pair mandibles
    - Chewing
    - 2 pair maxillae
    - Grasp food
    - Baling water
  - 3 pair maxillipeds
    - Feeding
    - Cleaning antennae
    - Baling water



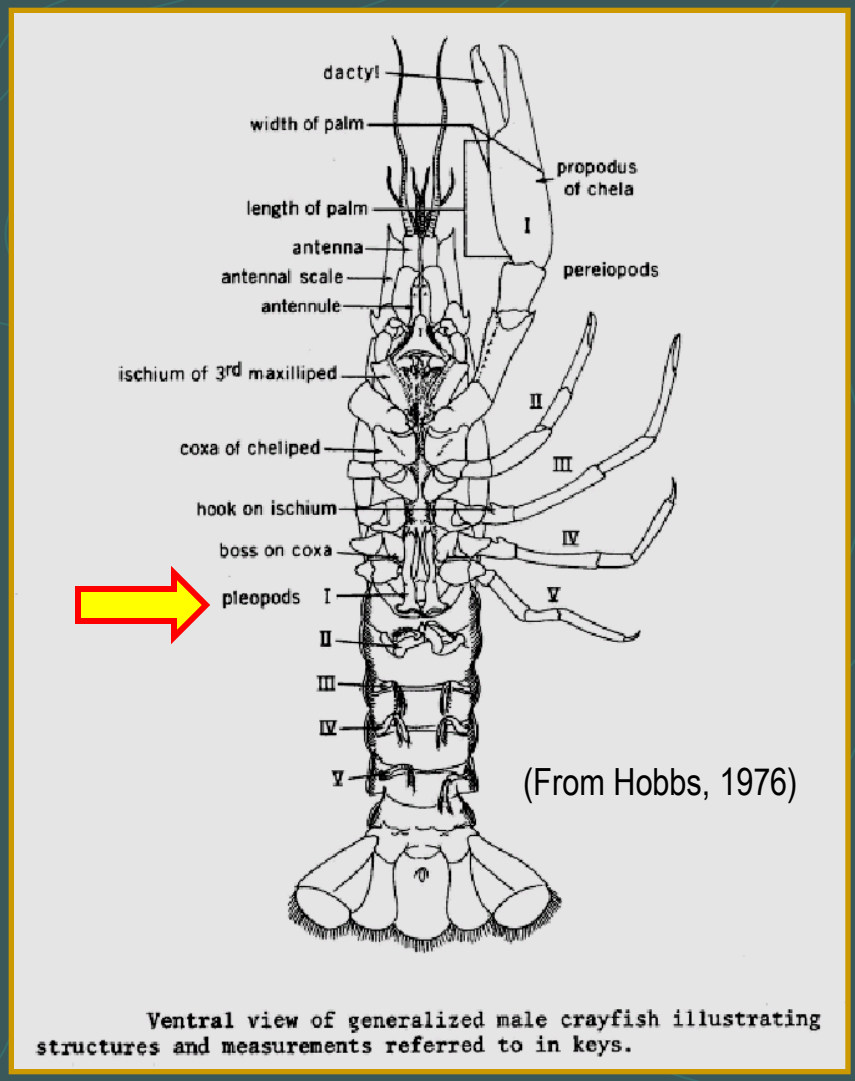
Appendages of the thorax

- Five pair of walking legs*
  - 1st three are chelate (w/ claw)
  - 1st called cheliped
    - Terminal end is called a chela
  - Each leg with seven segments
    - Coxa, basis, ischium, merus, carpus, propodus, dactylus



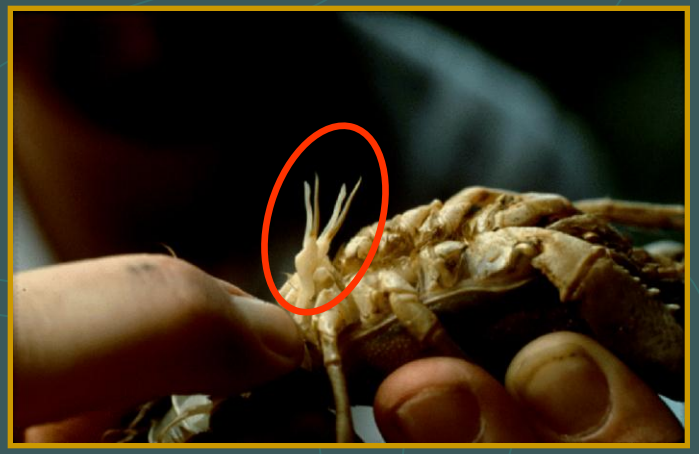
Appendages of the abdomen

- Pleopods (swimmerets)
  - 1st 5 segments
    - ♂, the 1st 2 modified for sperm transfer
    - ♀, no modification, reduced → brooding
  - 6th segment with:
    - Median telson
    - Lateral uropods

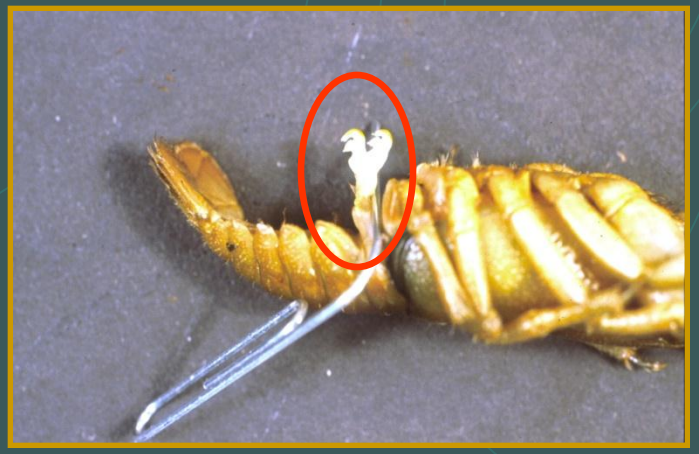


Female vs. male

- Males - Gonopods
  - Rod-like structures that attach on the underside of the first abdominal segment
  - Lie between the bases of the walking legs.



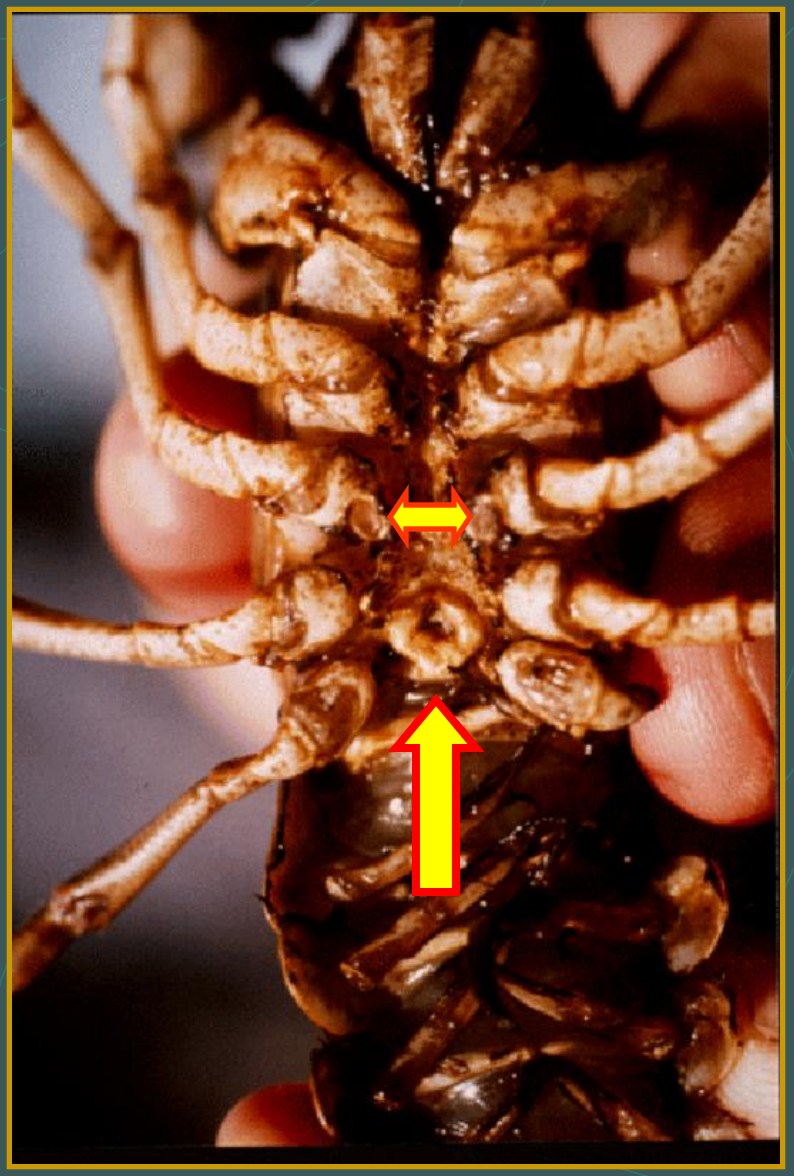
Male *Orconectes* sp.



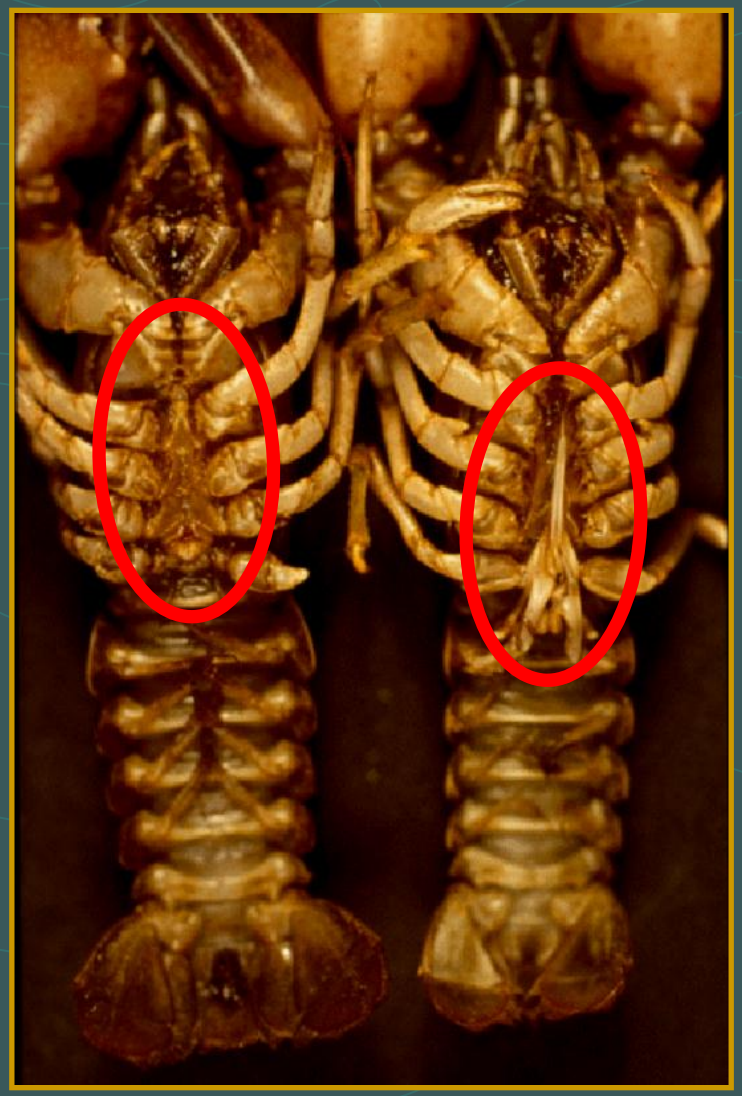
Male *Cambarus* sp.

Female vs. male

- Females
  - Annulus ventralis = pocket-like sperm receptacle between bases of last two pairs of walking legs.
  - Gonopore = Where eggs are extruded



Female vs. male



Orconectes ozarkae

(Ozark crayfish)

Life Histories and Population Biology

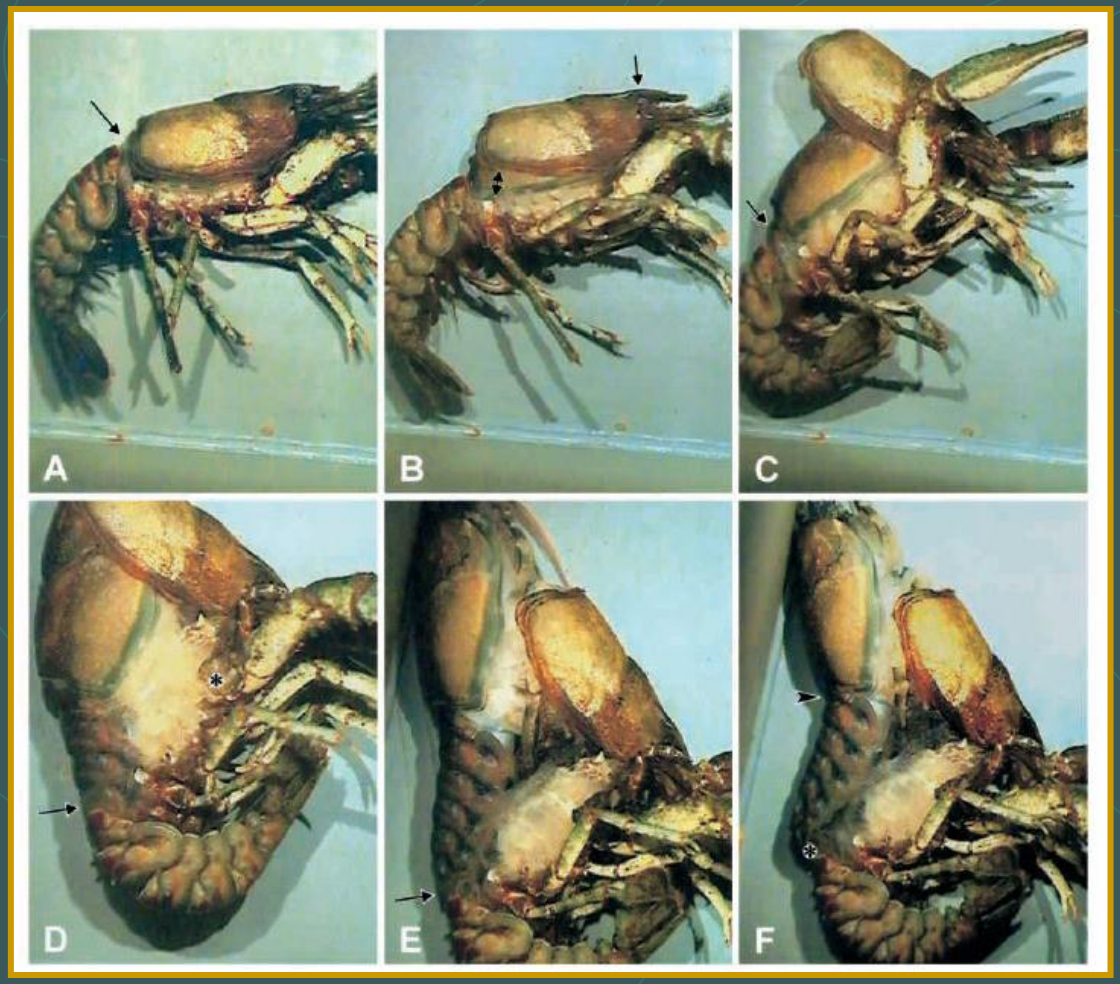
Cambarus ludovicianus (painted devil crayfish)

General life cycle

- March – April
  - Females oviposit; growth at 8° C (46° F)
- May – June
  - Hatch; YOY become ind.; adults molt (FII)
- August – September
  - Adults molt (FI); senescence
- October – November
  - Copulation; growth slows at 8° C (46° F)
- December – February
  - Eggs develop internally


Molting

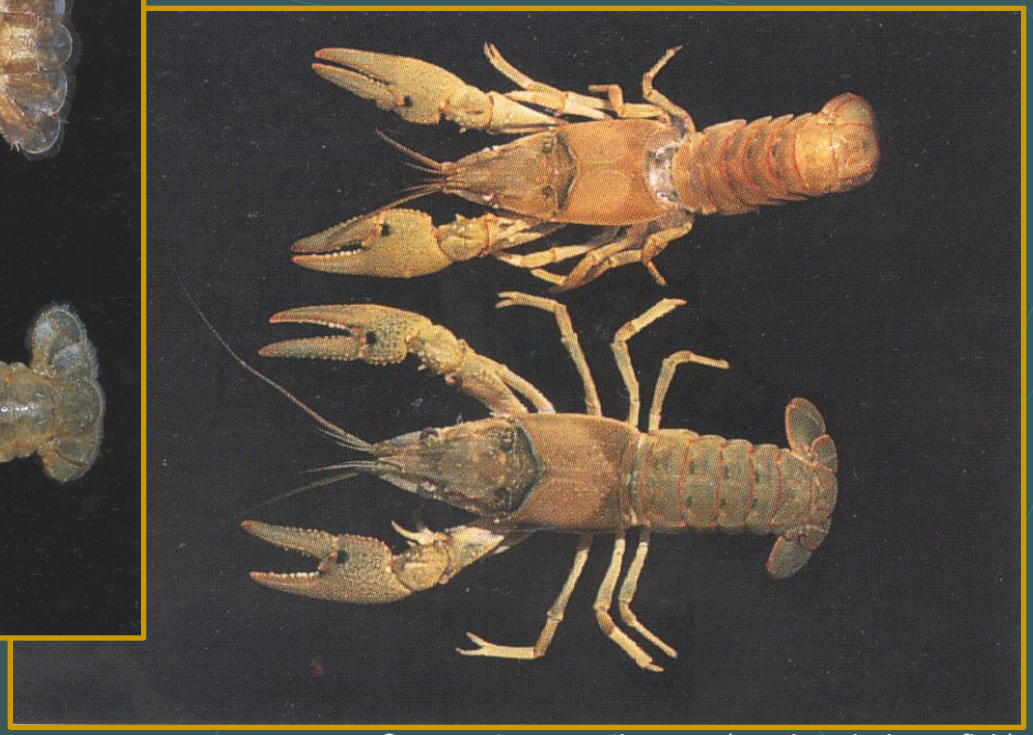
Molting



http://www.crayfishmates.com/crayfish_forum/uploads/1232285800/gallery_1_24_92405.jpg

Molting

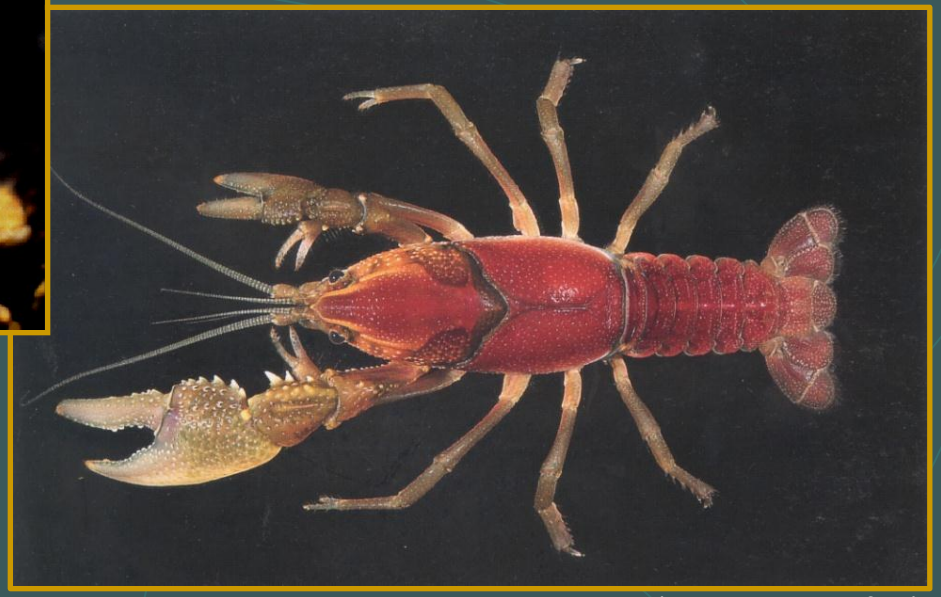
Fallicambarus fodiens (digger crayfish)



Orconectes punctimanus (spothanded crayfish)

Regeneration

Orconectes medius (saddlebacked crayfish)



Procambarus gracilis (grassland crayfish)

Male cyclic dimorphism

Male *Cambarus robustus* (big river crayfish)

Form I

Form II

Courtship and copulation

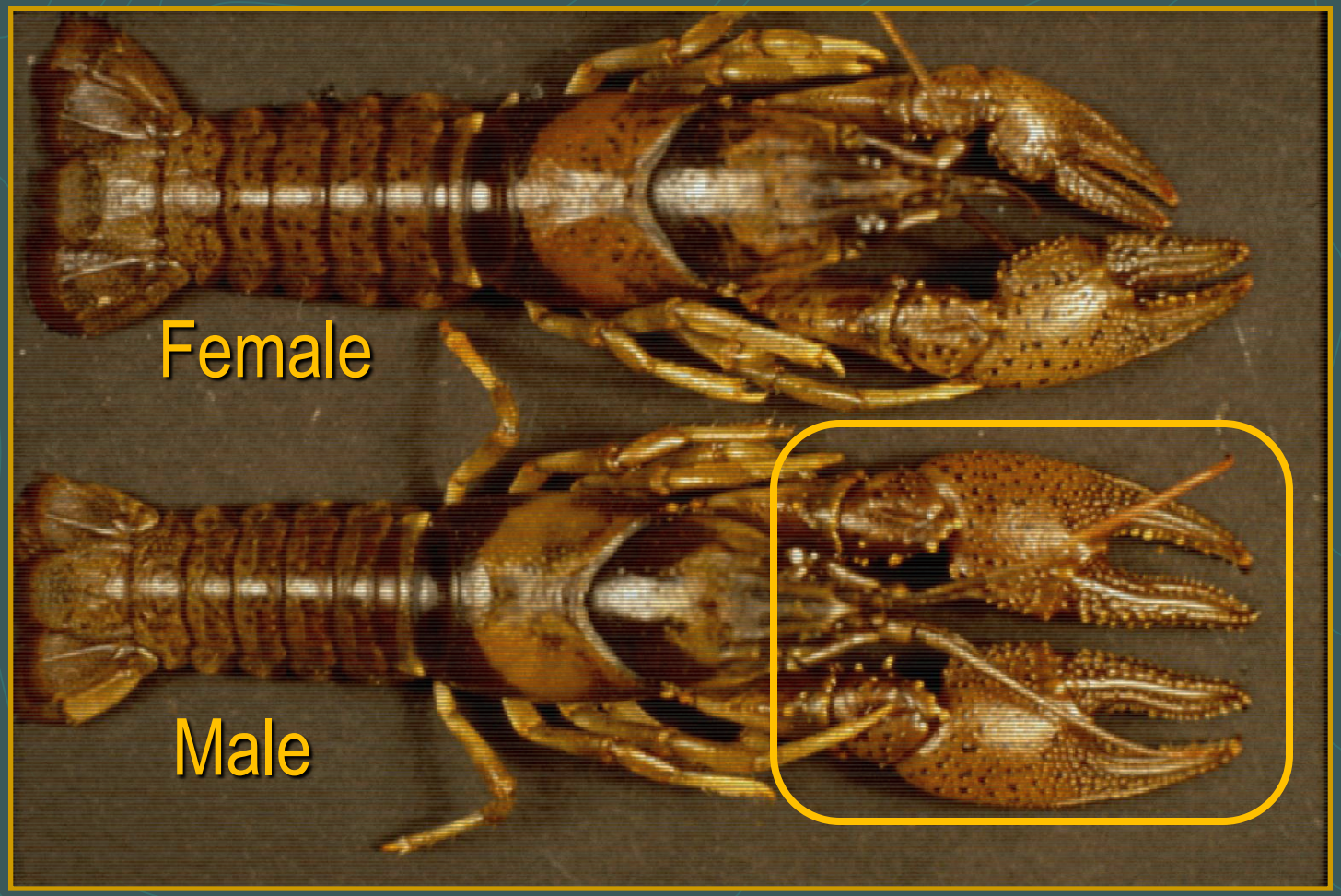
Cambarus batchi
(bluegrass crayfish)

Breeding

Cambarus longulus (Atlantic slope crayfish)

Orconectes luteus (golden crayfish)

Male vs. female



Orconectes ozarkae (Ozark crayfish)

Sperm plug

Orconectes quadrucnus (St. Francis River crayfish)

Glair glands

Female *Orconectes* sp.

Ovigerous (“in berry”)

Hatchlings

Cambarus b. bartonii with hatchlings

Hatchlings

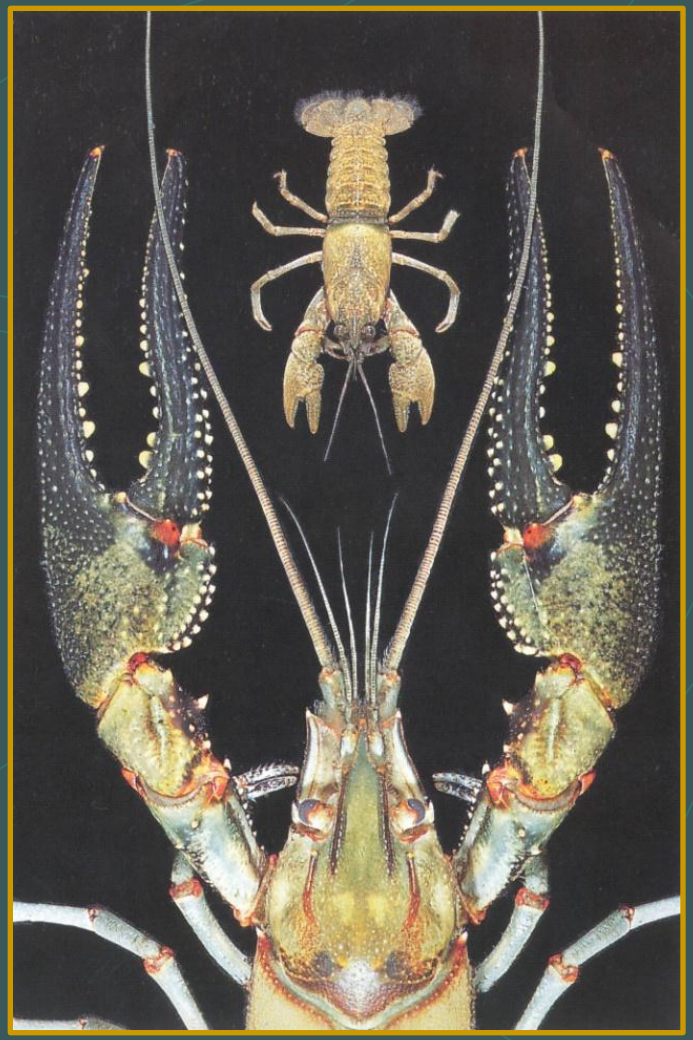
Orconectes luteus (golden crayfish) hatchlings

Metamorphic stages

Orconectes luteus (golden crayfish) hatchlings

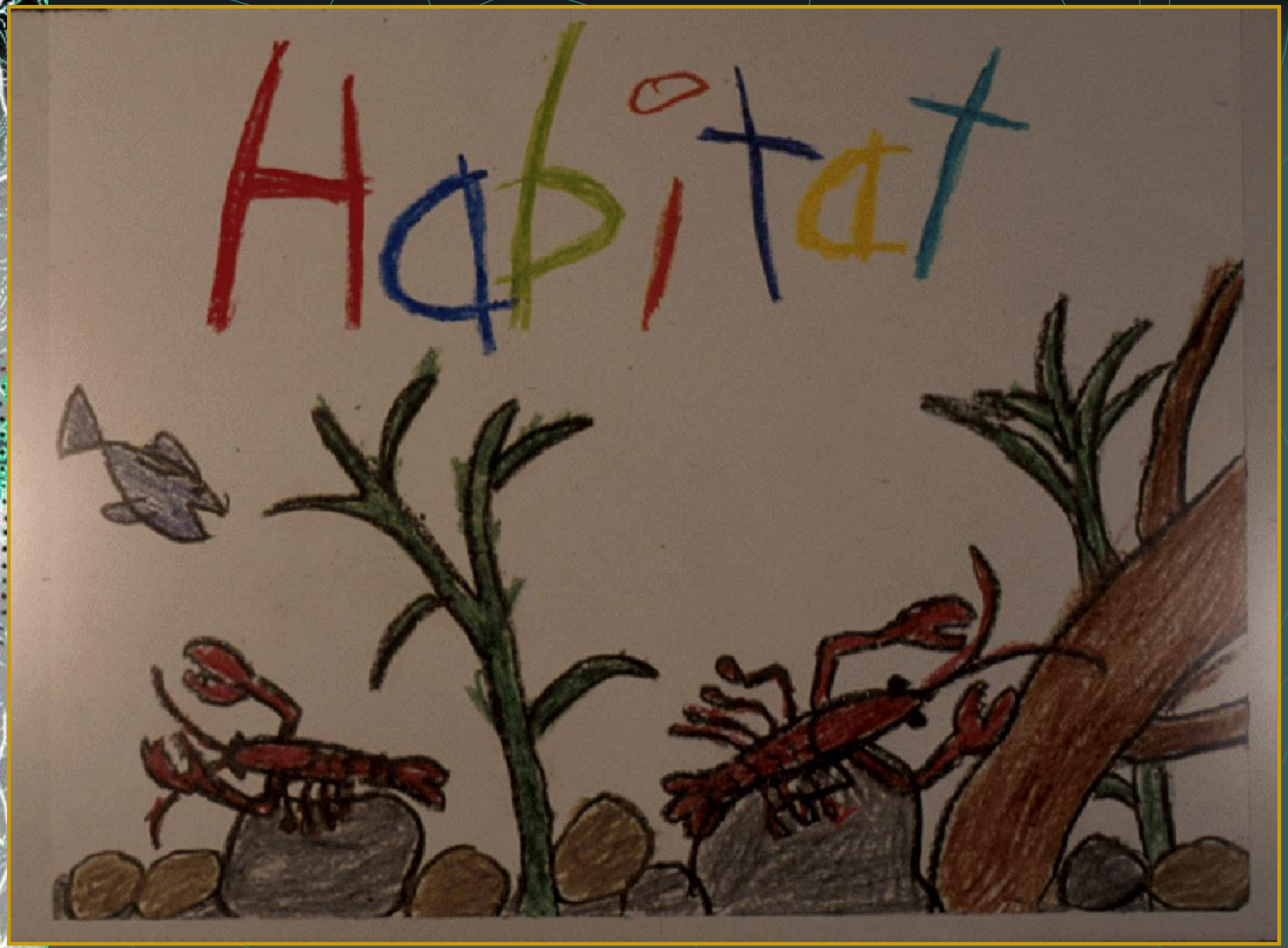
Growth and longevity

- Maximum 1 to 7 inches
- Growth slows in winter
- Maturity during 2nd year
- Live 2 to 3 years
- Cave species live longer



Orconectes macrus (Neosho midget crayfish, top)

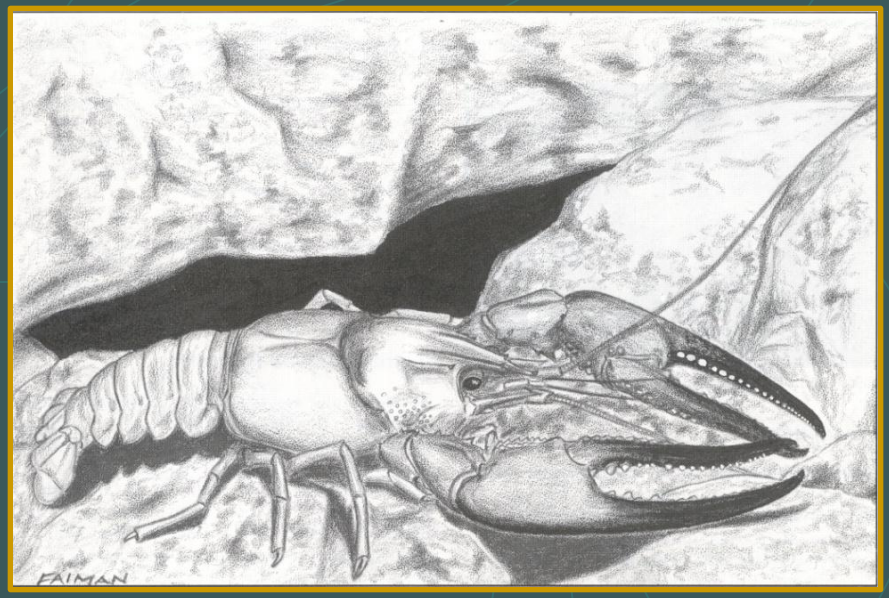
Orconectes longidigitus (longpincered crayfish, bottom)


Habitat

On land?

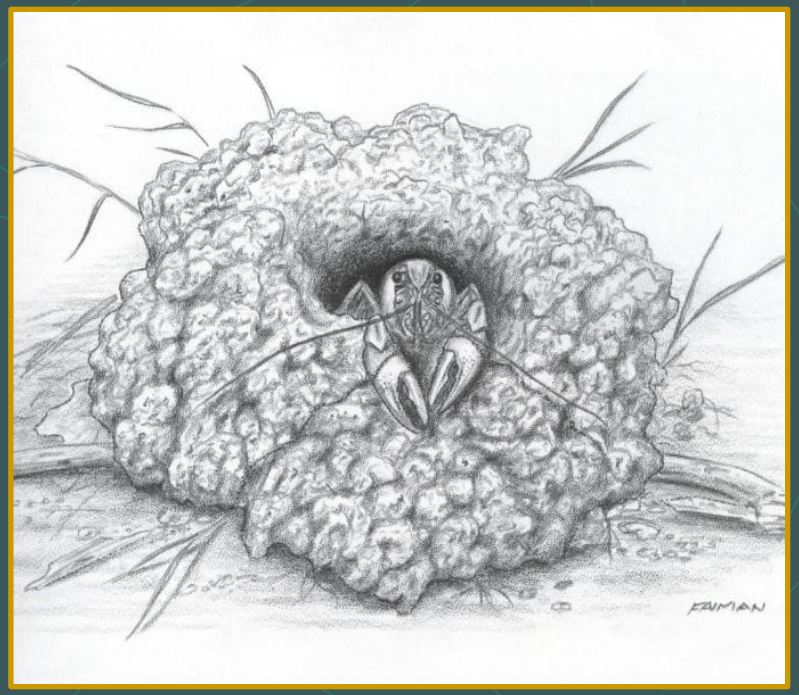
Habitat requirements

- Water = Crayfish
- Habit Partitioning
  - Species
  - Age



Burrowing crayfish

- Tertiary – most species
  - Winter, get below frost line
  - Egg laying and brooding
  - Water body dries up
- Secondary
  - Wander into open water during rainy season
- Primary – entire life
  - Can move nearly 18 tons/ac.



Fallicambarus fodiens (digger crayfish)

Burrow characteristics

- To the water table (up to 20 feet)
- Multiple tunnels (except tertiary burrowers)
- Primary with large rooms
- Plug during dry and cold periods
- Chimneys

Burrow characteristics

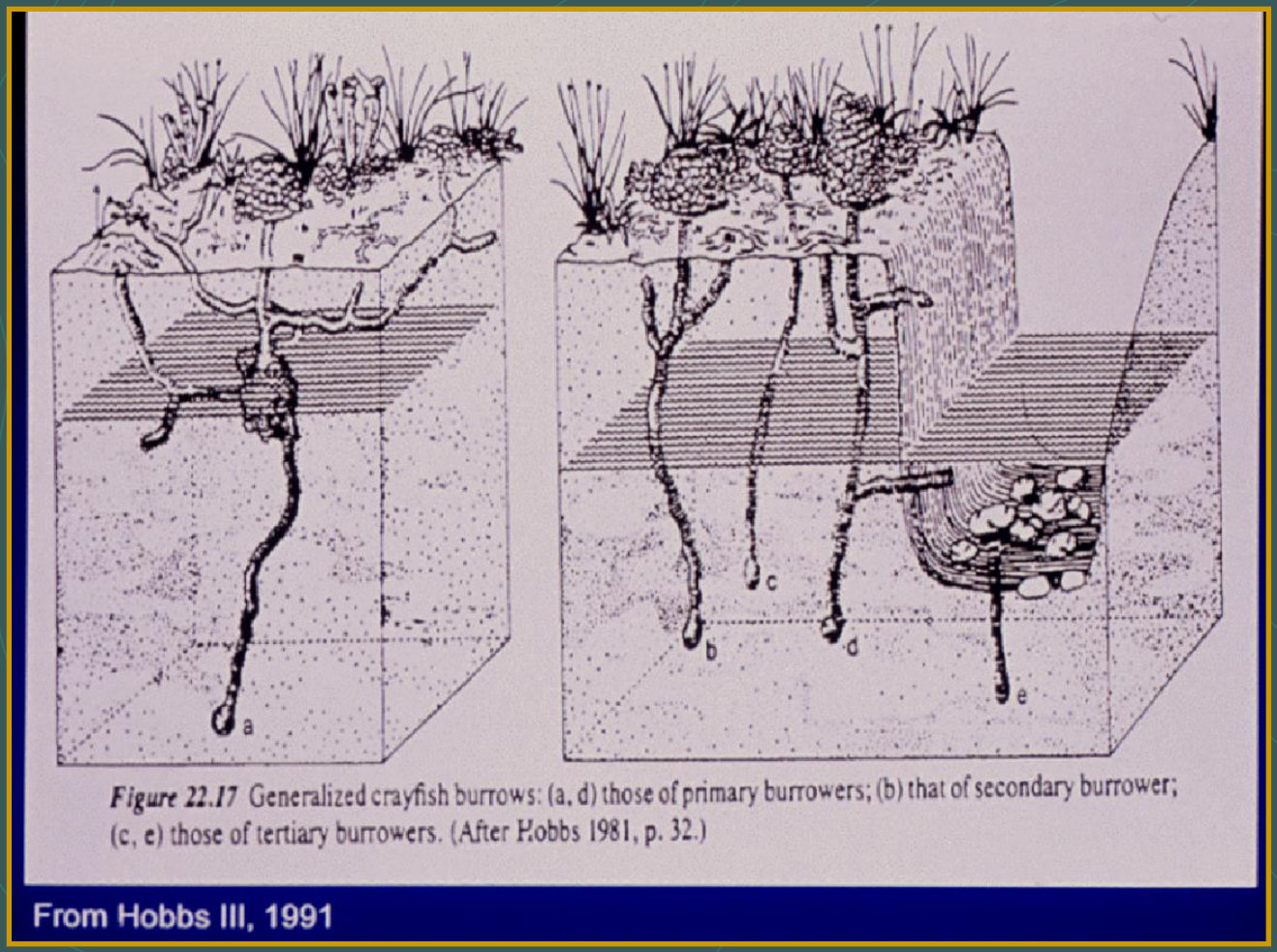


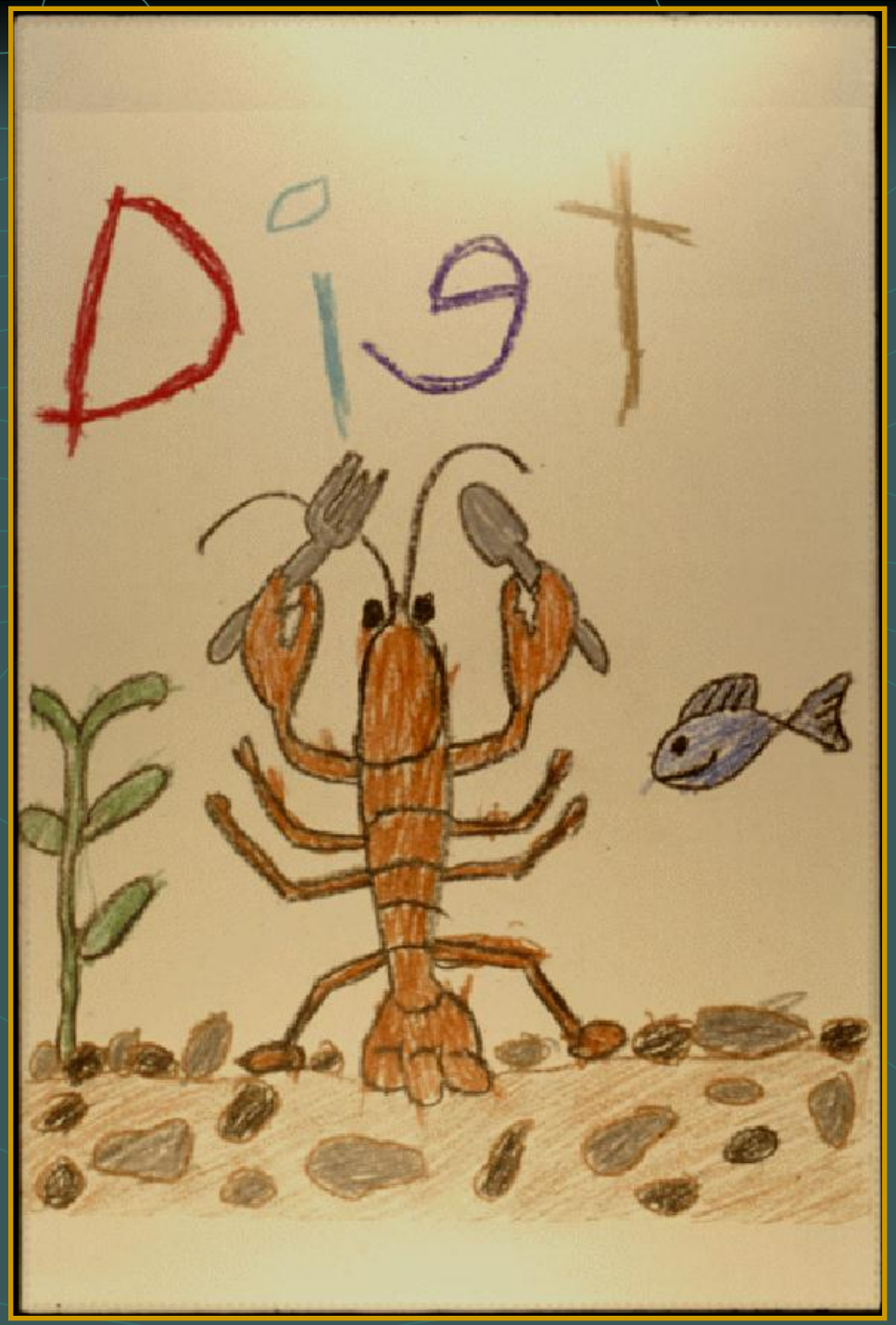
Figure 22.17 Generalized crayfish burrows: (a, d) those of primary burrowers; (b) that of secondary burrower; (c, e) those of tertiary burrowers. (After Hobbs 1981, p. 32.)

From Hobbs III, 1991

Cave dwellers ("stygo" → cave water specific)

- Stygophilic – not restricted
  - No loss/reduction of structures/color
- Stygobitic – restricted
  - Some loss/reduction of structures/color
  - Slow growth/long lived
  - 39 species and subspecies in NA


Ecology


Diet

Crayfish are polytrophic

- Eat living plant material
  - Algae, macrophytes
- Eat living animal flesh
  - Insects, snails, crayfish, fish
- Eat dead & decaying plant and animal matter
  - Leaves, woody debris, microbes

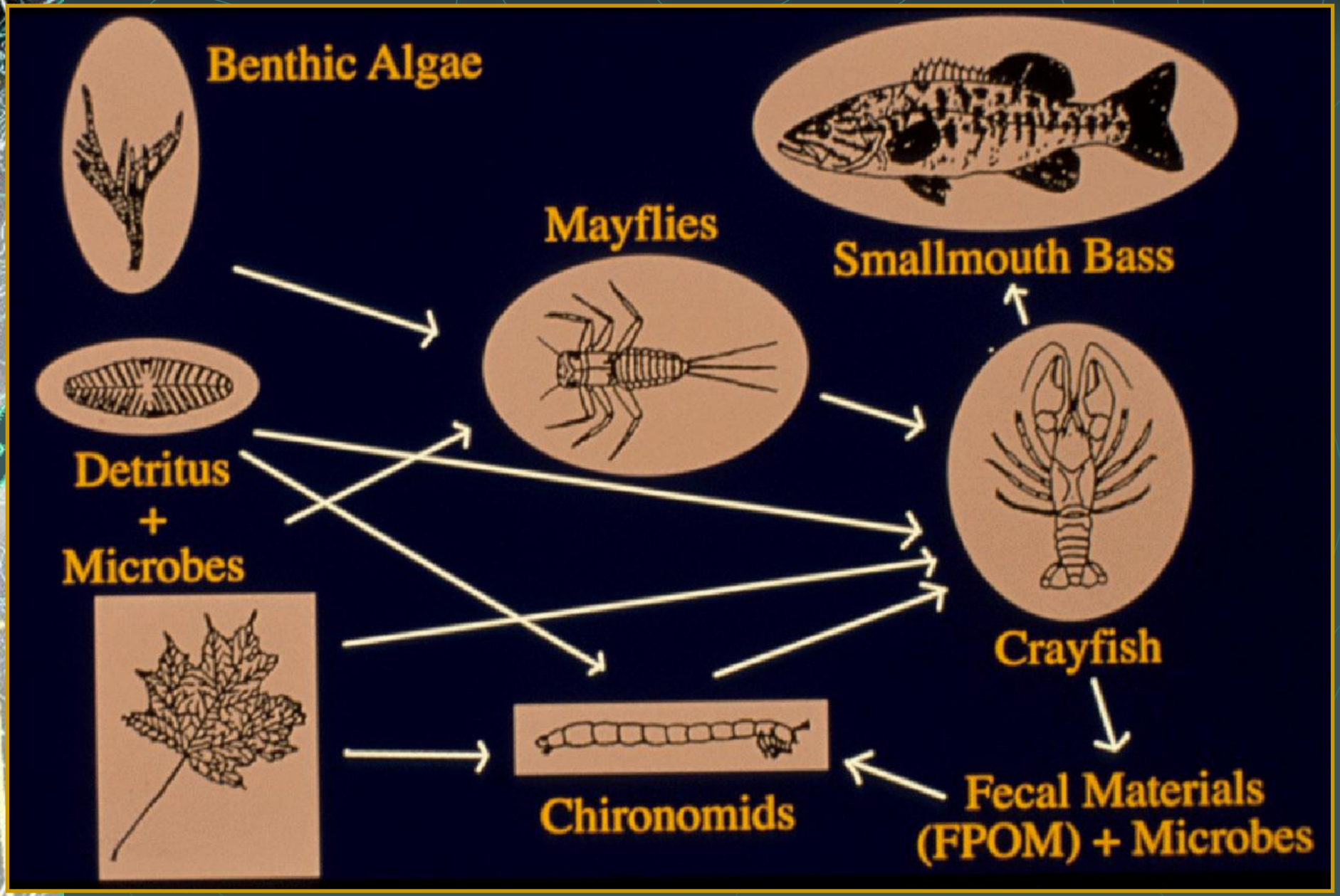
Orconectes medius (saddleback crayfish)

Orconectes virilis (virile crayfish)

North American crayfish predators

- Fishes – 81 species
- Birds – 77 species
- Reptiles – 40 species
- Amphibians – 18 species
- Mammals – 18 species
- 7 miscellaneous species

Smallmouth bass &
Orconectes ozarkae

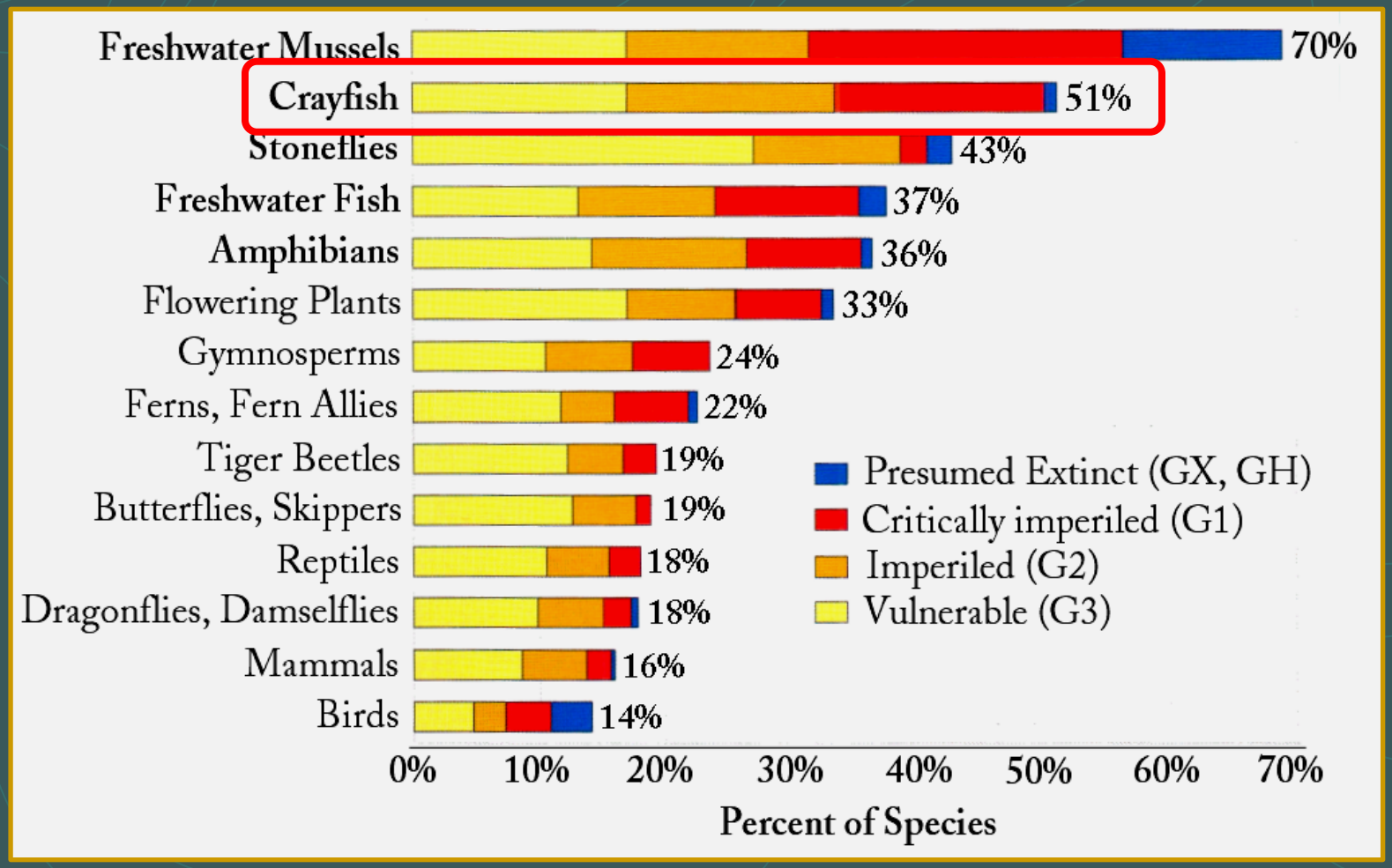

Benthic Algae
Smallmouth Bass
Mayflies
Detritus
+
Microbes
Crayfish
Chironomids
Fecal Materials
(FPOM) + Microbes

Keystone crayfish

- Restructure plant and invert communities
- Process up to 20% allochthonous input
  - Promotes nutrient cycling
- Compete with fish for invertebrates
- Production and biomass ≥ all other inverts
  - 2 crayfish species: P = 9.87 $g/m^2/yr$
  - Other invertebrates: P = 9.03 $g/m^2/yr$

Cambarus maculatus (freckled crayfish)

Endangered taxa (Stein et al. 2000)



Federal status

SPECIES	STATE	STATUS	HABITAT
Cambarus aculabrum	AR	E	Caves
Cambarus zophonastes	AR	E	Caves
Orconectes shoupi	TN	E	Streams
Pacifasticus fortis	CA	E	Streams

(Additional 50 of Concern and/or under review: http://ecos.fws.gov/tess_public/SpeciesReport.do)

Reasons for declines/concerns

- Limited range
- Habitat loss and fragmentation
- Dams, channelization, gravel mining, etc.
- Introduced species
- Overexploitation
- Pollution

Example crayfish introductions

SPECIES	INTRODUCTIONS	CITATIONS
Procambarus clarkii	Worldwide (except Aust. And Ant.)	Huner, 1988
Orconectes rusticus	Widespread	Capelli, 1975; Taylor and Redmer, 1996
Pacifasticus leniusculus	CA/Europe/Japan	Hogger, 1988; Lodge et al. 2000
Orconectes limosus	Europe	Laurent, 1988
Orconectes virilis	Widespread	Light et al. 1995

Crayfish introductions (continent to continent)

- Europe has 15 crayfish taxa; 10 introduced
- Africa never had crayfishes; *P. clarkii* introduced
  - Lake Naivasha, Kenya early 1970s; abundant in 5 yrs
  - Now introduced to most major river systems in Kenya
  - Ecological disaster; introduced major new predator
  - A cultural fiasco – locals won't eat them
  - Are grown for export

Crayfish introductions (continent to continent)

- Australian crayfishes (Family Parastacidae)
  - Introduced to Europe
  - Some reports of introductions in North America
- China
  - Major player in the crayfish food industry
  - Mostly from the introduced *P. clarkii*

Crayfish introductions (state to state)

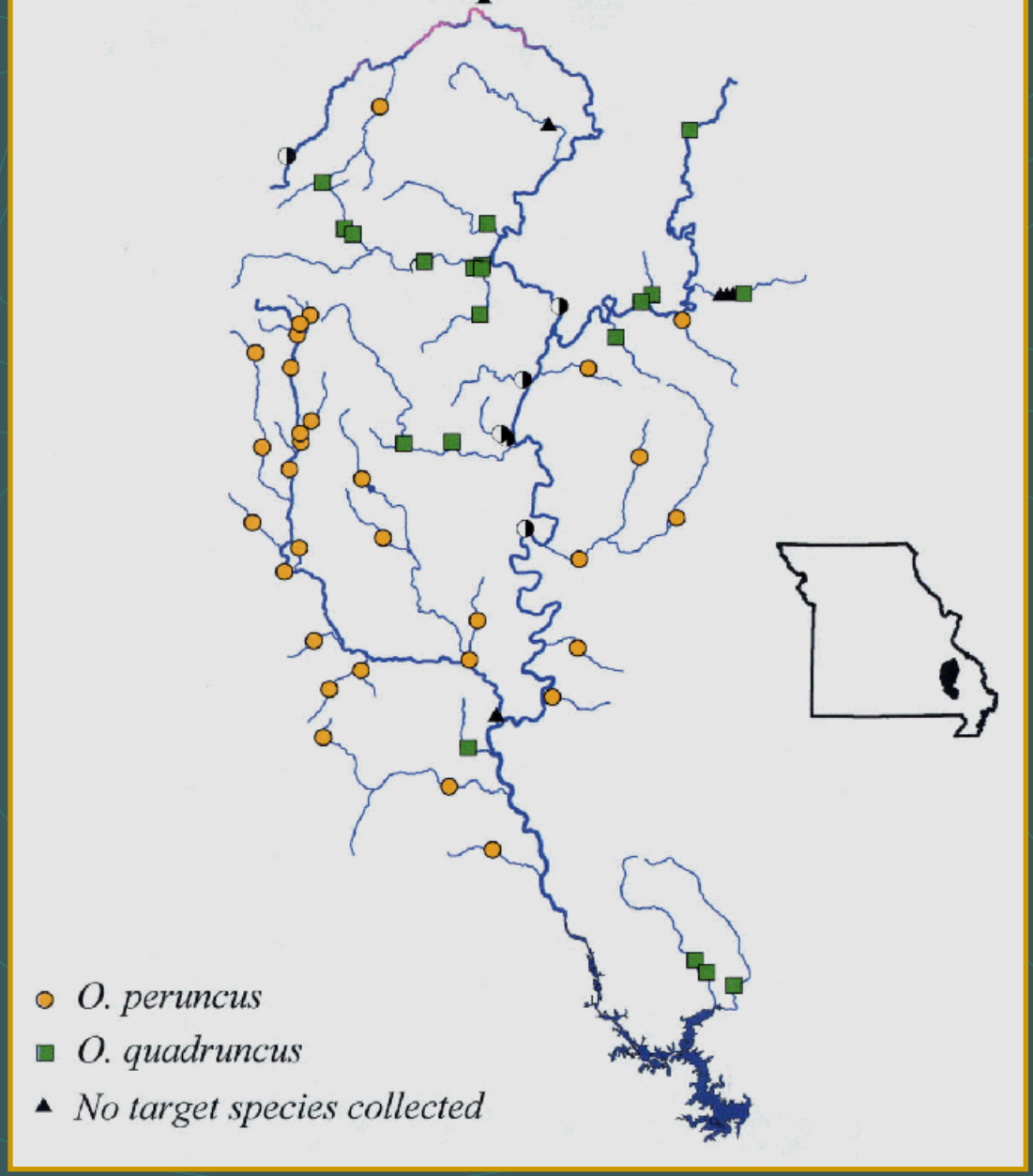
- *Orconectes rusticus*
  - Introduced in many states
  - Bait species, biological supply (classrooms)
  - Out-competes native species, restructures inverts
  - Documented in several states
- *Pacifasticus leniusculus*
  - Introduced into California
  - Causing declines in *P. fortis*

Crayfish introductions (drainage to drainage)

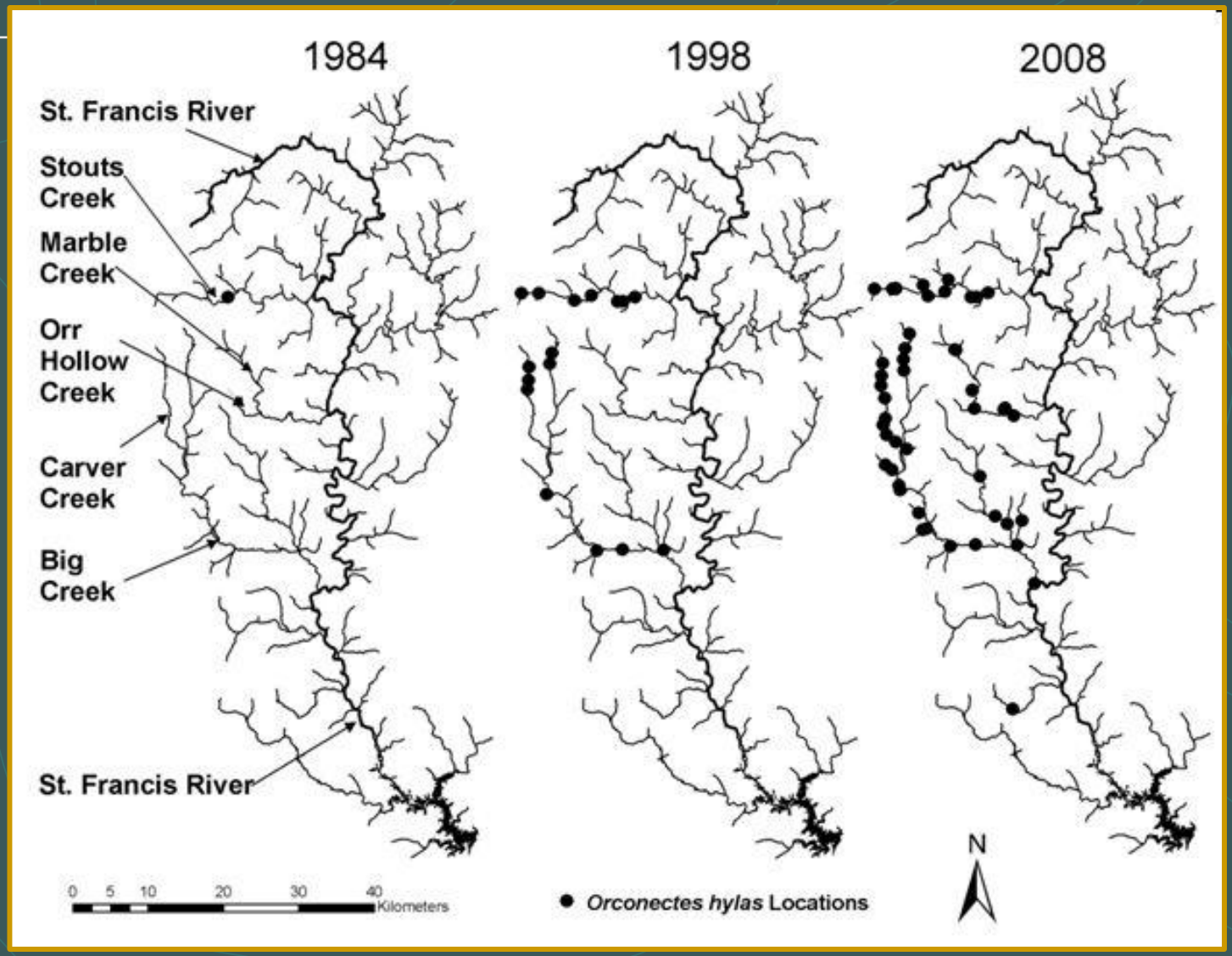
- Missouri examples
  - 25+ documented introductions
  - All “native” species
    - *Procambarus acutus* (white river crawfish)
    - *Orconectes neglectus* (ringed crayfish)
    - *Orconectes hylas* (woodland crayfish)

Orconectes hylas (woodland crayfish)

Distributions of O. peruncus and O. quadruncus



Spread of *O. hylas* (woodland crayfish)



Vectors of spread

- Aquaculture
- Bait bucket introductions
- Biological supply (teachers/classrooms)
- Pet industry
- Kids

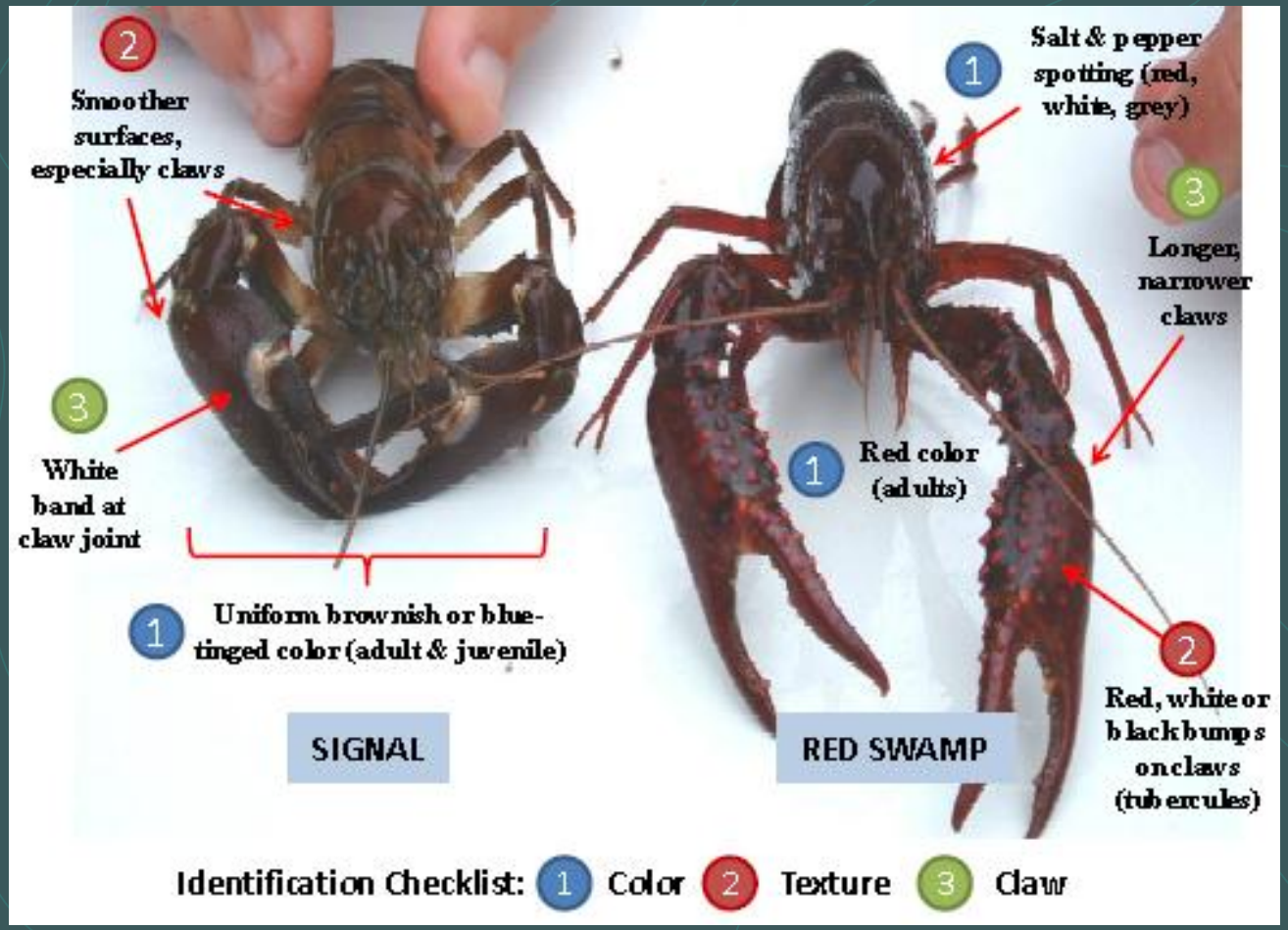
Orconectes virilis
(virile crayfish)

Possible displacement mechanisms

- Direct aggressive interaction
- Competition for resources
- Habitat alteration
- Reproductive advantages
- Developmental advantages
  - Faster growth/size, physiology

Orconectes neglectus
(ringed crayfish)

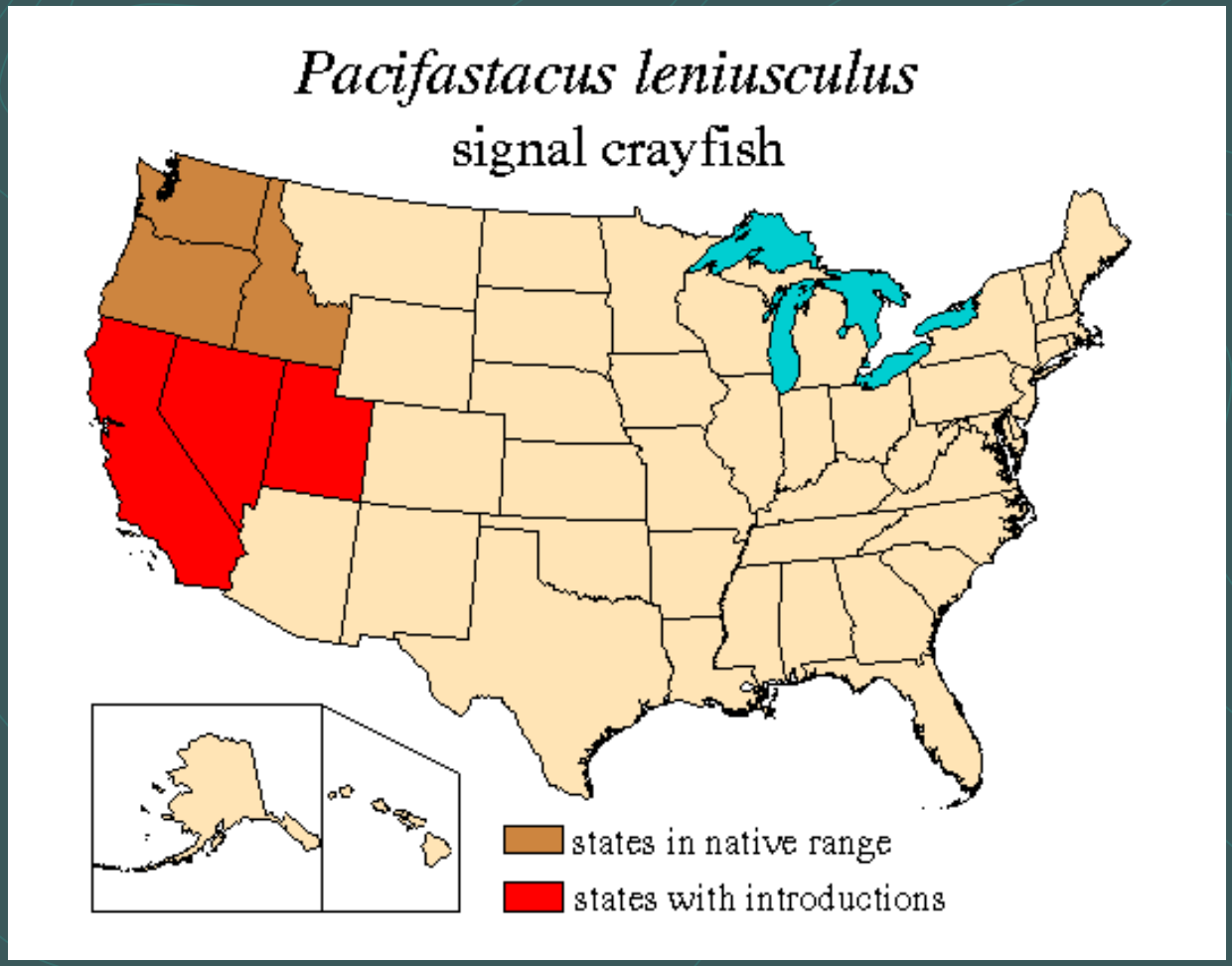
Signal and red swamp crayfish



Pacifasticus leniusculus (signal crayfish)

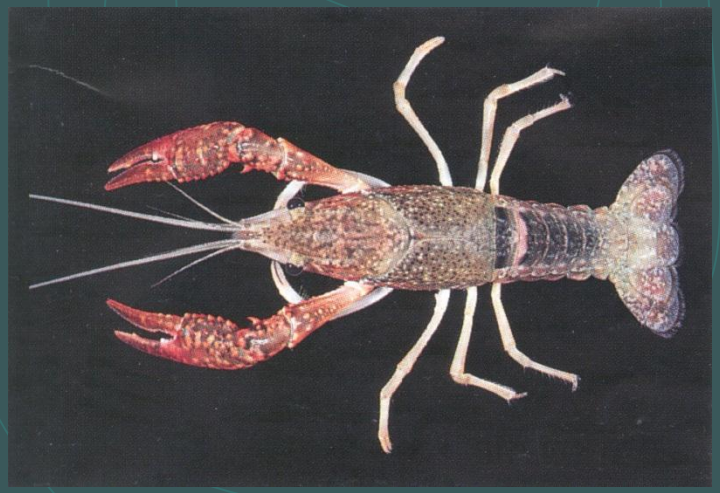
- Brownish or blue-tinged
- White band at claw joint
- Claw red underneath
- Smoother surfaces

Pacifasticus leniusculus (signal crayfish)

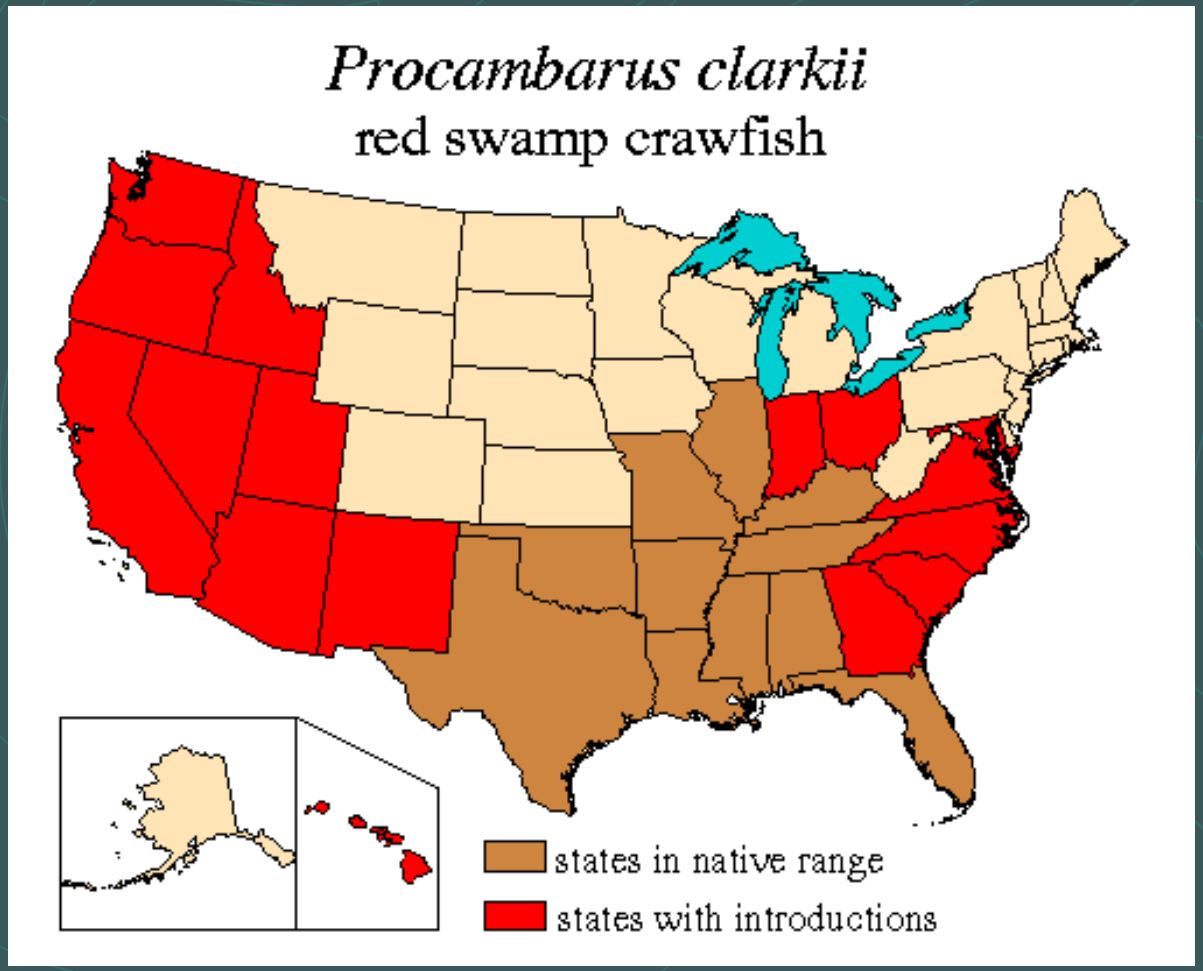


Procambarus clarkii (red swamp crayfish)

- Red with longer, narrower claws
- Black “V” pattern on abdomen
- Salt & pepper spotting
- Claws bumpy



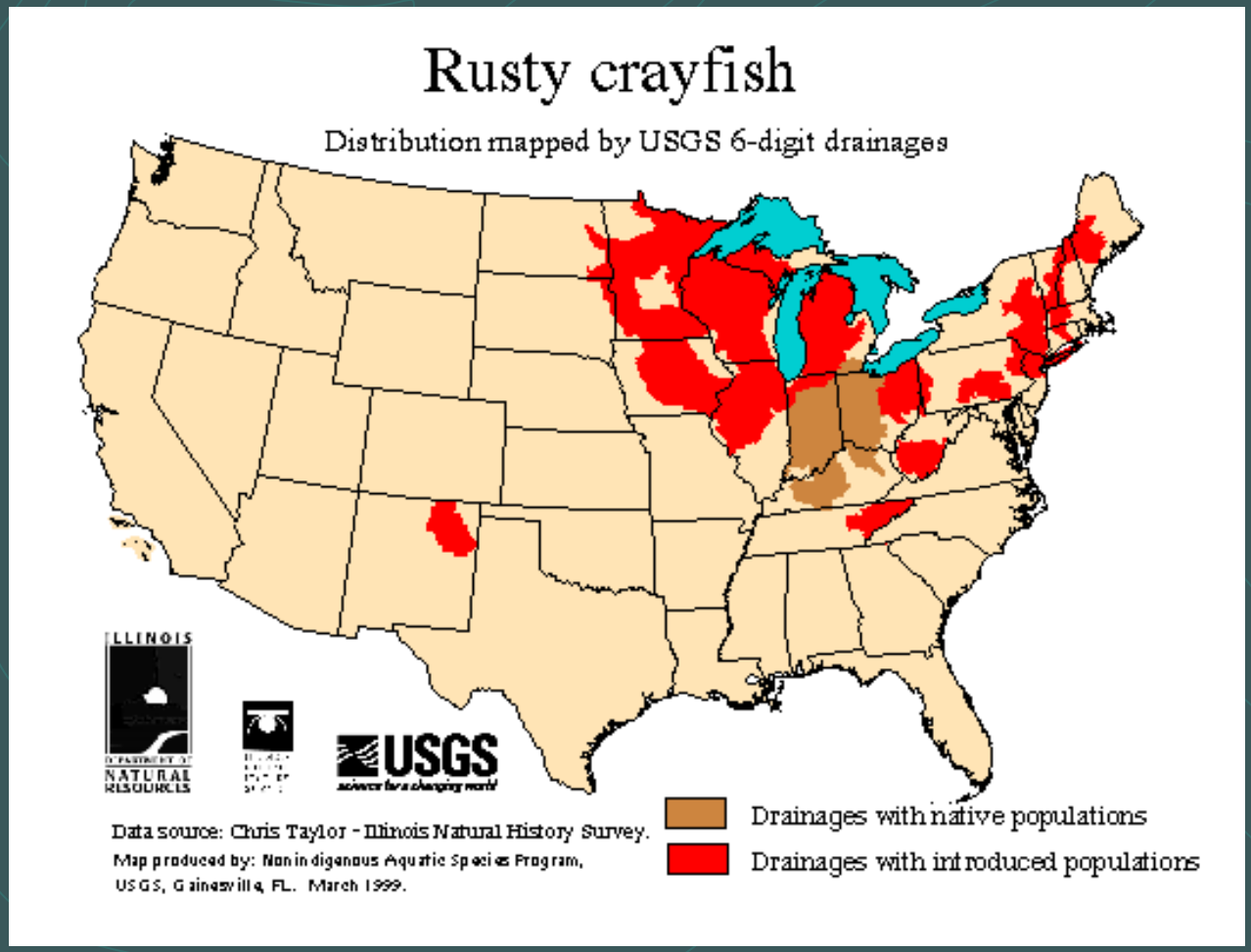
Procambarus clarkii (red swamp crayfish)



Orconectes rusticus (rusty crayfish)

- Rust colored spot on each side of carapace
- Gray-green to red-brown claws with black tips
- Claws have oval gap when closed
- The moveable claw smooth and S-shaped

Orconectes rusticus (rusty crayfish)



Why important? Wreak havoc!!

- Spread disease
- Overgraze food sources
- Reduce/eliminate aquatic plants
- Change fisheries
- Slower fish growth
- Changes community structure
- Cost $$

Crayfish collection

- Lake/stream species
  - Seines
  - Kick nets
  - Dip nets
  - Traps
  - Snorkeling
- Burrowers
  - Traps
  - Search rainy nights
  - Digging
- Regulations
  - Fishing license
  - Collector's permit

Crayfish collection (digging)

Crayfish collection (digging)

Crayfish collection (digging)

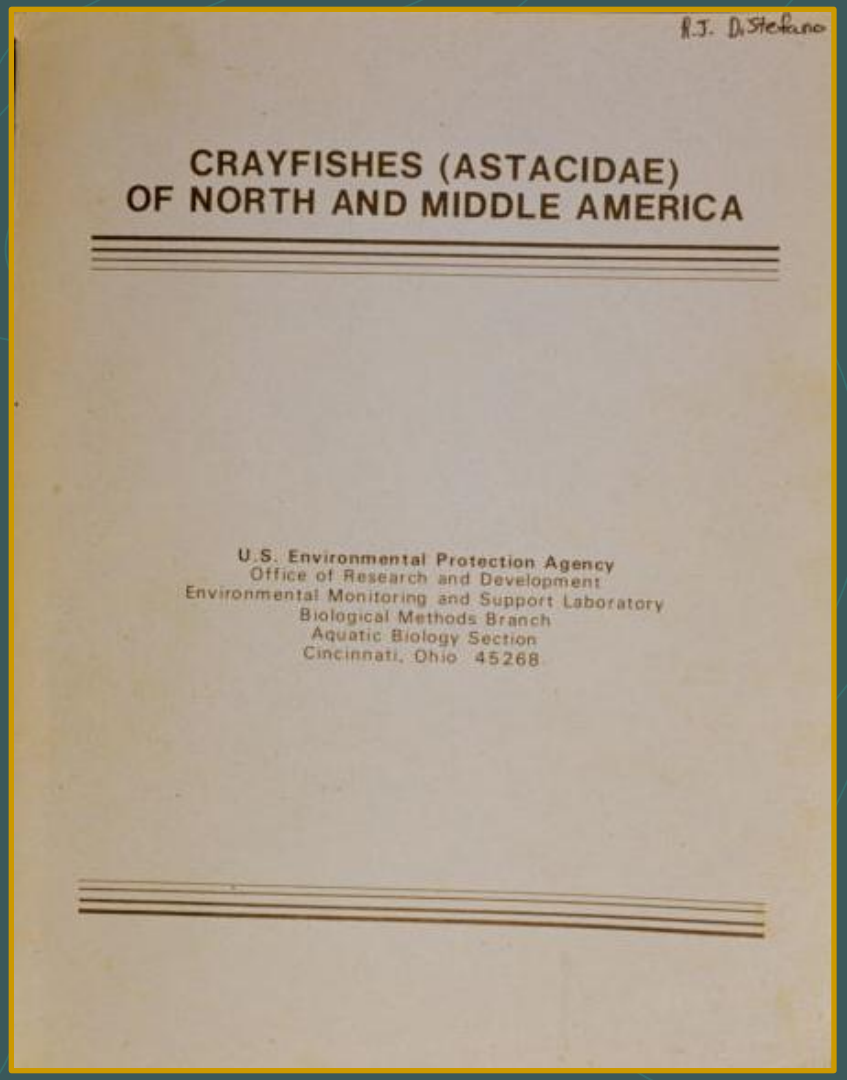
Crayfish collection (hand collection!!)

Crayfish identification keys

- Keys rely on FI male gonopods
  - No keys for FII, juveniles, or females
- Regional/state keys may be helpful
  - Limited fauna
  - Safer to consider color/marks
  - Distributional data
  - Google “Crayfish of *INSERT STATE NAME*”

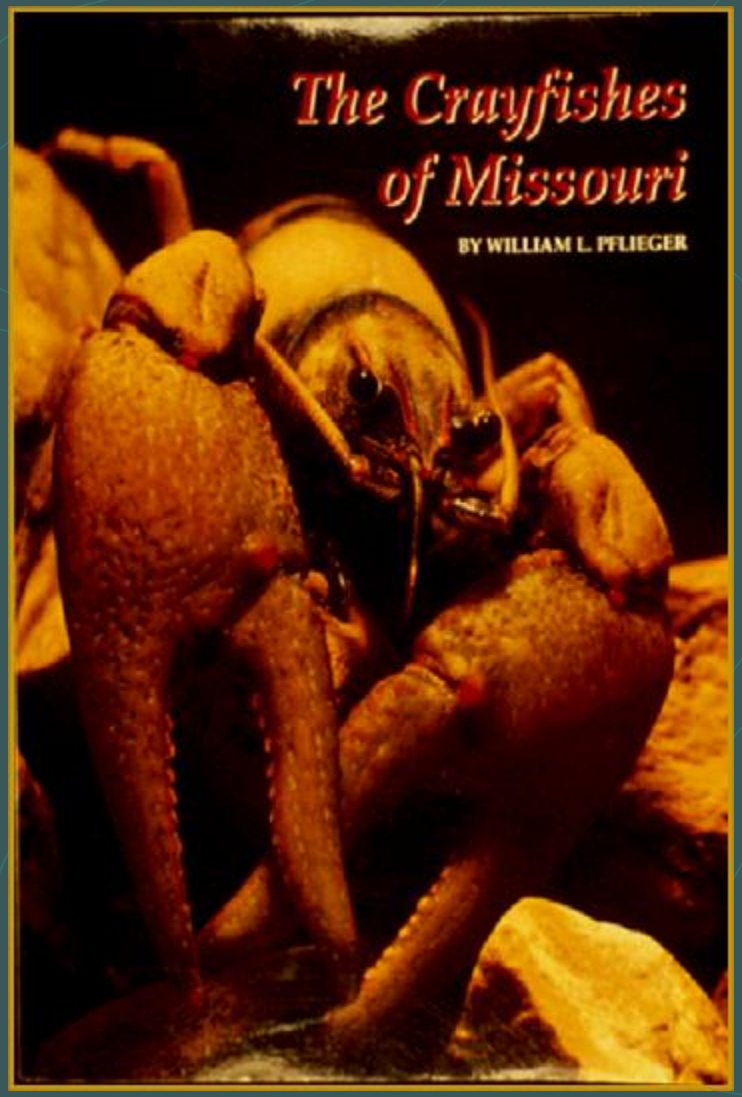
Hobbs' key

- THE key for crayfish ID
- Very technical
- Out of print
- Online:
  - http://iz.carnegiemnh.org/crayfish/Keys/index2.htm



The Crayfishes of Missouri

- Illustrations → examples
  - Annulus ventralis
  - FII gonopods
- Additional information
  - Species description
  - Meaning of scientific name
  - Similarities/differences
  - Distribution and habitat
  - Habits and life histories



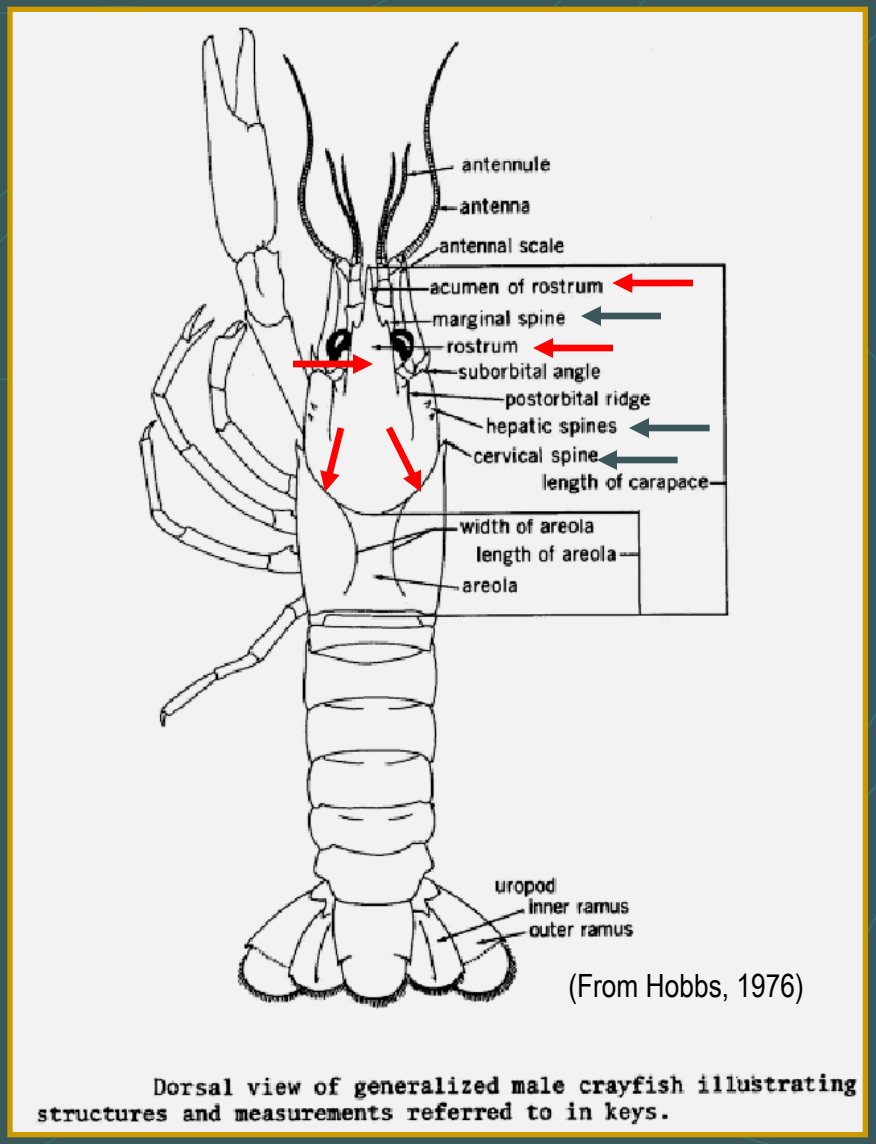
Using keys

- Use a series of individuals if possible
  - Individuals may vary
- Use ALL the clues in the couplet
- Use illustrations
- Use distributional data

Orconectes punctimanus
(spothanded crayfish)

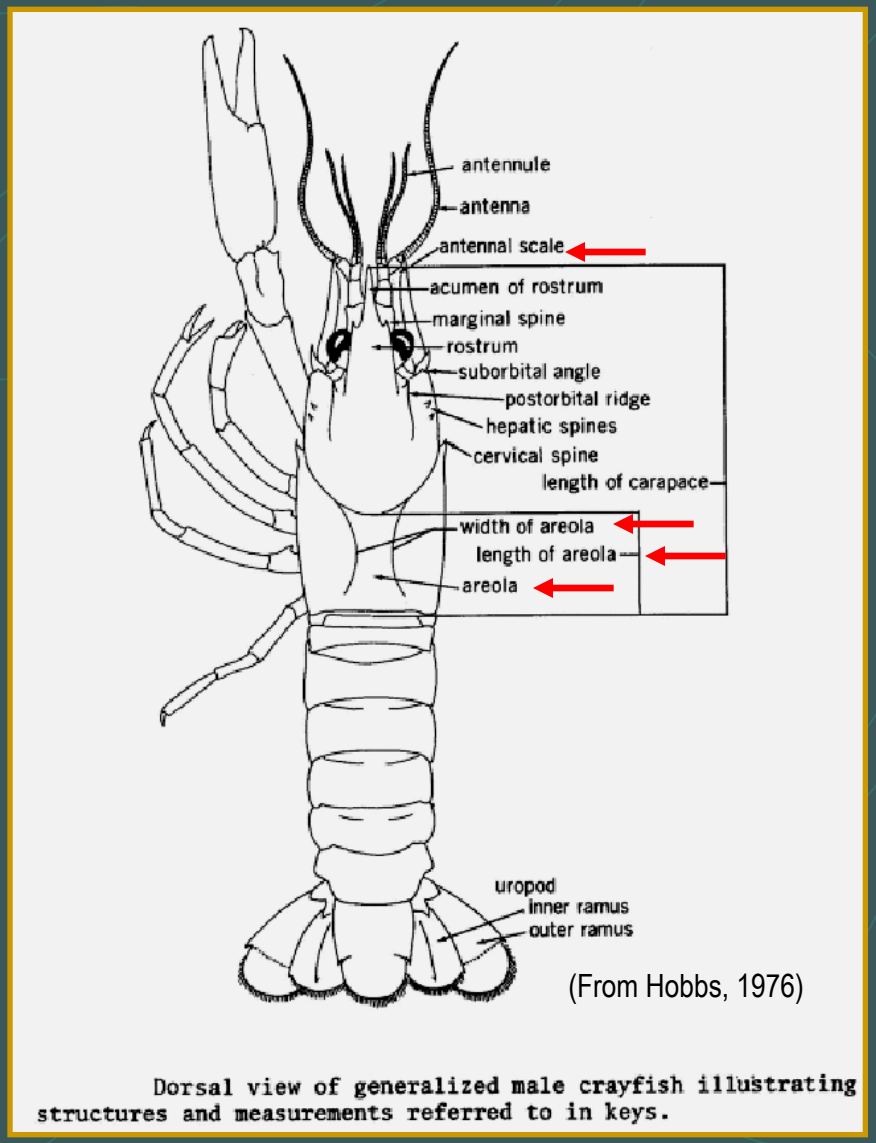
Characteristics of carapace

- Rostrum
  - Acumen
  - Carina
- Cervical groove
- Spines
  - Marginal
  - Hepatic
  - Cervical



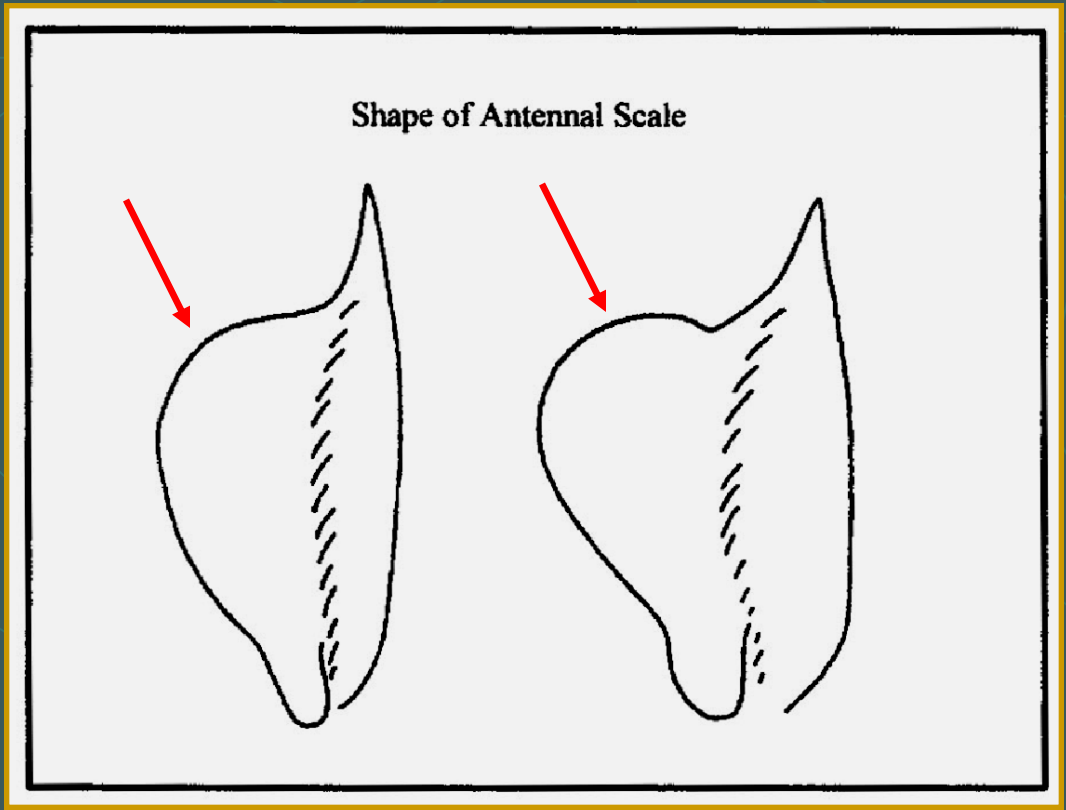
Characteristics of carpapce

- Antennal scale
- Areola
  - Areola length
  - Areola width



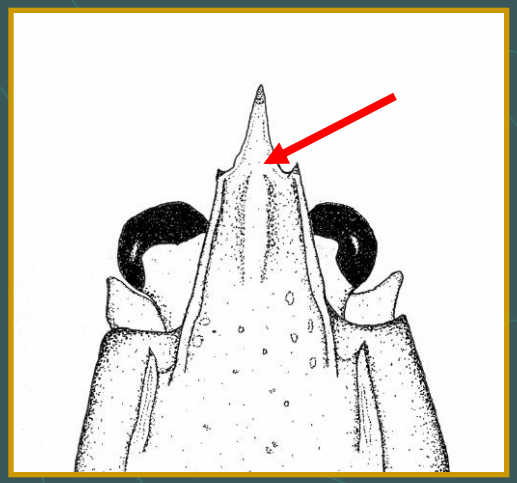
Antennal scale

- Look for angle

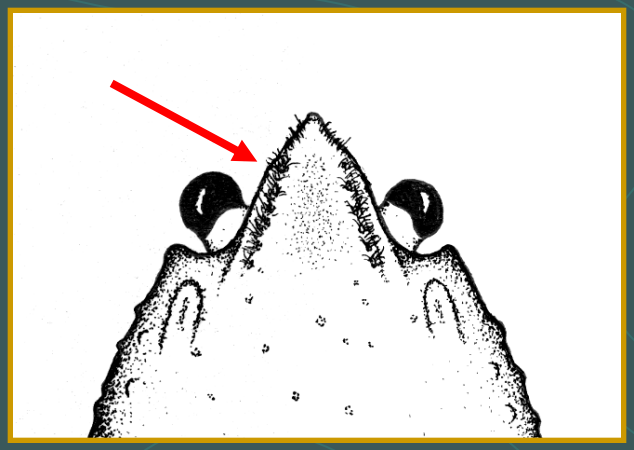


Marginal spines

- Rostrum with marginal spines

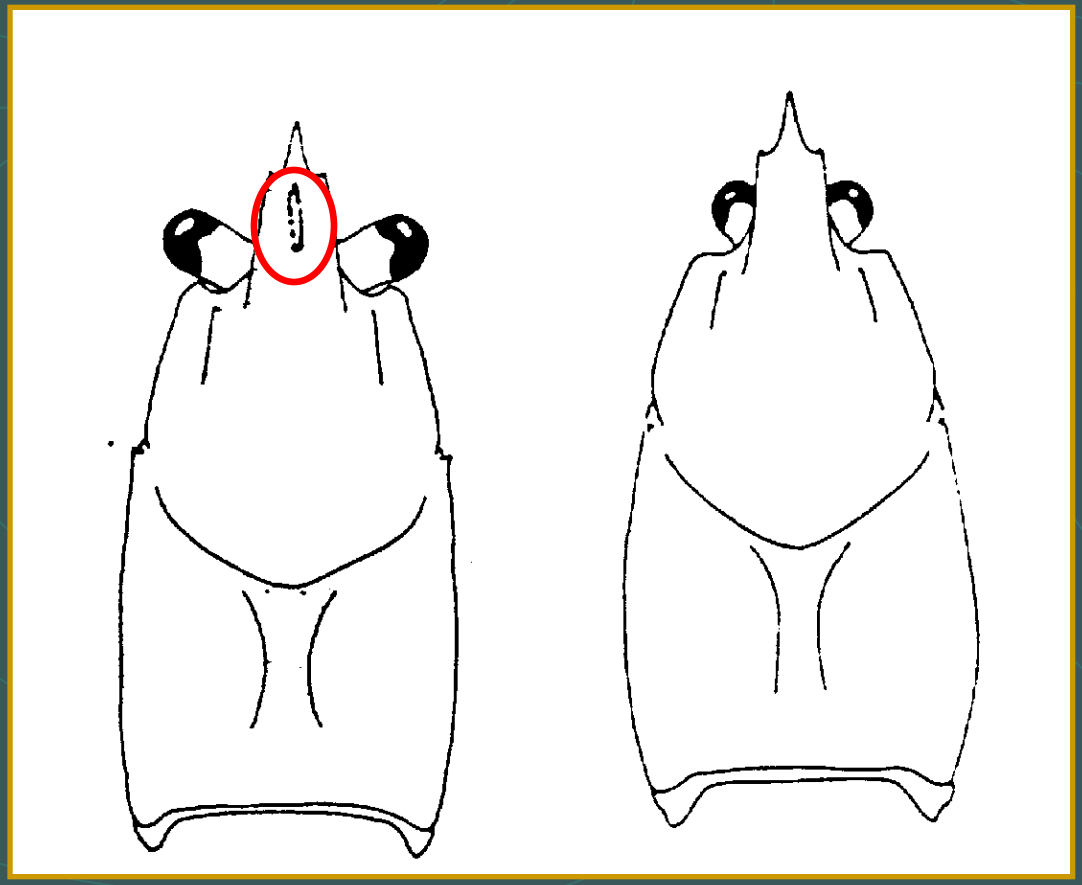


- Rostrum without marginal spines



Carina

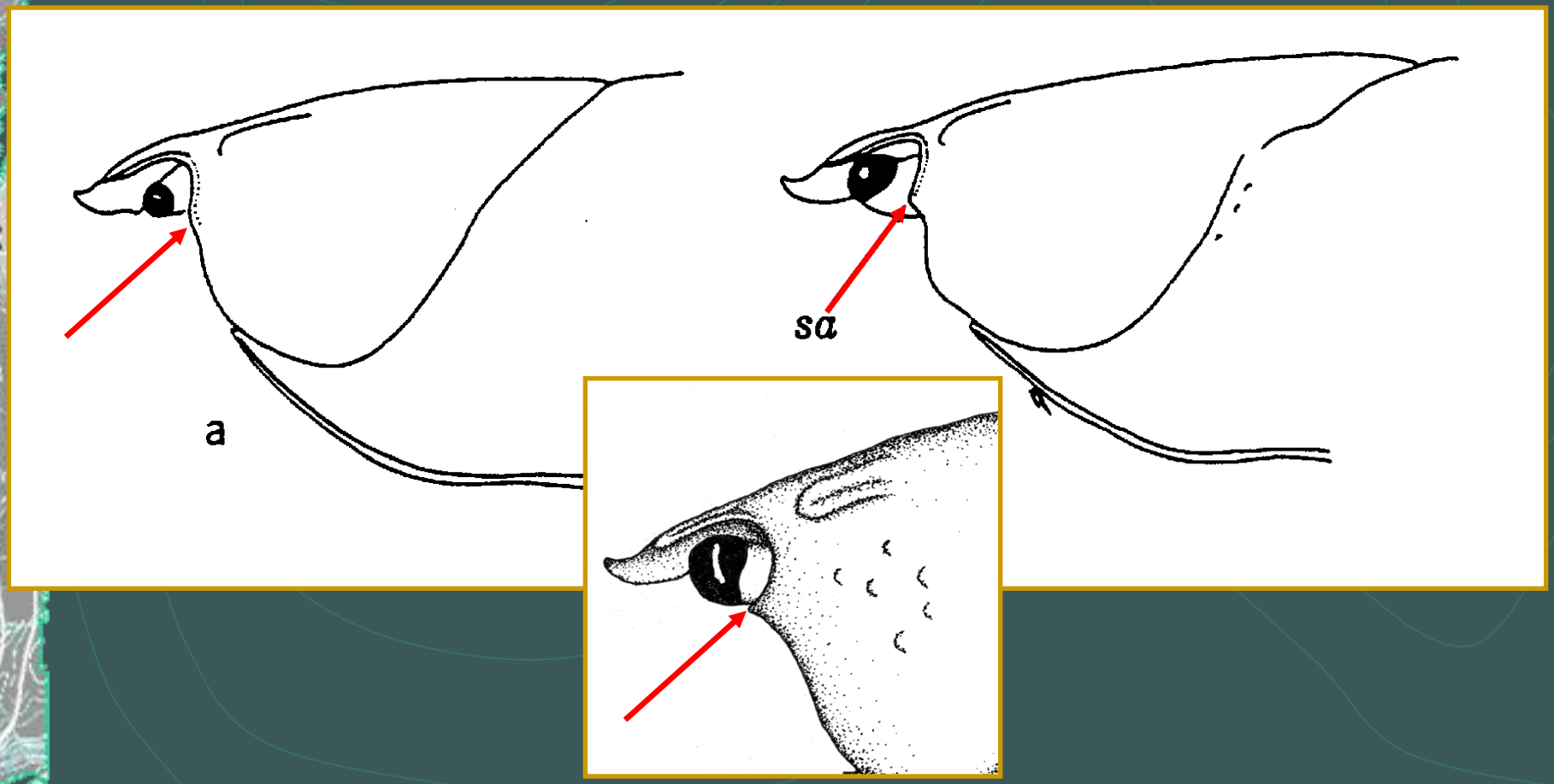
Rostrum with carina Rostrum w/o carina



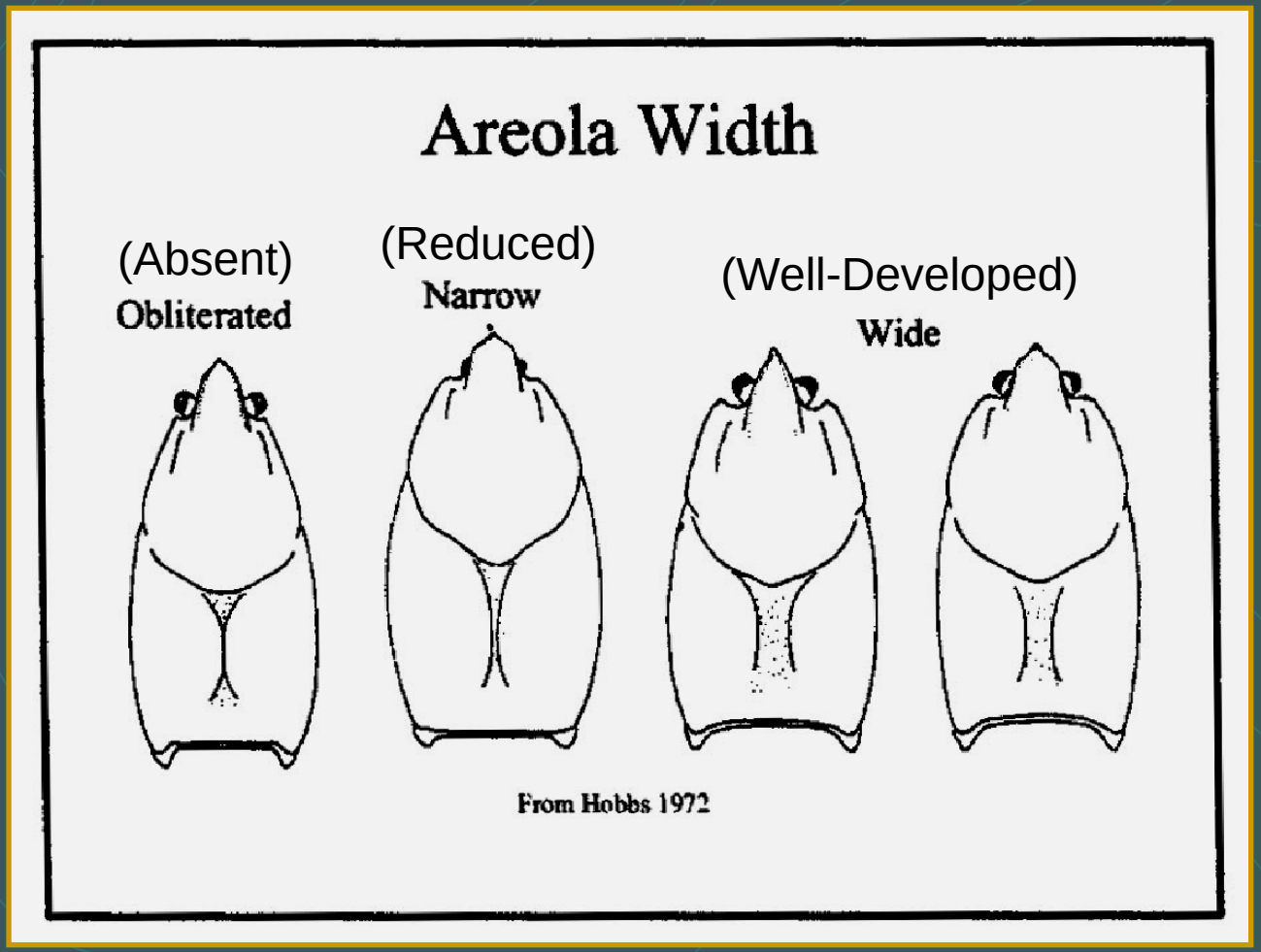
Suborbital angle

Obsolete

Acute



Areola width



Online resources

- International Association of Astacology
  - http://iz.carnegiemnh.org/crayfish/
- List by ecoregion
  - http://fl.biology.usgs.gov/afs_crayfish/map_object.html
- Introduced species
  - http://nas.er.usgs.gov/taxgroup/Crustaceans/crayfish.html

Online keys

- North America (Hobbs Key)
  - http://iz.carnegiemnh.org/crayfish/Keys/index2.htm
- West Coast
  - http://depts.washington.edu/oldenlab/wordpress/wp-content/uploads/2013/03/PineLake_VolunteerFieldGuide_v2.pdf
  - http://wdfw.wa.gov/fishing/shellfish/crayfish/crayfish_id_guide.pdf

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