Accessory
Air Breathing Organs

- **Majority of fishes have well developed gills for gaseous exchange but some tropical fishes have evolved special structures called the accessory air breathing organs to help their survival under unfavorable conditions**

1. **Skin**
2. **Gills**
3. **Alimentary Canal**
4. **Air Bladder**
5. **Buccopharynx**
6. **Diverticulum of branchial cavity**
7. **Diverticulum of opercular cavity**
8. **Neomorphic**

Skin

In several species, the skin becomes highly vascular and is kept moist by the mucus so that gaseous exchange takes place between blood and air

These fishes move out of water and migrate on land for short distance in search of another suitable water body. During migration through damp vegetation, skin function as an important respiratory organ like frog.

Eg: *Anguilla anguilla, Amphipnous cuchia, Mastacembelus, Rita rita, Periophthalmus, Boleophthalmus*

Mudskipper

Eel

Gills

- **In some fishes unmodified gills serve as site of gas exchange out of water, because gills secrete large amount of mucus to keep them moist to continue the gas exchange for some time when fish is out of water**

- **eg: *Rita rita, Mastacembelus***

Eel

Alimentary Canal

In some fishes, a part of the alimentary canal (stomach or intestine) becomes modified for aerial respiration. These fishes are commonly known as Gut Air Breather (GAB).

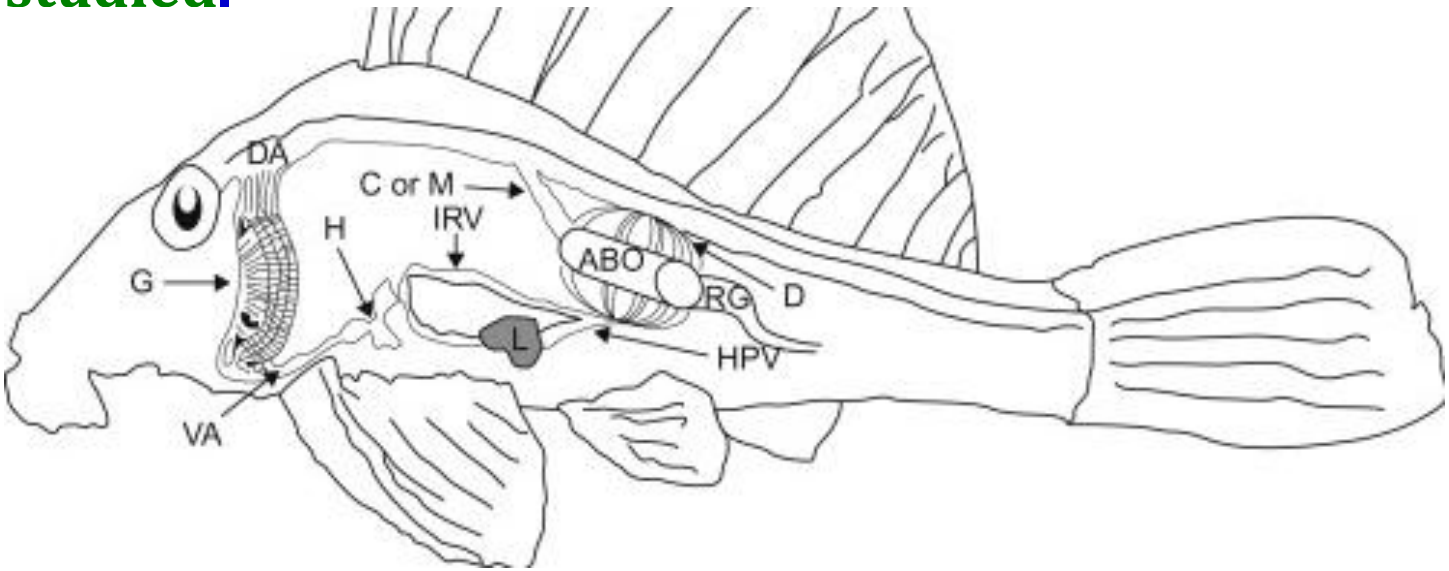
A. Stomach (Loricariidae)

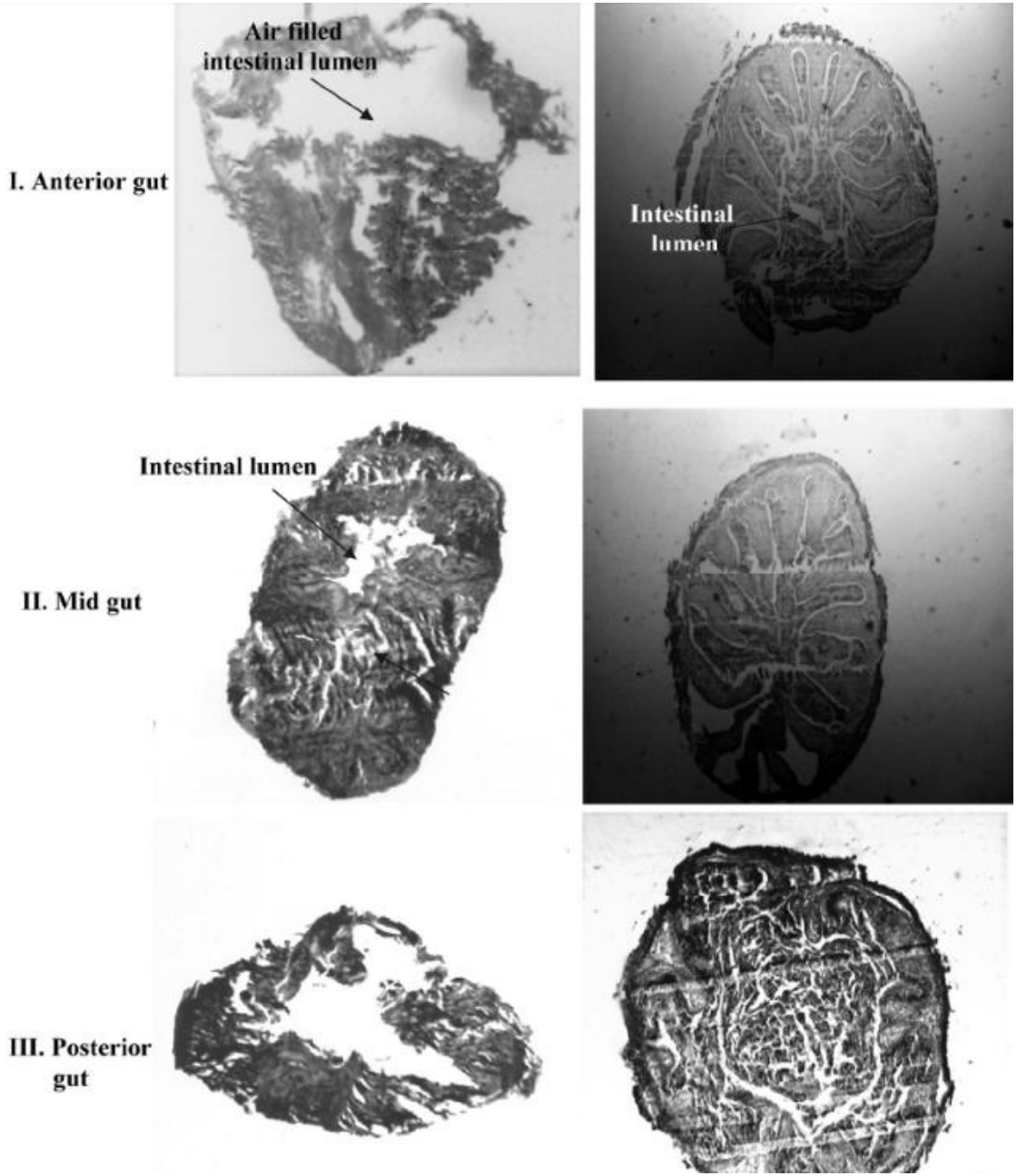
B. Intestine (Cobitidae)

Gut Air Breathing (GAB) Fishes

- When gut segments evolve into an air-breathing organ (ABO), there is generally a specialized region for exchange of gases where the gut wall has diminished, vascularization has increased, capillaries have penetrated into the luminal epithelium. This specialized region is generally separated from digestive portions of the gut by sphincters.

- Gut ABOs are generally used only for oxygen uptake; CO_2 elimination seems to occur *via* the gills and skin in all GAB fishes studied.





Lepidocephalicthys sp. ***Labeo rohita***

Modification of wall of stomach and intestine for aerial respiration

- The wall becomes extremely thin and transparent due to great reduction of muscle layer
- The inner layer of wall consists of a single layer of epithelial cell and richly supplied with blood capillaries.
- Mucus secreting cells and gland cells are absent

In these species air is swallowed and forced into alimentary canal where it is stored for sometime. After gas exchange, the air is passed out through anus or expelled by mouth

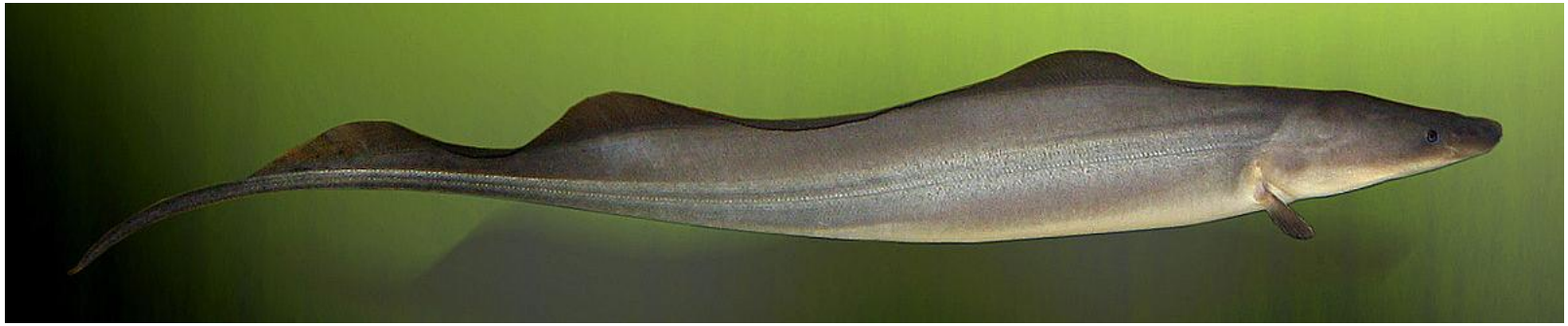
In loaches, the modified parts of the intestine serve for both digestive and respiratory functions. The digestive and respiratory phase may alternate at short intervals or the alimentary canal function as air breathing organ during summer and is non respiratory during winter.

Air Bladder

- Air bladder of some species is specially modified for aerial respiration
- In Polypterus, Amia, Lepidosteus, Gymnarchus and Dipnoi, it is highly vascular and compartmentalized into alveoli and sacculi to function as a lung
- Inner layer of air bladder has dense network of blood capillaries which facilitates gas exchange between blood and air contained in the bladder

Polypterus

Longnose Gar, *Lepidosteus*



Gymnarchus niloticus

The Dipnoi are a group of sarcopterygiian fish, are are commonly known as the lungfish. Their "lung" is a modified **swim bladder**, which in most fish is used for buoyancy in swimming, but in the lungfish also absorbs oxygen and removes wastes.

Buccopharynx

- **In some species, the epithelium lining of buccopharynx is highly vascular raised into fold, pleats or tongues like structure projecting into the buccopharyngeal cavity to form an efficient respiratory organs**
- **Eg: *Periopthalmus*, *Boleophthalmus*, *Amphipnous*, *Electrophorus, Channa***

- ✓ **More advanced condition is present in *Channa* species, where suprabranchial cavities are formed in the roof of the pharynx**

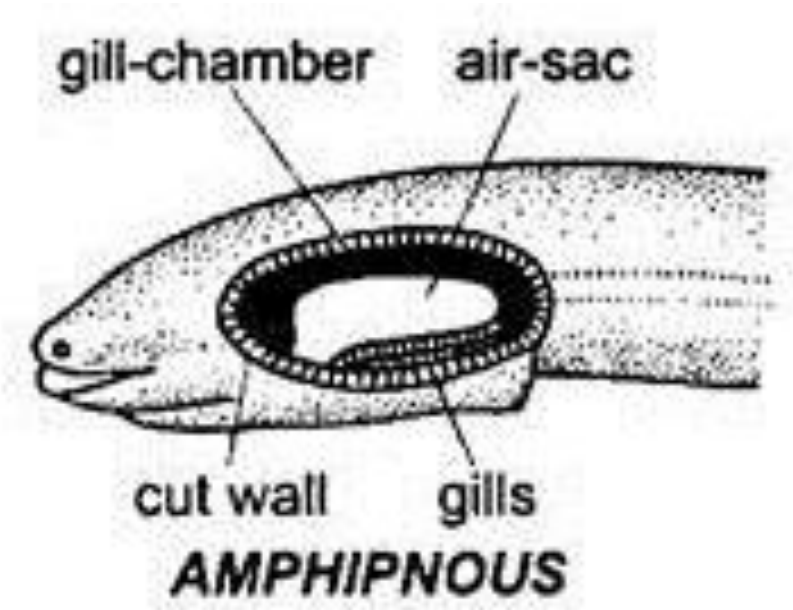
- ✓ **These cavities are lined with highly vascular respiratory membrane and contains respiratory islets**

- ✓ **The suprabranchial cavities have alveoli and open antero ventrally into buccopharynx and postero-ventrally into opercular cavity**

- ✓ **All gill arch bear filaments but they are reduced in size, on 4th arch filaments are greatly reduced**

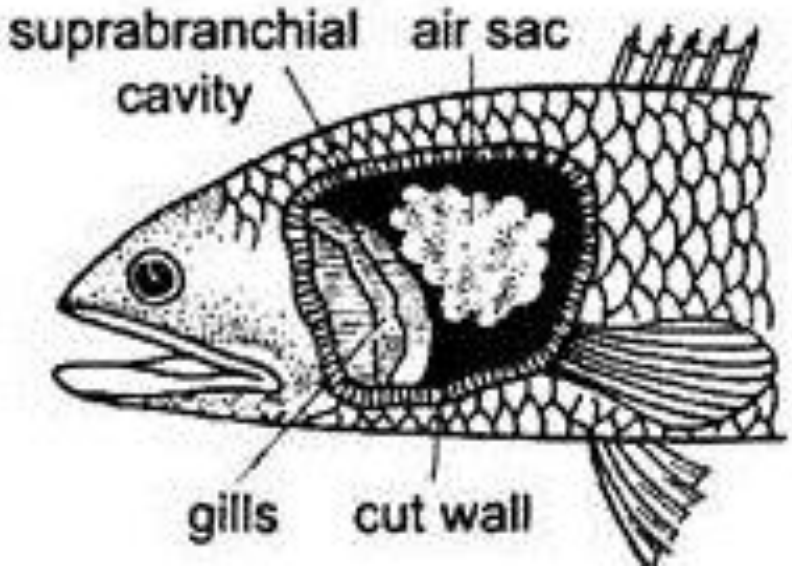
- **In cuchia eel also gills are reduced and only 2nd arch bears filament while 3rd has fleshy vascular membrane**
- **A pair of sacs situated on the lateral sides of the head, form the air breathing organ**
- **These sacs develop as diverticulae of pharynx and line with highly vascular folded epithelium**
- **The epithelium consists of vascular areas called islets bearing rosettes or papillae**

Accessory Breathing organ in *Amphipnous*



Amphipnous cuchia **is a bimodal breather. Respiratory gas exchange takes place in a pair of specialized air sacs extending from the pharyngeal cavity. Aquatic and aerial gas exchange also takes place in vestigial gills, across buccopharyngeal surfaces and in the skin.**

Accessory Breathing organ in *Channa*



More advanced condition is present in *Channa* species, where suprabranchial cavities are formed in the roof of the pharynx

Opercular Cavity Diverticulum

- **In *Periophthalmus* and *Boleophthalmus*, the opercular chamber serves for aerial respiration**

- **Modification in opercular chamber**
  a. **Opercualr chamber large and extends below the basibranchials and above gill arches**
  b. **Epithilial lining of opercular chamber is thin and highly vascular**
  c. **Opercular bones are thin and elastic**
  d. **Efficient mechanism have evolved foe closing and opening of the inhalant and exhalant apertures**

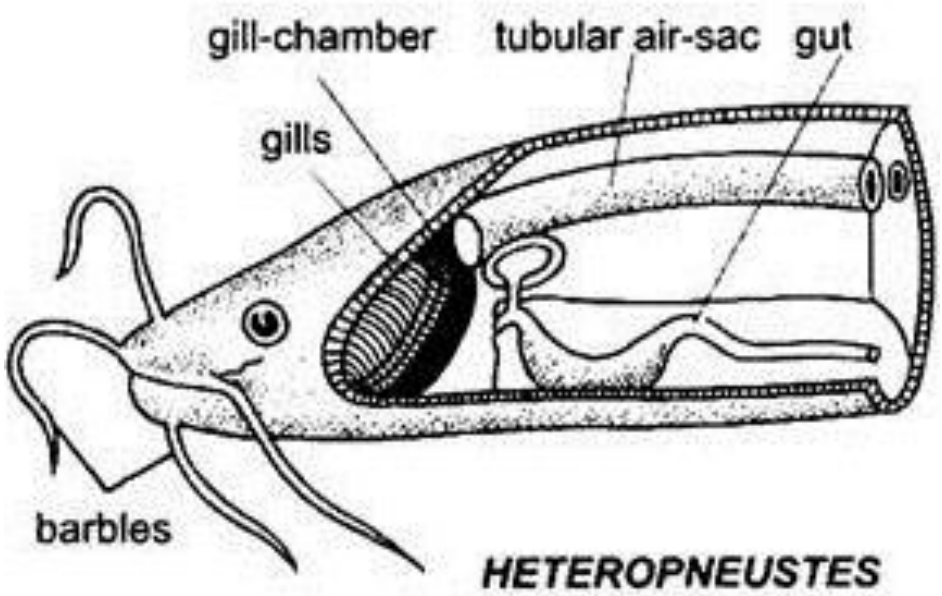
Accessory Breathing Organ in *Boleophthalmus*

The opercular cavity bulges out to form two little balloon like structure in the hinder region of head and inhaled air is passed through the gill slits, stored for sometime in cavity and balloons and after gaseous exchange air passed out through branchial aperture

Air Breathing organ in *H. fossilis*

- **Accessory air breathing organs in *H. fossilis* consist of (a) two air sacs (b) fan and (c) respiratory membrane**

A pair of simple sac like structure extend posteriorly one on each side from the suprabhranchial chamber of the opercular cavity extending upto the middle of the caudal region. These sacs are thin walled, tubular and highly vascular .

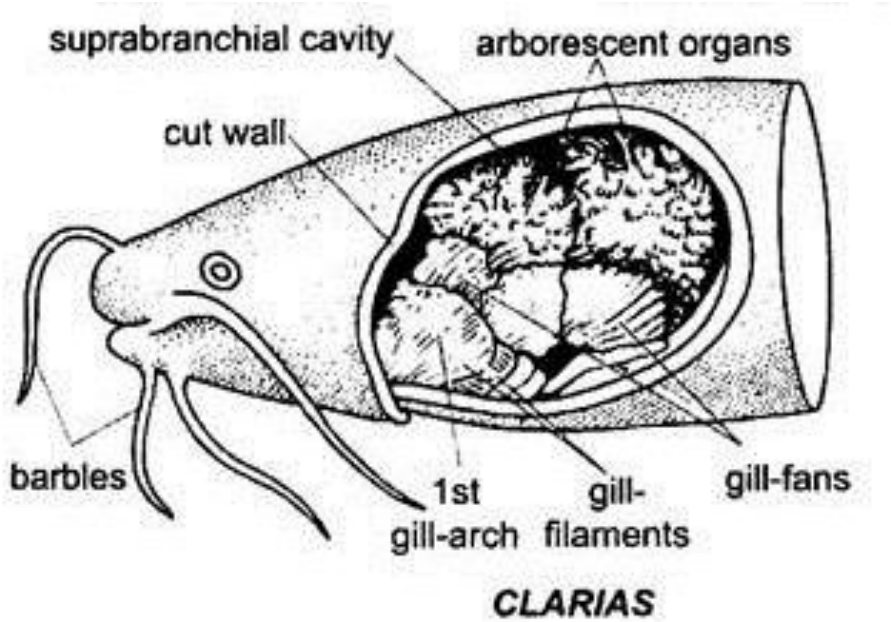


Air Breathing organ in *H. fossilis contd.*

- **Respiratory membrane lining of the air sac is composed of vascular and non vascular areas and have folds and ridges to increase the surface area**
- **During respiration, fish inhales air which enters the suprabranchial chamber through the inhalant aperture and is passed into the tubular sac. After gas exchange air is expelled by external branchial opening.**

Air Breathing organs of *Clarias batrachus*

- **Air breathing organ of *C. batrachus* consist of (a) suprabranchial chamber, (b) rosettes, (c) fans and (d) respiratory membrane**



Air Breathing organs of *Clarias batrachus Contd.*

- **Suprabranchial chamber is situated above gills and lined by highly vascular respiratory membrane**

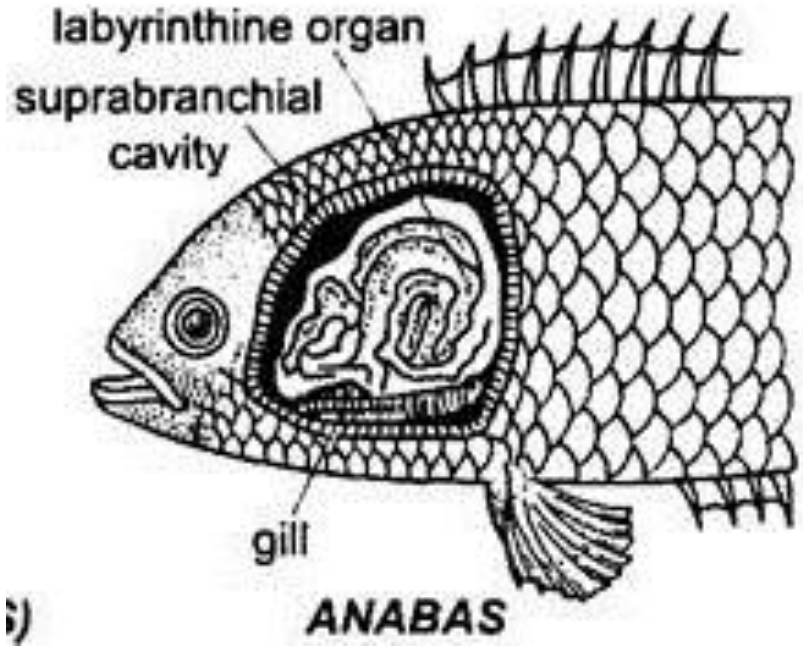
- **Two rossette are present one on the epibranchial of 2nd gill arch and another on the epibranchial of fourth gill arch**

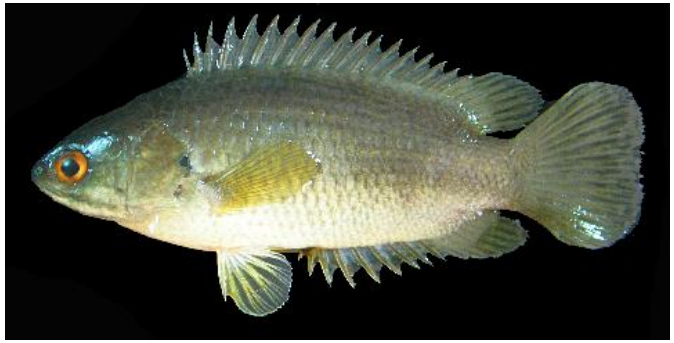
- **In addition to the rossette, some gill filaments of each arch fused and form four fans, one on each arch**

Air Breathing organs of *Anabas* & *Trichogaster*

- **Air breathing organs of anabas consist of a spacious air chamber and a labyrinthine organ on each side**

- **Air chamber lies between the 1st gill arch and the hyomandibular and opens into the buccopharyngeal and opercular cavity and epithelial lining is highly vascular**





Air Breathing organs of *Anabas* & *Trichogaster contd.*

- A well developed labyrinthine organs is present on the first gill arch
- It develops from first epibranchial and consists of three concentric bony plates
- Labyrinthine organ is covered by vascular respiratory epithelium

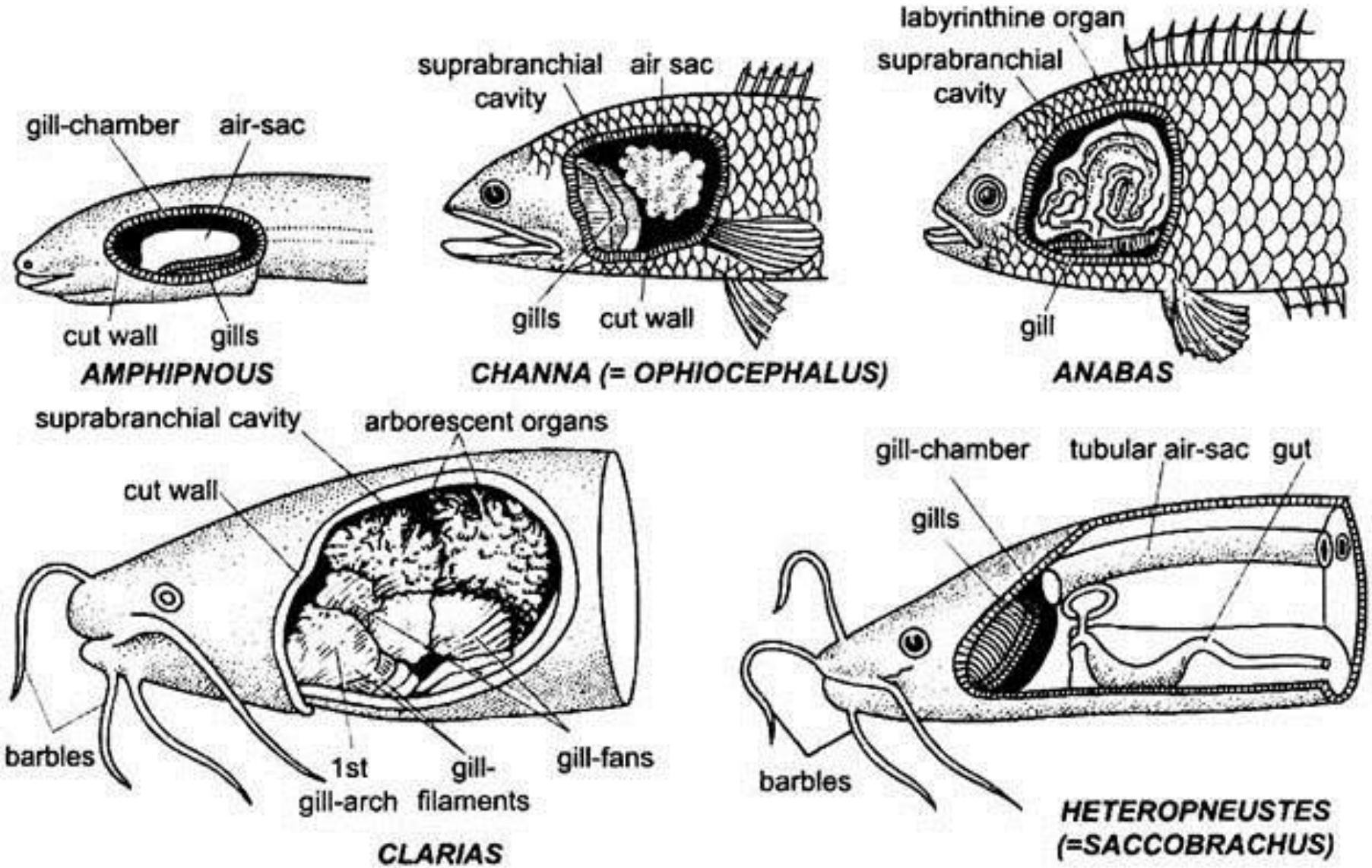


Fig. 17.8. Accessory respiratory organs dissected on the left side in some air-breathing teleost fishes.