

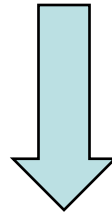
Temperature Regulation

- **Relation between temperature and biological activities.**

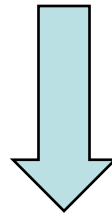
- **Temperature fluctuation is less in aquatic ecosystem and more in terrestrial ecosystem**
- **Ocean Temp. range → -2 to + 30oC
(more steady environment.)**
- **Land Temp. range → -70 to + 85oC
(wide fluctuating environment.)**
- **Life exists between 0 to 40oC**
- **Few bacteria & algae can live at 70oC
[e. g. in hot water springs]**

- **Some blue green alga *Synechococcus* can survive in temp. 75oC.**
- **Eggs of a fresh water crustacean
Triops can survive temp. 80oC to
103oC**

- **Temp. affect chemical Reaction Rate**
(reaction rate is higher at higher temp.)



- **Therefore temp. affects the Metabolic Rate**



- **Hence the Growth**

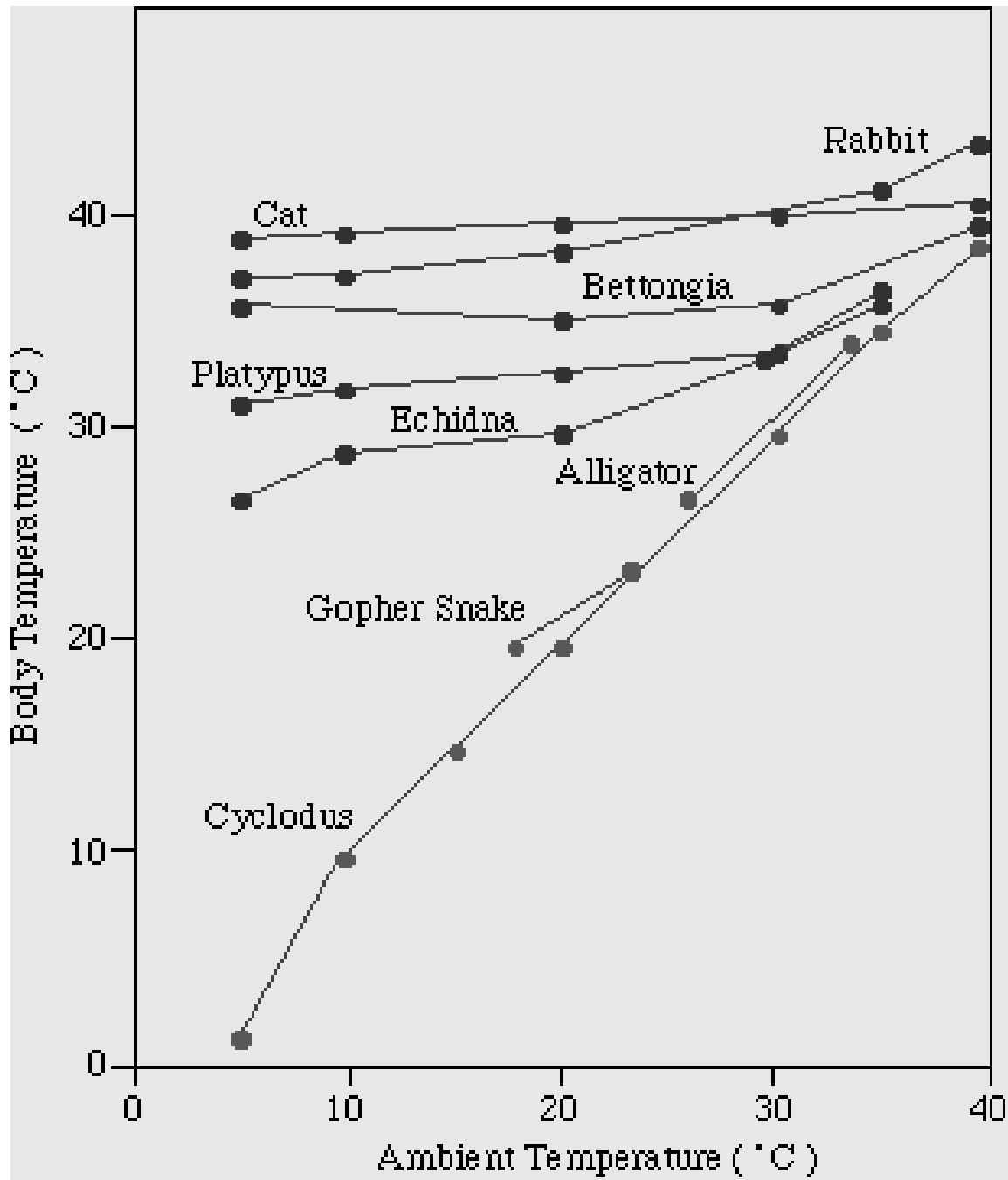
- **Very high temperature can cause heat death, which due to—**
- **Denaturation of proteins, thermal coagulation.**
- **Thermal inactivation of enzymes.**
- **Inadequate oxygen supply.**
- **Damage to membrane structure.**

- **Very low temperature can cause cold death. This depends on the tolerance of the organisms.**
- **Guppies die at 10°C. (normally live at 23°C)**
- **Some can survive freezing temperatures.**
- **Arctic fish Trematomus can swim at temp. – 1.3°C.**
- **They have anti freeze substance in their blood/ body fluid.**

- **Poikilotherms (Cold blooded animals)**
- **Poikilos means changeable.**
- **Have T_b almost similar to the environment. However due to metabolic processes T_b is slightly higher than T_a**
- **Ex. In Fish muscle temp. is 0.44°C higher than T_a .**
- **(T_a = Ambient temp. T_b = body temp.)**

- **Homootherms** – Maintain constant Tb.
- The constancy required especially for Nervous system.
- Due to the constancy of Tb they can occupy the environments of widely fluctuating temperatures.
- **Heterotherms** – Regulate when they are active, not when resting Ex. Armadillo, sloth, Marsupials etc.

- **The temperature regulating ability is better in higher mammals and birds as compared to the lower mammals and reptiles. This is illustrated by the following figure.**
- **It shows better regulation in cat, rabbit as compared to Platypus , Echidna which are better than snake and alligator.**



- **The regulation ability also shows Ontogenetic trend i.e. In a animal life young Regulates less, adult regulates better. New born are usually Poikilothermic, need more care. Exception to this is Caribou calf (a type of deer.)**

Temperature Regulation – is a Balance between heat loss and heat gain.

- **Heat loss is by --**
- **Evaporation**
- **Conduction**
- **Radiation**
- **Convection**
- **Heat Production is by --**
- **Ectothermy (absorption of heat)**
- **Endothermy (metabolic heat)**

- **For good Regulation Animals need ----**
 - 1. Sensitive Thermostat**
 - 2. Ability to use metabolic heat**
 - 3. Insulation to avoid Heat loss.**
- **Homeotherms have all these & they also can change metabolic rate according to need. Homeotherms can also change thickness of insulation.**
- **Poikilotherms – have poor insulation. They can not change basal metabolic rate. Hence they are poor regulators of temperature.**

Following figure shows how the homeotherms manage in changing ambient temperatures.

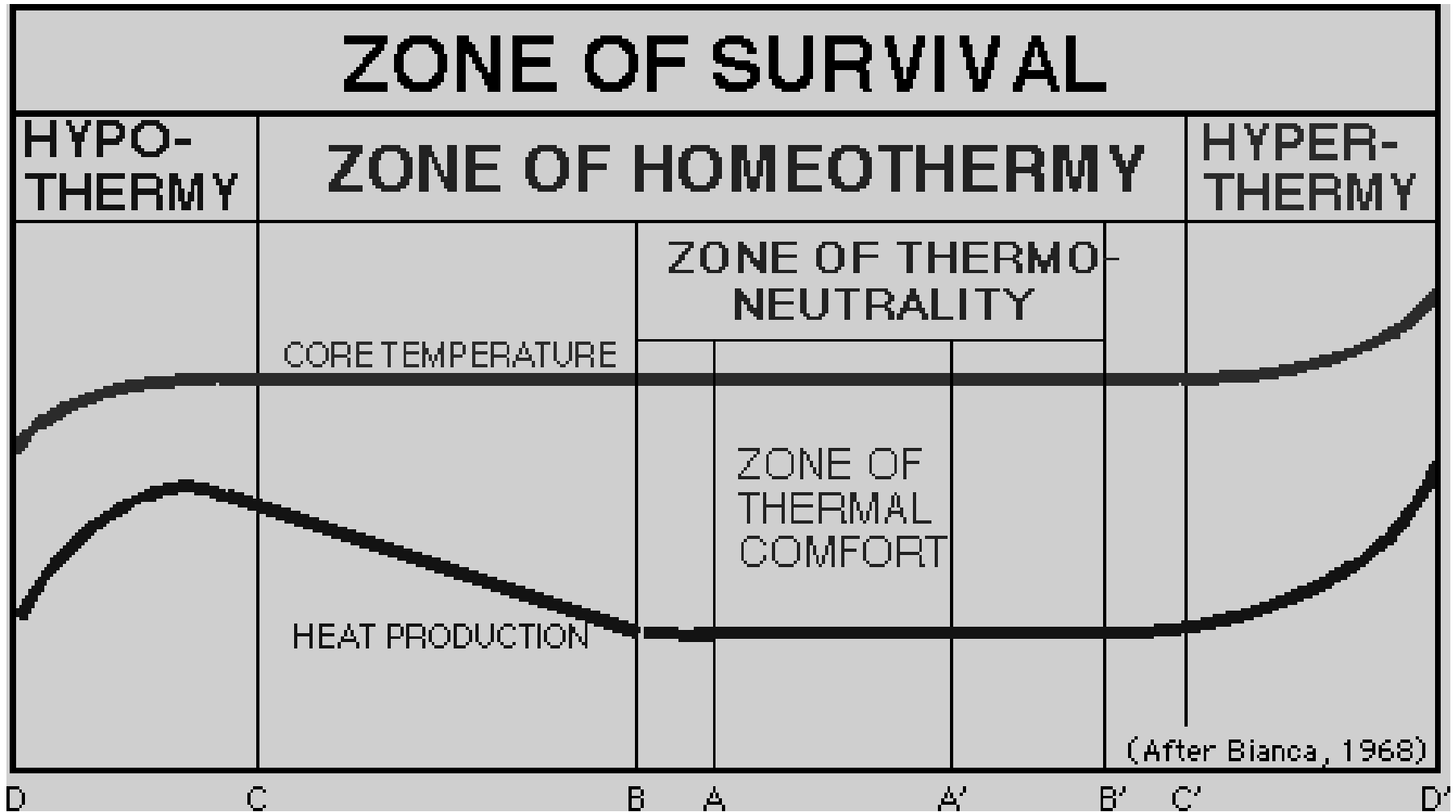


Figure - Zone of Survival (after Bianca 1968).

- Within the "Zone of Homeothermy" (C to C'), a mammal can maintain a constant, or steady state, core temperature. Within the **"Zone of Thermal Comfort" (A to A')**, there is little sensation of heat or cold, and a steady state core temperature can be maintained without any efforts . **B to B' is Thermoneutral zone when Basal Metabolic Rate (BMR) is the lowest.**

- At the **lower critical temperature (B)**, heat produced by increased metabolic activity maintains homeothermy. However, at **C (Incipient lethal temp.low)**, heat production cannot balance heat loss, the core temperature begins to fall, and the animal becomes **hypothermic**. With more cooling, heat production peaks, and then declines, further lowering the core temperature. At the lethal body temperature (**Cold death -D**), an animal dies from the cold. For most species, the lower lethal temperature is 59-68°F (15-20°C), or about 36°F (20°C) **below the normal core temperature**.

- With air temperature rising above the "Zone of Thermal Comfort" (A'), the animal makes efforts for cooling . At the **upper critical temperature (B')**, increased sweating and (or) panting may be associated with lowered metabolic heat production. Dogs, cat, rabbits, sheep can lower BMR (about 20%) in hot conditions. At C'(**Incipient lethal temp.high**), further intensification of sweating and (or) panting cannot maintain homeothermy, and the animal becomes **hyperthermic**.

- The rise in core temperature increases the metabolic rate **via the van't Hoff effect, triggering positive feedback, which further increases the core temperature.** Thermal death of an adult occurs at (**Heat death**) **D**. For mammals, the van't Hoff effect is the two-to three-fold rise in heat production caused by an 18°F (10°C) rise in tissue temperature. For most mammals, the upper lethal body temperature is 108-113°F (42-45°C), or about 5.4 to 10.8°F (3 to 6°C) above the normal core temperature.

- **Critical Temperature & Thermo neutral zone vary from Animal to animal.**
- **Critical temperature in naked man is 25 to 27oC. In Arctic fox it is -30 to -40oC**