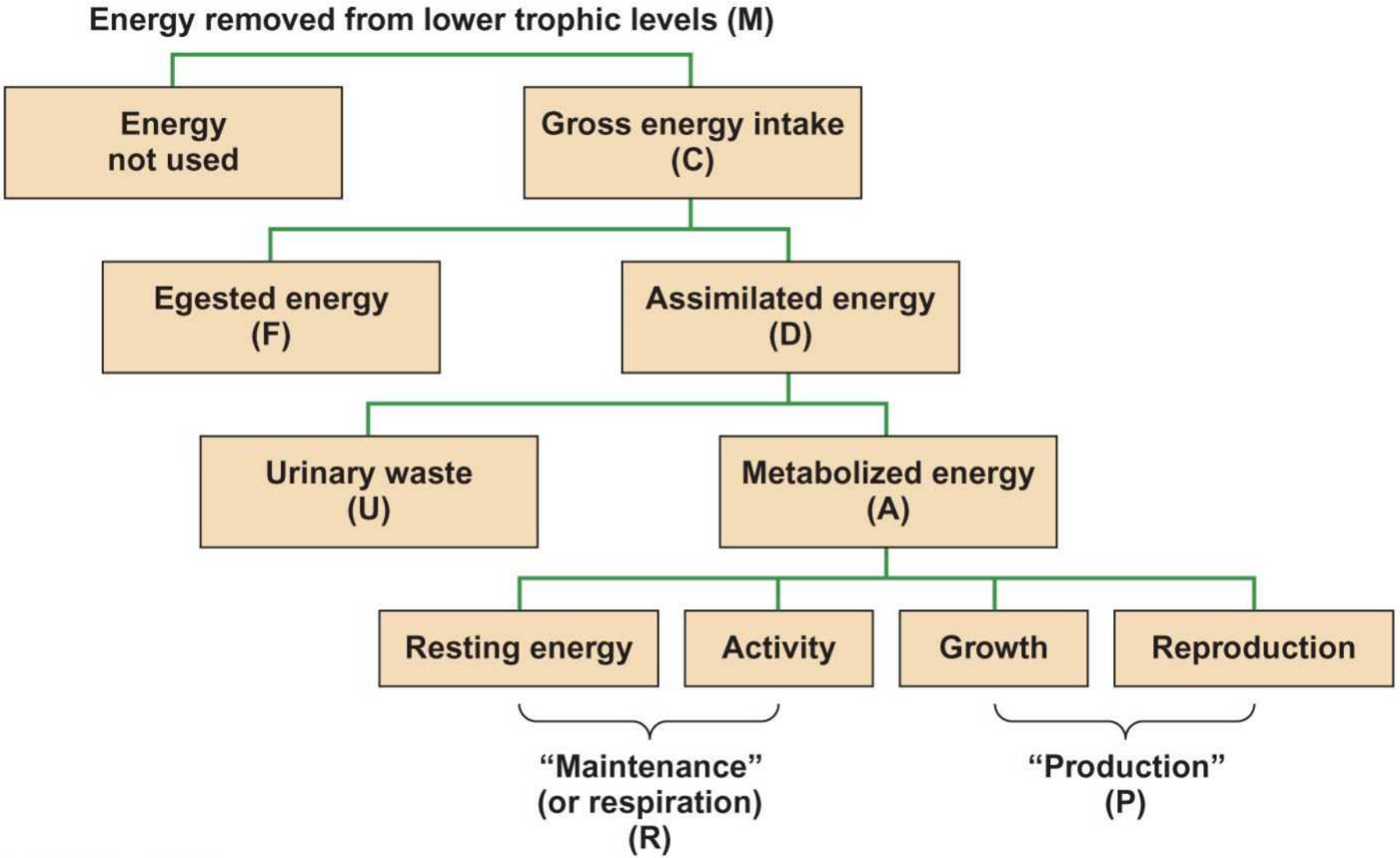
Teórica 13:
Metabolismo ecosistémico 2:
Productividad secundaria

Teórica 13: Esquema conceptual

- Partición de la energía en los consumidores
- Eficiencia ecológica:
  - eficiencia en la producción
  - eficiencia trófica
- Flujo de energía en los ecosistemas
- Limitantes de la producción secundaria
- Teoría metabólica

Partición de la energía por los consumidores



Eficiencia en la producción

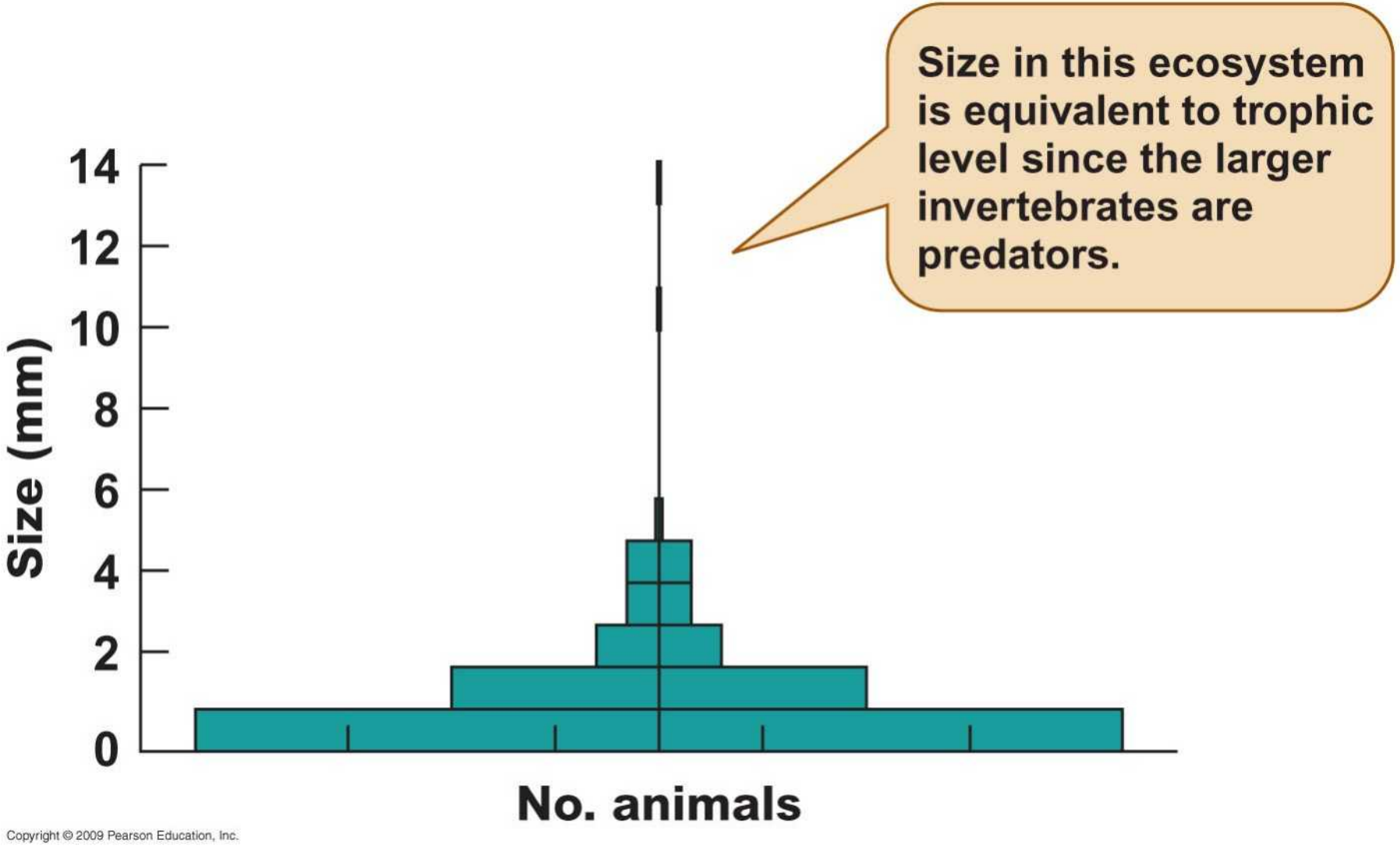
Table 23.2 Average production efficiencies.

Group	Production efficiency (%)	No. of studies
Insectivores	0.86	6
Birds	1.29	9
Small mammals	1.51	8
Other mammals	3.14	56
Fish and social insects	9.77	22
Other invertebrates (excluding insects)	25.0	73
Herbivores	20.8	15
Carnivores	27.6	11
Detritivores	36.2	23
Nonsocial insects	40.7	61
Herbivores	38.8	49
Detritivores	47.0	6
Carnivores	55.6	5

NOTE: Data are from 235 natural populations. A breakdown into trophic groups is presented for two of the groups for which adequate data are available.

SOURCE: After Humphreys (1979).

Pirámide de los números



Pirámide de los números

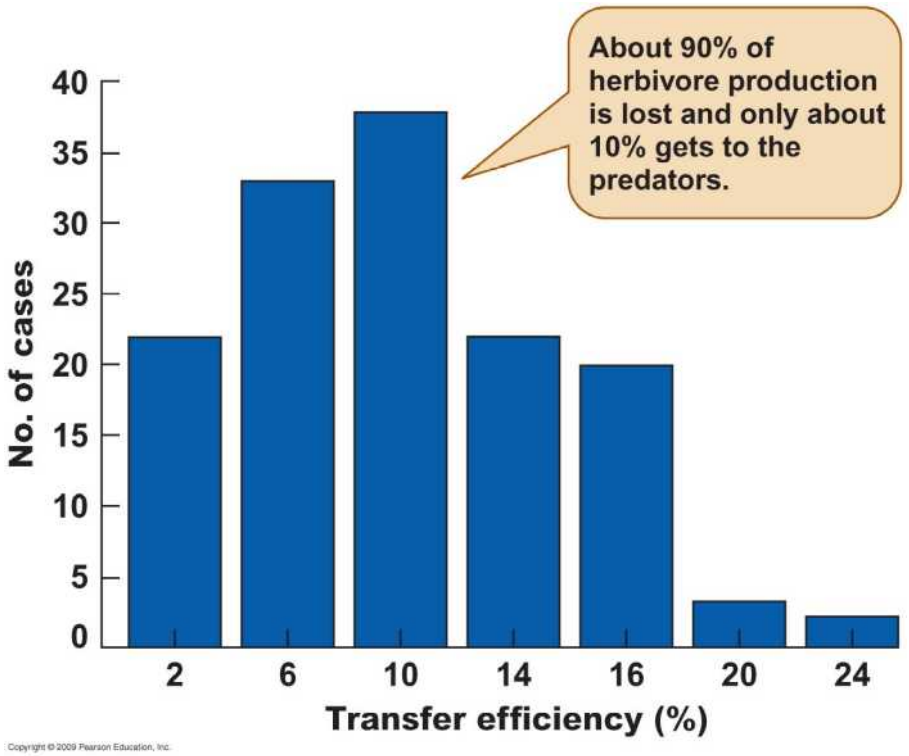
Raymond Lindeman

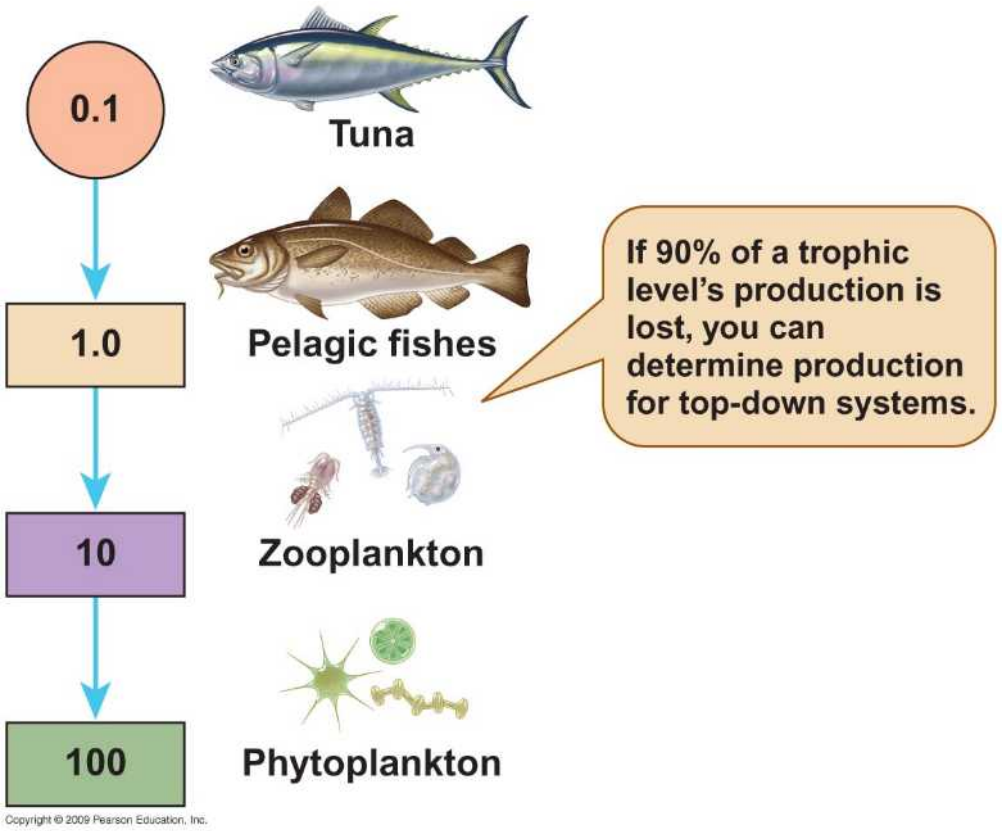
Las relaciones de energía de [esta pirámide] pueden ser representadas mediante el símbolo de productividad λ, del siguiente modo:

$$\lambda_0 > \lambda_1 > \lambda_2 > \ldots > \lambda_n$$

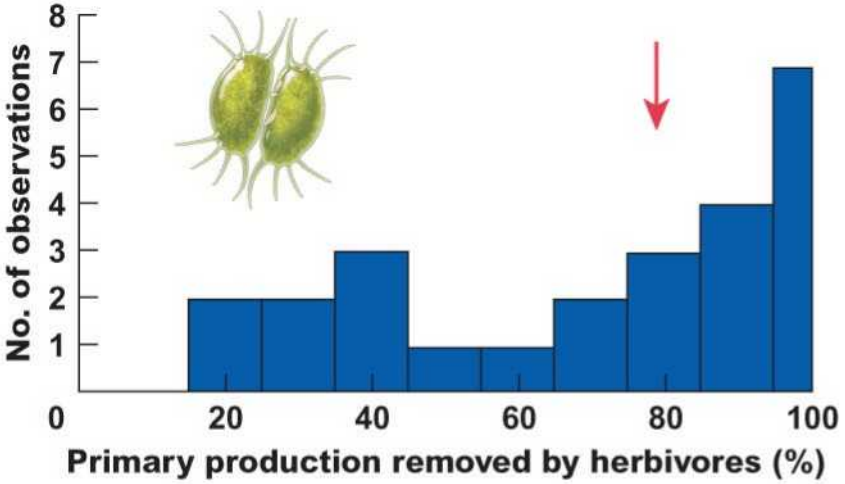
--Lindeman (1942)

Eficiencia trófica

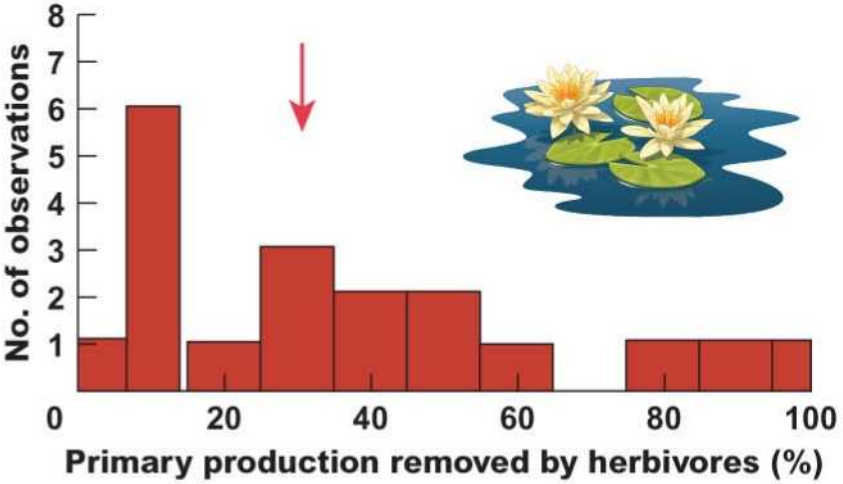




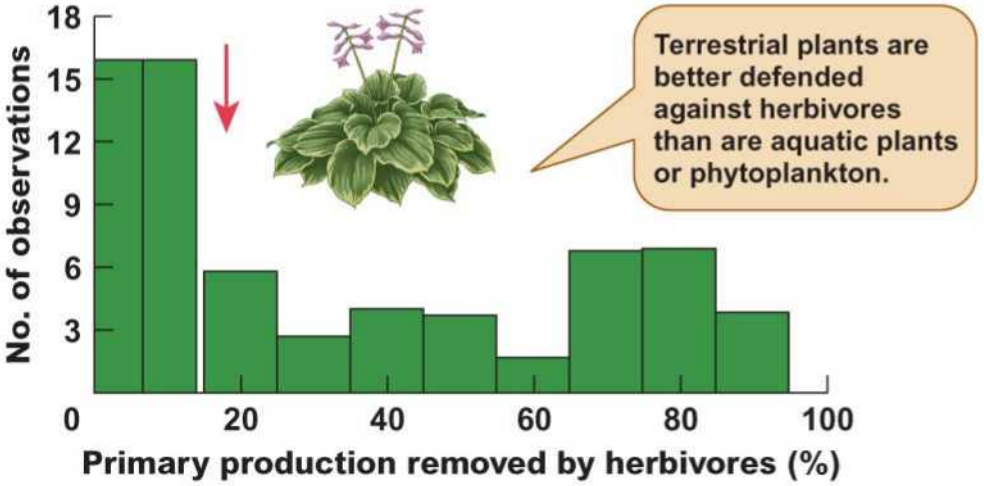
Consumo de PP en ambientes acuáticos y terrestres



(a) Aquatic algae



(b) Aquatic macrophytes



(c) Terrestrial plants

Consumo de PP en ambientes acuáticos y terrestres

Table 23.3 Global estimates of net primary production and the total catch to world fisheries (including discarded catches), and the calculated percent of primary production required to support the observed fishery catches.

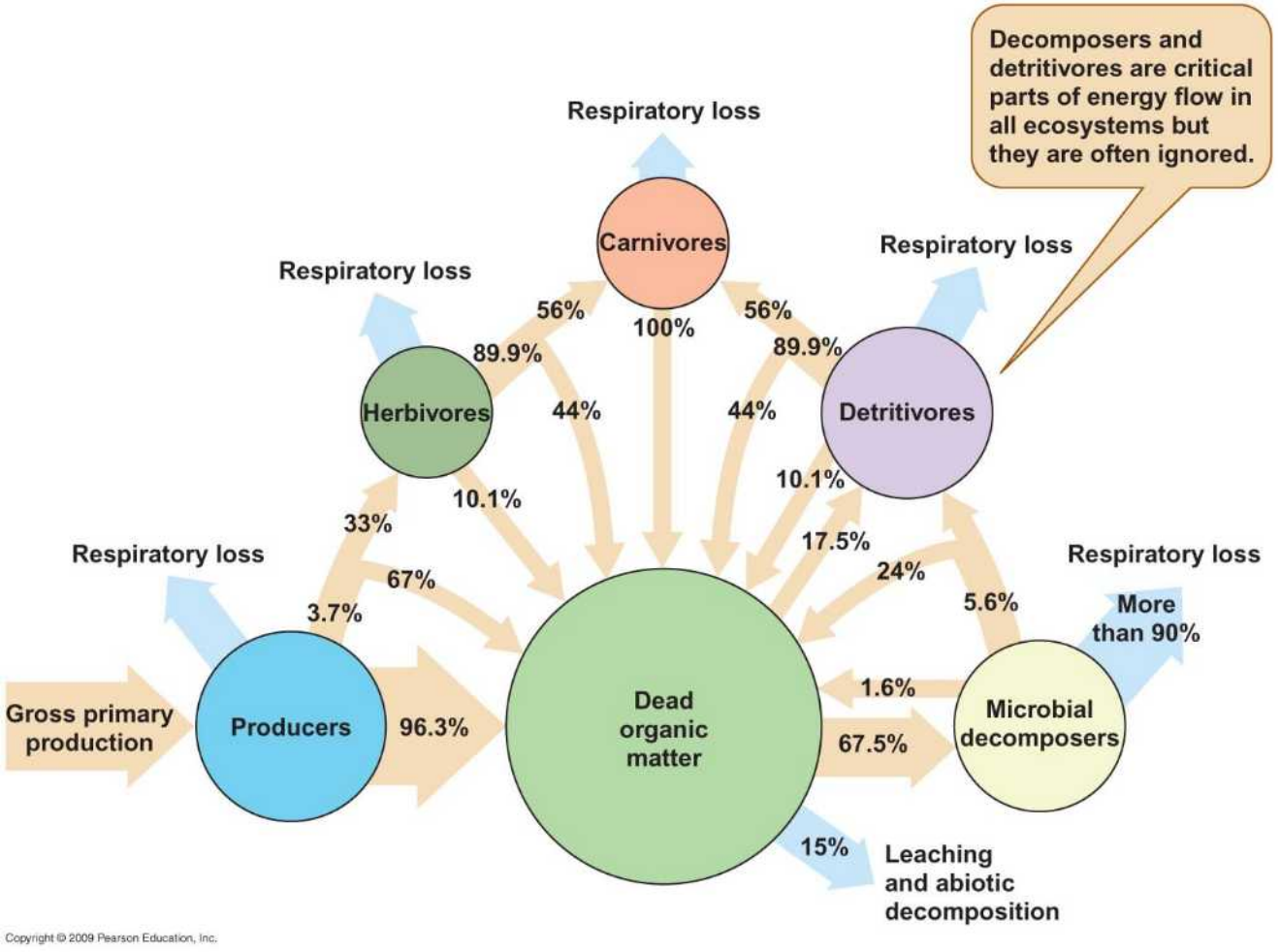
Ecosystem type	Area (10^6 km^2)	Net primary production (g C m^{-2}yr^{-1})	Fishery catch[a] (g C m^{-2}yr^{-1})	Primary production required (%)
Open ocean	332.0	103	0.012	1.8
Upwellings	0.8	973	25.560	25.1
Tropical shelves	8.6	310	2.871	24.2
Temperate shelves	18.4	310	2.306	35.3
Coastal/reef systems	2.0	890	10.510	8.3
Rivers and lakes	2.0	290	4.300	23.6
Weighted means		126	0.330	8.0

Data from 1988–1991 were used in these estimates.

[a]Includes an estimated 25% discards that are not counted in official fishery catch statistics.

SOURCE: From Pauly and Christensen (1995).

Consumo de PP en ambientes acuáticos y terrestres



Limitantes de la producción secundaria

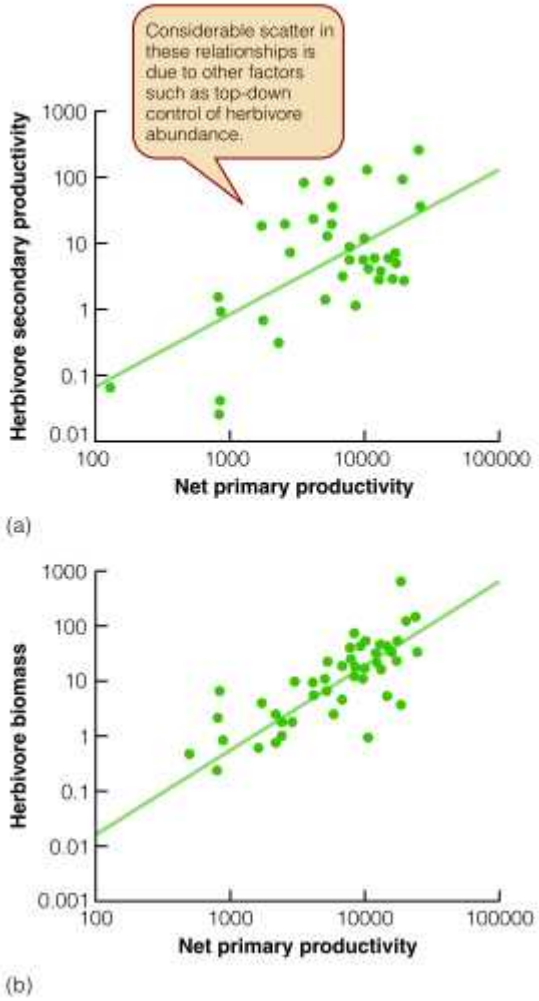


Figure 13 Relationships (a) between net aboveground primary production and net secondary productivity, and (b) between net primary production and herbivore biomass. Secondary production increases with primary production in a 1:1 ratio. Biomass measured as kJ/m^2, all others as kJ/m^2/yr. Data from 69 studies from arctic tundra to tropical forests. (From McNaughton et al. 1989.)

Limitantes de la producción secundaria

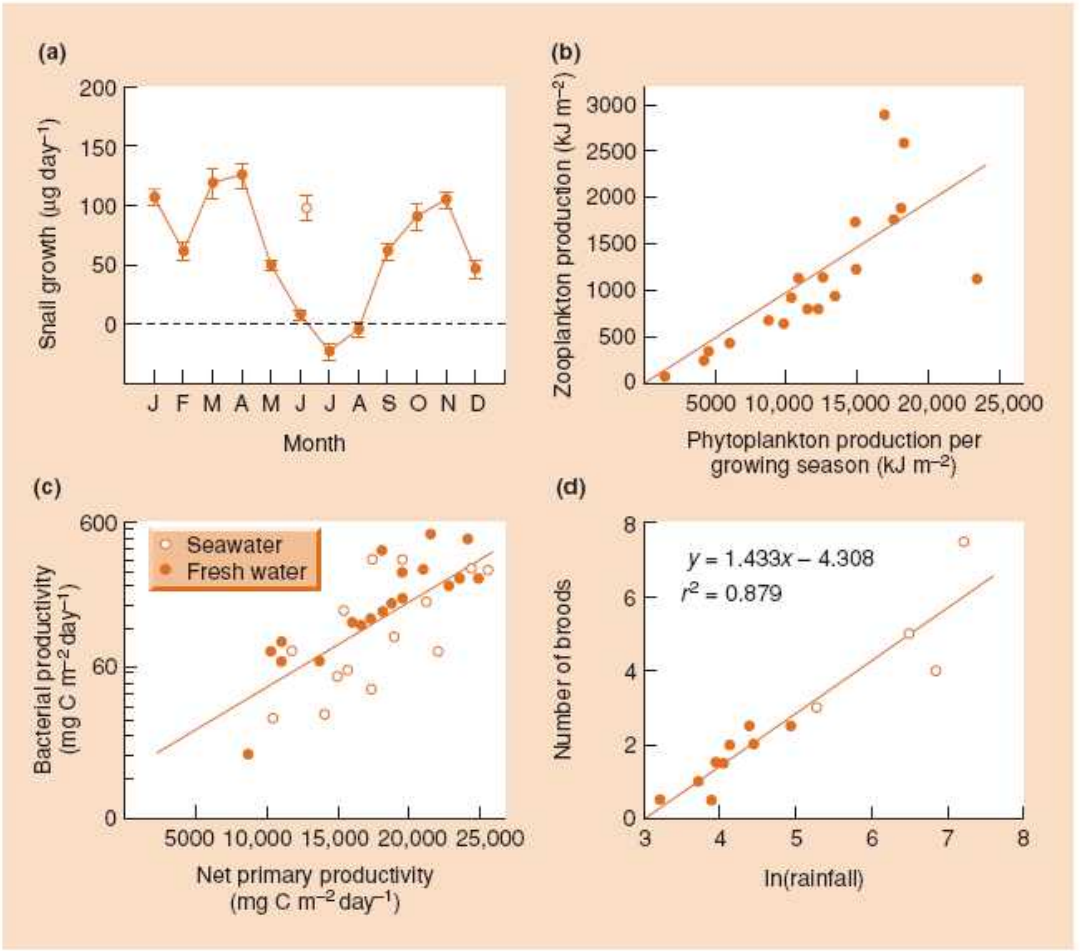
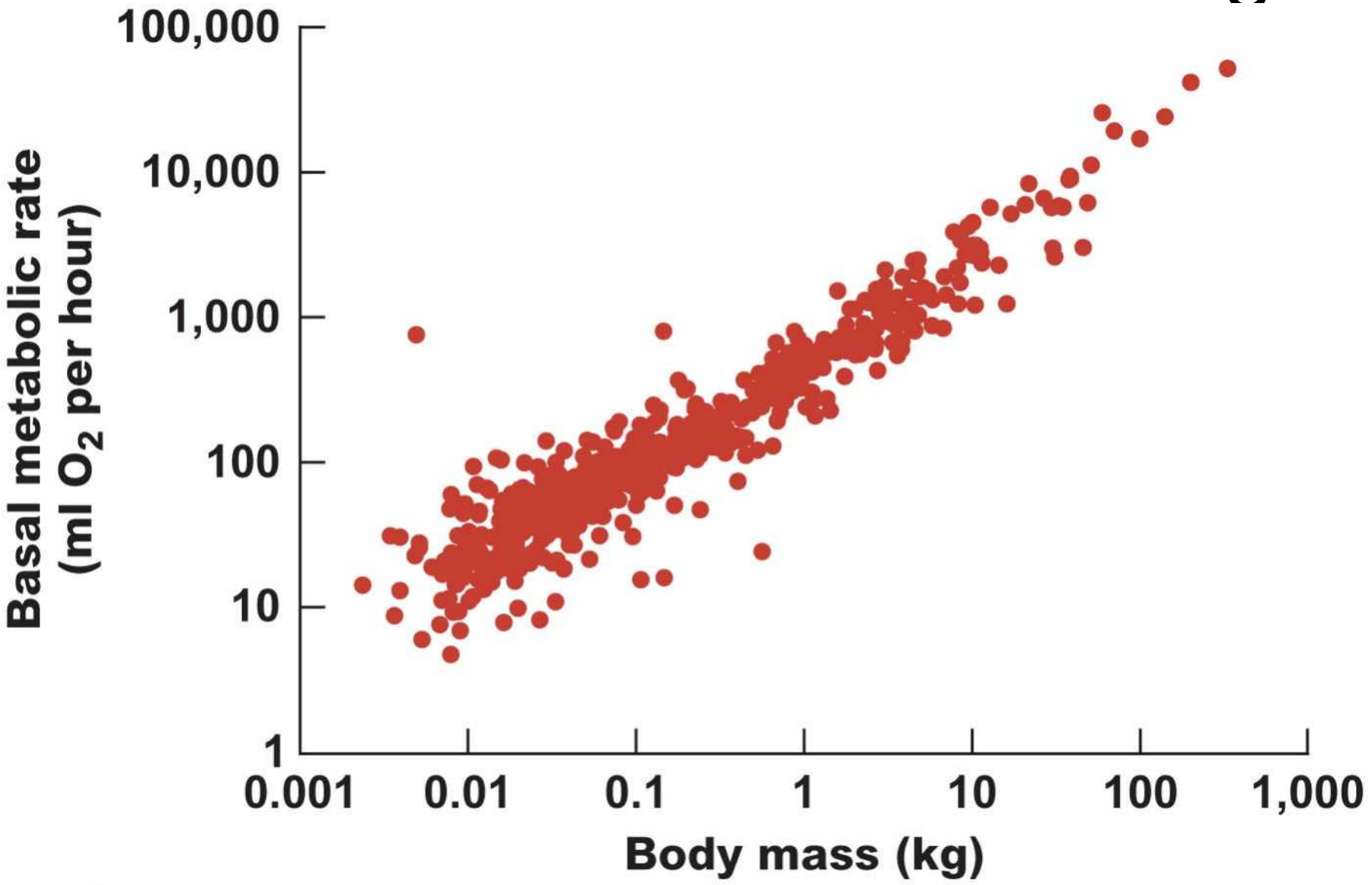
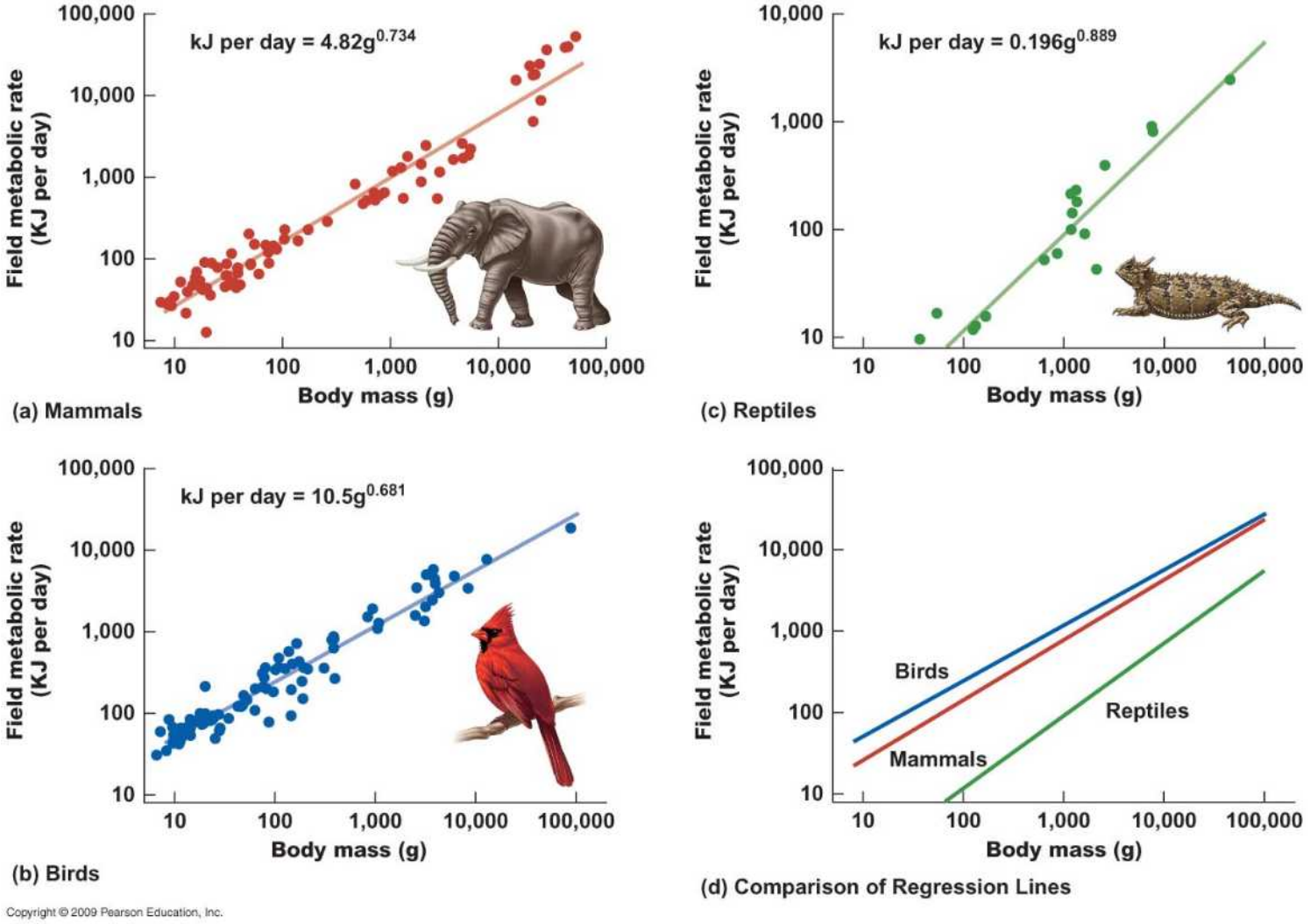


Figure 17.20 (a) Seasonal pattern of snail growth (mean increase in weight of individually marked snails during a month on the stream bed ± SE). The open circle represents growth at a nearby unshaded stream site in June. (After Hill *et al.*, 2001.) (b) Relationship between primary and secondary productivity for zooplankton in lakes. (After Brylinsky & Mann, 1973.) (c) Relationship between bacterial and phytoplankton productivity in fresh water and seawater. (After Cole *et al.* 1988.) (d) Mean clutch size of *Geospiza fortis* in relation to annual rainfall (positively related to primary productivity); the open circles are for particularly wet years when El Niño weather events occurred. (After Grant *et al.*, 2000.).

Teoría metabólica de la ecología



Teoría metabólica de la ecología



Teoría metabólica de la ecología

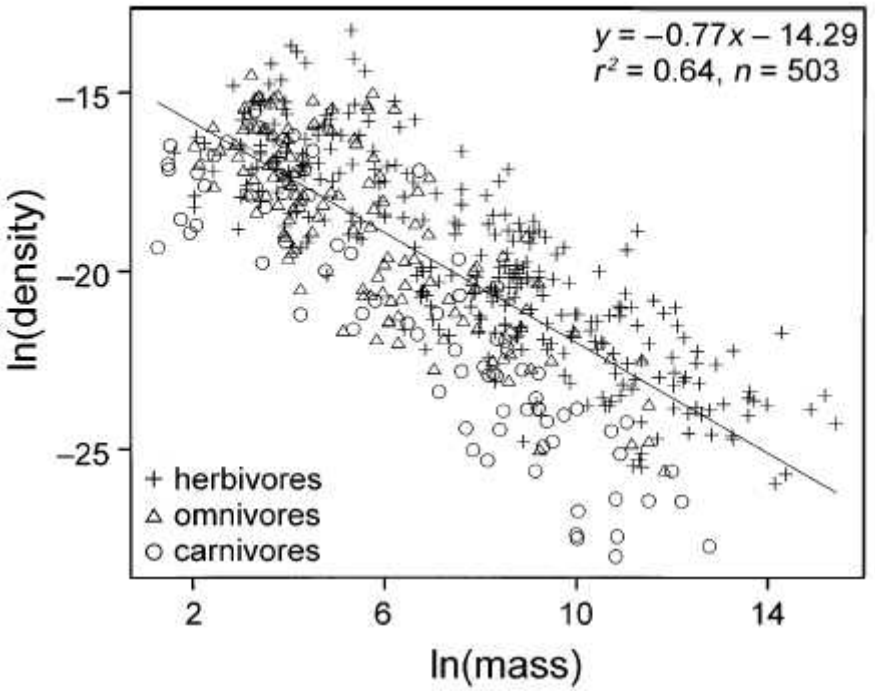
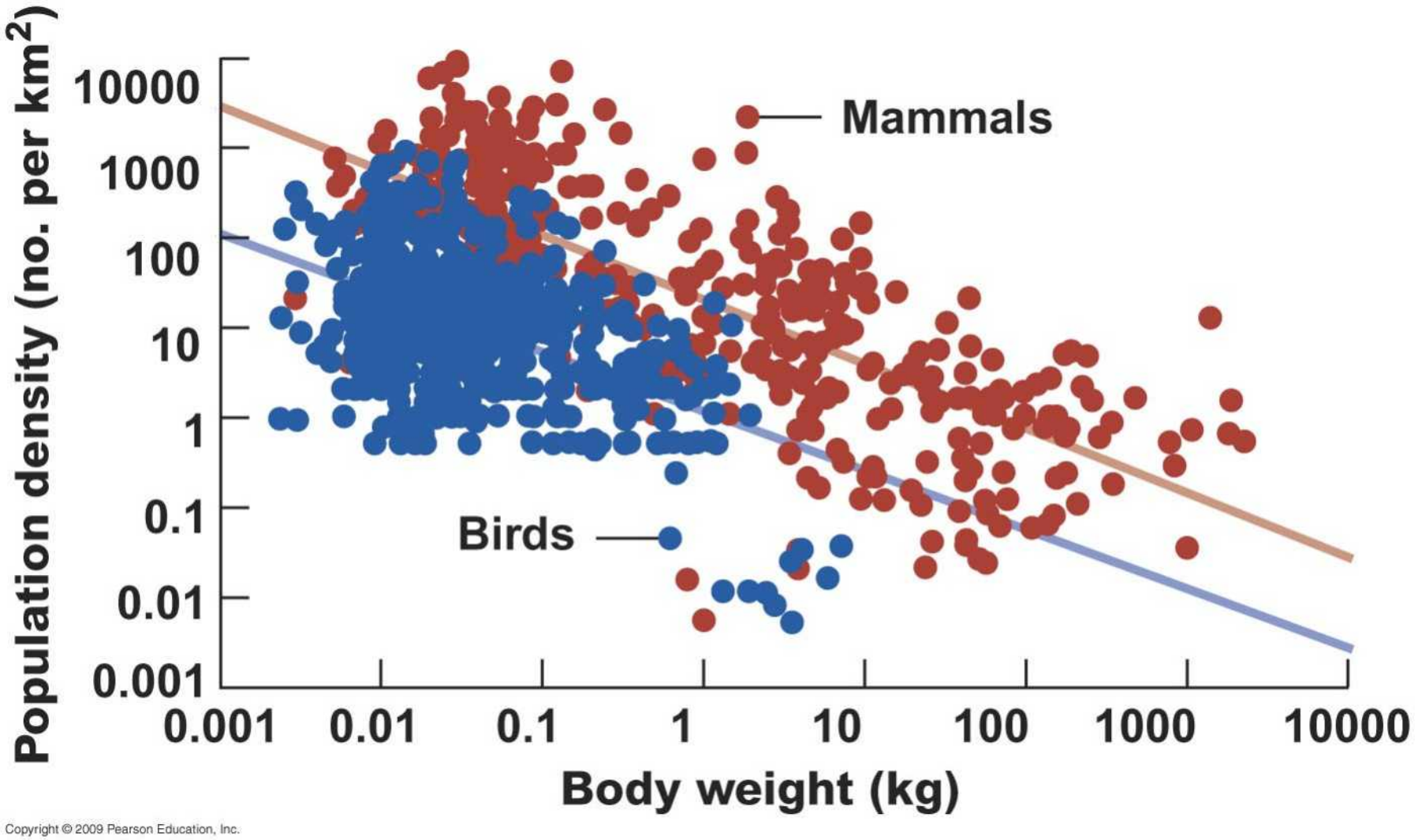
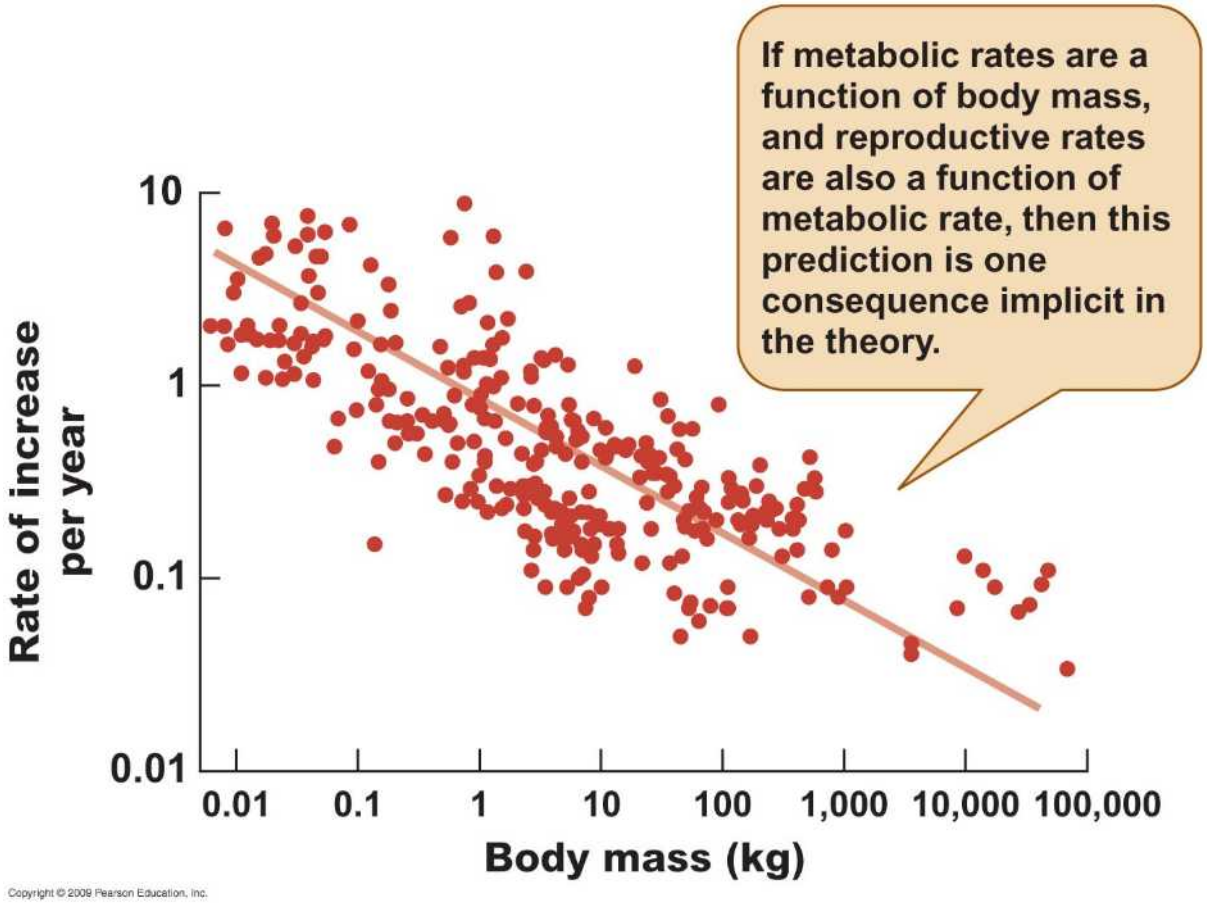


FIG. 6. Mass dependence of population density in terrestrial mammals (data sources are listed in Ernest et al. [2003], including data from Damuth [1987]). Density was measured as no. individuals/km², and mass was measured in grams. Data were analyzed without temperature correction because mammals have very similar body temperatures. The slope of this relationship gives an allometric exponent close to the predicted value of −¾ (95% CI, −0.72 to −0.82). There is considerable variation in the densities of mammals of similar size, which is not surprising since the data are for all kinds of mammals from throughout the world. So, for example, some of the residual variation is related to trophic level: carnivores with lower rates of resource supply tend to have lower population densities than herbivores.

Teoría metabólica de la ecología



Teoría metabólica de la ecología



Teoría metabólica de la ecología

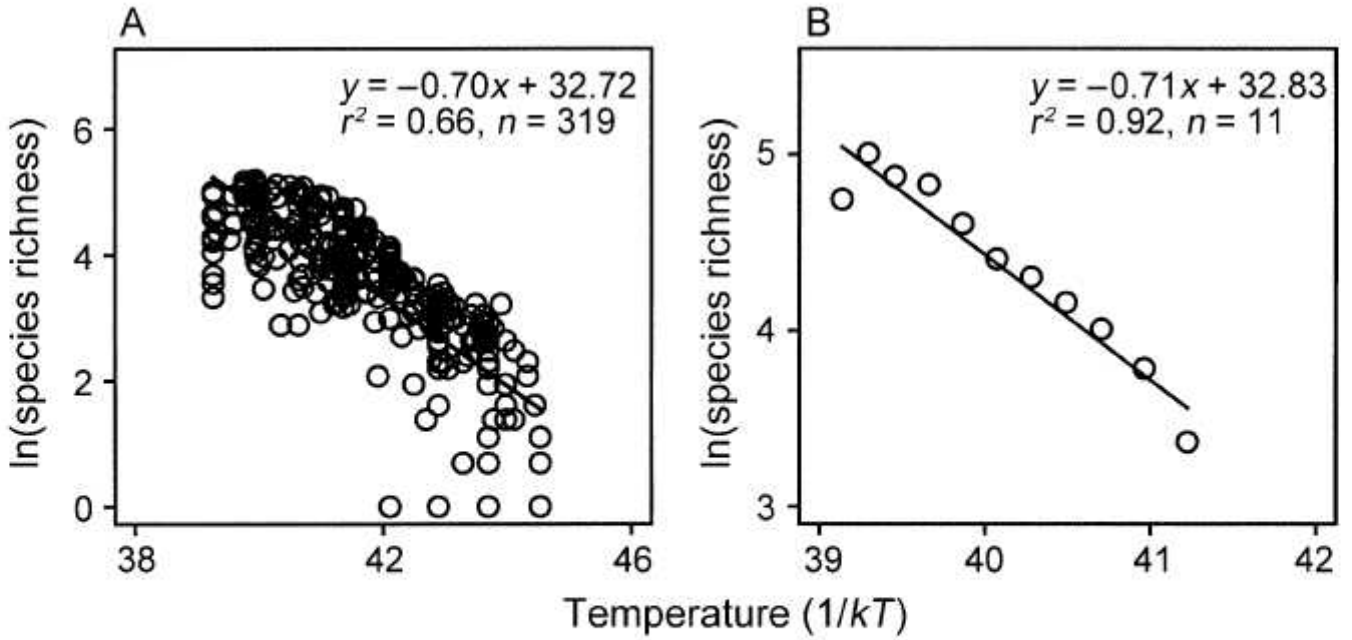


FIG. 7. Temperature dependence (temperature measured in K) of amphibian species richness in two geographic gradients (Allen et al. 2002). (A) A latitudinal gradient in North America (data from Currie 1991). (B) An elevational gradient over 2600 m on Volcan Barva in Costa Rica (data from Duellman 1988). The slopes indicate nearly identical effects of temperature on diversity in the two gradients, with activation energies close to the predicted value of 0.60–0.70 eV (95% confidence intervals, from left to right, 0.63–0.77 and 0.55–0.87).

Fuente: Brown et al. (2004) Ecology 85: 1771-1789

Teórica 13: Recapitulación

- La energía fijada por las plantas fluye a los herbívoros o al detrito, o se pierde en la respiración
- La proporción de PP consumida varía entre tipos de ecosistema; en general es mayor en ambientes acuáticos que en terrestres
- En general hay baja eficiencia en la transferencia de energía entre niveles tróficos
- La PS está limitada por la PP
- La teoría metabólica de la ecología es un intento de relacionar procesos fisiológicos de los individuos con procesos poblacionales y ecosistémicos