VARIABILNOST STABILNIH IZOTOPOV LAHKIH ELEMENTOV TER NJIHOVA RABA V GOZDARSTVU IN EKOLOGIJI

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XXXIV. GOZDARSKI ŠTUDIJSKI DNEVI

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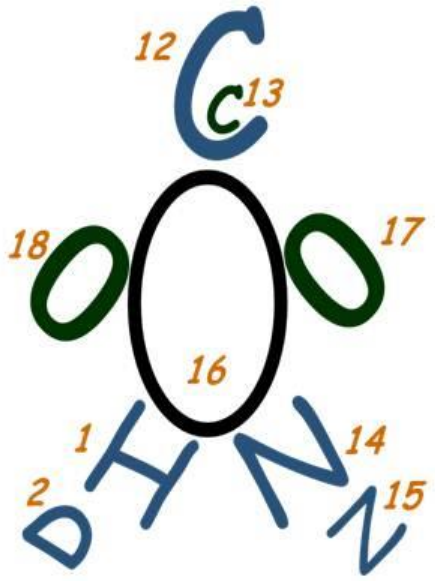
STABILNI IZOTOPI

ELEMENT	STABILNI IZOTOPI	ZASTOPANOST NA ZEMLJI (%)
Ogljik	^{12}C ^{13}C	98.9 1.1
Dušik	^{14}N ^{15}N	99.6 0.4
Vodik	^{1}H ^{2}H (D)	99.99 0.01
Kisik	^{16}O ^{18}O ^{17}O	99.76 0.20 0.04
Žveplo	^{32}S ^{34}S ^{33}S ^{36}S	95.00 4.20 0.70 0.01



„Gospodič Izotop.“, Vir: Wikipedia

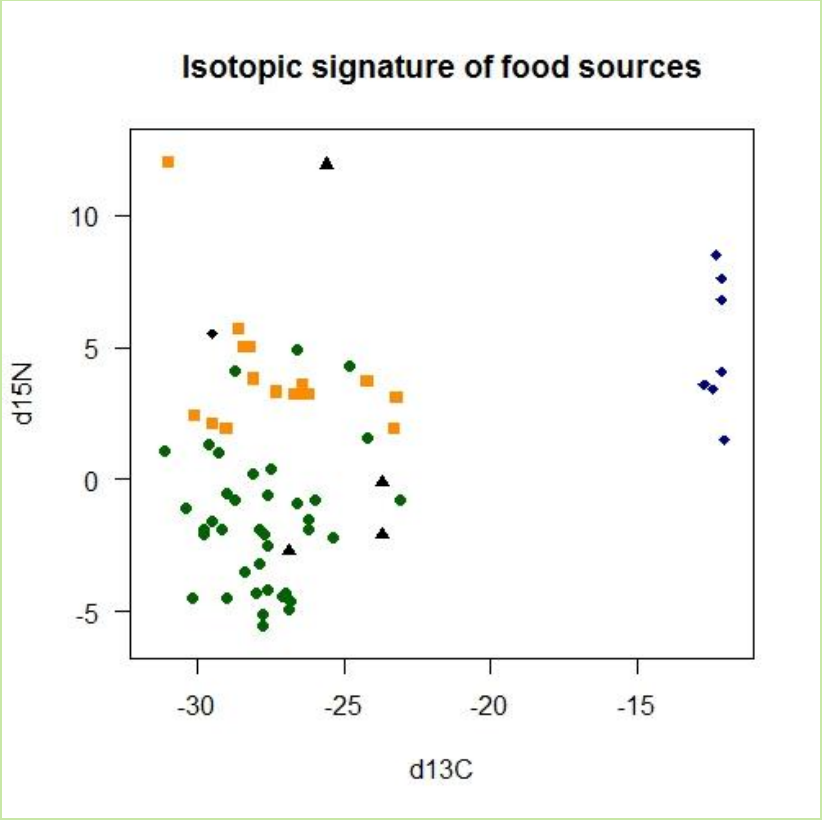
Povzeto in prirejeno po: Sulzman, 2007. V: Stable isotopes in Ecology and Environmental Science. Blackwell Publishing, 2nd edition

STABILNI IZOTOPI

- Izotopsko sestavo snovi vzorca izražamo v „delta“ (δ) notaciji.

$$\delta^{j}X = \left(\frac{Izotop.sestava\ vzorca}{Izotop.\ sestava\ standarda} - 1\right) \text{X } 1000\ [‰]$$

Foto: Maria Poca

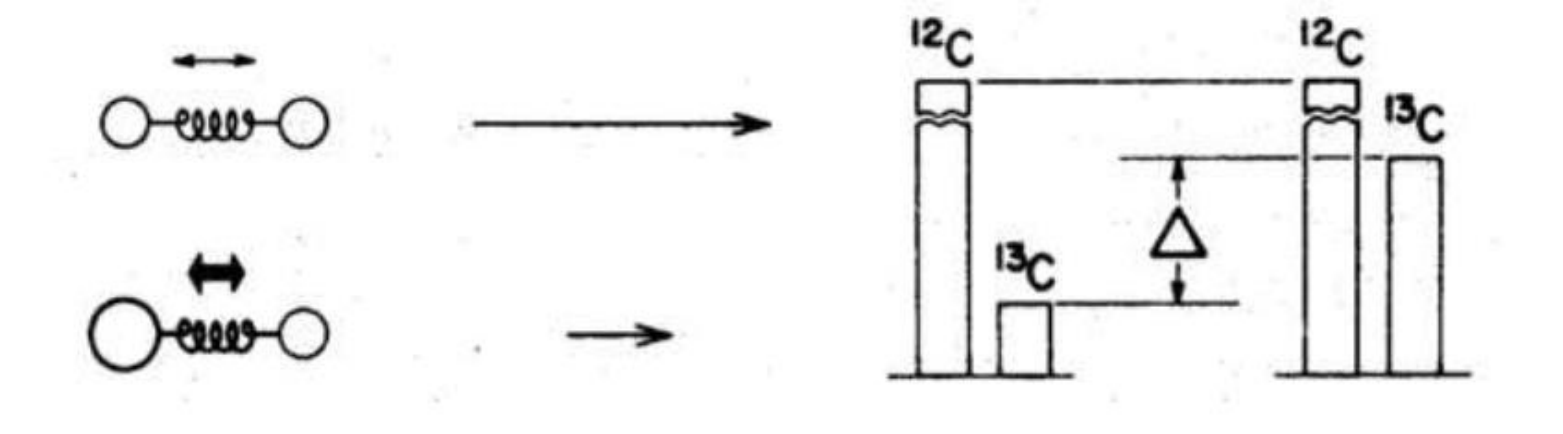


IZOTOPSKA SEPARACIJA

- Zaradi razlik v masi imajo izotopi drugačne fizikalne lastnosti.

- „Lažji“ izotopi reagirajo in difundirajo hitreje, kot „težji“.

- Posledica tega je **separacija izotopov**.



STABILNI IZOTOPI KOT RAZISKOVALNO ORODJE

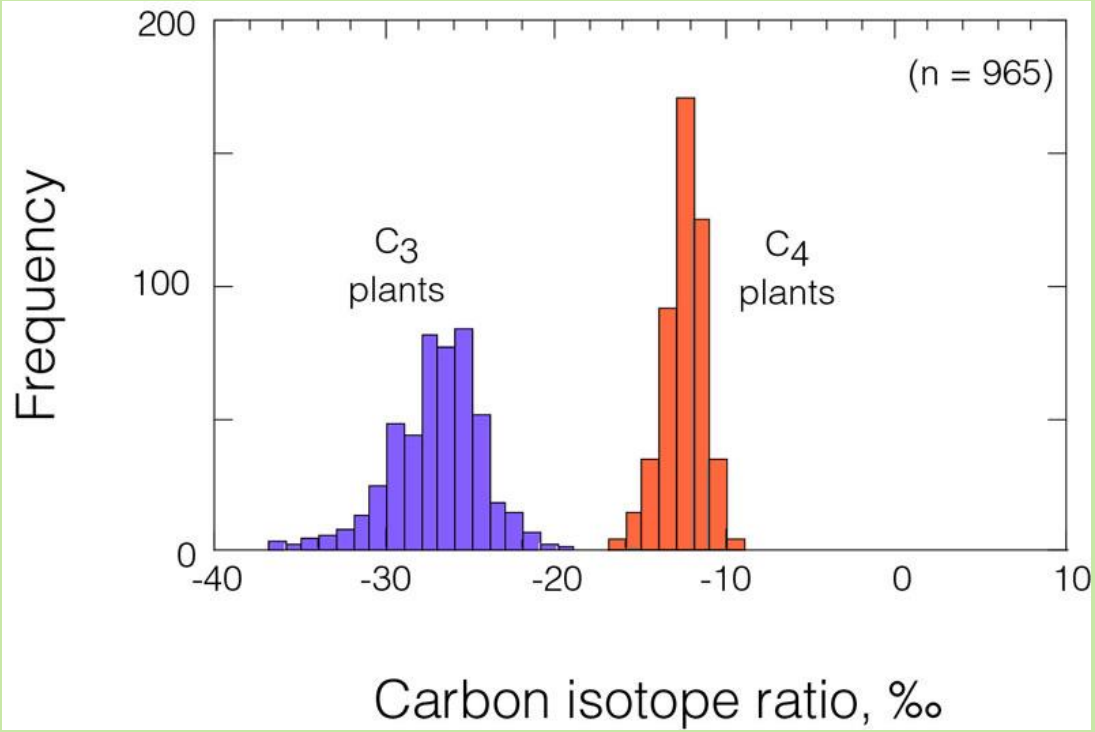
- Predpogoj za rabo stabilnih izotopov so **merljive razlike v izotopski sestavi** proučevanih sistemov/ snovi.

- Dva pristopa:
  - Izotopsko Označevanje „Isotope labelling“,
  - **Raziskave temelječe na naravni variabilnosti izotopske sestave.**

VARIABILNOST IZOTOPSKE SESTAVE OGLJIKA

- Rastline (primarni producenti) ustvarjajo veliko večino variabilnosti $\delta^{13}C$ vrednosti v kopenskih ekosistemih.

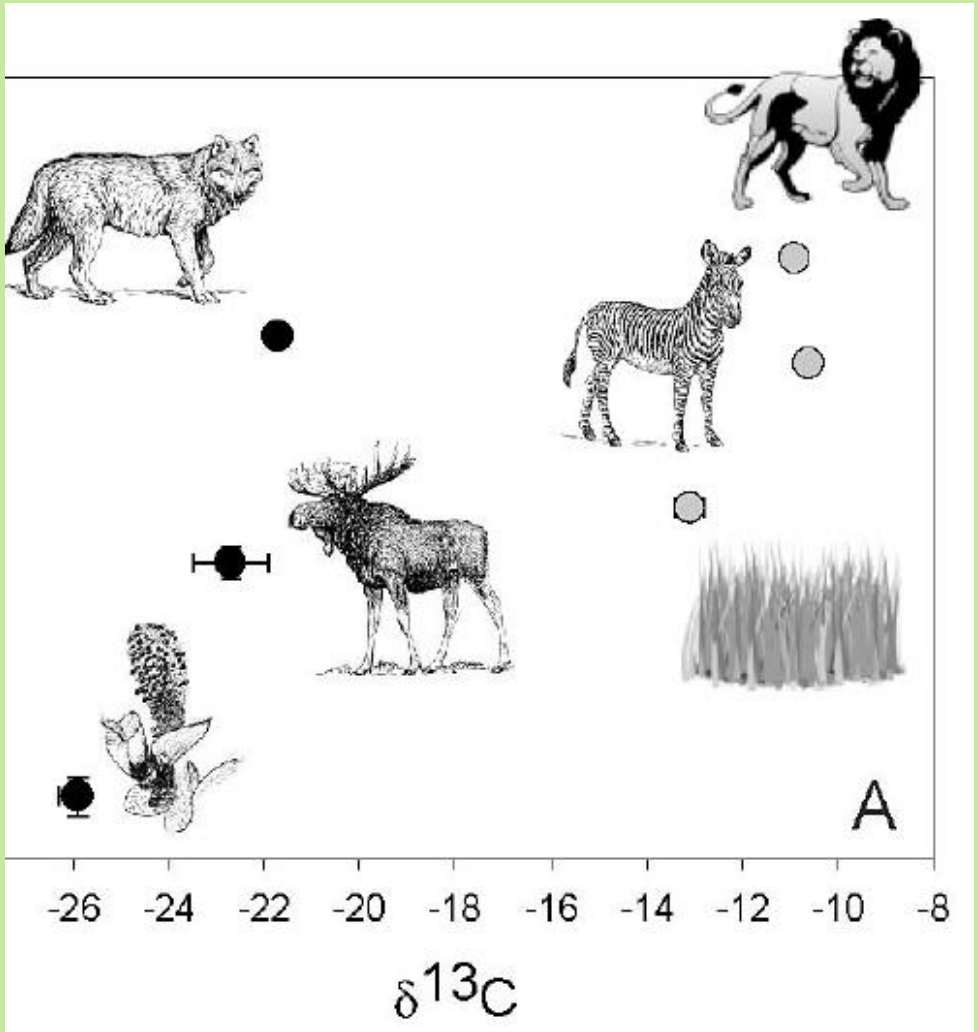
- TIP FOTOSINTEZE:



Vir: Cerling et al., 1997. *Nature* 389: 153–158

VARIABILNOST IZOTOPSKE SESTAVE OGLJIKA

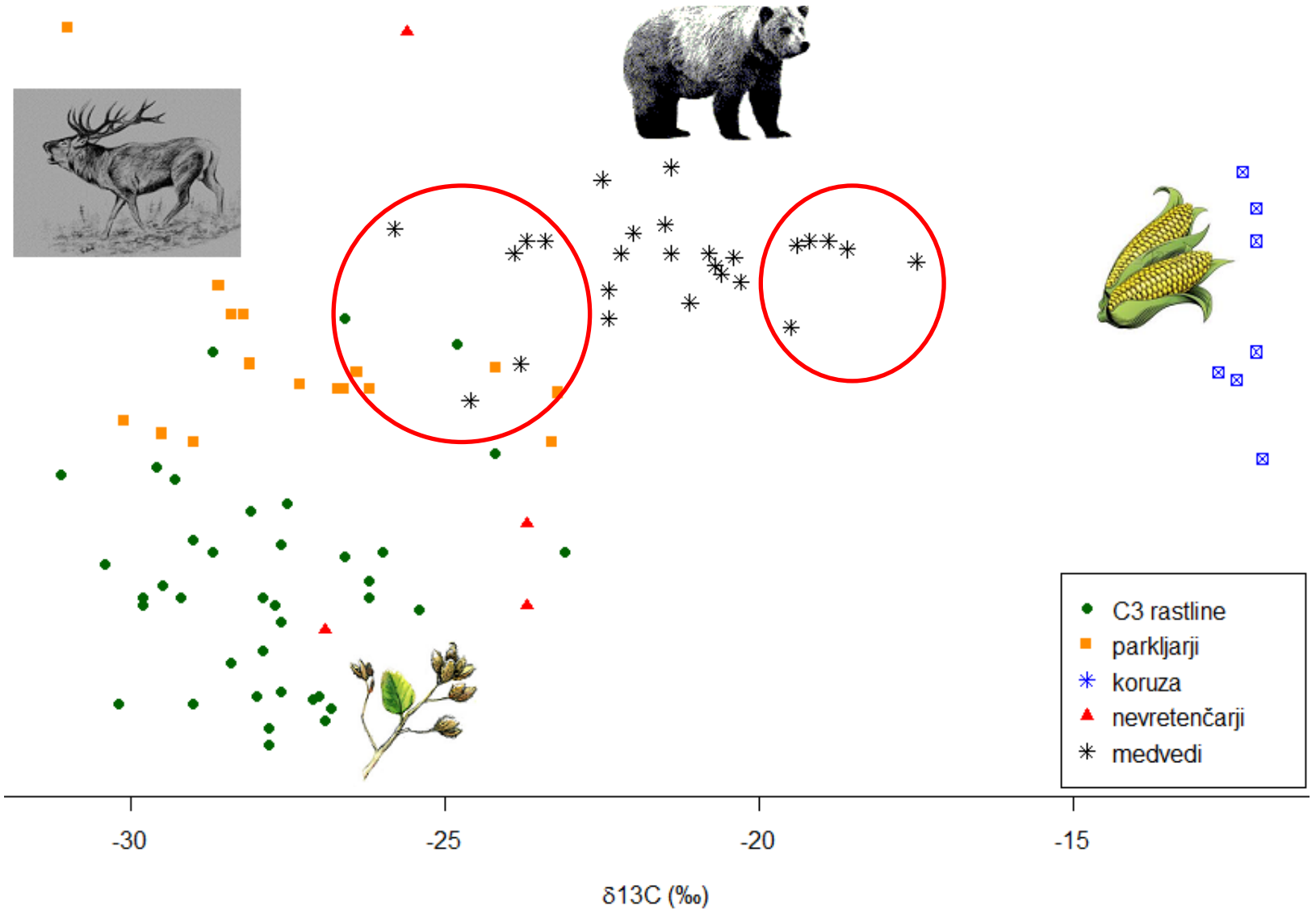
- C3 IN C4 RASTLINE V PREHRANI ŽIVALI:



Prirejeno po: Ben-David & Flaherty, 2012. *Journal of Mammalogy 93 (2)*: 312 -328

„You are what you eat (plus few permils)!“

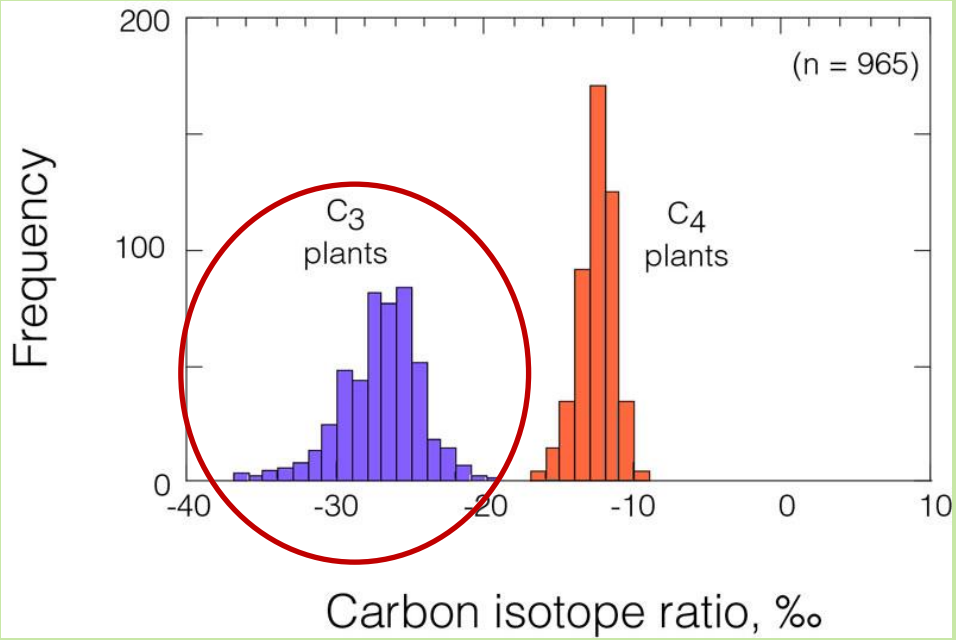
DeNiro & Epstein, 1976. Geological Society of America. Abstracts with Programs 8: 834–835.


C3 rastline
parkljarji
koruza
nevretenčarji
medvedi
-30
-25
-20
-15
δ13C (‰)

VARIABILNOST IZOTOPSKE SESTAVE OGLJIKA

- VARIABILNOST $\delta^{13}C$ VREDNOSTI MED C3 RASTLINAMI:

Na $\delta^{13}C$ vrednosti pomembno vpliva razmerje med koncentracijo intercelularnega (c_i) ter atmosferskega (c_a) CO_2 – c_i/c_a .



Vir: Cerling et al., 1997. *Nature* 389: 153–158

Fig. 4. Carbon isotope discrimination values of growth chamber grown *Salicornia europaea* ssp. *rubra* according to ψ_s of the nutrient solution. Values are not corrected for the isotopic composition of the growth chamber air

Fig. 5. Carbon isotope discrimination values of growth chamber grown *Puccinellia nuttalliana* according to ψ_s of the nutrient solution. Values are not corrected for the isotopic composition of the growth chamber air

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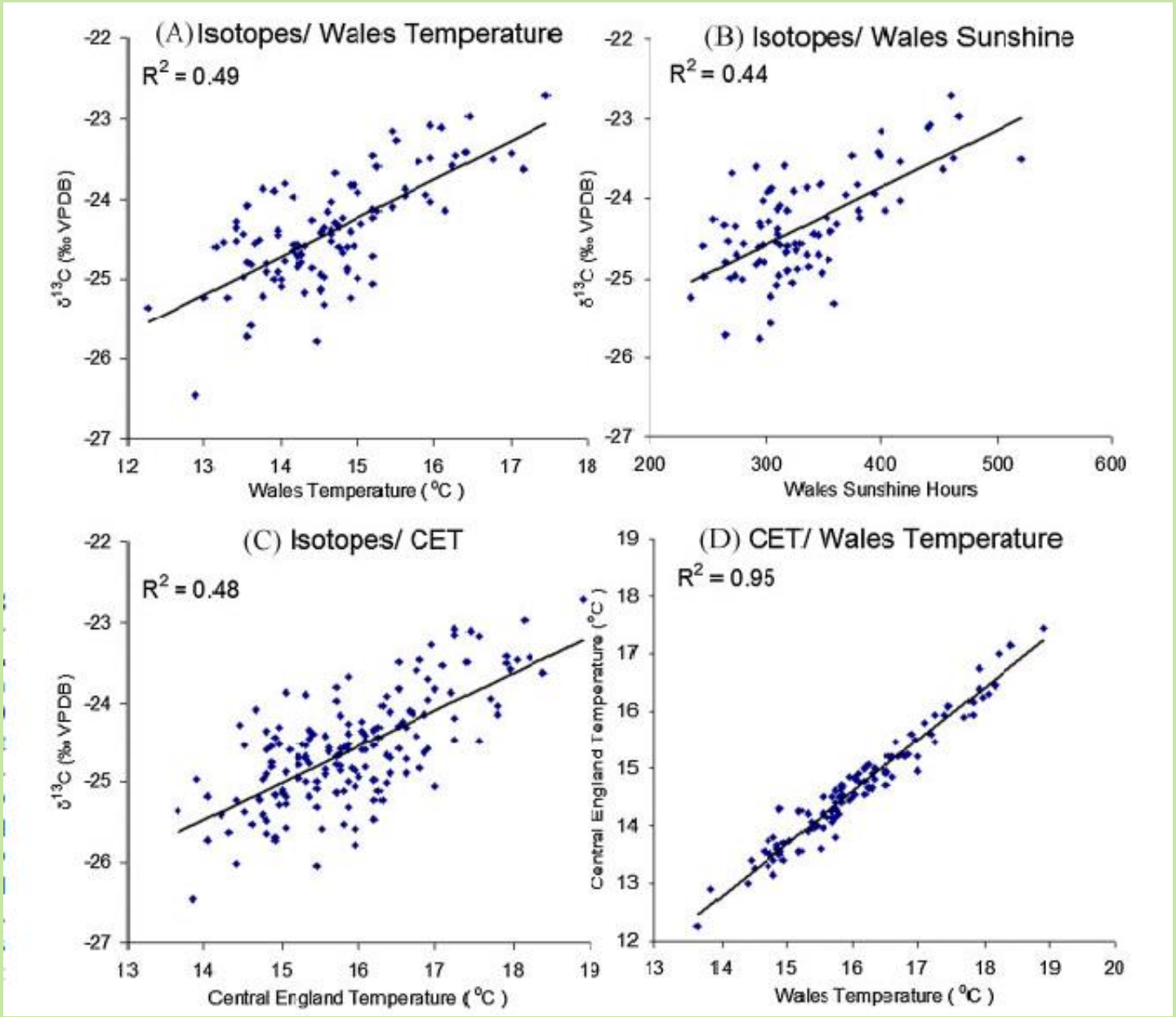
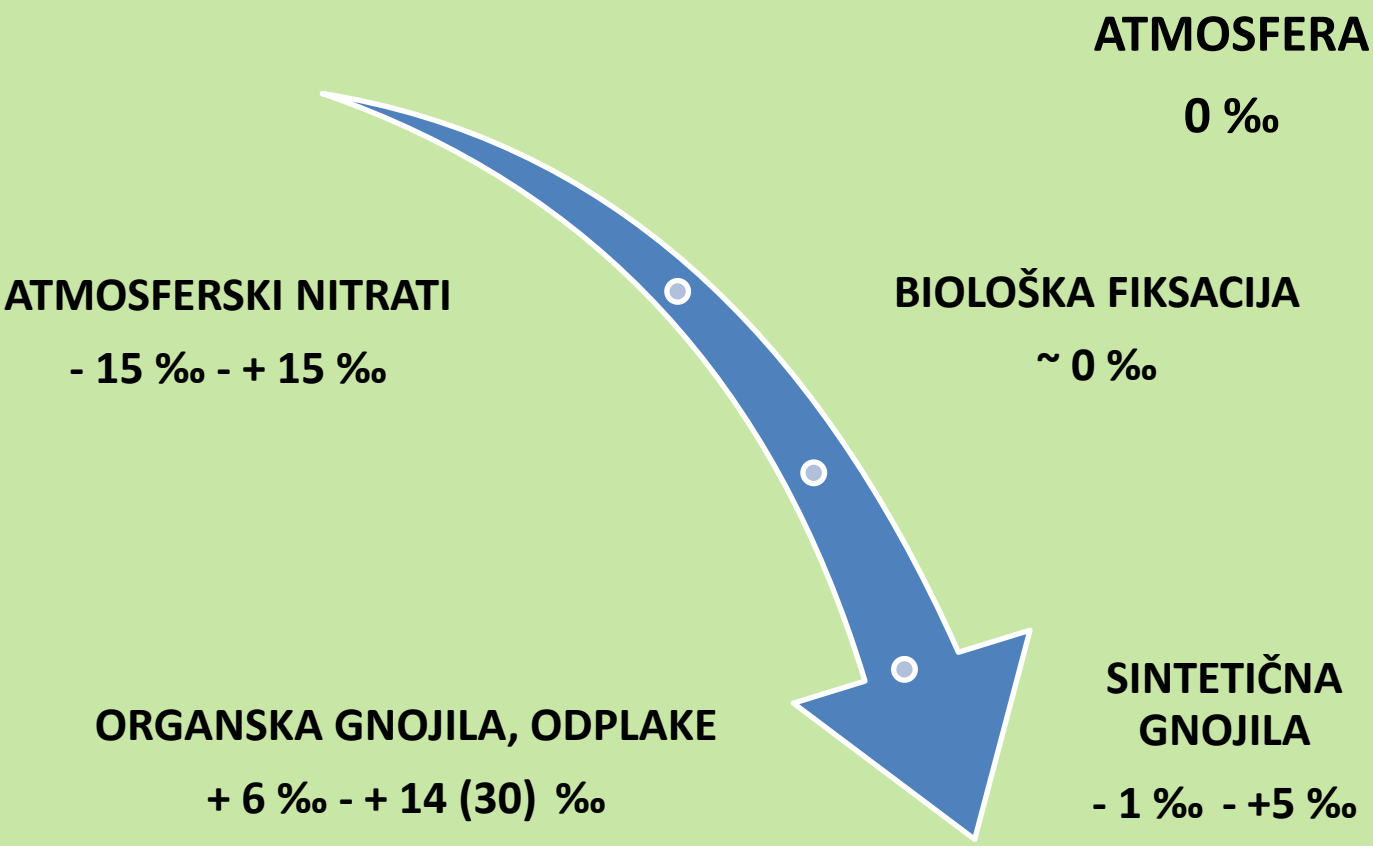
Vir: Guy et al., 1980. *Oecologia* 44: 241-247

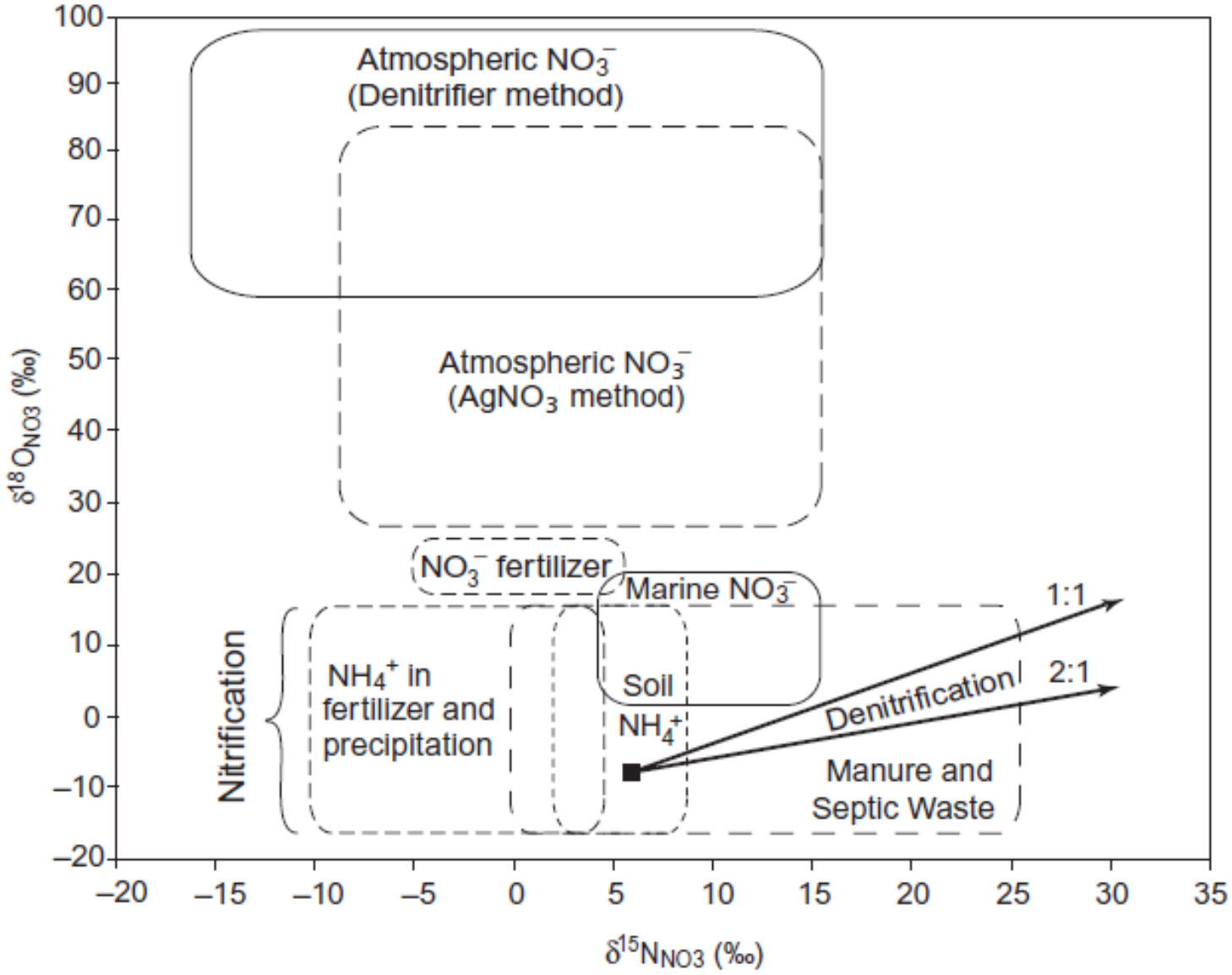


Vir: Young et al., 2012. *Journal of Quaternary Science 27(6)*: 606-614

VARIABILNOST IZOTOPSKE SESTAVE DUŠIKA

- δ^{15}N VREDNOSTI VIROV DUŠIKA:





Vir: Kendall, 2007. V: Stable isotopes in Ecology and Environmental Science. Blackwell Publishing, 2nd edition

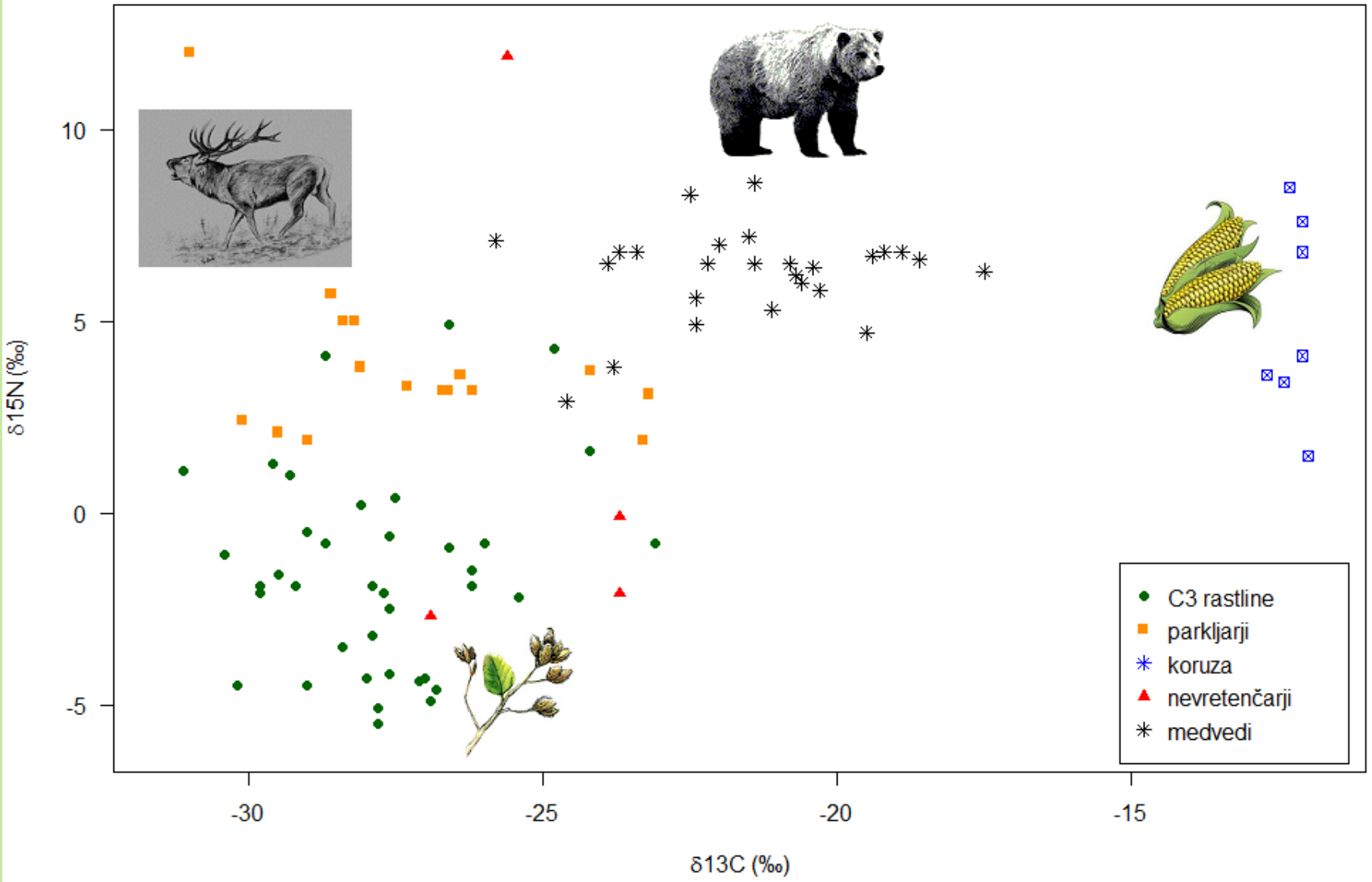
VARIABILNOST IZOTOPSKE SESTAVE DUŠIKA

- δ^{15}N VREDNOSTI RASTLIN:

  So odvisne zlasti od:

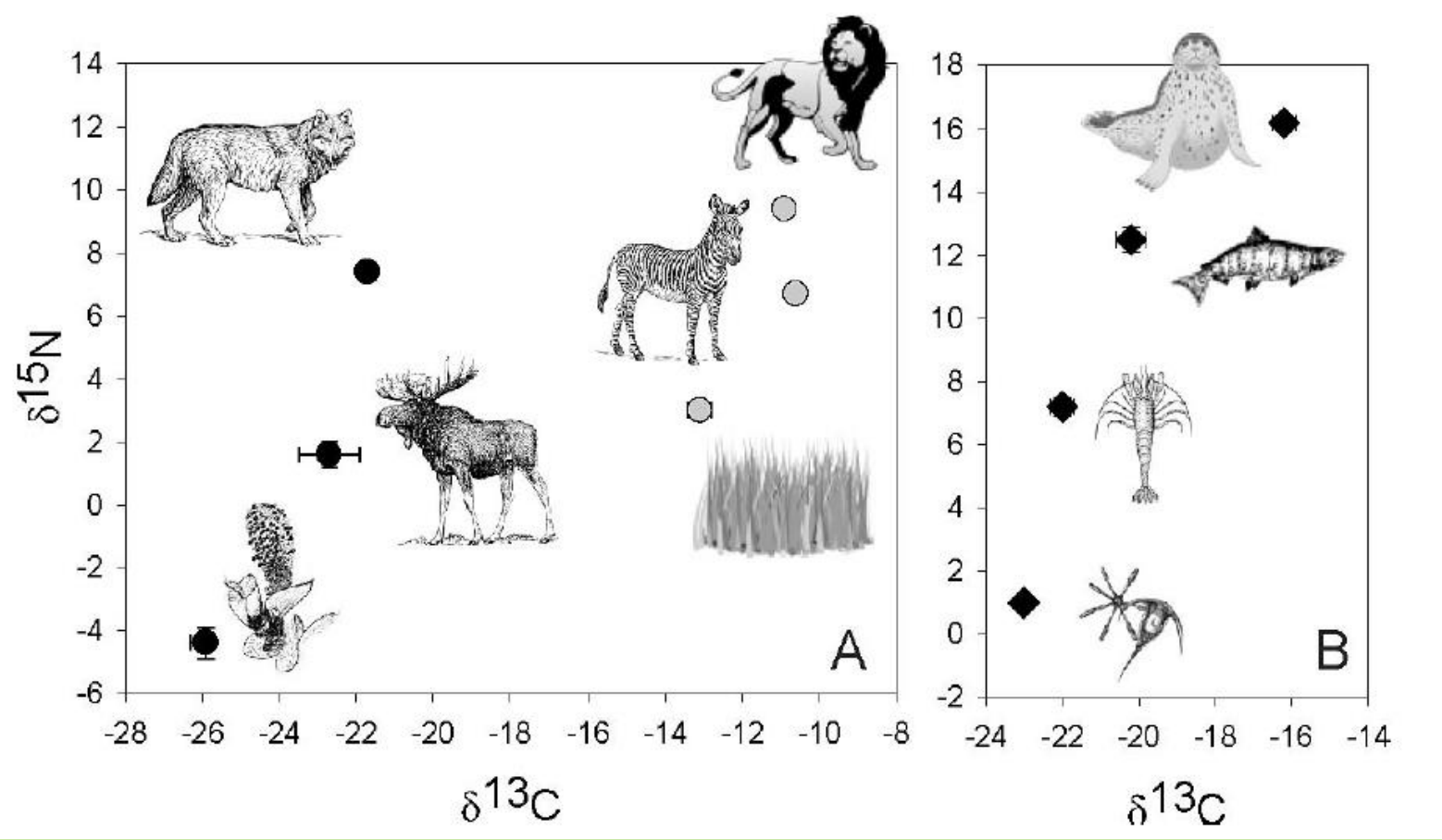
  – δ^{15}N vrednosti vira dušika v tleh (~ + 2 ‰ - *+ 5* ‰),

  – tipa mikorize.


10
5
0
-5
δ15N (‰)
-30
-25
-20
-15
δ13C (‰)
C3 rastline
parkljarji
koruza
nevretenčarji
medvedi

VARIABILNOST IZOTOPSKE SESTAVE DUŠIKA

- DOLOČANJE TROFIČNEGA NIVOJA:



Vir: Ben-David & Flaherty, 2012. *Journal of Mammalogy 93 (2)*: 312 -328

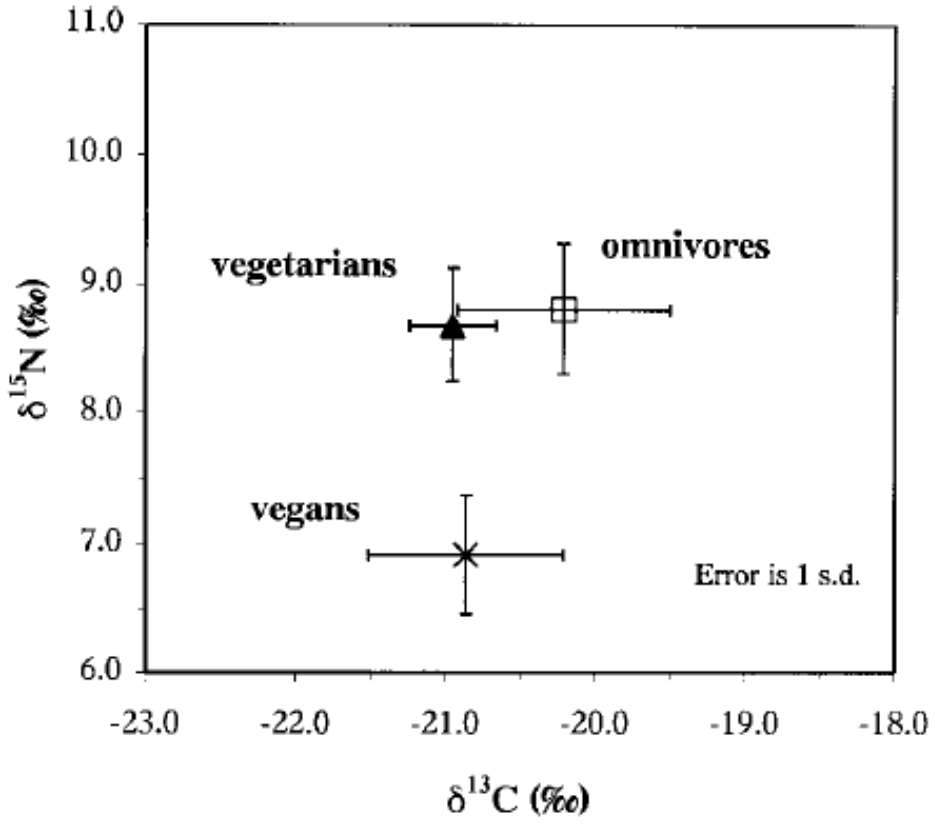


Fig. 2. Mean isotopic analyses for each dietary preference group.

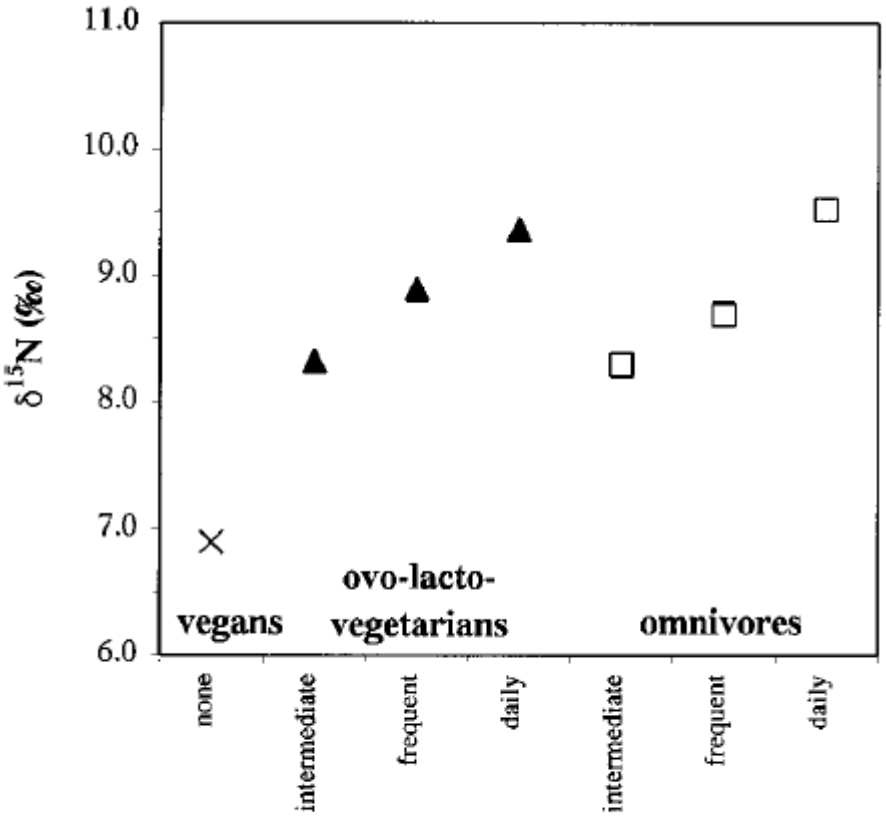


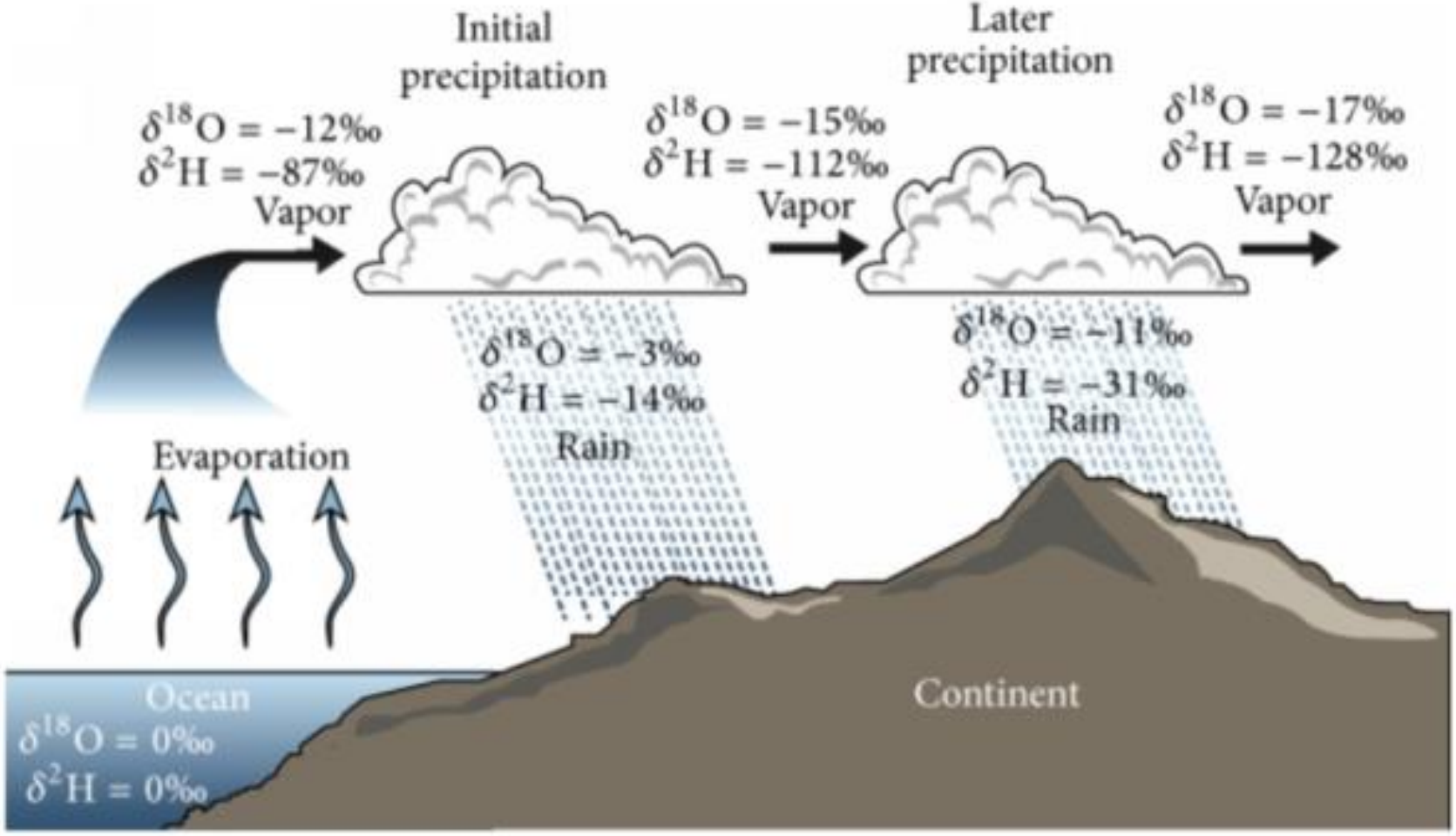
Fig. 3. Dependence of mean hair nitrogen isotopic values on the frequency of animal protein consumption for each dietary group.

Vir: O'Connell & Hedges, 1999. *American Journal of Physical Anthropology 108*: 409 - 425

VARIABILNOST IZOTOPSKE SESTAVE VODE (VODIKA IN KISIKA)

- Variabilnost δD in δ^{18}O v ekosistemih je zato tesno povezana z značilnostmi vodnega kroga.

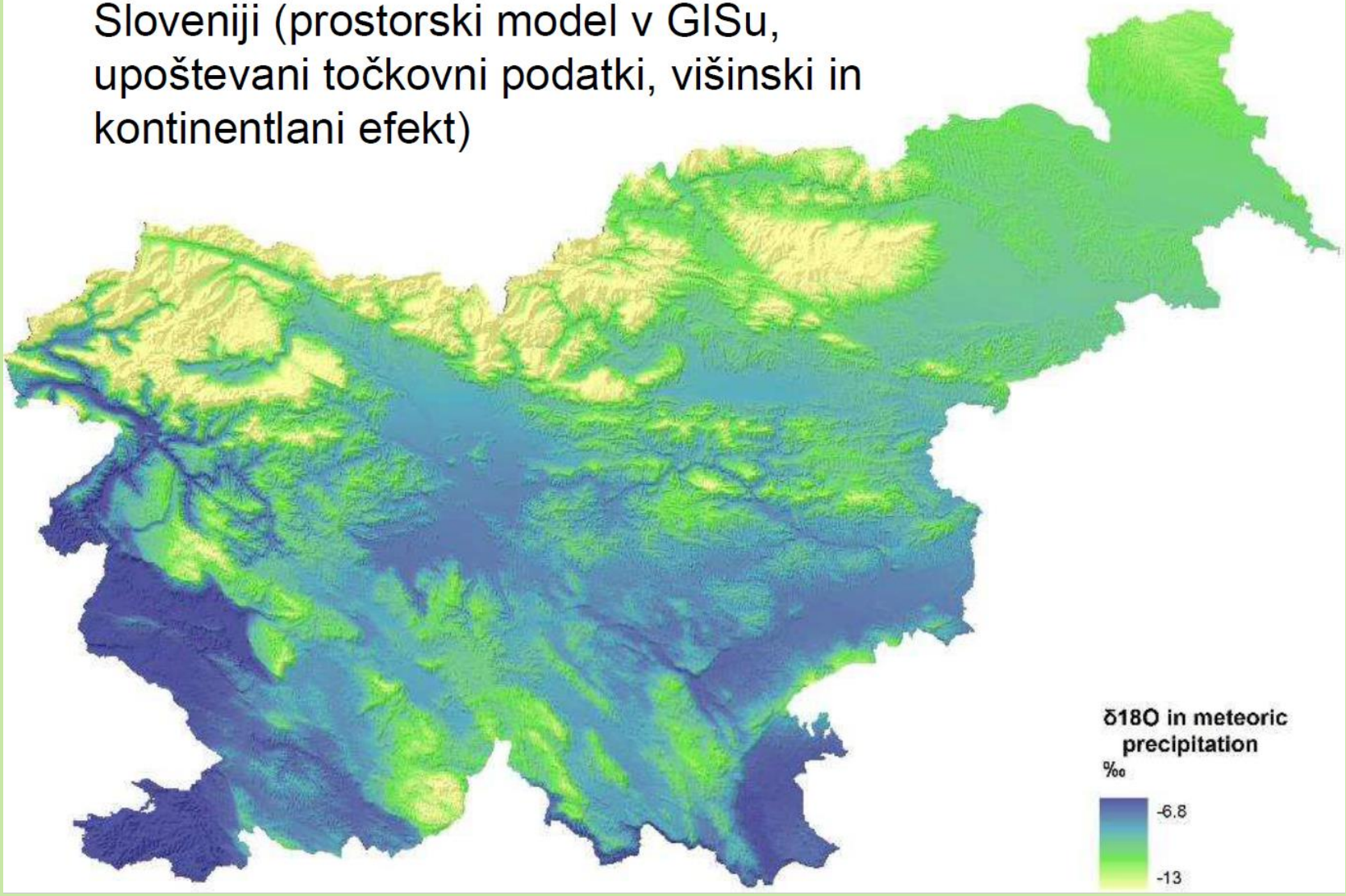
- Izotopska separacija je sestavni del prehoda vode iz plinastega in tekočega stanja (in obratno) in je ključni faktor variabilnosti δD in δ^{18}O vrednosti.


Initial precipitation
Later precipitation
$\delta^{18}O = -12‰$
$\delta^{2}H = -87‰$
Vapor
$\delta^{18}O = -15‰$
$\delta^{2}H = -112‰$
Vapor
$\delta^{18}O = -17‰$
$\delta^{2}H = -128‰$
Vapor
$\delta^{18}O = -3‰$
$\delta^{2}H = -14‰$
Rain
$\delta^{18}O = -11‰$
$\delta^{2}H = -31‰$
Rain
Evaporation
Ocean
$\delta^{18}O = 0‰$
$\delta^{2}H = 0‰$
Continent

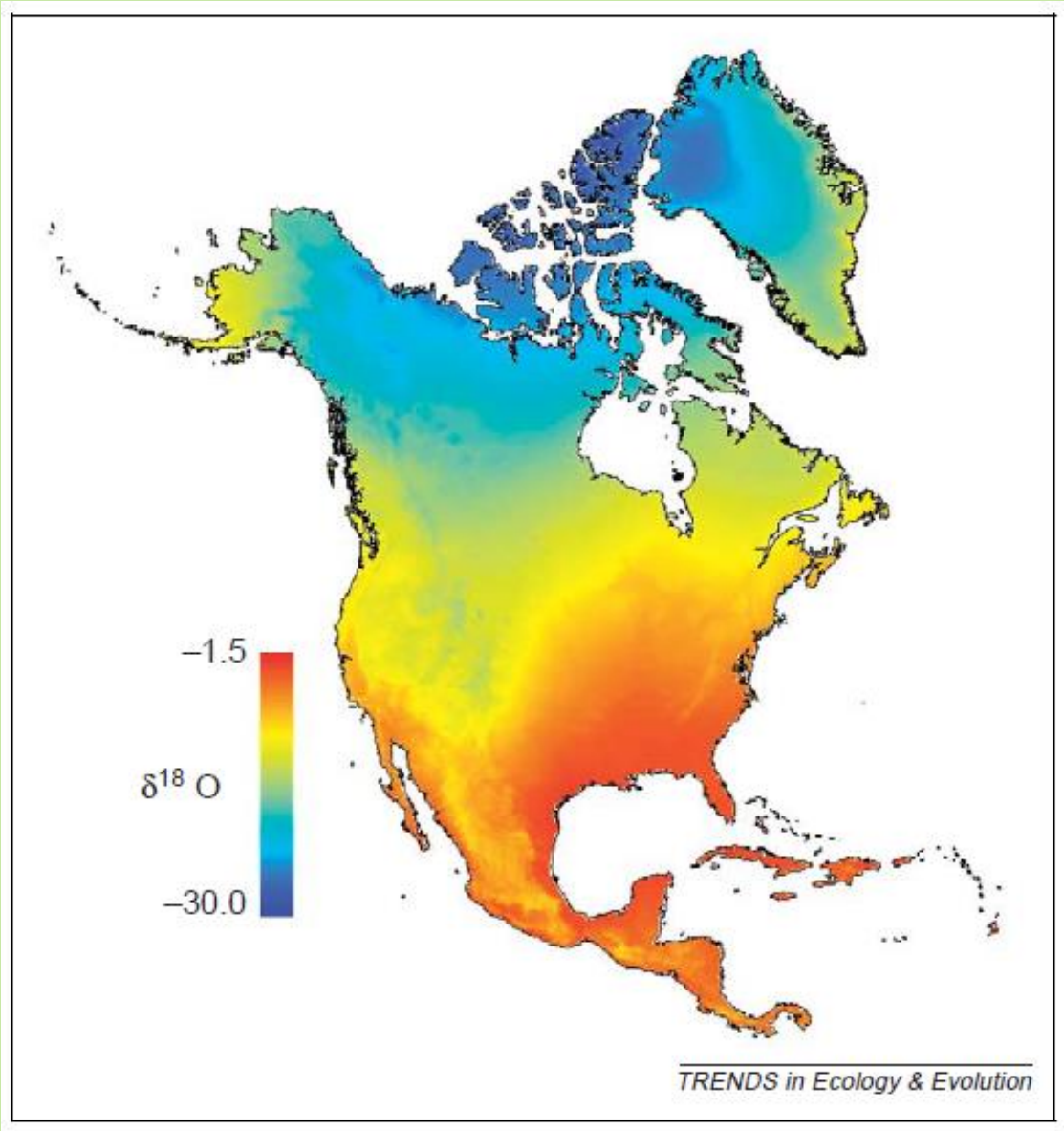
VARIABILNOST IZOTOPSKE SESTAVE VODE (VODIKA IN KISIKA)

- KAJ VPLIVA NA IZOTOPSKO SESTAVO PADAVIN?
  - Oddaljenost od morja,
  - nadmorska višina,
  - sezonske temperaturne razlike,
  - geografska širina.

Izotopska sestava kisika v padavinah v Sloveniji (prostorski model v GISu, upoštevani točkovni podatki, višinski in kontinentlani efekt)



Vir: Lojen & Kocman, 2017. Stabilni izotopi in geografsko poreklo hrane, I. Institut Jožef Stefan. Zapiski s predavanja.



Vir: West et al., 2006. *TRENDS in Ecology & Evolution 21 (7)*: 408 - 414

VARIABILNOST IZOTOPSKE SESTAVE ŽVEPLA

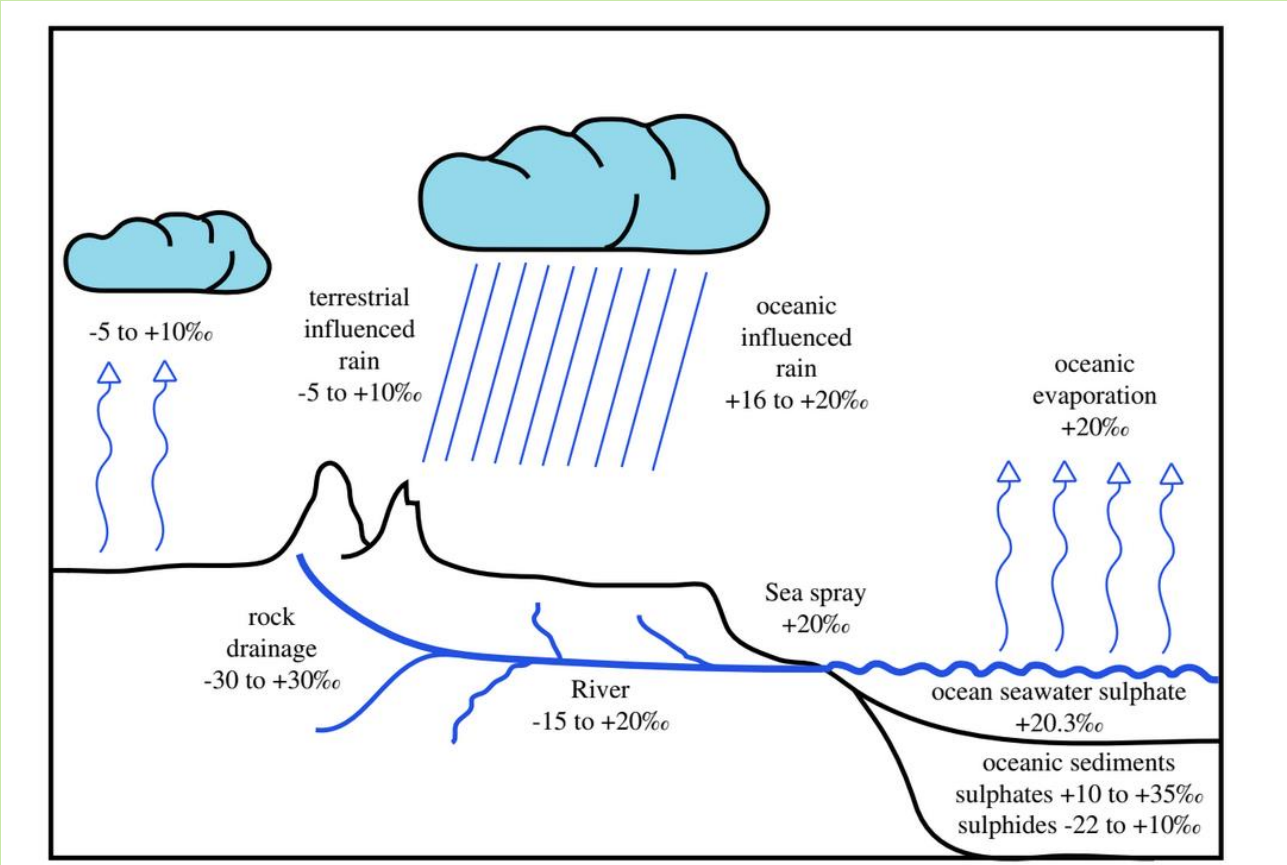
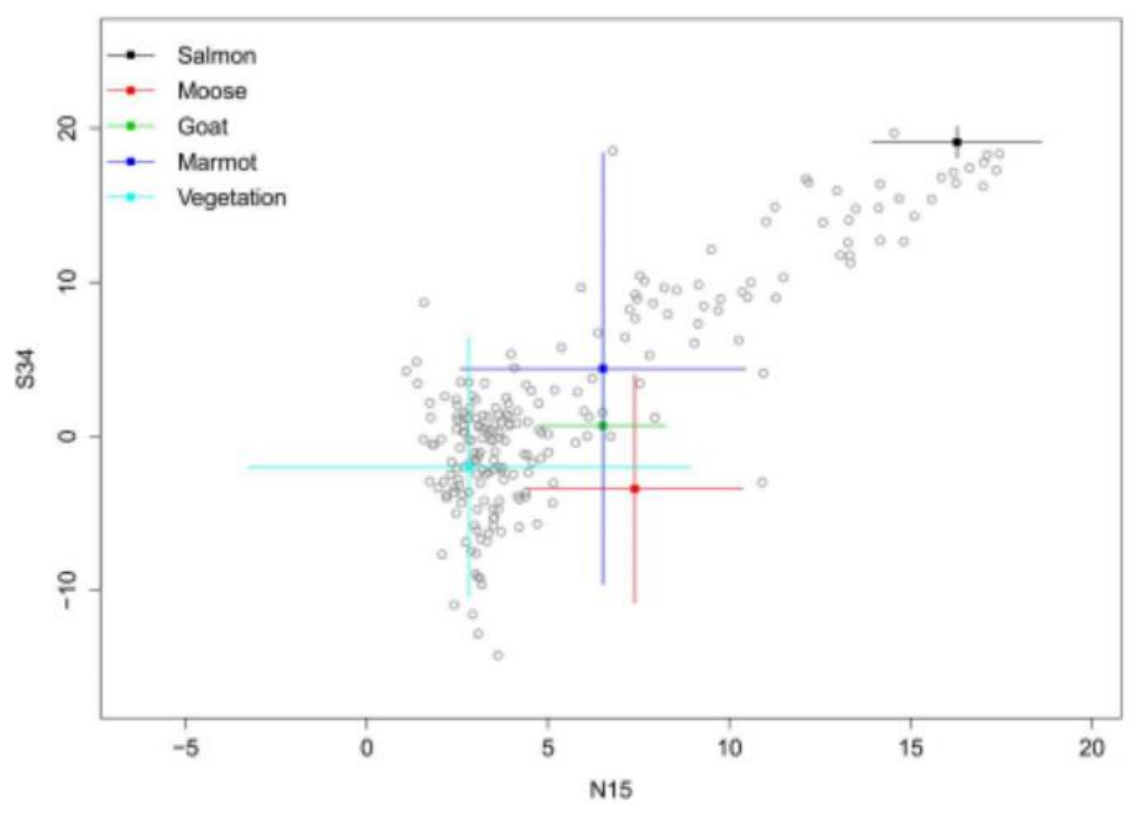


Fig. 2. Schematic overview of the cycling of sulphur and its expected sulphur isotope values within the environment.

Vir: Nehlich, 2015. *Earth-Science Reviews 142*: 1 - 17

VARIABILNOST IZOTOPSKE SESTAVE ŽVEPLA

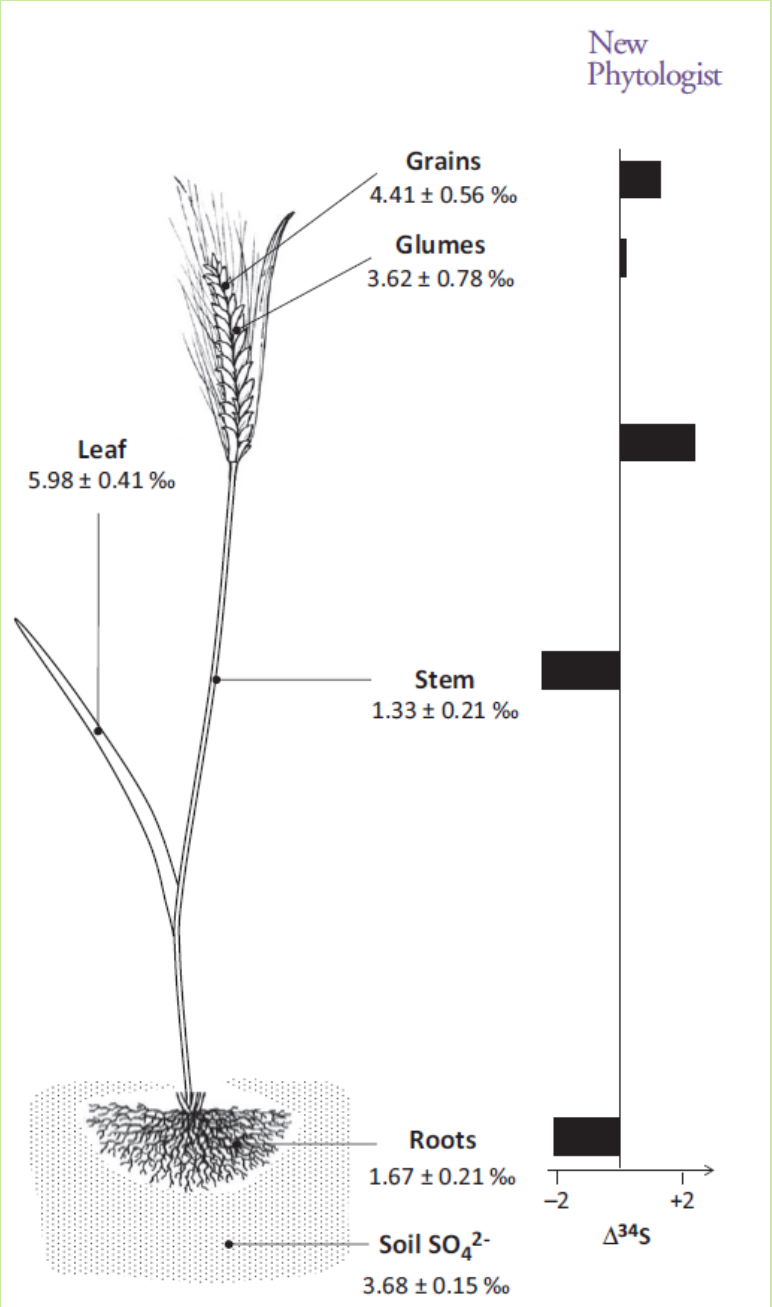
- δ^{34}S VREDNOSTI, KOT INDIKATOR HRANE MORSKEGA IZVORA



Vir: Mowat et al., 2017. PLoS ONE 12 (3)

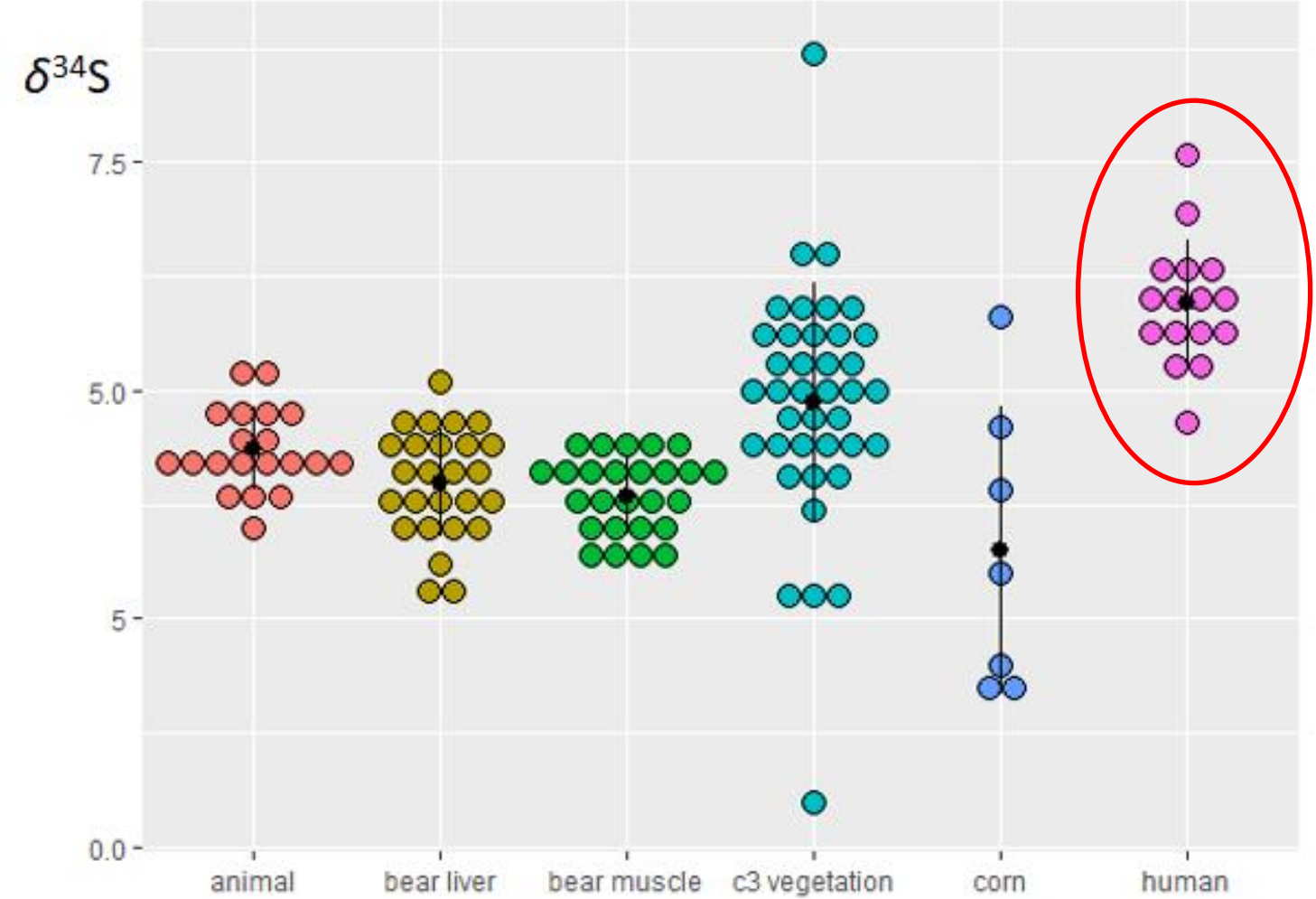
VARIABILNOST IZOTOPSKE SESTAVE ŽVEPLA

- $\delta^{34}S$ VREDNOSTI RASTLIN NJIHOVIH DELOV



Vir: Tcherkez & Tea, 2013. New Phytologist 200: 44-53

VARIABILNOST IZOTOPSKE SESTAVE ŽVEPLA



HVALA ZA VAŠO POZORNOST!