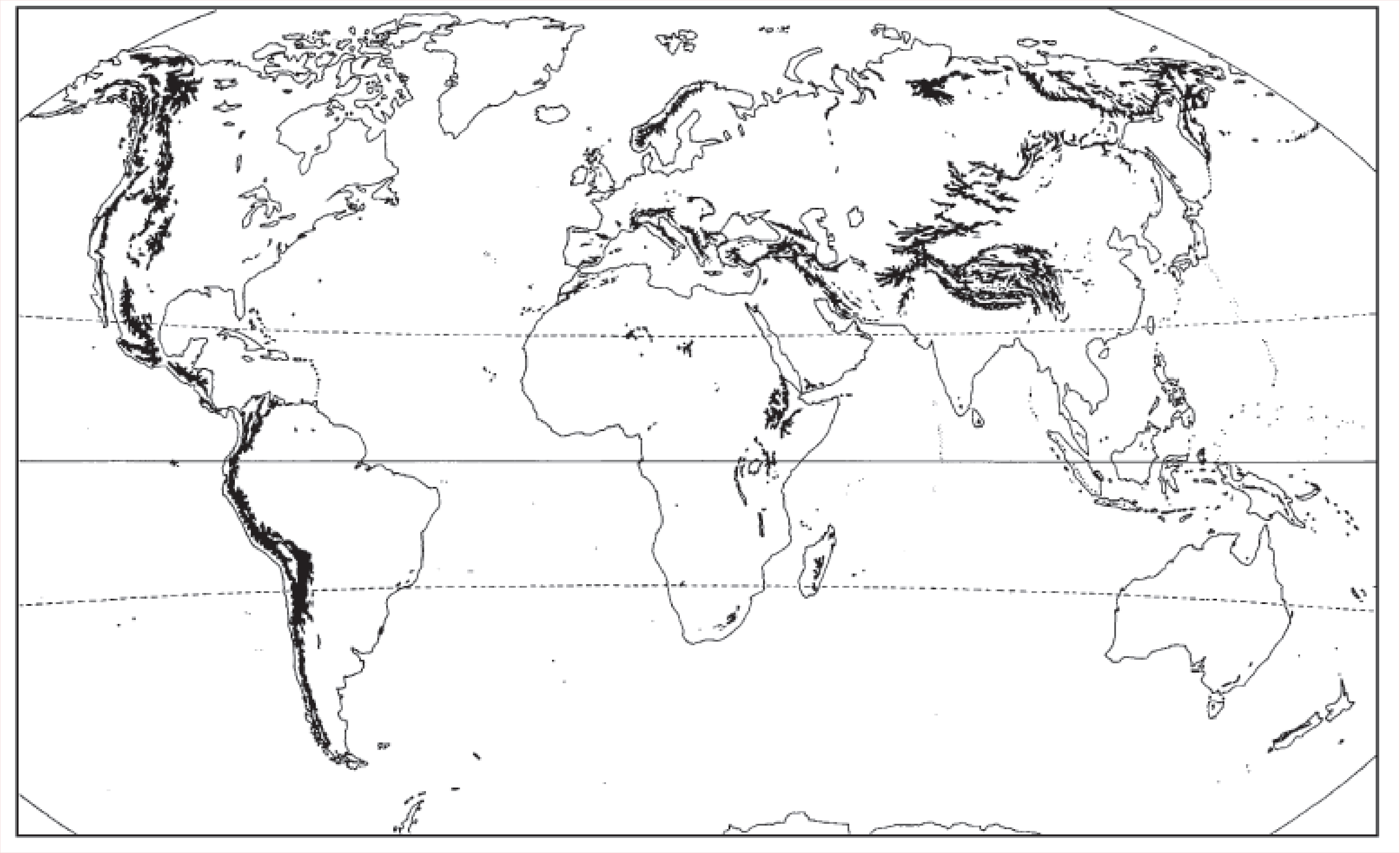
Ecología de plantas sistemas montañosos

Montañas del mundo



- **Este mapa parece no tener en cuenta sitios con montañas bajas (erosionadas) con afloramientos rocosos**

Importancia en el desarrollo de la biología

Centro de Origen

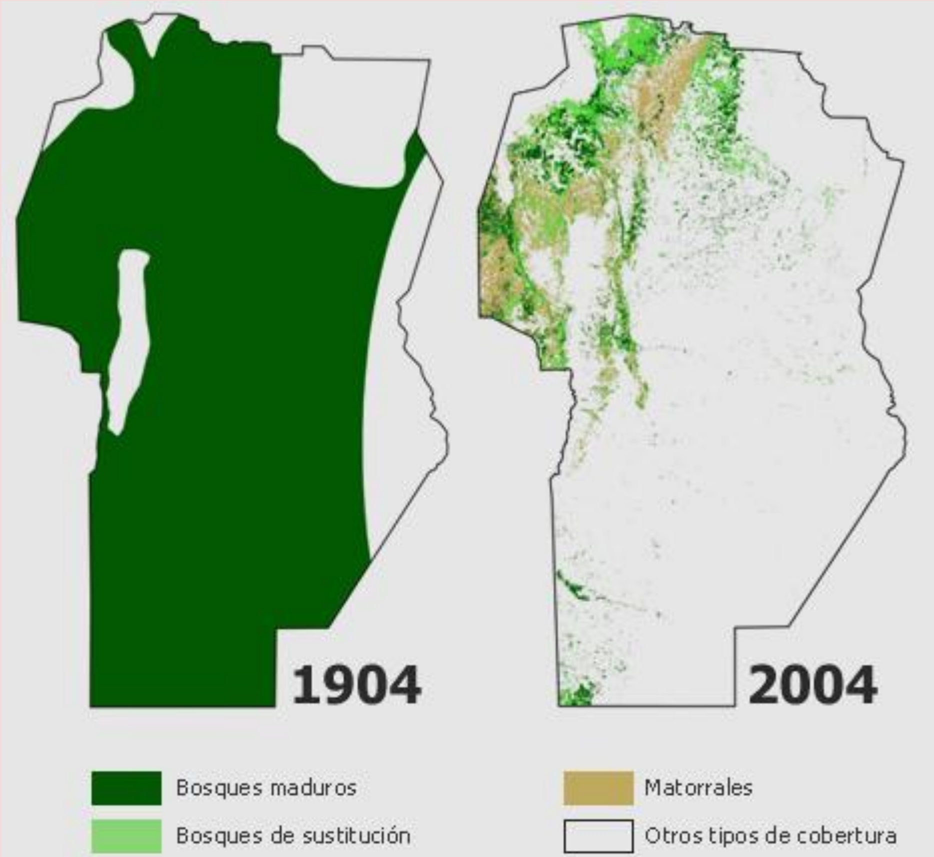
- Carl Linneo, observando los patrones altitudinales, propuso que el Eden era una montaña y que de ahí la biota se disperso a todo el mundo!!! Humboldt…

Importancia de Sistemas Montañosos

- Poseen una gran biodiversidad (mucho mayor que sistemas “planos”)
- Son un reservorio de biodiversidad (sistemas protegidos de usos intensivos, particularmente agricultura)
- Proveen servicios ecosistémicos: “agua”
- Sistemas interesantes para estudios básicos sobre distribución y efectos del cambio climático

Amenazas de los sistemas montañosos

- Son ambientes en serio riesgo de conservación
- Distintos usos del suelo/actividades: ganadería, urbanizaciones, minería, turismo
- Susceptibles al cambio climático



COBERTURA DE LA VEGETACIÓN DE LA PROVINCIA DE CÓRDOBA

a) Comienzos del siglo XX, reconstrucción a partir de información de Kurtz (1904)
b) Año 2004, elaborado por Cabido y Zak a partir de información satelital y control de campo.

Ambos mapas han sido modificados a los fines de esta publicación a partir de los originales de Kurtz (1904) y Zak y Cabido (2004)

- Debido a que no se puede realizar agricultura, las Sierras de Córdoba son el principal reservorio de ambientes naturales

- La mayor parte de los estudios en sistemas Alpinos (no particularmente en montañas) fueron realizados en Europa y América del Norte

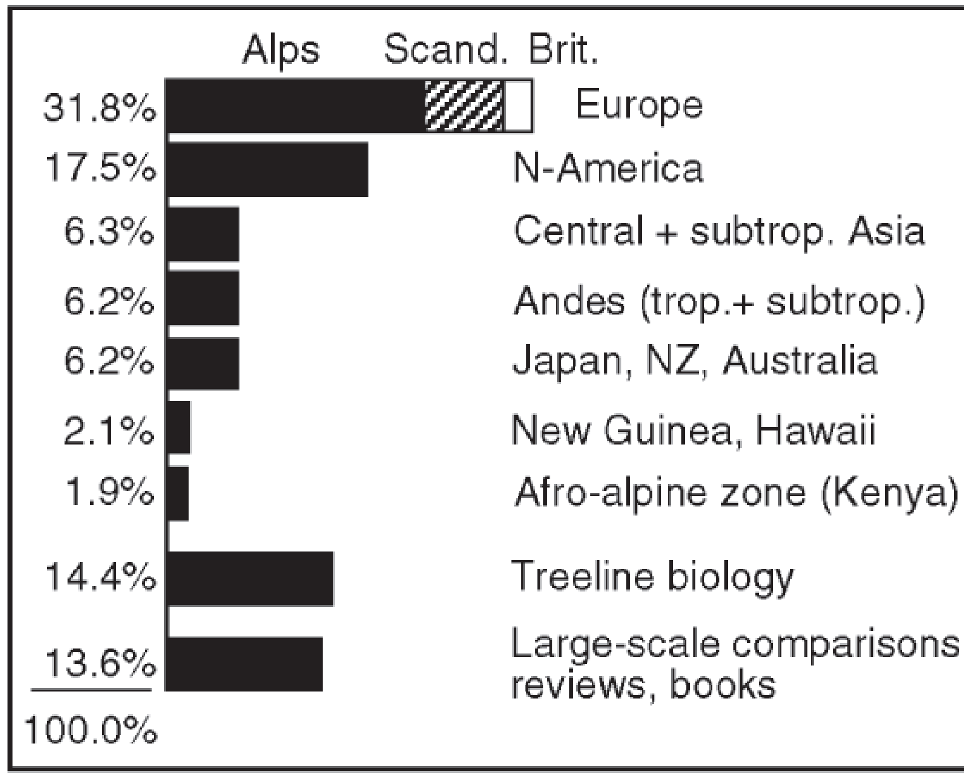


Fig. 1.3. Statistics of the geographical distribution of published research on the functional ecology of alpine plant ecology (evaluation of 800 publications). Publications on

El clima en ambientes de montaña

- Disminución de la temperatura
- Aumento de la radiación
- Patrones de precipitación dependen de la cadena montaña
- Características topográgicas son de suma importancia

En sistemas montañosos tropicales los cambios diarios son más importantes que los estacionales

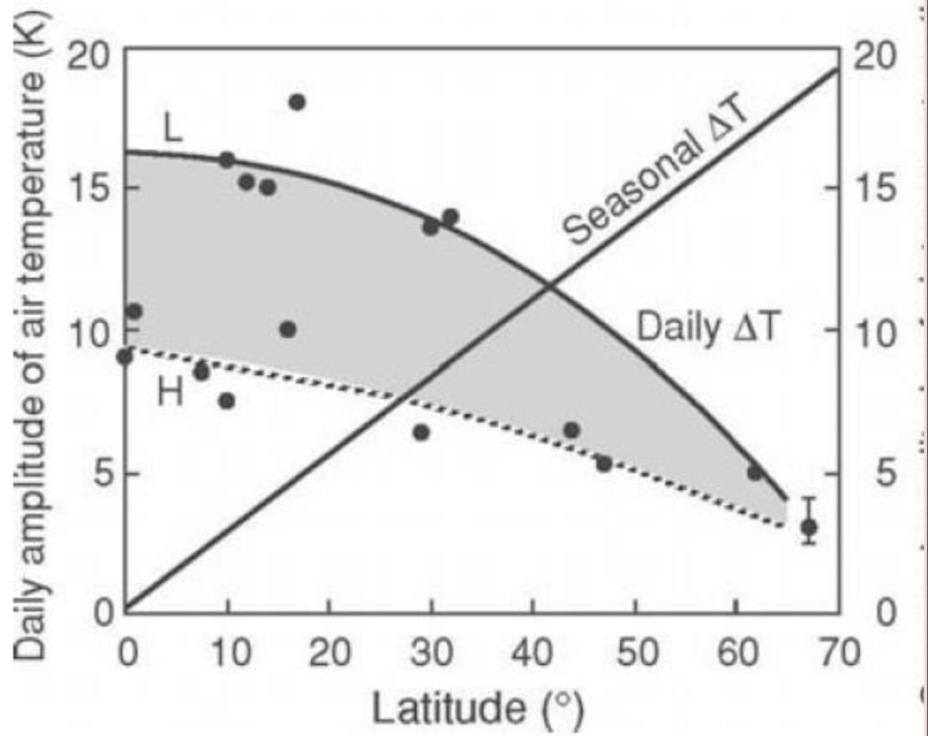


Fig. 3.3. The latitudinal variations in diurnal and seasonal amplitudes of air temperature at high elevation stations,

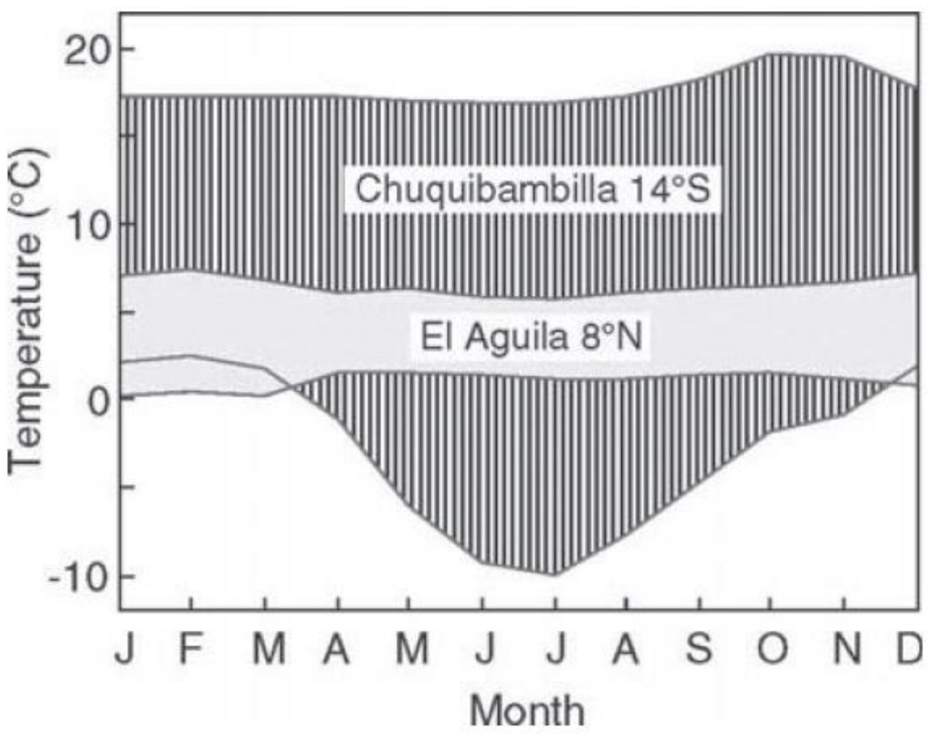


Fig. 3.4. The seasonal variation of minimum and maximum monthly mean air temperatures (amplitude *shaded*) for two high Andean stations of contrasting continentality. El Aguila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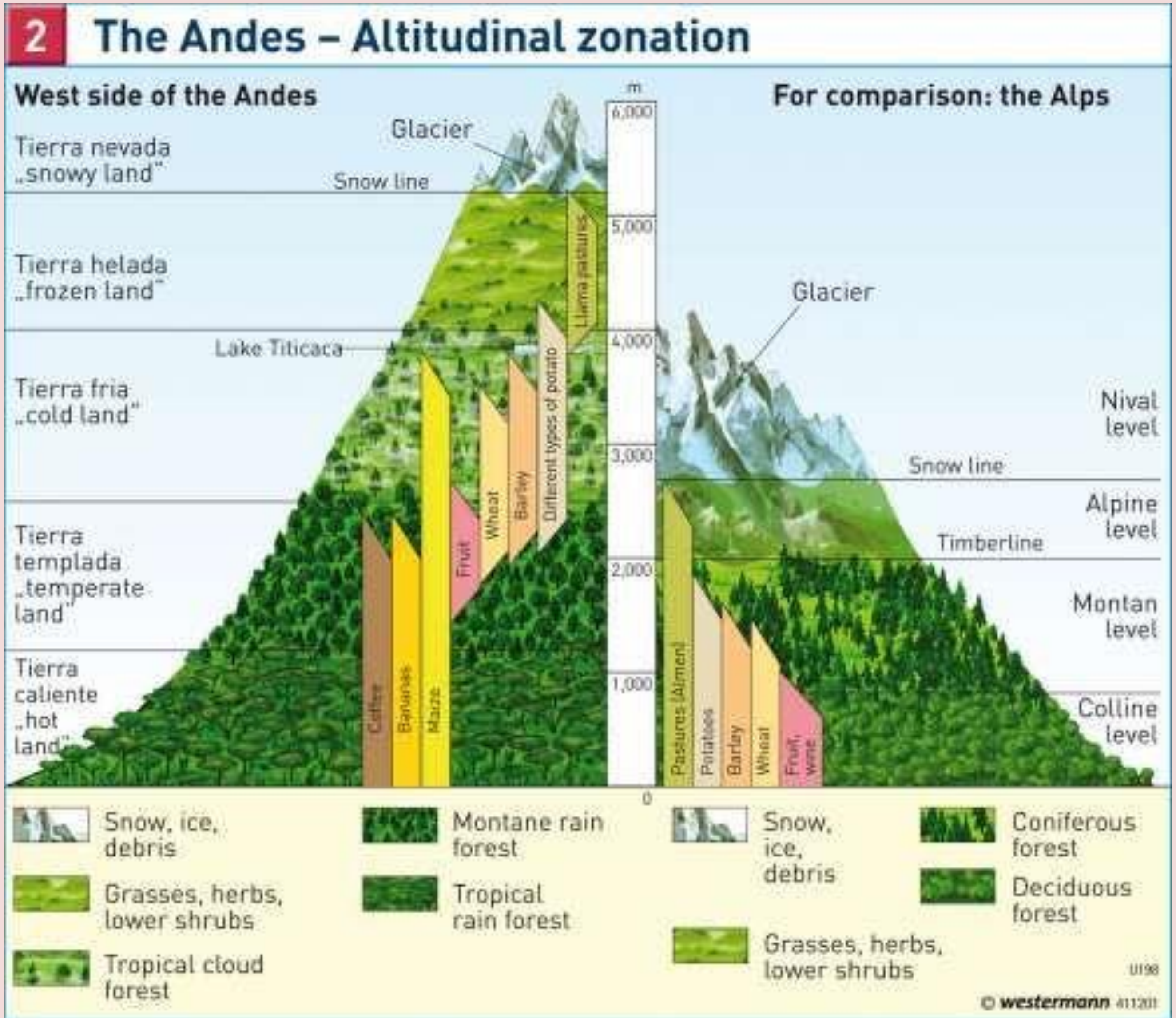
PHOTOGRAPHY

- Los ecosistemas montanos presenta diferentes BIOMAS



La presencia de niebla es importante en muchas montañas

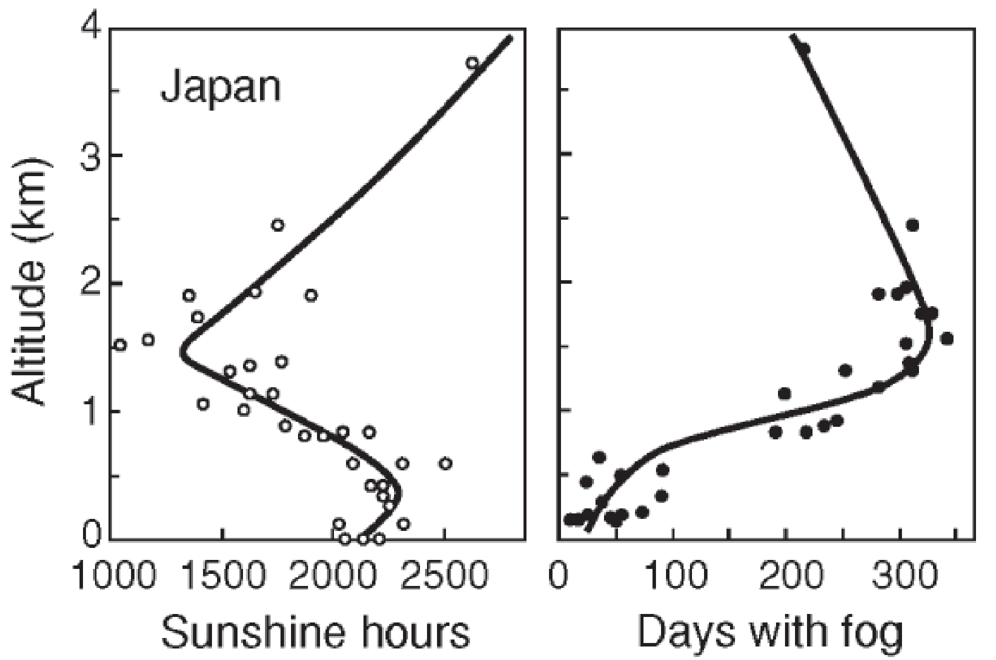
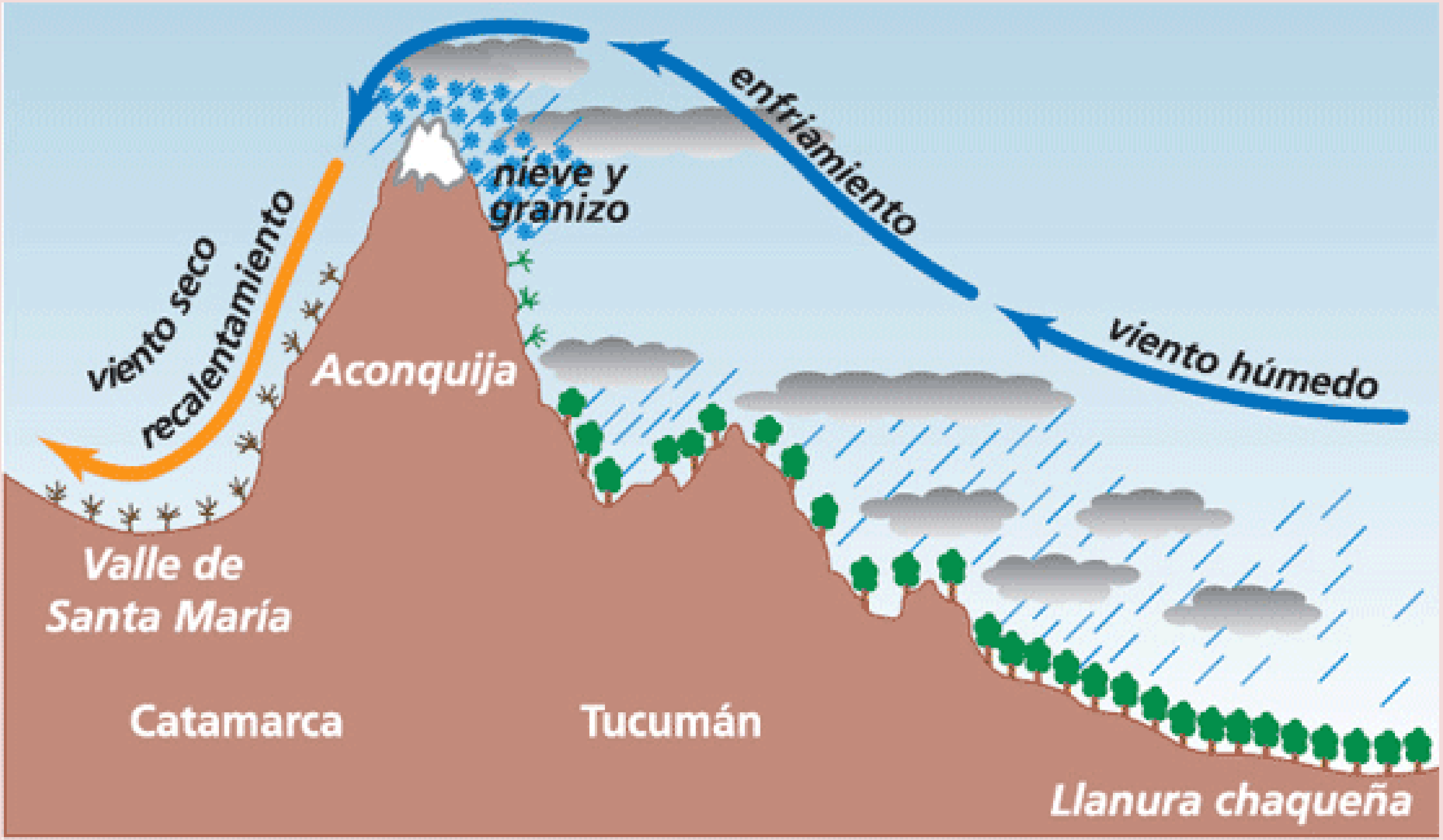


Fig. 3.7. Long-term sums of global radiation or, as here, numbers of sunshine hours do not follow any uniform

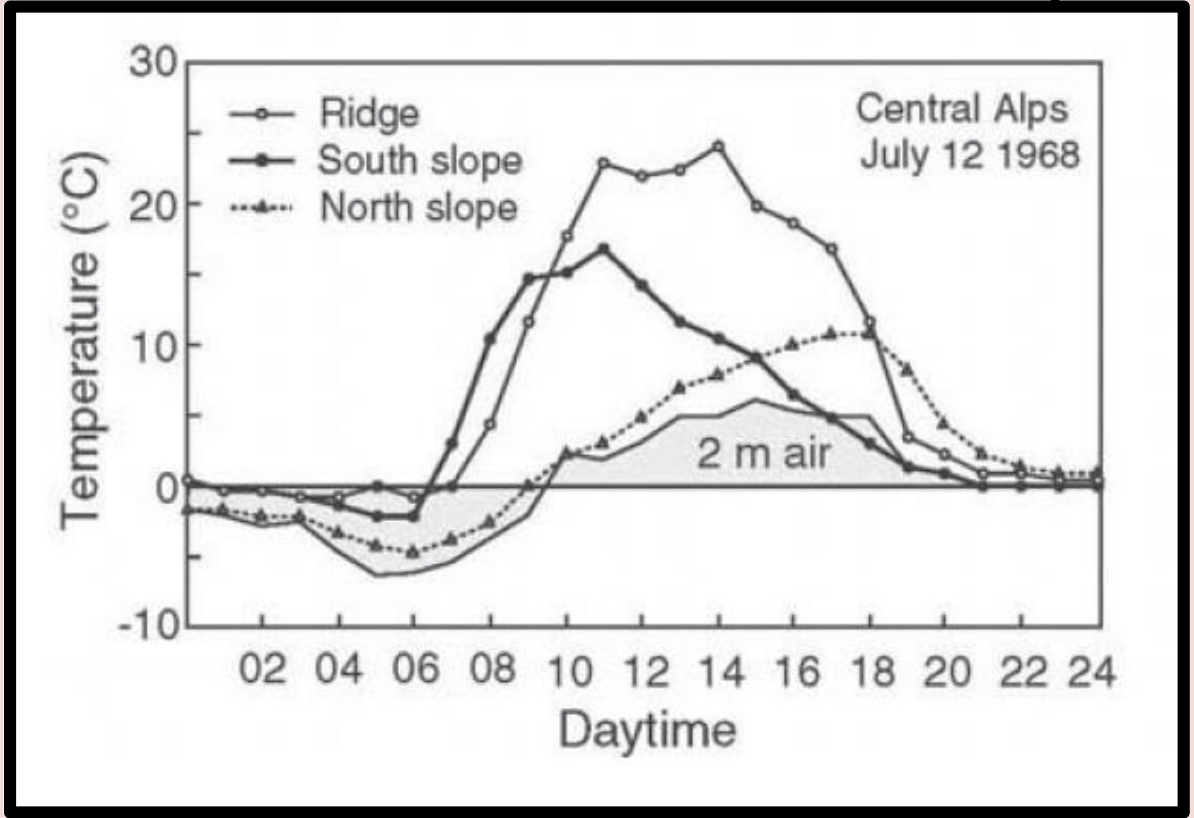
Nuboselva

- Una parte importante de la precipitación llega de manera de neblina

Lluvias orográficas




Las condiciones de temperatura son muy variables, debido a la topografía y a las características de las plantas



- La baja estatura de las plantas es una manera de **desacoplar** la temperatura ambiente de la propia

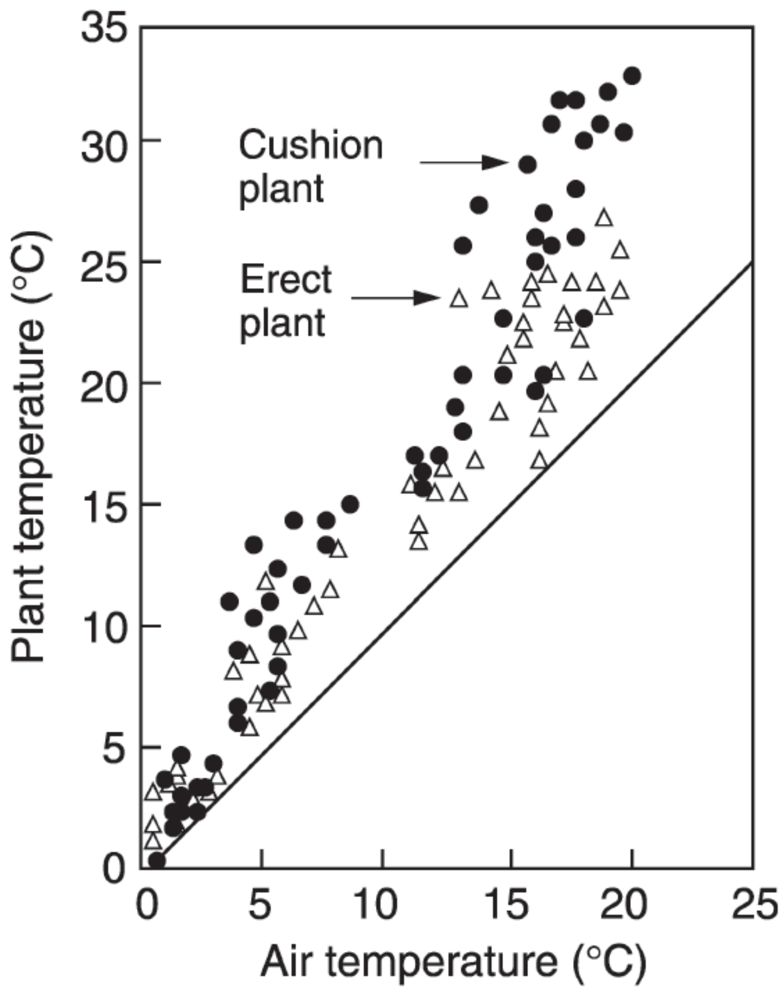


Fig. 4.9. Plant temperature as modified by plant life form at 3800 m altitude in the Rocky Mountains of Colorado. (Salisbury and Spomer 1964)

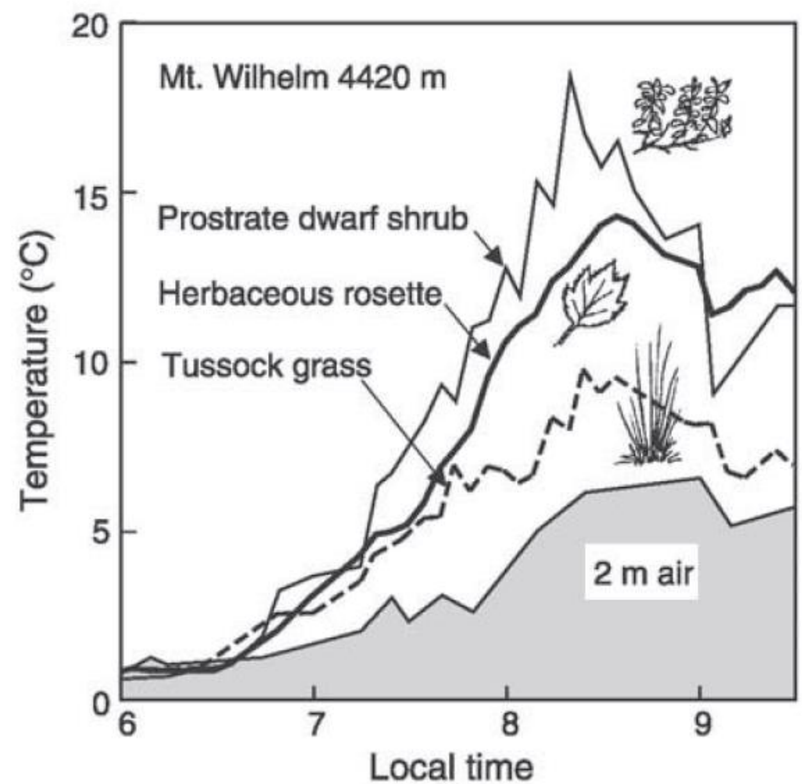


Fig. 4.11. The effect of growth form on leaf temperature in humid tropical-alpine vegetation at 4420 m altitude on Mt.


Importancia de la nieve

- La capa de nieve da protección térmica
- Permite la actividad de las plantas, incluso la fotosíntesis

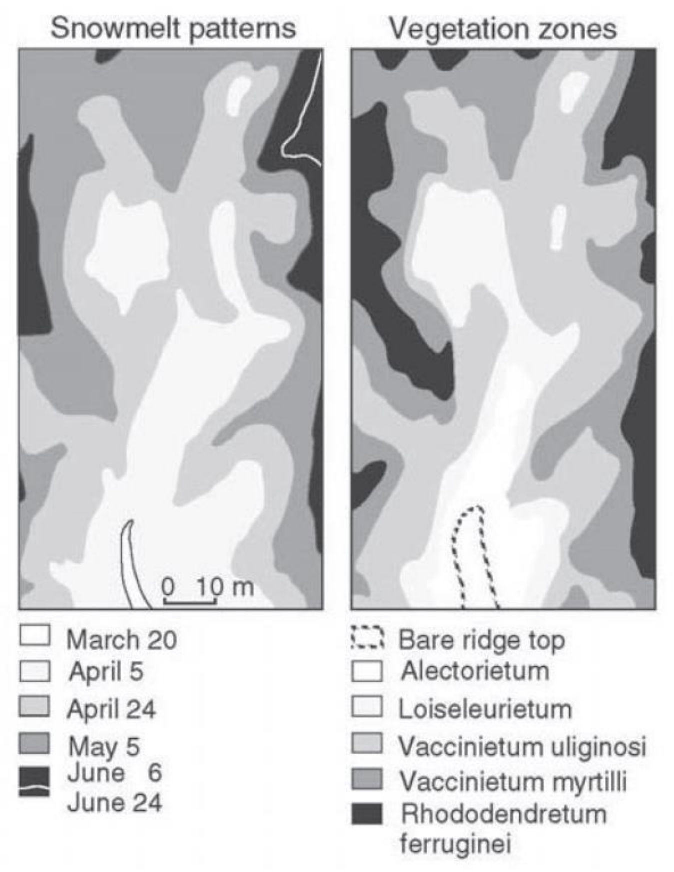


Fig. 4.5. Convergence of vegetation mosaics and contour lines of snowmelt in spring on steep terrain in the Ötztal Alps of Tirol. The plant sociological units indicate the importance of certain species in each zone. (After Friedel 1961)

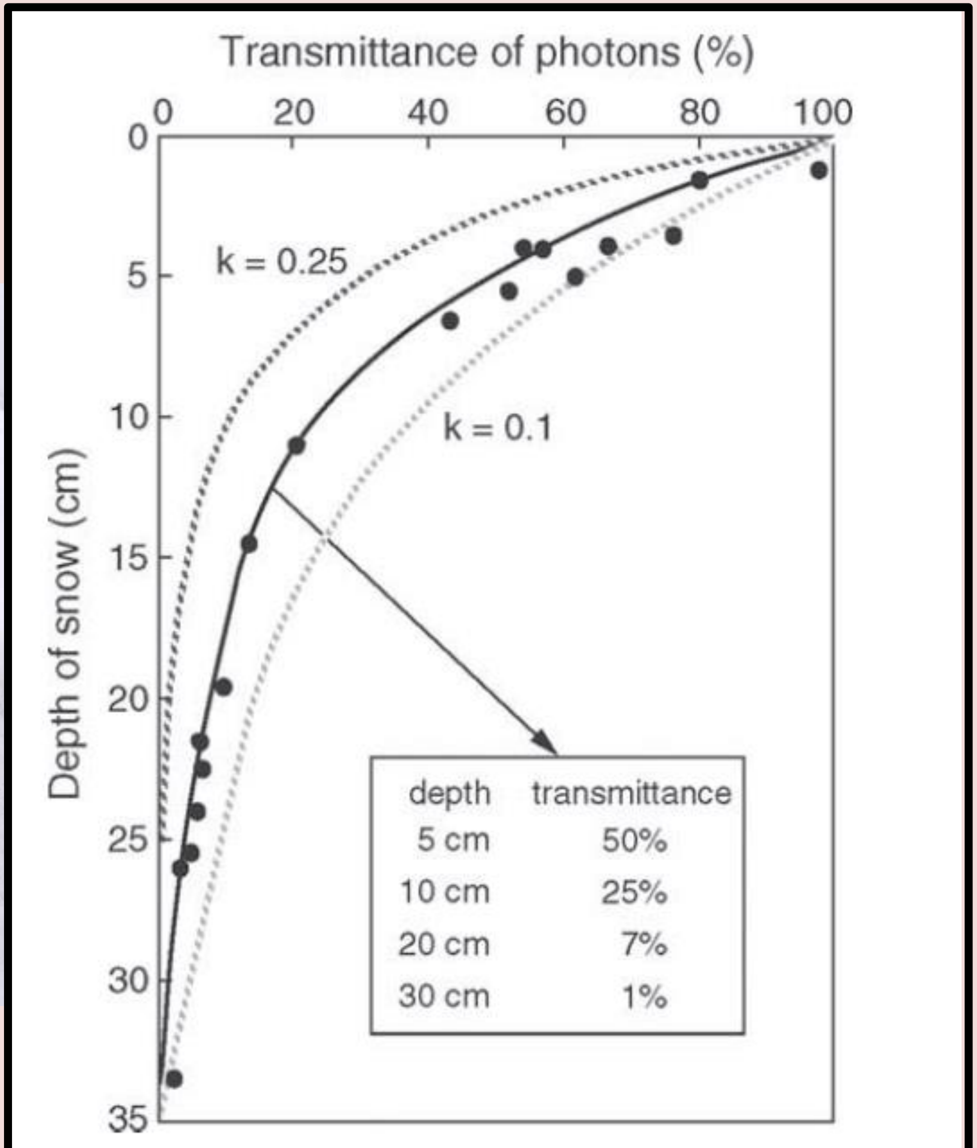
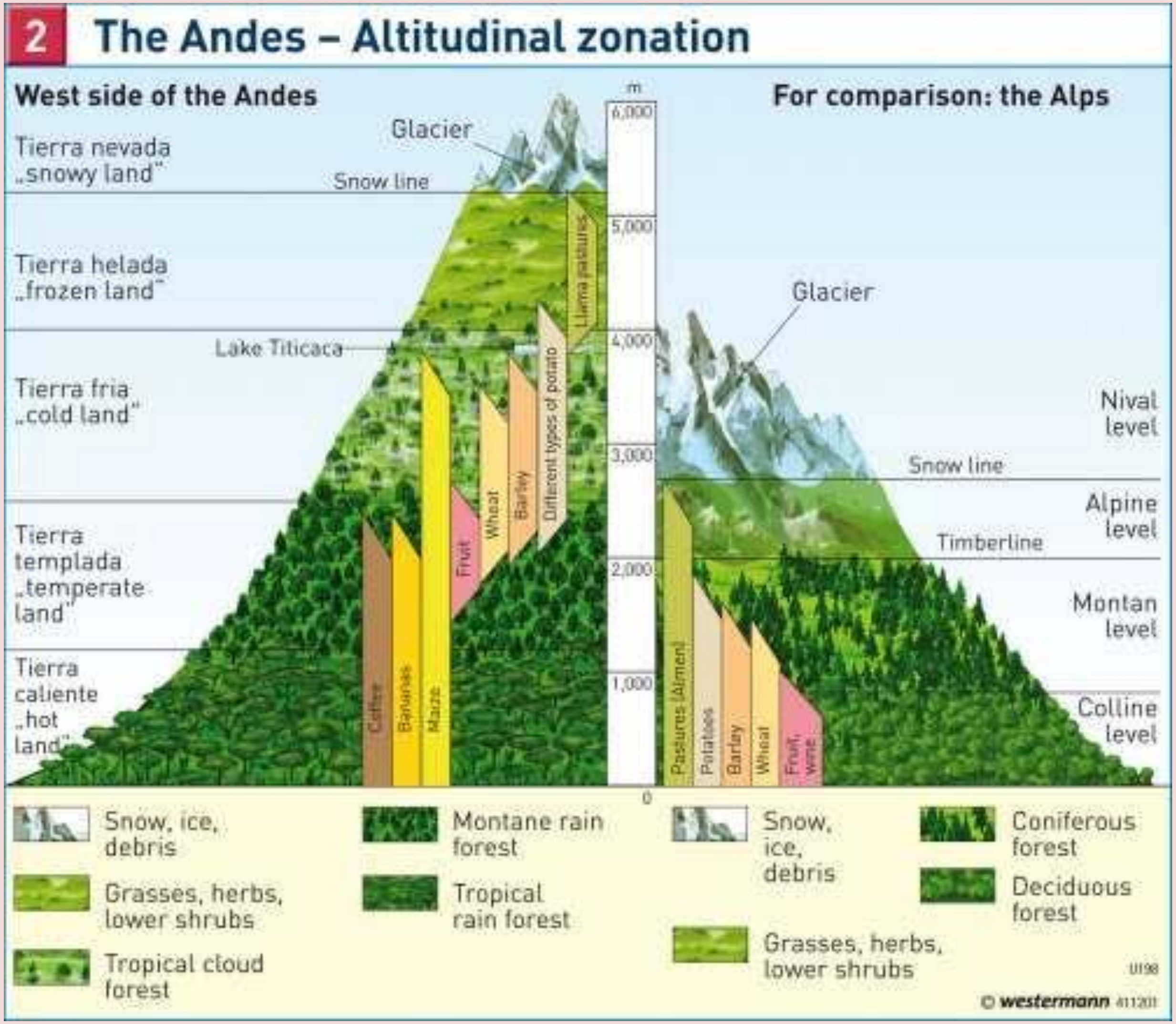


Fig. 5.1. Solar radiation under snow. *Dotted lines* Theoretical transmittance of radiation calculated from

- Los ecosistemas montanos pueden presentar diferentes BIOMAS



Bioma Alpino

- Bioma (casi) exclusivo de montañas. Es lo que esta arriba de la línea de bosque (treeline)
- Es muy diferente el mismo en latitudes bajas o latas

2 The alpine life zone

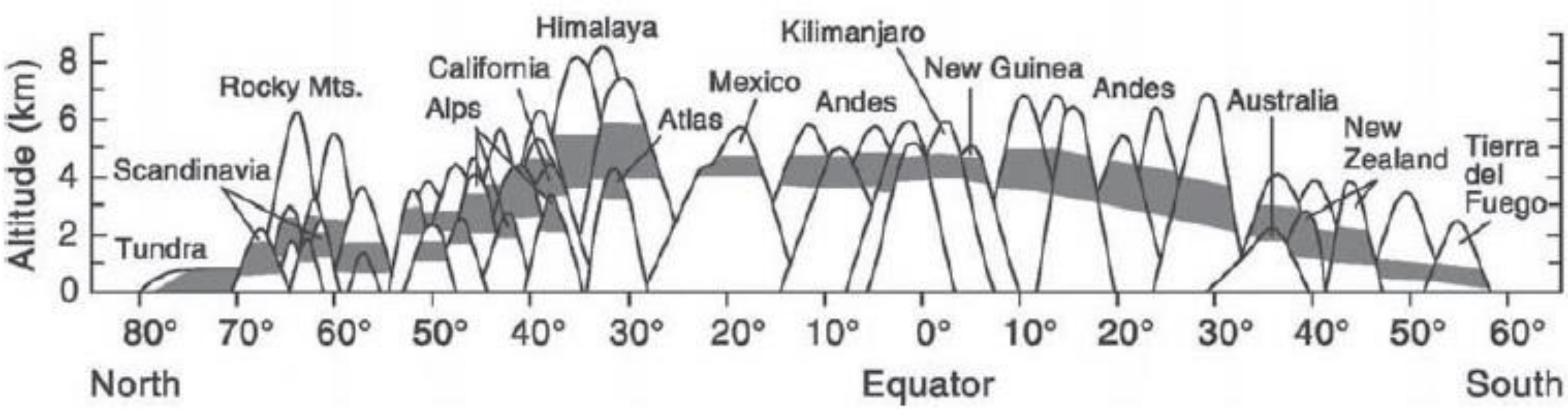
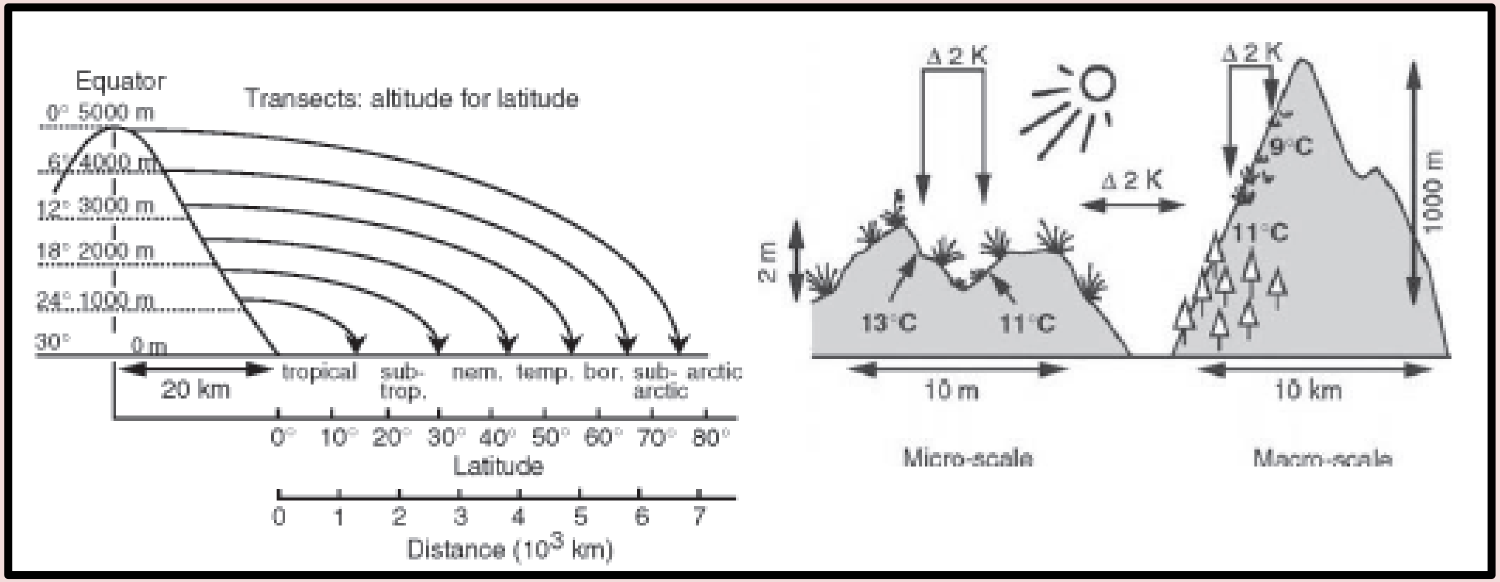


Fig. 2.1. A schematic presentation of the altitudinal position of the alpine life zone from arctic to antarctic latitudes

Table 2.1. Altitudinal limits of higher plants (after a list compiled by Grabherr et al. 1995)

	Individuals	Communities	Closed vegetation
Tropical mountains (maximum height)			
Mt. Kenya (5190 m)	5190	–	4400
Kilimanjaro (5896 m)	5760	5700	4300
Ruwenzori (5119 m)	5119	–	4500
Chimborazzo (6310 m)	5100	–	4600
Subtropical mountains			
Himalayas (8846 m)	6400	5960	5500
Andes (in this part, 7084 m)	5800	–	4600
Temperate zone mountains			
Alps (4607 m)	4450	3970	3480

Reemplazo altitud/latitud



- Esto puede funcionar para sistemas montañosos templados, pero **No** para sistemas de latitudes bajas

Características físicas de montañas

nature climate change

LETTERS

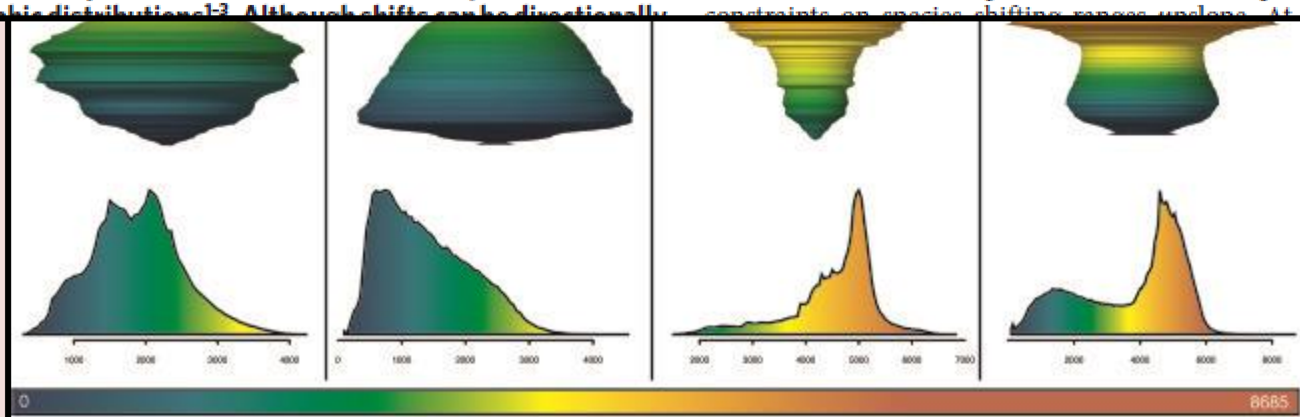
PUBLISHED ONLINE: 18 MAY 2015 | DOI: 10.1038/NCLIMATE2656

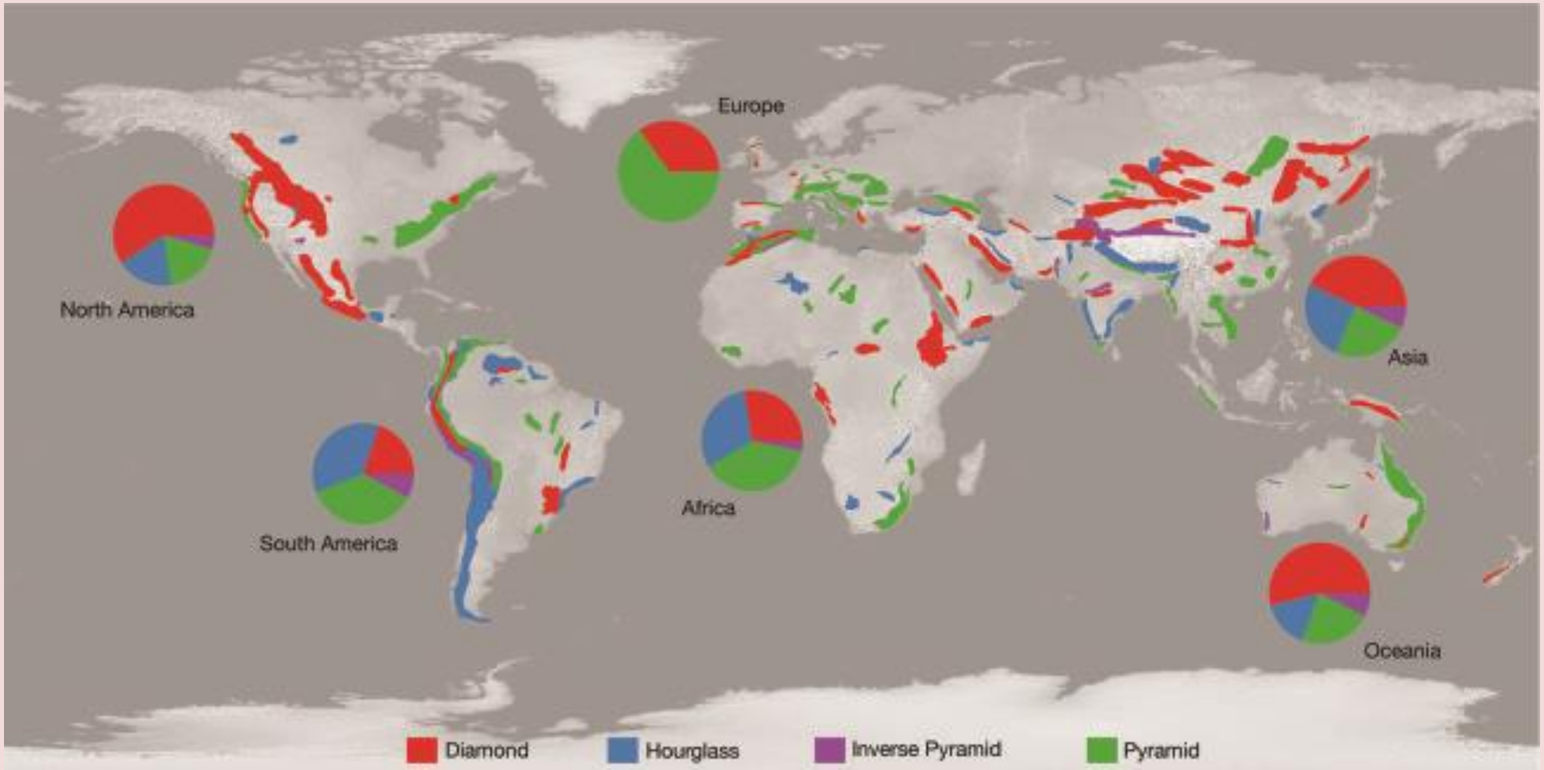
Global mountain topography and the fate of montane species under climate change

Paul R. Elsen[1*] and Morgan W. Tingley[2,3*]

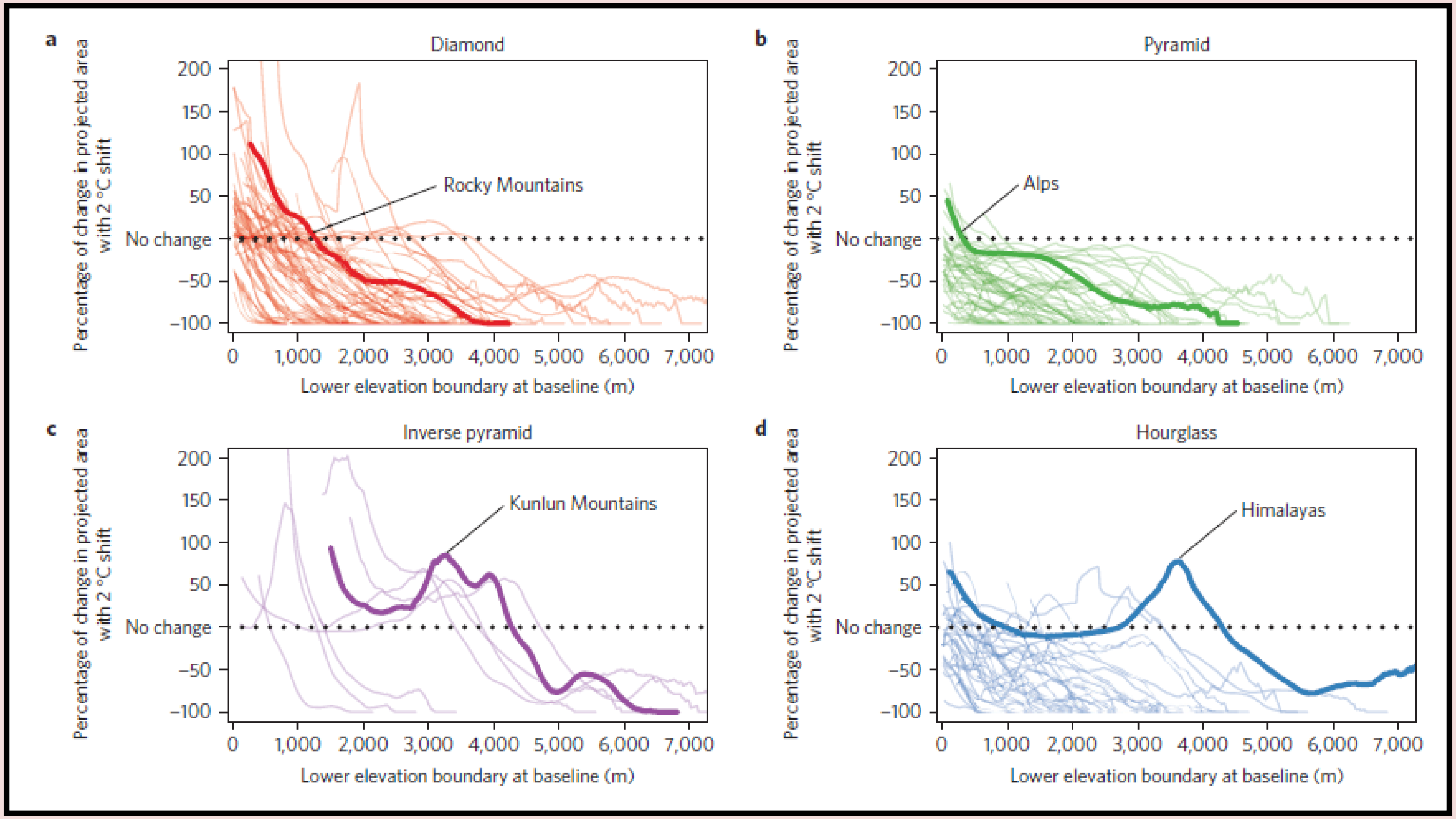
Increasing evidence indicates that species throughout the world are responding to climate change by shifting their

both the global and local (that is, peak) scales, area declines with elevation and imposes consistent and pronounced area



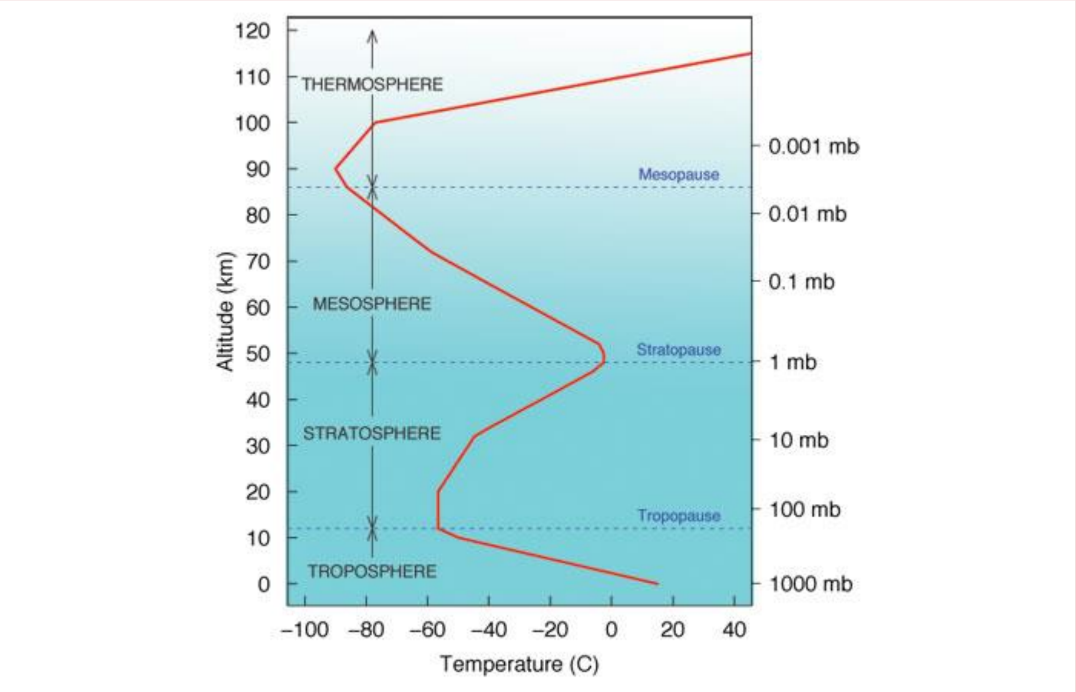

Europe
North America
Asia
South America
Africa
Oceania
Diamond
Hourglass
Inverse Pyramid
Pyramid

La disponibilidad de área, ante un escenario de cambia climático, es muy diferente entre montañas



La importancia de la temperatura

- En general la disminución de la temperatura es de 0,65°C cada 100 metros
- Enfriamiento adiabático



Cómo afecta la temperature a las plantas?

- Métabólico: actividad enzimática
- Daño mecánico

- Primero afecta fotosíntesis
- Crecimiento
- Reproducción

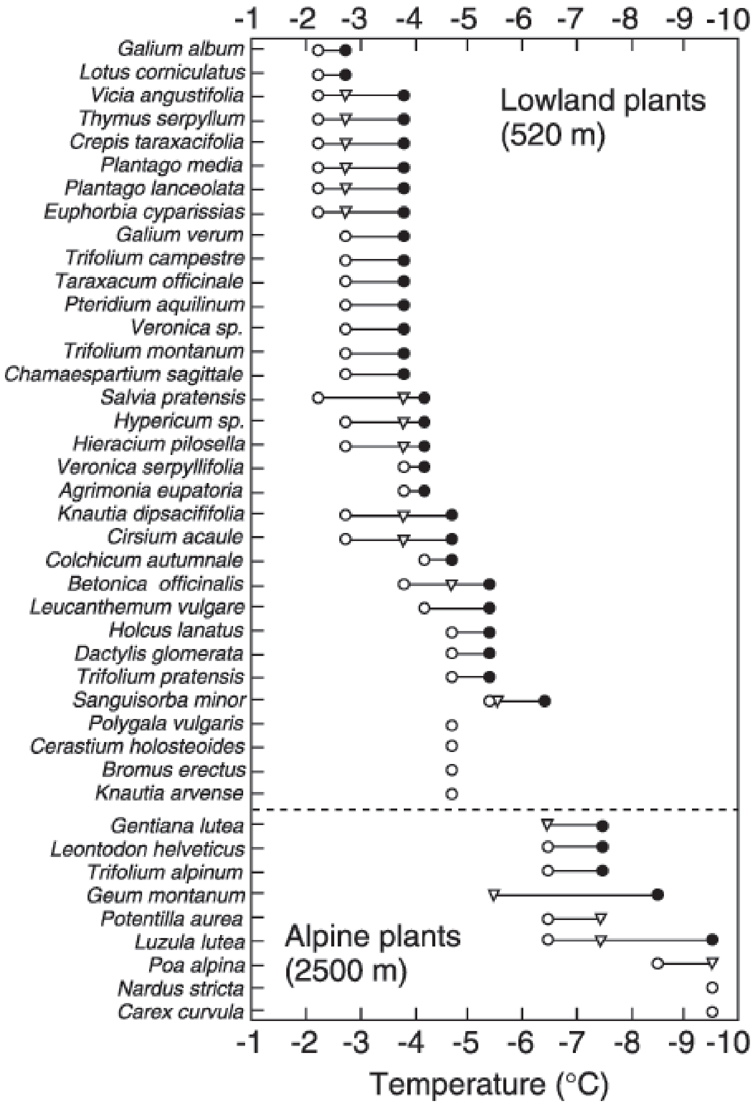


Fig. 8.3. A comparison of frost tolerance in alpine and lowland herbaceous plant species during peak season i.e. the second half of July at high altitude (2470 m, Furka Pass,

- La tolerancia a las heladas se asocia directamente al origen geográfico

- En sistemas de montañas a latitudes altas el problema de las heladas es principalmente **Estacional**

- Pero en montañas tropicales es **Diario**

¿Cómo responden las plantas ante un stress ambiental?

- Tolerar
  - Adaptaciones morfológicas y fisiológicas
- Evitar
  - Fenología
  - Morfología
  - Microhabitat

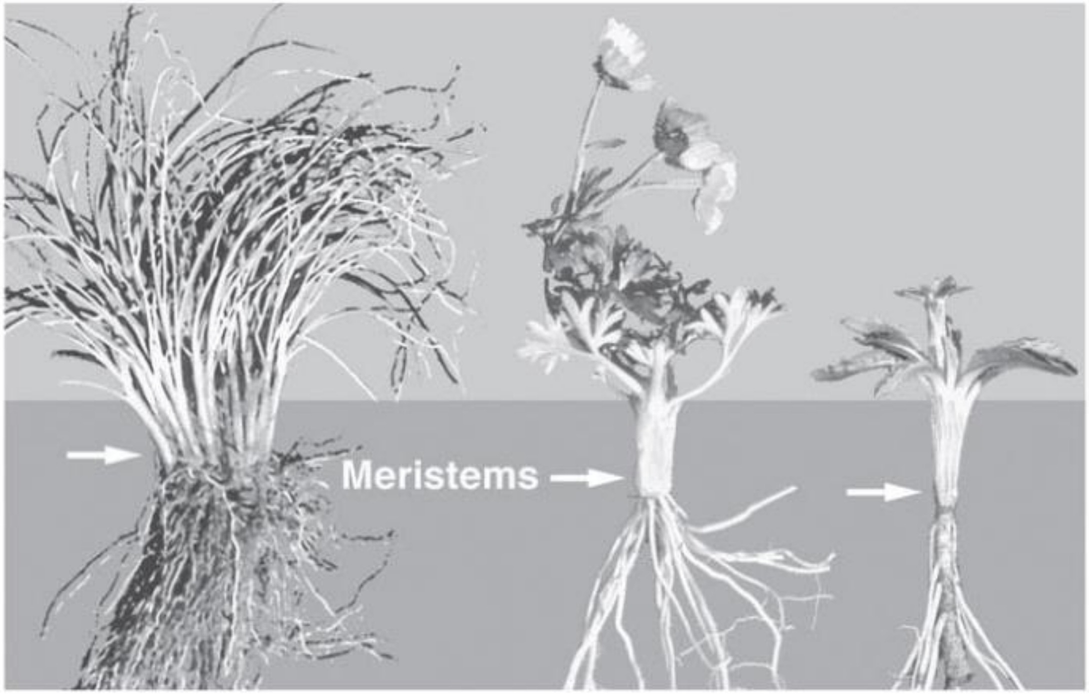


Fig. 8.4. In most alpine plants, vegetative shoot apices and leaf meristems are buried several centimeters below the ground, and thus are not exposed to low and high temperature extremes. *Carex curvula* and *Ranunculus glacialis*, both from the Alps (2500–3000 m), and *Perezia* sp. from the northwestern Argentinan Andes (4250 m).

Uso de agua en sistemas montanos

- Los patrones de precipitación varían entre sistemas montañosos
- Pero a igual precipitacion la temperatura regula el balance hídrico

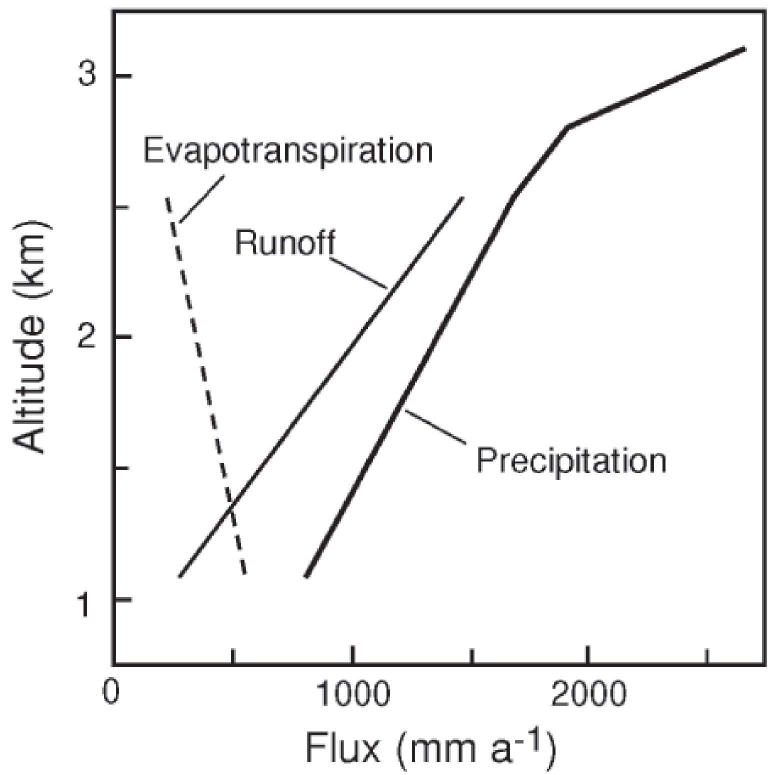


Fig. 9.2. The altitudinal variation of annual precipitation, evapotranspiration, and the sum of all drainage processes (runoff) for grassland areas in the eastern central Alps. (Data from lysimeter studies by Wieser et al. 1984)

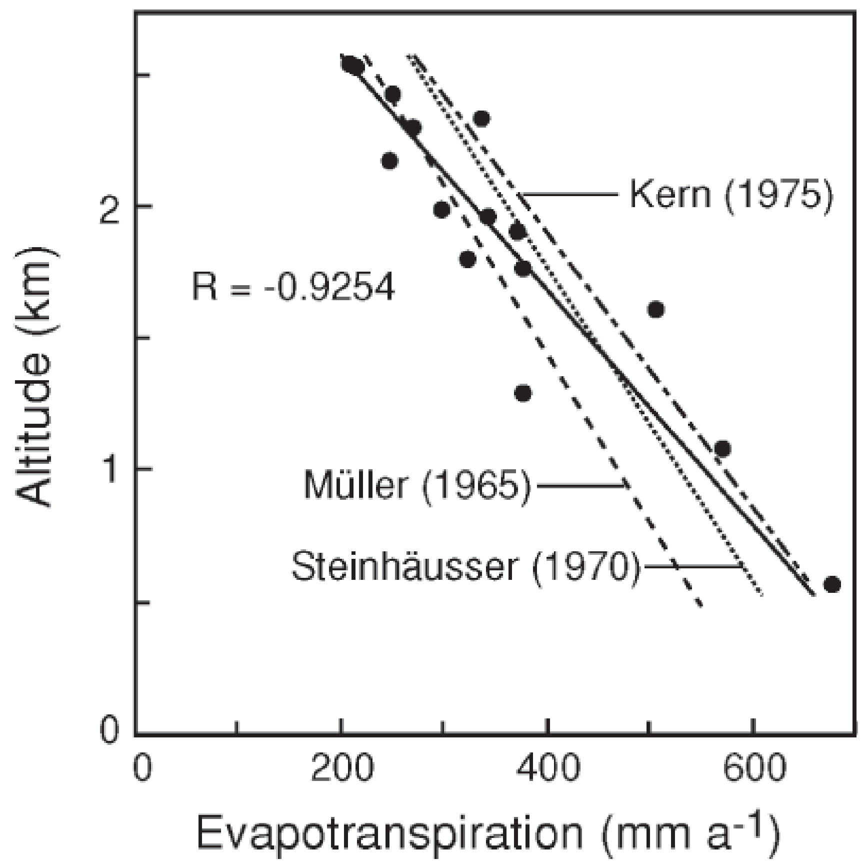


Fig. 9.3. The altitudinal variation of annual evapotranspiration (data points) at 14 grassland sites between 580 and 2530 m in the eastern Alps (treeline at

Densidad de estomas

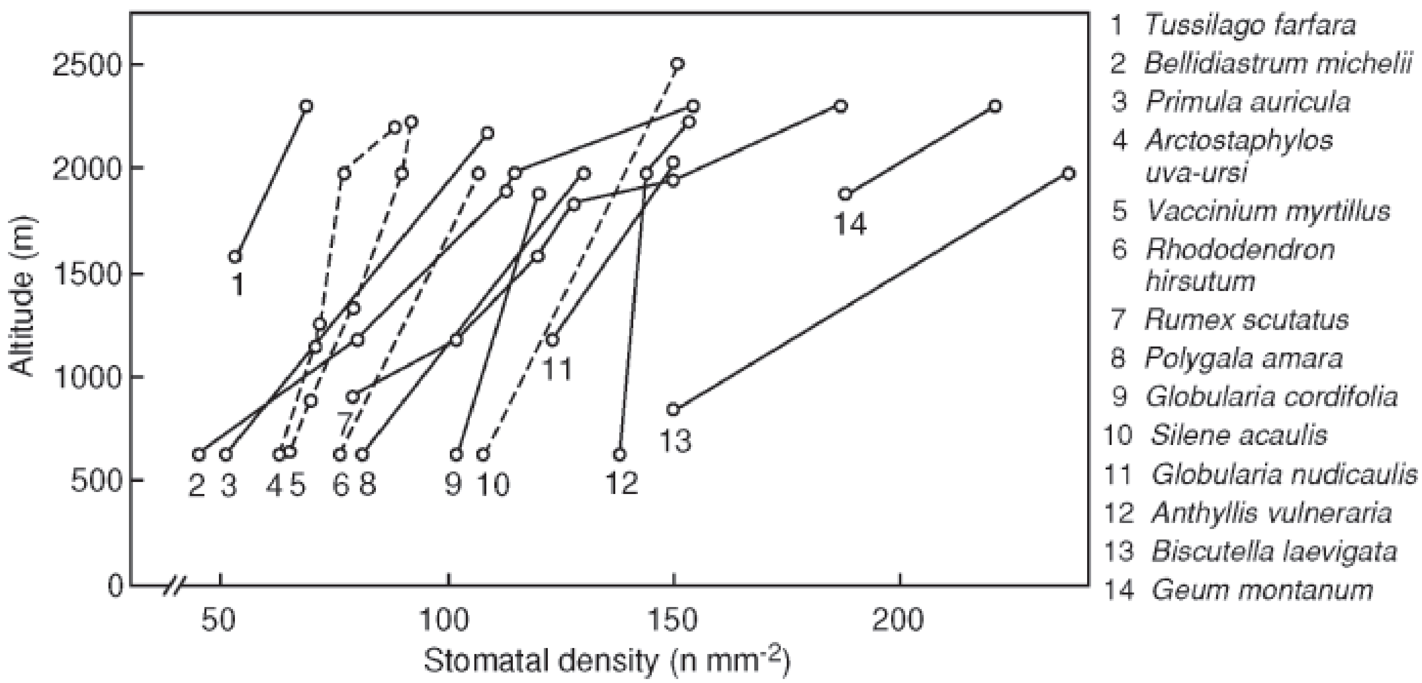


Fig. 9.13. Intraspecific altitudinal variation in stomatal frequency of herbaceous plants (*solid lines*) and dwarf shrubs (including one cushion species; *dashed lines*) in the Alps. Each line is for one species sampled at contrasting altitudes. Since

Fotosíntesis y distribución de C3 y C4

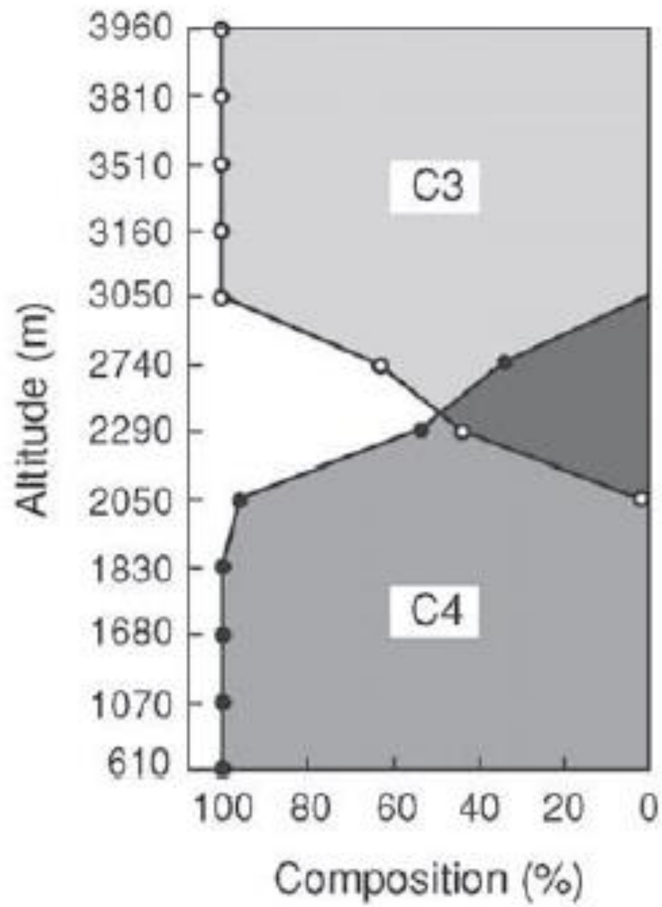


Fig. 11.15. The percentage of grass species which are C4 or C3, along an altitudinal transect on Mt. Kenya. (Tieszen et al. 1979)

Journal of Biogeography (1997) **24**, 197–204

Distribution of C_3 and C_4 grasses along an altitudinal gradient in Central Argentina

Marcelo Cabido*, Norma Ateca†, Marta E. Astegiano† and Ana M. Anton* **IMBIV, UNC-CONICET, CC 495, 5000 Córdoba, Argentina and †Facultad de Ciencias Agropecuarias, UNC. CC 509, 5000 Córdoba, Argentina*

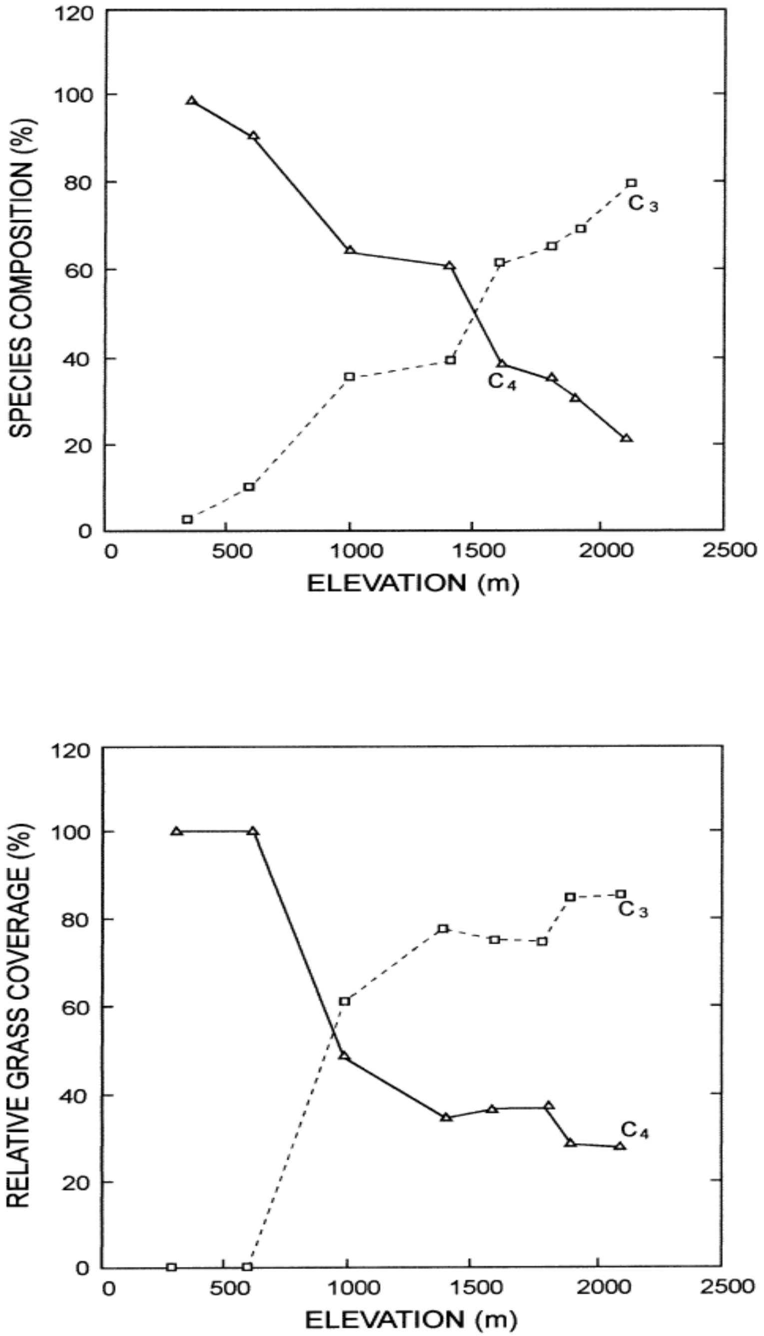


FIG. 2. Relative C_3/C_4 grass species composition (%) and coverage (%) along an altitudinal gradient in Central Argentina.

Plantas CAM

- Echeveria
- Sempervivum
- Varias Cactus

Alocación de biomasa

- Cambios en las formas de vida (especies más pequeñas) también ocurren a nivel de especies

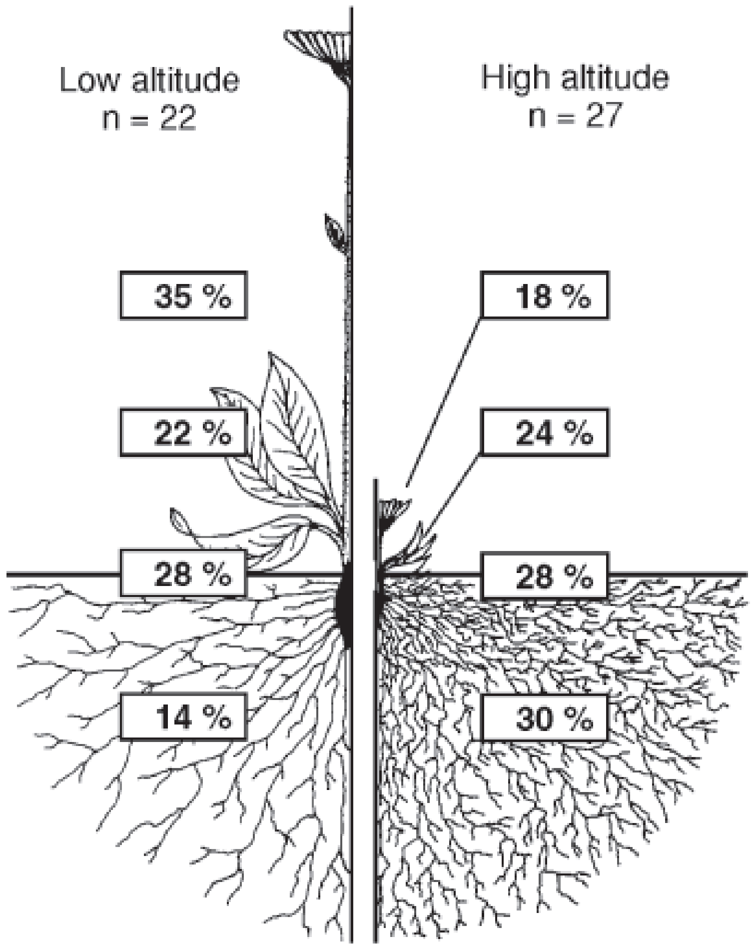
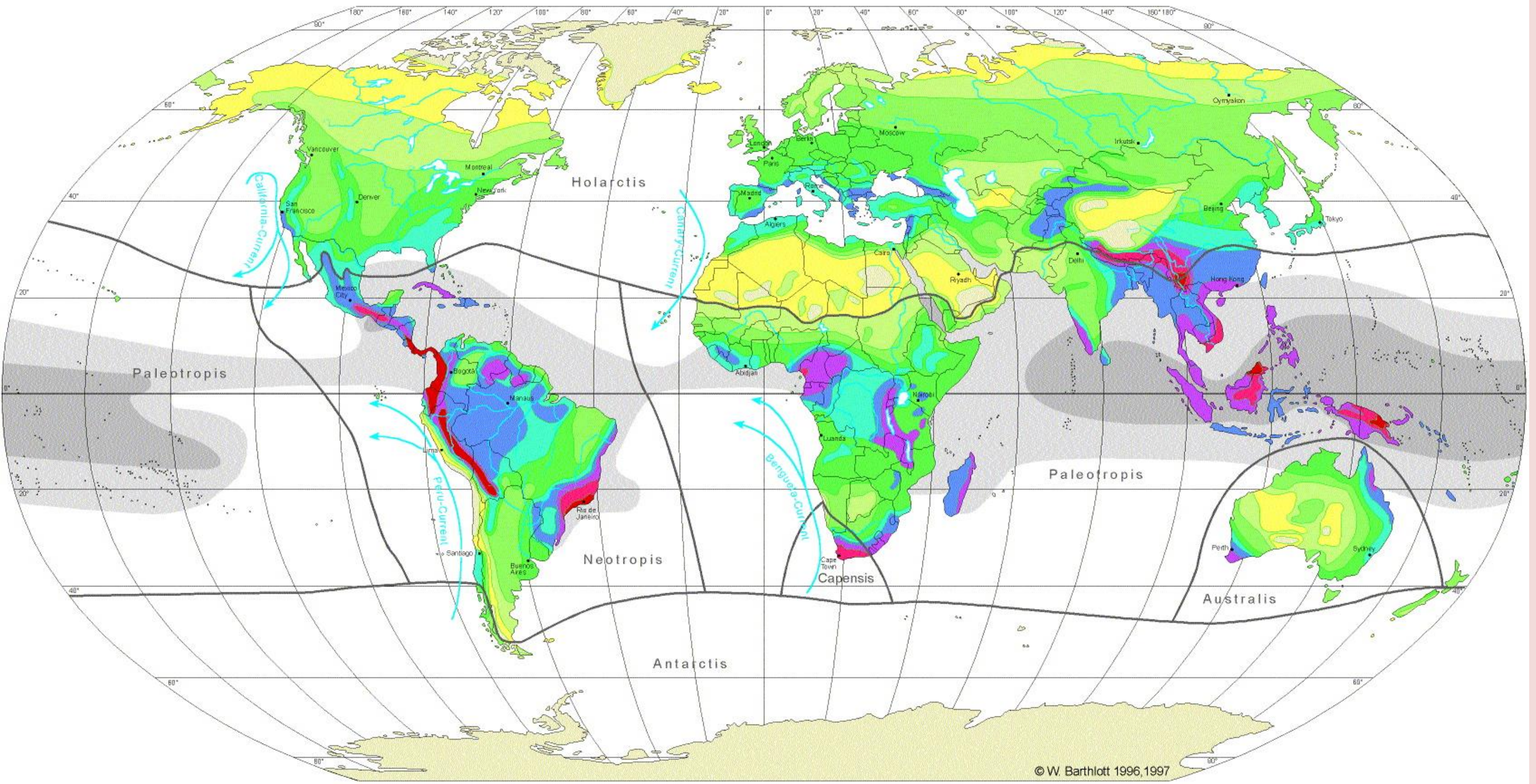


Fig. 12.14. Dry matter allocation in perennial herbaceous plant species from low and high altitudes in the Alps (stem plus flower, leaves, special storage organs plus thick roots, fine roots). (Körner and Renhardt 1987)

Diversidad en ambientes montañosos

GLOBAL BIODIVERSITY: SPECIES NUMBERS OF VASCULAR PLANTS



Robinson Projection
Standard Parallels 38°N und 38°S
Scale 1: 130000000

Diversity Zones (DZ): Number of species per 10.000km^2

- DZ 1 (<100)
- DZ 2 (100 - 200)
- DZ 3 (200 - 500)
- DZ 4 (500 - 1000)
- DZ 5 (1000 - 1500)
- DZ 6 (1500 - 2000)
- DZ 7 (2000 - 3000)
- DZ 8 (3000 - 4000)
- DZ 9 (4000 - 5000)
- DZ 10 (≥5000)

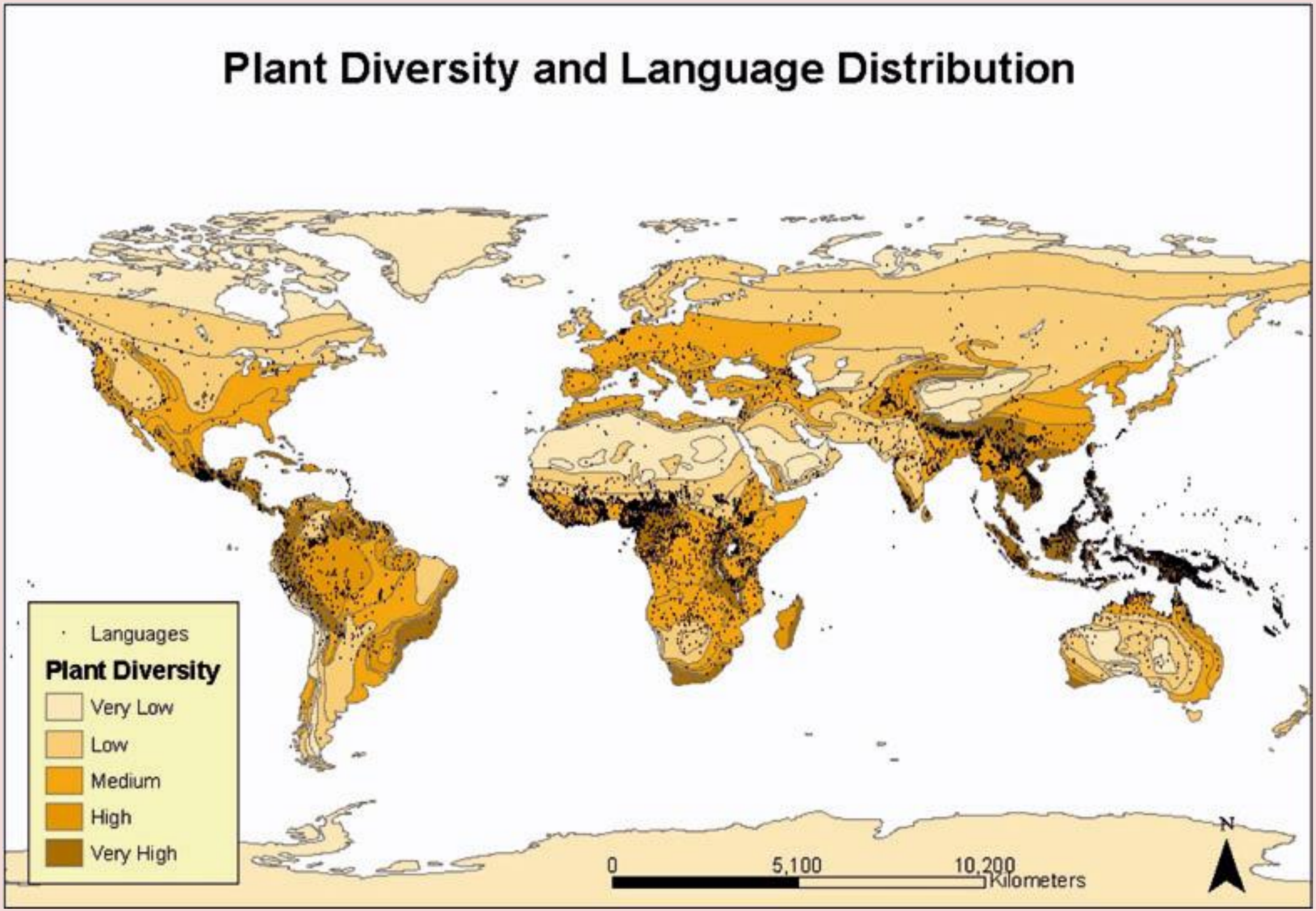
Capensis floristic regions

sea surface temperature

- >29°C
- >27°C

cold currents

W. Barthlott, N. Biedinger, G. Braun
F. Feig, G.Kier, W. Lauer & J. Mutke 1997
modified after
W. Barthlott, W. Lauer & A. Placke1996
Department of Botany and Geography
University of Bonn
German Aerospace Research Establishment, Cologne
Cartography: M. Gref
Department of Geography
University of Bonn



Burnside et al. 2011

¿Qué produce estos patrones en las montañas?

- Ambientes heterogéneos a diferentes escalas
- A escala de los gradientes altitudinales
- A escala de microhábitat
- Factores históricos (biogeográficos/geológicos)
- Biogeográficos: aislamiento, especiación

- Las montañas son importantes reservorios de biodiversidad
- A pesar que el uso del suelo puede ser importante, no se compara la transformación con lo que sucede en sistemas de llanura

Patrones diversidad en montañas

Global Ecology & Biogeography (2001) **10**, 3–13

ELEVATIONAL GRADIENTS IN MAMMALS: SPECIAL ISSUE

Elevation gradients of species-density: historical and prospective views

MARK. V. LOMOLINO *Oklahoma Biological Survey, Oklahoma Natural Heritage Inventory and Department of Zoology, University of Oklahoma, Norman, OK 73019, U.S.A.*
E-mail: island@ou.edu

We find that mountainous countries are richer in plants than flat countries, and that in primitive mountains the number of plants exceeds that of the floetz [flat, like ice-sheets] *mountains* (Willdenow, 1805, p. 353).

Willdenow, K.L. (1805) *The principles of botany, and vegetable physiology*. Blackwood, Cadell and Davies, London.

¿De que depende la diversidad en gradient altitudinal?

- Factores ecológicos
- Factores históricos
- Factores geográfico

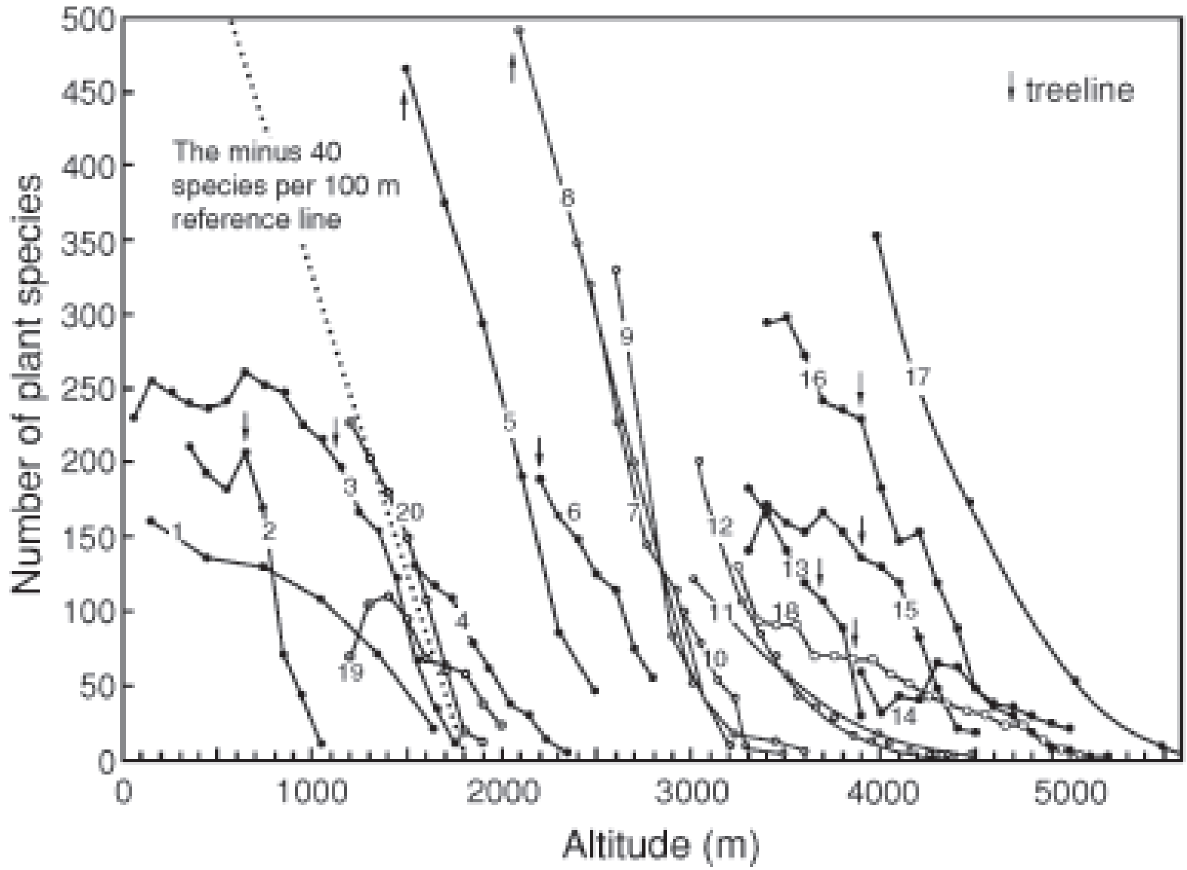


Fig. 2.8. The altitudinal reduction in higher plant species numbers above the climatic treeline in different mountain regions (the *dashed line* is the 40 sp/100 m reference; from various sources in Körner 2002). Data for Kilimanjaro by A. Hemp (pers.

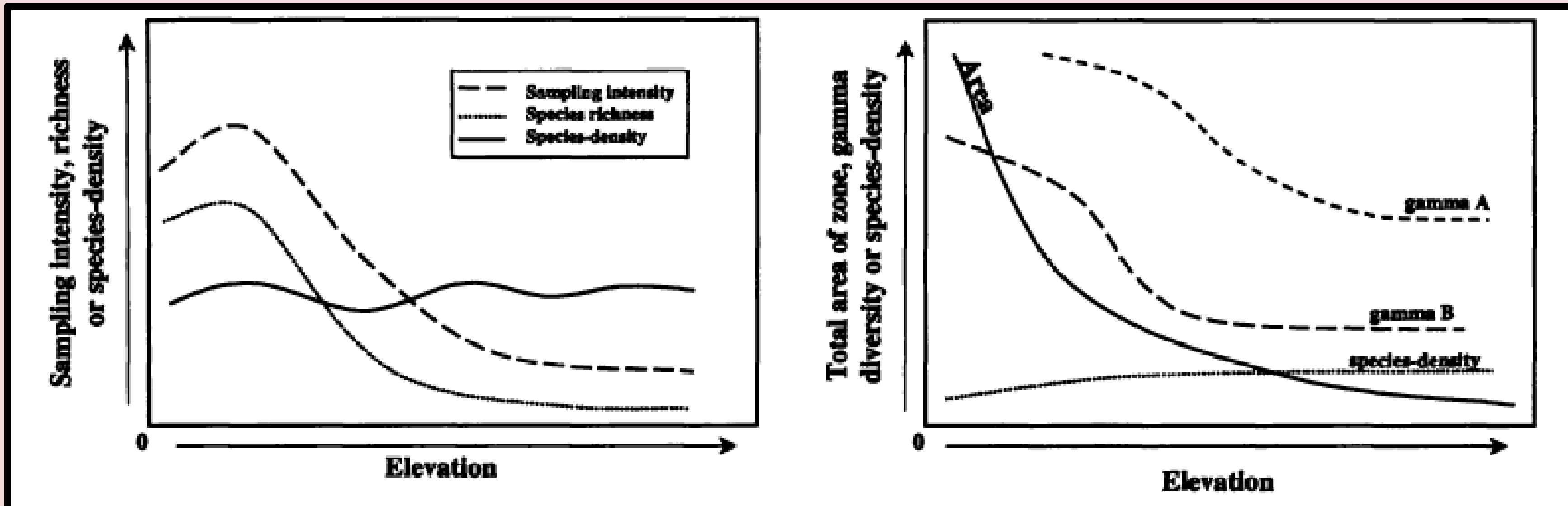


Fig. 1 Variation in sampling intensity may generate spurious patterns in species richness along elevation gradients; i.e. variation in richness may simply reflect variation in sampling intensity along this

Fig. 2 As we move up a mountain, the total area of each vegetation zone usually declines. As a result, gamma diversity (total number of species in a par-

- Intensidad de muestreo
- Área de franjas de altura

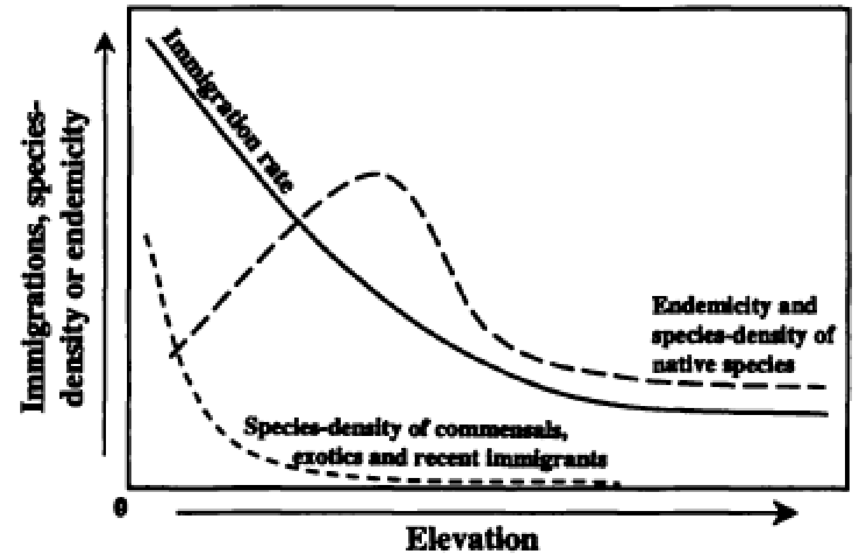


Fig. 3 Because higher elevation communities are more isolated from other communities, immigration rates should decline with elevation. The influence of

- Las partes más altas están aisladas, por lo que la inmigración disminuye
- Teoría de Biogeografía de Islas!

Riqueza de plantas Alpinas

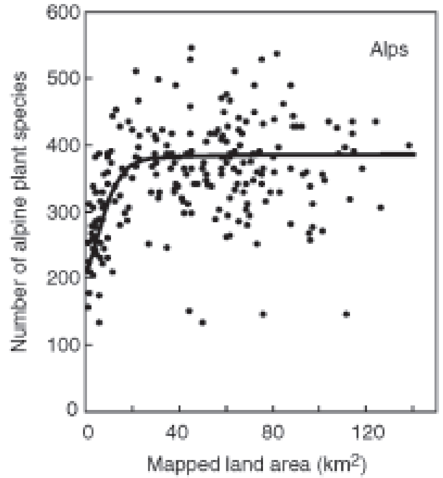


Fig. 2.4. Numbers of plant species (higher plants only) per inventoried area of regional alpine flora in the Alps. (Wohlgemuth 1993)

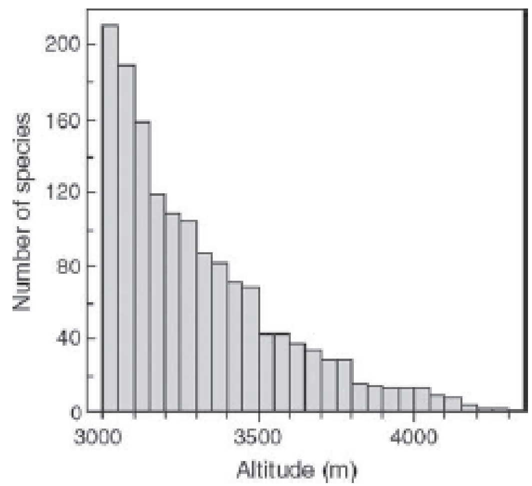


Fig. 2.5. The reduction of plant species number with altitude in steps of 50 m in the Alps. Note that the treeline is at ca. 2000 m and the upper limit of closed vegetation is mostly found around 2800 m altitude. (Grabherr et al. 1995)

- Depende del área muestreada y disminuye con la altitud

Distribution of plant life forms along an altitudinal gradient in the semi-arid valley of Zapotitlán, Mexico

Pavón, Numa P.[1*], Hernández-Trejo, Humberto[2] & Rico-Gray, Víctor[2]

[1]Departamento de Diagnóstico Regional; [2]Departamento de Ecología Vegetal, Instituto de Ecología, A.C. Apdo. 63, Xalapa, VER 91000, México; [*]Corresponding author; E-mail pavonnum@sun.ieco.conacyt.mx; ricogray@ecologia.edu.mx

Table 1. Abundance (%) of individuals per life form along the altitudinal gradient. CC = columnar cacti; CH = chamaephytes; E = epiphytes; G = geophytes; GC = globose cacti; HP = hemiparasites; MP = microphanerophytes; R = rosette plants; NP = nanophanerophytes; SC = succulents; T = therophytes.

Altitude (m)	1600	1700	1800	1900	2000	2100	2200
CC	11.42	4.33	0.33	0.07	0.00	0.00	0.00
R	18.94	27.53	14.63	30.49	42.00	33.09	19.47
NP	9.84	22.25	42.24	32.94	30.77	46.64	67.33
GC	38.39	4.04	5.67	3.71	1.71	0.74	3.73
T	0.42	5.87	7.97	8.16	8.06	8.93	0.73
MP	6.96	8.52	4.03	4.90	2.93	1.21	0.53
E	8.50	15.71	11.18	19.07	9.28	4.03	0.07
G	0.00	2.13	1.07	0.00	0.00	0.00	0.00
SC	5.52	8.30	12.57	0.22	1.65	1.21	0.53
CH	0.00	0.00	0.00	0.45	1.77	4.16	7.60
HP	0.00	1.32	0.33	0.00	1.83	0.00	0.00

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journal homepage: www.elsevier.com/locate/sajb

Diversity and composition of cactus species along an altitudinal gradient in the Sierras del Norte Mountains (Córdoba, Argentina)

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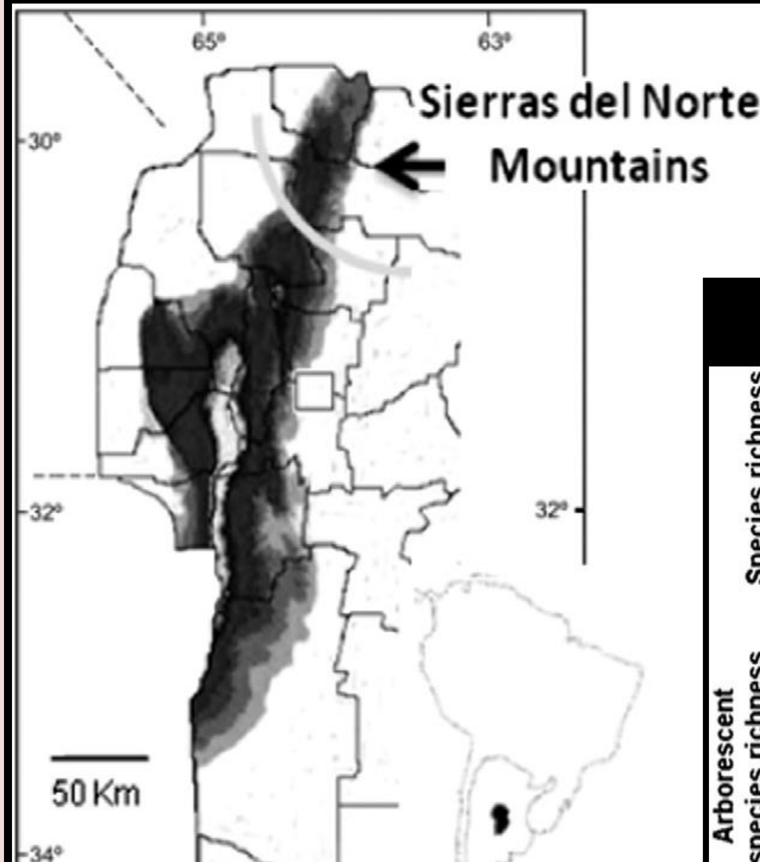
[a] Cátedra de Biogeografía & Instituto Multidisciplinario de Biología Vegetal (FCEFyN, CONICET-UNC), Av. Vélez Sarsfield 1611, CC495, CP 5000, Córdoba, Argentina
[b] NGO Ecosistemas Argentinos, 27 de abril 2050, CP 5000 Córdoba, Argentina

Species	Growth form	Relative Frequency (%)	Altitudinal range (m a.s.l.) Min–Max	
Subfamily Cactoideae				
Cereus aethiops Haworth	Short columnar	3.6	207	926
Cereus hankeanus K. Schumann	Arborescent	14.5	203	652
Cleistocactus baumannii (Lemaire) Lemaire	Short columnar	14.5	203	565
Echinopsis aurea Britton & Rose	Globose	38.2	203	926
Echinopsis candicans (Salm-Dyck) Hunt	Short columnar	40	296	968
Echinopsis leucantha (Salm-Dyck) Walpers	Short columnar	5.4	207	754
Echinopsis spiniflora (K. Schumann) Berger	Globose	21.8	203	968
Gymnocalycium bruchii (Spegazzini) Hosseus*	Globose	7.3	886	935
Gymnocalycium erinaceum Lambert*	Globose	56.4	203	970
Gymnocalycium monvillei (Lemaire) Britton & Rose*	Globose	12.7	849	970
Gymnocalycium mostii (Gürke) Britton & Rose*	Globose	32.7	346	941
Gymnocalycium quehlianum (F. Haage ex Quehl) Vaupel ex Hosseus*	Globose	12.7	430	797
Gymnocalycium robustum R. Kiesling, O. Ferrari & Metzing*	Globose	3.6	430	437
Gymnocalycium schickendantzii (F. A. C. Weber) Britton & Rose*	Globose	10.9	346	639
Harrisia pomanensis (F.A.C.Weber) Britton & Rose	Short columnar	27.3	203	652
Parodia erinacea (Haworth) Taylor	Globose	18.2	837	951
Parodia mammulosa (lemaire) Taylor	Globose	25.4	754	968
Stetsonia coryne (Salm-Dyck) Britton & Rose	Arborescent	29.1	203	652
Subfamily Opuntioideae				
Opuntia anacantha Spegazzini	Opuntioid	10.9	203	652
Opuntia elata Salm-Dyck	Opuntioid	18.2	430	951
Opuntia ficus-indica (L.) P. Miller	Opuntioid	1.8	633	633
Opuntia quimilo K. Schumann	Arborescent	18.2	344	652
Opuntia salmiana Parm.	Opuntioid	3.6	590	652
Opuntia sulphurea Gillies ex Salm-Dyck	Opuntioid	78.2	203	970

* Species endemic to Córdoba Mountains.




[redacted]



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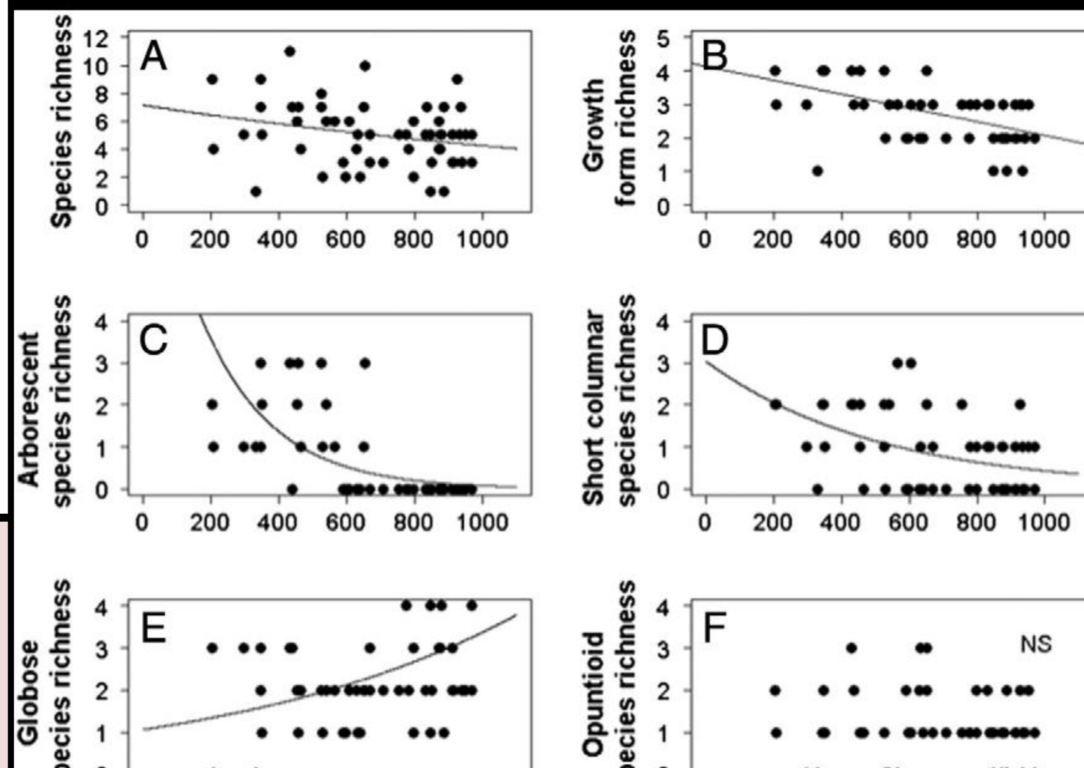


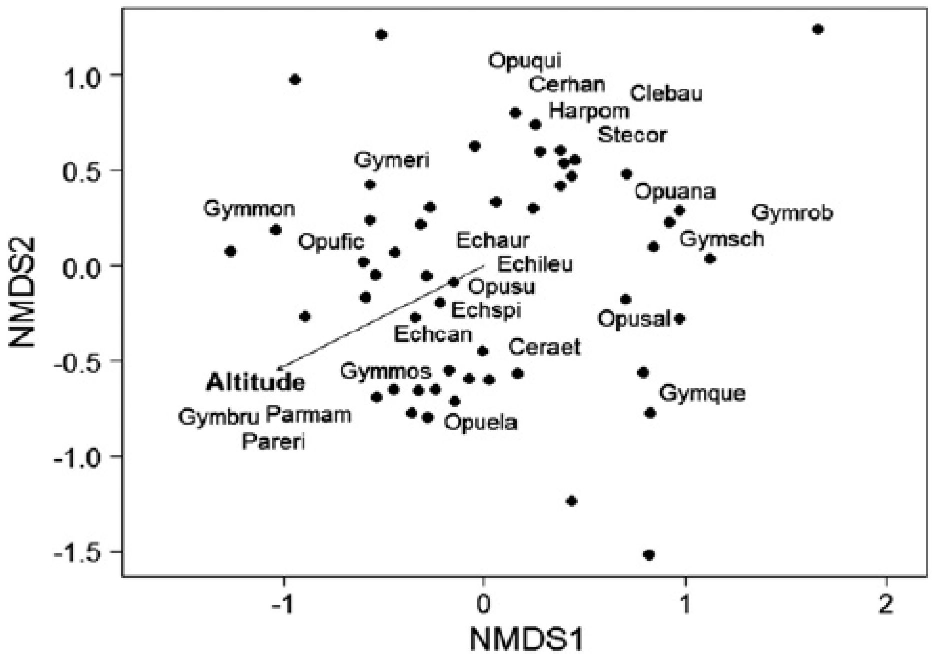


Fig. 3. Triplot and fitted surface of Altitude from a Non-metric Multidimensional Scaling (NMDS) of the 55 sites × 23 cacti species of Sierras del Norte Mountain, Córdoba. Stress values were 0.17 of this data set. Species abbreviations correspond to the first three letters of the genus and species detailed in Table 1. Each circle represents one site (n = 55).

La altura explica los cambios en la composición de especie en la región

Diversidad Beta

Table 3
Beta Diversity index among all combinations of the eight altitudinal belts. For this analysis we summarized the 55 sites in eight altitudinal belts. Light shaded area indicates low species turnover ($\beta < 0.33$); dark shaded area indicates high species turnover ($\beta > 0.66$; sensu Mourelle and Ezcurra, 1997).

	300–399	400–499	500–599	600–699	700–799	800–899	900–1000
200–299	0.28	0.49	0.49	0.56	0.70	0.90	0.83
300–399		0.21	0.14	0.28	0.70	0.90	0.90
400–499			0.14	0.28	0.63	0.97	0.97
500–599				0.14	0.63	0.97	0.97
600–699					0.63	0.97	0.97
700–799						0.35	0.35
800–899							0.00

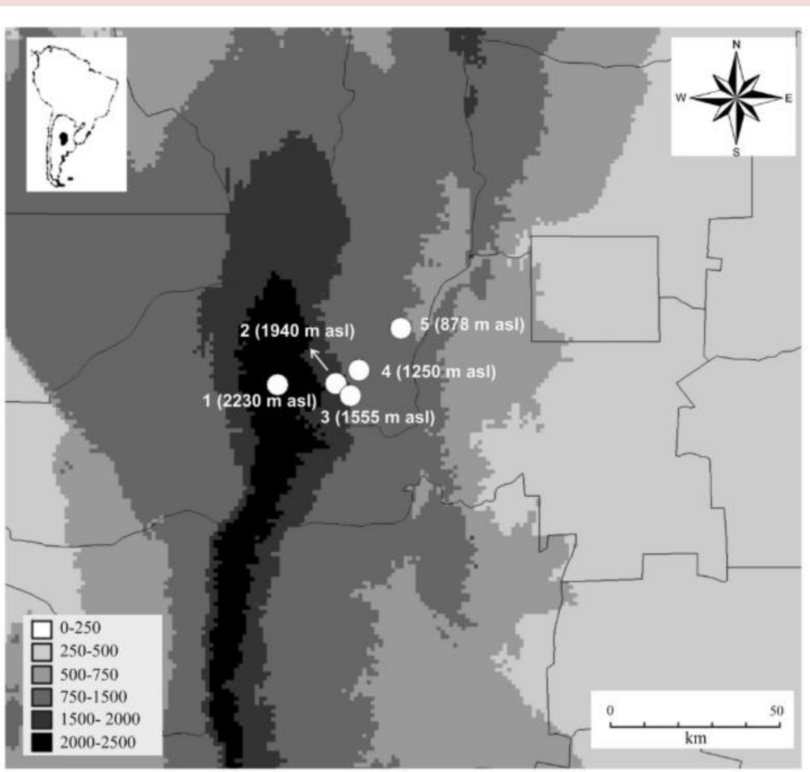
- Hay un cambio abrupto en la composición de especies alrededor de lo 700m, coincidente con la desaprición de epecies rboreas

NRC Research Press

NOTE

Are seed mass and seedling size and shape related to altitude? Evidence in *Gymnocalycium monvillei* (Cactaceae)

Karen Bauk, Reyes Pérez-Sánchez, Sebastián R. Zeballos, M. Laura Las Peñas, Joel Flores, and Diego E. Gurvich



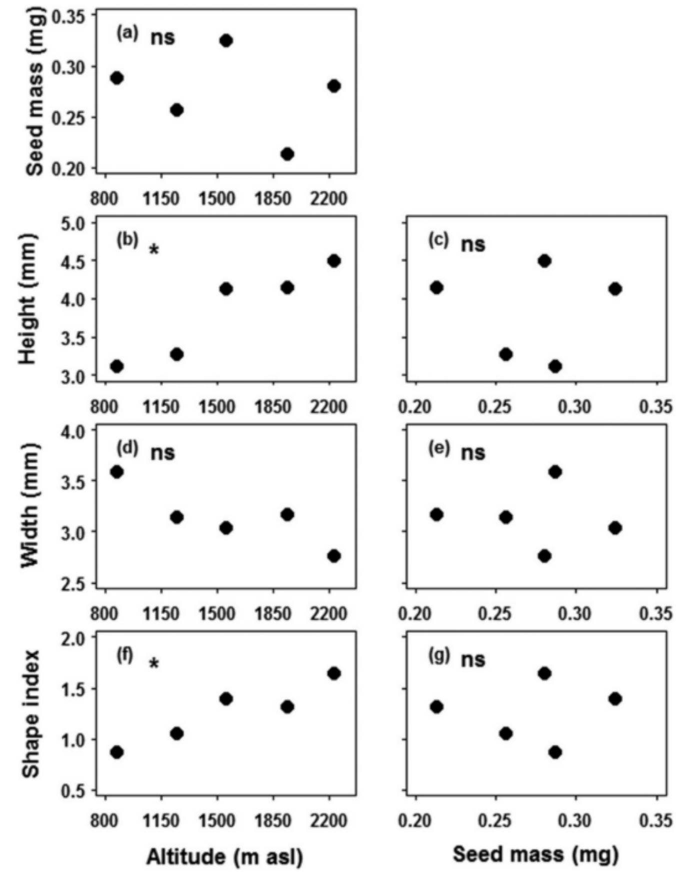


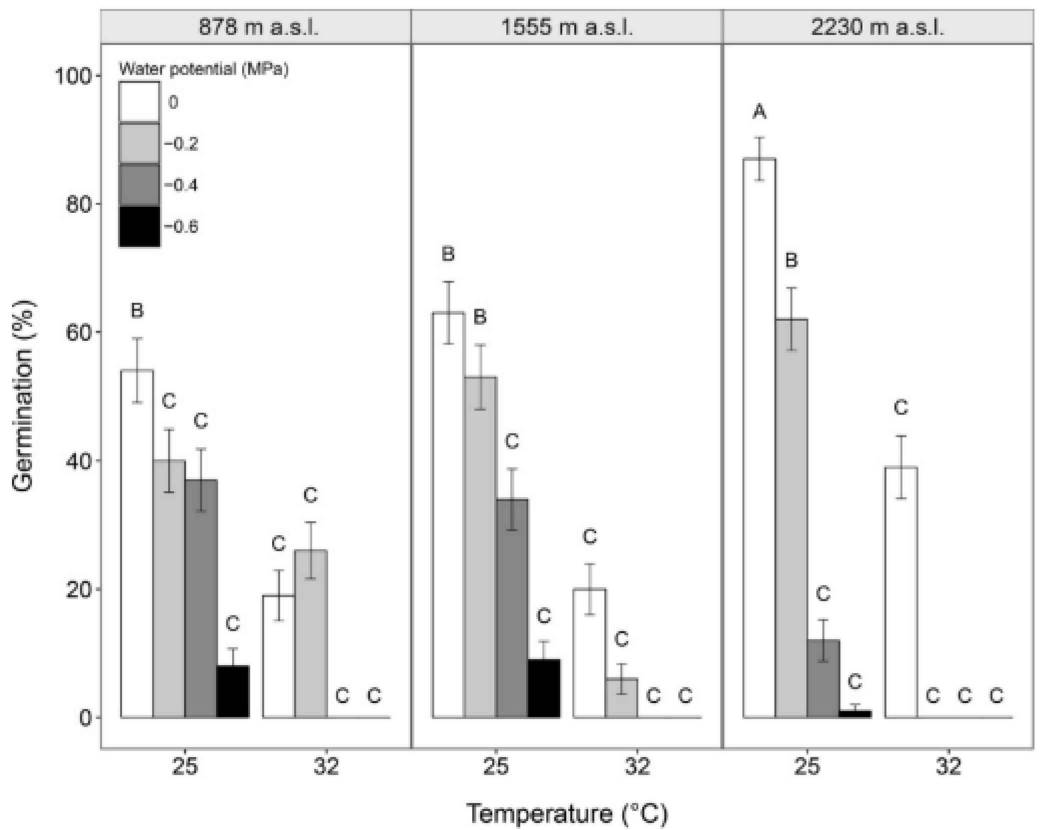
Fig. 3. Photographs of typical seedlings of *Gymnocalycium monvillei* for each altitudinal class.

NRC Research Press

ARTICLE

Germination characteristics of *Gymnocalycium monvillei* (Cactaceae) along its entire altitudinal range

Karen Bauk, Joel Flores, Cecilia Ferrero, Reyes Pérez-Sánchez, M. Laura Las Peñas, and Diego E. Gurvich



Las poblaciones de abajo responde mejor a mayores temperaturas y estrés hídrico

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Latitudinal and altitudinal patterns of the endemic cacti from the Atacama desert to Mediterranean Chile

P.C. Guerrero [a,*], A.P. Durán [b], H.E. Walter [c]

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[b] Biodiversity and Macroecology Group, Department of Animal and Plant Sciences, University of Sheffield, Sheffield S10 2TN, UK
[c] The EXSIS Project, Ex-situ & in-situ Cactaceae Conservation Project, Santiago, Chile and Munich, Germany

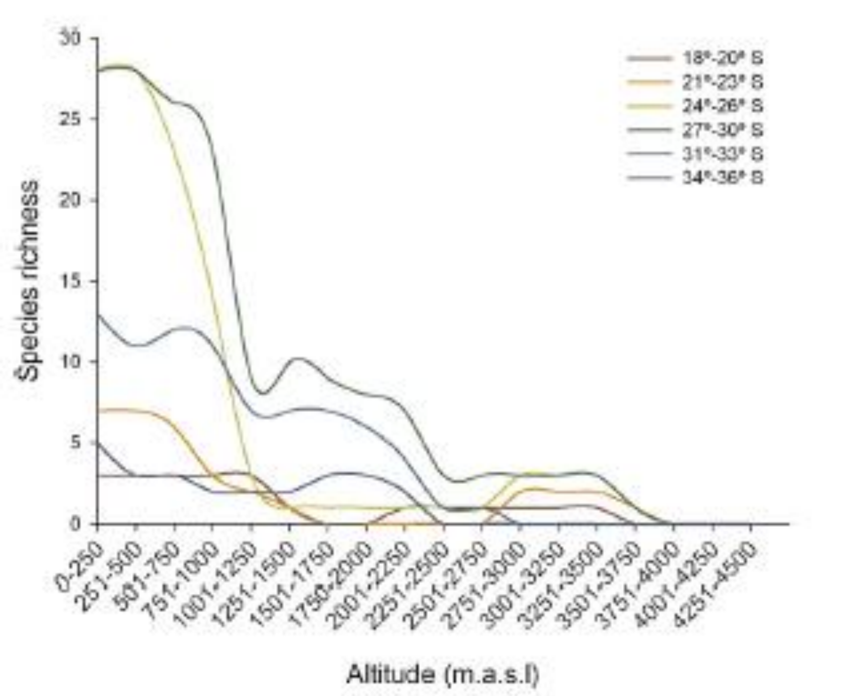


Fig. 4. Altitudinal gradient of species richness of endemic cacti at different latitudinal bands from 18° S to 36° S in Chile.

- Los patrones de diversidad varían según la latitud

Vegetational Change Along Altitudinal Gradients

Studies in Ethiopia show that discreteness of zonation varies with steepness of slope.

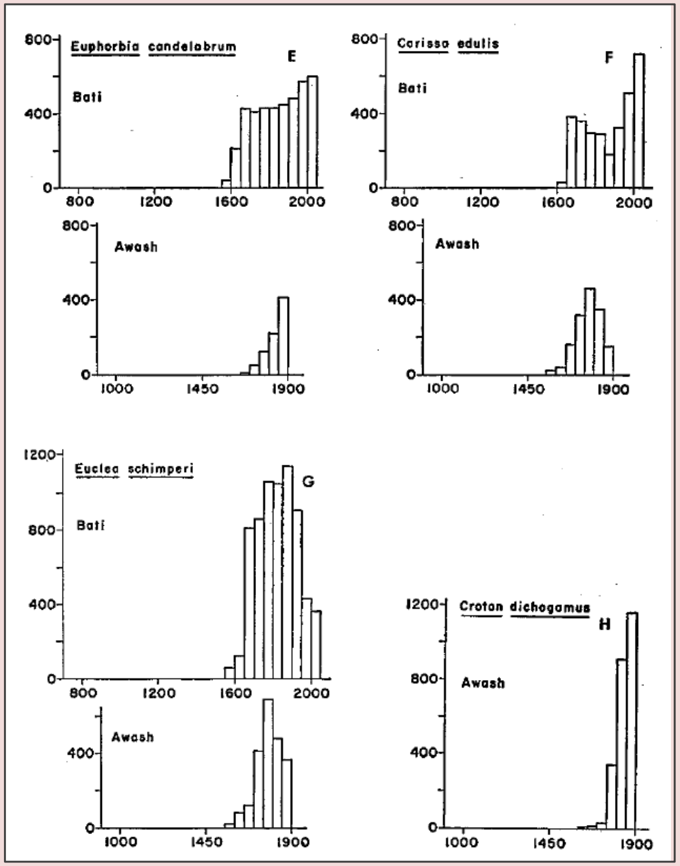
Edward W. Beals

Science
1969

- Estudio cambios en la vegetación en sitios con diferentes pendientes: abruptas suaves

  - Los cambios son más abruptos en sitios de pendientes pronunciadas

    La exclusión competitiva seria más importante en pendientes suaves Importancia de las interacciones biológicas actuando en la altura



Plant Ecology (2006) 184:27–42
DOI 10.1007/s11258-005-9049-4

Continuum or zonation? Altitudinal gradients in the forest vegetation of Mt. Kilimanjaro

Andreas Hemp
Lehrstuhl für Pflanzenphysiologie, Universität Bayreuth, Universitätsstr. 30, 95440, Bayreuth, Germany; (e-mail: andreas.hemp@uni-bayreuth.de; phone: +49-0-921-552630; fax: +49-0-921-552642)

Received 8 May 2005; accepted in revised form 23 August 2005

- La vegetación de distribuye de manera no continua
- Existen comunidades (altitudinales) bien diferenciables

THE SOUTHWESTERN NATURALIST 43(1):25–39 MARCH 1998

FLORISTIC AND LIFE-FORM DIVERSITY ALONG AN ALTITUDINAL GRADIENT IN AN INTERTROPICAL SEMIARID MEXICAN REGION

CARLOS MONTAÑA AND ALFONSO VALIENTE-BANUET

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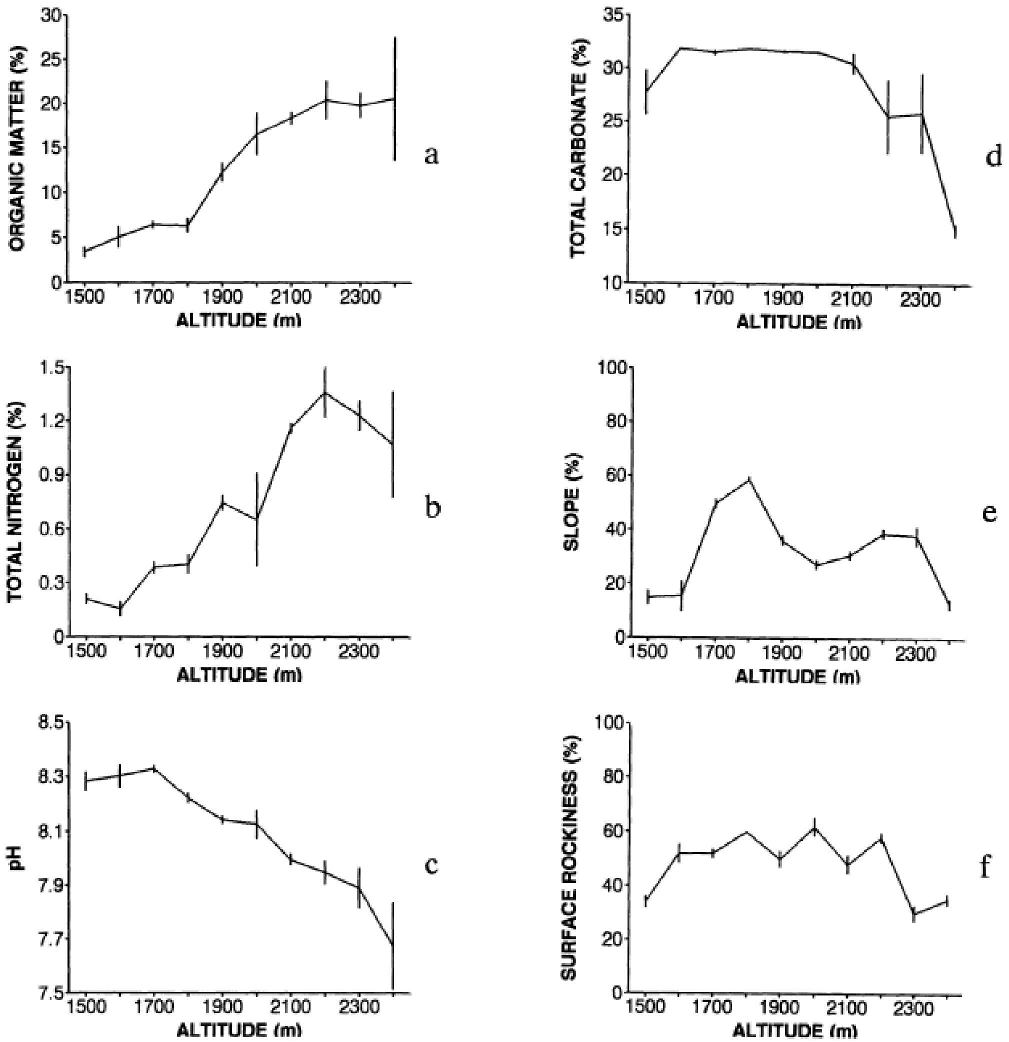
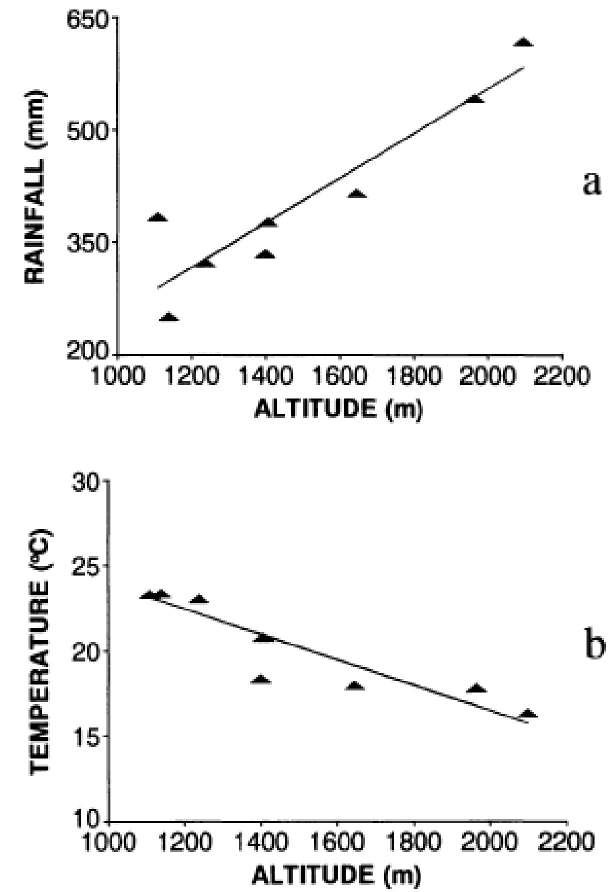
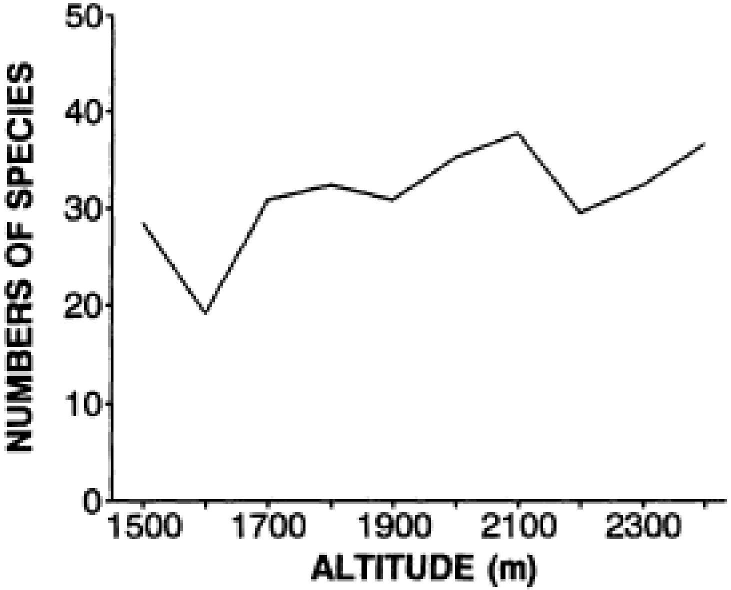
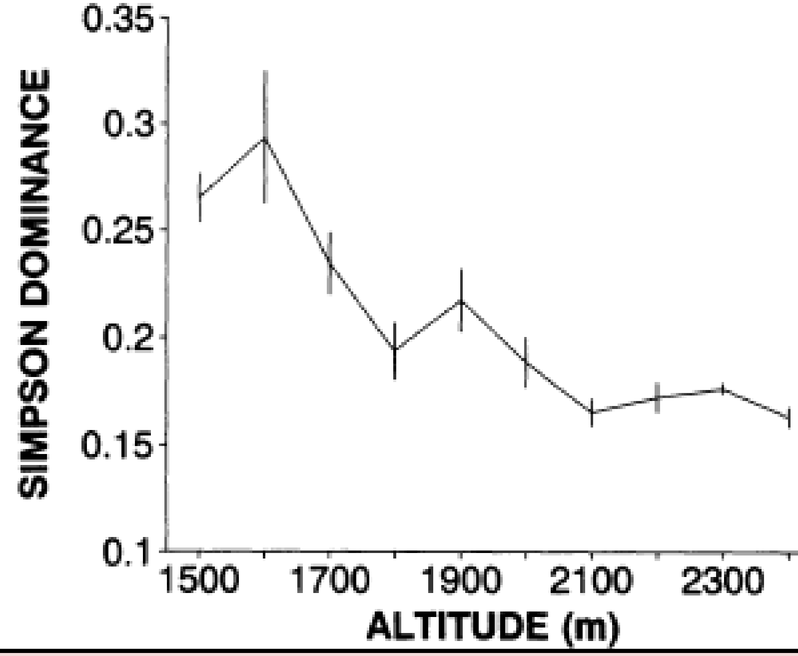


FIG. 4—Variation of (a) organic matter content, (b) total nitrogen content, (c) pH, (d) total carbonate content, (e) slope and (f) surface rockiness along altitude. Mean (±1 *SE*) of five samples collected each 100 m of altitude along the altitudinal gradient are shown.




NUMBERS OF SPECIES
0
10
20
30
40
50
1500
1700
1900
2100
2300
ALTITUDE (m)

a


SIMPSON DOMINANCE
0.1
0.15
0.2
0.25
0.3
0.35
1500
1700
1900
2100
2300
ALTITUDE (m)

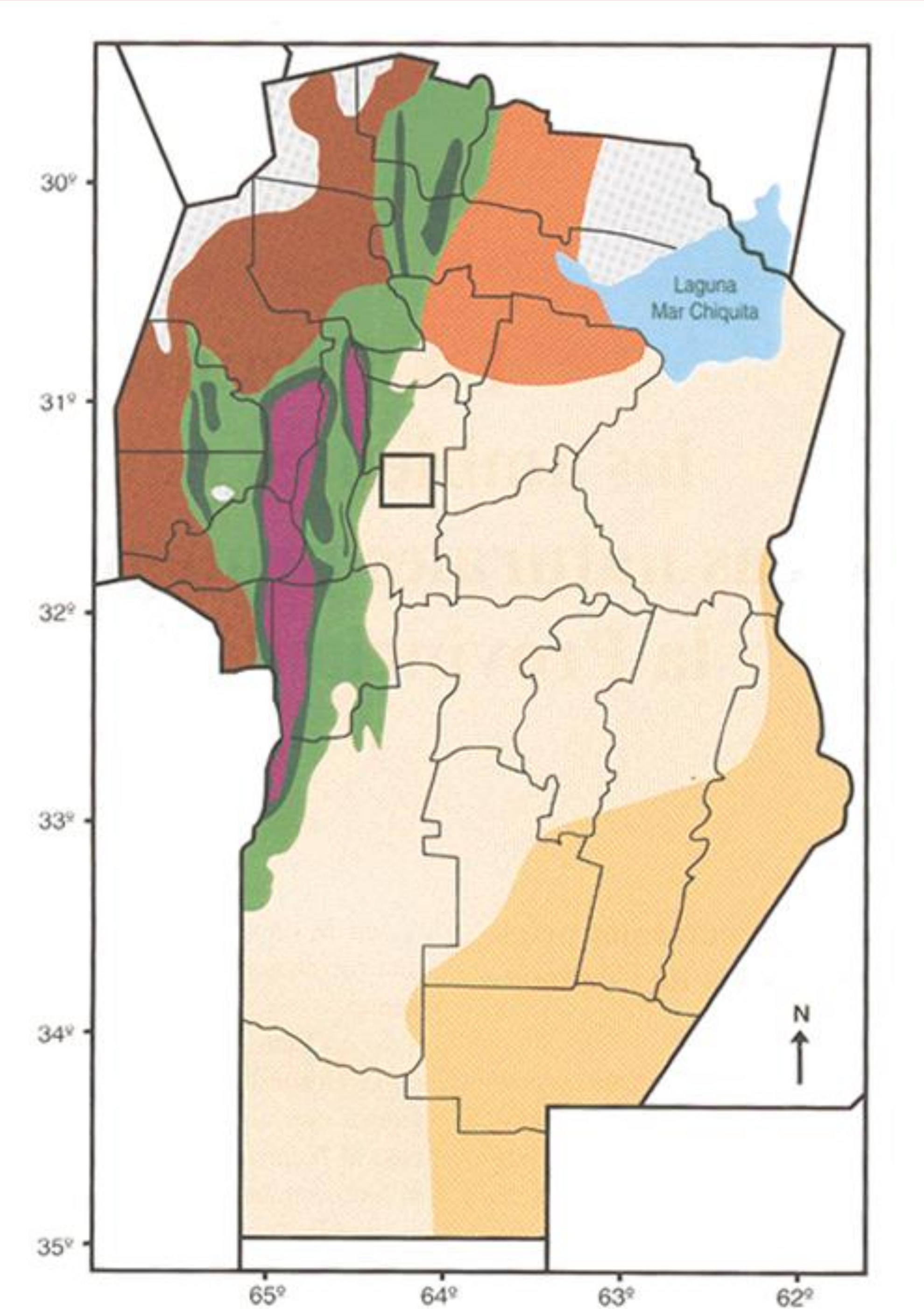
Cinturones de vegetacion

Applied Vegetation Science ■■ (2017)

Changes in floristic composition and physiognomy are decoupled along elevation gradients in central Argentina

Melisa A. Giorgis, Ana M. Cingolani, Diego E. Gurvich, Paula A. Tecco, Jorge Chiapella, Franco Chiarini & Marcelo Cabido

• En las … ba que los cintur…



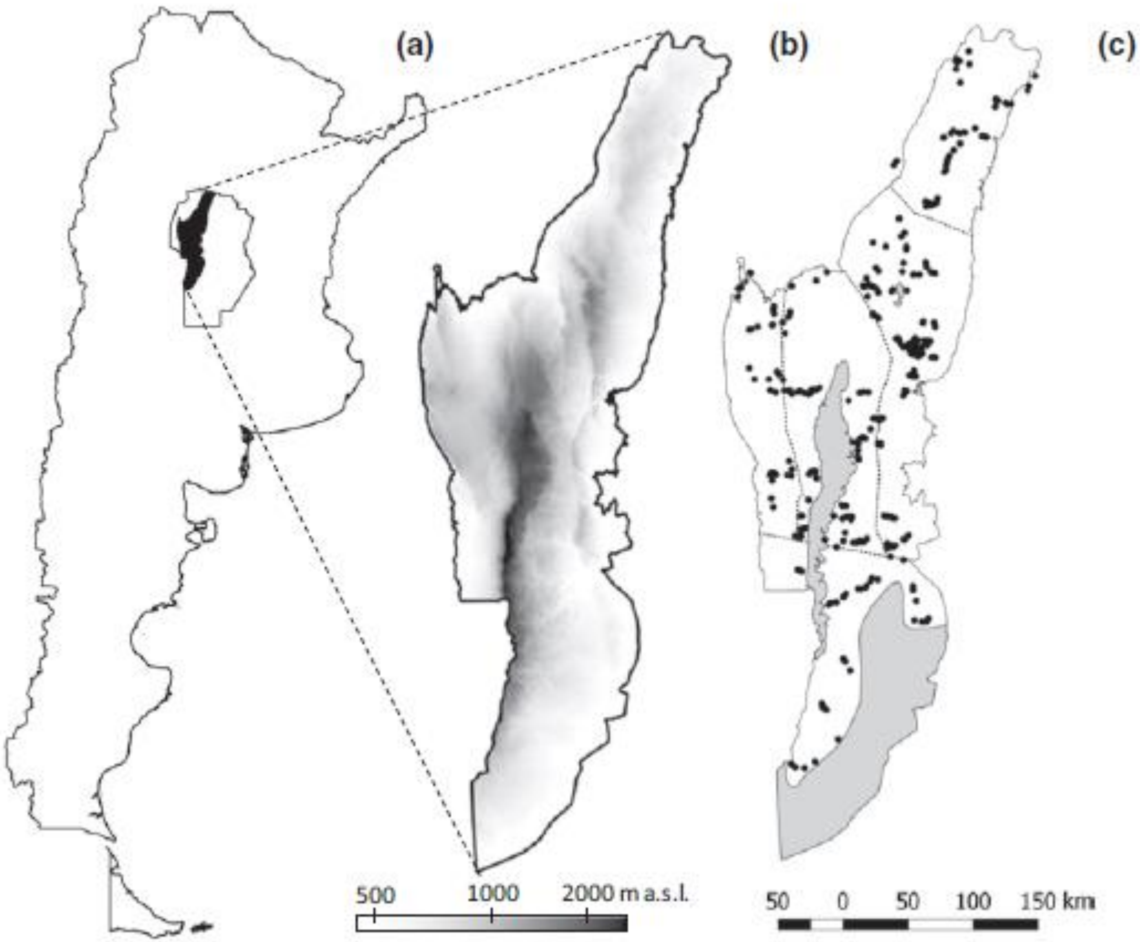
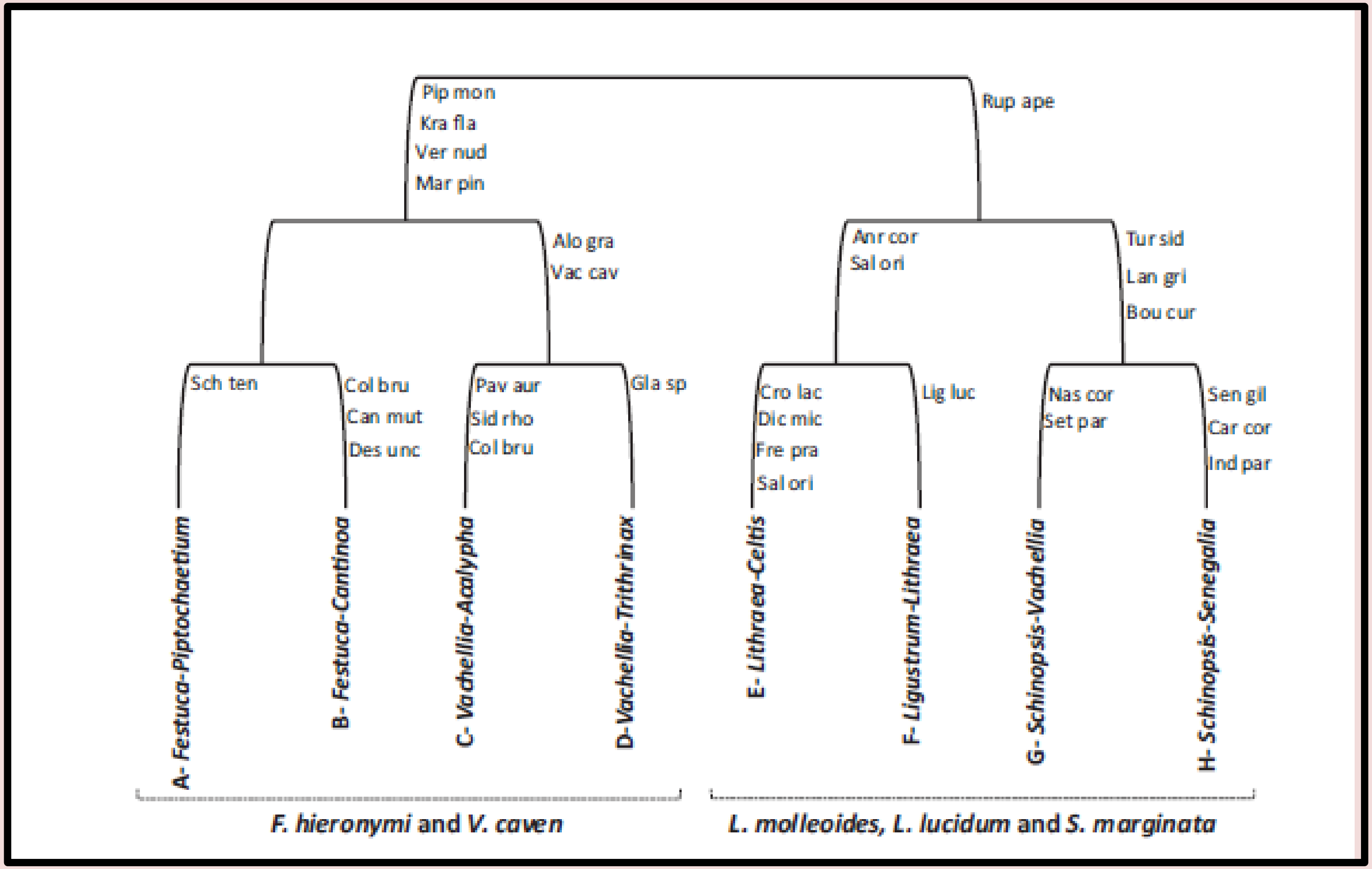
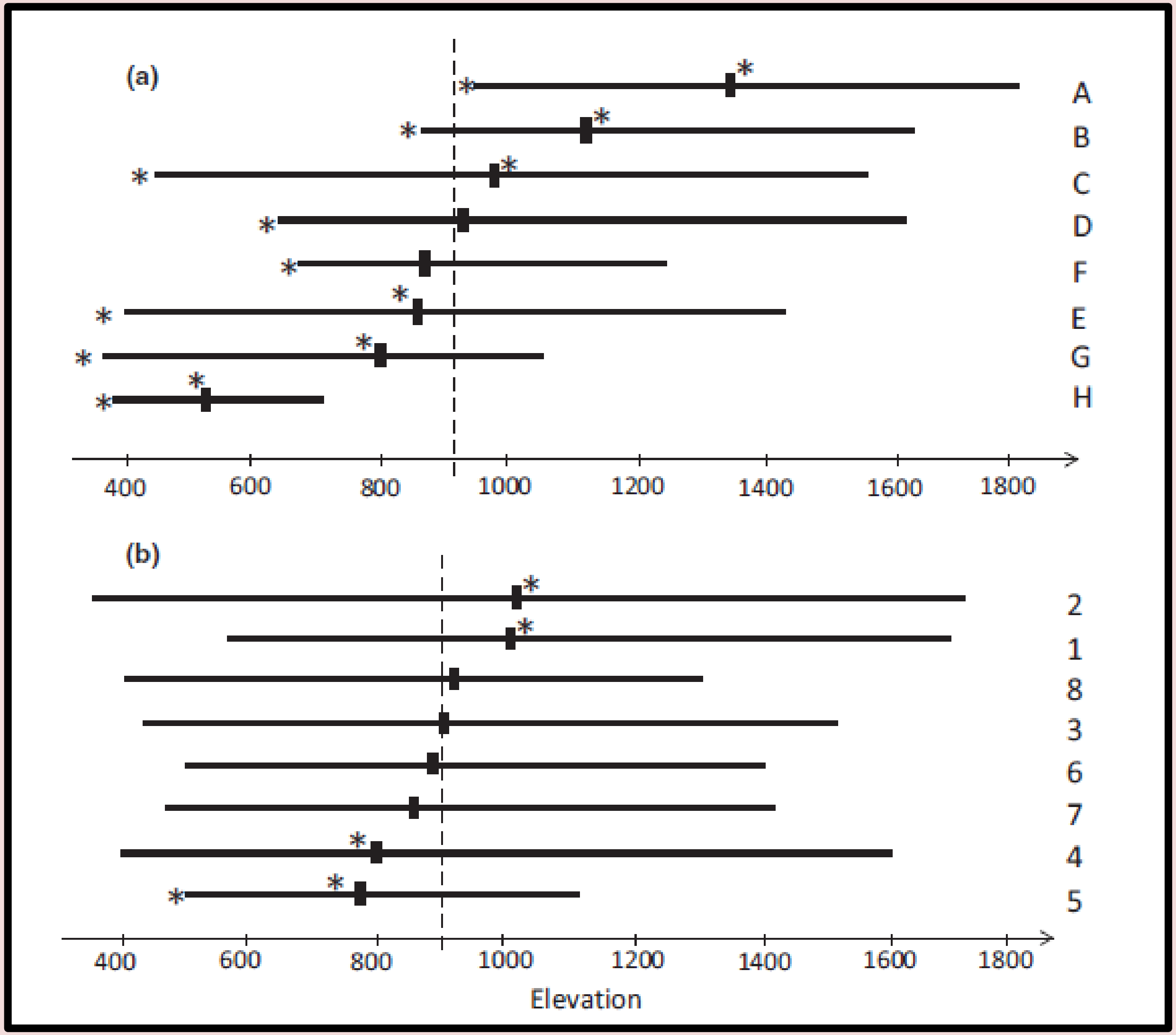


Fig 1. (**a**) Location of the study area (■) in Córdoba Province in Argentina. (**b**) Elevation gradient in the study area. (**c**) Distribution of the 437 relevés in the five sectors of the study area (□). Agricultural zones in the lower plains and the sub-Andean zone above 1700 m were not sampled (▒).



- Las comunidades están bien definidas (no hay un continuo!!)



Florístico

Fisonómico

- La fisonomía y la composición florística son propiedades independientes
- Las características **florísticas** (determinadas por la composición de especies) están más restringidas que las características **fisonómicas**