Is there really such a thing as *Tropical* Biology?

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1. INTRODUCTION

> *"This is an interesting and useful study, but I feel the manuscript is better suited to a specialized journal focusing on tropical ecosystems."*
>
> Subject Editor *(name and journal redacted)*

The conclusion from a Subject Editor regarding my submission to one of our field's well-known journals is likely familiar to many members of the Association for Tropical Biology & Conservation (ATBC). All three reviews were positive, with none of the referees identifying significant shortcomings or requesting major changes. So why was the manuscript rejected? My only clue was the Editor's concluding sentence, from which I gathered they felt studies done *in* the tropics were of limited relevance to researchers working *outside* the tropics. That's who a specialized journal is for, after all – a smaller community of subject-matter experts – and the journal to which we had submitted our study sought to publish "broad conceptual advances". In short, there's a Biology and there's *Tropical* Biology, with the latter a specialized subdiscipline of the former.

This narrow view of research in the tropics is not new. In 1963, P. W. Richards used his Presidential Address to the British Ecological Society to explain "what the Tropics can contribute to ecology", advocate for the tropics to be studied more intensively, and to try and convince students to visit "the most [biologically] exciting part of the world". His reason for choosing this topic, while self-deprecating, was also pointed - he was concerned that "a review of recent advances in tropical ecology. . . would probably bore the large part of my audience." (Richards, 1963). That that this was still the case after decades of effort by him and others (Chapman et al., 1945; Huxley, 1927; Park, 1945; Richards, 1946; "Tropical Botany," 1907) must have been very frustrating.

Sixty years on we find ourselves similarly frustrated. Field stations in the tropics remain underfunded (Corner, 1946; Eppley et al., n.d.). Support for tropical research continues to decline (Chapman et al., 1945; Sohmer, 1980; Stegmann et al., 2024). And while the tropics comprise the vast majority of the planet's biodiversity (Gaston, 2000), ~40% of its terrestrial surface area, and half the human population (Hoornweg & Pope, 2017), the study of tropical ecosystems is still viewed by many as a specialized subdiscipline. My objective here isn't to review the origins or consequences of this generalization (e.g., Chazdon & Whitmore, 2001; Raby, 2017), nor to critique the many plans that have put forward to advance research in the tropics (Bawa, Kress, Nadkarni, & Lele, 2004; Buechner & Fosberg, 1967; e.g., D. Janzen, 1972; D. H. Janzen, 1986; Richards, 1964; Robinson, 1978). Instead, I want to address the fundamental and (inexplicably) untested assumption: Is there really such a thing as *Tropical* Biology?

1. Why the answer is *'No'.*

> *". . . to this day ecology is biased by concepts and ideas appropriate mainly to the study of vegetation in temperate climate."*
>
> P. W. Richards (1963)

One means of evaluating if tropical biology is a distinct academic discipline is by considering the communities into which scientists self-organize. Scholarly societies and

journals two examples of these communities such community; their establishment requires both an intellectual pursuit with which individuals identify and a critical mass of like-minded individuals in search of community. Some of these communities coalesce around broad conceptual domains (e.g., *Evolutionary* Biology, *Conservation* Biology, *Integrative* Biology; Fig. 1A). Still others bring together individuals from different conceptual domains that share an interest in a particular system (e.g., *Avian* Biology, *Island* Biology; Fig. 1B). Finally, some scholarly societies comprise individuals grounded in a common methodological framework, though they may do so with disparate study systems or to address questions in distinct conceptual domains (e.g., *Molecular* Biology, *Mathematical* Biology, *Systematic* Biology; Fig. 1C).

Tropical Biology fails to align with any of these constructs. Its practitioners investigate fundamental questions across conceptual domains using a broad range of methodological approaches and study systems. Even the geographic descriptor that would seemingly be the unifying thread is challenging to operationalize. Strictly speaking, *The Tropics* are the portion of the Earth's surface receiving at least one day of direct overhead sunlight per year - a band delineated by the Tropics of Capricorn (23°26'10.4" S) and Cancer (23°26'10.4" N). There is, however, no *biological* definition of 'The Tropics', in large part because the ranges of many 'tropical' species extend far beyond these latitudinal boundaries[1]. Indeed, a review of over 200 scientific articles, by Feeley and Stroud (2018) identified at least eight distinct criteria by which authors defined 'The Tropics'. How then is it that *Tropical Biology* come to be seen as a distinct subdicipline despite the lack the sharp boundaries around which scientific groups typically coalesce?

1. The perception of tropical ecosystems as distant and distinct regions whose study "complements our understanding of biology" is the product of centuries of historical and cultural reinforcement (Driver & Yeoh, 2000).
2. The first Europeans to visit the tropics returned with vivid, captivating, and often pejorative descriptions of the places and people they encountered.
3. Their stories established a series of often contradictory cultural narratives about *'The Tropics'* - a Paradise on Earth or a Green Hell, where one would encounter either 'Gentle Natives' or 'Bloodthirsty Savages', and they filled with incalculable wealth - but only if one had the requisite strength, courage, and faith to conquer them - that were reinterpreted and reinforced by subsequent visitors.
4. The historian David Arnold has argued that these narratives, and referring to this part of the globe as 'The Tropics', allowed Europeans to define the region as environmentally and culturally distinct while also superimposing a high degree of common identity between the very distinct parts of the tropical world.

This perception of the tropics and the resulting stereotypes (Gourou et al., 1966), were prevalent in North American and Europe at the time Ecology was consolidating as academic an discipline (Raby, 2017). Because Europe and North America were also where many of the field's pioneers were based, ecology's fundamental paradigms and theory were informed by and developed to explain patterns documented in the temperate zone (Corner,

[1] Perhaps the most extreme examples are migratory birds such as the northern wheatear (*Oenanthe oenanthe*), which fly over 14,000 km from sub-Saharan Africa to their breeding grounds in the Arctic (Bairlein et al., 2012)

1946; Richards, 1946, 1963, 1964). These scientists were not ignorant of the tropics, indeed, many considered a trip to the tropics an essential rite of passage for their students (Webb, 1960). Other went even further - in in his 1945 Presidential Address to the Ecological Society of America, Orlando Park impressed upon his audience the importance of the tropics and encouraged ESA to establish a formal tropical program, *including a new journal focused on the biology of the tropics* (Park, 1945). But these efforts were often thwarted by the way in which tropical biology could quickly overwhelm temperate theory (Richards, 1963). Richards (1963) wasn't a reorienting of the field towards these high-diversity ecosystems. Instead, it was to translate the notion that "the tropics are *culturally* unique" into the scientific truism that "the *biologically* unique".

2. Why the answer is *'Maybe'.*

> *"It is also evident that much of our current teaching in ecology, as well as in other branches of biology, would be set in a truer perspective if more consideration were given to tropical vegetation and the conditions... in the tropics."*
>
> P. W. Richards (1946)

> *"In attempting to study vegetation and to arrive at generalizations which will serve to relate the various plant communities to one another, it would be more logical to begin with the floristically rich vegetation of the tropics than, as we now do, with the impoverished vegetation of northem Europe and North America."*
>
> P. W. Richards (1946)

Even if *The Tropics* is a historical construct, *Tropical Biology* could still be conceptually distinct field of study if, over time, the scientific community converged on a suite of topics either unique to or best studied in tropical systems. Using text-mining tools, I compared the content of 15,568 articles reporting research from the tropics with 26,620 studies conducted in other parts of the world. I began by extracting all keywords, title words (e.g., *seed*, *species*), and title bigrams (i.e., pairs of sequential words, e.g., *seed predation*, *species diversity*) from the entire collection of articles; this resulted in N = 70,114 keywords, N= 39,918 title words, and N = 141,029 bigrams. I then calculated the percentage of tropical and non-tropical articles using each of these terms; the results below are based on the top N = 75 terms in each category. For a complete description of the methods for selecting, assigning, and processing articles see *Online Supplement 1.*

Two major patterns emerge from this analysis. The first is that 32% of the most frequently used keywords from 'tropical' articles were study systems or geographic locations (e.g., *Costa Rica*, *Amazonia*, *bats*), while the overwhelming majority from non-tropical articles (96%) were conceptual (e.g., *competiton*, *ecosystem function*, *sexual selection*; Table 1). The second is that after removing the system- and location-specific keywords, there is ample conceptual overlap between tropical and non-tropical studies (Table 2). That said, the most common research topics within each article category often differ dramatically in their relative rankings, and there are notable areas of topical divergence (Table 2,

Supplementary Figure **X**). Similar patterns emerge when comparing individual title words (Supplementary Figure **X**) and title word bi-grams (Supplementary Figure **X**).

One interpretation of these results is that *Tropical* Biology is indeed a biological subdiscipline focused on problems and topics unique to or most relevant in tropical locations - it is undoubtedly true that there are some questions best addressed in or relevant to tropical ecosystems. However, the observed differences could also reflect the historical relegation of certain academic subjects to the tropics, which is then reinforcing by "temperate biases" (*sensu* Zuk (2016)) that shape the development of theory and determine what data are used to test it (Raby, 2017). A similar argument has been put forward for the social sciences, where Castro Torres and Alburez-Gutierrez (2022) argue that the far greater prevalence of geographic markers in the titles of articles by authors in the Global South indicates (and perpetuates) an "unwarranted claim on universality" by scholars from North America and Europe. Although their parallel evidence and argument are compelling, it remains unclear based on these data if there is indeed a distinct *Tropical* Biology.

3. Why the answer is *'Yes'.*

> *"No education complete without trip to the Tropics."*
>
> J. E. Webb (1960)

Finally, I suggest that 'Tropical Biology' could indeed be a unique discipline, but not for the reasons that have typically been put forward by those to have previously wrestled with this question. What sets Tropical Biology apart is not the science *per se*. Rather, what binds Tropical Biologists as an intellectual community is the broader context in which their scholarship is embedded and conducted. Research anywhere can be difficult, but for most tropical biologists the daily struggle with precarious infrastructure, economic volatility, drastically reduced funding for research and education, and political instability can feel insurmountable - and all this is before having to communicate one's results in a foreign language (Amano, González-Varo, & Sutherland, 2016) to the potentially biased reviewers (O. M. Smith et al., 2023) and readers of journals that charge open access fees equivalent to several months salary (A. C. Smith et al., 2021). When added to the physical and emotional toll of disease, crime, working in isolation, field sites being cleared at unprecedented rates, and threats of professional retribution or physical violence, tropical biology and conservation can be uniquely dangerous - even deadly. Lamentably, this is also true for the truly heroic environmental journalists and advocates with whom we collaborate.

4. The Future of (Tropical) Biology

> *"There are few things more presumptuous than a US scientist holding forth on the future of tropical ecology"*
>
> D. H. Janzen (1972)

The cultural and scientific consequences of framing the tropics as different and distinct - instead of what they are, which is dominant, and fundamental - have been raised repeatedly (e.g., Ripley, 1967), yet this generalization persists to this day. Once could

wonder how the past and present would differ if the scientific community had paid heed to —- and others and centered the tropics as the foundation on which ecology and evolution were built? Universities in Europe and the USA might offer elective courses in "Temperate Biology" taught by faculty that present their research at the annual meeting of the *Association for Temperate Biology & Conservation* (Fig. 3), with the resulting articles published in 'specialized' journals that - in contrast to the more generalizable research done in the tropics - emphasize the systems in which they work (Fig. 2). Instead, I prefer to look forward, and consider what the ambiguity of my conclusions implies for how we should move forward. I suggest that the future of lies in neither dropping the adjective that motivates so many of us, nor keeping it and accepting status as as specialization. Instead, I call on ATBC members to ***reclaim and reshape the Tropical narrative*** by continuing to take pride and elevate what makes biology in the tropics distinct and important - the places and context in which we work - while also working to properly recenter tropical ecosystems as the foundation of Biology and focus of conceptual attention. Here are six simple ways I propose that anyone can contribute to this movement:

1. ***Cite with purpose.*** Citation is a powerful and political act: it conveys legitimacy on the scholarship in the article being cited as well as its author, helps elevate the profile of the author and study system, and those reading your work will cite these articles when writing their own. For many scientists it also plays an important role in their professional advancement. Be mindful of this power and the opportunity it presents when choosing which articles to cite. Cite scientists whose work or approach you feel is undervalued or overlooked. Cite scientists from countries or institutions that have been ignored by the broader scientific community. Cite scientists whose approach to research you feel others should emulate. Cite studies conducted in the tropics.
2. ***Teach with Purpose.*** All tropical biologists are teachers, whether it be in a classroom or in a meeting with policy makers, and teaching also provides an opportunity to elevate the scholarship of others. Be mindful of whose papers are assigned as readings, the studies and systems used to illustrate concepts, the scientists highlighted in presentations, and who is invited to speak in seminar series or present guest lectures. Use your syllabus as a tool to recast the biological narrative about tropical ecosystems and the composition of the scientific community that studies them. Train students in the skills needed when working in tropical systems - collaboration, facilitation, conflict resolution, and communication to diverse audiences (Duchelle et al., 2009; Kainer et al., 2006).
3. ***Collaborate with Purpose.*** International collaboration can be challenging, but personally and professionally beneficial (M. J. Smith, Weinberger, Bruna, & Allesina, 2014). Be mindful of global scientific inequities. Allow community members to guide the identification of research questions (Kainer et al., 2009). Push for organizations to strengthen collaborations with - and especially within - the Global South. Return research results to the communities in which you work.
4. ***Build on public fascination with the tropics.*** Public fascination with the tropics and their charismatic species (Albert, Luque, & Courchamp, 2018) provides unparalleled opportunities for outreach and education (Moreira & Robles, 2017).

Global events like the World Cup (Melo et al., 2014), teams with tropical species as mascots (Sartore-Baldwin & McCullough, 2019), movies set in the tropics (Yong, Fam, & Lum, 2011), tropical images in fashion (Kutesko, 2014), viral videos about tropical fruits (*South Florida Couple Goes Viral on TikTok, Now Selling Exotic Fruit Online – WSVN 7News | Miami News, Weather, Sports | Fort Lauderdale*, n.d.) - we can find creative ways to leverage this universal appeal into support for tropical research and conservation.

5. ***Get in the Game.*** It's trite, but true - change requires action. Organizations like the ATBC provide many opportunities for meaningful engagement. Help make the process of publishing more fair by serving as a review or subject editor for *Biotropica*. Contribute to capacity building efforts by reviewing student seed grants proposals or serving as a judge for student presentations at the annual meeting. Is there an issue about which you are passionate? Join an ATBC committee or chapter and organize a webinar, workshop, hackathon, or reading group on the topic. What should the Association be doing differently? Tell the leadership at the Council Meetings or stand for election and push for change as a Councillor.
6. ***Support and celebrate one another.*** Finally, remember that the work done by tropical biologists addresses the "neglected problems that afflict most of the world's people" (Annan, 2003). Conducting research - regardless of the subject - advances the socioeconomic condition of the country in which it's conducted. It is difficult, frustrating, and not without risk. Seek opportunities to thank and congratulate each other for your contributions, and the effort and resilience that they required - you're truly making the world a better place.

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Supplmentary Online Material

Bibliometric analysis

To identify the conceptual domains studied by researchers working in 'Tropical' and "non-Tropical' locations, I used information extracted from the bibliographic records of articles published in N = 11 focal journals: . Specifically, I compared (1) article keywords, (2) individual words in article titles (e.g., *seed*, *species*), and (3) title bigrams (i.e., pairs of sequential words in titles, e.g., *seed predation*, *species diversity*). Below I describe how the article records were identified, downloaded, processed, and assigned to the 'Tropical' and"non-Tropical' categories using code written in the `R` statistical programming language (R Core Team, 2023) and available at —REPO CITATION—.

Methods: On –DATE–, I downloaded all bibliographic data available in SCOPUS and the Web of Science 'Core Collection' for articles published in the focal journals (both databases were queried because they differ in the years indexed for each journal). I then used the `refsplitr` package to process the records and remove any duplicates. After removing all stopwords from article titles (Benoit, Muhr, & Watanabe, 2021) and keywords, I spell-checked, stemmed, and lemmatized all of the keywords and title words. I also extracted bigrams from titles with the `tidytext` library (Silge & Robinson, 2016). Finally, I identified each article as either 'Tropical' or 'non-Tropical'; all articles published in *Biotropica*, *Journal of Tropical Ecology*, *Tropical Ecology*, *Tropical Conservation Science*, or *Revista de Biologia Tropical* were assigned to the 'Tropical' category, while articles published in the other journals were assigned to one of these categories based on a search of the titles, keywords, or abstracts for a list of domain-specific terms (TABLE). These procedures resulted in N = 42,188 total articles published, of which N = 15,568 reported research conducted in the tropics and N = 26,620 were based on work conducted in other locations. Collectively, these articles used N = 70,114, N = 39,918 unique title words, and N = 141,029 title bigrams.

Visualization: Because the number of articles varies widely between journals, as does the number of keywords per article, comparing counts of keyword frequency in tropical and non-tropical articles could bias trends towards contentpublished a small number of journals. To correct for this, I calculated the percentage of articles in each geographic category that uising each keyword, title word, or bigram. I then selected the N = 75 most frequently used terms in each geographic category, and identified (a) any terms that 'tropical' and 'non-tropical' articles had in common, and (b) any terms that were unique to each article category.

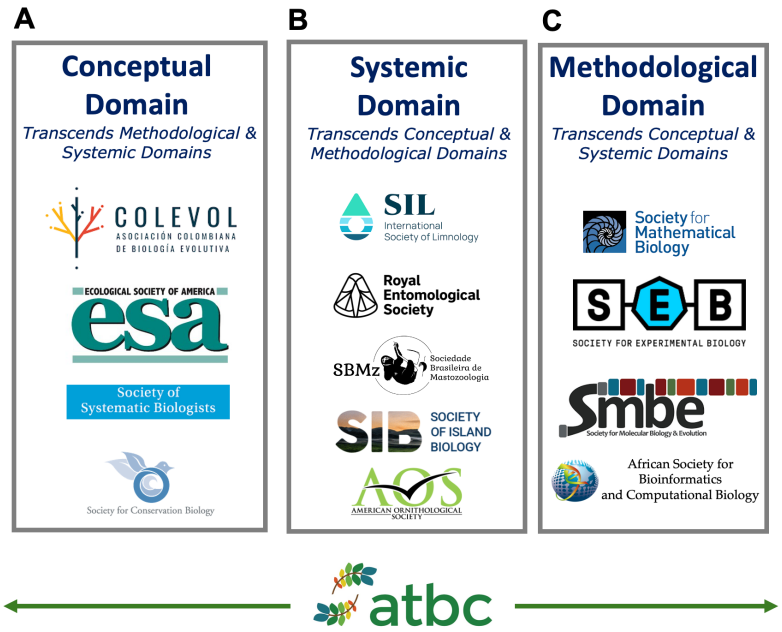

Figure 1. (A) Alternative ways in which researchers self-organize: scholarly societies focused on (A) Conceptual Domains, (B) Systemic Domains, or (C) Methodological Domains. The Association for Tropical Biology transcends these three, as it has members that study a wide variety of systems using different conceptual approaches and tools.

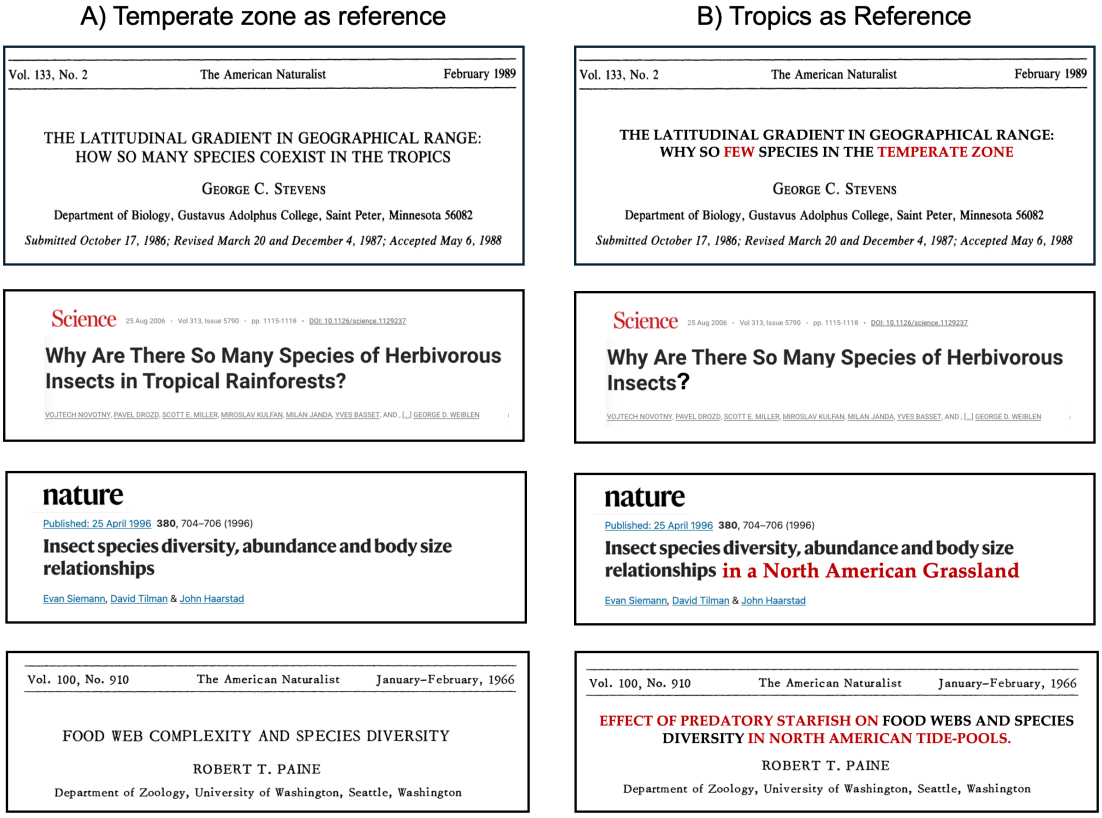

Figure 2. Alternative publication titles with framing centering (A) the Temperate Zone (B) the Tropics as the ecological reference.

Figure 3. The logo for a proposed new scholarly society specializing on temperate ecosystems..

Table 1
Keywords - with System

Top Keywords - Tropical Studies (rank)	Shared Keywords (rank in Tropical, rank in Nontropical)	Top Keywords - Nontropical Studies (rank)
costa rica (1)	diversity (2, 6)	phenotypic plasticity (4)
tropical forest (3)	conservation (7, 75)	tradeoff (9)
mexico (4)	herbivory (9, 11)	natural selection (12)
seed dispersal (5)	disturbance (10, 27)	fitness (16)
tropical rainforest (6)	climate change (11, 3)	coevolution (17)
brazil (8)	species richness (14, 24)	body size (18)
rainforest (12)	competition (17, 2)	evolution (19)
panama (13)	phenology (18, 45)	local adaptation (20)
neotropic (15)	growth (19, 74)	gene flow (21)
savanna (16)	predation (22, 14)	quantitative genetic (23)
seed germination (20)	speciation (23, 5)	food web (25)
frugivory (21)	pollination (26, 47)	heritability (26)
tropical dryforest (24)	biogeography (32, 62)	coexistence (28)
seasonality (25)	dispersal (35, 7)	experimental evolution (29)
reproduction (27)	nitrogen (36, 44)	hybridization (30)
venezuela (28)	temperature (40, 37)	selection (31)
distribution (29)	functional trait (41, 60)	reproductive isolation (32)
caribbean (30)	succession (42, 68)	survival (33)
biomass (31)	mutualism (46, 35)	facilitation (36)
abundance (33)	lifehistory (50, 8)	maternal effect (38)
seed predation (34)	population dynamic (63, 13)	metapopulation (39)
amazon (37)	community structure (64, 73)	**usa (40)**
taxonomy (38)	demography (67, 34)	extinction (41)
atlantic forest (39)	phylogeny (68, 22)	mate choice (42)
colombia (43)	density dependence (72, 15)	sperm competition (43)
mortality (44)	sexual selection (74, 1)	ecosystem function (46)
phosphorus (45)	adaptation (75, 10)	sexual conflict (48)
tropic (47)		mating system (49)
fire (48)		migration (50)
bird (49)		inbreeding depression (51)
coral reef (51)		genetic correlation (52)
mangrove (52)		lifehistory evolution (53)
regeneration (53)		**grassland (54)**
diet (54)		colonization (55)
fragmentation (55)		sexual dimorphism (56)
recruitment (56)		community assembly (57)
cerrado (57)		kin selection (58)
bci (58)		**drosophila (59)**
puerto rico (59)		genetic variation (61)
species diversity (60)		resistance (63)
africa (61)		sex ratio (64)
amazonia (62)		invasive species (65)
litter (65)		predator prey interaction (66)
ecology (66)		senescence (67)
mammal (69)		invasion (69)
beta diversity (70)		microsatellite (70)
decomposition (71)		habitat selection (71)
habitat fragmentation (73)		allometry (72)

Table 2
KW - No System

Top Keywords - Tropical Studies (rank)	Shared Keywords (rank in Tropical, rank in Nontropical)	Top Keywords - Nontropical Studies (rank)
seed dispersal (2)	diversity (1,6)	tradeoff (2)
seed germination (11)	conservation (3,72)	natural selection (11)
frugivory (12)	herbivory (4,11)	fitness (12)
seasonality (15)	disturbance (5,27)	coevolution (15)
distribution (18)	climate change (6,3)	evolution (18)
biomass (19)	species richness (7,24)	local adaptation (19)
seed predation (21)	competition (8,2)	gene flow (21)
abundance (22)	growth (9,71)	quantitative genetic (22)
taxonomy (25)	phenology (10,44)	food web (25)
mortality (29)	predation (13,14)	heritability (29)
phosphorus (31)	speciation (14,5)	experimental evolution (31)
fire (32)	pollination (16,46)	hybridization (32)
coral reef (34)	reproduction (17,75)	selection (34)
regeneration (35)	biogeography (20,59)	reproductive isolation (35)
diet (36)	dispersal (23,7)	facilitation (36)
fragmentation (37)	nitrogen (24,42)	maternal effect (37)
recruitment (38)	temperature (26,37)	metapopulation (38)
species diversity (39)	functional trait (27,57)	extinction (39)
litter (42)	succession (28,65)	mate choice (42)
ecology (43)	mutualism (30,35)	sperm competition (43)
beta diversity (46)	lifehistory (33,8)	ecosystem function (46)
decomposition (47)	population dynamic (40,13)	sexual conflict (47)
habitat fragmentation (49)	community structure (41,70)	migration (49)
morphology (52)	demography (44,34)	mating system (52)
nutrient (54)	phylogeny (45,22)	inbreeding depression (54)
deforestation (56)	density dependence (48,15)	genetic correlation (56)
seedling (57)	adaptation (50,10)	lifehistory evolution (57)
drought (58)	sexual selection (51,1)	colonization (58)
new species (60)	body size (53,18)	sexual dimorphism (60)
remote sensing (61)	phenotypic plasticity (55,4)	kin selection (61)
forest fragmentation (63)	invasive species (59,62)	genetic variation (63)
climate (64)	allometry (62,69)	resistance (64)
community ecology (65)	community assembly (66,55)	sex ratio (65)
liana (67)	survival (72,33)	predator prey interaction (67)
density (68)	coexistence (74,28)	senescence (68)
forest (69)		invasion (69)
forest dynamic (70)		microsatellite (70)
population structure (71)		habitat selection (71)
plant animal interaction (73)		population genetic (73)
tree (75)		fecundity (75)

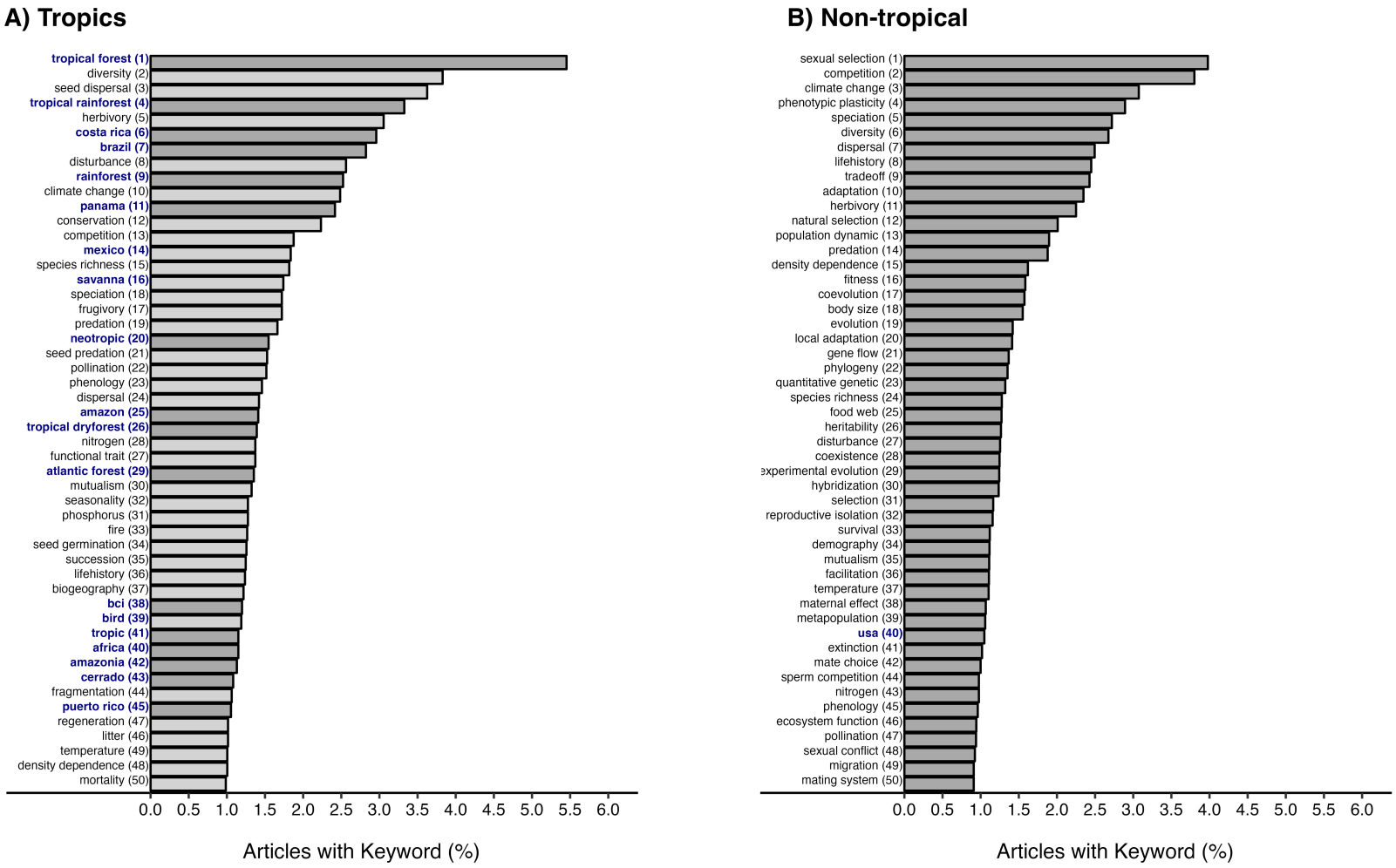

Figure 4. Keywords Caption

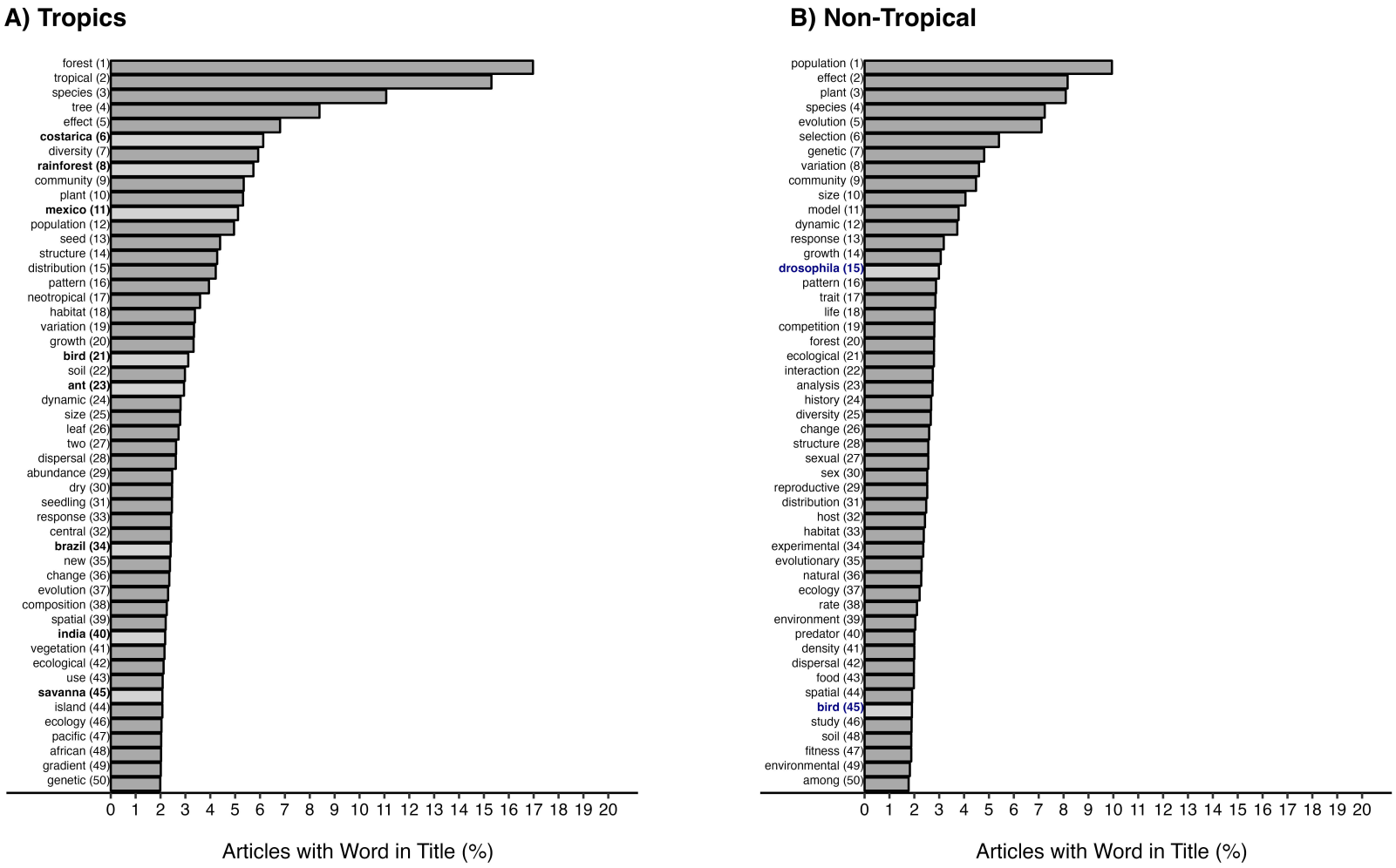

Figure 5. Title Words Caption

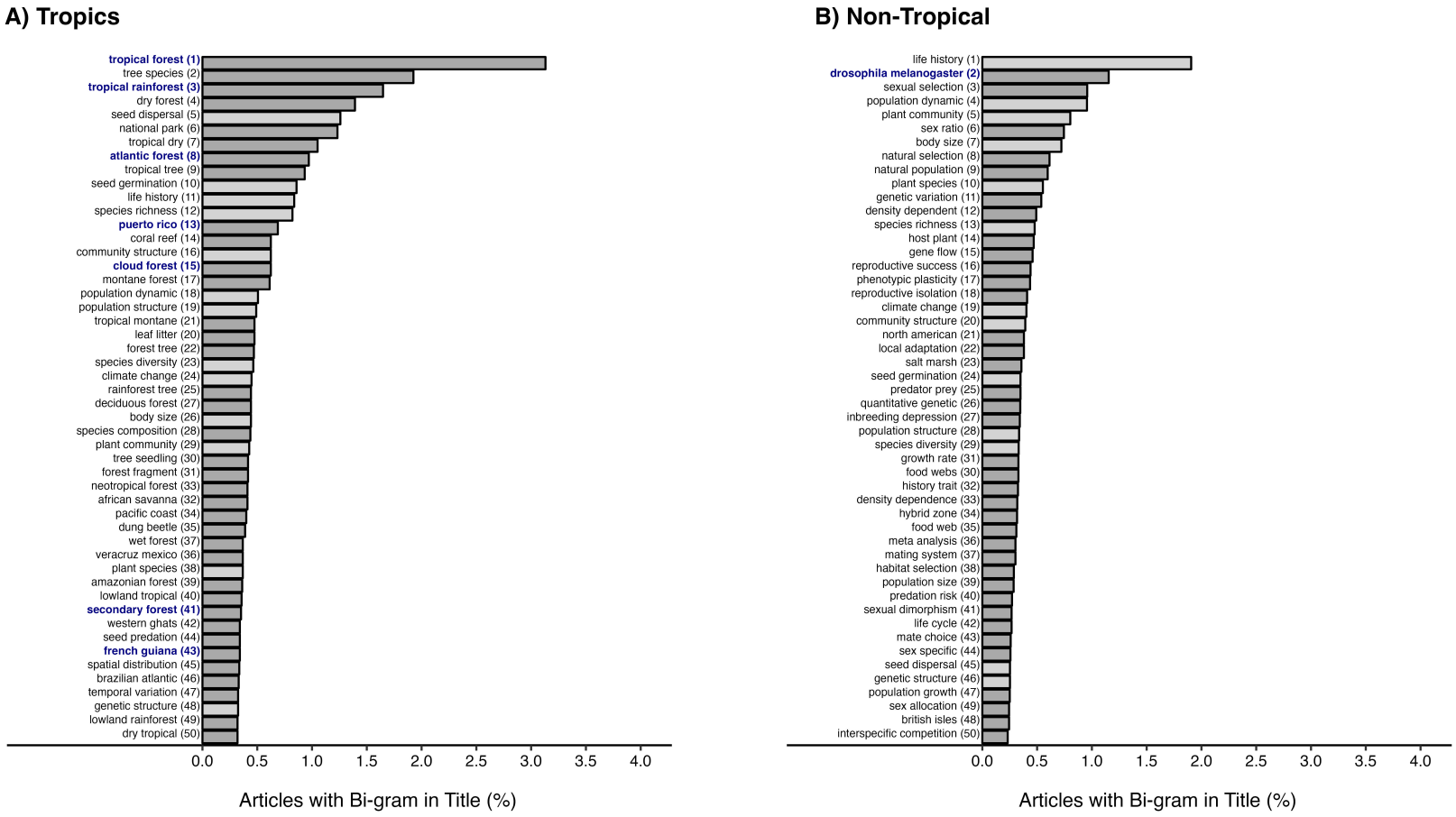

Figure 6. Title Bigrams Caption