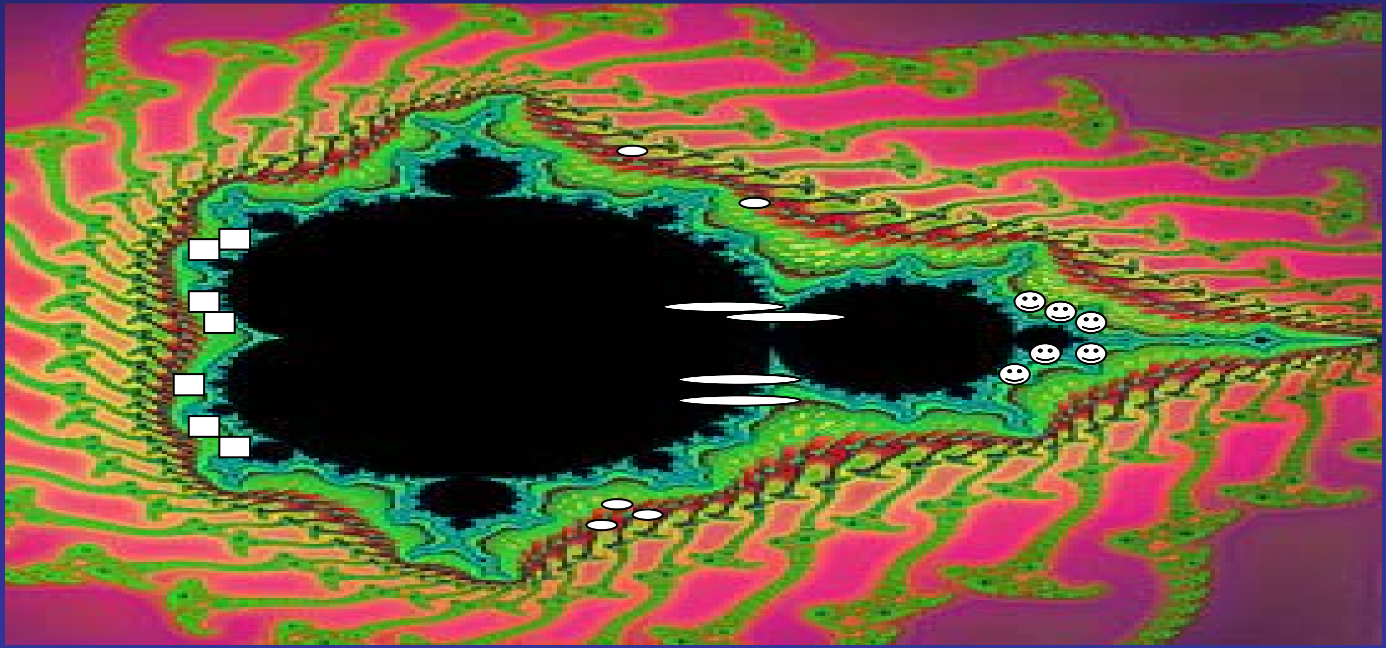
The Parasite Community Species Accumulation Curve

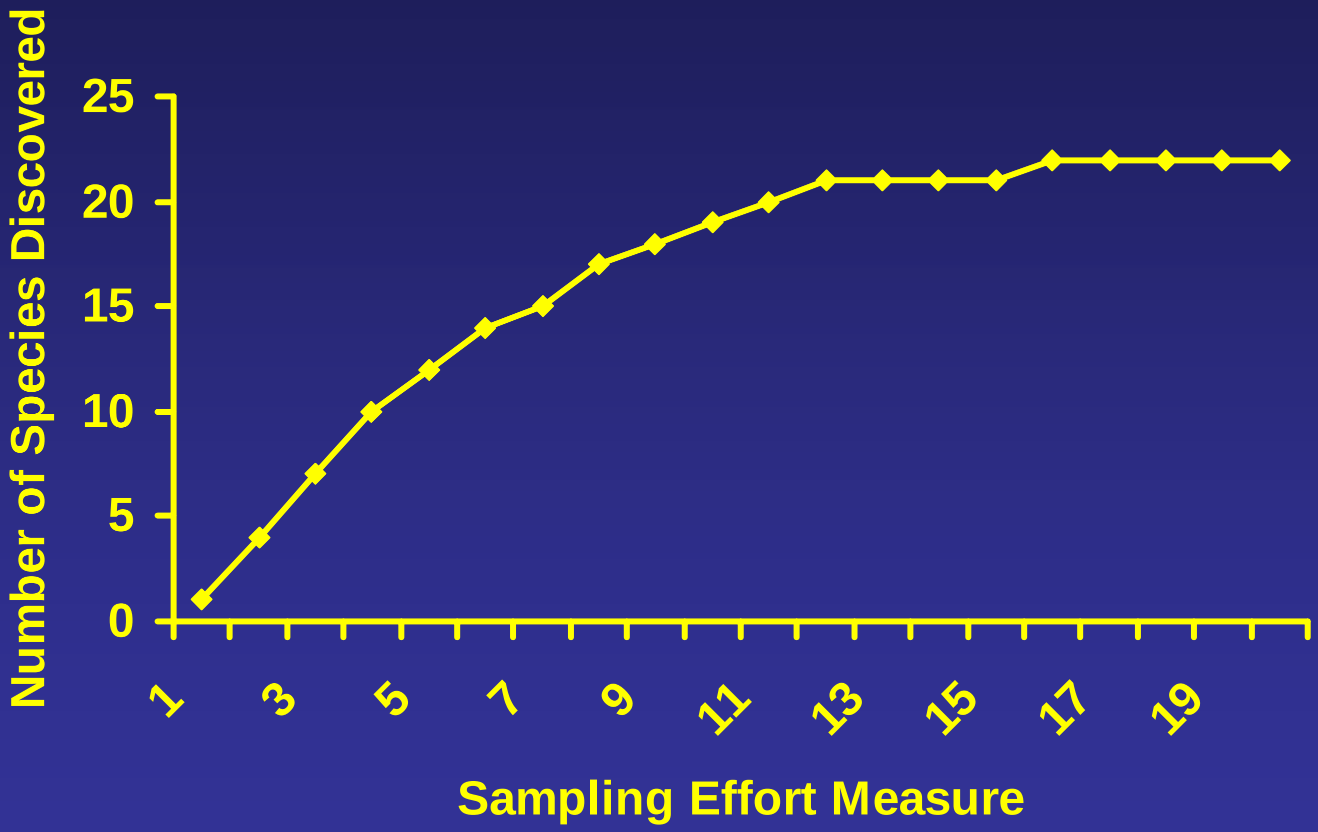
An enzyme kinetics metaphor [or vice versa?]

John Janovy, Jr.; January 18, 2007

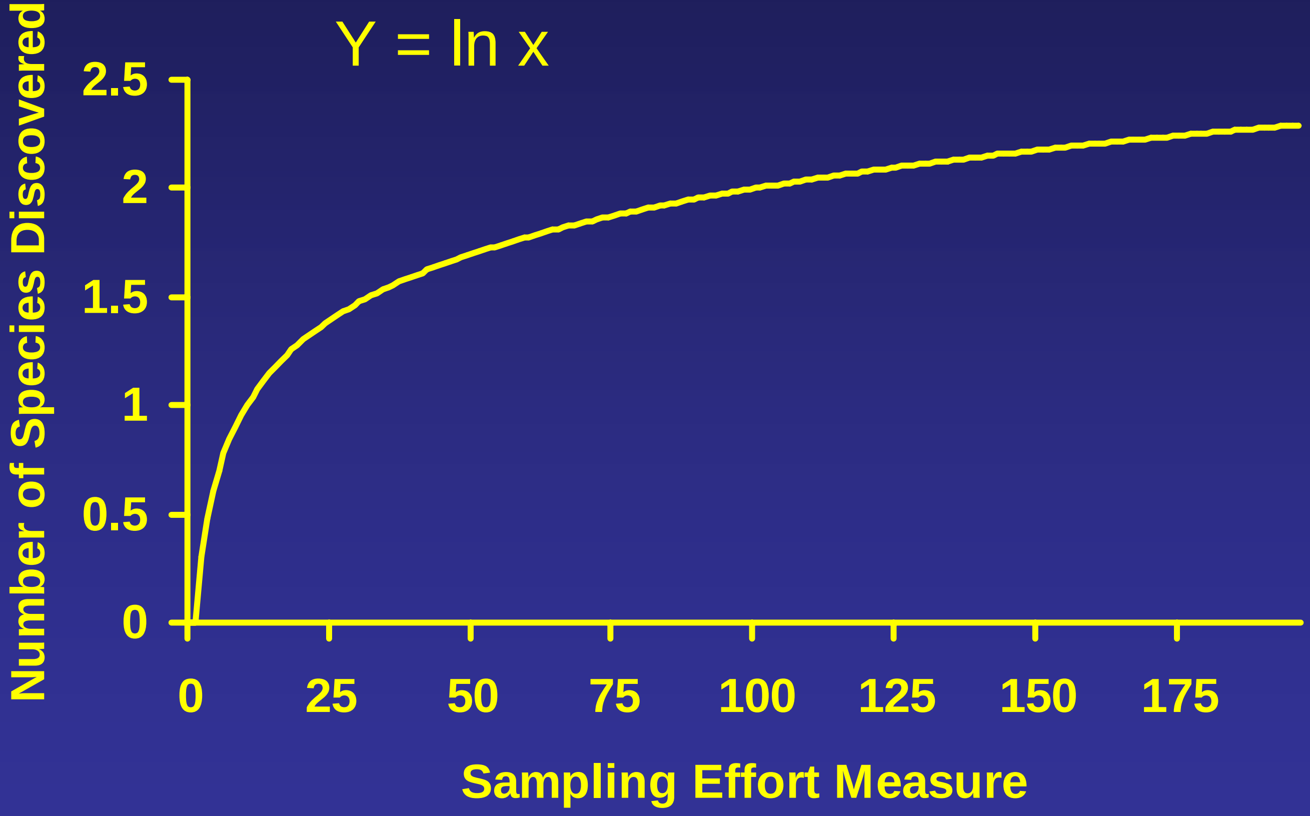


© Phillip Colla OceanLight.com
http://www.gygis.com

Typical species accumulation curve



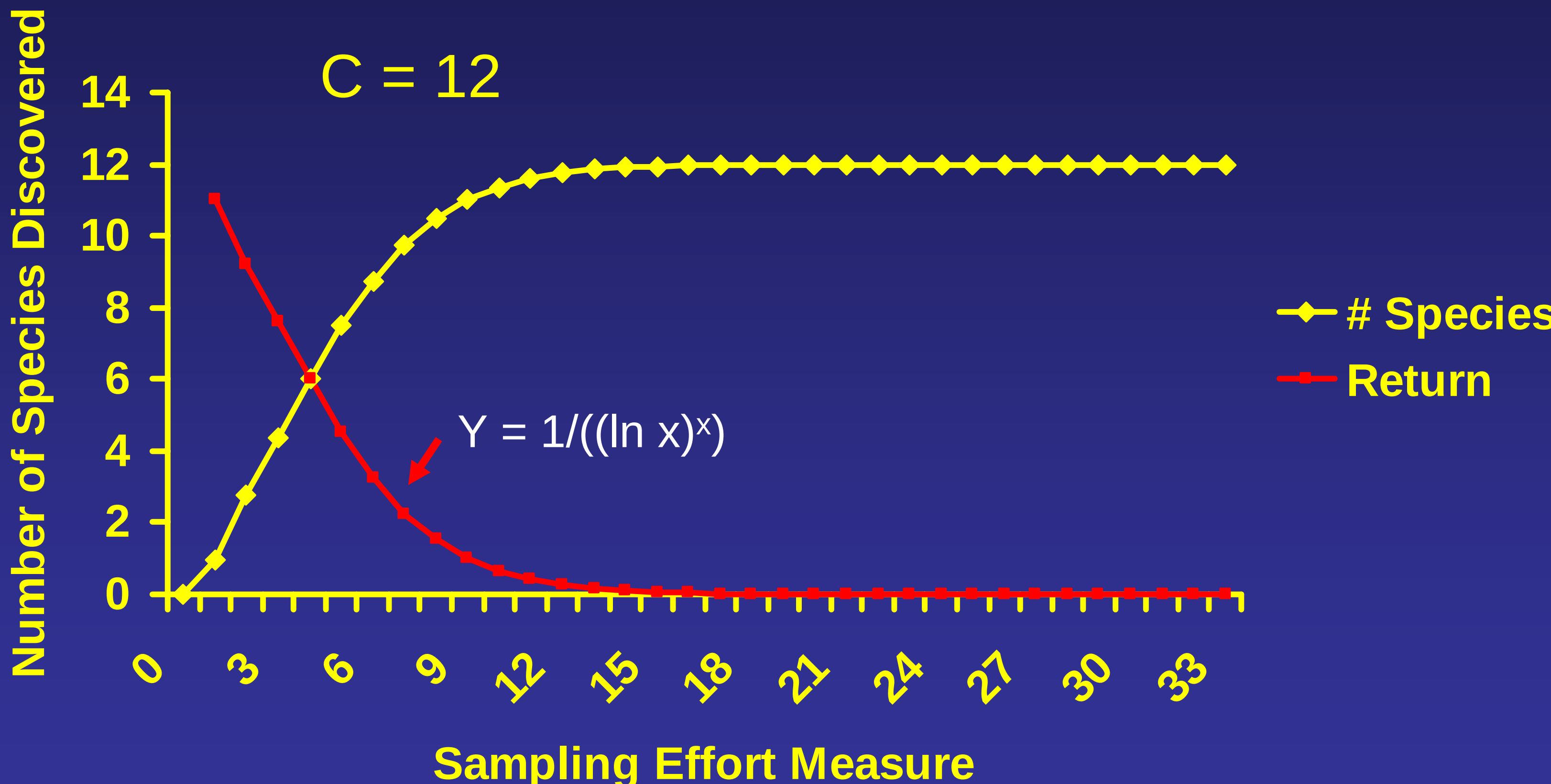
Typical species accumulation curve (first approximation, expectation)



A typical species accumulation curve (max = 12 species; an impoverished community)

$Y = c - [1/((\ln x)^x)]$

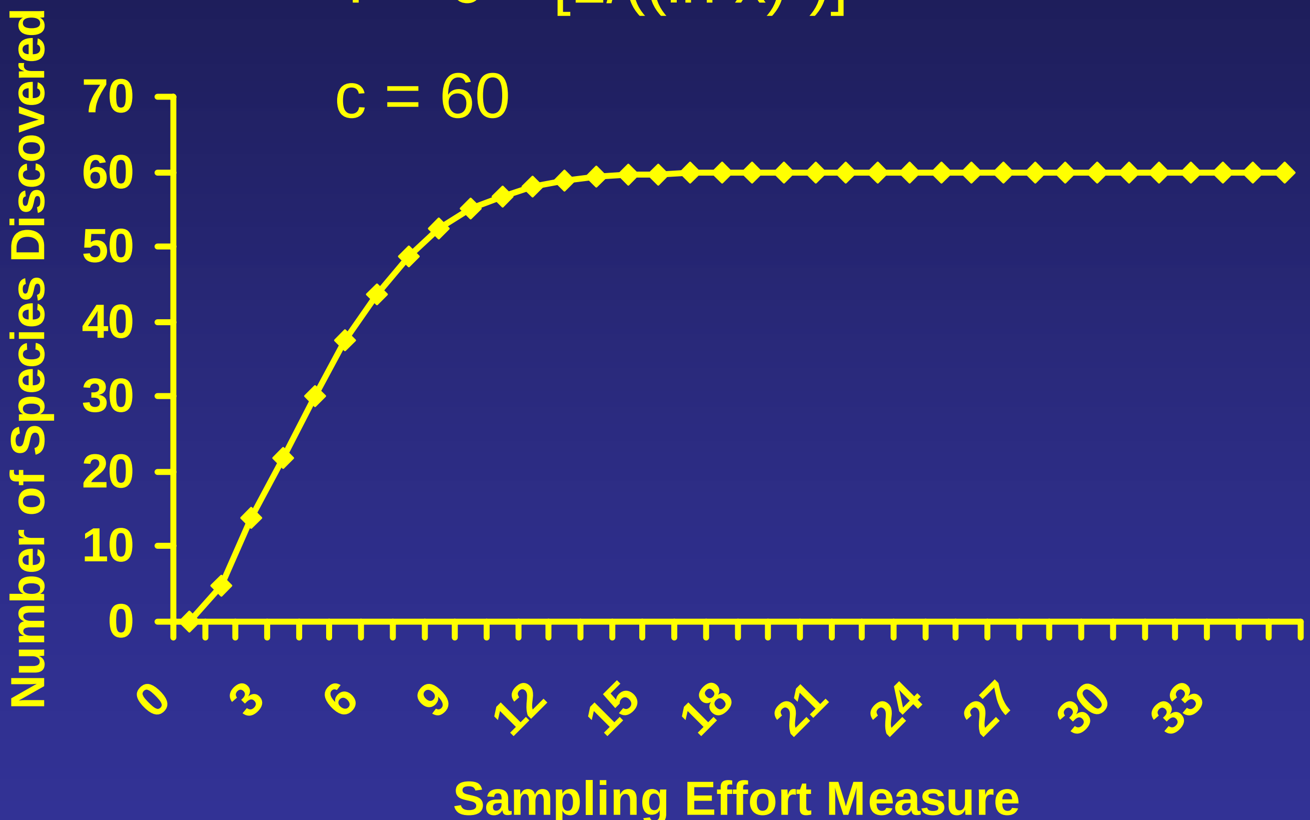
C = 12



Another typical species accumulation curve (max = 60 species, a relatively rich community)

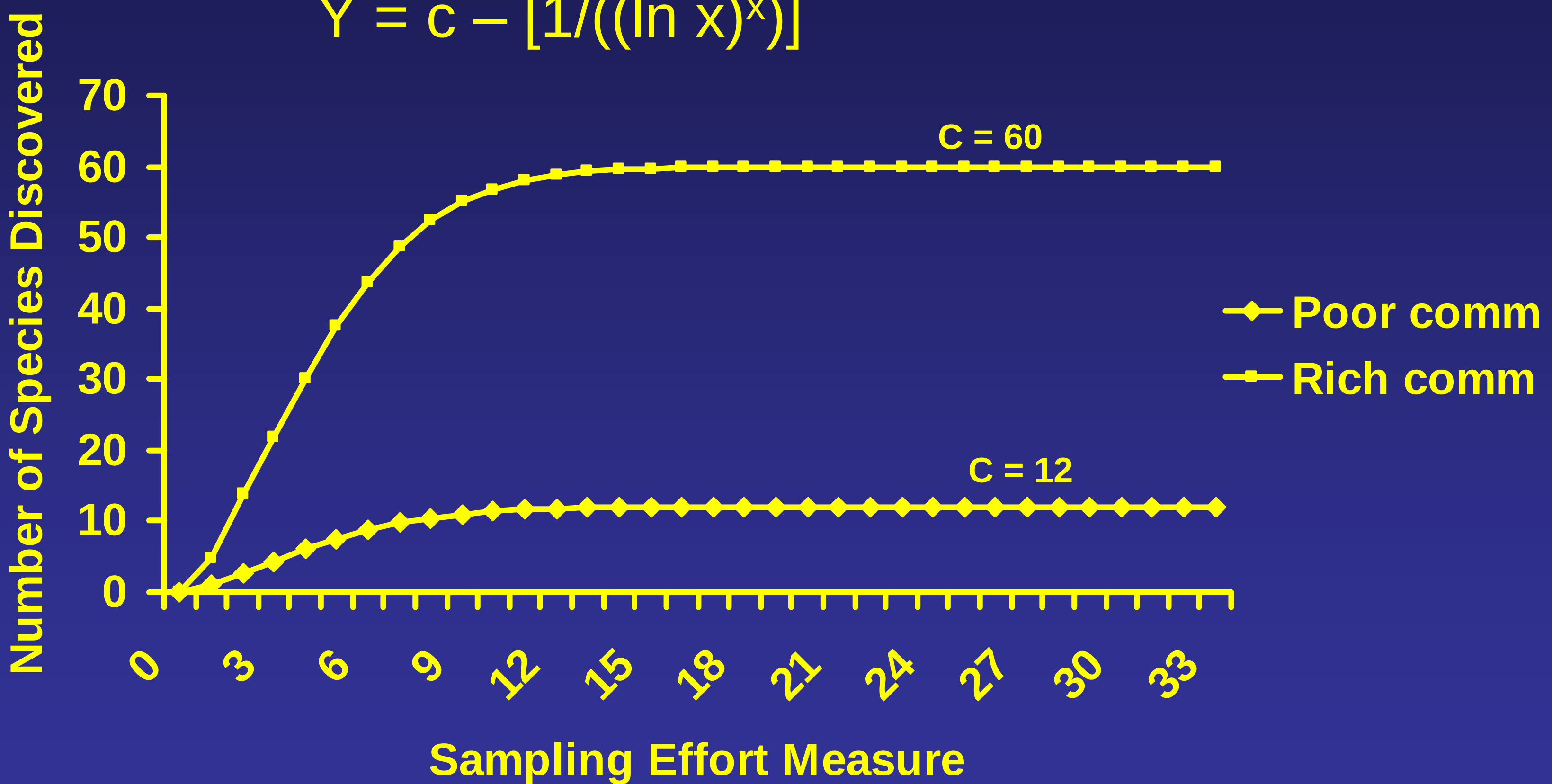
$$Y = c - [1/((\ln x)^{x})]$$

$$c = 60$$



Two typical species accumulation curves (two different communities; two different "c" values)

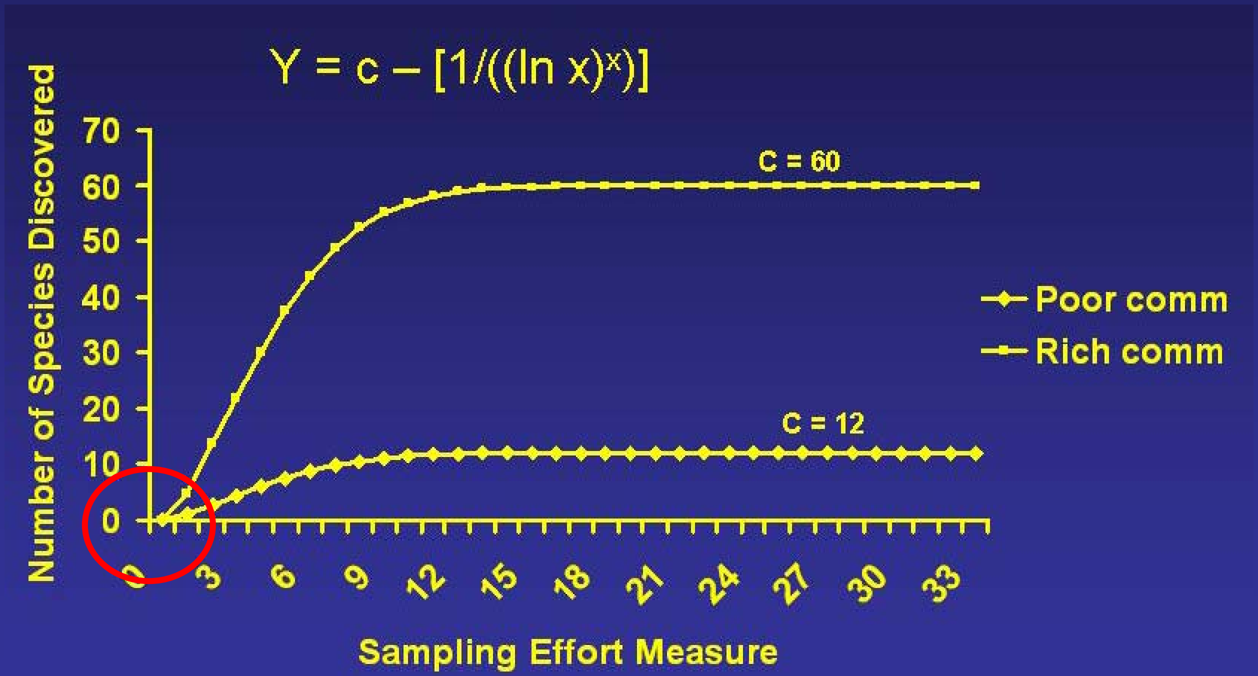
$$Y = c - [1/((\ln x)^x)]$$



"c" can be considered a richness constant, or a richness parameter

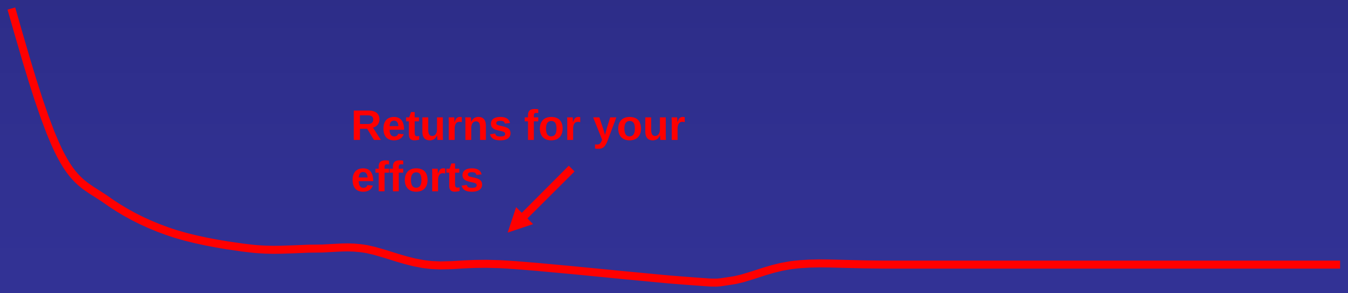
Some points to consider:

- These curves are actually typical saturation curves.

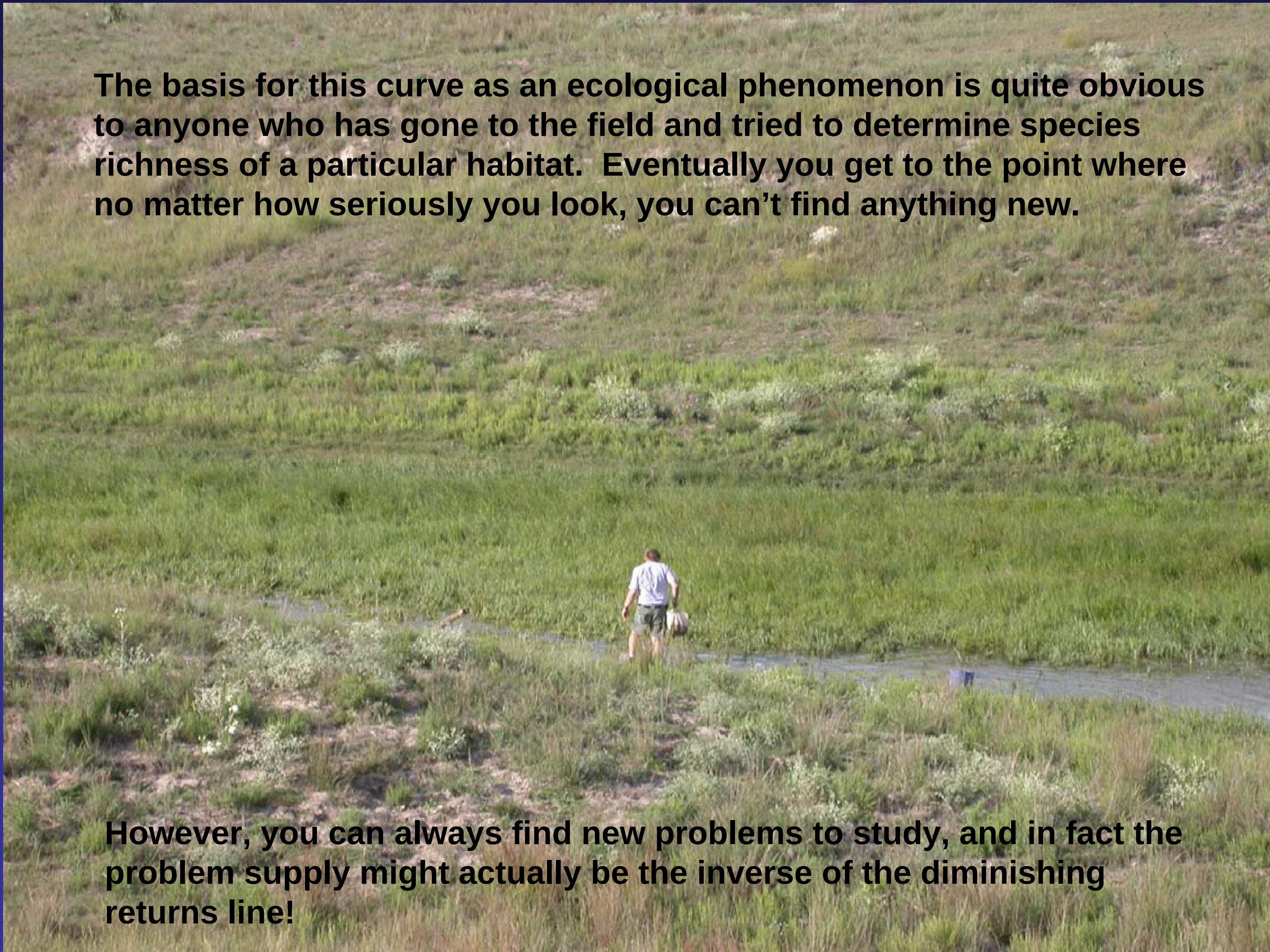


Some points to consider:

- These curves are actually typical saturation curves.
- Saturation curves are characteristic of any process in which increased input initially results in increased output, but eventually input increases do not result in increased output (the diminishing returns idea).



The basis for this curve as an ecological phenomenon is quite obvious to anyone who has gone to the field and tried to determine species richness of a particular habitat. Eventually you get to the point where no matter how seriously you look, you can't find anything new.



However, you can always find new problems to study, and in fact the problem supply might actually be the inverse of the diminishing returns line!

Some points to consider:

- These curves are actually typical saturation curves.
- Saturation curves are characteristic of any process in which increased input initially results in increased output, but eventually input increases do not result in increased output (the diminishing returns idea).
- So the real issue, parasitologically, is what determines the value of "c"* (i.e., the landscape epizootiology/epidemiology problem).

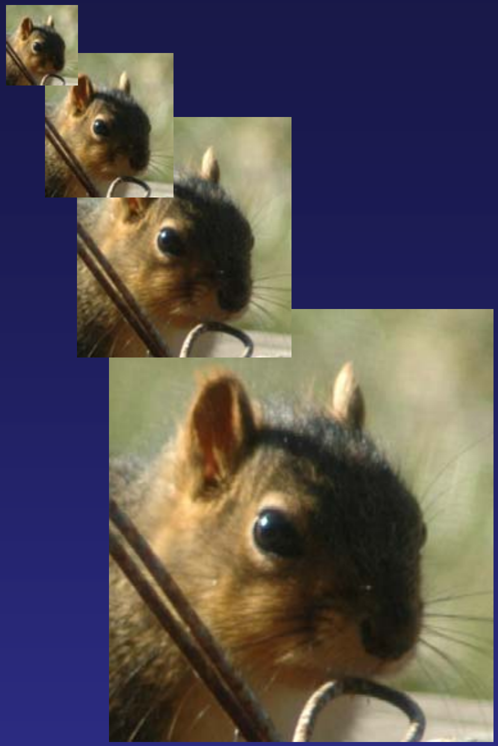
Now, the enzyme kinetics "metaphor" →

*And the relative prevalences or p/inf/ of the c species.

The multiple-kind lottery:

A A A A 0 0 0 0 0 0 B B 0 0 0 0 0 0 0 0 . . . . . . n n n n n 0 0 0 0 0

(the parasites; species “a” through “n” [“n” = any number])

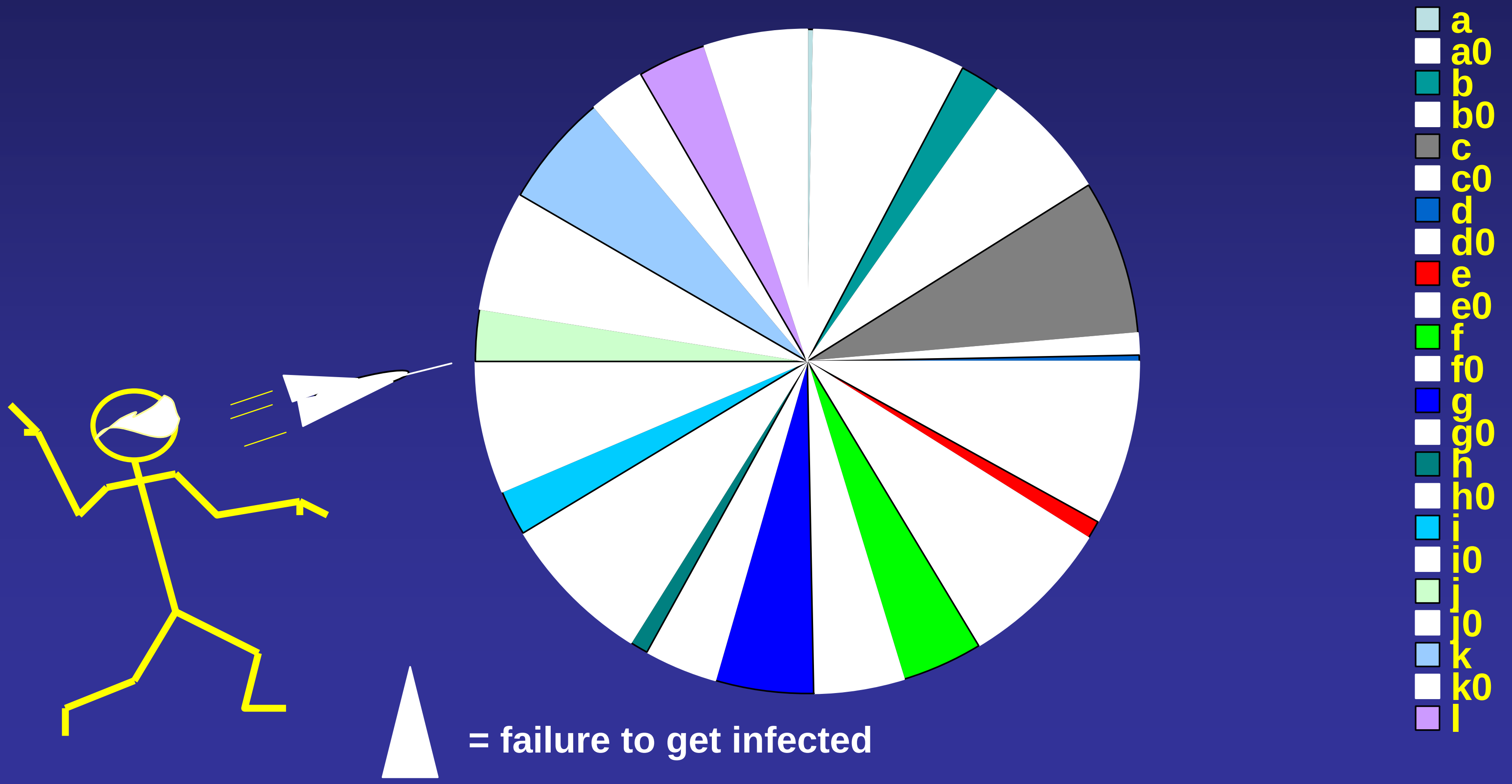


Host can sample this pool as often as the keyboard God declares (= the effort)

The parasite supply (n species, distributed in the landscape so as to provide different relative probabilities of infection, and of failure to get infected)

Multiple kind lottery – model prevalences of species "a" through "l"

(prevalences = an estimate of the relative probabilities of infection)



Prevalences to start the investigation:

A = 0.04

B = 0.23

C = 0.87

D = 0.06

E = 0.12

F = 0.45

G = 0.56

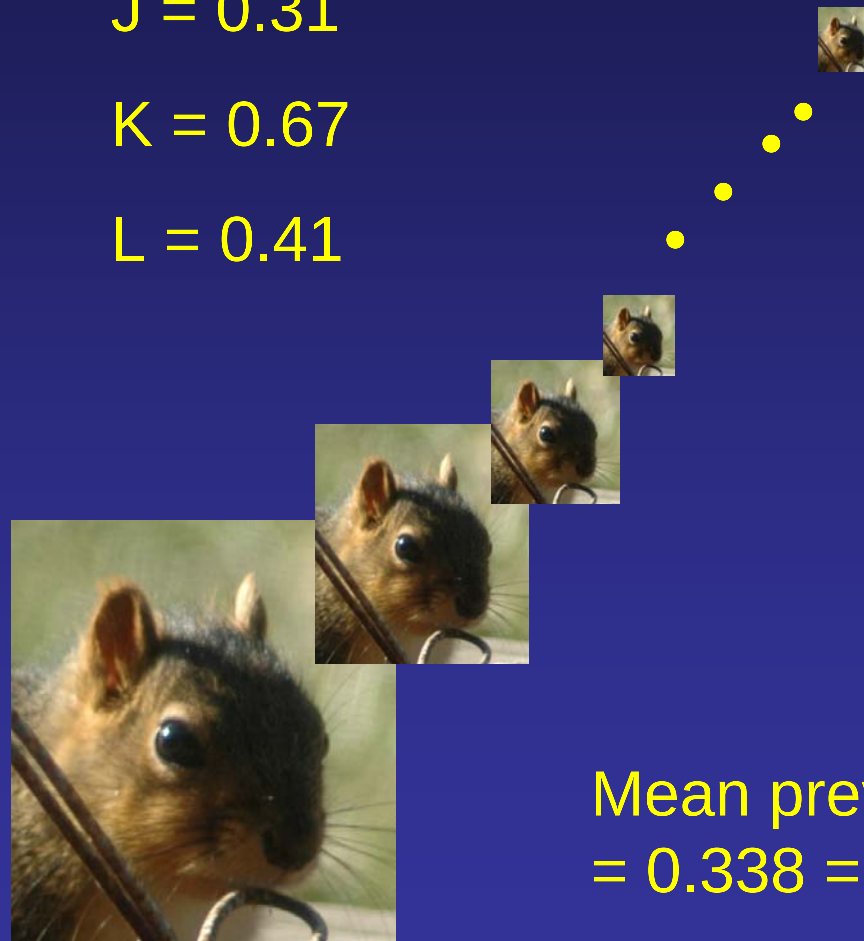
H = 0.09

I = 0.24

J = 0.31

K = 0.67

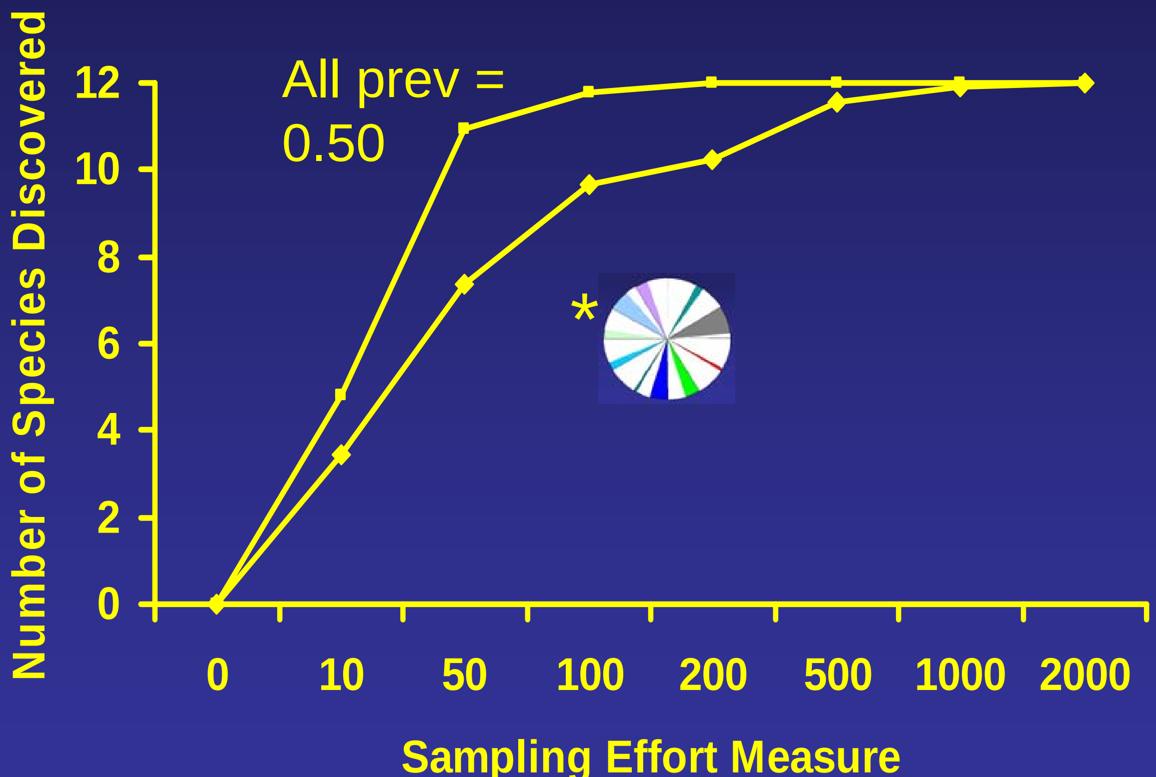
L = 0.41



Mean prevalence
= 0.338 = 33.8%

Species accumulation curve (different p/inf/ per species*)

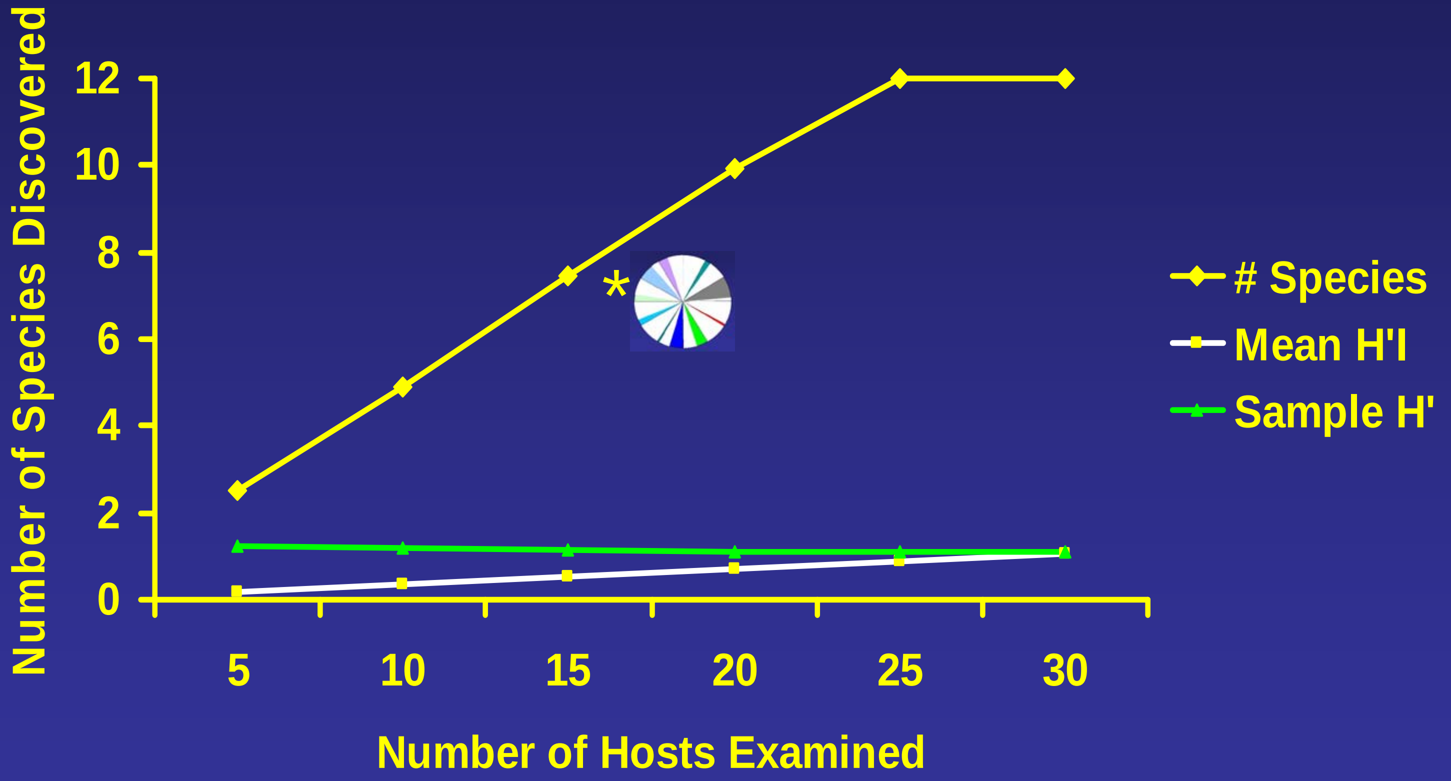
Mean infra-richness in a sample of 24 hosts, each making the effort.



*=the relative probabilities of infection as shown on the previous pie chart

Species accumulation curve (different p/inf/ per species*)

Mean infra-richness in a sample of hosts, each making an effort of 1000.



*=the relative probabilities of infection as shown on the previous pie chart



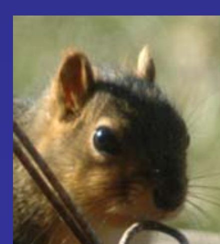
H' value (diversity index) varies with number of species and even-ness of representation.


You can calculate this parasite community diversity for individuals (infradiversity) or for the sample as a whole (sample diversity).



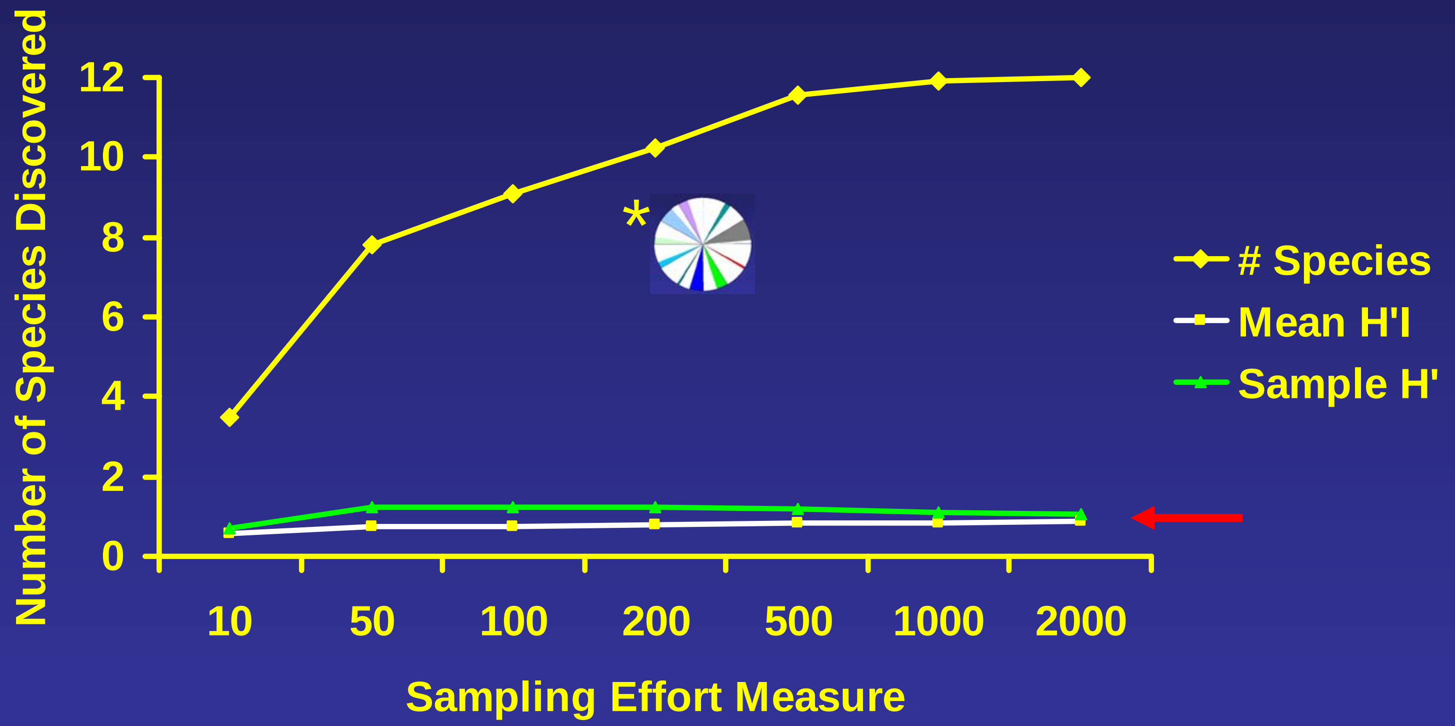




Species accumulation curve (different p/inf/ per species*)

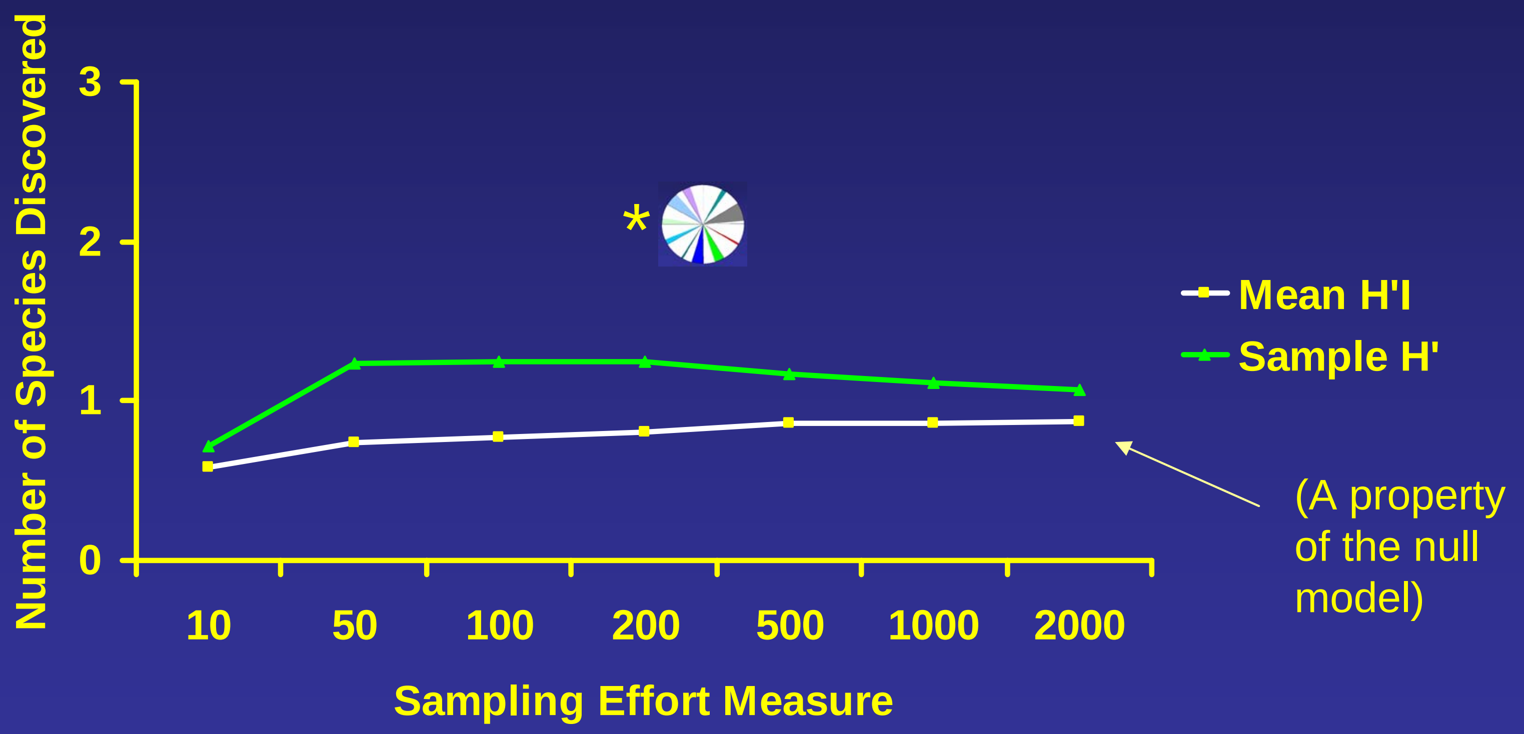
Mean infra-richness in a sample of 24 hosts, each making the effort.



*=the relative probabilities of infection as shown on the previous pie chart

Species accumulation curve (different p/inf/ per species*)

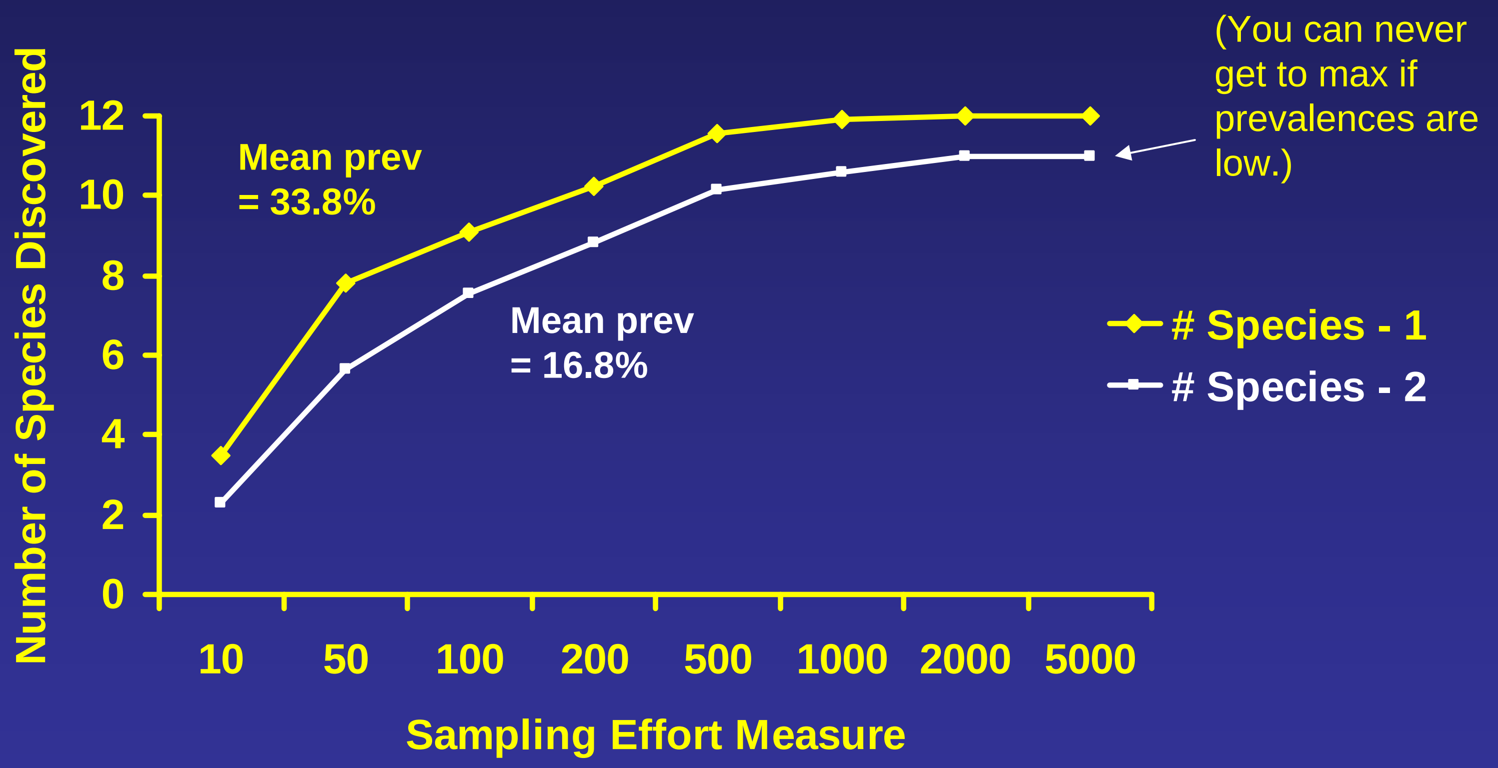
Mean infra-richness in a sample of 24 hosts, each making the effort.



*=the relative probabilities of infection as shown on the previous pie chart

Species accumulation curve (two communities, different p/inf/ per species*)

Mean infra-richness in a sample of 24 hosts, each making the effort.



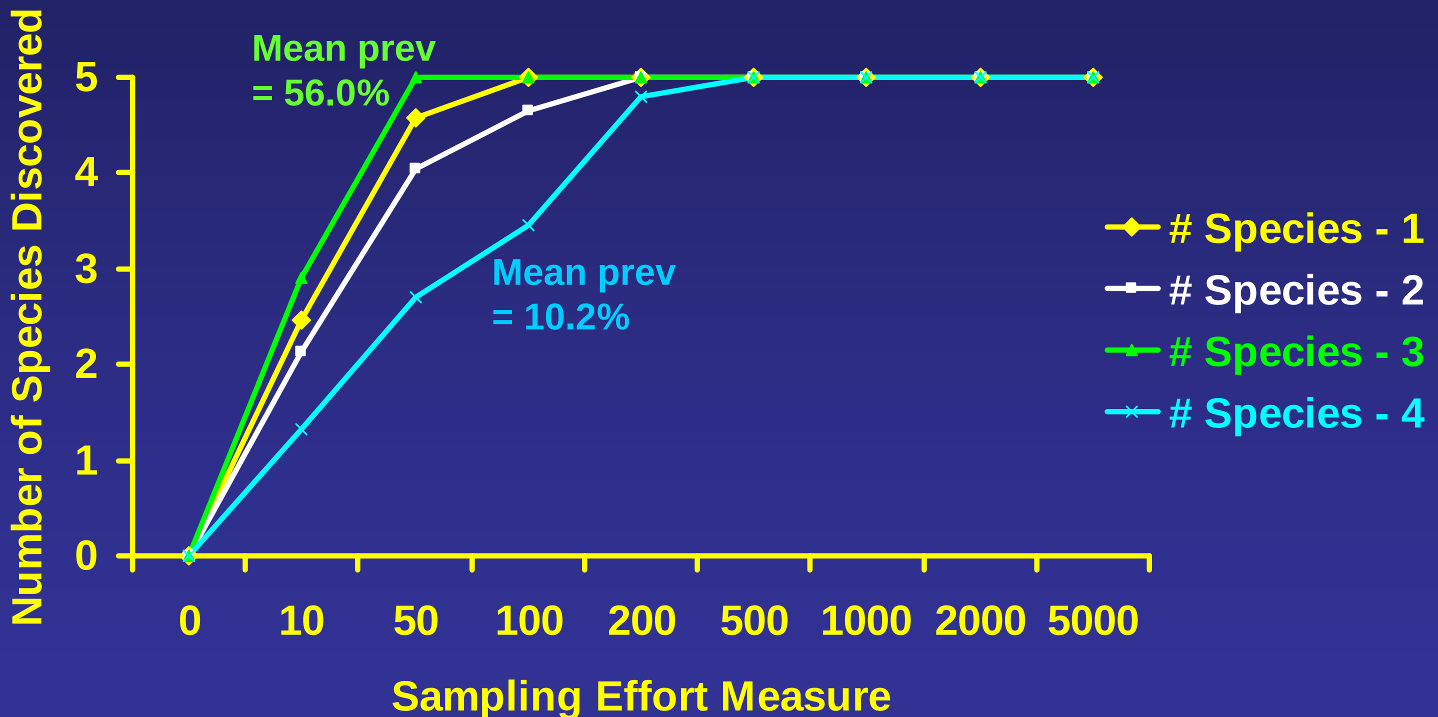
You can increase your efforts 500-fold and still not find all the species in a parasite community if mean prevalence is low.

Some model communities:

Prev's (%)	Comm 1	Comm 2	Comm 3	Comm 4
Sp A	17	9	68	7
Sp B	34	12	45	4
Sp C	56	45	55	12
Sp D	23	15	38	32
Sp E	87	61	74	18
Mean Prev.	43.4	28.4	56	14.6

Species accumulation curve (two communities, different p/inf/ per species)

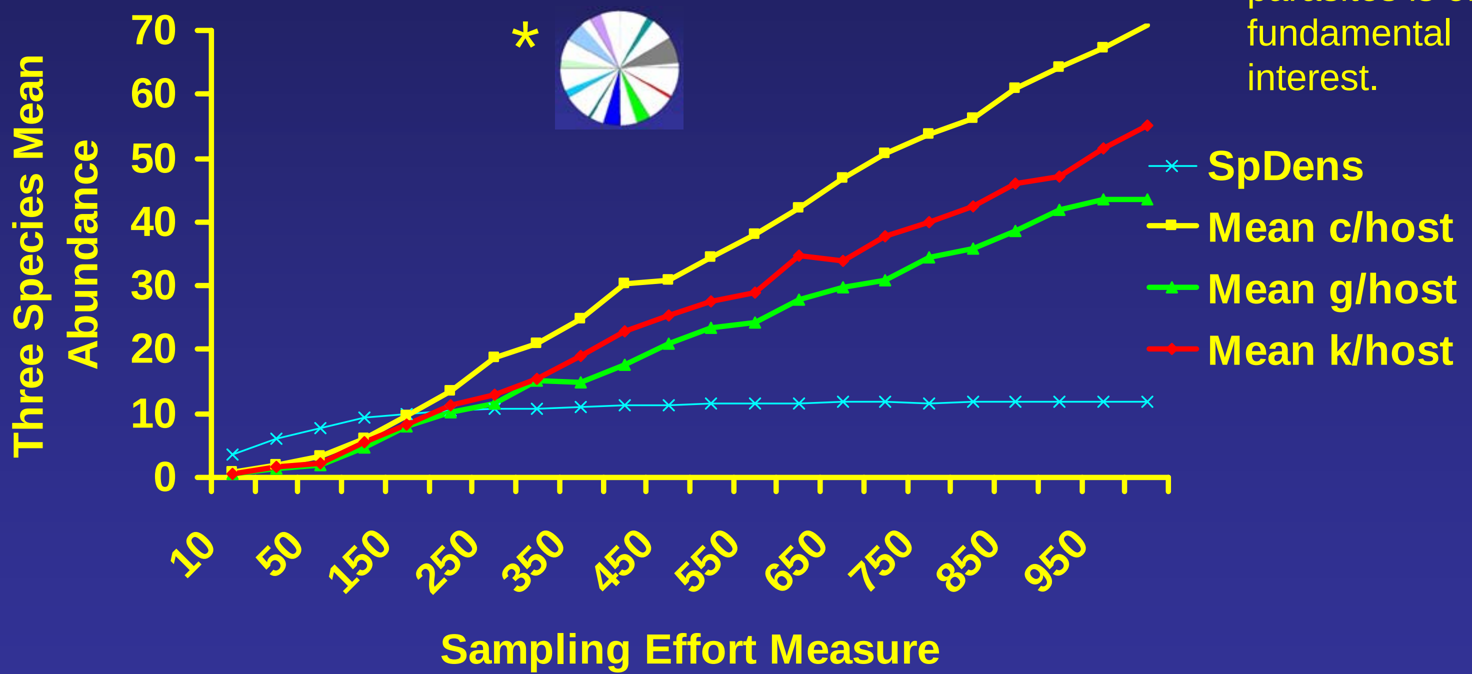
Mean infra-richness in a sample of 24 hosts, each making the effort.



In a poor community, you find most of the species in a hurry.

Community diversity measures (different p/inf/ per species*)

Results from a sample of 24 hosts, each making the effort.

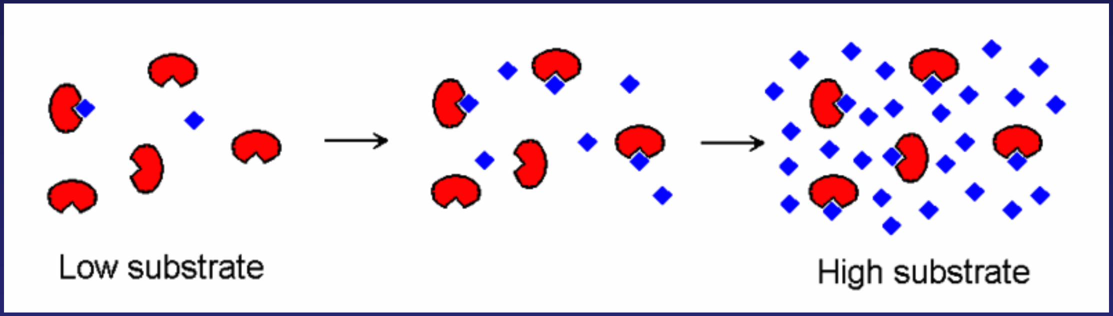


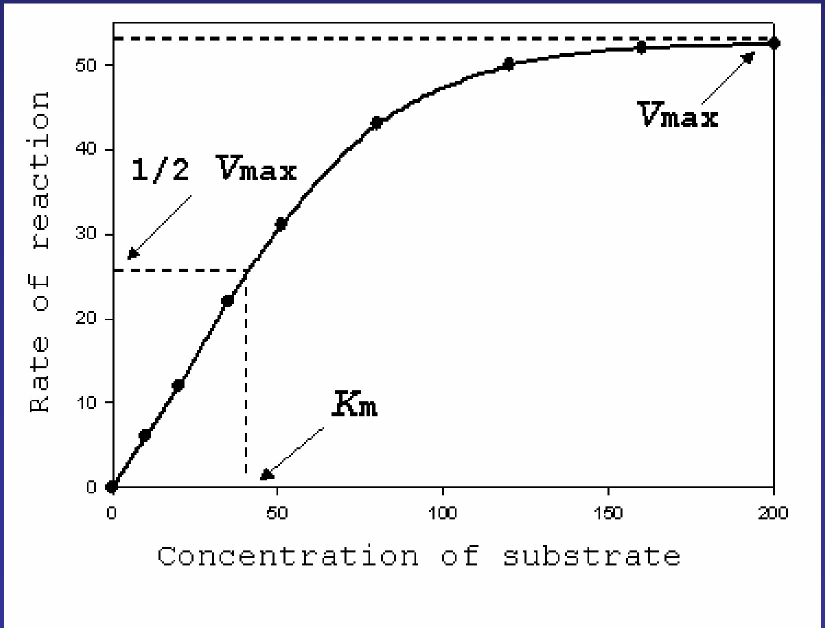
*

Accumulation of parasites is of fundamental interest.

*=the relative probabilities of infection as shown on the previous pie chart

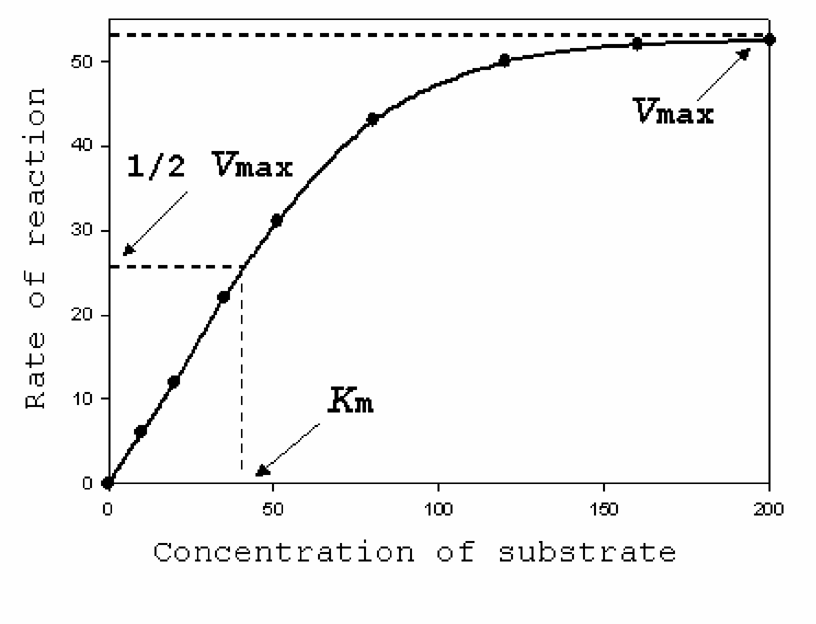
However, saturation curves also are characteristic of enzymatic reactions, in which active sites eventually become saturated.

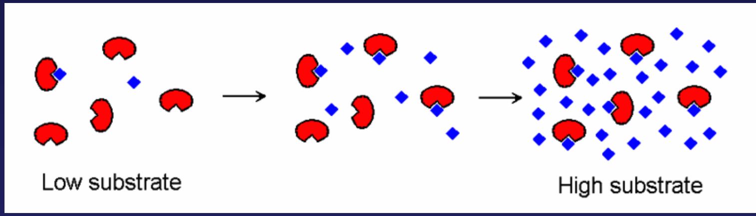


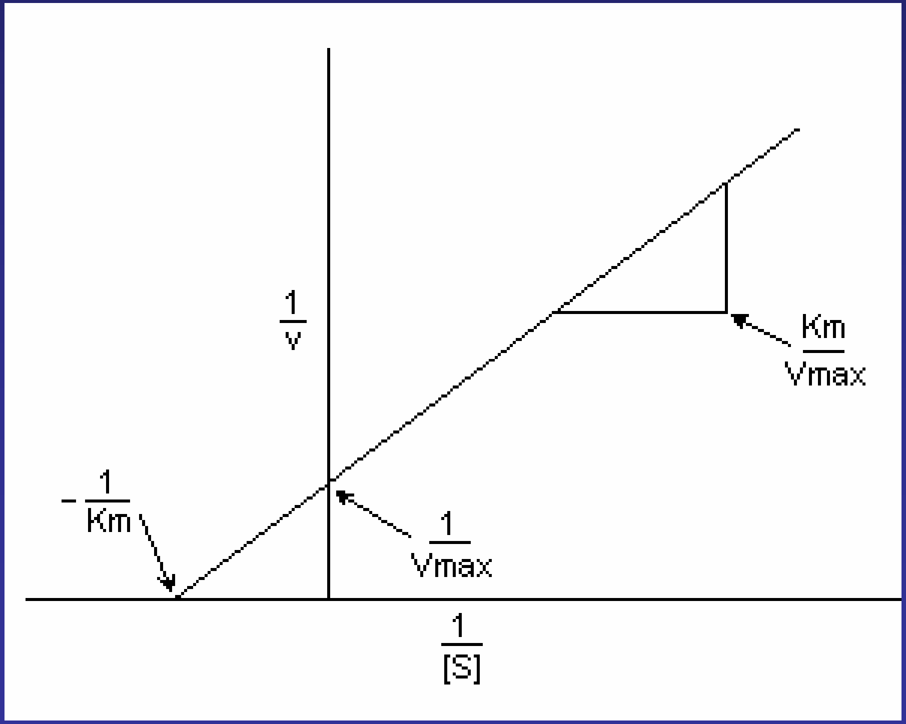


Figs. from en.wikipedia.org/wiki/Enzyme_kinetics

Thus, the enzyme kinetics metaphor:





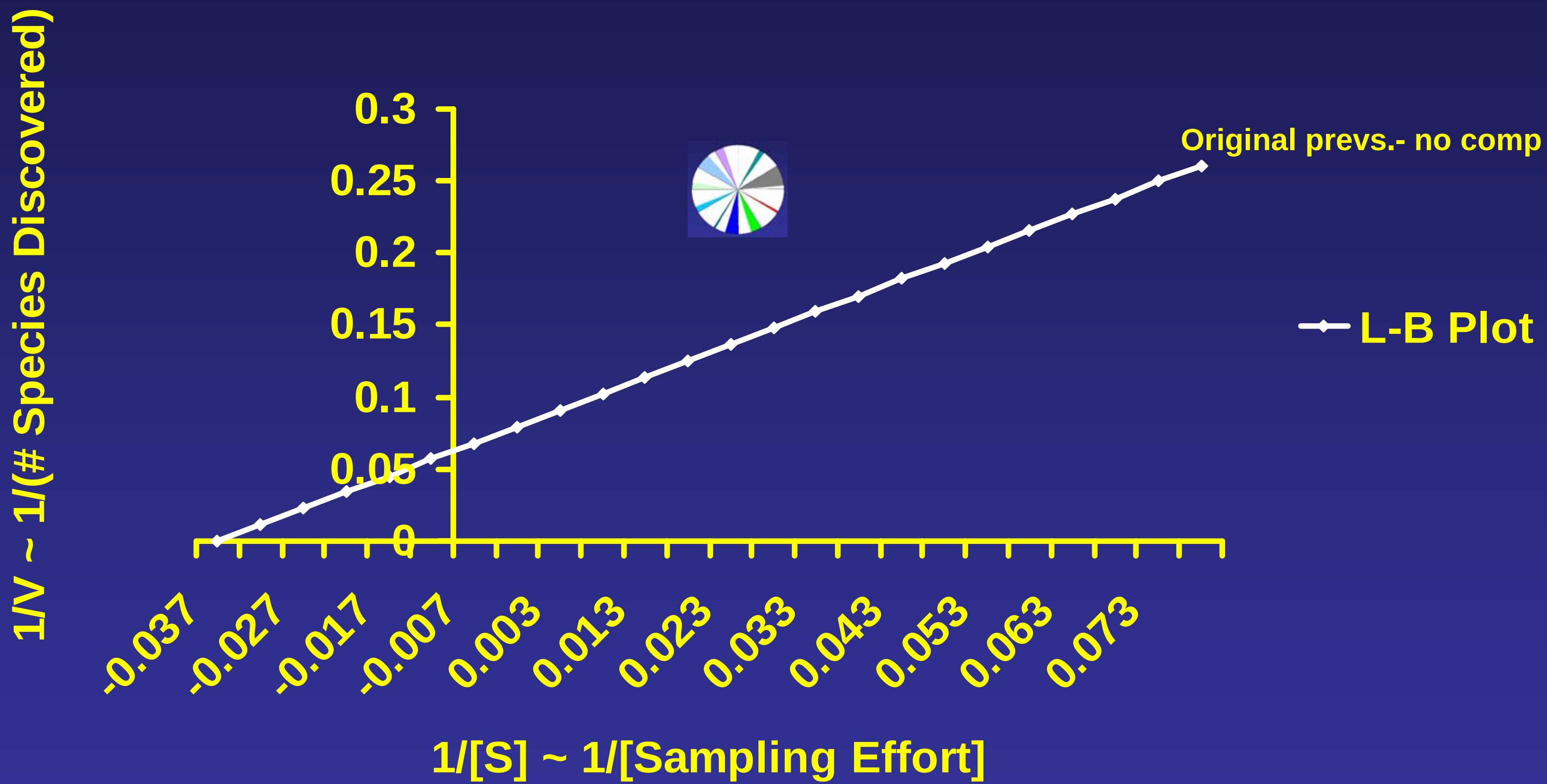


$1/V = \{(K_m/V_{max}) \times (1/[S])\} + (1/V_{max})$

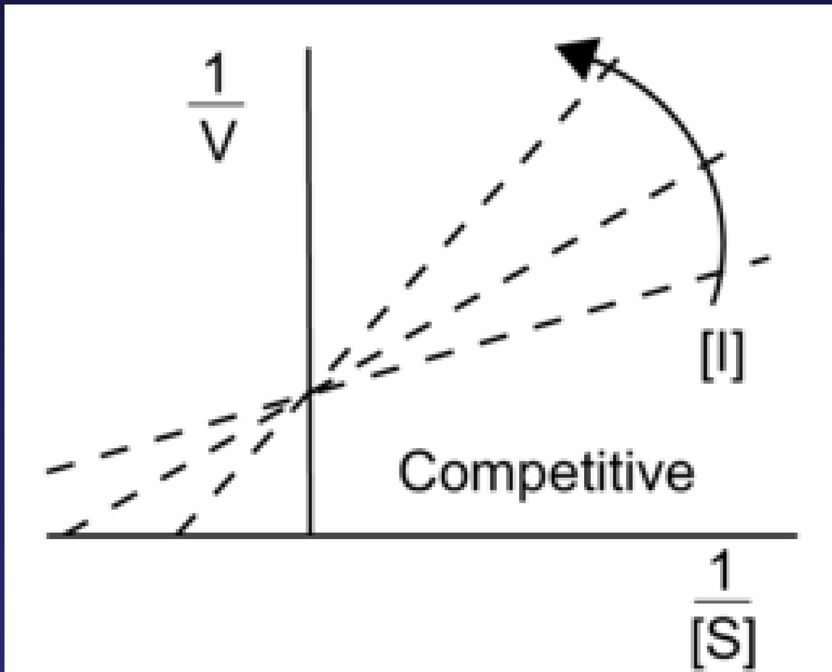
So all you have to do is calculate K_m and the slope, then draw the line.

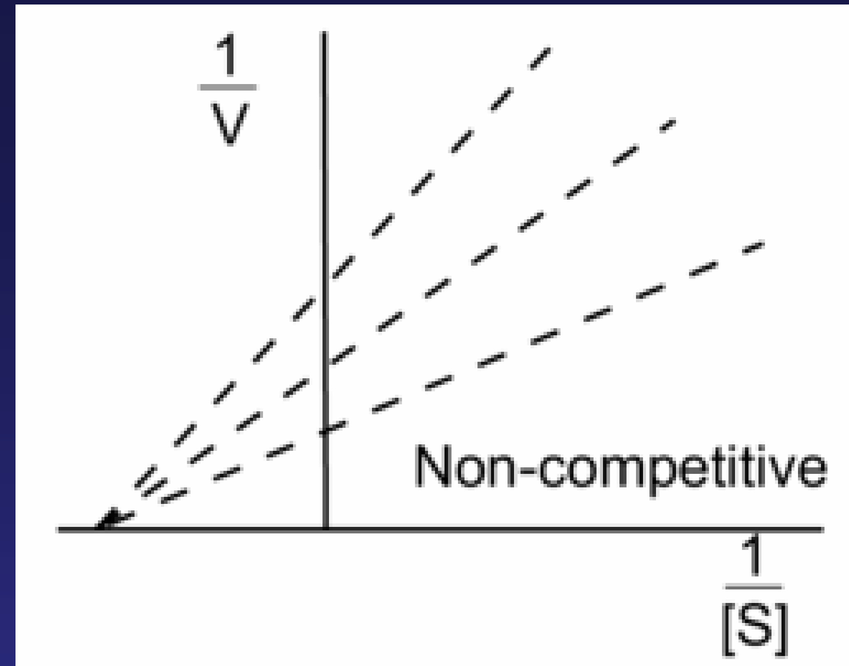
Figs. from en.wikipedia.org/wiki/Enzyme_kinetics

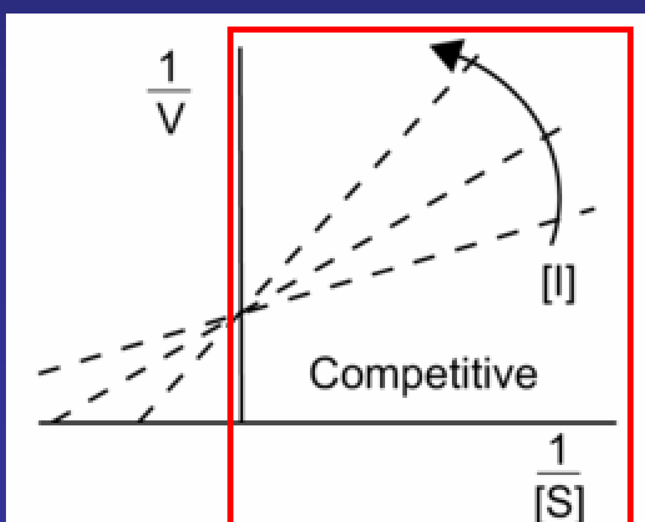
Lineweaver-Burk Plot of Pie Community



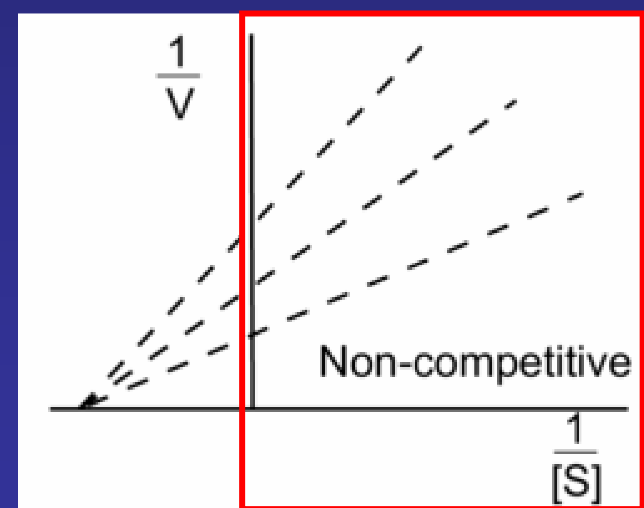
24 hosts, each sampling a supra-community of parasites





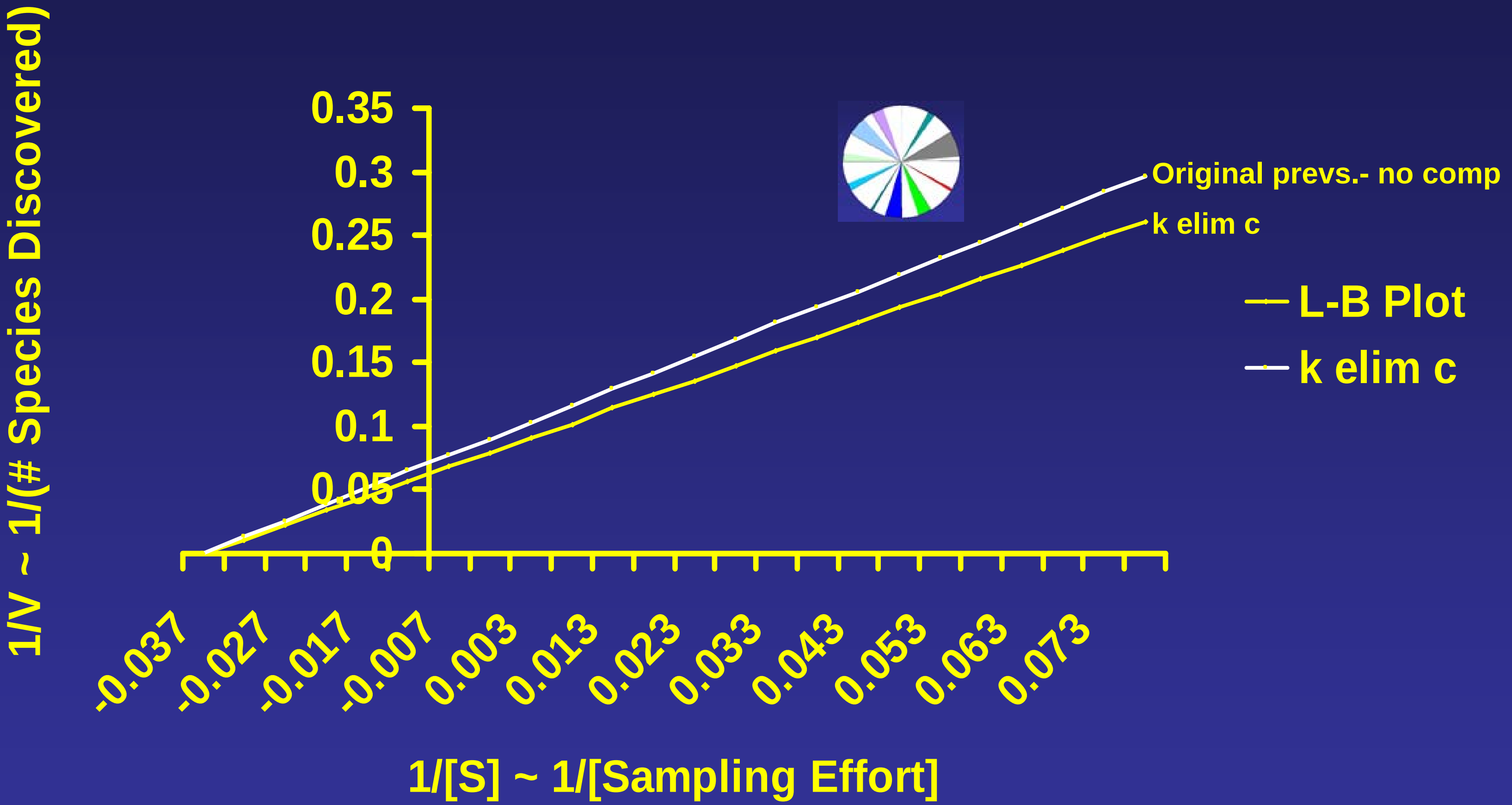


The inhibition exercise



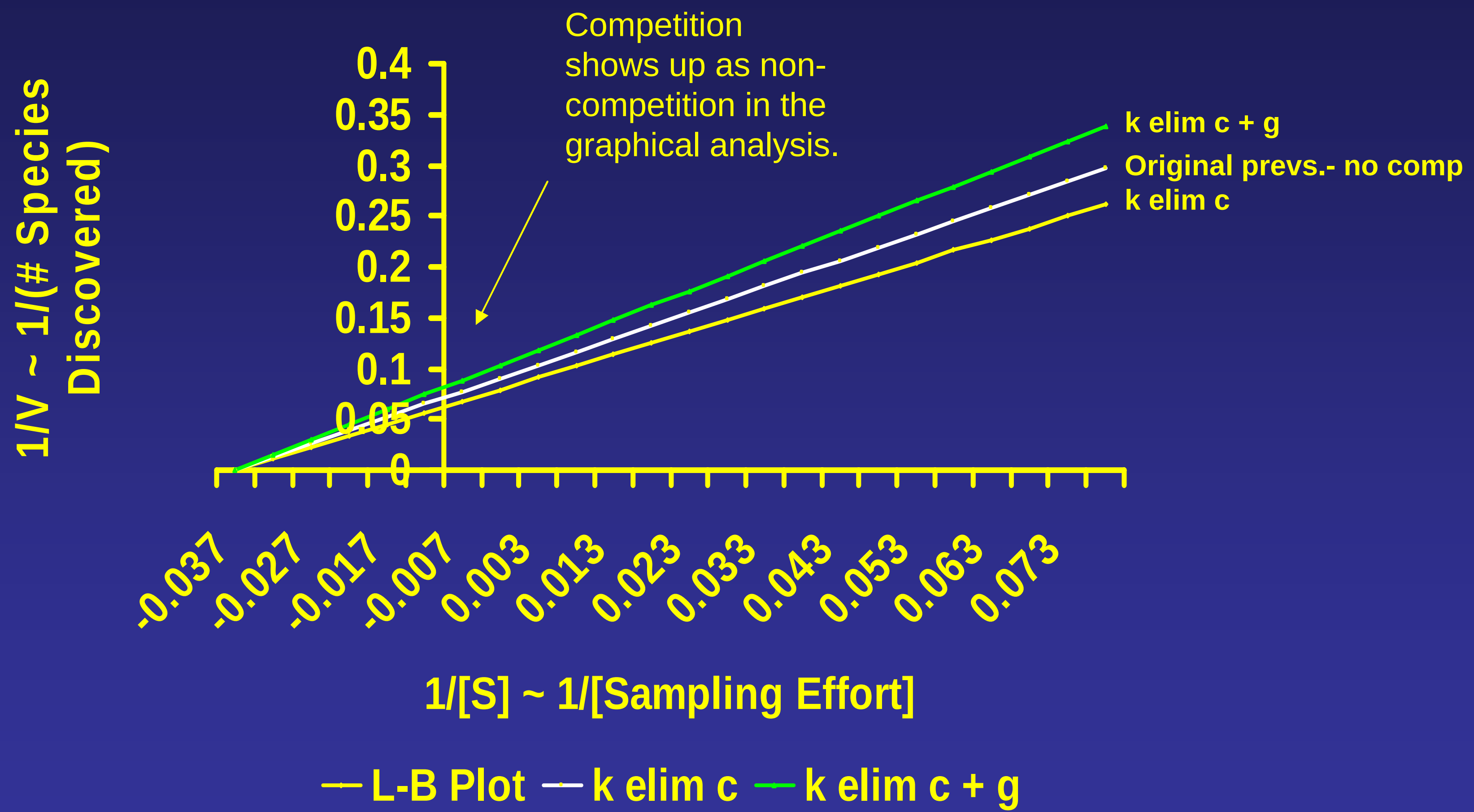
Figs. from en.wikipedia.org/wiki/Enzyme_kinetics

Lineweaver-Burk Plot of Pie



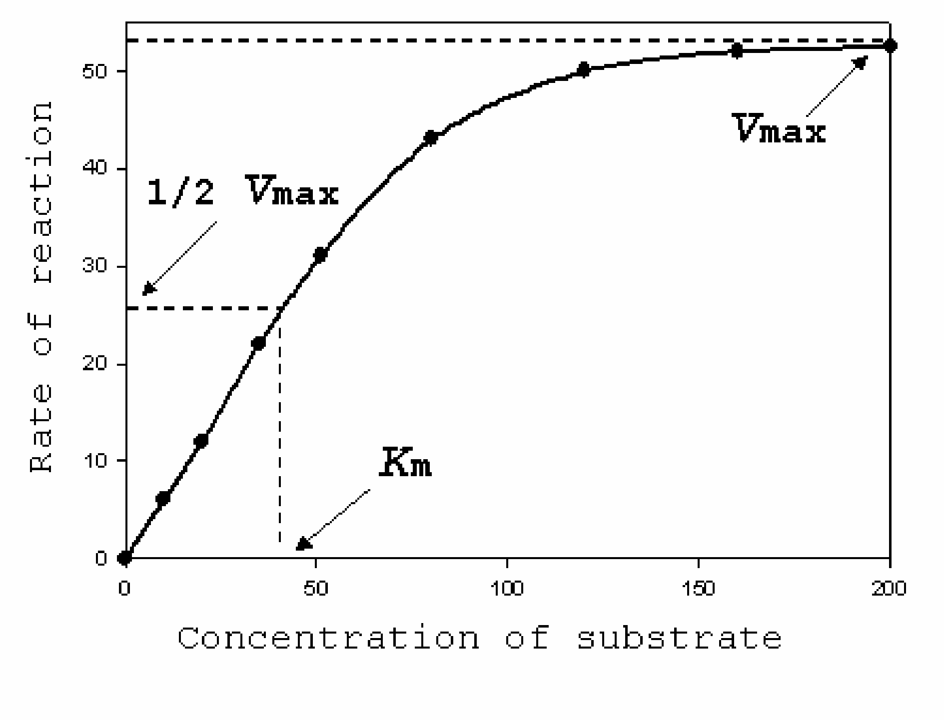
24 hosts, each sampling a supra-community of parasites

Lineweaver-Burk Plot of Pie



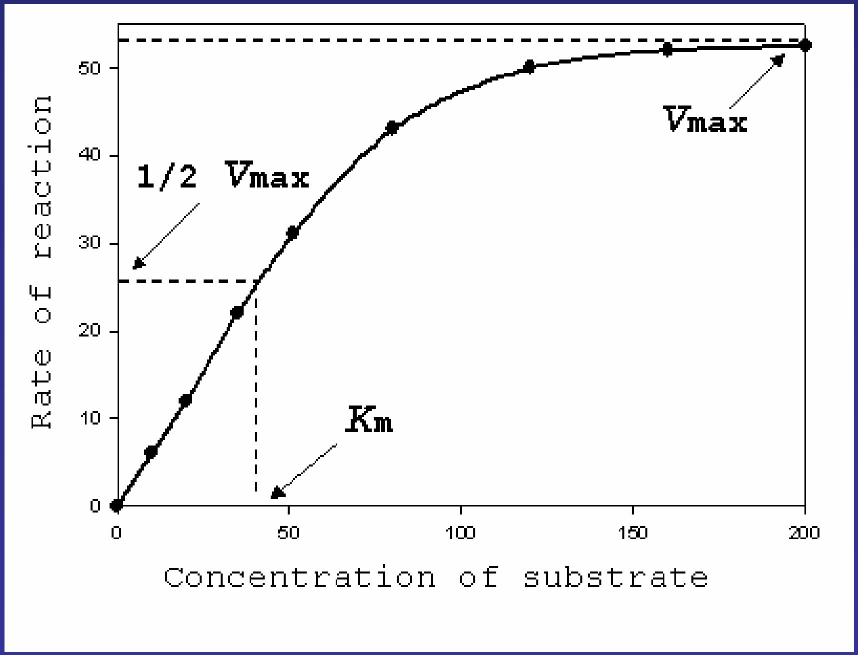
24 hosts, each sampling a supra-community of parasites

For parasite communities, and for individuals seeking to use the SAC as a guide to investigation of community and population dynamics, what, actually, are "V" and "S" in the metaphorical sense?



For parasite communities, and for individuals seeking to use the SAC as a guide to investigation of community and population dynamics, what, actually, are “V” and “S” in the metaphorical sense?

In enzyme kinetics studies, V is velocity, or rate or product production, whereas S is the substrate, and substrate concentration, or [S], is the independent variable.

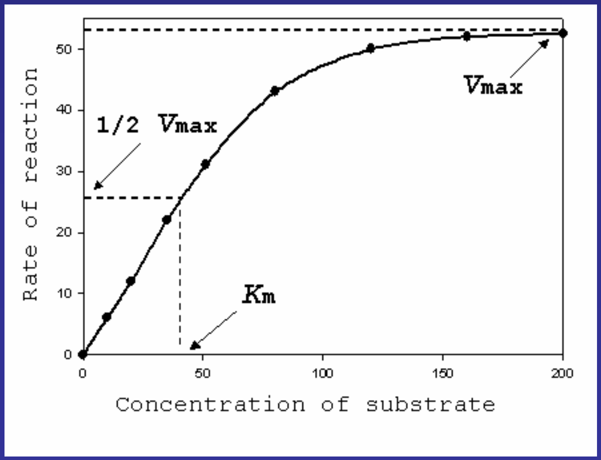


For parasite communities, and for individuals seeking to use the SAC as a guide to investigation of community and population dynamics, what, actually, are “V” and “S” in the metaphorical sense?

In enzyme kinetics studies, V is velocity, or rate or product production, whereas S is the substrate, and substrate concentration, or [S], is the independent variable.

But in parasitological studies, V is actually the number of species found, and S is actually the sampling effort.

So the analytical geometry is intriguing, but we’re still a ways off from figuring out how to decide whether communities are “interactive” or “isolationist”.



The Old Parasitologist's Conclusion:

In landscape epidemiology (epizootiology), the real issue is relative prevalence, and ultimately relative probability of infection that drives both SAC dynamics.

And it really matters how much the *host,* not the parasitologist, samples the system.