薜荔及其传粉小蜂的协同进化

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2014年8月15日，沈阳

榕-榕传粉小蜂共生体系

- 榕及其传粉小蜂形成强制性共生关系

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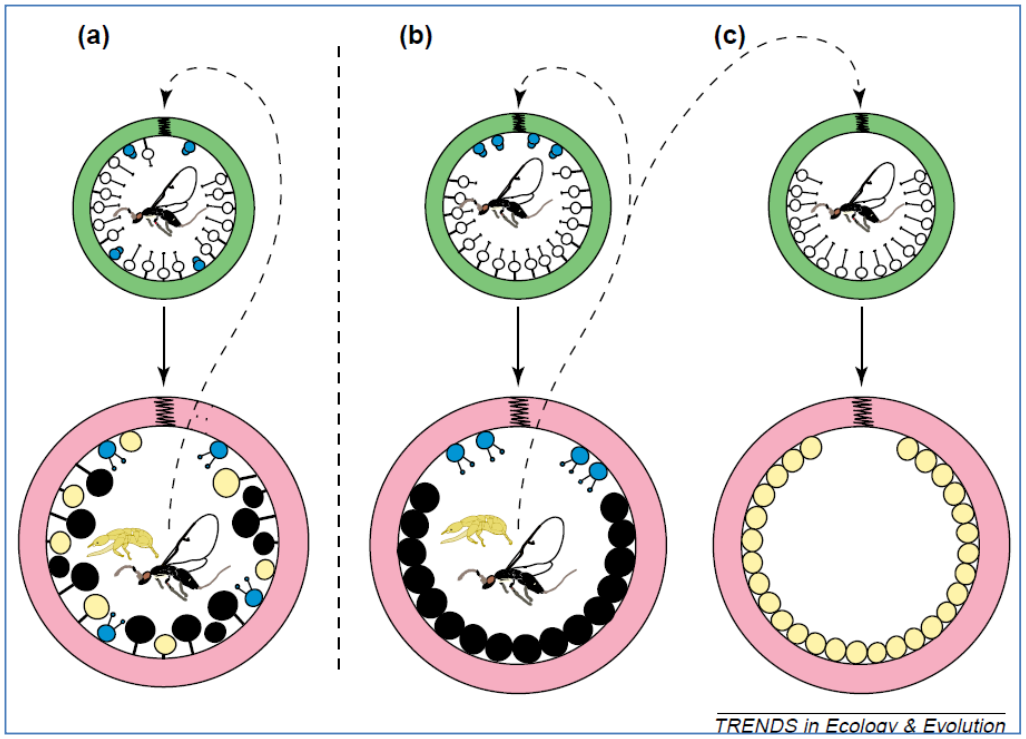
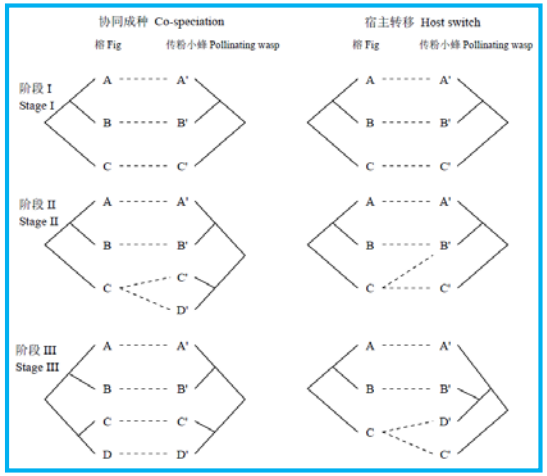
- 雌雄同株、雌雄异株

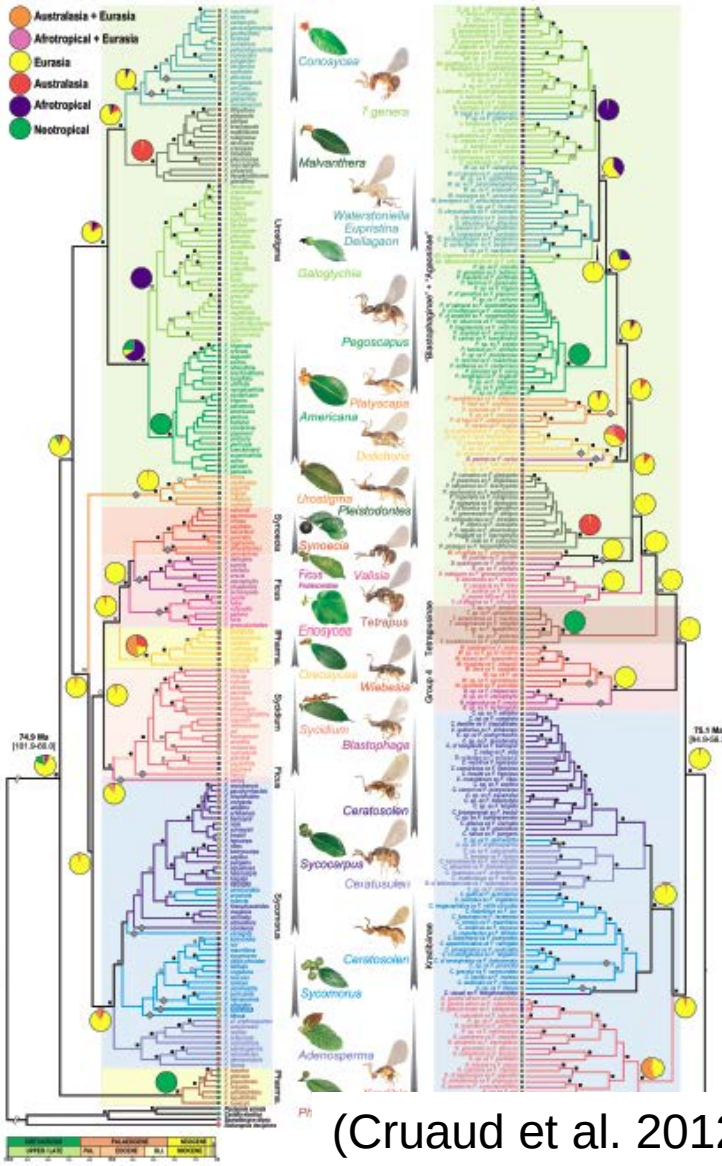


(Cook & Rasplus 2003)

榕-榕传粉小蜂共生体系



Subgenera	Diversity	Section	Oecy	Distribution	Pollinator	Mode
Pharmacosycea	82	*Pharmacosycea*	M		*Tetrapus*	P
		Oreosycea	M		*Dolichoris*	A
Sycomorus	142	*Sycocarpus*	D		*Ceratosolen*	A
		Sycomorus	MD			
		Adenosperma	D			
Sycidium	109	*Sycidium*	D		*Kradibia*	A
		Palaeomorphe	D			
Synoecia	74	*Kissosycea*	D		*Wiebesia*	AP
		Rhizocladus	D			
Ficus	61	*Ficus*	D		*Blastophaga*	P
		Eriosycea	D		*Valisia*	A
Urostigma	288	*Americana*	M		*Pegoscapus*	AP
		Galoglychia	M		7 genera*	A
		Malvanthera	M		*Pleistodontes*	AP
		Urostigma	M		*Platyscapa*	AP
		Conosycea	M		*Eupristina* &	AP
					2 genera**	P

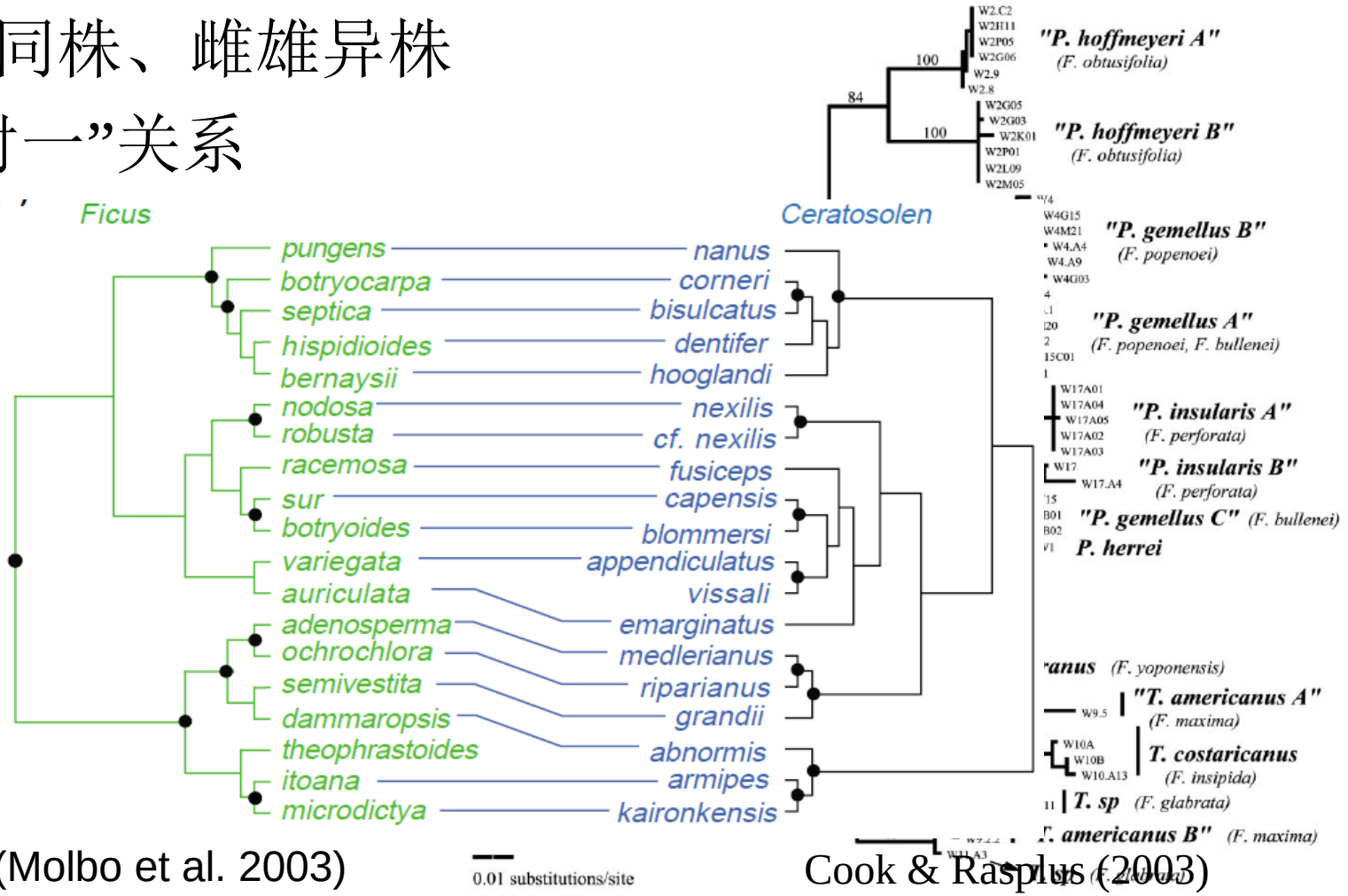


(Cruaud et al. 2012)

榕-榕传粉小蜂共生体系

- 榕及其传粉小蜂形成强制性共生关系
- 雌雄同株、雌雄异株
- “一对一”关系

分子
榕树存在
存种，并
了一对一



(Molbo et al. 2003)

Cook & Rasplus (2003)

- 榕属植物传粉小蜂中隐存种是否常见？
- 若存在多种传粉小蜂，它们是如何形成的？

薜荔-传粉小蜂：生活史

- 薜荔(*Ficus pumila*)：常绿、功能上雌雄异株
  - subgenus *Synoecia*, section *Rhizocladus*
  - 2个变种(薜荔、爱玉子)

薜荔

爱玉子

薜荔-传粉小蜂：生活史

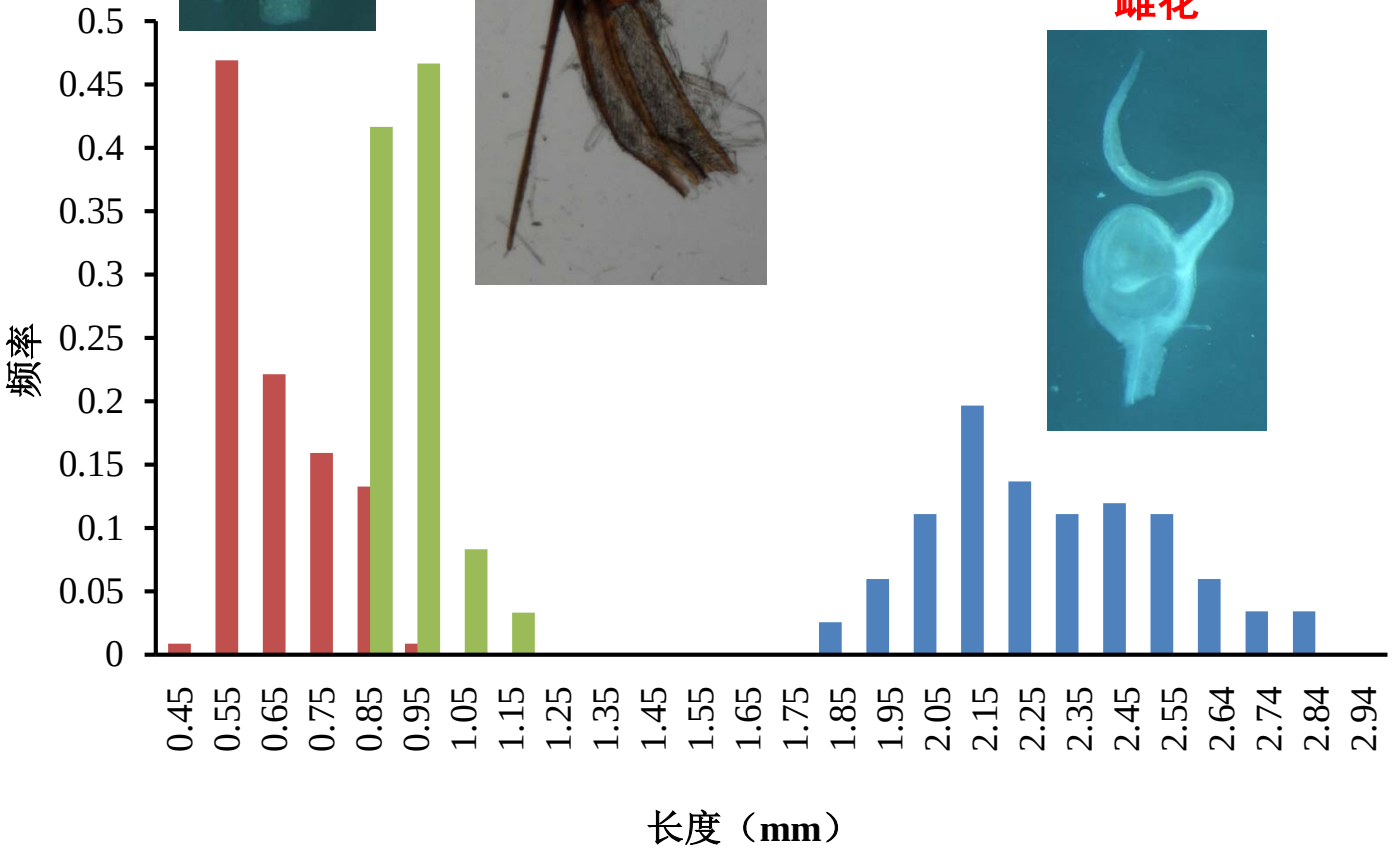
- 薜荔(*Ficus pumila*)：常绿、功能上雌雄异株
  - subgenus *Synoecia*, section *Rhizocladus*
  - 2个变种(薜荔、爱玉子)
- 薜荔传粉小蜂(*Wiebesia pumilae*)
  - Hill (1967)在香港发现并描述，归入*Blastophaga* 属，Wiebes(1994)将之转入*Wiebesia*属

雄瘿株

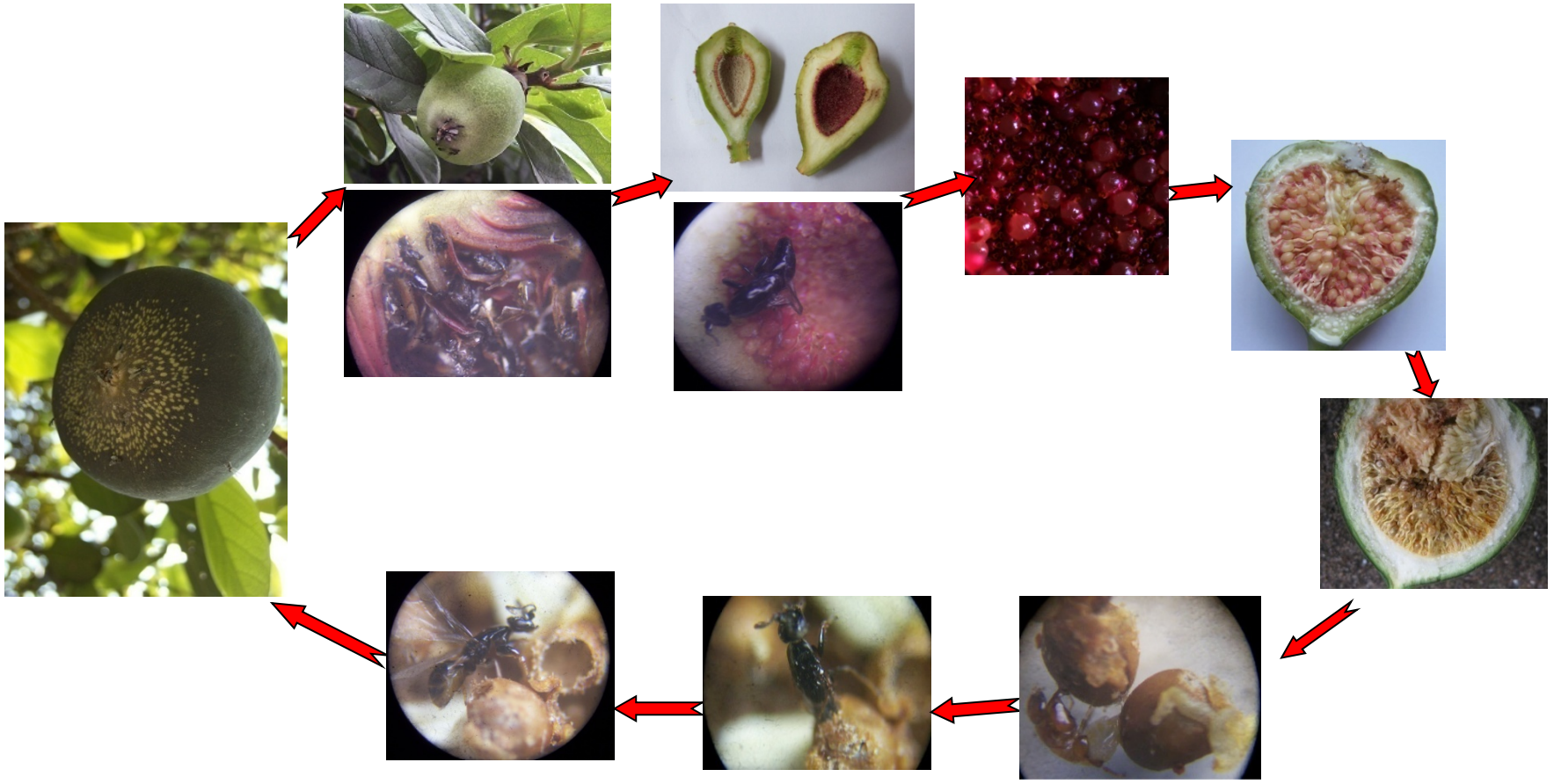
雌花(瘿花)

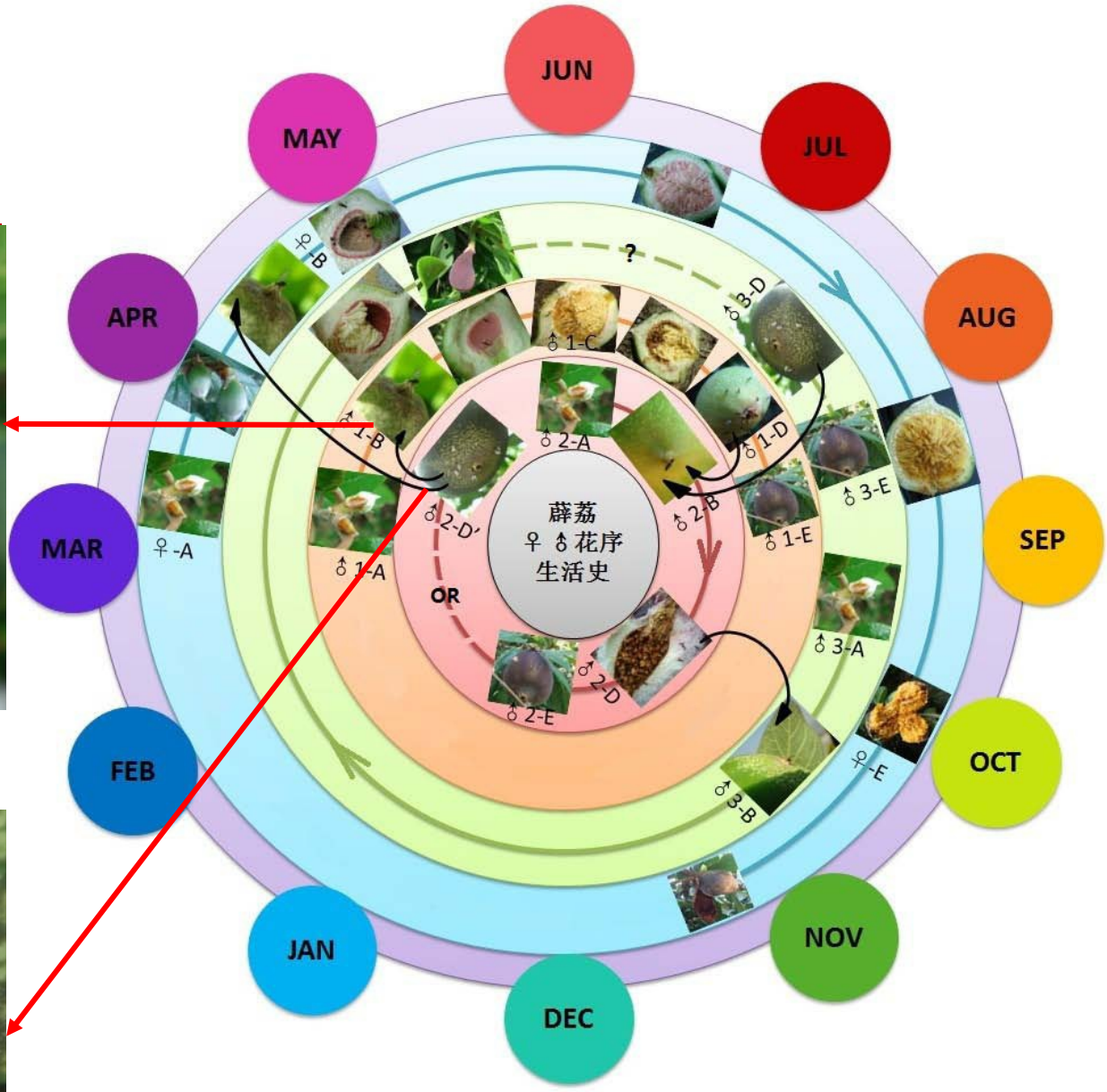
雌株

雌花



薜荔-传粉小蜂：生活史




JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
薜荔
♀♂花序
生活史
♀-B
♂1-C
♂3-D
♂1-B
♂2-A
♂1-D
♂2-B
♂3-E
♂2-D'
♂1-E
♀-A
♂1-A
OR
♂3-A
♂2-D
♂2-E
♂3-B
♀-E
?

薜荔-传粉小蜂：生活史

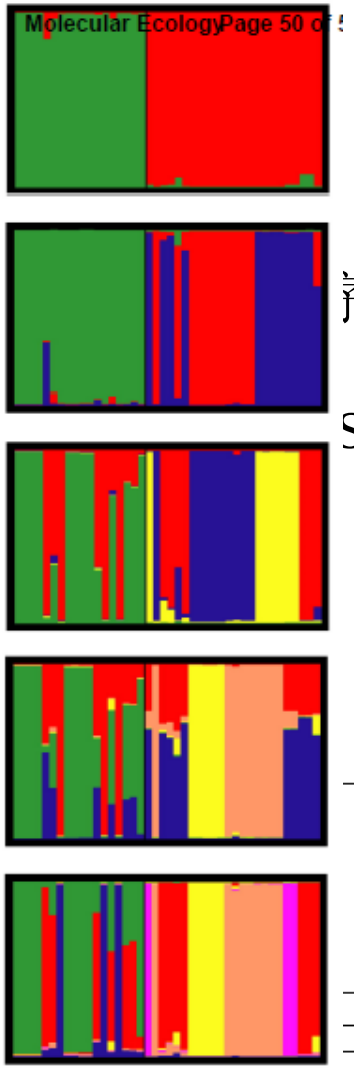
- **非传粉小蜂：** 出飞时间与传粉小蜂基本同步
  分布范围窄(福建永安、福州, 浙江衢州)

(右图来源：吴文珊)

薛荔-传粉小蜂：物种形成

- 薛荔

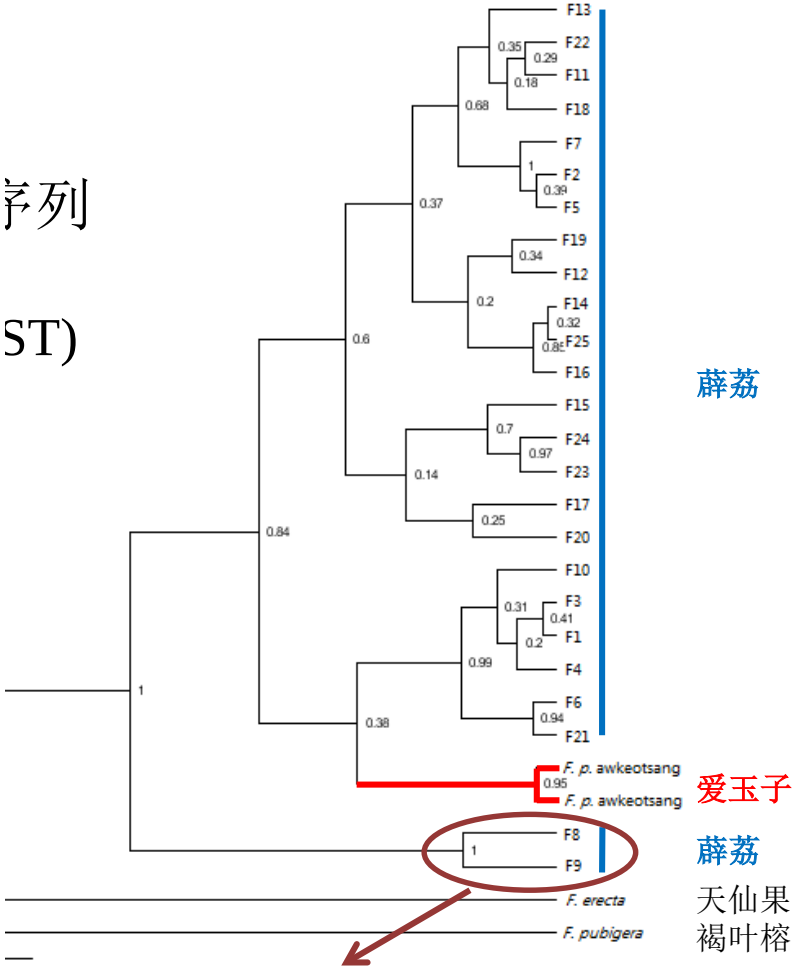
微卫星标记
(Wang et al.
2013 Mol Ecol)



序列

ST)

爱玉子　薛荔



薛荔

爱玉子

薛荔

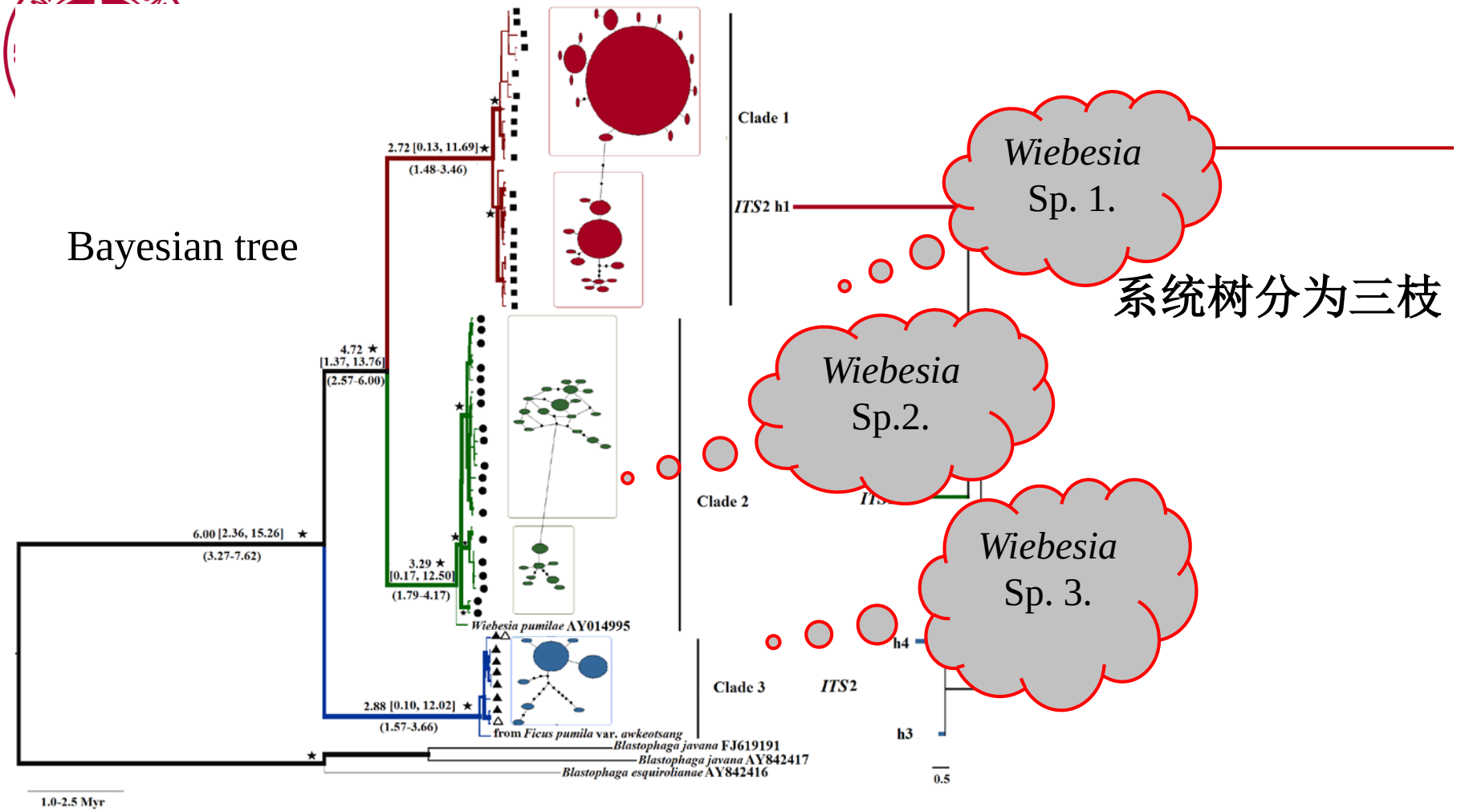
天仙果
褐叶榕

与珍珠莲共享单倍型

薜荔-传粉小蜂：物种形成

- 薜荔小蜂系统进化

Bayesian tree

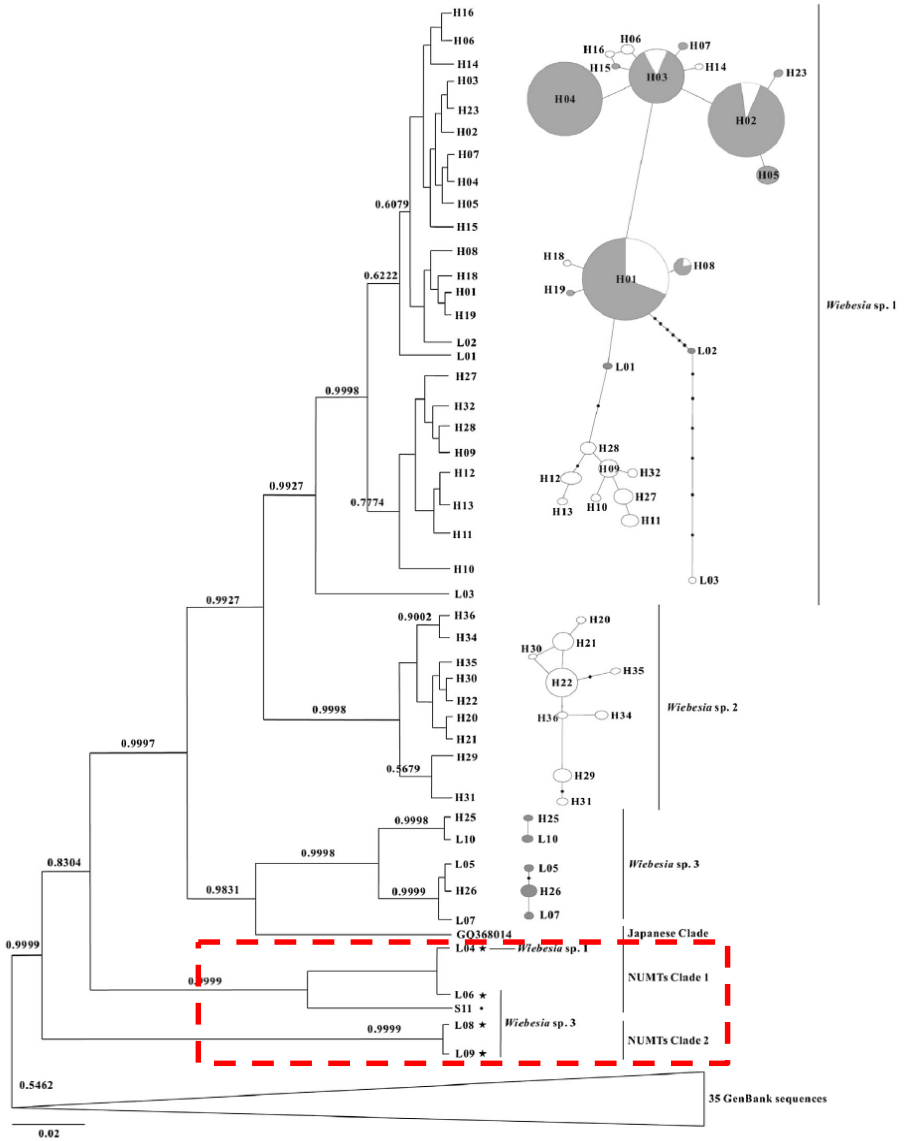


系统树分为三枝

	Clade I	Clade II	Clade III
Clade I	0.0058		
Clade II	0.0663	0.0042	
Clade III	0.1094	0.1069	0.0070

(Chen et al. 2012 Mol Ecol)

薛荔-传粉小蜂： 物种形成

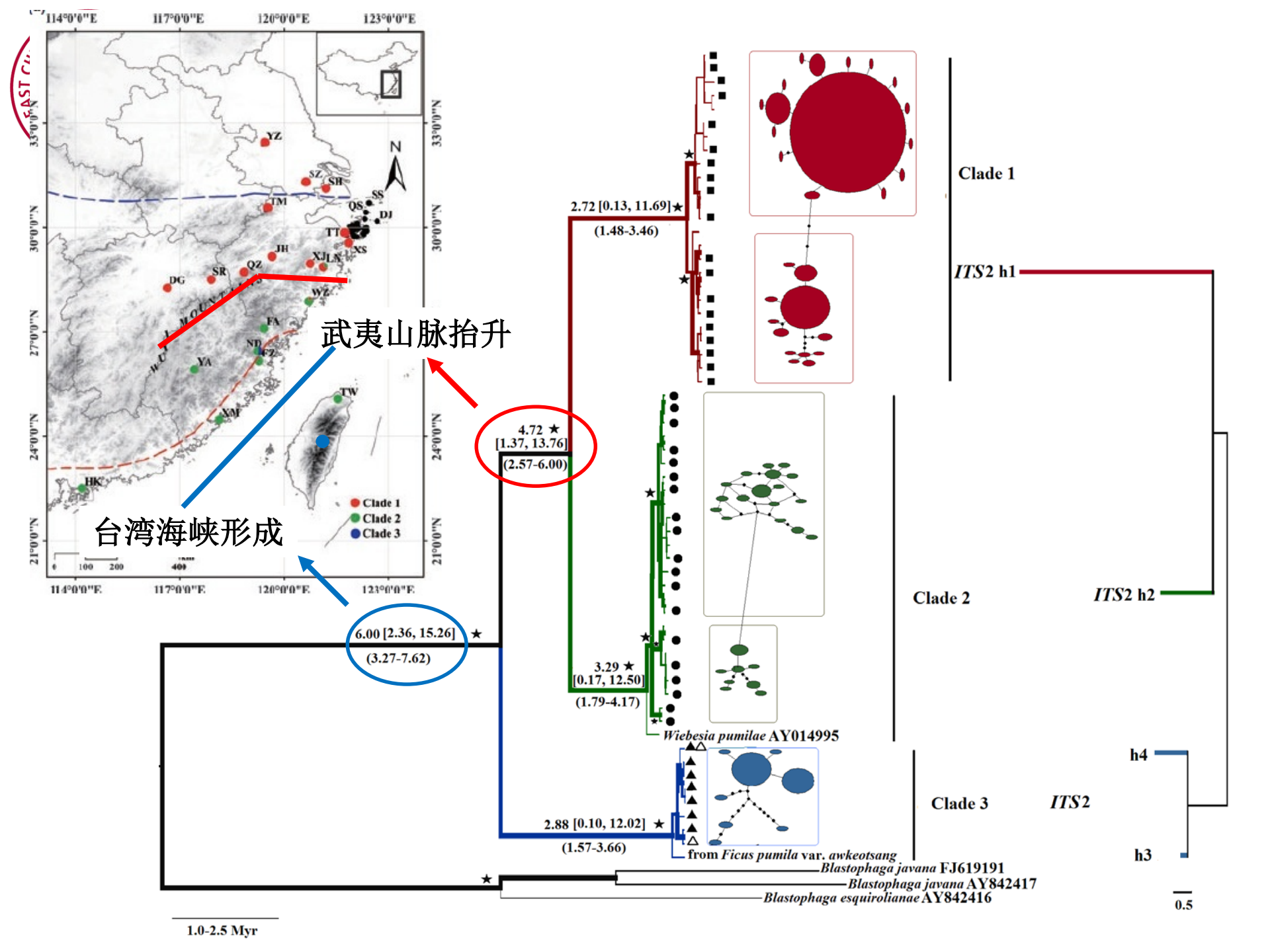


Cyt b NUMTs

(协同) 分化成种

姊妹种

位于基部


114°0'0"E
117°0'0"E
120°0'0"E
123°0'0"E
33°0'0"N
30°0'0"N
27°0'0"N
24°0'0"N
21°0'0"N
YZ
SZ
SH
SS
QS
DJ
TM
TT
XS
JH
XJ
LS
SR
QZ
DG
WZ
FA
ND
FZ
YA
XM
TW
HK
N
Clade 1
Clade 2
Clade 3
0
100
200
400
武夷山脉抬升
台湾海峡形成
2.72 [0.13, 11.69]★
(1.48-3.46)
4.72 ★
[1.37, 13.76]
(2.57-6.00)
6.00 [2.36, 15.26] ★
(3.27-7.62)
3.29 ★
[0.17, 12.50]
(1.79-4.17)
2.88 [0.10, 12.02] ★
(1.57-3.66)
★
Clade 1
Clade 2
Clade 3
ITS2 h1
ITS2 h2
ITS2
h4
h3
Wiebesia pumilae AY014995
from Ficus pumila var. awkeotsang
Blastophaga javana FJ619191
Blastophaga javana AY842417
Blastophaga esquirolianae AY842416
0.5
1.0-2.5 Myr

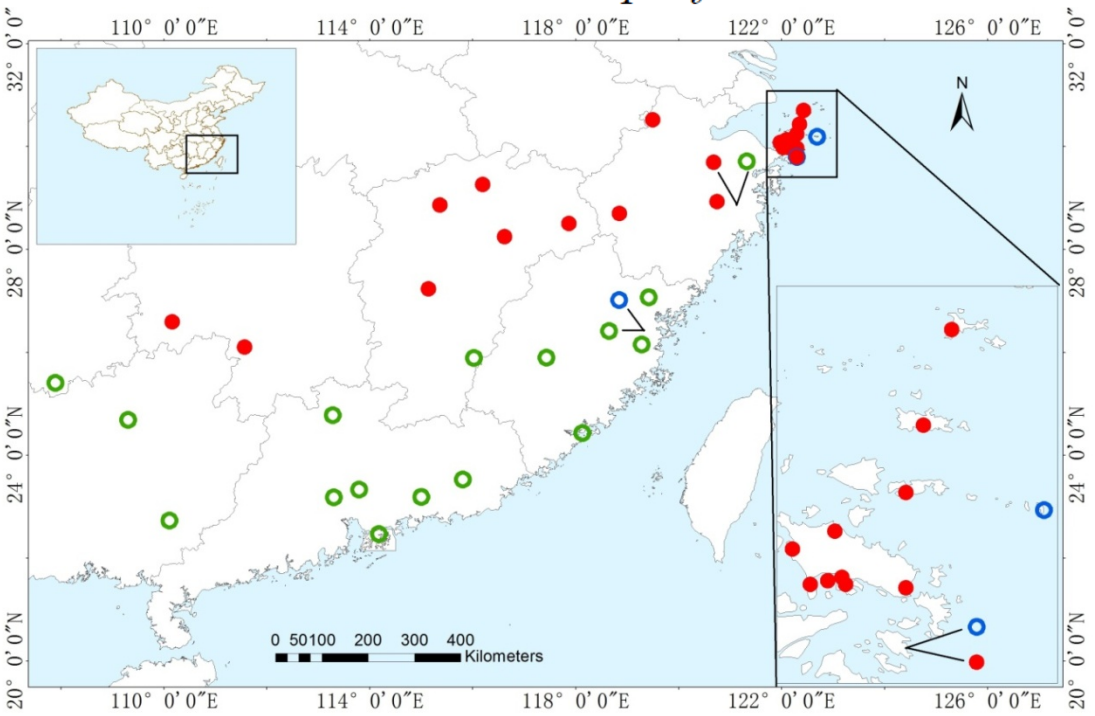
薛荔-传粉小蜂：物种形成

- *Wolbachia*感染
  - 分析的小蜂1所有种群、所有个体均感染
  - 小蜂2、3均未感染

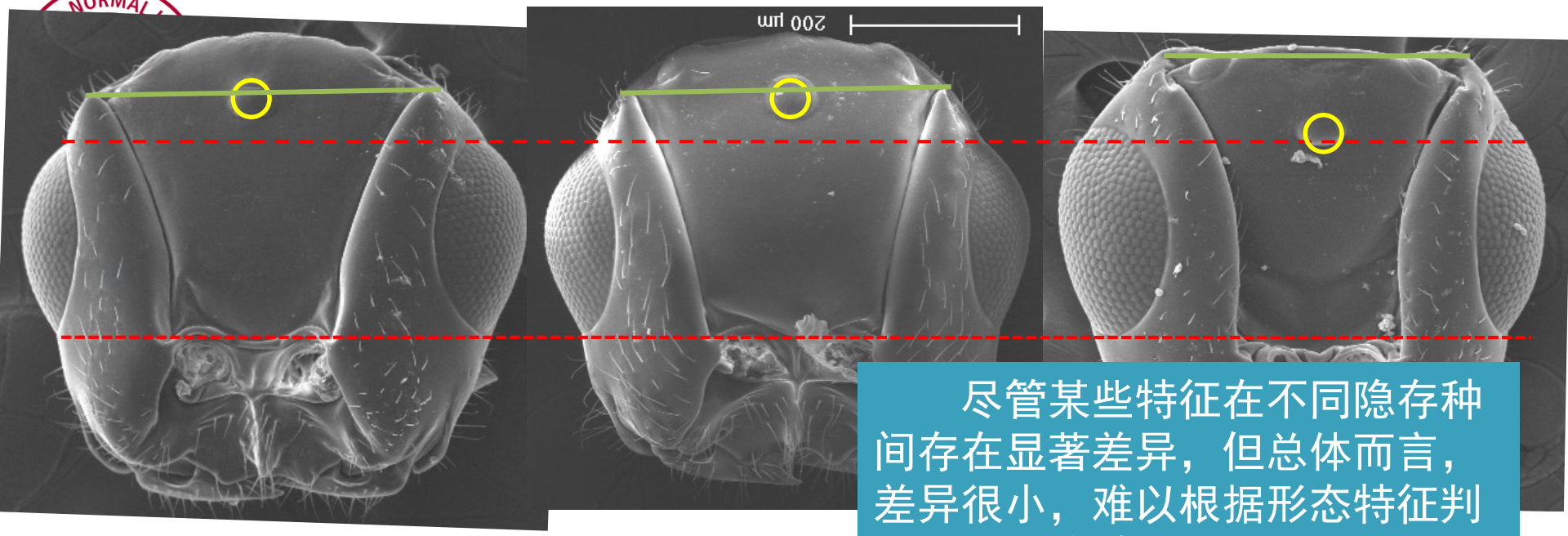
在传粉小蜂中*Wolbachia*的感染符合“全或无”模式。

传粉小蜂的物种形可能与*Wolbachia*感染无关

wsp、*ftsZ* 及 *16S rRNA*



*Wolbachia*在传粉小蜂中的分布



尽管某些特征在不同隐存种间存在显著差异，但总体而言，差异很小，难以根据形态特征判断传粉小蜂种类。

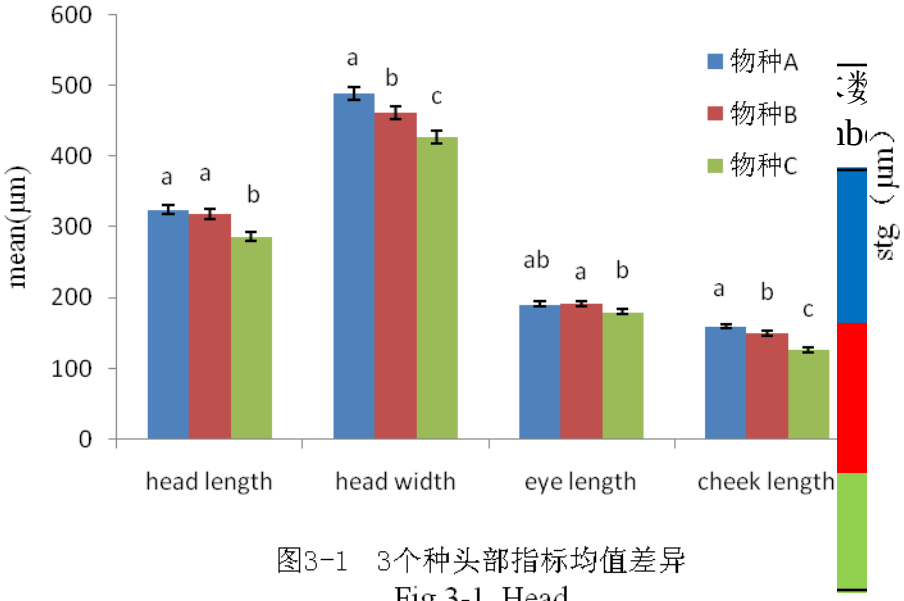


图3-1　3个种头部指标均值差异
Fig.3-1 Head

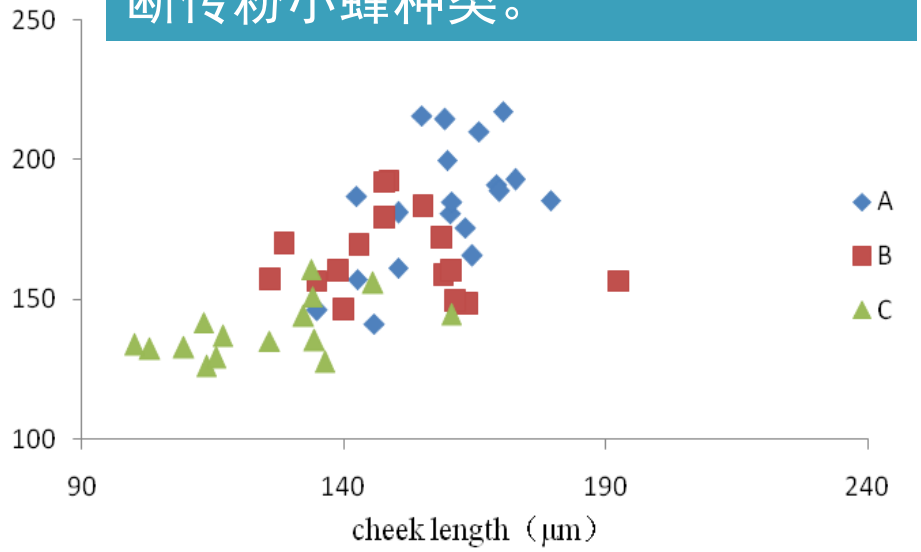
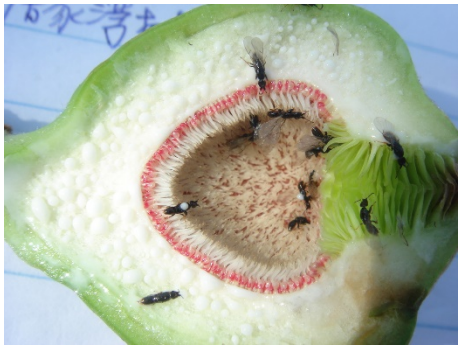


图4-7 种A、B、C脸长(x)-stg(y)比较
Fig4-7 cheek length(x)-stg(y) comparison of ABC

多种传粉小蜂是否可以稳定共存？

- 生态位理论



同一榕果内各种环境因素没有明显差异

多种不同的物种具有相同的生态位

生态位相同的不同物种可以共存？

多种传粉小蜂是否可以稳定共存？

- 生态位理论

Ecology Letters, (2004) **7**: 165–169 doi: 10.1111/j.1461-0248.2004.00569.x

IDEA

Coexistence of cryptic species

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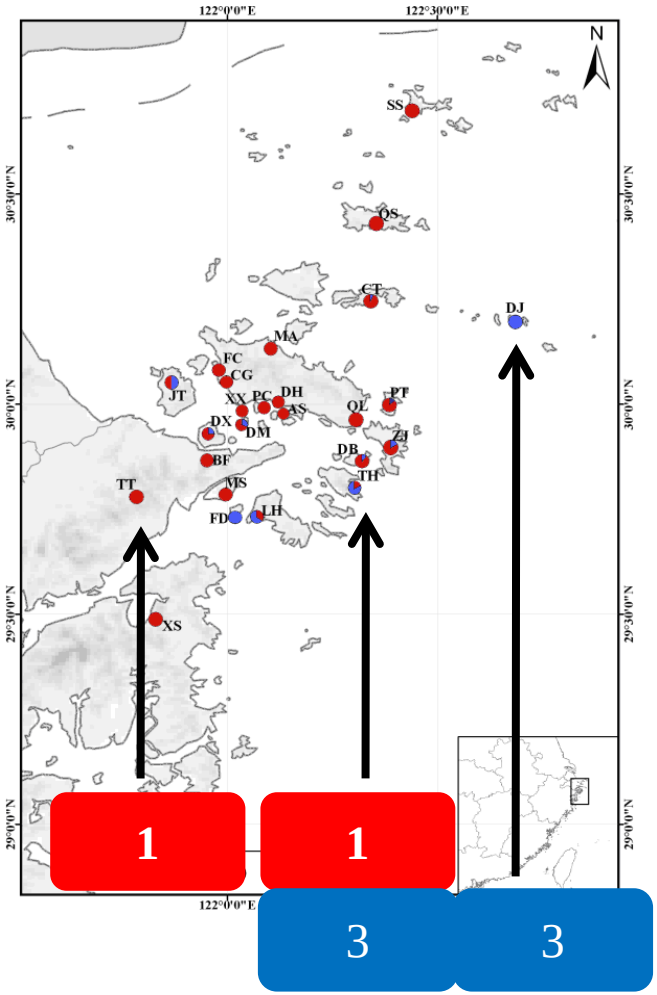
[2]Department of Ecology and Systematics, PO Box 65, Viikinkaari 1, University of

Abstract

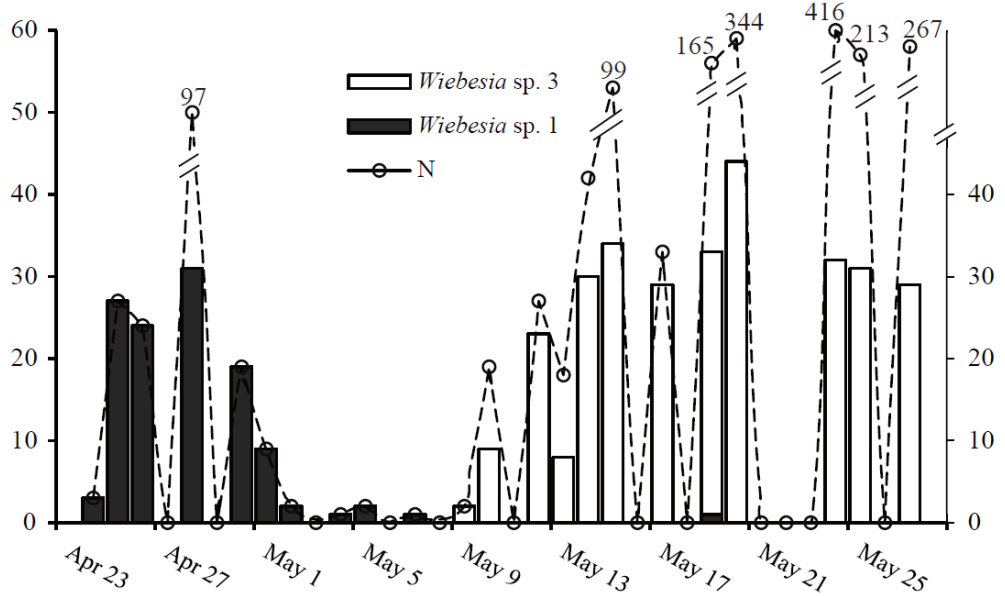
Recent discovery of cryptic species in fig-pollinating wasps creates a puzzle for the ecological competition theory: how do two or more apparently identical species coexist? Conventional theory predicts that they should not. Chesson (Trends Ecol. Evol., 1991, **6**, 26–28) identified one exception which he considered unlikely to occur in reality: coexistence might be possible if appropriate social behaviour was discriminately directed towards conspecifics and heterospecifics. Here we present an example of the exception by showing that two identical species with local mate competition and population size-dependent sex ratio adjustment may coexist. The new findings about fig-pollinating wasps provide a putative example of unexpected coexistence of identical competitors via this mechanism.

多种传粉小蜂是否可以稳定共存？

- 生态位理论
- 同域分布的薜荔传粉小蜂1与3



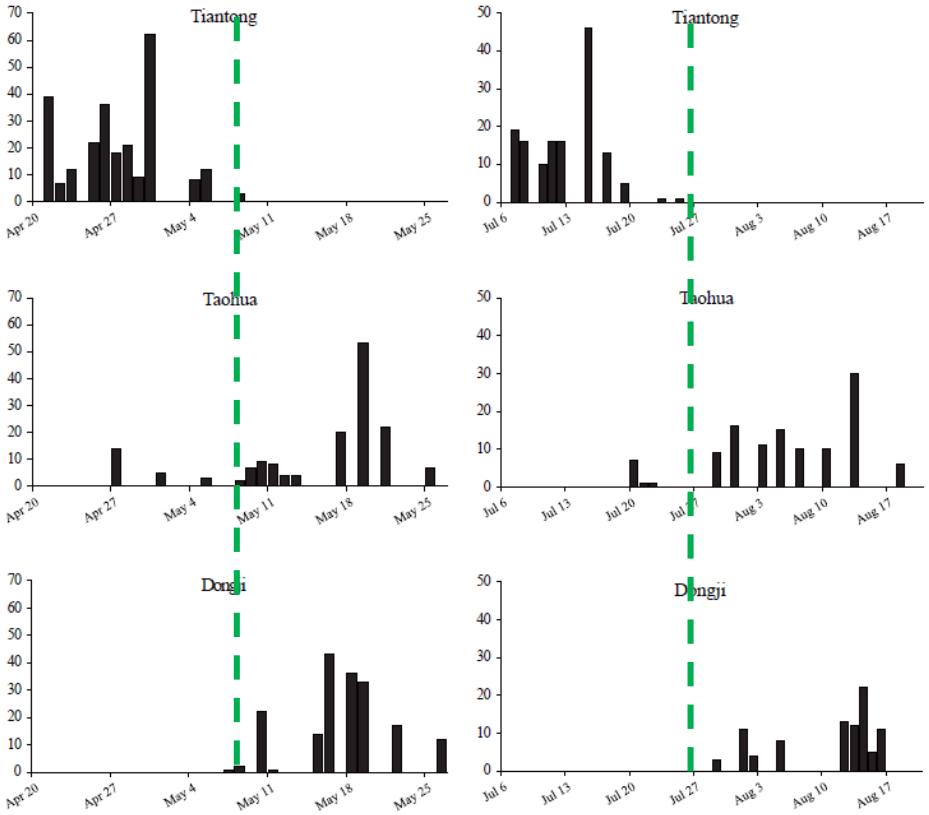
mtDNA COI测序



- 两个物种不能稳定共存
- 物种1相对物种3具有竞争优势：优先占领

多种传粉小蜂是否可以稳定共存？

- 生态位理论
- 同域分布的薜荔传粉小蜂1与3



结论

- 薜荔小蜂存在多个隐存种，薜荔分化出不同的亚种，符合协同成种模式
- 地质历史事件在薜荔-传粉小蜂体系分化中起关键左右，*Wolbachia*感染在薜荔传粉小蜂中的作用可能很小
- 同域分布的薜荔不同传粉小蜂，因竞争而不能稳定共存

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