A Ped c on A go fo Co p ng e y d za on N e of o ees

Magnus Bordewich[1], **Simone Linz**[2,3], **Katherine St. John**[4], **and Charles Semple**[2]

[1] p n of Co p d c nc n y L n d n do

[2] B o c C n p n of M c nd c n y of C n y C e e N nd

[3] p n of B o nfo c n e n n y do f ny

[4] p n of M c nd Co p d c nc L n Co C y n y of N Yo A

Correspondence: on L nz B o c C n p n of M c nd c n y of C n y B C e e N nd nz c n d do f d

Running head: A d c on A o fo y d z on

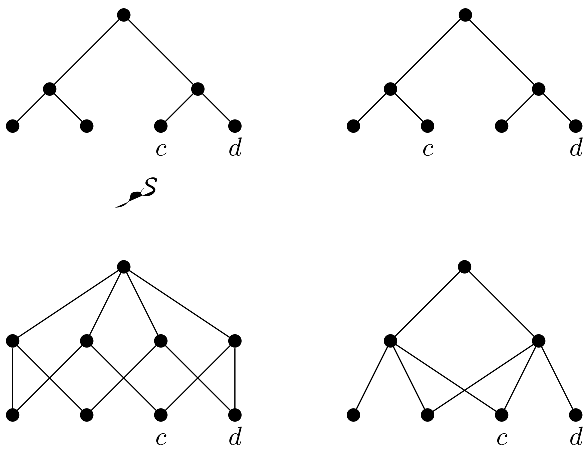
Key words: y d z on n o c o on n fo

1 Abstract

y d z on n po n o on y p oc fo ny o p of p c con c n n d y no of p n o od n o d o f c y d z on p y d n c n f f

[illegible] n [illegible] n co [illegible] c on con [illegible] of [illegible] o [illegible] oo [illegible] d [illegible] n [illegible] y [illegible] y o [illegible] n [illegible] c [illegible] Bo [illegible] d [illegible] nd [illegible] p [illegible] Con [illegible] n y [illegible] of [illegible] co p [illegible] on d c y o c [illegible] n [illegible] con d [illegible] o [illegible] p o [illegible] no [illegible] o [illegible] fo [illegible] pp o [illegible] n [illegible] p o [illegible] o [illegible] of [illegible] o [illegible] o [illegible] o n [illegible] c [illegible] d [illegible] on of [illegible] p o [illegible] nd L [illegible] n [illegible] on **et al.** [illegible] N [illegible] **et al.** [illegible] o [illegible] po [illegible] yno [illegible] c [illegible] no [illegible] n [illegible] of [illegible] c o [illegible] n [illegible] of [illegible] o on [illegible] N [illegible] **et al.** [illegible]

[illegible] n [illegible] p p [illegible] d [illegible] c [illegible] n [illegible] nd [illegible] c n y [illegible] p [illegible] n [illegible] d [illegible] c [illegible] o [illegible] fo [illegible] o [illegible] n [illegible] o [illegible] p o [illegible] no [illegible] c on [illegible] d on [illegible] d c on [illegible] p [illegible] o n of [illegible] y [illegible] d z on A of [illegible] d c on [illegible] of [illegible] c [illegible] n [illegible] o [illegible] c n y c [illegible] n [illegible] o [illegible] n [illegible] o of [illegible] d c on [illegible] no [illegible] o [illegible] n [illegible] o [illegible] d p [illegible] c [illegible] c [illegible] p [illegible] n c [illegible] of [illegible] y [illegible] d z on o [illegible] p n [illegible] n [illegible] o [illegible] Bo [illegible] d [illegible] nd [illegible] p [illegible] c [illegible] n [illegible] o [illegible] n [illegible] c n y [illegible] n [illegible] n c [illegible] c o nd [illegible] d [illegible] n n [illegible] d c on o [illegible]



1 2

Figure 1. o oo d n y y o n c nd nd o y d z on n o 1 nd 2 p n o

co n on of d p d c d n Bo d nd d p o p oof of co c n n y opo on of p p nd c d c on d c d n B on **et al.** o p oof of co c n n y o n p p p c y n p p on y d c n d o d n d n d o o n p p

3 Reduction Algorithm for Hybridization

n fo d c p on of o p A **rooted binary phylogenetic** X**-tree** oo d f X nd o oo d o o n o c d A **cluster** of of X con n p c y n d c nd n of o of

A **rooted acyclic digraph** d p no d c d cyc d p d n d o nd z o nd p op y d c d p fo o y o o n d p d no **in-degree** of n of d d c d n o y d^- nd **out-degree** of n of d d c d o of y d^+ A **hybridization network** on X oo d cyc c d p oo n X of c of o d z o

d^+ nd

e n o z of n n fo fo
nd z of fo n c of n fo n
o nd f n n n fo fo nd n on c n
p oc o con c y c d z on n o p n
nd

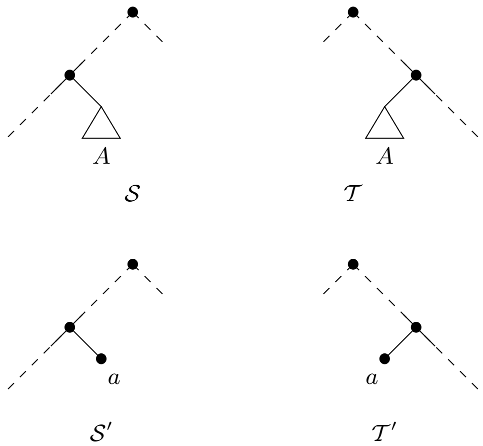


Figure 2. [illegible]

[illegible] of Bo[illegible]d[illegible] and [illegible] [illegible]

Bo[illegible]d[illegible] and [illegible] [illegible] **Hybridization Number** [illegible]

[illegible] **et al.** [illegible] $\mathcal{N}$ [illegible] conn[illegible]c[illegible]d co[illegible]pon[illegible]n[illegible] of [illegible] $\mathcal{N}$ [illegible] $\mathcal{N}$ [illegible]

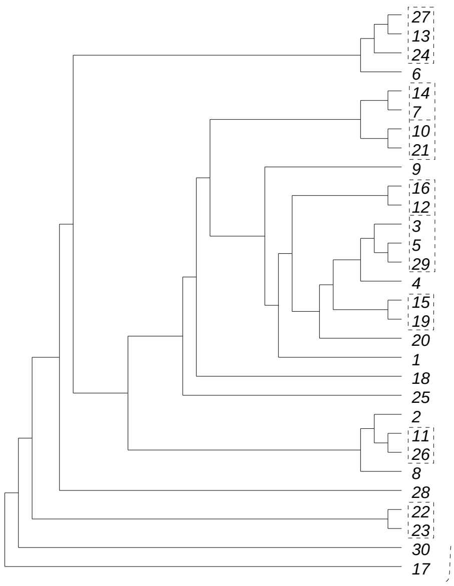
[illegible] B[illegible]on **et al.** [illegible]

Table 2. fo **Poaceae** d

pairwise combination		# taxa	hybridization number	run time[a]
nd	yB	40	14	11 h
nd	cL	36	13	11.8 h
nd	oC	34	12	26.3 h
nd	ry	19	9	320 s
nd	[illegible]	46	at least 15	2 d
yB	cL	21	4	1 s
yB	oC	21	7	180 s
yB	ry	14	3	1 s
yB	[illegible]	30	8	19 s
cL	oC	26	13	29.5 h
cL	ry	12	7	230 s
cL	[illegible]	29	at least 9	2 d
oC	ry	10	1	1 s
oC	[illegible]	31	at least 10	2 d
ry	[illegible]	15	8	620 s

[a]run time on a 2000 MHz CPU, 2 GB RAM machine measured in seconds (s), hours (h), and days (d), respectively

p nc y o o B **phyB** nd n c nc of n n n c d p c of o o NA **ITS** n pp n of p n d y p c o nd c d y y c


27
13
24
6
14
7
10
21
9
16
12
3
5
29
4
15
19
20
1
18
25
2
11
26
8
28
22
23
30
17

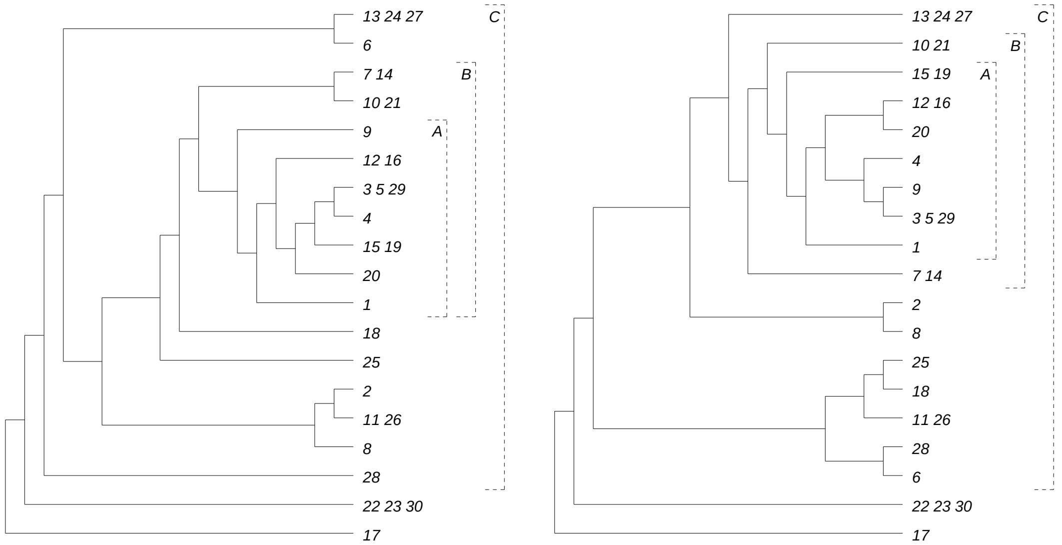
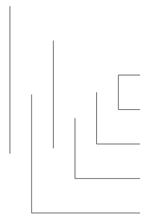

13 24 27
6
7 14
10 21
9
12 16
3 5 29
4
15 19
20
1
18
25
2
11 26
8
28
22 23 30
17
A
B
C
13 24 27
10 21
15 19
12 16
20
4
9
3 5 29
1
7 14
2
8
25
18
11 26
28
6
22 23 30
17
A
B
C

Figure 6.



c n o c y fo ny o o c p
n o p fo c y nd y dz on n c
c n fo nd n on

No HybridNumber c c o ond fo n c
of y dz on n o p n d nc c n o p y o n c
n n y dz on ony c of ncon nc
c n o po n c of y dz on
n pp n d d n o on of co c on of p n d y
p c nd con d on nd d nd d po c o
o y dz on n n con z d N o
p d po n n c n

N L nd n L A A f nd cc c fo con c n o zon n n n **Proceedings of the Eleventh International Computing and Combinatorics Conference (COCOON 05)** L c No n Co p dc nc o p n p

N L no L nd C con c n c o on n p c o y nd p c c **Journal of Computational Biology 12**

n M d o f NA L oo fo con c on of p y o n c of NA nc n ood **Comput Appl Biosci 10**

L y ond o n M M o co o c n on n d n o f c d y y d z on **Science 301**

d A y o n c f o d n n n do f

d p C nd M **Phylogenetics** fo d n y

Appendix

A Pseudocode

p n p docod of **HybridNumber** o oo d n y p y o n c X nd A of X d no n of conn c n n n A y A d no fo d y p c n c A n f c y A c B of X B o d no p y o n c o n d f o y d n of n n B nd pp n ny n d o n y d no fo o n d f o y d n d n B c of n d c on n p o **HybridNumber** nc d f nc on on p of c n n o z o fo p n n np

Algorithm A.1: HybridNumber($\mathcal{S}$)

$\mathcal{S}$ ← SubtreeReduction($\mathcal{S}$)

$\mathcal{S}$ ← ChainReduction($\mathcal{S}$)

if n co on c C of $\mathcal{S}$ nd **and**

C n c of of $\mathcal{S}$

do $\mathcal{S}$ 1 1 1 $\mathcal{S}$ 2 2 2 ← ClusterReduction($\mathcal{S}$)

1 ← Exhaustustustustustustu $\mathcal{S}$ 2

Algorithm A.4: ClusterReduction($\mathcal{S}$)

C n co on c of $\mathcal{S}$ nd
$\mathcal{S}_1$ $\mathcal{S}$ C
$\mathcal{S}_2$ $\mathcal{S}$ C c
1 C
2 C c
1 c d o p of n C
2 c d o p of no n C
return $\mathcal{S}_1$ 1 1 $\mathcal{S}_2$ 2 2

Algorithm A.5: ExhaustiveSearch($\mathcal{S}$)

if $\mathcal{S}$ **return**
n c of of $\mathcal{S}$

repeat
for each c of d of $\mathcal{S}$
c $\mathcal{S}$
do
if n cyc c n fo of $\mathcal{S}$ nd
do
P o d n
$\sum_{(a,b)\in P}$
if
do

until
return

Remarks

c p n d o con n o p n co p d o p docod n o d o p nn n do no c o c o c nn n n p c c y n c An p no n fo n o d n n nc n do no n d o con d of d of z o d fo $\mathcal{S}$ con n d nc d n p c

n HybridNumber fo o n c o c d c on c d c nno d c d ny f n d c on n c d y c ExhaustiveSearch o y no c po o f d c nd of nd o c HybridNumber