

P A U P *
Version 4.0a (build 167) for Macintosh (X86) (built on Feb 1 2020 at 22:15:41)
Tuesday, 16. June 2020 at 10:21:01 Central European Summer Time

-----NOTICE-----
This is a test version that is still changing rapidly.
It will expire on 1 Aug 2020.

Please report bugs to dave@phylosolutions.com

```
#####  
#                                     #  
#                               WARNING                               #  
#                                     #  
# The GUI version of PAUP for Mac will NOT run under               #  
# MacOS 10.15 (Catalina). Do not upgrade to Catalina                #  
# if having a GUI version of PAUP* on your Mac is more              #  
# important to you than having the latest MacOS version!           #  
#                                     #  
# I hope to have a 64-bit version sometime in early 2020.          #  
# Please join the Google Group paup-announce to receive            #  
# update announcements.                                             #  
#                                     #  
#####
```

Running on IA-32 architecture (64-bit word length)
SSE vectorization enabled
SSSE3 instructions supported
Multithreading enabled for likelihood using Pthreads
Compiled using Intel compiler (icc) 11.1.0 (build 20091012)

Processing of file "~/Desktop/Supplementary_data_2_R1.nex" begins...

Data matrix has 33 taxa, 102 characters
Valid character-state symbols: 01234
Missing data identified by '?'
Gaps identified by '-'

Character types changed:
Of 102 total characters:
All characters are of type 'unord'
All characters have equal weight

*** Skipping "NOTES" block

*** Skipping "MESQUITECHARMODELS" block

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| | Taxon | Status |
|----|------------------|--------|
| 1 | Rhinobatos | 0 |
| 2 | Raja | 0 |
| 3 | Hexatrygon | – |
| 4 | Paratrygon | – |
| 5 | Styracura | – |
| 6 | Heliotrygon | – |
| 7 | Plesiotrygon | – |
| 8 | Potamotrygon | – |
| 9 | Aetomyleus | – |
| 10 | Myliobatis | – |
| 11 | Weissobatis | – |
| 12 | Promyliobatis | – |
| 13 | Aetobatus | – |
| 14 | Rhinoptera | – |
| 15 | Mobula | – |
| 16 | Pastinachus | – |
| 17 | Himantura | – |
| 18 | Dasyatis | – |
| 19 | Pteroplatytrygon | – |
| 20 | Neotrygon | – |
| 21 | Taeniura | – |
| 22 | Protohimantura | – |
| 23 | Heliobatis | – |

- 24 Asterotrygon -
- 25 Tethytrygon -
- 26 Urobatis -
- 27 Urotrygon -
- 28 Trygonoptera -
- 29 Urolophus -
- 30 Arechia -
- 31 Gymnura -
- 32 Plesiobatis -
- 33 Lessiniabatis -

paup> CStatus full;

Character-status summary:
Current optimality criterion = parsimony
No characters are excluded
Of 102 total characters:
All characters are of type 'unord'
All characters have equal weight
3 characters are constant (proportion = 0.0294118)
10 variable characters are parsimony-uninformative
Number of parsimony-informative characters = 89

Current status of all characters:

| Character | Type | Status | Weight | States |
|---|-------|--------|--------|--------|
| 1 (Tubules of subpleural components of hyomandibular lateral line canals) | Unord | - | 1 | 01 |
| 2 (Subpleural components of the hyomandibular lateral line canals) | Unord | - | 1 | 012 |
| 3 (Suborbital components of infraorbital lateral line canals) | Unord | - | 1 | 012 |
| 4 (Scapular loops formed by scapular components of trunk lateral line canals) | Unord | - | 1 | 01 |
| 5 (Anterior process of neurocranium) | Unord | - | 1 | 01 |
| 6 (Preorbital process) | Unord | - | 1 | 01 |
| 7 (Preorbital canal for passage of superficial ophthalmic nerve) | Unord | - | 1 | 01 |
| 8 (Foramen for the optic (II) nerve) | Unord | - | 1 | 01 |
| 9 (Postorbital process of neurocranium) | Unord | - | 1 | 01 |
| 10 (Extent of orbital region) | Unord | - | 1 | 01 |
| 11 (Postorbital process) | Unord | - | 1 | 01 |
| 12 (Ventrolateral expansion of nasal capsules) | Unord | - | 1 | 01 |
| 13 (Articulation between hyomandibula and Meckel?s cartilage) | Unord | - | 1 | 01 |
| 14 (Angular cartilages) | Unord | - | 1 | 01 |
| 15 (Secondary hyomandibular cartilages) | Unord | - | 1 | 01 |
| 16 (Symphysial fusion of upper and lower jaws) | Unord | - | 1 | 01 |
| 17 (Mandibular width at symphysis) | Unord | - | 1 | 01 |
| 18 (Lateral projections of lower jaws) | Unord | - | 1 | 01 |
| 19 (Basihyal cartilage) | Unord | - | 1 | 0123 |
| 20 (Fusion of ventral pseudohyoid and first ceratobranchial) | Unord | - | 1 | 01 |
| 21 (Arrangement of posterior ceratobranchials) | Unord | - | 1 | 012 |
| 22 (Median projection of the basibranchial medial plate) | Unord | - | 1 | 01 |

| | | | | |
|--|-------|----|---|------|
| 23 (Articulation between fifth epi? and ceratobranchial elements to scapulocoracoid) | Unord | – | 1 | 01 |
| 24 (Lateral stay of synarcual) | Unord | – | 1 | 012 |
| 25 (Fossa on dorsal scapular region) | Unord | – | 1 | 01 |
| 26 (Contact between pro- and mesopterygium in the pectoral fin) | Unord | – | 1 | 01 |
| 27 (Distinct components of the mesopterygium) | Unord | – | 1 | 012 |
| 28 (Lateral expansion of radials in pectoral region) | Unord | – | 1 | 01 |
| 29 (External margin of mesopterygium) | Unord | – | 1 | 0123 |
| 30 (Median prepelvic process) | Unord | – | 1 | 01 |
| 31 (Pelvic girdle shape) | Unord | – | 1 | 01 |
| 32 (Dorsal fin) | Unord | – | 1 | 01 |
| 33 (Cartilaginous rod in tail) | Unord | – | 1 | 01 |
| 34 (Caudal fin) | Unord | – | 1 | 012 |
| 35 (Adductor mandibulae complex) | Unord | – | 1 | 01 |
| 36 (Spiracularis muscle) | Unord | – | 1 | 012 |
| 37 (Depressor mandibularis muscle) | Unord | – | 1 | 01 |
| 38 (Coracohyoideus muscle) | Unord | – | 1 | 01 |
| 39 (Urea retention) | Unord | – | 1 | 01 |
| 40 (Rectal gland) | Unord | – | 1 | 01 |
| 41 (Spiracular tentacle) | Unord | – | 1 | 01 |
| 42 (Cephalic lobes) | Unord | – | 1 | 0123 |
| 43 (Nasal curtain) | Unord | – | 1 | 01 |
| 44 (Tooth type in both upper and lower jaws) | Unord | – | 1 | 01 |
| 45 (Arrangement of teeth in both upper and lower jaws) | Unord | – | 1 | 01 |
| 46 (Tooth shape) | Unord | – | 1 | 012 |
| 47 (Lateral teeth) | Unord | U | 1 | 01 |
| 48 (Differentiation of median teeth from lateral teeth) | Unord | – | 1 | 01 |
| 49 (Differentiation among lateral teeth) | Unord | U | 1 | 01 |
| 50 (Relative amount of curvature in expanded lower teeth) | Unord | – | 1 | 012 |
| 51 (Upper tooth curvature) | Unord | U | 1 | 01 |
| 52 (Direction of tooth curvature) | Unord | U | 1 | 12 |
| 53 (Tooth association) | Unord | – | 1 | 01 |
| 54 (Tooth Interlocking mechanism) | Unord | – | 1 | 012 |
| 55 (Shape of interlocking tongue) | Unord | U | 1 | 012 |
| 56 (Crown height) | Unord | – | 1 | 01 |
| 57 (Occlusal surface) | Unord | – | 1 | 012 |
| 58 (Crown shape in anterior or posterior view) | – | UC | 1 | 0 |
| 59 (Lateral margins) | – | UC | 1 | 0 |
| 60 (Root type) | Unord | – | 1 | 01 |
| 61 (Number of roots) | Unord | – | 1 | 01 |
| 62 (Roots in basal view) | Unord | – | 1 | 012 |
| 63 (Distance between roots) | Unord | – | 1 | 01 |
| 64 (Inclination of roots) | Unord | U | 1 | 012 |
| 65 (Root groove position) | – | UC | 1 | 01 |
| 66 (Levator and depressor rostri muscles) | Unord | – | 1 | 01 |
| 67 (Serrated tail stings) | Unord | – | 1 | 01 |
| 68 (Placoid scales) | Unord | – | 1 | 012 |
| 69 (Thorns) | Unord | – | 1 | 01 |
| 70 (Pulp cavities in tooth roots) | Unord | – | 1 | 0123 |
| 71 (Tooth vascularization) | Unord | – | 1 | 012 |

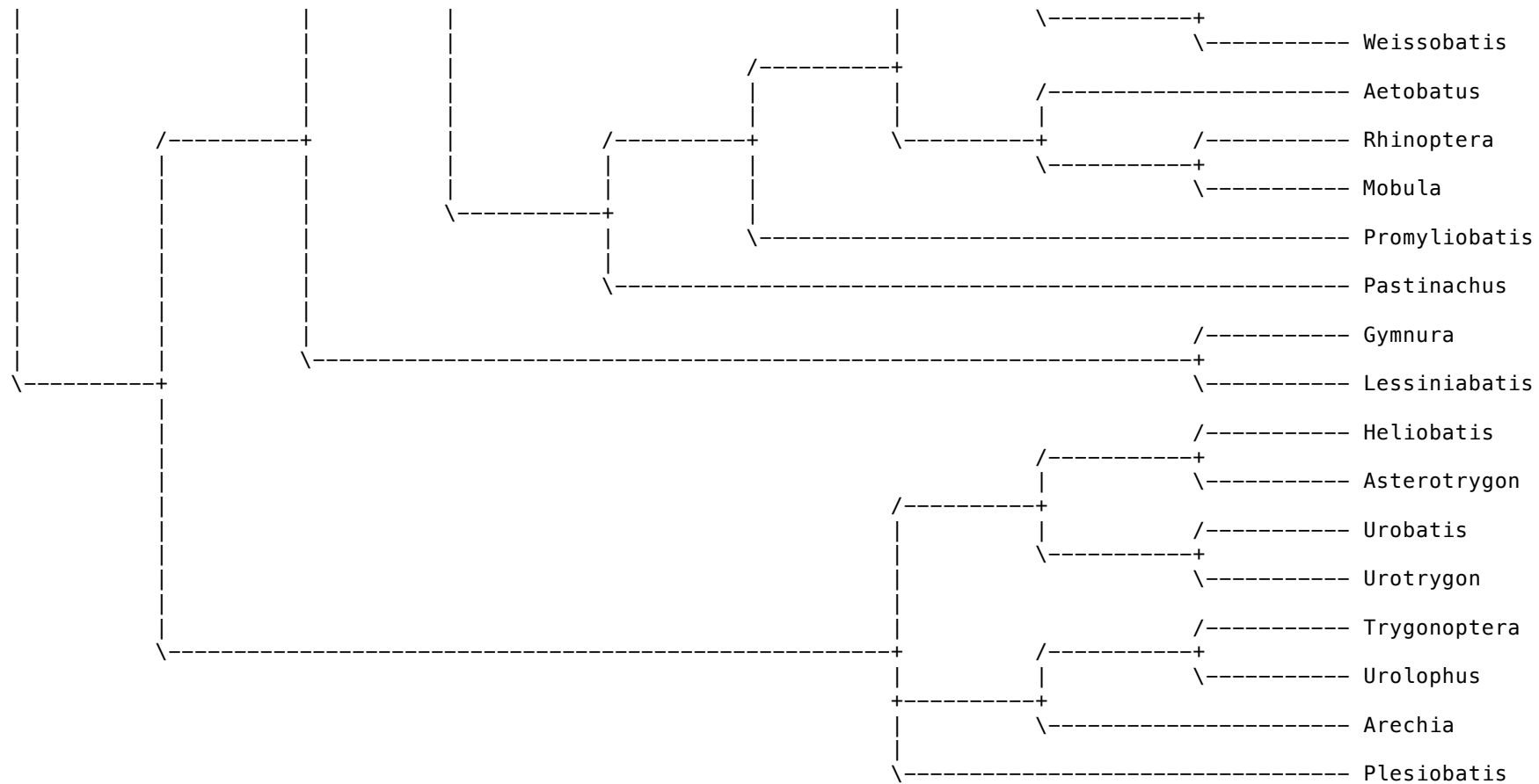
| | | | | |
|---|-------|---|---|------|
| 72 (Infraorbital loop of suborbital and infraorbital canals) | Unord | – | 1 | 0123 |
| 73 (Rostral cartilage) | Unord | – | 1 | 01 |
| 74 (Postorbital process) | Unord | – | 1 | 01 |
| 75 (Jugal arch) | Unord | – | 1 | 01 |
| 76 (Basihyal and first hypobranchial) | Unord | – | 1 | 0123 |
| 77 (Suprascapulae) | Unord | U | 1 | 012 |
| 78 (Ball and socket articulation between scapular process and synarcual) | Unord | – | 1 | 01 |
| 79 (Second (thoracolumbar) synarcual) | Unord | – | 1 | 01 |
| 80 (Ribs) | Unord | U | 1 | 01 |
| 81 (Segmentation of propterygium) | Unord | – | 1 | 0123 |
| 82 (Pseudosiphon) | Unord | – | 1 | 01 |
| 83 (Dorsal marginal clasper cartilage) | Unord | – | 1 | 01 |
| 84 (Dorsal terminal cartilage) | Unord | – | 1 | 01 |
| 85 (Cartilage forming component claw) | Unord | – | 1 | 0123 |
| 86 (Ventral terminal cartilage (accessory terminal 1 cartilage in rajids)) | Unord | U | 1 | 012 |
| 87 (Ventral terminal cartilage (accessory terminal 1 cartilage in rajids)) | Unord | – | 1 | 01 |
| 88 (Spiracularis) | Unord | – | 1 | 0123 |
| 89 (Sexual heterodonty) | Unord | – | 1 | 01 |
| 90 (Medial symphyseal processes of the Meckel's cartilage) | Unord | – | 1 | 01 |
| 91 (Lateral processes of the palatoquadrate extending far anteriorly) | Unord | – | 1 | 01 |
| 92 (Anterior processes of the Meckel's cartilage) | Unord | – | 1 | 012 |
| 93 (Lateral oral diastema alt) | Unord | – | 1 | 01 |
| 94 (Upper jaw profile) | Unord | – | 1 | 012 |
| 95 (Upper jaw mineralization) | Unord | U | 1 | 01 |
| 96 (Lower jaw profile) | Unord | – | 1 | 01 |
| 97 (Upper and lower jaw trabeculae) | Unord | – | 1 | 012 |
| 98 (Second transverse keel) | Unord | – | 1 | 01 |
| 99 (Calcification pattern of radials) | Unord | – | 1 | 01 |
| 100 (Body disc shape) | Unord | – | 1 | 01 |
| 101 (Mid-dorsal surface of disc covered by heart-shaped denticles arranged in an antero-posteriorly) | Unord | – | 1 | 01 |
| 102 (File of enlarged ?caniniform? teeth in the upper jaw) | Unord | – | 1 | 01 |

paup> Set maxtrees=30000;

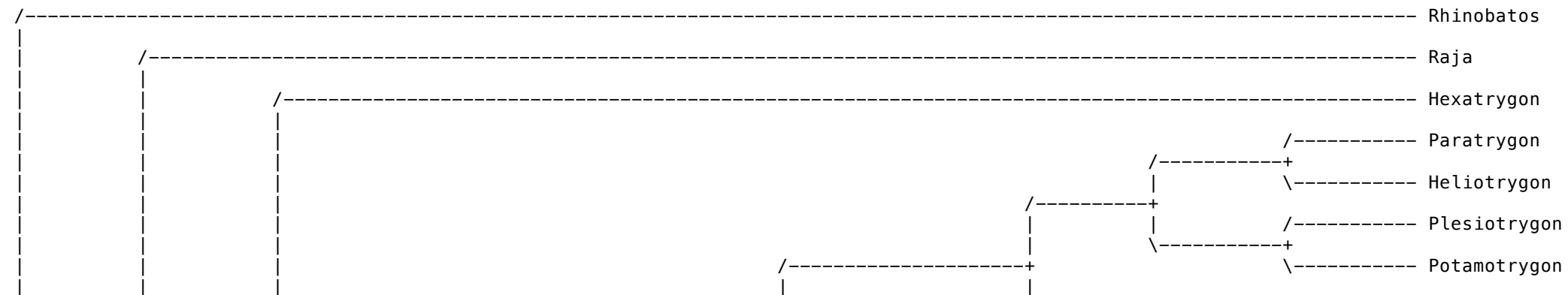
Maxtrees reset to 30000

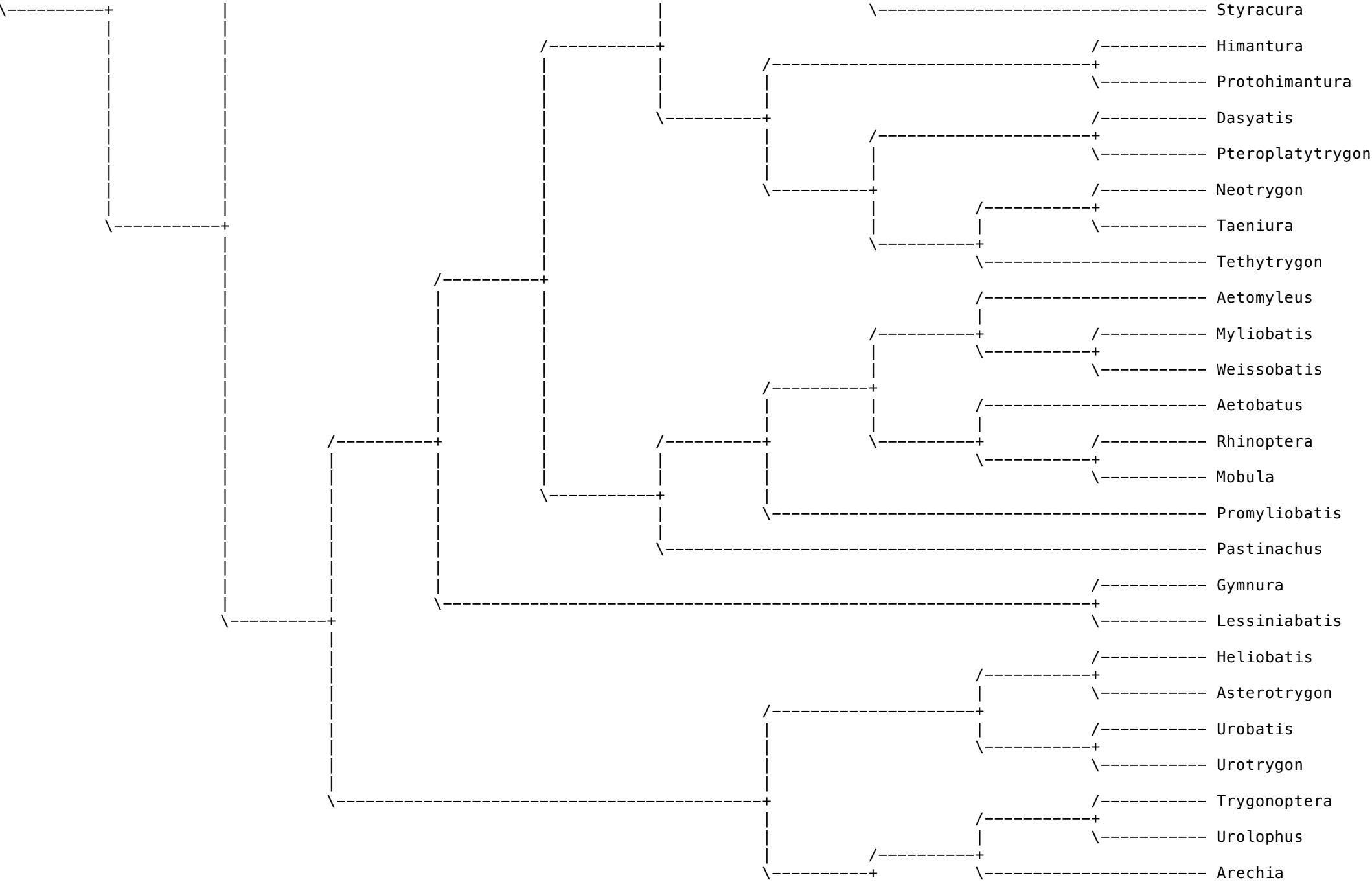
paup> HSearch;

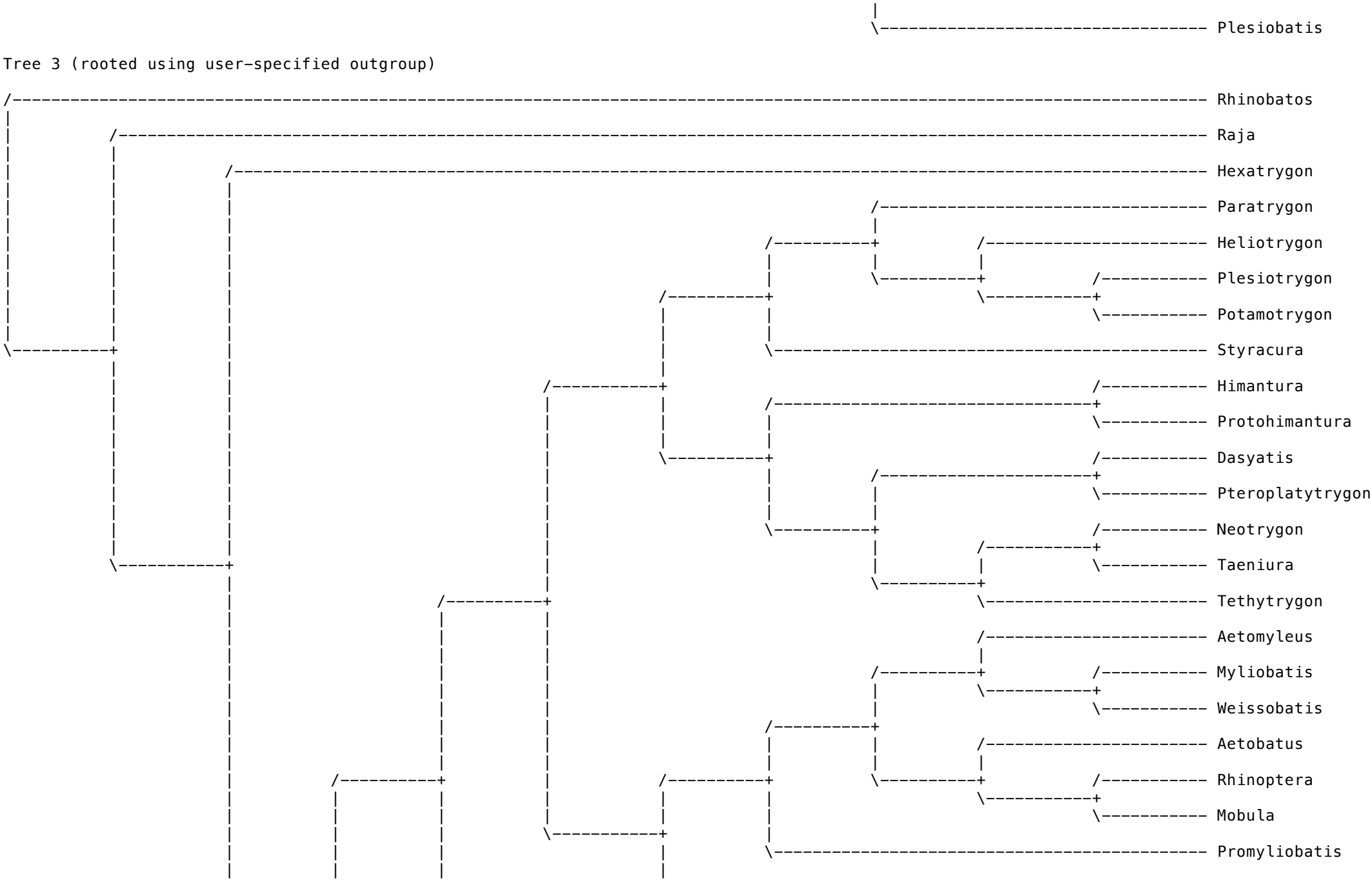
Heuristic search settings:
Optimality criterion = parsimony
Character-status summary:
Of 102 total characters:
All characters are of type 'unord'
All characters have equal weight
3 characters are constant (proportion = 0.0294118)
10 variable characters are parsimony-uninformative
Number of parsimony-informative characters = 89
Gaps are treated as "missing"
Multistate taxa interpreted as uncertainty

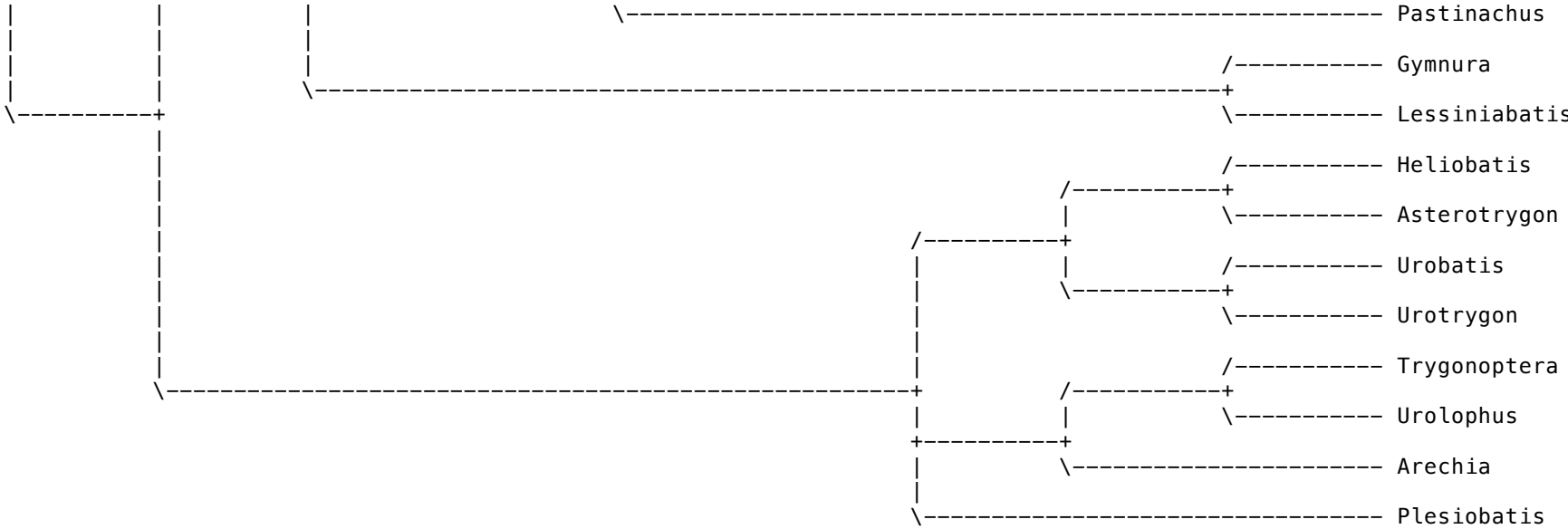


Tree 2 (rooted using user-specified outgroup)

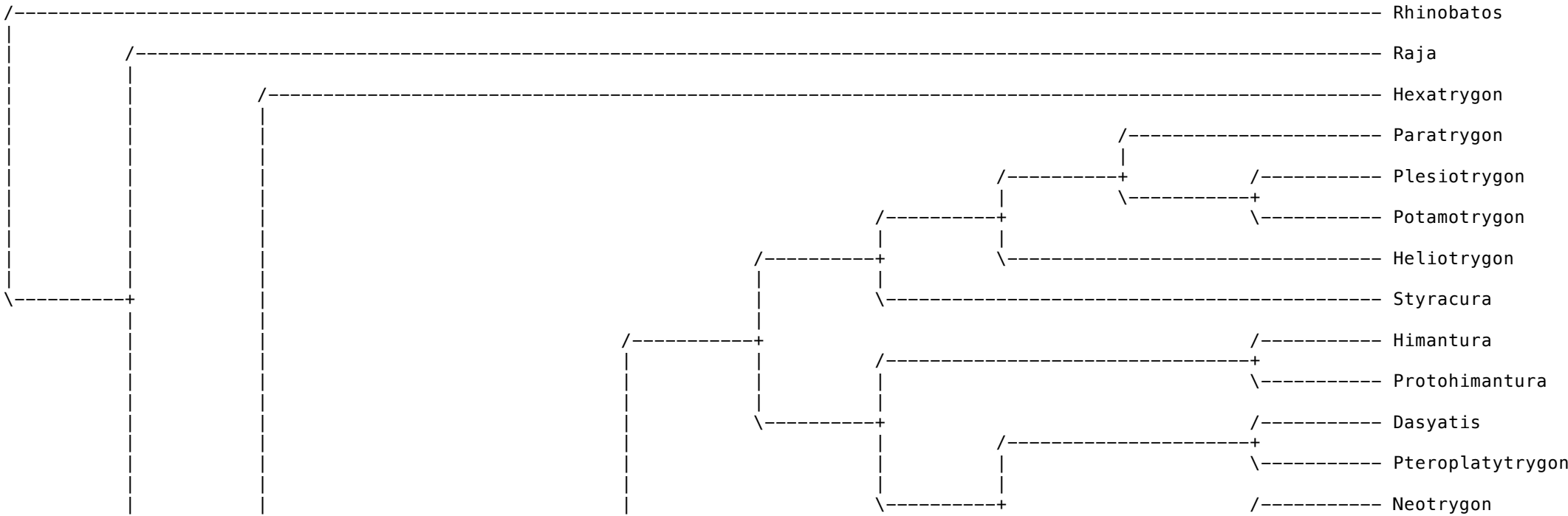


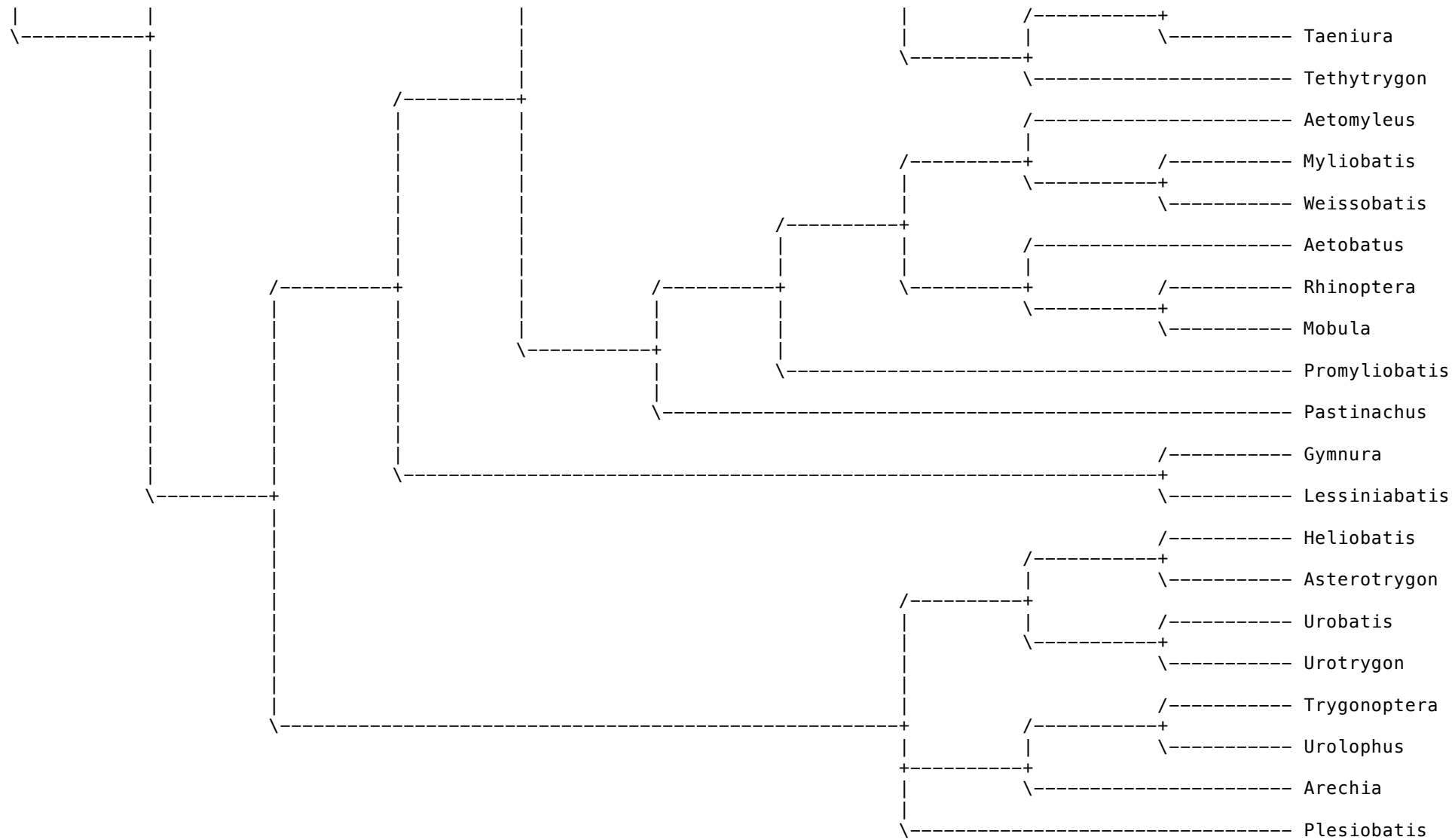




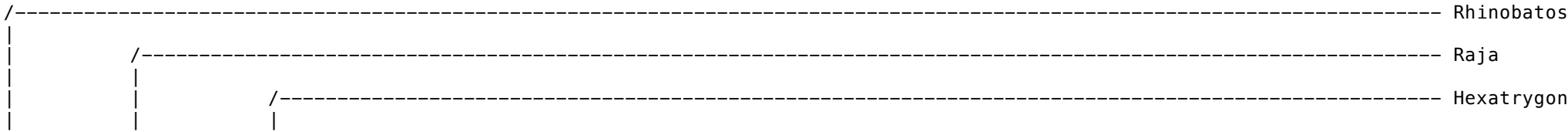


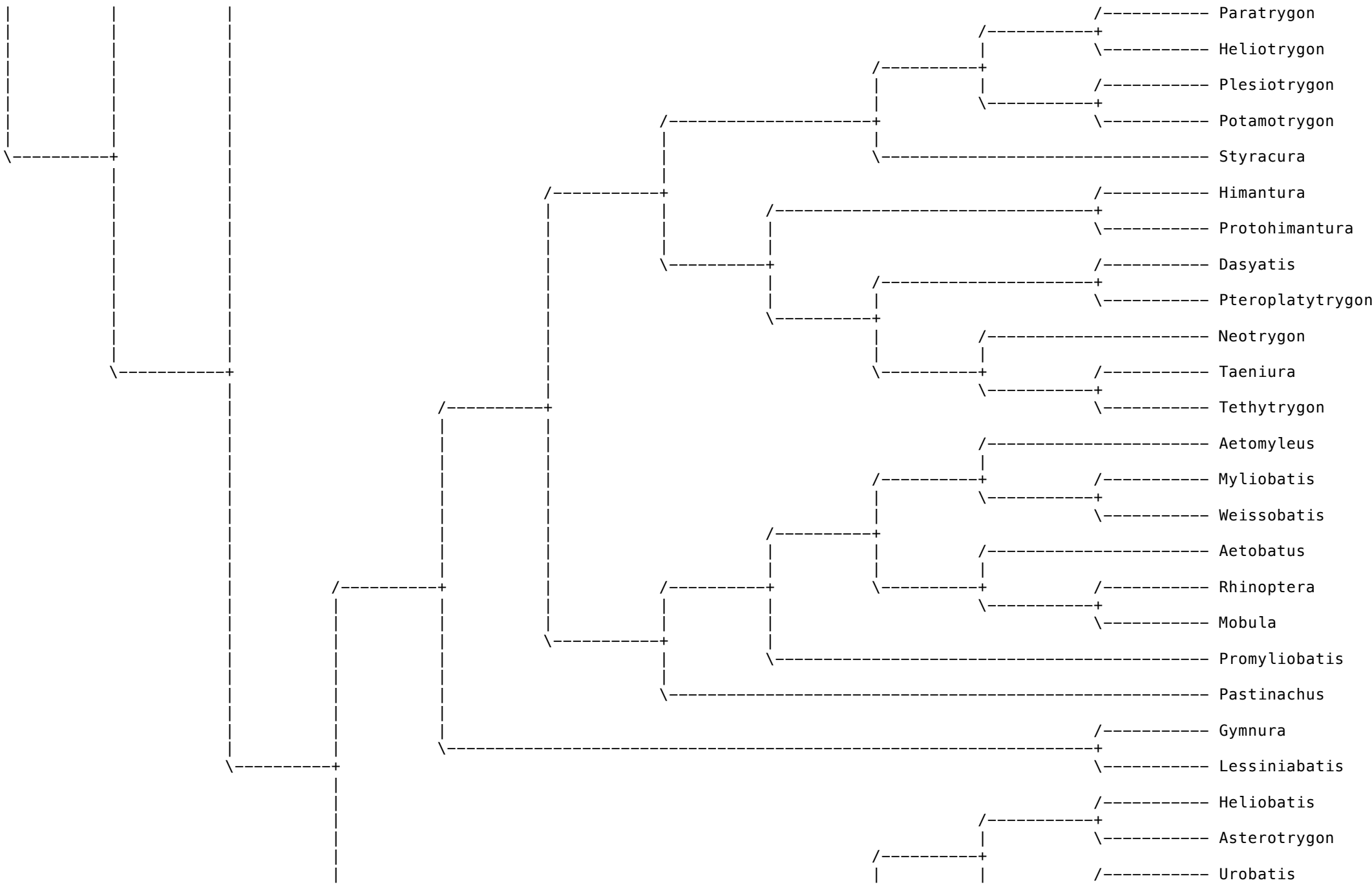
Tree 4 (rooted using user-specified outgroup)

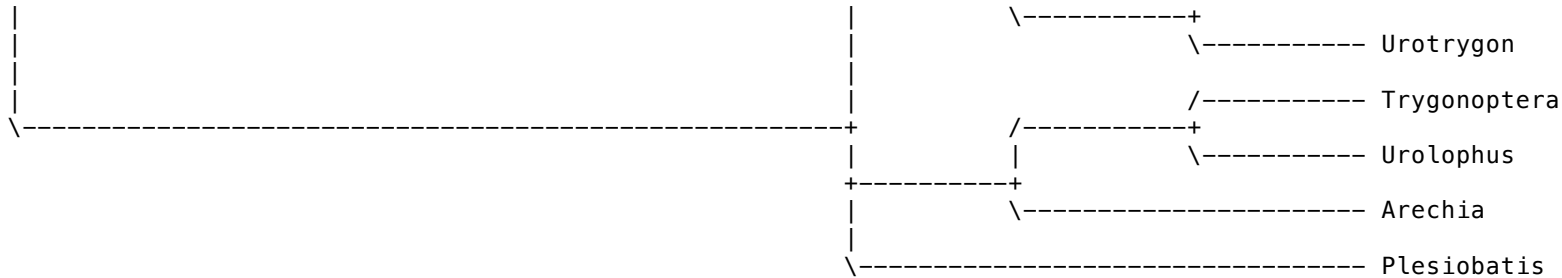




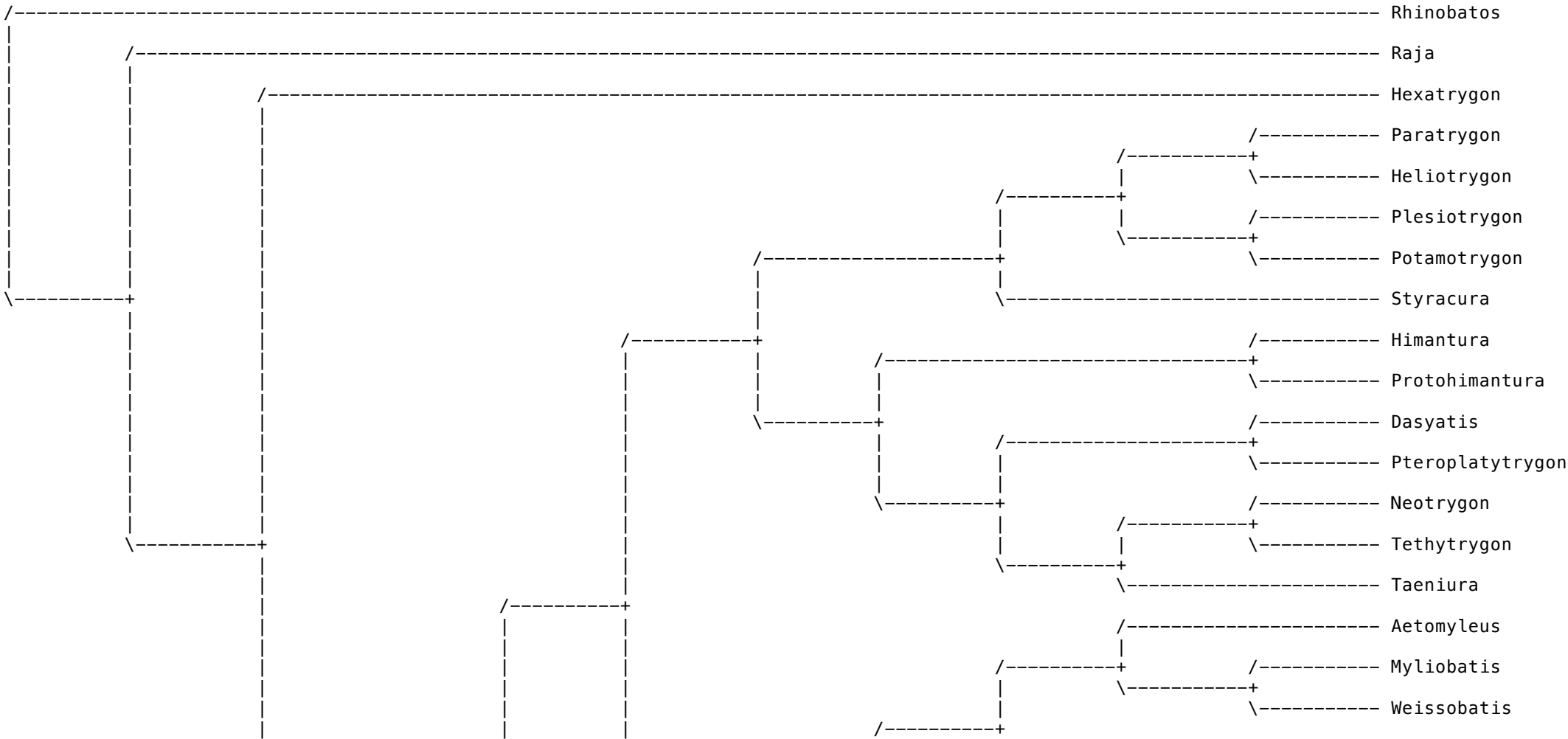
Tree 5 (rooted using user-specified outgroup)

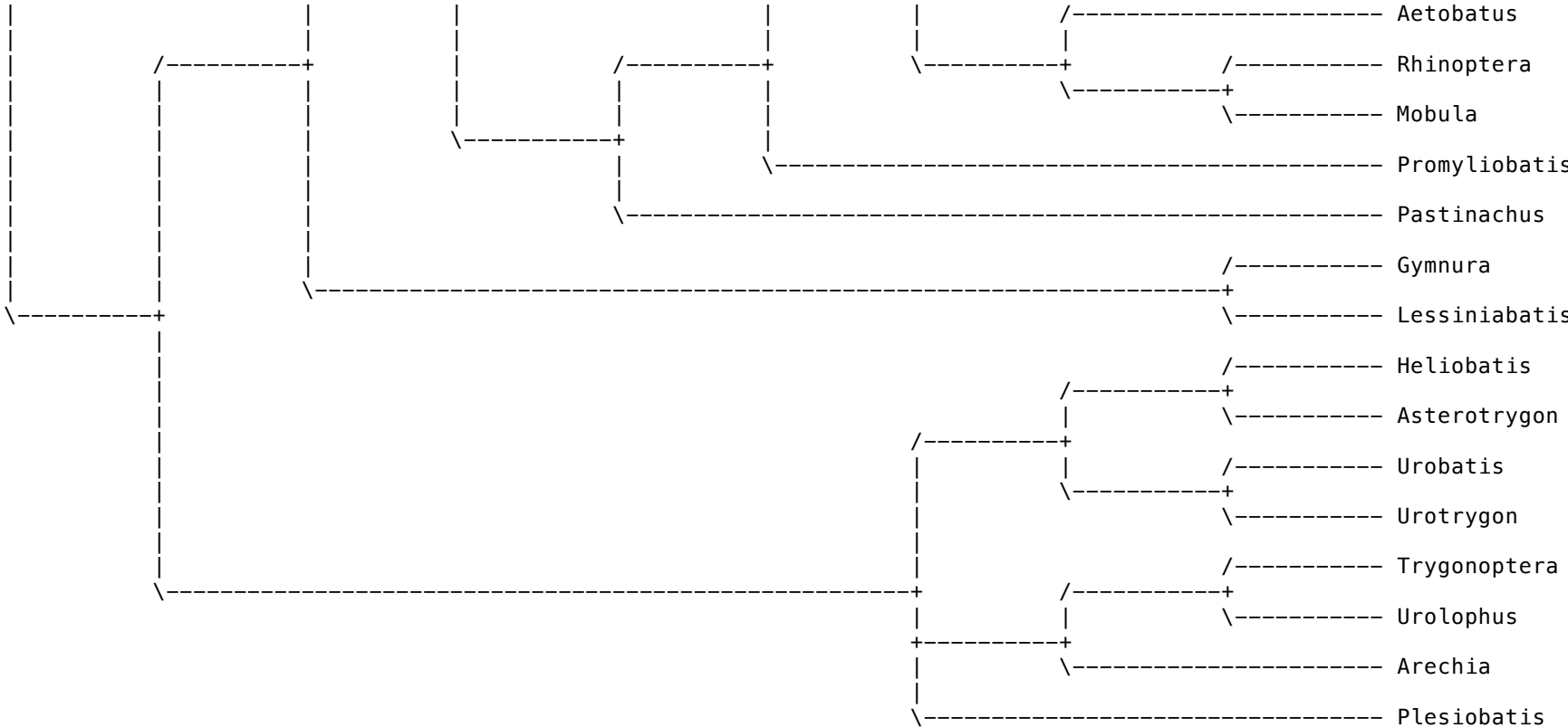




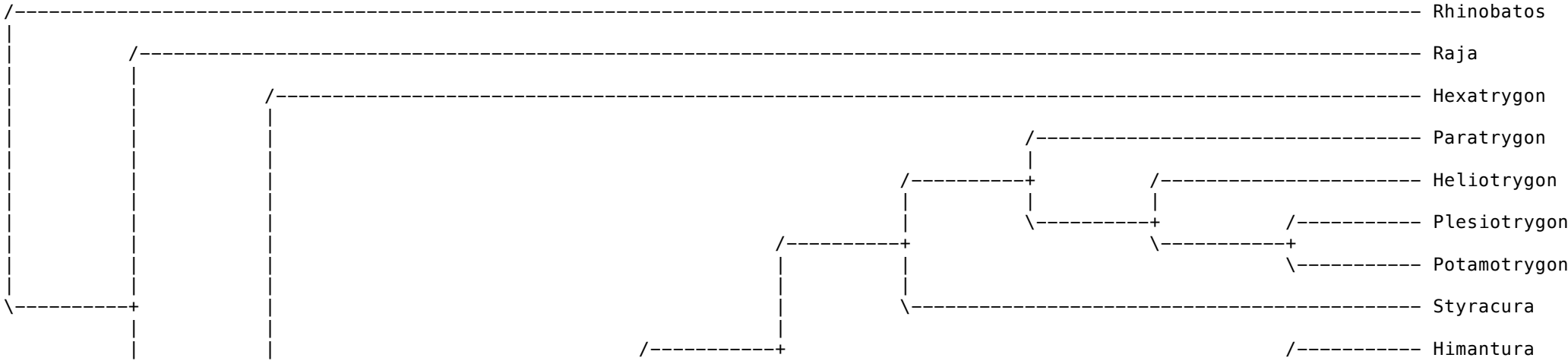


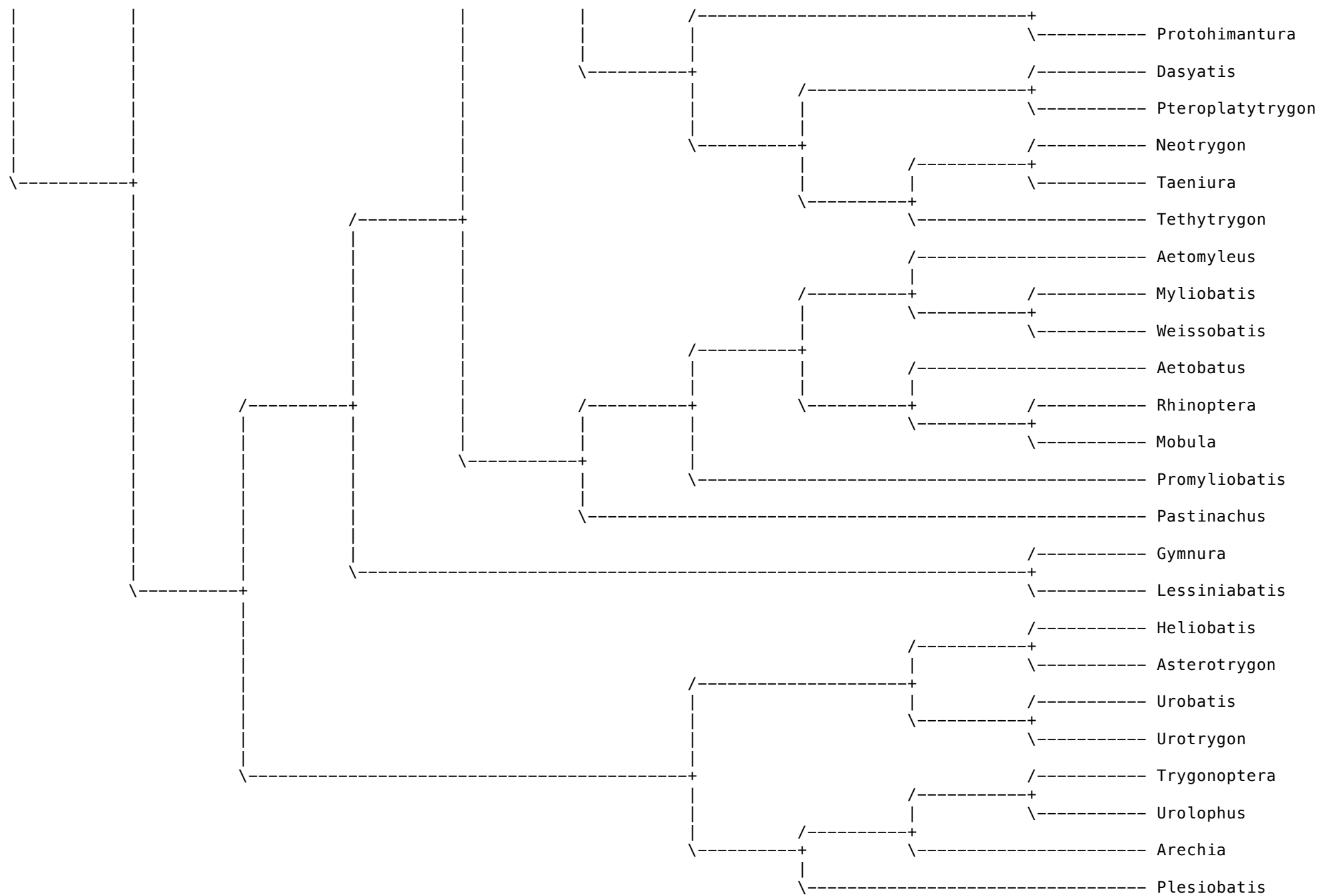
Tree 6 (rooted using user-specified outgroup)



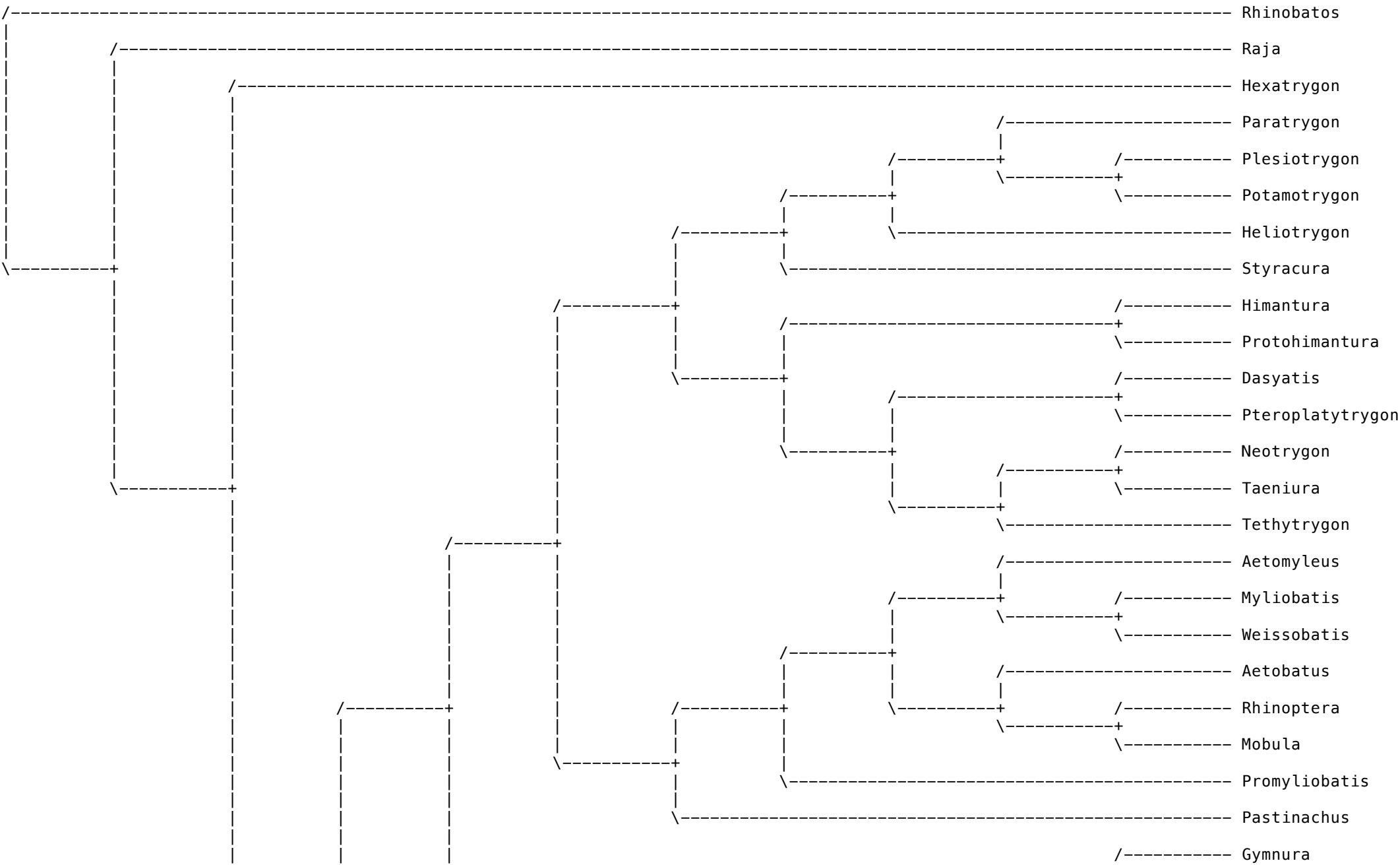


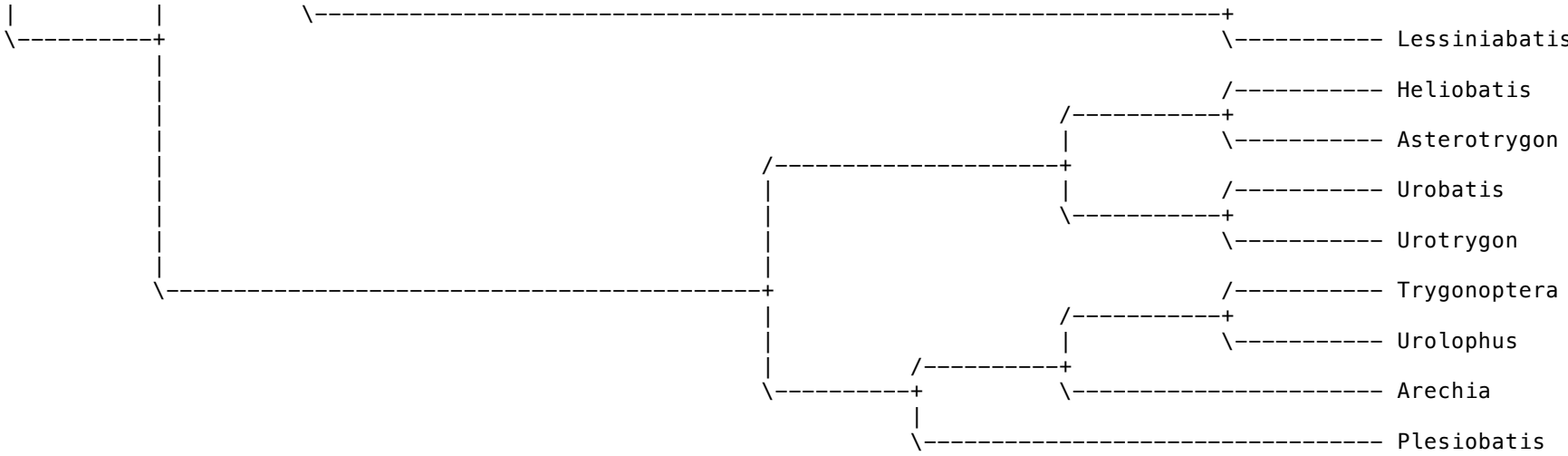
Tree 7 (rooted using user-specified outgroup)



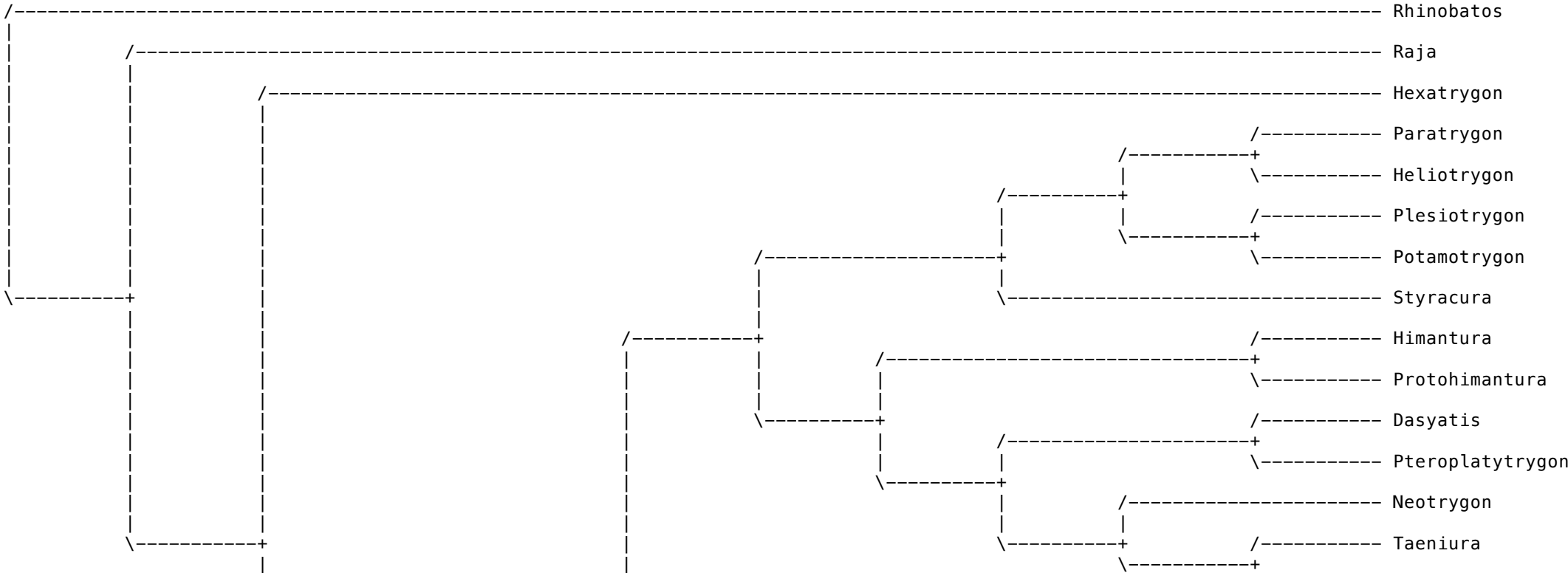


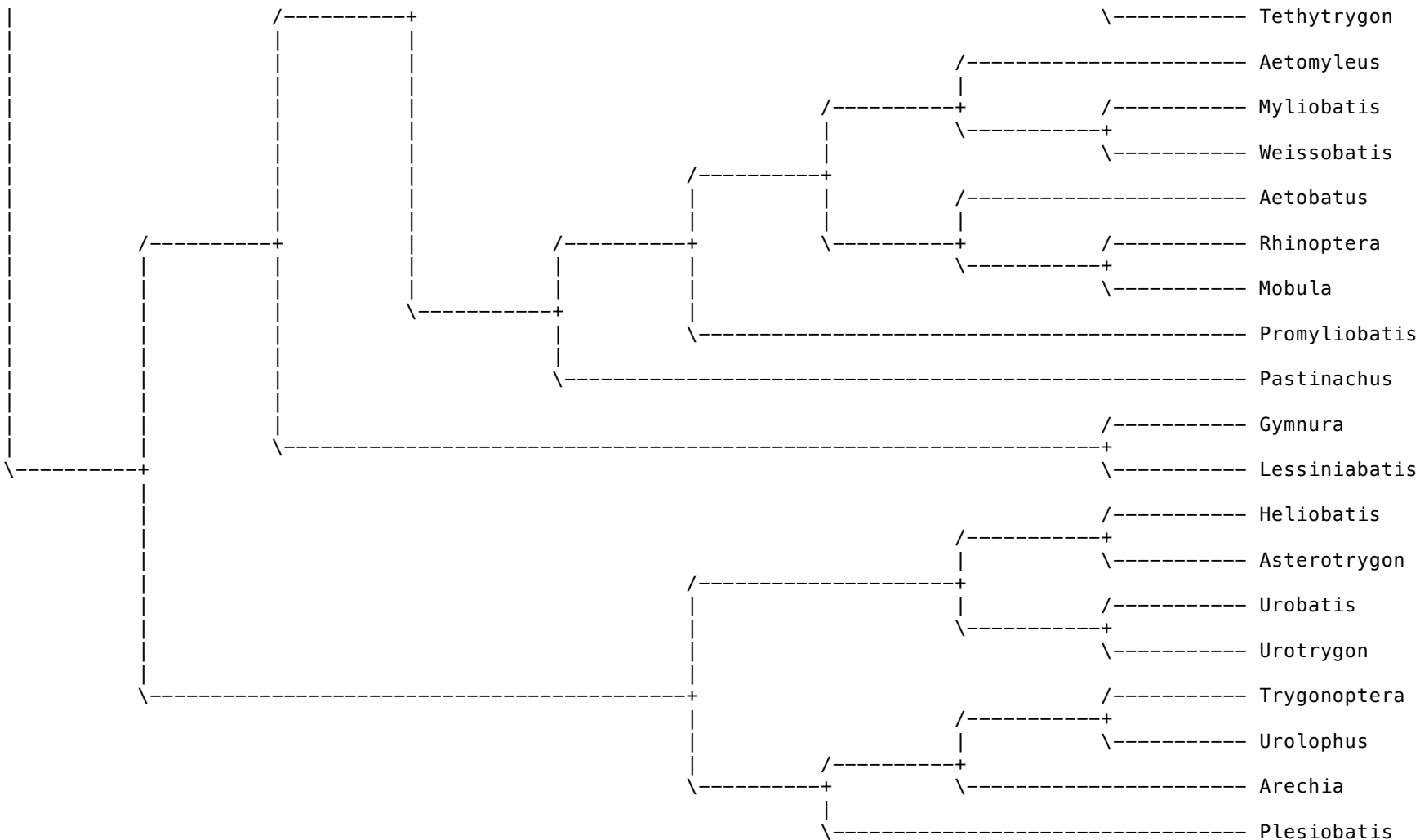
Tree 8 (rooted using user-specified outgroup)



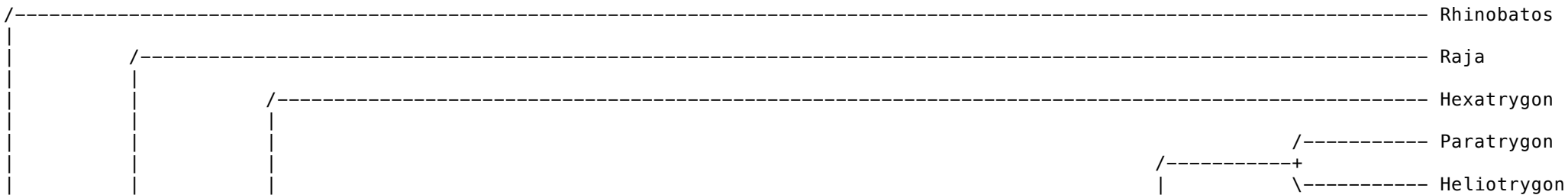


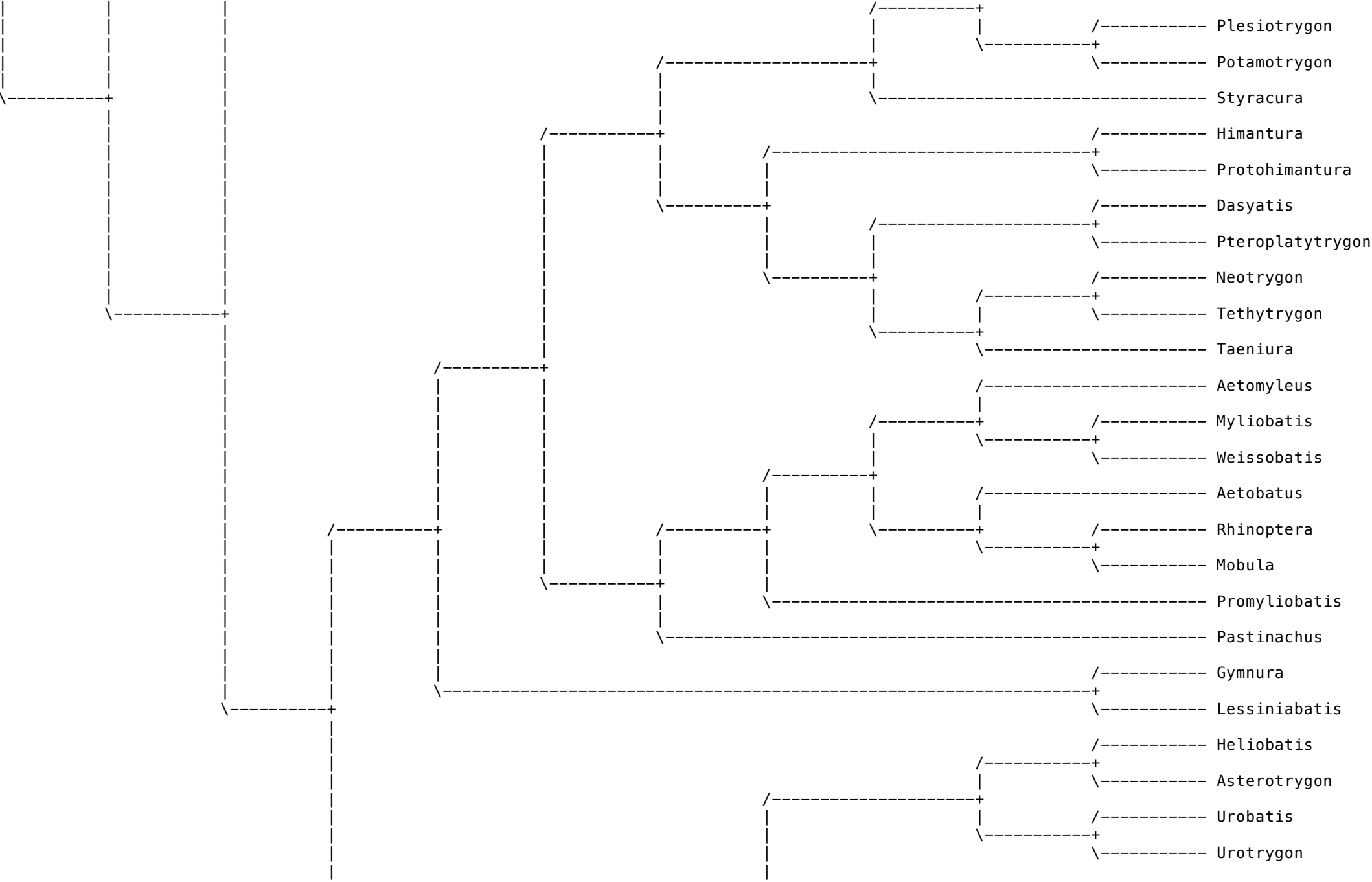
Tree 9 (rooted using user-specified outgroup)

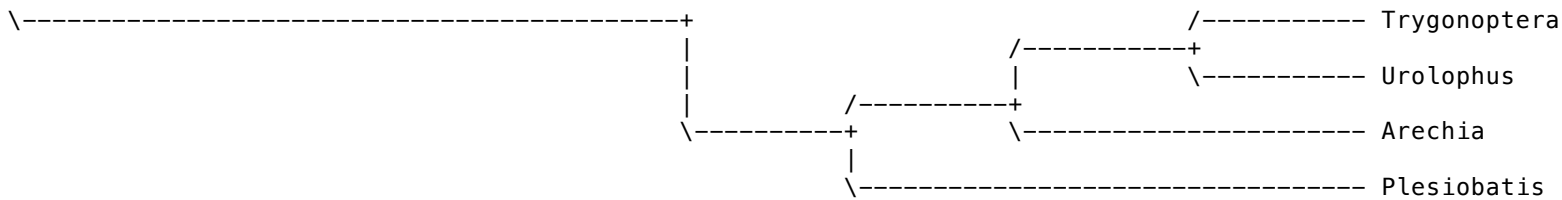




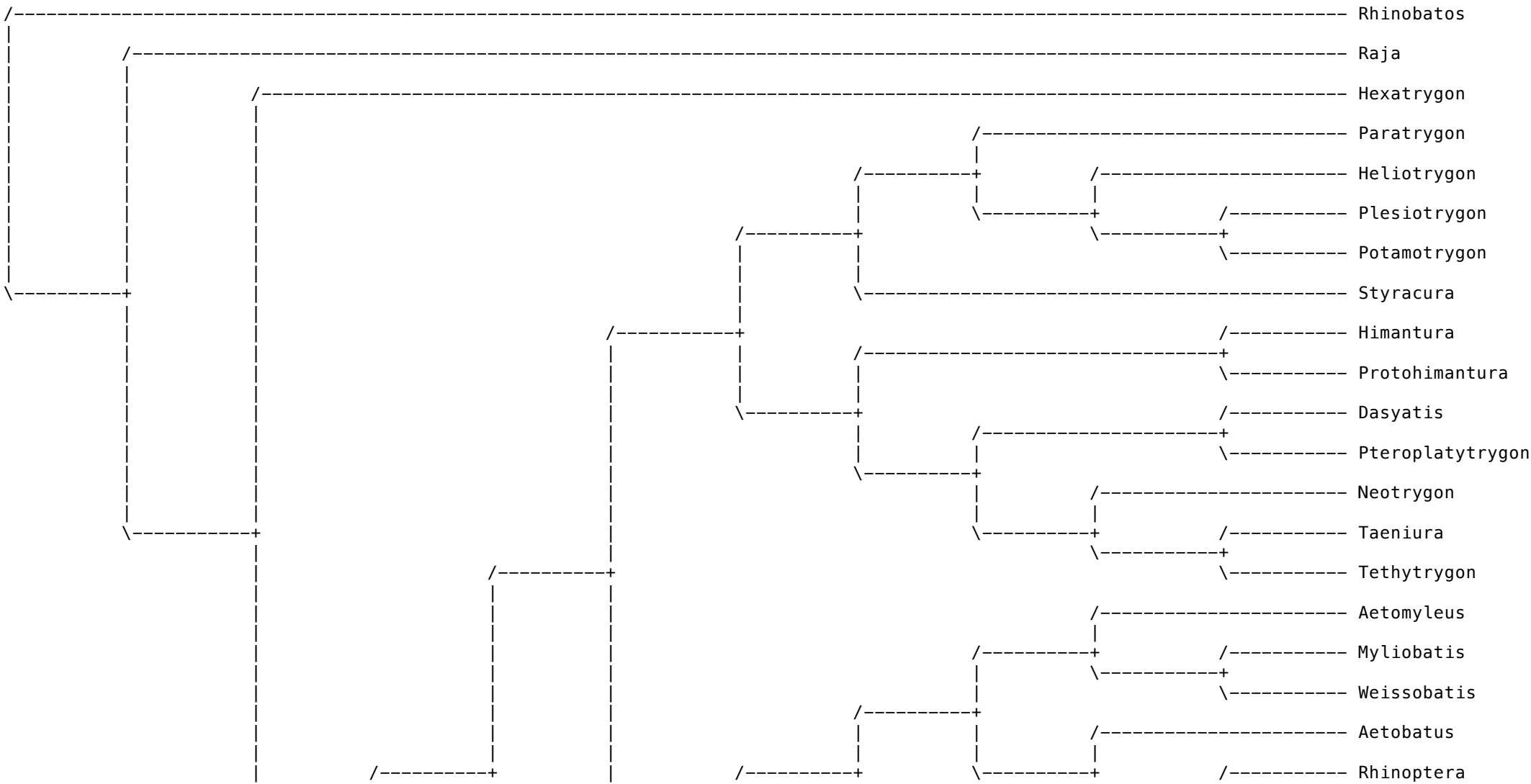
Tree 10 (rooted using user-specified outgroup)

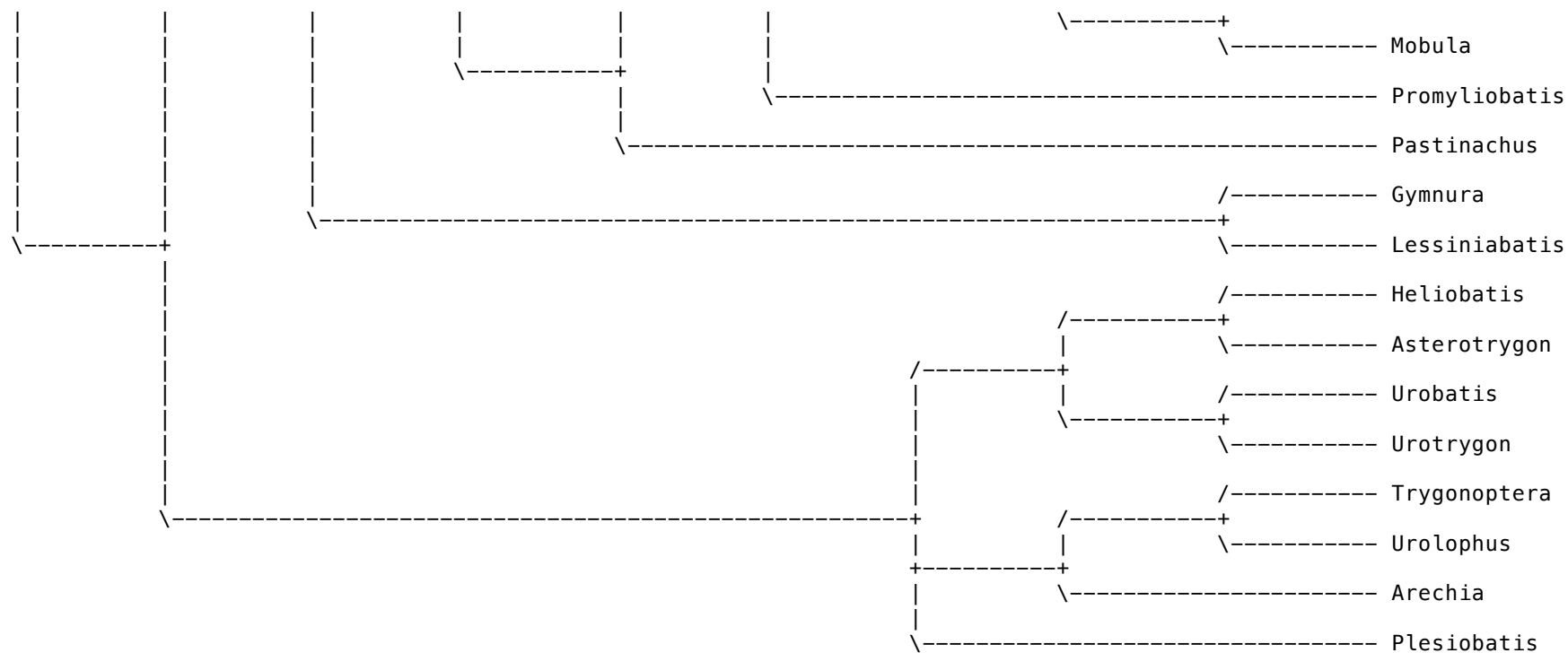




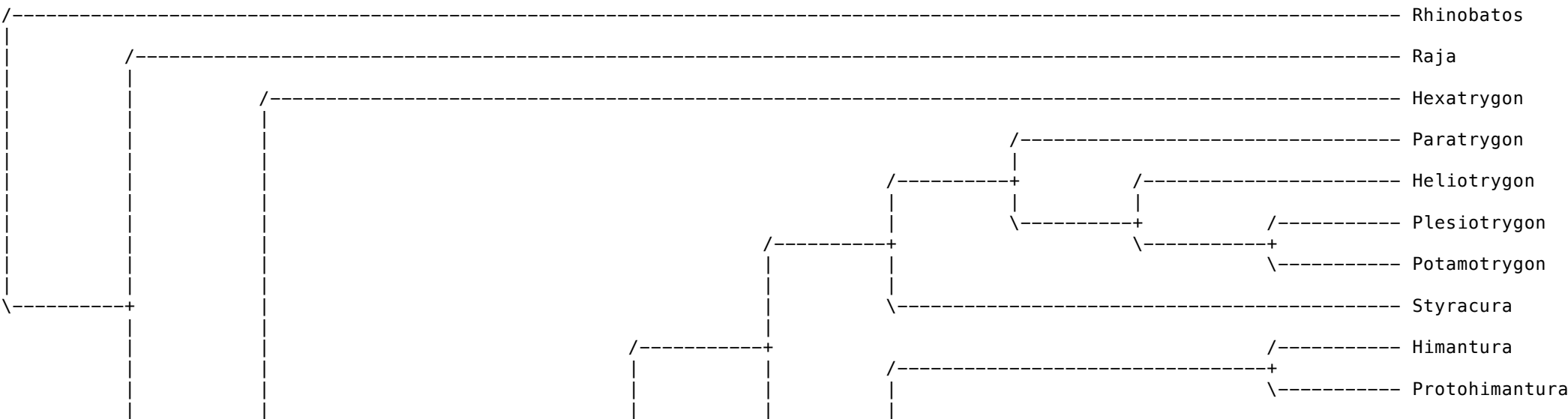


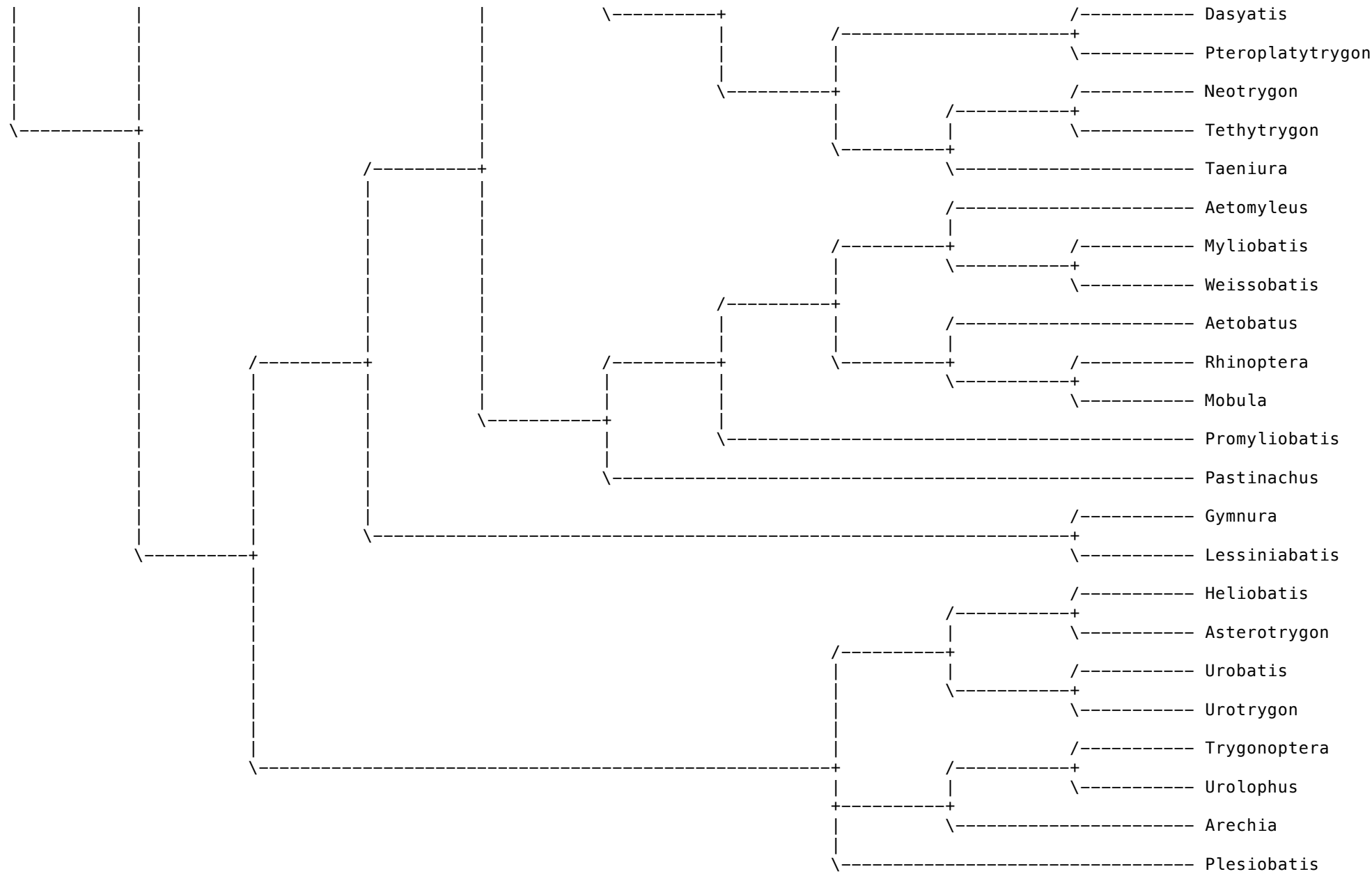
Tree 11 (rooted using user-specified outgroup)





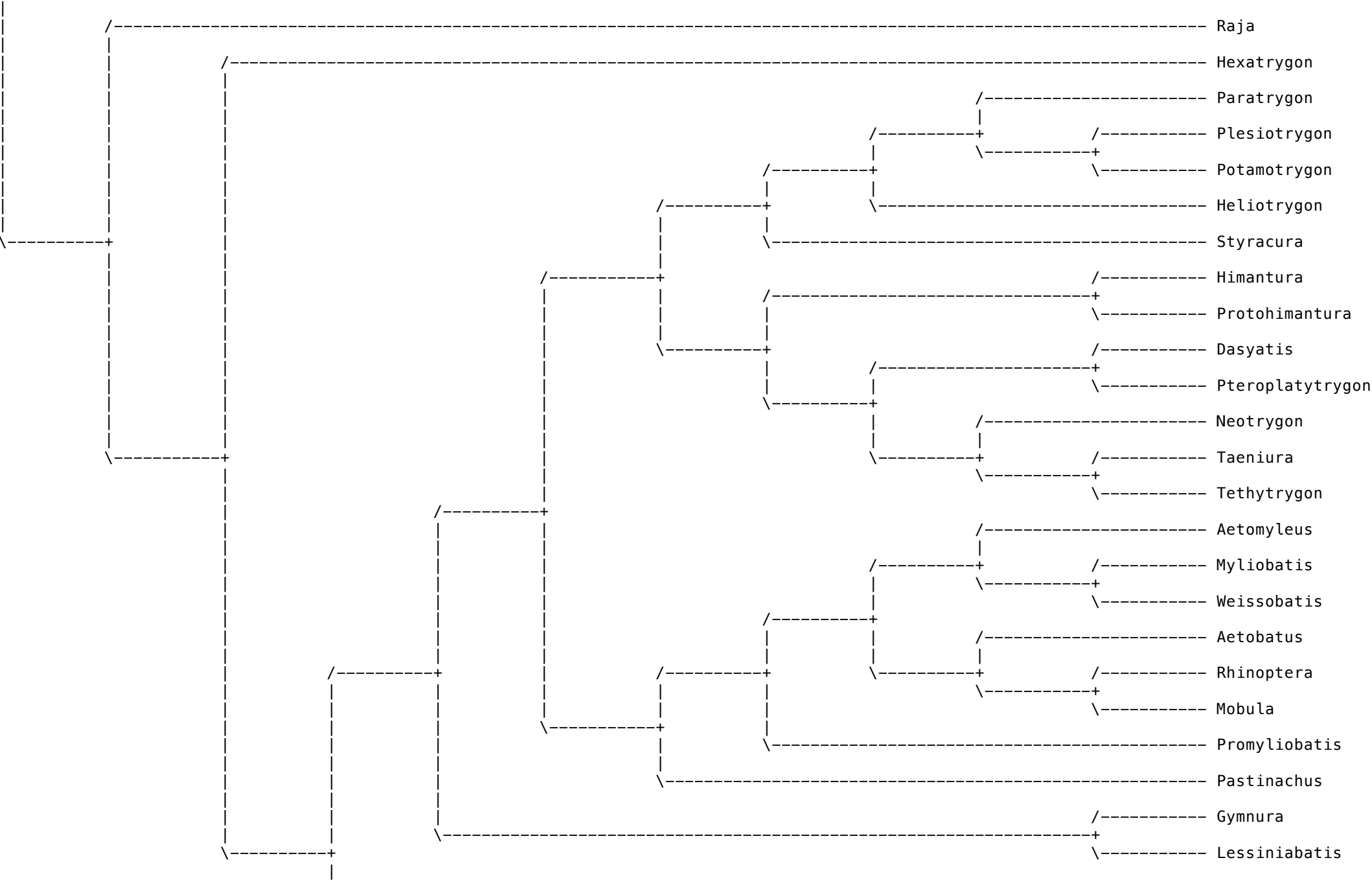
Tree 12 (rooted using user-specified outgroup)

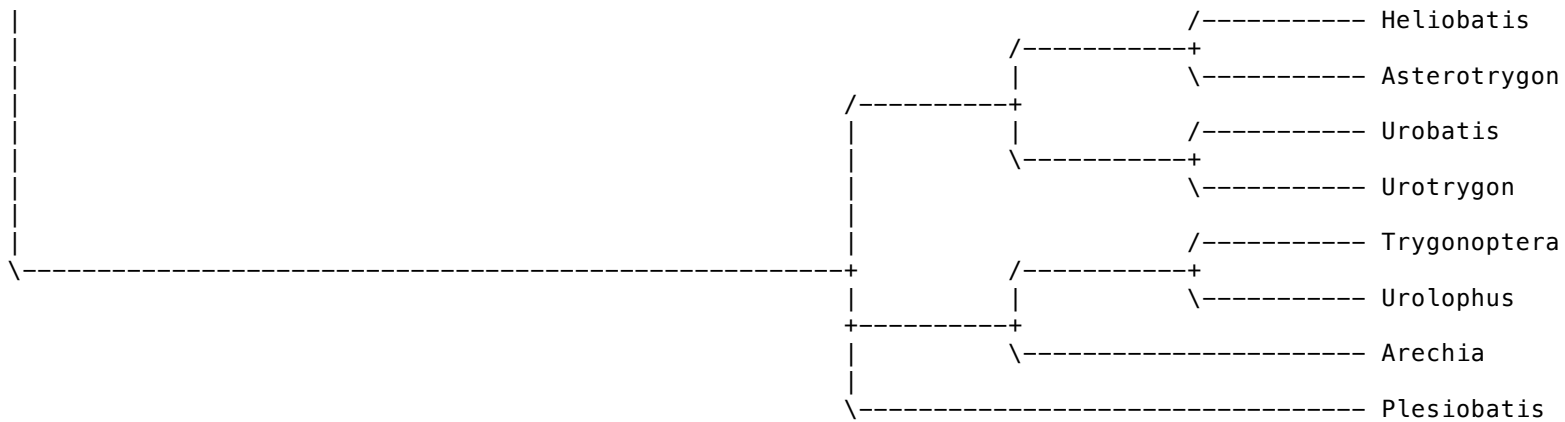




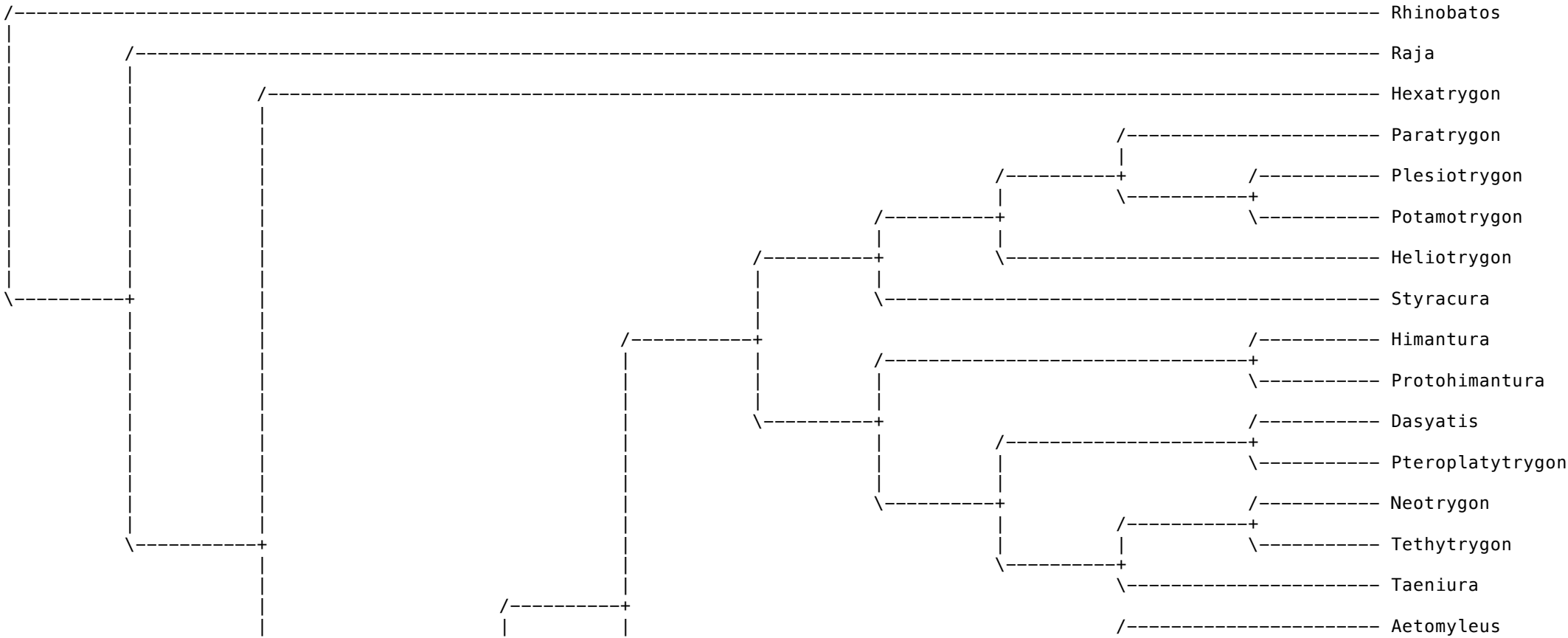
Tree 13 (rooted using user-specified outgroup)

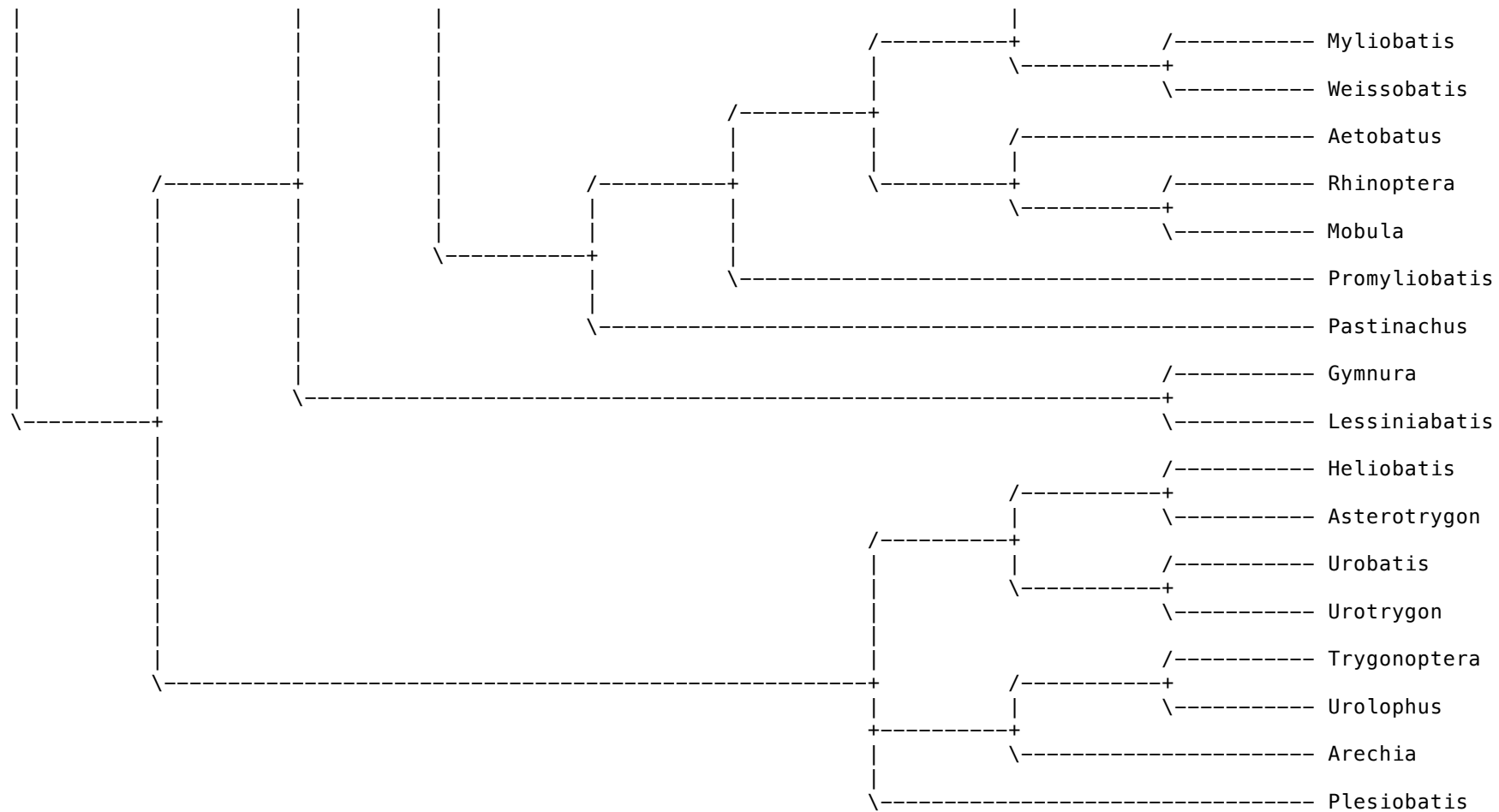
/----- Rhinobatos



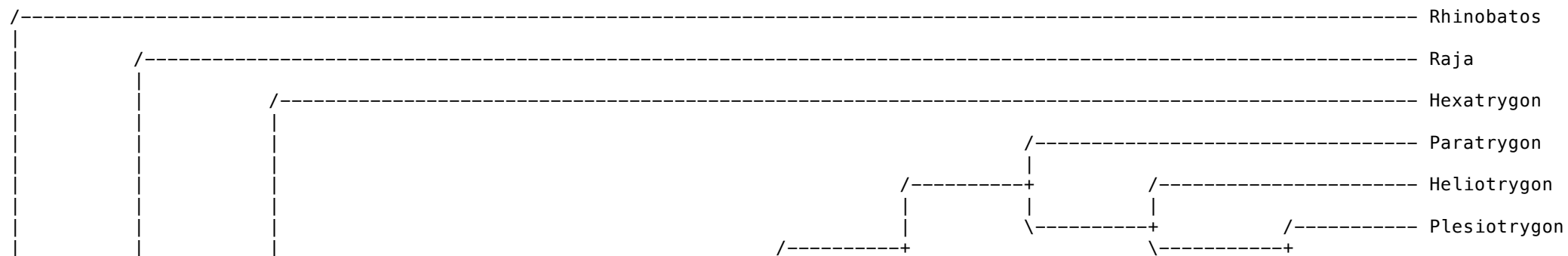


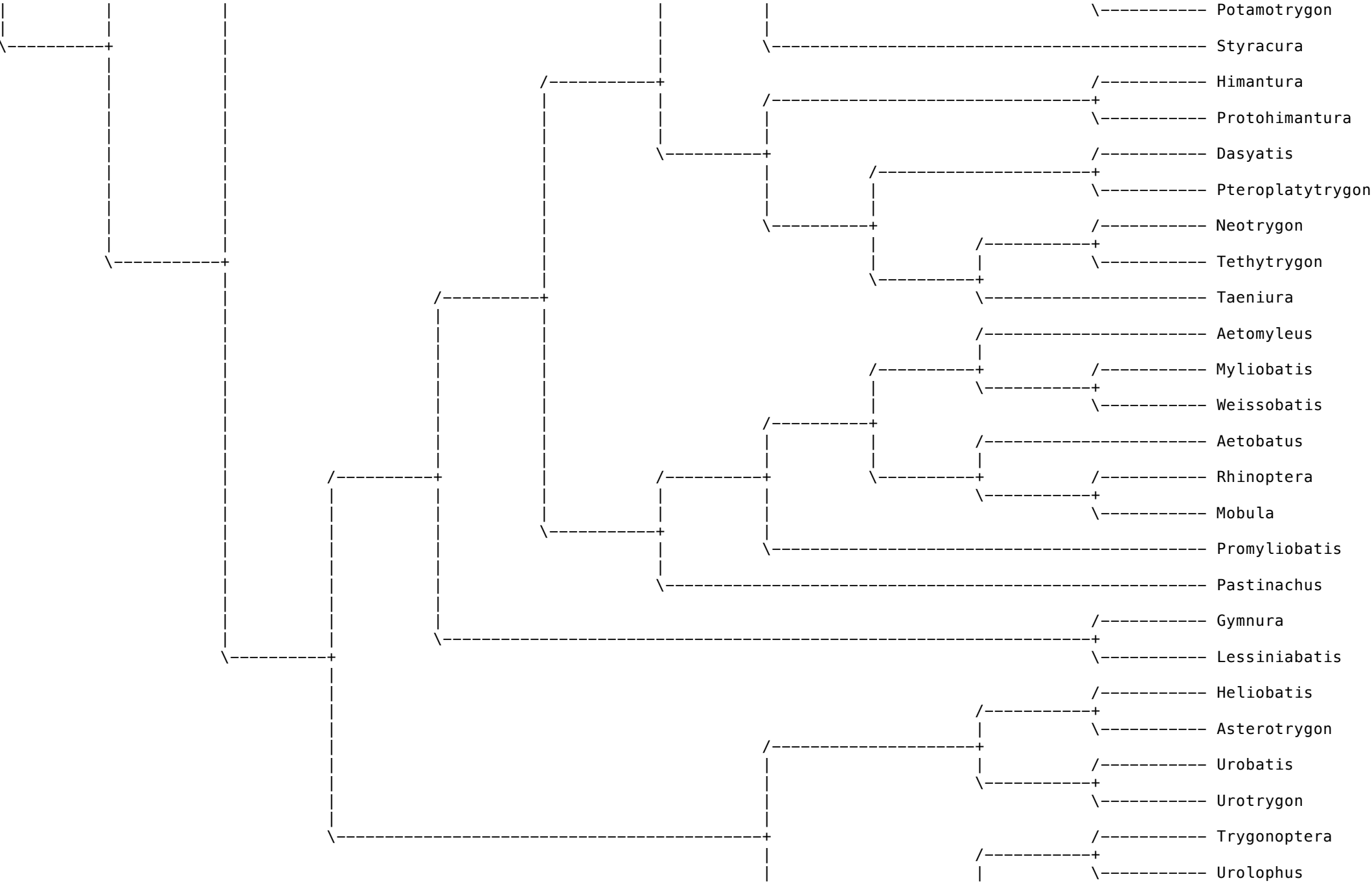
Tree 14 (rooted using user-specified outgroup)

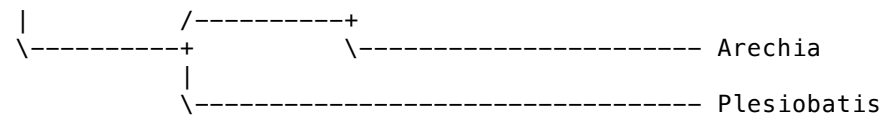




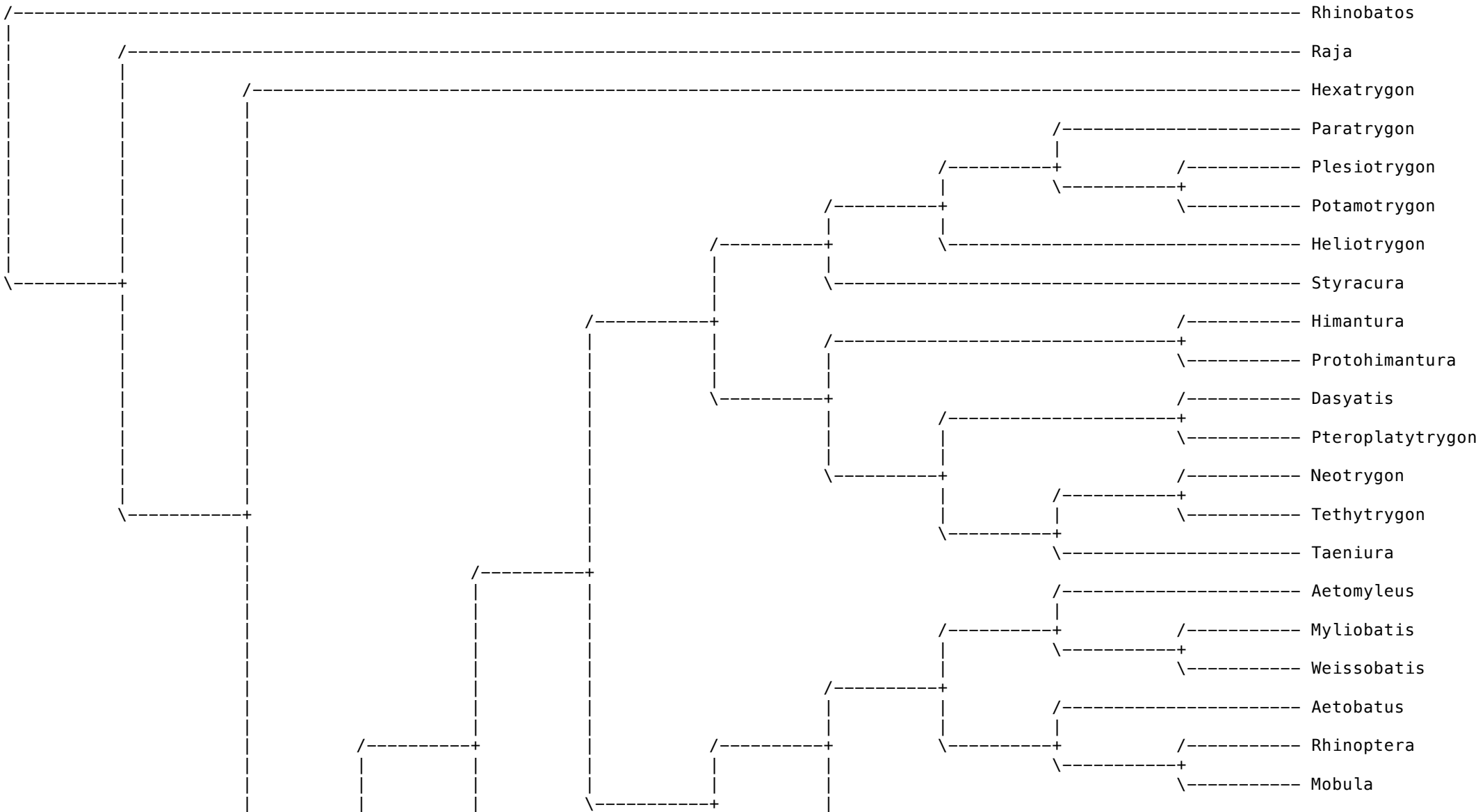
Tree 15 (rooted using user-specified outgroup)

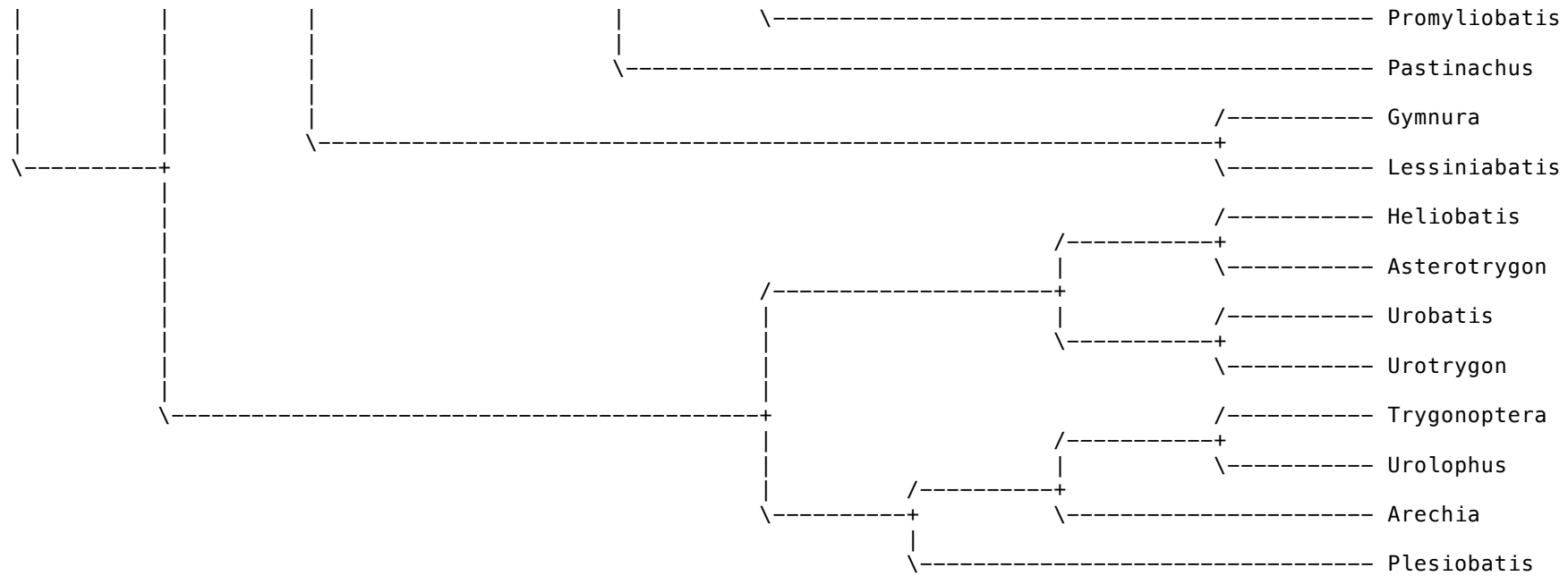




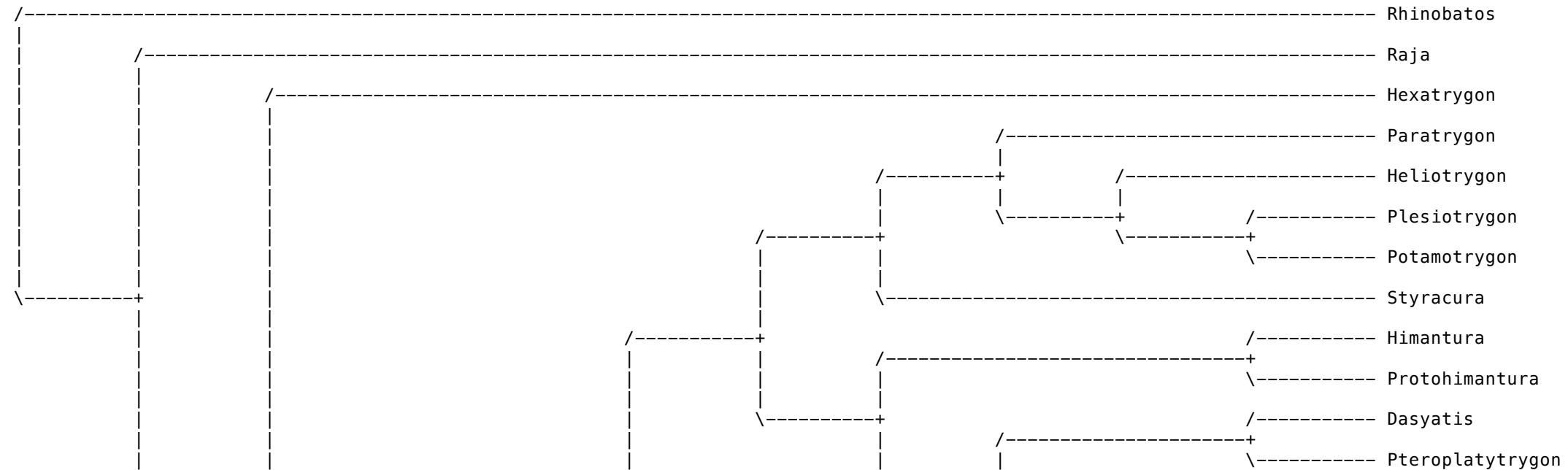


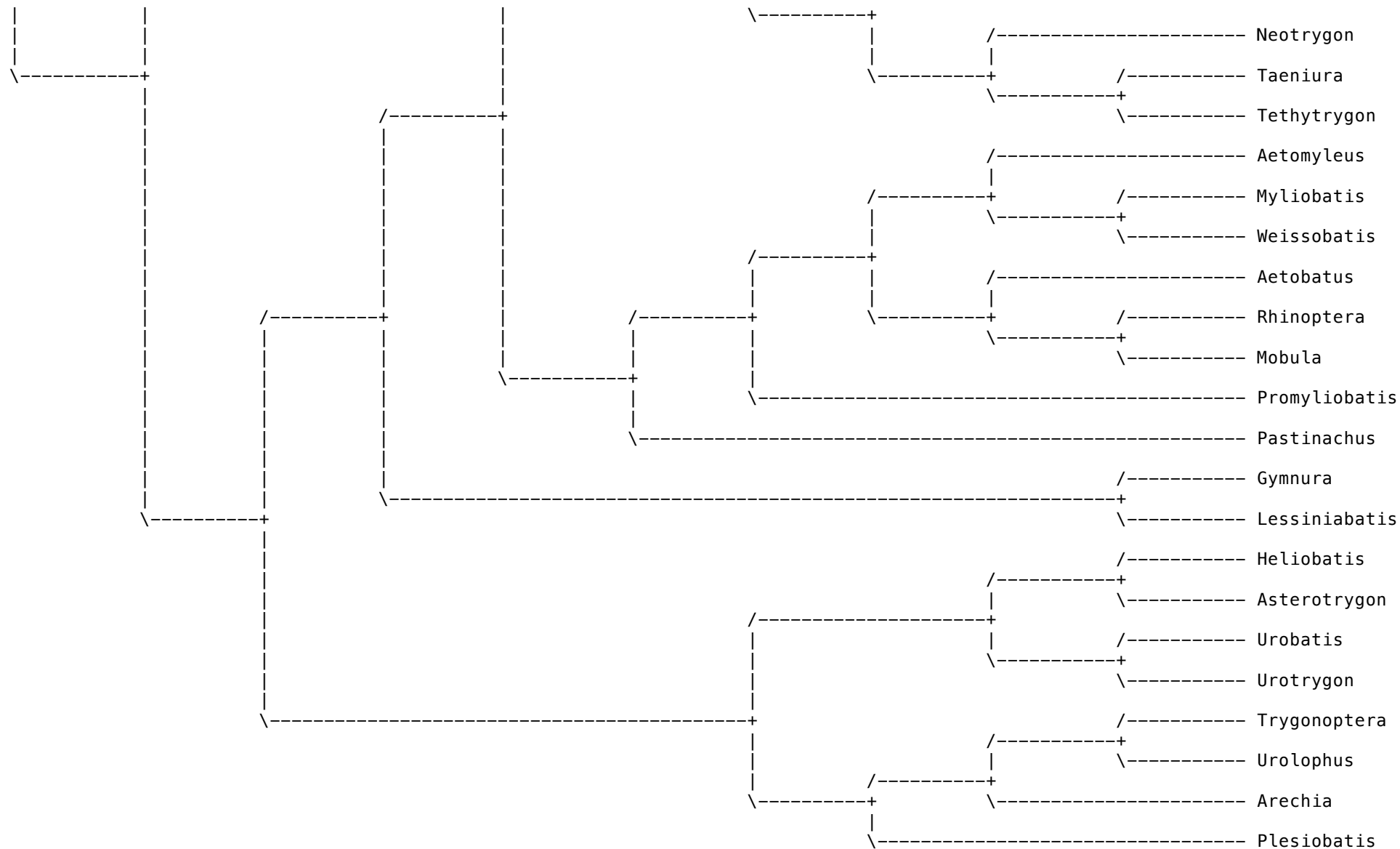
Tree 16 (rooted using user-specified outgroup)



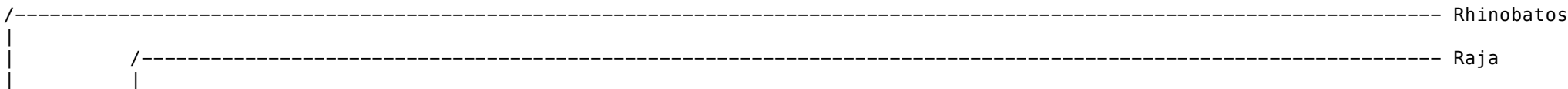


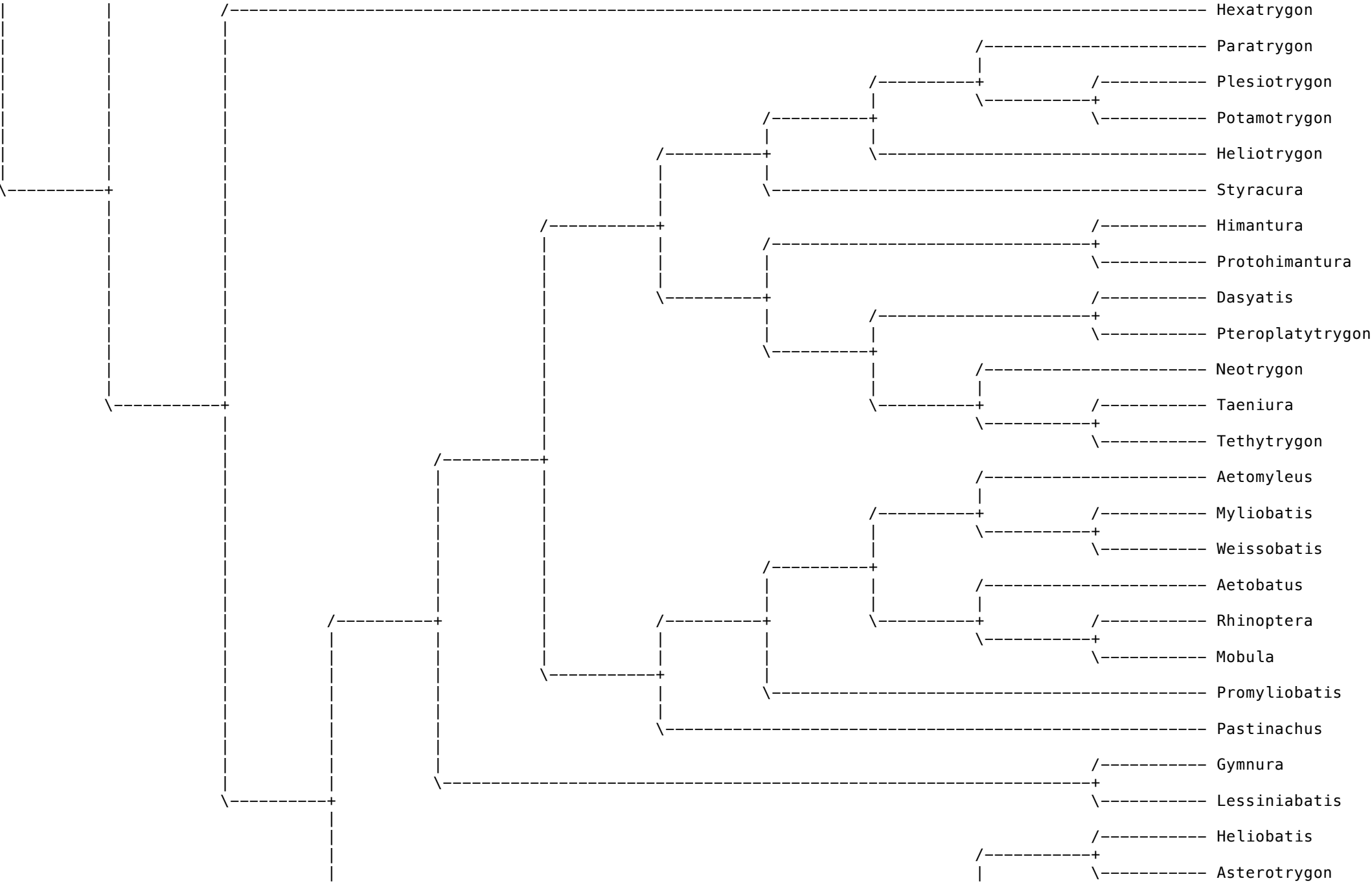
Tree 17 (rooted using user-specified outgroup)

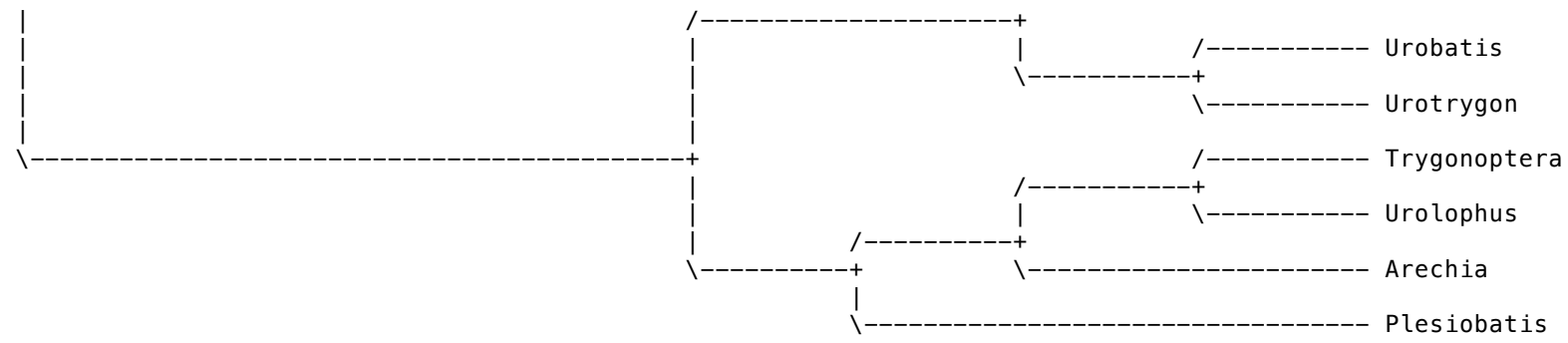




Tree 18 (rooted using user-specified outgroup)







```
paup> Log File='/Users/a535-nbkriwet/Desktop/README.log' start;
```

```
-----NOTICE-----
This is a test version that is still changing rapidly.
It will expire on 1 Aug 2020.

Please report bugs to dave@phylosolutions.com
-----
```

```
#####
#
#           WARNING
#
#   The GUI version of PAUP for Mac will NOT run under
#   MacOS 10.15 (Catalina). Do not upgrade to Catalina
#   if having a GUI version of PAUP* on your Mac is more
#   important to you than having the latest MacOS version!
#
#   I hope to have a 64-bit version sometime in early 2020.
#   Please join the Google Group paup-announce to receive
#   update announcements.
#
#####
```

```
Logging output to file "~/Desktop/README.log".

Current directory set to /Users/a535-nbkriwet/Desktop

paup> Log;

Logging of output to file "README.log" discontinued.

Logging output to file "~/Desktop/README.log".
```