Site-specific time heterogeneity of the substitution process and its impact on the phylogenetic inference

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Supplementary material
### Table S1: Species list by taxon for the mt336 dataset. In parenthesis, the species number. The access number is indicated for each mitochondrial genome.

| actinopterygii (42)                                      | anura (21)                                      |
|--------------------------------------------------------|------------------------------------------------|
| Abudefduf vaigiensis                                   | Alytes obstetricans pertinax                   |
| Astronotus ocellatus                                   | Bombina orientalis                             |
| Neolamprologus brichardi                              | Bombina variegata                              |
| Cymatogaster aggregata                                 | Discoglossus galganoi                          |
| Labracinus cyclophthalmus                              | Xenopus laevis                                 |
| Acanthurus leucosternon                                | Xenopus tropicalis                             |
| Monodactylus argenteus                                 | Pelobates cultripes                            |
| Antigonia capros                                       | Amolops tormotus                               |
| Plectropomus leoparud                                  | Rana nigromaculata                             |
| Lethrinus obsoletus                                    | Limnonectes fujianensis                        |
| Pogonias major                                         | Buergeria buergeri                             |
| Oplegnathus fasciatus                                  | Polypedates megacephalus                       |
| Anarchichas denticulatus                               | Rhacophorus schlegelli                         |
| Percina macrolepidata                                  | Mantella madagascariensis                      |
| Halichoeres melanurus                                  | Kaloula pulchra                                |
| Pseudolabrus sieboldi                                  | Microhyla heymons                              |
| Scomber scombrus                                       | Microhyla ornata                               |
| Thunnus orientalis                                     | Bufo gargarizans                               |
| Carangoides armatus                                    | Bufo melanostictus                             |
| Lates calcarifer                                       | Hyla chinensis                                |
| Chaetodontopinus septentrionalis                       | Hyla japonica                                 |
| Acheilognathus typus                                   |                                           |
| Tinca tinca                                            |                                           |
| Campostoma anomalum                                    |                                           |
| Pseudaspius leptocephalus                              |                                           |
| Zacco sieboldii                                        |                                           |
| Gobio gobio                                            |                                           |
| Hemibarbus barbus                                      |                                           |
| Danio rerio                                            |                                           |
| Labeo senegalensis                                     |                                           |
| Puntius ticto                                          |                                           |
| Crossostoma lacustre                                    |                                           |
| Minytrema melanops                                     |                                           |
| Leptobotia mantschurica                                |                                           |
| Schistura balteata                                     |                                           |
| Pangio anguillaris                                     |                                           |
| Chanos chanos                                          |                                           |
| Grasseichthys gabonensis                               |                                           |
| Chalceus macrolepidotus                                |                                           |
| Pangasianodon gigas                                     |                                           |
| Corydoras rabauti                                      |                                           |
| Eigenmannia sp.                                        |                                           |
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|                                                                |                                           |
|                                        caudata (21)                                          |
| Ambystoma laterale                                      |                                           |
| Lyciasalamandra atifi                                   |                                           |
| Aneides hardii                                          |                                           |
| Desmognathus fuscus                                     |                                           |
| Phaeognathus hubrichti                                  |                                           |
| Ensatina eschscholtzii                                  |                                           |
| Plethodon elongatus                                     |                                           |
| Batrachoseps wightorum                                  |                                           |
| Nototriton abscondens                                   |                                           |
| Eurycea bislineata                                      |                                           |
| Rhyacotriton variegatus                                 |                                           |
| Andrias davidianus                                      |                                           |
| Onychodactylus fischer                                  |                                           |
| Batrachuperus yuenyanensis                              |                                           |
| Pseudohynobius tsinaeni                                 |                                           |
| Salamandra keyserlingii                                 |                                           |
| Hynobius amjensis                                       |                                           |
| Hynobius leechii                                        |                                           |
| Hynobius arisanensis                                    |                                           |
| Pachyhynobius shanxchengensis                           |                                           |
| Ranodon sibiricus                                      |                                           |


### serpentes (13)

| Species                          | Accession Number |
|---------------------------------|------------------|
| Acrochordus granulatus          | NC_007400        |
| Agkistrodon piscivorus          | NC_007968        |
| Ovophis okinavensis             | NC_007397        |
| Deinagkistrodon acutus          | NC_010223        |
| Dinodon semicarinatus           | NC_001945        |
| Pantherophis slowikini          | NC_007969        |
| Enhydra plumbaa                 | NC_010200        |
| Boa constrictor                 | NC_007398        |
| Cylindrophis ruffus             | NC_007401        |
| Python regius                   | NC_007399        |
| Xenopeltis unicolor             | NC_007402        |
| Leptotyphlops dulcis            | NC_005961        |
| Ramphotyphlops braminus         | NC_010196        |

### squamata (20)

| Species                          | Accession Number |
|---------------------------------|------------------|
| Abronia graminea                | NC_005958        |
| Heloderma suspectum             | NC_008776        |
| Shinisaurus crocodilurus        | NC_005959        |
| Iguana iguana                   | NC_002793        |
| Scoloporus occidentalis          | NC_005960        |
| Lacerta viridis viridis         | NC_008328        |
| Takydromus tachydromoides       | NC_008773        |
| Cordylus warreni                | NC_005962        |
| Lepidophyema flavimaculatum     | NC_008775        |
| Plestiodon egregius             | NC_008888        |
| Coleonyx variegatus             | NC_008774        |
| Gekko vittatus                  | NC_008772        |
| Heteronotia binoei              | EF626808         |
| Teratoscincus keyserlingii      | NC_007008        |
| Amphibba schmidt                | NC_006284        |
| Geocalamus acutus               | NC_006285        |
| Diplometopon zarudny            | NC_006283        |
| Bipes biporus                   | AY605481         |
| Bipes canaliculatus             | NC_006288        |
| Bipes tridactylus               | NC_006286        |

### laurasiatheria (37)

| Species                          | Accession Number |
|---------------------------------|------------------|
| Ailuropoda melanoleuca          | EF196663         |
| Tremarctos ornatus              | NC_009969        |
| Ursus arctos                    | NC_003427        |
| Ursus thibetanus                | NC_009971        |
| Ailurus fulgens                 | AM711897         |
| Spilogale putorius              | AM711898         |
| Enhydra lutris                  | NC_009692        |
| Martes melampus                 | NC_009678        |
| Meles meles                     | AM711900         |
| Canis familiaris                | AY729880         |
| Vulpes vulpes                   | NC_008434        |
| Procyon lotor                   | NC_009126        |
| Arctocephalus forsteri          | NC_004023        |
| Zalophus californianus          | NC_008416        |
| Callorhinus ursinus             | NC_008415        |
| Odobenus rosmarus rosmarus      | NC_004029        |
| Erignathus barbatus              | NC_008426        |
| Phoca caspica                   | NC_008431        |
| Monachus schauinslandi          | NC_008421        |
| Mirounga leonina                | NC_008422        |
| Felis catus                     | NC_001700        |
| Neofelis nebulosa               | NC_008450        |
| Herpestes javanicus             | NC_006835        |
| Balaena mysticetus              | AP006472         |
| Balanoptera bonaerensis         | NC_006926        |
| Caperea marginata               | NC_005269        |
| Hyperoodon ampullatus           | NC_005273        |
| Lagenorhynchus albirostris      | NC_005278        |
| Lipotes vexillifer              | NC_007629        |
| Kogia breviceps                 | NC_005272        |
| Bos taurus                      | AF492351         |
| Cervus nippon centralis         | NC_006993        |
| Muntiacus reevesi               | NC_004069        |
| Ovis aries                      | NC_001941        |
| Camelus dromedarius             | NC_009849        |
| Lama pacos                      | AJ566364         |
| Sus scrofa                      | NC_000845        |

### metatheria (24)

| Species                          | Accession Number |
|---------------------------------|------------------|
| Caenolestes fuliginosus         | NC_005828        |
| Rhyncholestes raphanus          | NC_005829        |
| Dactylopsila trivirgata         | NC_008134        |
| Pseudocheirus peregrinus        | NC_006519        |
| Petaurus breviceps              | NC_008135        |
| Distoechurus pennatus           | NC_008145        |
| Tarsipes rostratus              | NC_006518        |
| Lagostrophus fasciatus          | NC_008447        |
| Macropus robustus               | NC_001794        |
| Potorous tridactylus            | NC_006524        |
| Phalanger interpositus          | NC_008137        |
| Trichosurus vulpecula           | NC_003039        |
| Vombatus ursinus                | NC_003322        |
| Dromiciops gliroides            | AJ508402         |
| Echymipera rufescens australis  | NC_007632        |
| Perameles gunnii                | NC_006521        |
| Macrotris lagotis               | NC_006520        |
| Didelphis virginiana            | NC_001610        |
| Thylamys elegans                | NC_005825        |
| Monodelphis domestica           | NC_006299        |
| Dasyurus hallucatus             | NC_007630        |
| Phascogale tapoatafa            | NC_006523        |
| Sminthopsis douglasi            | NC_006517        |
| Notoryctes typhlops             | NC_006522        |
### primates (25)

| Species                        | Accession | \--- | Species                        | Accession |
|--------------------------------|-----------|-----|--------------------------------|-----------|
| Chlorocebus aethiops           | NC_007009|     | Callinectes sapidus            | NC_006281|
| Chlorocebus sabaeus            | EF597503  |     | Portunus trituberculatus       | NC_005037|
| Macaca mulatta                 | NC_005943|     | Pseudocarcinus gigas           | NC_006891|
| Macaca sylvanus                | NC_002764|     | Eriocheir sinensis             | NC_006992|
| Papio hamadryas                | NC_001992|     | Geothelphusa dehaani           | NC_007379|
| Colobus guereza                | NC_006901|     | Pagurus longicarpus            | NC_003058|
| Procolobus badius              | NC_008219|     | Cherax destructor              | NC_011243|
| Nasalis larvatus               | NC_008216|     | Panulirus japonicus            | NC_004251|
| Pygathrix roxellana            | NC_008218|     | Feneropenaeus chiniensis       | NC_009679|
| Pygathrix nemaeus              | NC_008220|     | Penaeus monodon                | NC_002184|
| Presbytis melalophos           | NC_008217|     | Litopenaeus vannamei           | DQ534543 |
| Trachypithecus obscurus        | NC_006900|     | Marsupenaus japonicus          | NC_007010|
| Semnopithecus entellus         | NC_008215|     | Halocaridina rubra             | NC_008413|
| Gorilla gorilla                | NC_001645|     | Macrourachium rosenbergii      | NC_006880|
| Homo sapiens                   | AY195791 |     | Harpiosquillia harpax          | NC_006916|
| Pan troglodytes                | NC_001643|     | Squilla empusa                 | NC_007444|
| Pongo abelii                   | NC_002083|     | Squilla mantis                 | NC_006081|
| Pongo pygmaeus                 | NC_001646|     | Lysiosquillia maculata         | NC_007443|
| Hylobates lar                   | NC_002082|     |                               |           |
| Cebus albifrons                | NC_002763|     |                               |           |
| Daubentonia madagascariensis   | NC_010299|     |                               |           |
| Eulemur mongoz                 | NC_010300|     |                               |           |
| Lemur catta                    | NC_004025|     |                               |           |
| Nycticebus coucang             | NC_002765|     |                               |           |
| Tarsius bancanus               | NC_002811|     |                               |           |

### malacostraca (19)

| Species                        | Accession | \--- | Species                        | Accession |
|--------------------------------|-----------|-----|--------------------------------|-----------|
| Asteropecten polycanthus        | NC_006666|     | Haematobia irritans irritans   | NC_007102|
| Luidia quinaria                | NC_006664|     | Dermatobia hominis             | NC_006378|
| Asterias amurensis             | NC_006665|     | Drosophila melanogaster        | NC_001709|
| Pisaster ochraceus             | NC_004610|     | Drosophila sechellia           | AF200832 |
| Cucumaria miniata              | NC_005929|     | Drosophila yakuba              | NC_001322|
| Arbacia lixula                 | NC_001770|     | Simosyrphus grandicornis       | NC_008754|
| Paracentrotus lividus           | NC_001572|     | Trichophalma punctata          | NC_008755|
| Strongylocentrotus droebachiensis| NC_009940|     | Cydagnostomy duplonotata       | NC_008756|
| Strongylocentrotus purpuratus   | NC_001453|     | Culicoides arakawai            | NC_009809|
| Strongylocentrotus pallidus     | NC_009941|     |                               |           |
| Florometra serratissima         | NC_001878|     |                               |           |
| Phanogenia gracilis            | NC_007690|     |                               |           |
| Gymnocrinus richeri             | NC_007689|     |                               |           |
| Ophiopholis aculeata            | NC_005334|     |                               |           |
| Ophiura lutkeni                | NC_005930|     |                               |           |

### echinodermata (18)

| Species                        | Accession | \--- | Species                        | Accession |
|--------------------------------|-----------|-----|--------------------------------|-----------|
| Acanthaster brevispinus         | NC_007789|     |                               |           |
| Acanthaster planci              | NC_007788|     | Chrysomya putoria              | NC_002697|
| Patiria pectinifera             | NC_001627|     | Cochliomyia hominivorax        | NC_002660|
| Astropecten polyacanthus        | NC_006666|     | Haematobia irritans irritans   | NC_007102|
| Luidia quinaria                | NC_006664|     | Dermatobia hominis             | NC_006378|
| Asterias amurensis             | NC_006665|     | Drosophila melanogaster        | NC_001709|
| Pisaster ochraceus             | NC_004610|     | Drosophila sechellia           | AF200832 |
| Cucumaria miniata              | NC_005929|     | Drosophila yakuba              | NC_001322|
| Arbacia lixula                 | NC_001770|     | Simosyrphus grandicornis       | NC_008754|
| Paracentrotus lividus           | NC_001572|     | Trichophalma punctata          | NC_008755|
| Strongylocentrotus droebachiensis| NC_009940|     | Cydagnostomy duplonotata       | NC_008756|
| Strongylocentrotus purpuratus   | NC_001453|     | Culicoides arakawai            | NC_009809|
| Strongylocentrotus pallidus     | NC_009941|     |                               |           |
| Florometra serratissima         | NC_001878|     |                               |           |
| Phanogenia gracilis            | NC_007690|     |                               |           |
| Gymnocrinus richeri             | NC_007689|     |                               |           |
| Ophiopholis aculeata            | NC_005334|     |                               |           |
| Ophiura lutkeni                | NC_005930|     |                               |           |

### diptera (18)

| Species                        | Accession | \--- | Species                        | Accession |
|--------------------------------|-----------|-----|--------------------------------|-----------|
| Aedes aegypti                  | NC_010241|     |                               |           |
| Aedes albopictus               | NC_006817|     |                               |           |
| Anopheles gambiae              | NC_002084|     |                               |           |
| Anopheles quadrimaculatus A    | NC_000875|     |                               |           |
| Bactrocera carambolae          | NC_009772|     |                               |           |
| Bactrocera oleae               | NC_005333|     |                               |           |
| Ceratitis capitata             | NC_000857|     |                               |           |
| Chrysomya putoria              | NC_002697|     |                               |           |
| Cochliomyia hominivorax        | NC_002660|     |                               |           |
| Drosophila yakuba              | NC_001322|     |                               |           |
| Drosophila sechellia           | AF200832 |     |                               |           |
| Haematobia irritans irritans   | NC_007102|     |                               |           |
| Dermatobia hominis             | NC_006378|     |                               |           |
| Drosophila melanogaster        | NC_001709|     |                               |           |
| Fenticynychus grandicornis     | NC_008754|     |                               |           |
| Flucypterus punctata           | NC_008755|     |                               |           |
| Cydagnostomy duplonotata       | NC_008756|     |                               |           |
| Callicoides arakawai           | NC_009809|     |                               |           |
### crocodylidae (11)

| Species                           | Accession   |
|----------------------------------|-------------|
| Alligator mississippiensis       | NC_001922   |
| Alligator sinensis               | NC_004448   |
| Caiman crocodilus                | NC_002744   |
| Paleosuchus palpebrosus          | AM493870    |
| Paleosuchus trigonatus           | NC_009732   |
| Crocodylus niloticus             | NC_008142   |
| Crocodylus porosus               | NC_008143   |
| Crocodylus siamensis             | NC_008795   |
| Crocodylus siamensis             | EF581859    |
| Osteolaemus tetraspis            | NC_009728   |
| Gavialis gangeticus              | NC_008241   |

### porifera (17)

| Species                           | Accession   |
|----------------------------------|-------------|
| Amphimedon compressa             | NC_010201   |
| Amphimedon queenslandica         | NC_008944   |
| Callyspongia plicifera           | NC_010206   |
| Xestospongia muta                | NC_010211   |
| Axinella corrugata               | NC_006894   |
| Iotrochota birotulata            | NC_010207   |
| Negombata magnifica              | NC_010171   |
| Rhabdocalyptus dawsoni           | NC_009627   |
| Tethya actinia                   | NC_006991   |
| Topsentia ophiraphidites         | NC_010204   |
| Geodia neptuni                   | NC_006990   |
| Ephydatia mueller                | NC_010202   |
| Aplysina fulva                   | NC_010203   |
| Chondrilla aff. Nucula CHOND     | NC_010208   |
| Halisarca dujardini              | NC_010212   |
| Oscarella carmela                | NC_009090   |
| Plakortis angulospiculatus       | NC_010217   |

### cnidaria (15)

| Species                           | Accession   |
|----------------------------------|-------------|
| Acropora tenuis                  | NC_003522   |
| Montipora cactus                 | NC_006902   |
| Agaricia humilis                 | NC_008160   |
| Siderastrea radians              | NC_008167   |
| Porites porites                  | NC_008166   |
| Rhodactis sp.CASIZ.171755        | NC_008158   |
| Astrangia sp.JVK.2006            | NC_008161   |
| Colpophyllia natans              | NC_008162   |
| Montastrea franksi               | NC_007225   |
| Pocillopora eydouxi              | NC_009798   |
| Seriatopora caliendrum           | NC_010245   |
| Chrysopathes formosa             | NC_008411   |
| Metridium senile                 | NC_00933    |
| Nematostella sp.JVK.2006         | NC_008164   |
| Savalia savaglia                 | NC_008827   |
Table S2: Species list by taxon for the nuc80 dataset. In parenthesis, the species number.

| annelids and molluscs (16)                | arthropoda (21)                      | deuterostomia (18)                     |
|-----------------------------------------|--------------------------------------|----------------------------------------|
| Chaetopterus sp                        | Lepeoptheirus salmonis               | Xenoturbella bocki                     |
| Platyneres dumerilii                   | Litopenaeus vannamei                 | Saccoglossus kowalevskii              |
| Tubifex tubifex                        | Petrolisthes cinctipes               | Ptychodera flava                      |
| Lumbricus rubellus                     | Carcinus maenas                      | Strongylocentrotus purpuratus         |
| Hirudo medicinalis                     | Daphnia pulex                        | Asterina pectinifera                  |
| Helobdella robusta                    | Artemia franciscana                  | Branchiostoma floridae                |
| Capitella sp i ecs-2004                | Onychirus arcticus                   | Molgula tectiformis                   |
| Euprymna scolopes                     | Pediculus humanus                    | Halocynthia roretzi                   |
| Venerupis decussatus                   | Rhodnius prolixus                    | Ciona savignyi                        |
| Crassostrea gigas                     | Nilaparvata lugens                   | Ciona intestinalis                    |
| Mytilus galloprovincialis             | Locusta migratoria                   | Petromyzon marinus                    |
| Argopecten irradians                  | Gryllus bimaculatus                  | Eptatretus burgeri                    |
| Lottia gigantea                       | Tribolium castaneum                  | Squalus acanthias                     |
| Lymnaea stagnalis                     | Diabrotica virgifera                 | Tetraodon nigroviridis                |
| Biomphalaria glabrata                 | Spodoptera frugiperda                | Danio rerio                           |
| Aplysia californica                   | Bombyx mori                          | Homo sapiens                          |
|                                       | Nasonia vitripennis                  | Xenopus tropicalis                    |
|                                       | Apis mellifera                       | Ambystoma mexicanum                   |
|                                       | Ixodes scapularis                    |                                        |
|                                       | Boophilus microplus                  |                                        |
|                                       | Acanthoscurria gomesiana             |                                        |
| nematodds (16)                         |                                      |                                        |
| Trichinella spiralis                   | Macrostomum lignano                  |                                        |
| Onchocerca volvulus                   | Schistosoma japonicum                |                                        |
| Brugia malayi                          | Schistosoma mansoni                  |                                        |
| Ascaris suum                          | Opisthorchis viverrini               |                                        |
| Strongyloides ratti                   | Fasciola hepatica                    |                                        |
| Meloidogyne incognita                 | Taenia solium                        |                                        |
| Radopholus similis                    | Echinococcus granulosus              |                                        |
| Heteroderma glycines                  | Schmidtea mediterranea               |                                        |
| Globoderma rostochiensis              | Dugesia ryukyuensis                  |                                        |
| Bursaphelenchus xylophilus            |                                      |                                        |
| Pristionchus pacificus                |                                        |                                        |
| Caenorhabditis briggsae               |                                        |                                        |
| Caenorhabditis elegans                |                                        |                                        |
| Heterorhabditis bacteriophora         |                                        |                                        |
| Haemonchus contortus                  |                                        |                                        |
| Ancylostoma canium                    |                                        |                                        |
|                                        |                                        |                                        |
| platyhelmintes (9)                     |                                        |                                        |
| Macrostomum lignano                    |                                        |                                        |
| Schistosoma japonicum                 |                                        |                                        |
| Schistosoma mansoni                   |                                        |                                        |
| Opisthorchis viverrini                |                                        |                                        |
| Fasciola hepatica                     |                                        |                                        |
| Taenia solium                         |                                        |                                        |
| Echinococcus granulosus               |                                        |                                        |
| Schmidtea mediterranea                |                                        |                                        |
| Dugesia ryukyuensis                   |                                        |                                        |
### Table S3: Species list by taxa for the mt68 dataset. In parenthesis, the species number.

| Porifera (23) | Protostomia (15) | Deutetostomia (13) | Choanoflagellata (2) |
|---------------|------------------|--------------------|----------------------|
| **Agelas schmidti** (23) | **Protaster phos hommai** (NC 008141) | **Asymmetron lucayanum** (NC 006464) | **Capsaspora owczarzaki** (MBE(2008)) |
| NC 01201 | **Epiphanes pyloi** (NC 009082) | **Balanoglossus carnosus** (NC 001887) | **Monosiga brevicolis** (NC 004309) |
| NC 008944 | **Limulus polyphemus** (NC 003057) | **Branchiostoma belcheri** (NC 004537) | **25:664-72** |
| NC 01203 | **Loxocorone allax** (NC 010431) | **Cucumaria miniata** (NC 005929) | **Monosiga brevicolis** (NC 004309) |
| NC 006894 | **Lumbricus terrestris** (NC 001673) | **Gymnocrinus richeri** (NC 007689) | **25:664-72** |
| NC 01206 | **Metaperipatus inae** (NC 010961) | **Latimeria chalumnae** (AB257297) | **Monosiga brevicolis** (NC 004309) |
| NC 006990 | | **Lepidosiren paradoxa** (NC 003342) | **Strongylocentrotus droebachiensis** (NC 009940) |
| NC 01212 | | **Ophiura lutkeni** (NC 005930) | **Petromyzon marinus** (NC 001626) |
| NC 01216 | | **Pisaster ochraceus** (NC 004610) | **Saccoglossus kowalevskii** (NC 007438) |
| NC 01207 | | **Squalus acanthius** (NC 002012) | **Strongylocentrotus droebachiensis** (NC 009940) |
| NC 010171 | | **Latimeria chalumnae** (AB257297) | **Capsaspora owczarzaki** (MBE(2008)) |
| NC 009090 | | | **25:664-72** |
| NC 010217 | | | **Monosiga brevicolis** (NC 004309) |
| NC 012021 | | | **25:664-72** |

| Plakortis angulospiculatus | **Ptiloaulus walpersi** | **Adoxophyes honmai** | **25:664-72** |
|---------------------------|------------------------|----------------------|------------------|
| NC 010217 | EU237488 | **Asymmetron lucayanum** | **25:664-72** |
| NC 009627 | **Balanoglossus carnosus** | **Balanoglossus carnosus** | **25:664-72** |
| NC 008164 | **Branchiostoma belcheri** | **Branchiostoma belcheri** | **25:664-72** |
| NC 009090 | **Cucumaria miniata** | **Cucumaria miniata** | **25:664-72** |
| NC 008165 | **Gymnocrinus richeri** | **Gymnocrinus richeri** | **25:664-72** |
| NC 008166 | **Latimeria chalumnae** | **Latimeria chalumnae** | **25:664-72** |
| NC 009798 | **Lepidosiren paradoxa** | **Lepidosiren paradoxa** | **25:664-72** |
| NC 008159 | **Ophiura lutkeni** | **Ophiura lutkeni** | **25:664-72** |
| NC 008174 | **Pisaster ochraceus** | **Pisaster ochraceus** | **25:664-72** |
| NC 008157 | **Saccoglossus kowalevskii** | **Saccoglossus kowalevskii** | **25:664-72** |
| NC 008167 | **Strongylocentrotus droebachiensis** | **Strongylocentrotus droebachiensis** | **25:664-72** |

| Cnideria (15) | Protostomia (15) | Deutetostomia (13) | Choanoflagellata (2) |
|---------------|------------------|--------------------|----------------------|
| **Astrangia sp.JVK.2006** (2) | **Balanoglossus carnosus** (NC 001887) | **Asymmetron lucayanum** (NC 006464) | **Capsaspora owczarzaki** (MBE(2008)) |
| NC 008161 | **Epiphanes pyloi** (NC 009082) | **Balanoglossus carnosus** (NC 001887) | **Monosiga brevicolis** (NC 004309) |
| NC 008411 | **Limulus polyphemus** (NC 003057) | **Branchiostoma belcheri** (NC 004537) | **25:664-72** |
| NC 008162 | **Loxocorone allax** (NC 010431) | **Cucumaria miniata** (NC 005929) | **Monosiga brevicolis** (NC 004309) |
| NC 008072 | **Lumbricus terrestris** (NC 001673) | **Gymnocrinus richeri** (NC 007689) | **25:664-72** |
| NC 011160 | **Metaperipatus inae** (NC 010961) | **Latimeria chalumnae** (AB257297) | **Monosiga brevicolis** (NC 004309) |
| NC 009933 | **Ophiura lutkeni** (NC 005930) | | **25:664-72** |
| NC 007225 | **Pisaster ochraceus** (NC 004610) | | **Monosiga brevicolis** (NC 004309) |
| NC 008165 | **Saccoglossus kowalevskii** (NC 007438) | | **25:664-72** |
| NC 009798 | **Squalus acanthius** (NC 002012) | | **Monosiga brevicolis** (NC 004309) |
| NC 008159 | **Strongylocentrotus droebachiensis** (NC 009940) | | **25:664-72** |

| Montipora cactus | **Squalus acanthius** (NC 002012) | | **25:664-72** |
|-----------------|----------------------|------------------|------------------|
| NC 006902 | | **Strongylocentrotus droebachiensis** (NC 009940) | **25:664-72** |
| NC 006902 | | | **Monosiga brevicolis** (NC 004309) |
| NC 008164 | | | **25:664-72** |
| NC 008165 | | | **Monosiga brevicolis** (NC 004309) |
| NC 008167 | | | **25:664-72** |

| Nemastella sp.JVK.2006 | **Pavona clavus** | **Asymmetron lucayanum** | **Capsaspora owczarzaki** (MBE(2008)) |
|------------------------|------------------|----------------------|------------------|
| NC 008164 | NC 008165 | **Balanoglossus carnosus** | **Monosiga brevicolis** (NC 004309) |
| NC 008166 | **Branchiostoma belcheri** | **Balanoglossus carnosus** | **25:664-72** |
| NC 009798 | **Cucumaria miniata** | **Branchiostoma belcheri** | **25:664-72** |
| NC 008166 | **Gymnocrinus richeri** | **Cucumaria miniata** | **25:664-72** |
| NC 008159 | **Latimeria chalumnae** | **Gymnocrinus richeri** | **25:664-72** |
| NC 008827 | **Lepidosiren paradoxa** | **Latimeria chalumnae** | **25:664-72** |
| NC 008167 | **Ophiura lutkeni** | **Lepidosiren paradoxa** | **25:664-72** |

| Pocillopora eydouxi | **Pavona clavus** | **Balanoglossus carnosus** | **Capsaspora owczarzaki** (MBE(2008)) |
|--------------------|------------------|----------------------|------------------|
| NC 009798 | | | **Monosiga brevicolis** (NC 004309) |
| NC 008166 | | | **25:664-72** |
| NC 008167 | | | **Monosiga brevicolis** (NC 004309) |
| NC 008159 | | | **25:664-72** |
| NC 008827 | | | **Monosiga brevicolis** (NC 004309) |
| NC 008167 | | | **25:664-72** |
Table S4: Unrooted species trees for the three datasets.

| Dataset | Tree | Description |
|---------|------|-------------|
| mt336 | Unrooted species tree | For the mt336 dataset, the unrooted species tree is shown. The tree is constructed using a phylogenetic analysis method, with branch lengths indicating evolutionary distance. The tree includes representatives from various groups such as mammals, birds, and fish, providing a comprehensive view of evolutionary relationships. |
Heteropecilly – Supplementary material

nuc80 dataset

(((Acanthoscur:0.119,(Boophilus_:0.041,Ixodes_sca:0.040):0.098):0.060,(((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Apis_melli:0.062,Nasonia_vi:0.059):0.047,((Bombyx_mor:0.025,Spodoptera:0.020):0.118,(Diabrotica:0.057,Pelotis:0.040):0.097):0.060,(((((((Ap
Table S5: Mean of the number of sites with a PIPn value equal to 0 according to the number of points extracted after the burn in. Test done with the nuc80 dataset.

| # points | # sites with PIPn=0 |
|----------|-------------------|
| 100      | 1012              |
| 200      | 710               |
| 500      | 450               |
| 1000     | 324               |
| 2000     | 243               |
| 3000     | 193               |
| 5000     | 144               |

Table S6: Alignment size after removal of the most heterogeneous positions

|                    | removed sites | alignment size |
|--------------------|---------------|----------------|
|                    | no | %  |               |
| PIPn=0             | 168 | 8.7 | 1759          |
| >12                | 165 | 8.6 | 1594          |
| >8                 | 177 | 9.2 | 1417          |
| >6                 | 177 | 9.2 | 1240          |
| >4,5               | 201 | 10.4 | 1039         |

Table S7: Posterior Probabilities (PP) of various nodes for the mtp336 dataset and 10 simulated datasets after recoding of the sequences by the 20 most frequent profiles. In bold, PP greater or equal to 0.7

| model data | CAT+Γ₄ | GTR+Γ₄ |
|------------|--------|--------|
|            | Real   | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      |
| Bilateria  | 0.99   | 0.02   | 0.53   | 0.03   | 0.46   | 0.01   | 0.02   | 0.12   | 0.04   | 0.18   | 0.03   |
| Pancrustacea| 0.69  | 0      | 0.54   | 0.07   | 0.13   | 0.03   | 0.29   | 0.04   | 0      | 0.25   | 0.12   |
| Deuterostomia| 0.23 | 0      | 0.04   | 0      | 0.02   | 0      | 0      | 0.04   | 0      | 0      | 0      |
| Vertebrata  | 0.7    | 0      | 0.01   | 0      | 0      | 0      | 0      | 0.01   | 0      | 0      | 0      |
| Tetrapoda   | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| Amphibia    | 0.1    | 0      | 0.14   | 0.04   | 0.29   | 0.07   | 0.02   | 0      | 0.03   | 0      | 0      |
| Amniota     | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| Sauria      | 0.02   | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| Archosaurus | 0.49   | 0      | 0.03   | 0.06   | 0.05   | 0.04   | 0.01   | 0.15   | 0.04   | 0.07   | 0.06   |
| Lepidosaurus| 0.19   | 0.18   | 0      | 0.05   | 0      | 0      | 0      | 0.23   | 0      | 0.1    | 0.04   |
| Mammalia    | 0.84   | 0      | 0      | 0      | 0      | 0      | 0      | 0.01   | 0      | 0.02   | 0.02   |

| model data | Real   | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|            |        | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      |
| Bilateria  | 1      | 0.01   | 0.67   | 0      | 0.52   | 0      | 0      | 0.05   | 0.05   | 0.46   | 0.16   |
| Pancrustacea| 1     | 0.01   | **0.93**| 0.09   | 0.08   | 0      | 0.33   | 0.01   | 0      | 0.57   | 0.04   |
| Deuterostomia| 0    | 0      | 0.035  | 0      | 0.01   | 0      | 0      | 0      | 0.01   | 0      | 0      |
| Vertebrata  | 1      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| Tetrapoda   | **0.83**| 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| Amphibia    | 0.94   | 0      | 0.45   | 0.03   | 0.04   | 0.19   | 0.04   | 0      | 0.01   | 0      | 0      |
| Amniota     | 0.14   | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| Sauria      | 0.62   | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| Archosaurus | **0.97**| 0      | 0.01   | 0.06   | 0.02   | 0      | 0      | 0.12   | 0.06   | 0.1    | 0.05   |
| Lepidosaurus| **0.94**| 0.15   | 0      | 0.01   | 0      | 0      | 0      | 0.32   | 0      | 0.14   | 0.05   |
| Mammalia    | 1      | 0      | 0.04   | 0      | 0      | 0      | 0      | 0      | 0      | 0.02   | 0.02   |
Table S8: p-values of Khi-square tests on the distribution of profiles according to clades and physico-chemical properties of profiles. Five profile categories are considered: small, charged, aromatic, aliphatic and other properties. For mt368 and nuc80 datasets, tests were performed for all sites, most heteropecillous sites and most homopecillous sites.

| Mitochondrial data | all sites (1851) | PIPn=0 | PIPn~1 | Site number* |
|--------------------|-----------------|--------|--------|--------------|
| all sites (1851)   | 0               | 0      | 2,0e^-102 | 480 (>=5,7e^-8) |
| 500 fastest evolving sites (>52,79 substitutions per site) | 2,0e^-249 | 6,9e^-16 | 1,3e^-06 | 103 (>=1,5e^-3) |

| Nuclear data | all sites (12608) | PIPn=0 | PIPn~1 | Site number* |
|--------------|------------------|--------|--------|--------------|
| all sites (12608) | 7,7e^-48 | 0,980 | 1 | 327 (>=0,595) |
| 3000 fastest evolving sites (>20,12 substitutions per site) | 7,0e^-04 | 0,993 | 1 | 269 (>=0,366) |
| 500 fastest evolving sites (>45,77 substitutions per site) | 0,996 | 1 | 1 | 81 (>=0,039) |

*: number of sites involved in calculation for heteropecillous (i.e. PIPn=0) or homopecillous (i.e. PIPn~1). In parenthesis, smaller value of PIPn to consider homogeneity.

Table S9: Statistical supports for nodes grouping Eumetazoa and Cnidaria+Porifera according to various models of evolution. Support values are Posterior Probabilities for CAT model, and Bootstrap values for GTR and mtREV models. All inferences are conducted with 4 gamma categories.

| Model (program) | Monophyletic taxa | Sequence length | 
|-----------------|------------------|-----------------|
| CAT+Γ₄ (Phylobayes) | Eumetazoa | 0,295 | 0,435 | 0,98 | 0,955 | 0,965 | 0,605 |
| | Cnid+Pori | 0,695 | 0,555 | 0,01 | 0,035 | 0,015 | 0,365 |
| GTR+Γ₄ (RAxML) | Eumetazoa | 0 | 0 | 2 | 3 | 7 | 2 |
| | Cnid+Pori | 100 | 100 | 98 | 97 | 93 | 98 |
| mtREV+Γ₄ (RAxML) | Eumetazoa | 0 | 0 | 0 | 0 | 1 | 1 |
| | Cnid+Pori | 100 | 100 | 100 | 99 | 97 |

Table S10: Evaluation of GTR+Γ₄ and mtREV+Γ₄ models fit by cross-validation compared with the CAT+Γ₄ model on the mt68 complete dataset and subsets alignments after removal of heteropecillous sites (columns 1 and 3). In columns 2 and 4, score divided by the sequence length.

| sequence length | CAT+G4 / GTR+G4 | CAT+G4 / MTREV+G4 |
|-----------------|-----------------|-----------------|
| score likelihood fit | score / length | score likelihood fit | score / length |
| 1927 | 70.7 ± 57.7 | 0,0367 | -22.8 ± 53.9 | -0,0119 |
| 1759 | 4.4 ± 21.6 | 0,0025 | -83.7 ± 30.9 | -0,0476 |
| 1594 | -40.7 ± 31.4 | -0,0255 | -121.9 ± 33.0 | -0,0765 |
| 1417 | -52.1 ± 35.0 | -0,0368 | -117.2 ± 31.8 | -0,0827 |
| 1240 | -45.2 ± 47.0 | -0,0365 | -101.4 ± 47.1 | -0,0818 |
| 1039 | -47.5 ± 12.4 | -0,0457 | -99.6 ± 20.0 | -0,0958 |
