**APPENDIX S1.** Samples from the 1KP transcriptome data (Leebens-Mack et al., 2019a) used to make the reference alignments from which the GoFlag 451 probe set was designed.

| **Lineage** | **Order** | **Taxon** | **1KP code** |
| --- | --- | --- | --- |
| Hornwort | Anthocerotales | *Anthoceros agrestis* | TWUW |
| Hornwort | Anthocerotales | *Leiosporoceros dussii* | FANS |
| Hornwort | Anthocerotales | *Nothoceros aenigmaticus* | DXOU |
| Hornwort | Anthocerotales | *Nothoceros vincentianus* | TCBC |
| Hornwort | Anthocerotales | *Paraphymatoceros hallii* | FAJB |
| Hornwort | Anthocerotales | *Phaeoceros carolinianus* | ZFRE |
| Hornwort | Dendrocerotales | *Megaceros flagellaris* | UCRN |
| Hornwort | Dendrocerotales | *Phaeomegaceros coriaceus* | AKXB |
| Liverwort | Jungermanniales | *Barbilophozia barbata* | OFTV |
| Liverwort | Jungermanniales | *Bazzania trilobata* | WZYK |
| Liverwort | Jungermanniales | *Calypogeia fissa* | RTMU |
| Liverwort | Jungermanniales | *Odontoschisma prostratum* | YBQN |
| Liverwort | Jungermanniales | *Scapania nemorosa* | IRBN |
| Liverwort | Jungermanniales | *Schistochila* sp. | LGOW |
| Liverwort | Lunulariales | *Lunularia cruciata* | TXVB |
| Liverwort | Marchantiales | *Conocephalum conicum* | ILBQ |
| Liverwort | Marchantiales | *Marchantia emarginata* | TFYI |
| Liverwort | Marchantiales | *Marchantia paleacea* | LFVP |
| Liverwort | Marchantiales | *Marchantia polymorpha* | JPYU |
| Liverwort | Marchantiales | *Ricciocarpos natans* | WJLO |
| Liverwort | Metzgeriales | *Metzgeria crassipilis* | NRWZ |
| Liverwort | Pallaviciniales | *Pallavicinia lyellii* | YFGP |
| Liverwort | Pelliales | *Pellia* cf. *epiphylla* | PIUF |
| Liverwort | Pelliales | *Pellia neesiana* | JHFI |
| Liverwort | Porellales | *Frullania* sp. | TGKW |
| Liverwort | Porellales | *Porella navicularis* | KRUQ |
| Liverwort | Porellales | *Porella pinnata* | UUHD |
| Liverwort | Porellales | *Radula lindenbergiana* | BNCU |
| Liverwort | Ptilidiales | *Ptilidium pulcherrimum* | HPXA |
| Liverwort | Sphaerocarpales | *Sphaerocarpos texanus* | HERT |
| Moss | Andreaeales | *Andreaea rupestris* | WOGB |
| Moss | Bartramiales | *Philonotis fontana* | ORKS |
| Moss | Bryales | *Bryum argenteum* | JMXW |
| Moss | Bryales | *Plagiomnium insigne* | BGXB |
| Moss | Bryales | *Rosulabryum* cf. *capillare* | XWHK |
| Moss | Buxbaumiales | *Buxbaumia aphylla* | HRWG |
| Moss | Buxbaumiales | *Diphyscium foliosum* | AWOI |
| Moss | Dicranales | *Ceratodon purpureus* | FFPD |
| Moss | Dicranales | *Dicranum scoparium* | NGTD |
| Moss | Dicranales | *Leucobryum albidum* | VMXJ |
| Moss | Dicranales | *Leucobryum glaucum* | RGKI |
| Moss | Encalyptales | *Encalypta streptocarpa* | KEFD |
| Moss | Funariales | *Physcomitrium* sp. | YEPO |
| Moss | Grimmiales | *Racomitrium elongatum* | ABCD |
| Moss | Grimmiales | *Racomitrium varium* | RDOO |
| Moss | Grimmiales | *Scouleria aquatica* | BPSG |
| Moss | Hedwigiales | *Hedwigia ciliata* | YWNF |
| Moss | Hypnales | *Anomodon attenuatus* | QMWB |
| Moss | Hypnales | *Calliergon cordifolium* | TAVP |
| Moss | Hypnales | *Claopodium rostratum* | VBMM |
| Moss | Hypnales | *Climacium dendroides* | MIRS |
| Moss | Hypnales | *Fontinalis antipyretica* | DHWX |
| Moss | Hypnales | *Leucodon brachypus* | ZACW |
| Moss | Hypnales | *Leucodon julaceus* | IGUH |
| Moss | Hypnales | *Loeskeobryum brevirostre* | WSPM |
| Moss | Hypnales | *Neckera douglasii* | TMAJ |
| Moss | Hypnales | *Pseudotaxiphyllum elegans* | QKQO |
| Moss | Hypnales | *Rhynchostegium serrulatum* | JADL |
| Moss | Hypnales | *Stereodon subimponens* | LNSF |
| Moss | Hypnales | *Thuidium delicatulum* | EEMJ |
| Moss | Polytrichales | *Atrichum angustatum* | ZTHV |
| Moss | Polytrichales | *Polytrichum commune* | SZYG |
| Moss | Pottiales | *Syntrichia princeps* | GRKU |
| Moss | Rhizogoniales | *Aulacomnium heterostichum* | WNGH |
| Moss | Rhizogoniales | *Orthotrichum lyellii* | CMEQ |
| Moss | Sphagnales | *Sphagnum lescurii* | GOWD |
| Moss | Sphagnales | *Sphagnum palustre* | RCBT |
| Moss | Sphagnales | *Sphagnum recurvum* | UHLI |
| Moss | Takakiales | *Takakia lepidozioides* | SKQD |
| Moss | Tetraphidales | *Tetraphis pellucida* | HVBQ |
| Moss | Timmiales | *Timmia austriaca* | ZQRI |
| Lycophyte | Isoetales | *Isoetes* sp. | PYHZ |
| Lycophyte | Isoetales | *Isoetes tegetiformans* | PKOX |
| Lycophyte | Lycopodiales | *Dendrolycopodium obscurum* | XNXF |
| Lycophyte | Lycopodiales | *Diphasiastrum digitatum* | WAFT |
| Lycophyte | Lycopodiales | *Huperzia lucidula* | GKAG |
| Lycophyte | Lycopodiales | *Huperzia myrsinites* | CBAE |
| Lycophyte | Lycopodiales | *Huperzia selago* | YHZW |
| Lycophyte | Lycopodiales | *Huperzia squarrosa* | GAON |
| Lycophyte | Lycopodiales | *Lycopodiella appressa* | ULKT |
| Lycophyte | Lycopodiales | *Lycopodium annotinum* | ENQF |
| Lycophyte | Lycopodiales | *Lycopodium deuterodensum* | PQTO |
| Lycophyte | Lycopodiales | *Phylloglossum drummondii* | ZZEI |
| Lycophyte | Lycopodiales | *Pseudolycopodiella caroliniana* | UPMJ |
| Lycophyte | Selaginellales | *Selaginella acanthonota* | ZYCD |
| Lycophyte | Selaginellales | *Selaginella apoda* | LGDQ |
| Lycophyte | Selaginellales | *Selaginella* cf. *pallescens* | ABIJ |
| Lycophyte | Selaginellales | *Selaginella kraussiana* | ZFGK |
| Lycophyte | Selaginellales | *Selaginella moellendorffii* | ZZOL |
| Lycophyte | Selaginellales | *Selaginella selaginoides* | KUXM |
| Lycophyte | Selaginellales | *Selaginella wallacei* | JKAA |
| Lycophyte | Selaginellales | *Selaginella willdenowii* | KJYC |
| Eusporangiate fern | Equisetales | *Equisetum diffusum* | CAPN |
| Eusporangiate fern | Equisetales | *Equisetum hyemale* | JVSZ |
| Eusporangiate fern | Marattiales | *Angiopteris evecta* | NHCM |
| Eusporangiate fern | Marattiales | *Danaea nodosa* | DFHO |
| Eusporangiate fern | Marattiales | *Marattia attenuata* | UGNK |
| Eusporangiate fern | Ophioglossales | *Botrypus virginianus* | BEGM |
| Eusporangiate fern | Ophioglossales | *Ophioglossum petiolatum* | WTJG |
| Eusporangiate fern | Ophioglossales | *Sceptridium dissectum* | EEAQ |
| Eusporangiate fern | Psilotales | *Psilotum nudum* | QVMR |
| Eusporangiate fern | Psilotales | *Tmesipteris parva* | ALVQ |
| Leptosporangiate fern | Cyatheales | *Alsophila pinulosa* | GANB |
| Leptosporangiate fern | Cyatheales | *Culcita macrocarpa* | PNZO |
| Leptosporangiate fern | Cyatheales | *Plagiogyria japonica* | UWOD |
| Leptosporangiate fern | Cyatheales | *Thyrsopteris elegans* | EWXK |
| Leptosporangiate fern | Gleicheniales | *Dipteris conjugata* | MEKP |
| Leptosporangiate fern | Hymenophyllales | *Hymenophyllum bivalve* | QIAD |
| Leptosporangiate fern | Osmundales | *Osmunda javanica* | VIBO |
| Leptosporangiate fern | Osmundales | *Osmunda* sp. | UOMY |
| Leptosporangiate fern | Osmundales | *Osmundastrum cinnamomeum* | RFMZ |
| Leptosporangiate fern | Polypodiales | *Adiantum aleuticum* | WCLG |
| Leptosporangiate fern | Polypodiales | *Adiantum raddianum* | BMJR |
| Leptosporangiate fern | Polypodiales | *Argyrochosma nivea* | XDDT |
| Leptosporangiate fern | Polypodiales | *Asplenium* cf. ×*lucrosum* | BMIF |
| Leptosporangiate fern | Polypodiales | *Asplenium nidus* | PSKY |
| Leptosporangiate fern | Polypodiales | *Asplenium platyneuron* | KJZG |
| Leptosporangiate fern | Polypodiales | *Athyrium* sp. | AFPO |
| Leptosporangiate fern | Polypodiales | *Blechnum spicant* | VITX |
| Leptosporangiate fern | Polypodiales | *Bolbitis repanda* | JBLI |
| Leptosporangiate fern | Polypodiales | *Ceratopteris thalictroides* | PIVW |
| Leptosporangiate fern | Polypodiales | *Cryptogramma acrostichoides* | WQML |
| Leptosporangiate fern | Polypodiales | *Cystopteris fragilis* | XXHP |
| Leptosporangiate fern | Polypodiales | *Cystopteris protrusa* | YOWV |
| Leptosporangiate fern | Polypodiales | *Cystopteris reevesiana* | RICC |
| Leptosporangiate fern | Polypodiales | *Cystopteris utahensis* | HNDZ |
| Leptosporangiate fern | Polypodiales | *Davallia fejeensis* | OQWW |
| Leptosporangiate fern | Polypodiales | *Dennstaedtia davallioides* | MTGC |
| Leptosporangiate fern | Polypodiales | *Didymochlaena truncatula* | RFRB |
| Leptosporangiate fern | Polypodiales | *Diplazium wichurae* | UFJN |
| Leptosporangiate fern | Polypodiales | *Gaga arizonica* | DCDT |
| Leptosporangiate fern | Polypodiales | *Gymnocarpium dryopteris* | HEGQ |
| Leptosporangiate fern | Polypodiales | *Homalosorus pycnocarpos* | OCZL |
| Leptosporangiate fern | Polypodiales | *Leucostegia immersa* | WGTU |
| Leptosporangiate fern | Polypodiales | *Lindsaea linearis* | NOKI |
| Leptosporangiate fern | Polypodiales | *Lindsaea microphylla* | YIXP |
| Leptosporangiate fern | Polypodiales | *Lonchitis hirsuta* | VVRN |
| Leptosporangiate fern | Polypodiales | *Myriopteris rufa* | GSXD |
| Leptosporangiate fern | Polypodiales | *Nephrolepis exaltata* | NWWI |
| Leptosporangiate fern | Polypodiales | *Notholaena montieliae* | YCKE |
| Leptosporangiate fern | Polypodiales | *Onoclea sensibilis* | HTFH |
| Leptosporangiate fern | Polypodiales | *Parahemionitis cordata* | ZXJO |
| Leptosporangiate fern | Polypodiales | *Phlebodium pseudoaureum* | ZQYU |
| Leptosporangiate fern | Polypodiales | *Phymatosorus grossus* | ORJE |
| Leptosporangiate fern | Polypodiales | *Pityrogramma trifoliata* | UJTT |
| Leptosporangiate fern | Polypodiales | *Pleopeltis polypodioides* | UJWU |
| Leptosporangiate fern | Polypodiales | *Polypodium amorphum* | YLJA |
| Leptosporangiate fern | Polypodiales | *Polypodium glycyrrhiza* | CJNT |
| Leptosporangiate fern | Polypodiales | *Polypodium hesperium* | ZRAV |
| Leptosporangiate fern | Polypodiales | *Polystichum acrostichoides* | FQGQ |
| Leptosporangiate fern | Polypodiales | *Pteris ensiformis* | FLTD |
| Leptosporangiate fern | Polypodiales | *Pteris vittata* | POPJ |
| Leptosporangiate fern | Polypodiales | *Thelypteris acuminata* | MROH |
| Leptosporangiate fern | Polypodiales | *Vittaria appalachiana* | NDUV |
| Leptosporangiate fern | Polypodiales | *Vittaria lineata* | SKYV |
| Leptosporangiate fern | Polypodiales | *Woodsia ilvensis* | YQEC |
| Leptosporangiate fern | Polypodiales | *Woodsia scopulina* | YJJY |
| Leptosporangiate fern | Salviniales | *Azolla* cf. *caroliniana* | CVEG |
| Leptosporangiate fern | Salviniales | *Pilularia globulifera* | KIIX |
| Leptosporangiate fern | Schizaeales | *Anemia tomentosa* | CQPW |
| Leptosporangiate fern | Schizaeales | *Lygodium japonicum* | PBUU |
| Gymnosperm | Cycadales | *Cycas micholitzii* | XZUY |
| Gymnosperm | Cycadales | *Dioon edule* | WLIC |
| Gymnosperm | Cycadales | *Encephalartos barteri* | GNQG |
| Gymnosperm | Cycadales | *Stangeria eriopus* | KAWQ |
| Gymnosperm | Ginkgoales | *Ginkgo biloba* | SGTW |
| Gymnosperm | Gnetales | *Ephedra sinica* | VDAO |
| Gymnosperm | Gnetales | *Gnetum montanum* | GTHK |
| Gymnosperm | Gnetales | *Welwitschia mirabilis* | TOXE |
| Gymnosperm | Pinales | *Abies lasiocarpa* | VSRH |
| Gymnosperm | Pinales | *Acmopyle pancheri* | HILW |
| Gymnosperm | Pinales | *Agathis robusta* | MIXZ |
| Gymnosperm | Pinales | *Amentotaxus argotaenia* | IAJW |
| Gymnosperm | Pinales | *Araucaria rulei* | XTZO |
| Gymnosperm | Pinales | *Araucaria* sp. | ACWS |
| Gymnosperm | Pinales | *Athrotaxis cupressoides* | XIRK |
| Gymnosperm | Pinales | *Austrocedrus chilensis* | YYPE |
| Gymnosperm | Pinales | *Austrotaxus spicata* | BTTS |
| Gymnosperm | Pinales | *Callitris gracilis* | IFLI |
| Gymnosperm | Pinales | *Callitris macleayana* | RMMV |
| Gymnosperm | Pinales | *Calocedrus decurrens* | FRPM |
| Gymnosperm | Pinales | *Cathaya argyrophylla* | NPRL |
| Gymnosperm | Pinales | *Cedrus libani* | GGEA |
| Gymnosperm | Pinales | *Cephalotaxus harringtonia* | WYAJ |
| Gymnosperm | Pinales | *Chamaecyparis lawsoniana* | AIGO |
| Gymnosperm | Pinales | *Cryptomeria japonica* | HOUF |
| Gymnosperm | Pinales | *Cunninghamia lanceolata* | ZQVF |
| Gymnosperm | Pinales | *Cupressus dupreziana* | QNGJ |
| Gymnosperm | Pinales | *Dacrycarpus compactus* | FMWZ |
| Gymnosperm | Pinales | *Dacrydium balansae* | IZGN |
| Gymnosperm | Pinales | *Diselma archeri* | GKCZ |
| Gymnosperm | Pinales | *Falcatifolium taxoides* | ROWR |
| Gymnosperm | Pinales | *Fokienia hodginsii* | UEVI |
| Gymnosperm | Pinales | *Glyptostrobus pensilis* | OXGJ |
| Gymnosperm | Pinales | *Halocarpus bidwillii* | OWFC |
| Gymnosperm | Pinales | *Juniperus scopulorum* | XMGP |
| Gymnosperm | Pinales | *Keteleeria evelyniana* | JUWL |
| Gymnosperm | Pinales | *Lagarostrobos franklinii* | ZQWM |
| Gymnosperm | Pinales | *Larix speciosa* | WVWN |
| Gymnosperm | Pinales | *Manoao colensoi* | CDFR |
| Gymnosperm | Pinales | *Metasequoia glyptostroboides* | NRXL |
| Gymnosperm | Pinales | *Microbiota decussata* | XQSG |
| Gymnosperm | Pinales | *Microcachrys tetragona* | MHGD |
| Gymnosperm | Pinales | *Microstrobos fitzgeraldii* | BBDD |
| Gymnosperm | Pinales | *Nageia nagi* | UUJS |
| Gymnosperm | Pinales | *Neocallitropsis pancheri* | JDQB |
| Gymnosperm | Pinales | *Nothotsuga longibracteata* | AREG |
| Gymnosperm | Pinales | *Papuacedrus papuana* | OVIJ |
| Gymnosperm | Pinales | *Parasitaxus usta* | JZVE |
| Gymnosperm | Pinales | *Phyllocladus hypophyllus* | JRNA |
| Gymnosperm | Pinales | *Picea engelmannii* | AWQB |
| Gymnosperm | Pinales | *Pilgerodendron uviferum* | ETCJ |
| Gymnosperm | Pinales | *Pinus jeffreyi* | MFTM |
| Gymnosperm | Pinales | *Pinus parviflora* | IIOL |
| Gymnosperm | Pinales | *Pinus ponderosa* | JBND |
| Gymnosperm | Pinales | *Pinus radiata* | DZQM |
| Gymnosperm | Pinales | *Platycladus orientalis* | BUWV |
| Gymnosperm | Pinales | *Podocarpus coriaceus* | SCEB |
| Gymnosperm | Pinales | *Podocarpus rubens* | XLGK |
| Gymnosperm | Pinales | *Prumnopitys andina* | EGLZ |
| Gymnosperm | Pinales | *Pseudolarix amabilis* | AQFM |
| Gymnosperm | Pinales | *Pseudotaxus chienii* | YLPM |
| Gymnosperm | Pinales | *Pseudotsuga wilsoniana* | IOVS |
| Gymnosperm | Pinales | *Retrophyllum minus* | VGSX |
| Gymnosperm | Pinales | *Saxegothaea conspicua* | QCGM |
| Gymnosperm | Pinales | *Sciadopitys verticillata* | YFZK |
| Gymnosperm | Pinales | *Sequoia sempervirens* | HBGV |
| Gymnosperm | Pinales | *Sequoiadendron giganteum* | QFAE |
| Gymnosperm | Pinales | *Sundacarpus amarus* | KLGF |
| Gymnosperm | Pinales | *Taiwania cryptomerioides* | QSNJ |
| Gymnosperm | Pinales | *Taxodium distichum* | FHST |
| Gymnosperm | Pinales | *Taxus baccata* | WWSS |
| Gymnosperm | Pinales | *Taxus cuspidata* | ZYAX |
| Gymnosperm | Pinales | *Tetraclinis* sp. | CGDN |
| Gymnosperm | Pinales | *Thuja plicata* | VFYZ |
| Gymnosperm | Pinales | *Thujopsis dolabrata* | NKIN |
| Gymnosperm | Pinales | *Torreya nucifera* | HQOM |
| Gymnosperm | Pinales | *Torreya taxifolia* | EFMS |
| Gymnosperm | Pinales | *Tsuga heterophylla* | GAMH |
| Gymnosperm | Pinales | *Widdringtonia cedarbergensis* | AUDE |
| Gymnosperm | Pinales | *Wollemia nobilis* | RSCE |