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MOLECULAR TAXONOMY OF ASTERACEAE SPECIES IN THE NUROTA PHYTOGEOGRAPHIC DISTRICT

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Annotation: the study analyzed 85 species of the Asteraceae family distributed in the Nurota phytogeographic district to determine their molecular taxonomic position. The data were mainly downloaded from the NCBI GenBank database. At the same time, molecular markers for Cousinia botschantzevii Juz. ex Tscherneva, an endemic representative of the Nurota district, were sequenced and analyzed for the first time.

Keywords: genBank, phytogeographic, endemic, phylogenetic, internal transcribed spacer.

Annotatsiya: Tadqiqotda Nurota fitogeografik okrugida tarqalgan Asteraceae (Qoqio‘tlardoshlar) oilasiga mansub 85 ta tur molekulyar taksonomik o‘rnini aniqlash maqsadida tahlil qilindi.Ma’lumotlar asosan NCBI GenBank ma’lumotlar bazasidan yuklab olindi. Shu bilan birga, Nurota okrugining endemik vakili bo‘lgan Cousinia botschantzevii Juz. ex Tscherneva uchun molekulyar markerlar birinchi marta ketma-ketlikka olindi va tahlil qilindi.

Kalit so‘zlar:genBank, fitogeografik, endemik, filogenetik, internal transcribed spacer.

Аннотация: в ходе исследования было проанализировано 85 видов семейства Asteraceae, распространенных в Нуратинском фитогеографическом районе, с целью определения их молекулярно-таксономического положения. Данные были получены преимущественно из базы данных NCBI GenBank. При этом впервые были секвенированы и проанализированы молекулярные маркеры для эндемичного для Нуратинского района вида Cousinia botschantzevii Juz. ex Tscherneva.

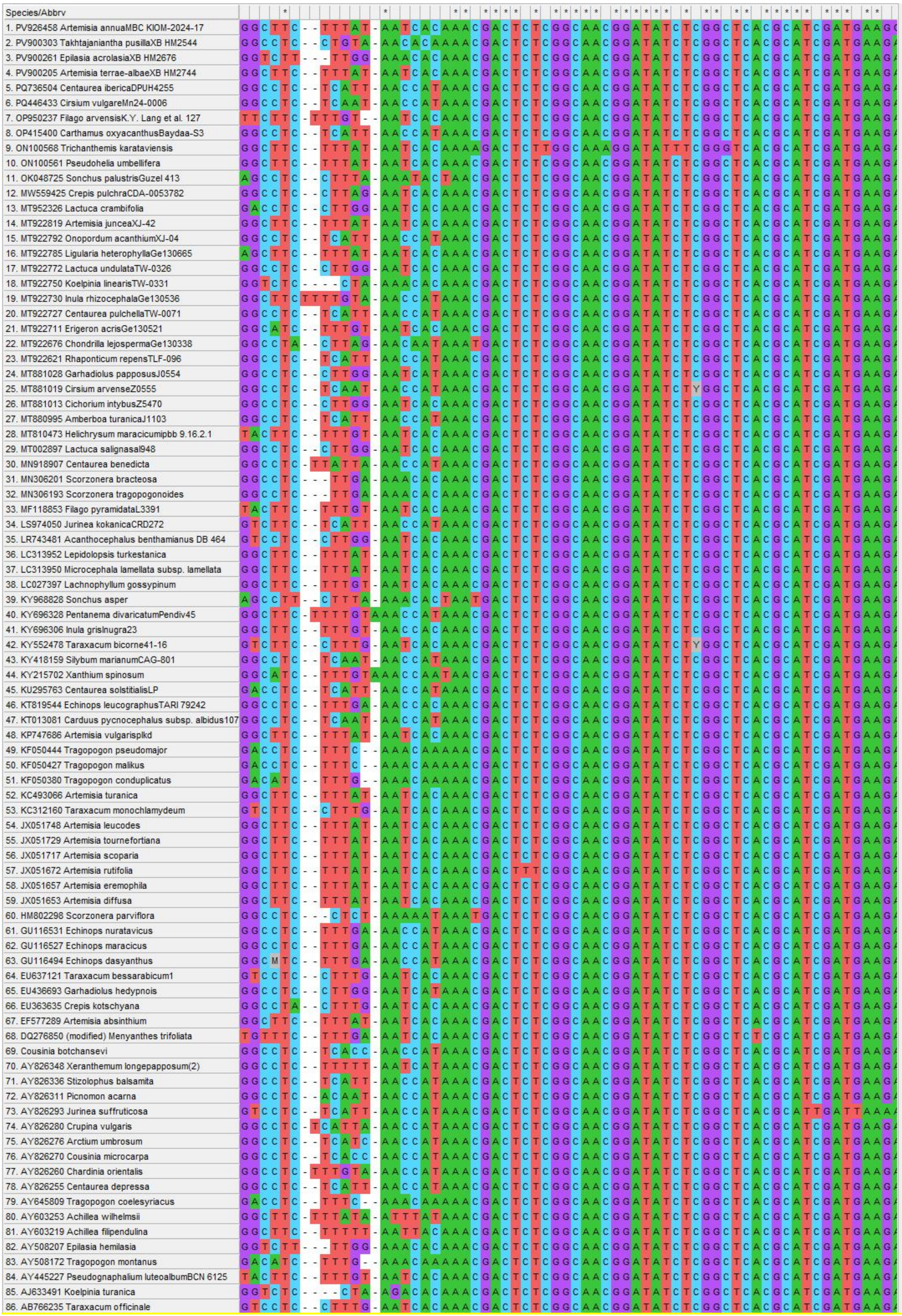
Ключевые слова: генБанк, фитогеографический, эндемичный, филогенетический, внутренний транскрибируемый спейсер.

In this study, 85 species of the Asteraceae family distributed in the Nurota phytogeographic district were analyzed to determine their molecular taxonomic position. The data were mainly downloaded from the NCBI GenBank database. At the same time, molecular markers for Cousinia botschantzevii Juz. ex Tscherneva, an endemic representative of the Nurota district, were sequenced and analyzed for the first time. This allowed us to introduce new molecular data for this species into science.

For molecular phylogenetic analysis, widely used ribosomal DNA markers were selected. In particular, internal transcribed spacer 1 (ITS1, partial sequence), 5.8S ribosomal RNA gene, internal transcribed spacer 2 (ITS2, complete sequence), and large subunit gene (LSU rDNA) of ribosomal RNA sequences were used. These markers are effective in studying the phylogenetic relationships of the Asteraceae family due to their high resolution at the species level. One of the species Menyanthes trifoliata L. (Menyanthaceae family) was used as an outgroup in constructing phylogenetic trees. This selection allowed us to determine the rooting of the tree and more accurately assess the branching within the ingroup.

The overall matrix alignment based on the obtained sequences consisted of 660 nucleotides. As a result of the analysis, the following were noted in this matrix: 201 conservative (unchanged) nucleotide positions, 51 parsimony informative sites, 62 singleton sites (see Figure 16).

The results serve to shed light on the molecular diversity of species of the Asteraceae family distributed in the Nurota phytogeographical district and their evolutionary relationships.



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Species/Abbrv                                             *         *      ** **** * ***** ****** * ** ** ***** *** **
1. PV926458 Artemisia annuaMBC KIOM-2024-17           GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
2. PV900303 Takhtajaniantha pusillaXB HM2544          GGCCTC--CTGTA-AACACAAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
3. PV900261 Epilasia acrolasiaXB HM2676               GGTCTT---TTGG-AAACACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
4. PV900205 Artemisia terrae-albaeXB HM2744           GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
5. PQ736504 Centaurea ibericaDPUH4255                 GGCCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
6. PQ446433 Cirsium vulgareMn24-0006                  GGCCTC--TCAAT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
7. OP950237 Filago arvensisK.Y. Lang et al. 127       TTCTTC-TTTGT--AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
8. OP415400 Carthamus oxyacanthusBaydaa-S3            GGCCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
9. ON100568 Trichanthemis karataviensis               GGCTTC--TTTAT-AATCACAAAAGACTCTTGGCAAAGGATATTTCGGGTCACGCATCGATGAAG
10. ON100561 Pseudohelia umbellifera                  GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
11. OK048725 Sonchus palustrisGuzel 413               AGCCTC--CTTTA-AAATACTAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
12. MW559425 Crepis pulchraCDA-0053782                GGCCTC--CTTAG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
13. MT952326 Lactuca crambifolia                      GACCTC--CTTGG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
14. MT922819 Artemisia junceaXJ-42                    GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
15. MT922792 Onopordum acanthiumXJ-04                 GGCCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
16. MT922785 Ligularia heterophyllaGe130665           AGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
17. MT922772 Lactuca undulataTW-0326                  GGCCTC--CTTGG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
18. MT922750 Koelpinia linearisTW-0331                GGTCTC----CTA-AAACACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
19. MT922730 Inula rhizocephalaGe130536               GGCTTCTTTTGTA-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
20. MT922727 Centaurea pulchellaTW-0071               GGCCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
21. MT922711 Erigeron acrisGe130521                   GGCATC--TTTGT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
22. MT922676 Chondrilla lejospermaGe130338            GGCCTA--CTTAG-AACAATAAATGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
23. MT922621 Rhaponticum repensTLF-096                GGCCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
24. MT881028 Garhadiolus papposusJ0554                GGCCTC--CTTGG-AATCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
25. MT881019 Cirsium arvenseZ0555                     GGCCTC--TCAAT-AACCATAAACGACTCTCGGCAACGGATATCTYGGCTCACGCATCGATGAAG
26. MT881013 Cichorium intybusZ5470                   GGCCTC--CTTGG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
27. MT880995 Amberboa turanicaJ1103                   GGCCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
28. MT810473 Helichrysum maracicumipbb 9.16.2.1       TACTTC--TTTGT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
29. MT002897 Lactuca salignasal948                    GGCCTC--CTTGG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
30. MN918907 Centaurea benedicta                      GGCCTC-TTATTA-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
31. MN306201 Scorzonera bracteosa                     GGCCTC---TTGA-AAACACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
32. MN306193 Scorzonera tragopogonoides               GGCCTC---TTGA-AAACACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
33. MF118853 Filago pyramidataL3391                   TACTTC--TTTGT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
34. LS974050 Jurinea kokanicaCRD272                   GTCTTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
35. LR743481 Acanthocephalus benthamianus DB 464      GTCCTC--CTTGG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
36. LC313952 Lepidolopsis turkestanica                GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
37. LC313950 Microcephala lamellata subsp. lamellata  GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
38. LC027397 Lachnophyllum gossypinum                 GGCTTC--TTTGT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
39. KY968828 Sonchus asper                            AGCCTT--CTTTA-AAACACTAATGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
40. KY696328 Pentanema divaricatumPendiv45            GGCTTC-TTTTGTAAACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
41. KY696306 Inula grisInugra23                       GGCTTC--TTTGT-AACCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
42. KY552478 Taraxacum bicorne41-16                   GTCTTC--CTTTG-AATCACAAACGACTCTCGGCAACGGATATCTYGGCTCACGCATCGATGAAG
43. KY418159 Silybum marianumCAG-801                  GGCCTC--TCAAT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
44. KY215702 Xanthium spinosum                        GGCATC--TTTGTAAACCAATAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
45. KU295763 Centaurea solstitialisLP                 GACCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
46. KT819544 Echinops leucographusTARI 79242          GGCCTC--TTTGA-AACCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
47. KT013081 Carduus pycnocephalus subsp. albidus107  GGCCTC--TCAAT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
48. KP747686 Artemisia vulgarisplkd                   GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
49. KF050444 Tragopogon pseudomajor                   GACCTC--TTTC--AAACAAAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
50. KF050427 Tragopogon malikus                       GACCTC--TTTC--AAACAAAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
51. KF050380 Tragopogon conduplicatus                 GACATC--TTTG--AAACAAAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
52. KC493066 Artemisia turanica                       GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
53. KC312160 Taraxacum monochlamydeum                 GTCTTC--CTTTG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
54. JX051748 Artemisia leucodes                       GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
55. JX051729 Artemisia tournefortiana                 GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
56. JX051717 Artemisia scoparia                       GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
57. JX051672 Artemisia rutifolia                      GGCTTC--TTTAT-AATCACAAACGACTTTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
58. JX051657 Artemisia eremophila                     GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
59. JX051653 Artemisia diffusa                        GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
60. HM802298 Scorzonera parviflora                    GGCCTC---CTCT-AAAAATAAATGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
61. GU116531 Echinops nuratavicus                     GGCCTC--TTTGA-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
62. GU116527 Echinops maracicus                       GGCCTC--TTTGA-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
63. GU116494 Echinops dasyanthus                      GGCMTC--TTTGA-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
64. EU637121 Taraxacum bessarabicum1                  GTCCTC--CTTTG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
65. EU436693 Garhadiolus hedypnois                    GGCCTC--CTTGG-AATCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
66. EU363635 Crepis kotschyana                        GGCCTA--CTTTG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
67. EF577289 Artemisia absinthium                     GGCTTC--TTTAT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
68. DQ276850 (modified) Menyanthes trifoliata         TGTTTC--TTTGA-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCTCGCATCGATGAAG
69. Cousinia botchansevi                              GGCCTC--TCACC-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
70. AY826348 Xeranthemum longepapposum(2)             GGCCTC--TTTTT-AATCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
71. AY826336 Stizolophus balsamita                    GGCCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
72. AY826311 Picnomon acarna                          GGCCTC--ACAAT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
73. AY826293 Jurinea suffruticosa                     GTCCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATTGATTAAA
74. AY826280 Crupina vulgaris                         GGCCTC-TCATTA-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
75. AY826276 Arctium umbrosum                         GGCCTC--TCATC-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
76. AY826270 Cousinia microcarpa                      GGCCTC--TCACC-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
77. AY826260 Chardinia orientalis                     GGCCTC-TTTGTA-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
78. AY826255 Centaurea depressa                       GGCCTC--TCATT-AACCATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
79. AY645809 Tragopogon coelesyriacus                 GACCTC--TTTC--AAACAAAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
80. AY603253 Achillea wilhelmsii                      GGCTTC-TTTATA-ATTTATAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
81. AY603219 Achillea filipendulina                   GGCTTC--TTTTT-AATTACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
82. AY508207 Epilasia hemilasia                       GGTCTT---TTGG-AAACACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
83. AY508172 Tragopogon montanus                      GACATC--TTTG--AAACAAAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
84. AY445227 Pseudognaphalium luteoalbumBCN 6125      TACTTC--TTTGT-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
85. AJ633491 Koelpinia turanica                       GGTCTC----CTA-AGACACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
86. AB766235 Taraxacum officinale                     GTCCTC--CTTTG-AATCACAAACGACTCTCGGCAACGGATATCTCGGCTCACGCATCGATGAAG
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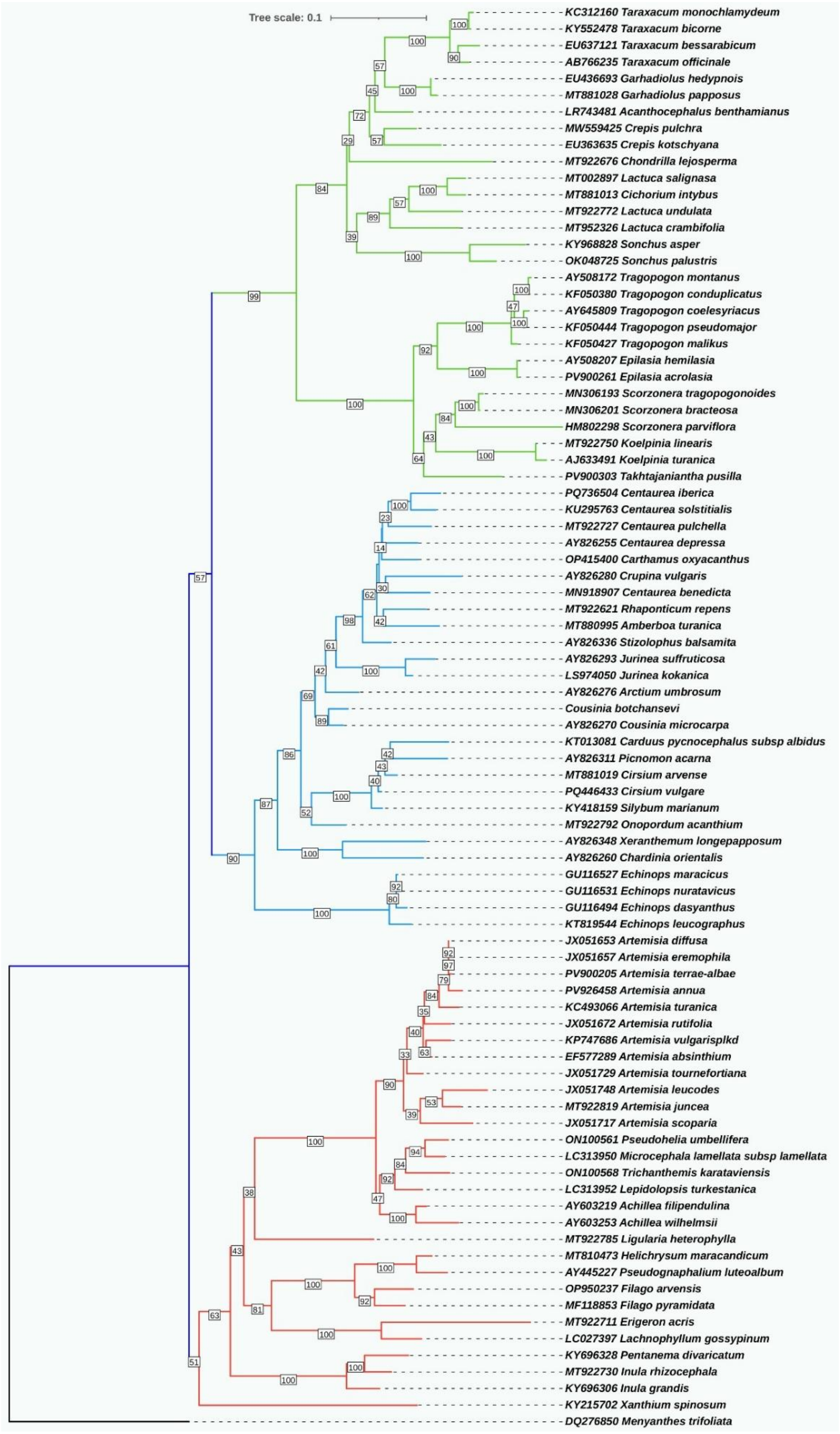
1-picture. General multiple alignment matrix of ITS nucleotide sequences of species of the Asteraceae family.

The tree shows three large, well-separated clades (see Figure 17), which correspond to the traditional subfamilies Asteroideae, Carduoideae, and Cichorioideae of the Asteraceae family. The trunk (main) branches are separated by high support, with the monophyly of Cichorioideae and Carduoideae confirmed by high/large bootstraps; the Asteroideae show extensive and diverse branching at the basal (bottom of the tree) part. Some internal nodes show moderate support (around 60–85), which may reflect rapid diversification within the tribes or the resolution limits of the ITS marker.

The basal part of the phylogenetic tree unites species belonging to the subfamily Asteroideae. This clade includes representatives of genera such as Artemisia, Achillea, Inula, Filago, Xanthium, Helichrysum. Most of them are medicinal and essential oil plants. Bootstrap values are in the range of 80–100%, and intergeneric relationships within the clade are well resolved.

The central part of the tree corresponds to the subfamily Carduoideae. This clade includes thorny plants such as Centaurea, Carthamus, Cousinia, Jurinea, Echinops, Cirsium, Silybum. An endemic species typical for the flora of Uzbekistan — Cousinia bostchansevii — was included in molecular analyses for the first time

The upper part of the phylogenetic tree corresponds to the subfamily Cichorioideae. This clade includes the genera Taraxacum, Lactuca, Cichorium, Sonchus, Tragopogon, Crepis, Chondrilla, Scorzonera. A distinctive feature of this group is the presence of milky juice in the leaves. In the tree, the species Taraxacum officinale, Taraxacum bessaarabicum and Taraxacum bicorne were grouped together with 100% bootstrap, showing a high level of genetic similarity within the family.


Tree scale: 0.1
KC312160 Taraxacum monochlamydeum
KY552478 Taraxacum bicorne
EU637121 Taraxacum bessarabicum
AB766235 Taraxacum officinale
EU436693 Garhadiolus hedypnois
MT881028 Garhadiolus papposus
LR743481 Acanthocephalus benthamianus
MW559425 Crepis pulchra
EU363635 Crepis kotschyana
MT922676 Chondrilla lejosperma
MT002897 Lactuca salignasa
MT881013 Cichorium intybus
MT922772 Lactuca undulata
MT952326 Lactuca crambifolia
KY968828 Sonchus asper
OK048725 Sonchus palustris
AY508172 Tragopogon montanus
KF050380 Tragopogon conduplicatus
AY645809 Tragopogon coelesyriacus
KF050444 Tragopogon pseudomajor
KF050427 Tragopogon malikus
AY508207 Epilasia hemilasia
PV900261 Epilasia acrolasia
MN306193 Scorzonera tragopogonoides
MN306201 Scorzonera bracteosa
HM802298 Scorzonera parviflora
MT922750 Koelpinia linearis
AJ633491 Koelpinia turanica
PV900303 Takhtajaniantha pusilla
PQ736504 Centaurea iberica
KU295763 Centaurea solstitialis
MT922727 Centaurea pulchella
AY826255 Centaurea depressa
OP415400 Carthamus oxyacanthus
AY826280 Crupina vulgaris
MN918907 Centaurea benedicta
MT922621 Rhaponticum repens
MT880995 Amberboa turanica
AY826336 Stizolophus balsamita
AY826293 Jurinea suffruticosa
LS974050 Jurinea kokanica
AY826276 Arctium umbrosum
Cousinia botchansevi
AY826270 Cousinia microcarpa
KT013081 Carduus pycnocephalus subsp albidus
AY826311 Picnomon acarna
MT881019 Cirsium arvense
PQ446433 Cirsium vulgare
KY418159 Silybum marianum
MT922792 Onopordum acanthium
AY826348 Xeranthemum longepapposum
AY826260 Chardinia orientalis
GU116527 Echinops maracicus
GU116531 Echinops nuratavicus
GU116494 Echinops dasyanthus
KT819544 Echinops leucographus
JX051653 Artemisia diffusa
JX051657 Artemisia eremophila
PV900205 Artemisia terrae-albae
PV926458 Artemisia annua
KC493066 Artemisia turanica
JX051672 Artemisia rutifolia
KP747686 Artemisia vulgarisplkd
EF577289 Artemisia absinthium
JX051729 Artemisia tournefortiana
JX051748 Artemisia leucodes
MT922819 Artemisia juncea
JX051717 Artemisia scoparia
ON100561 Pseudohelia umbellifera
LC313950 Microcephala lamellata subsp lamellata
ON100568 Trichanthemis karataviensis
LC313952 Lepidolopsis turkestanica
AY603219 Achillea filipendulina
AY603253 Achillea wilhelmsii
MT922785 Ligularia heterophylla
MT810473 Helichrysum maracandicum
AY445227 Pseudognaphalium luteoalbum
OP950237 Filago arvensis
MF118853 Filago pyramidata
MT922711 Erigeron acris
LC027397 Lachnophyllum gossypinum
KY696328 Pentanema divaricatum
MT922730 Inula rhizocephala
KY696306 Inula grandis
KY215702 Xanthium spinosum
DQ276850 Menyanthes trifoliata

2-picture. Phylogenetic tree constructed using Maximum Likelihood (ML) method based on ITS sequences of members of the Asteraceae family.

Foydalanilgan adabiyotlar ro‘yxati:

1. Raunkiaer, C. (1934). The Life Forms of Plants and Statistical Plant Geography. Oxford University Press.

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