Table 1. List of the soil and plant community samples examined in this study

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sample | Coordinates | Altitude  | Community  | Common taxa |
| XJM1 | 45°08′58.3″N, 121°57′08.4″E | 190 m | *Hemarthria sibirica* Community  | *Hemarthria sibirica, Setaria viridis, Polygonum salinum, Salsola collina.* |
| XJM2 | 45°08′58.3″N, 121°57′08.4″E | 19 0m | *Deyeuxia arundinacea* Community | *Polygonum salinum, Hemarthria sibirica, Artemisia scoparia*  |
| XJM3 | 45°08′58.3″N, 121°57′08.4″E | 190 m | *Setaira viridis* Community  | *Setaria viridis, Hemarthria sibirica, Artemisia scoparia*  |
| XJM4 | 45°08′58.3″N, 121°57′08.4″E | 190 m | *Hemarthria sibirica* Community  | *Hemarthria sibirica, Artemisia lavandulaefolia, Artemisia scoparia*  |
| XJM5 | 45°08′58.3″N, 121°57′08.4″E | 190 m | *Leymus chinensis* Community  | *Leymus chinensis, Hemarthria sibirica, Artemisia scoparia*  |
| HS1 | 45°06′19.9″N, 121°20′0.4″E | 384 m | *Achnatherum splendens* Community | *Achnatherum splendens, Setaira viridis, Lespedeza hedysaroides*  |
| HS2 | 45°06′19.9″N, 121°20′0.4″E | 384 m | *Setaira viridis* Community  | *Setaira viridis, Sanguisorba tenuifolia, Artemisia scoparia* |
| HS3 | 45°06′19.9″N, 121°20′0.4″E | 384 m | *Leymus chinensis* Community  | *Leymus chinensis, Cannabis ruderalis, Sanguisorba tenuifolia* |
| HS4 | 45°06′19.9″N, 121°20′0.4″E | 384 m | *Setaira viridis* Community  | *Setaira viridis, Sanguisorba tenuifolia, Artemisia scoparia* |
| HS5 | 45°06′19.9″N, 121°20′0.4″E | 384 m | *Setaira viridis* Community  | *Setaira viridis, Achnatherum splendens, Potentilla chinensis* |
| HS6 | 45°06′19.9″N, 121°20′0.4″E | 384 m | *Achnatherum splendens* Community | *Achnatherum splendens, Bupleurum chinense, Leymus chinensis*  |
| DQTL1 | 45°12′54.5″N, 121°30′06.2″E | 310 m | *Setaira viridis* Community  | *Setaria viridis, Leymus chinensis, Artemisia scoparia*  |
| DQTL2 | 45°12′54.5″N, 121°30′06.2″E | 310 m | *Stipa capillata* Community  | *Stipa capillata, Setaria viridis, Equisetum hyemale* |
| DQTL3 | 45°12′54.5″N, 121°30′06.2″E | 310 m | *Hemistepta lyrata* Community | *Artemisia scoparia, Hemistepta lyrata, Setaria viridis* |
| DQTL4 | 45°12′54.5″N, 121°30′06.2″E | 310 m | *Artemisia lavandulaefolia* Community | *Artemisia lavandulaefolia, Artemisia scoparia, Setaria viridis* |
| DQTL5 | 45°12′54.5″N, 121°30′06.2″E | 310 m | *Equisetum hyemale* Community | *Equisetum hyemale, Artemisia scoparia, Lespedeza bicolor.* |
| DLNG1 | 42°42′13.2″N, 126°44′43.1″E | 549 m | *Ulmus davidiana -Athyrium brevifrons* Community | Grass: *Sanicula chinensis, Athyrium brevifrons, Festuca ovina* Woody: *Ulmus davidiana, Acer triflorum, Syringa reticulata* |
| DLNG2 | 42°42′13.2″N, 126°44′43.1″E | 549 m | *Ulmus davidiana -Carex rigescens* Community | Grass: *Carex rigescens, Carex siderosticta, Coniogramme japonica*  Woody: *Ulmus davidiana, Pinus sylvestnis, Albizia kalkora* |
| BMZ1 | 42°44′58.9″N, 126°42′32.9″E | 451 m | *Juglans mandshurica-Setaira viridis*  Community  | Grass: *Setaria viridis, Artemisia.sylvatica, Athyrium brevifrons*  Woody: *Tilia amurensis, Acer triflorum, Juglans mandshurica*  |
| BMZ2 | 42°44′58.9″N, 126°42′32.9″E | 451 m | *Ulmus davidiana.-Setaira viridis* Community  | Grass: *Setaria viridis, Peucedanum terebinthaceum, Dioscorea opposita* Woody: *Ulmus davidiana, Acer triflorum, Acer mono*  |
| BMZ3 | 42°44′58.9″N, 126°42′32.9″E | 451 m | *Acer triflorum -Setaira viridis* Community  | Grass: *Setaria viridis, Carex siderosticta, Meehania fargesii*  Woody: *Acer triflorum, Alnus mandshurica, Acer mono* |
| LZG | 43°07′35.3″N, 126°31′52.9″E | 345 m | *Quercus mongolica- Carex siderosticta* Community | Grass: *Carex siderosticta, Artemisia.sylvatica, Vicia unijuga* Woody: *Quercus mongolica, Castanea mollissima, Ulmus macrocarpa*  |
| JHX | 41°26′13.9″N，128°02′39.4″E | 773 m | *Fraxinus mandshurica -Carex rigescens* Community | Grass: *Carex rigescens, Vicia unijuga, Glycine soja*  Woody: *Fraxinus mandschurica, Quercus mongolica, Acer mono*  |
| SLJD | 41°26′29.6″N，127°57′15.4″E | 615 m | *Larix olgensis +Acer mono - Carex siderosticta* Community  | Grass: *Carex siderosticta, Athyrium brevifrons, Vicia unijuga* Woody: *Larix olgensis, Acer mono, Acer pseudo-sieboldianum* |
| XL1 | 42°16′ 59.3″ N，127°23′29.7″ E | 862 m | *Acer mono -Carex siderosticta* Community | Grass: *Carex siderosticta, Vicia unijuga, Galium aparine* Woody: *Acer mono, Quercus mongolica, Acer mandshuricum* |
| XL2 | 42°16′ 59.3″ N，127°23′29.7″ E | 862 m | *Acer pseudo-sieboldianum-Meehania urticifolia* Community | Grass: *Meehania urticifolia, Chloranthus japonicus, Poa annua* Woody: *Acer pseudo-sieboldianum, Populus davidiana, Quercus mongolica* |
| HQC | 42°14′39.6″N，127°31′42.9″E | 743 m | *Tilia amurensis- Carex siderosticta* Community | Grass: *Carex siderosticta, Equisetum hyemale, Cardamine leucantha* Woody: *Pinus koraiensis, Tilia amurensis, Syringa reticulata, Acer mono*  |
| HQC | 42°14′39.6″N，127°31′42.9″E | 743 m | *Acer mono -Carex siderosticta* Community | Grass: *Carex siderosticta, Equisetum hyemale, Athyrium multidentatum* Woody: *Tilia amurensis, Acer mono, Populus davidiana* |
| HQC | 42°14′39.6″N，127°31′42.9″E | 743 m | *Fraxinus mandschurica -Carex siderosticta* Community | Grass: *Carex siderosticta, Cardamine leucantha, Galium aparine* Woody: *Pinus koraiensis, Fraxinus mandschurica, Albizia kalkora* |
| QYC1 | 42°20′14.3″N, 127°36′0.6″E | 806 m | *Acer mono-Carex rigescens* Community | Grass: *Urtica laetevirens, Carex rigescens, Athyrium brevifrons*  Woody: *Tilia amurensis, Juglans mandshurica, Acer mono* |
| QYC2 | 42°20′14.3″N, 127°36′0.6″E | 806 m | *Betula platyphylla.-Carex rigescens* Community | Grass: *Meehania urticifolia, Carex rigescens, Ostericum uiridiflorum*  Woody: *Betula platyphylla, Ulmus davidiana, Acer mono* |
| QYC3 | 42°20′14.3″N, 127°36′0.6″E | 806 m | *Juglans mandshurica -Carex rigescens* Community | Grass: *Carex rigescens, Cardamine leucantha, Anthriscus sylvestris*  Woody: *Juglans mandshurica, Betula platyphylla, Ulmus macrocarpa* |
| FMC2 | 41°58′18.7″N，127°40′45.7″E | 930 m | *Larix olgensis +Quercus mongolica - Carex rigescens* Community | Grass: *Carex siderosticta, Equisetum hyemale, Carex rigescens*  Woody: *Larix olgensis, Quercus mongolica, Acer mono* |
| JJB1 | 42°00′38.4″N, 127°40′45.7″E | 893 m | *Tilia amurensis -Deyeuxia arundinacea* Community | Grass: *Deyeuxia arundinacea, Galium aparine, Carex rigescens*  Woody: *Quercus mongolica, Tilia amurensis, Acer mono* |
| JJB2 | 42°00′38.4″N, 127°40′45.7″E | 893 m | *Quercus mongolica-Calamagrostis epigeios* Community | Grass: *Carex siderosticta, Equisetum hyemale, Calamagrostis epigeios* Woody: *Quercus mongolica, Tilia amurensis, Ulmus davidiana*  |
| JJB3 | 42°00′38.4″N, 127°40′45.7″E | 893 m | *Populus davidiana-Calamagrostis epigeios* Community | Grass: *Calamagrostis epigeios, Carex siderosticta, Filipendula palmata*  Woody: *Populus davidiana* |
| CSN1 | 41°52′7.6″N, 127°41′13.5″E | 888 m | *Acer triflorum -Urtica laetevirens* Community | Grass: *Urtica laetevirens, Equisetum hyemale, Galium aparine*  Woody: *Quercus mongolica, Acer triflorum, Acer mono*  |
| CSN2 | 41°52′7.6″N, 127°41′13.5″E | 888 m | *Acer triflorum -Equisetum hyemale* Community | Grass: *Urtica laetevirens, Equisetum hyemale, Carex siderosticta*  Woody: *Quercus mongolica, Acer triflorum, Ulmus davidiana* |
| CSN3 | 41°52′7.6″N, 127°41′13.5″E | 888 m | *Abies nephrolepis - Equisetum hyemale* Community | Grass: *Equisetum hyemale, Urtica laetevirens, Cardamine leucantha*  Woody: *Quercus mongolica, Acer triflorum* |

Table 2. List of the soil samples examined in this study

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sample | Coordinates | Altitude | Community types | Soil type |
| TY | 44°57′35.5″, 122°35′08.9″ | 183 | *Leymus chinensis* community | Meadow soil  |
| SJZ | 44°54′18.4″, 122°48′03.1″ | 179 | *Setaira viridis* community | Meadow soil |
| BZ | 44°31′31.0″, 123°09′06.7″ | 122 | *Leymus chinensis* community | Meadow soil |
| HJD | 44°51′40.5″, 123°2′51.8″ | 149 | *Hemarthria sibirica* community | Chernozem soil |
| FT | 44°47′28.8″, 123°2′24.5″ | 156 | *Setaira viridis* community | Eolian sand soil |
| ELM | 44°46′39.4″, 123°0′17.6″ | 153 | *Leymus chinensis* community | Eolian sand soil |
| WLH | 44°43′18.9″, 122°40′10.2″ | 161 | *Setaria glauca* community | Eolian sand soil |
| DM | 44°40′09″, 122°37′40.6″ | 165 | *Leymus chinensis* community | Eolian sand soil |
| LHT | 44°36′19.6″, 122°38′02.5″ | 157 | *Potentilla flagellaris* community | Meadow soil |
| SYS | 44°28′54.8″, 122°38′0.2″ | 157 | *Deyeuxia arundinacea* community | Chernozem soil |
| DFT | 44°20′38″, 122°34′40.7″ | 160 | *Setaira viridis* community | Meadow soil  |
| BYTH | 44°10′17.2″, 122°20′13.1″ | 159 | *Phragmites australis* community | Meadow soil  |
| HRGT | 44°09′33″, 122°32′51.5″ | 159 | *Serratula centauroides* community | Chestnut soil |
| XHLM | 44°05′40.4″, 122°42′54.4″ | 154 | *Artemisia sylvatica* community | Chestnut soil |
| BXTS | 43°52′58.5″, 122°42′09.7″ | 153 | *Leymus chinensis* community | Eolian sand soil |
| BSX | 49°04′12.2″, 128°52′42.7″ | 351 | *Larix olgensis* – *Carex siderosticta* community | Dark brown soil |
| KEB | 48°48′12.5″, 128°56′15.5″ | 439 | *Betula platyphylla*-*Carex rigescens* community | Dark brown soil |
| JY | 48°41′54.3″, 129°12′27.3″ | 525 | *Pinus koraiensis*-*Athyrium brevifrons* community | Dark brown soil |
| WYL | 48°36′55.1″, 129°24′7.1″ | 422 | *Abies fabri*-*Filipendula Palmata* community | Dark brown soil |
| YQ | 48°24′8.1″, 129°34′3.7″ | 332 | *Larix olgensis* –*Athyrium brevifrons* community | Peat soil |
| HX | 48°14′5.1″, 129°25′27″ | 322 | *Betula platyphylla*-*Carex rigescens* community | Boggy soil |
| YX | 48°01′52.3″, 129°8′9.8″ | 323 | *Pinus koraiensis*-*Athyrium brevifrons* community | Dark brown soil |
| CY | 45°28′34.5″, 127°28′55.2″ | 287 | *Juglans mandshurica*-*Artemisia latifolia* community | Dark brown soil |
| MYS | 47°12′15.2″, 128°21′49.7″ | 293 | *Phellodendron amurense*-*Carex siderosticta* community | Dark brown soil |
| WH | 47°05′49.6″, 128°13′13.8″ | 248 | *Juglans mandshurica*-*Filipendula Palmata* community | Dark brown soil |
| XL | 47°00′22.8″, 127°35′16.2″ | 202 | *Ulmus davidiana*-*Hippochaete hiemale* community | Black soil |
| SL | 46°46′55.4″, 127°24′6.1″ | 220 | *Quercus mongolica*-*Carex siderosticta* community | Dark brown soil |
| JBS | 46°39′18.6″, 127°30′4.2″ | 220 | *Larix olgensis*-*Carex siderosticta* community | Dark brown soil |
| HSH | 46°38′32″, 127°24′43.5″ | 177 | *Quercus mongolica*-*Hippochaete hiemale* community | Dark brown soil |

Table 3. Representative index values of different phytolith morphotypes in the western grassland area

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Types | Morphotypes | A | U | O | CC | C | R |
| Associative types | Saddle(H) | 1.00 | 0.00 | 0.00 | 1.00 | 0.25 | 2.14 |
| Rondel(H) | 1.00 | 0.00 | 0.00 | 1.00 | 0.18 | 2.17 |
| Bilobate(H) | 1.00 | 0.00 | 0.00 | 1.00 | 0.12 | 1.08 |
| Cross(H) | 0.60 | 0.31 | 0.18 | 0.75 | -0.30 | 0.47 |
| Cylindrical polylobate(H) | 0.69 | 0.15 | 0.21 | 0.81 | 0.10 | 1.42 |
| Trapeziform sinuate(H) | 0.94 | 0.00 | 0.06 | 0.97 | 0.08 | 5.17 |
| Elongate psilate(U) | 1.00 | 0.00 | 0.00 | 1.00 | -0.35 | 7.61 |
| Elongate echinate(U) | 0.75 | 0.00 | 0.25 | 0.86 | -0.08 | 9.48 |
| Elongate attenuate(U) | 0.75 | 0.08 | 0.20 | 0.86 | -0.05 | 0.51 |
| Lanceolate(H) | 1.00 | 0.00 | 0.00 | 1.00 | 0.43 | 4.28 |
| Tabular irregular(U) | 0.75 | 0.00 | 0.25 | 0.86 | -0.17 | 8.94 |
| Over-representedtypes | Elongate crenate(H) | 0.38 | 0.00 | 0.63 | 0.55 | -0.22 | 9.00 |
| Elongate tabular(W) | 0.50 | 0.00 | 0.50 | 0.67 | -0.25 | 20.55 |
| Square(U) | 0.40 | 0.14 | 0.57 | 0.57 | 0.01 | 7.49 |
| Rectangle(U) | 0.63 | 0.09 | 0.33 | 0.77 | -0.46 | 17.82 |
| Cubic(W) | 0.06 | 0.00 | 0.94 | 0.12 | -0.18 | 14.84 |
| Lanceolate attenuate(U) | 0.25 | 0.00 | 0.75 | 0.40 | -0.31 | 30.64 |
| Scutiform(H) | 0.00 |  | 1.00 | 0.00 |  |  |
| Cuneifrom(H) | 0.00 |  | 1.00 | 0.00 |  |  |
| Blocky irregular(W) | 0.38 | 0.00 | 0.63 | 0.55 | -0.17 | 12.86 |
| Under- represented types | Microhair(H) | 0.00 | 1.00 |  | 0.00 |  | 0.00 |
| Stomata(U) | 0.14 | 0.86 | 0.00 | 0.25 | 0.37 | 0.03 |
| Conical epidermal(H) | 0.29 | 0.33 | 0.67 | 0.44 | 0.36 | 0.22 |
| Epidermal phytolith(U) | 0.31 | 0.64 | 0.33 | 0.47 | -0.13 | 0.74 |
| Elongate dendritic(W) | 0.30 | 0.57 | 0.50 | 0.46 | -0.07 | 0.21 |
| Hair base(U) | 0.00 | 1.00 |  | 0.00 |  | 0.00 |
| Tracheid(U) | 0.38 | 0.55 | 0.29 | 0.56 | -0.02 | 0.52 |
| Special types | Prickle(H) | 0.00 |  | 1.00 | 0.00 |  |  |
| Tabular sinuate(U) | 0.00 | 1.00 | 1.00 | 0.00 | -0.18 | 0.00 |
| Carinate(H) | 0.00 | 1.00 | 1.00 | 0.00 | -0.07 | 0.00 |
| Blocky faceted(U) | 0.00 |  | 1.00 | 0.00 |  |  |
| Elongate sinuate(U) | 0.17 | 0.00 | 0.83 | 0.29 | 0.38 | 1.21 |
| Elongate cavate terminal(H) | 0.17 | 0.60 | 0.78 | 0.29 | 0.24 | 1.57 |
| Macrohair(U) | 0.00 | 1.00 | 1.00 | 0.00 |  | 0.00 |

Note: Phytoliths from woody plants, herbaceous plants and unknown are abbreviated as W, H and U, respectively.

Table 4. Representative index values of different phytolith morphotypes in the eastern forested area

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Types | Morphotypes | A | O | U | CC | C | R |
| Associative types | Elongate psilate(U) | 0.91 | 0.00 | 0.09 | 0.95 | 0.23 | 15.18 |
| Elongate tabular(W) | 1.00 | 0.00 | 0.00 | 1.00 | 0.19 | 4.89 |
| Elongate echinate(U) | 0.65 | 0.00 | 0.35 | 0.79 | 0.07 | 5.67 |
| Elongate attenuate(U) | 0.83 | 0.17 | 0.00 | 0.90 | -0.22 | 0.34 |
| Lanceolate(H) | 1.00 | 0.00 | 0.00 | 1.00 | -0.16 | 11.78 |
| Blocky irregular(U) | 1.00 | 0.00 | 0.00 | 1.00 | 0.22 | 8.79 |
| Tabular irregular(U) | 1.00 | 0.00 | 0.00 | 1.00 | 0.12 | 4.51 |
| Tabular sinuate(U) | 0.65 | 0.25 | 0.17 | 0.79 | 0.20 | 0.53 |
| Cuneifrom(H) | 1.00 | 0.00 | 0.00 | 1.00 |  |  |
| Over-represented types | Elongate sinuate(U) | 0.48 | 0.15 | 0.48 | 0.65 | 0.18 | 3.48 |
| Elongate crenate(H) | 0.57 | 0.00 | 0.43 | 0.72 | -0.01 | 10.46 |
| Trapeziform sinuate(H) | 0.64 | 0.00 | 0.36 | 0.78 | -0.09 | 6.19 |
| Lanceolate attenuate(U) | 0.70 | 0.00 | 0.30 | 0.82 | -0.15 | 15.95 |
| Rondel(H) | 0.74 | 0.00 | 0.26 | 0.85 | 0.52 | 30.82 |
| Bilobate(H) | 0.61 | 0.00 | 0.39 | 0.76 | 0.34 | 13.02 |
| Cylindrical polylobate(H) | 0.32 | 0.13 | 0.67 | 0.48 | 0.32 | 2.58 |
| Saddle(H) | 0.43 | 0.09 | 0.55 | 0.61 | -0.07 | 7.80 |
| Prickle(H) | 0.35 | 0.00 | 0.65 | 0.52 | 0.09 | 7.01 |
| Under- represented types | Epidermal phytolith(U) | 0.61 | 0.39 | 0.00 | 0.76 | 0.11 | 0.24 |
| Tracheid(U) | 0.48 | 0.52 | 0.00 | 0.65 | -0.01 | 0.04 |
| Conical epidermal(H) | 0.30 | 0.70 | 0.00 | 0.47 | 0.25 | 0.00 |
| Elongate cavate terminal(H) | 0.42 | 0.50 | 0.29 | 0.59 | 0.18 | 0.83 |
| Stomata(U) | 0.04 | 0.96 | 0.00 | 0.08 | -0.18 | 0.00 |
| Blocky faceted(U) | 0.30 | 0.68 | 0.14 | 0.46 | -0.27 | 1.05 |
| Macrohair(U) | 0.04 | 0.96 | 0.00 | 0.08 | -0.04 | 0.00 |
| Special types | Elongate dendritic(W) | 0.11 | 0.88 | 0.50 | 0.19 | -0.16 | 0.04 |
| Scutiform(H) | 0.00 |  | 1.00 | 0.00 |  |  |
| Cross(H) | 0.13 | 0.60 | 0.83 | 0.24 | -0.22 | 0.40 |
| Carinate(H) | 0.00 | 1.00 | 1.00 | 0.00 | -0.15 | 0.00 |
| Sclereid(W) | 0.11 | 0.86 | 0.67 | 0.20 | -0.08 | 0.00 |