A Study of an Alder Forest and an Elm Forest with Special Reference to their Geomorphological Conditions in a Small Tributary Basin

by

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Introduction

An alder (*Alnus japonica*) forest and an elm (*Ulmus davidiana*) forest are typical swamp forests in Japan. Not a few reports are published referring to these types of forest in various regions (Kato 1952, Suzuki 1954, Kashimura *et al.* 1965, Tatewaki *et al.* 1967, Asano *et al.* 1969, Makita *et al.* 1976, etc.). Many of them, however, deel with only floristic compositions and structures of the communities and a close investigation of their habitat conditions has not been enough. In the present paper, a certain aspect of the relationship between community types and habitat conditions, shall be discussed especially geomorphological units and their surface materials, in a small tributary basin, called tentatively "Iwana-zawa". It has a streamlet in which *Iwana* (chars) live, and the greater part of the valley floor is covered with such swamp forest communities.

I. A general view of the study area.

The study area lies in a small tributary valley which is dissecting a hilly

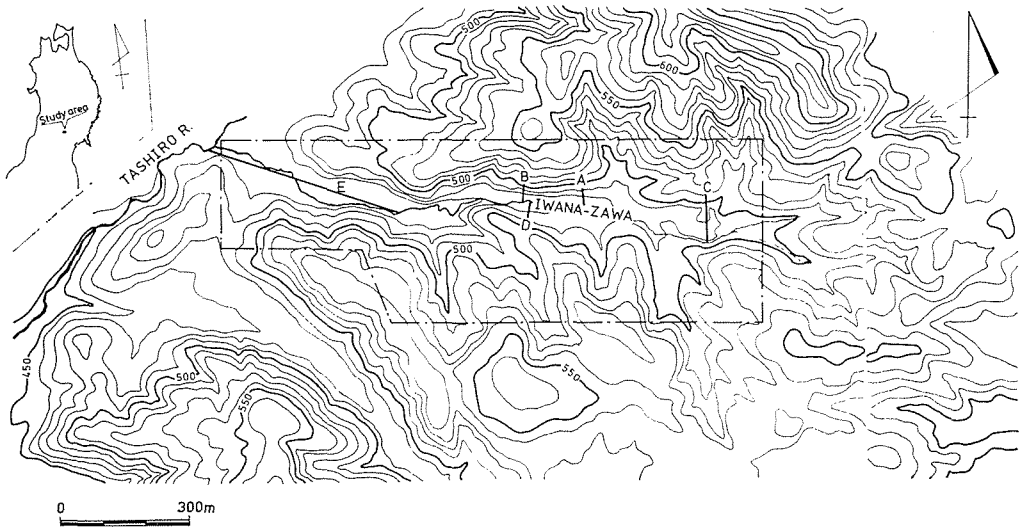

Fig. 1. Index map of the study area. A-E correspond to the location of cross-section shown in Figs. 4–8.

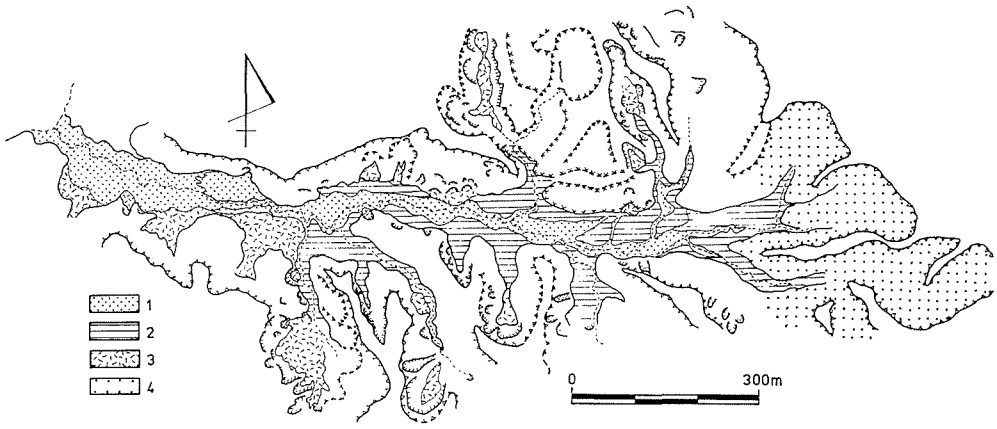

Fig. 2. Geomorphological map of Iwana-zawa. 1: Flood plain. 2: Depositional surface called "Iwana-zawa surface". 3: Debris of landslides. 4: Trough type valley head."

land, 600m a. s. l. at the highest point, in the northwesternmost part of Miyagi Prefecture, northeast Japan (Fig. 1).

This tributary, of which catchment area is 1 km^2, joins with the main stream, the Tashiro River, at a point 80 m lower in relative height and 1,500 m in distance from the divide. It is divided into three parts, the upper, the middle and the lower, and the last two are very gentle in inclination and their valley floors are 50–100 m and 50–70 m in width respectively. The larger part of the valley floor is covered with flood plains which is usually low and very humid, though it is paptly not or humid or mesic.

Failures, namely slumps and landslides, are often found on side slopes and small mudflow deposits and alluvial cones develop at mouths of small tributaries joining the Iwana-zawa. Such mass movement deposits cover the valley floor forming a depositional surface. Such depositional landforms prevail especially in the middle part while the lower part is occupied mainly by a flood plain (Fig. 2).

A small knick point is found near the boundary of the middle and the lower parts where a base rock is exposed in the valley floor. The upper part with a narrower valley floor along with the valley head lies out side the present study area.

Valley slopes are mostly covered with a semi-natural *Quercus serrata* forest, while the valley floor with stands of *Alnus japonica* and *Ulmus davidiana* with a few stards of *Q. serrata* and *Miscanthus sinensis* grasslands (Fig. 3).

A result of classification of the *Alnus japonica* forest and the *Ulmus davidiana* forest by the aid of species composition is shown in Table 1.

II. Plant communities.

1. *Ulmus davidiana* forest.

Ulmus davidiana, with the occasional occurence of *Magnolia kobus*, *Juglans ailanthifolia*, *Morus bombycis*, *Fraxinus mandshurica* var. *japonica*, *Acer mono*,

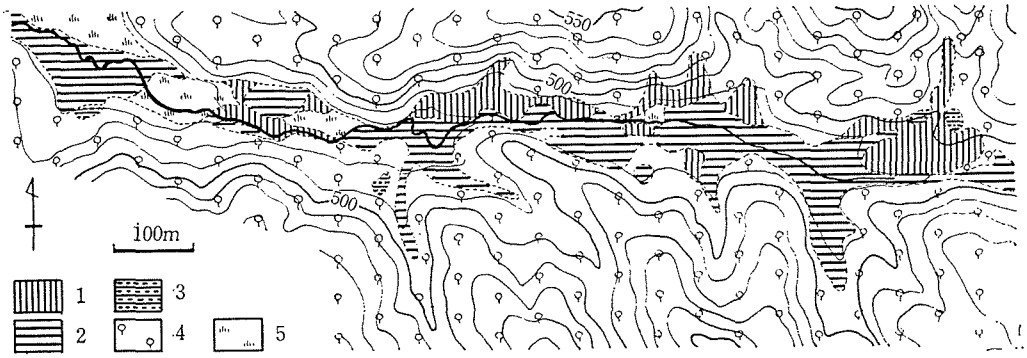

Fig. 3. Vegetation map of Iwana-zawa. 1: *Ulmus devidiana* community. 2: *Alnus japonica-Carex fulta* comm., including *Alnus japonica-Sasa senanensis* comm. 3: *Alnus japonica-Miscanthus sinensis* comm. 4: *Quercus serrata* comm. 5: Grassland.

etc., composes a tree layer that reaches 12 m, at the maximum 20 m, in height and 80–90% in coverage. Saplings of *Ulmus davidiana* occur with high constancy in poorly developed subtree and shrub layers accompanied with *Acer palmatum* var. *matsumurae*, *Viburnum opulus* var. *calvescens*, *Ligustrum tschonoskii*, *Sambucus sieboldiana*.

A herb layer develops well with coverage of 50–70%, comprising tall herbs such as *Cacalia hastata* var. *orientalis*, *Ligularia stenocephala*, *Heracleum dulce*, *Angelica ursina*, *Cirsium nipponicum*, etc.

2. *Alnus japonica-Carex fulta* community.

Two types are distinguished in this community (Table 1). One of them, a *Filipendula kamtschatica* type, has a tree layer of which height reaches 12–15 m and coverage 70–90%, while another, a *Phragmites communis* type, has one of 8–15m in height and 10–80% in coverage. Although only a few scatter in some stands of the latter, *Alnus japonica* dominates both types accompanied with *Fraxinus mandshurica* var. *japonica*. Subtree layers poorly develop in both types. Shrub layers develop markedly containing many *Hydrangea paniculata*, *Viburnum opulus* var. *calvescens*, *Ligustrum tschonoskii*, *Symplocos chinensis* var. *leucocarpa* f. *pilosa* and their coverage reaches sometimes up to 70%. Herb layers develop still more markedly showing the coverage of 50–70% in both types having common constituents in low moors in Japan, such as *Carex fulta*, *C. rhynchophysa*, *Ligularia fischeri*, *Dryopteris tokyoenses*, *Osmundastrum cinnamoneum* var. *fokiense*, *Onoclea sensibilis* var. *interrupta* and so on.

3. *Alnus japonica-Sasa senanensis* community.

Alnus japonica with a few *Fraxinus mandshurica* var. *japonica* dominates a tree layer which is 15m in height and 70–90% in coverage. A subtree layer is grown 30–70% in coverage with *Acer palmatum* var. *matsumurae*, *A. japonicum*, etc. Dense growth of *Sasa senanensis* constituting a shrub layer up to 100% in coverage is a remarkable characteristic of this community. Also *Cephalotaxus harringtonia* var. *nana*, *Ilex crenata* var. *paludosa*, *Hydrangea paniculata*, *Ligustrum tschonoskii*, etc. occur in this layer but very small in number. A herb

layer is extremely poor.

4. *Alnus japonica-Miscanthus sinensis* community.

A tree layer consists mostly of *Alnus japonica* with a few *Fraxinus mandshurica* var. *japonica*, and is 15–18m in height and 70–80% in coverage.

In the subtree layer *Fraxinus mandshurica* var. *japonica*, *Acer palmatum* var. *matsumurae*, etc. are found but in low coverage of 10–40%. A luxuriant shrub layer with coverage up to 70% is constituted by *Viburmun dilatatum*, *V. opulus* var. *calvescens*, *Ilex crenata* var. *paludosa*, *Hydrangea paniculata*, *Ligustrum tschonoskii*. A herb layer is grown well with coverage of 40–60% by *Miscanthus sinensis*, *Pteridium aquilinum* var. *latiusculum*, *Viburnum dilatatum*, *Rubus parvifolius* and others which are common to the *Quercus serrata* forest and to grasslands. It is a remarkable characteristic of this community.

III. Landforms and surface materials of the valley floor as habitats of the plant communities

As stated above many failures are found on the side slopes along the Iwana-zawa and its small tributaries, supplying a lot of materials to the Iwana-zawa till today. From the knick point, mentioned above, upward, a depositional surface called "Iwana-zawa surface" (Makita *et al.* 1976) composed mainly of mass-movement deposits is found. On the other hand, from the point downward, the streamlet transported failure materials and deposited them on the valley floor as a gray gravel bed of a few meter in thickness at the maximum. Present landforms in this valley, classified as in Fig. 2, have been constructed through secondary small-scale massmovements and fluvial processes which have taken place in the above materials. From the knick point upward, the Iwana-zawa surface is covered with massmovement deposits of about 1m in depth, which are originated from earthflow deposits at mouths of tributaries and secondary failures on side slopes. Along the stream, flood plains of 30–60cm in height from the river bed develop cutting the Iwana-zawa surface.

In the area within 100–200m from the knick point downward, wash materials (brown gravel bed, subround to round) cover the gray gravel bed ligulately forming a mesic surface of 1–2m in height from the river bed. Still more downward clay and silt cover the gray gravel bed as muck and humus scattering

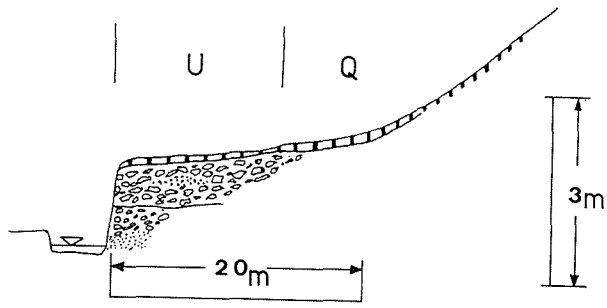

Fig. 4. Cross-section of Iwanazawa surface along the line A in Fig. 1. For keys to sediments and community types see Fig. 8.

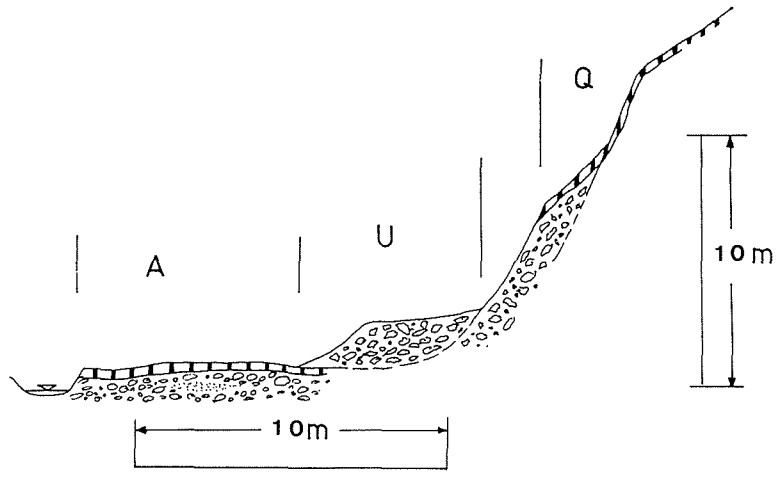

Fig. 5. Cross-section of flood plain and small failures along the line B in Fig. 1. For keys to sediments and community types see Fig. 8.

over the valley floor forming a wide swamp.

^{14}C ages of wood pieces found from the brown round gravel, silt and clay are 210±85 (TH-255) and 500±90 (TH-257) years B. P. A burried humus layer just below those recent deposits shows a ^{14}C age of 1,500±120 years B. P. (TH-256) (Omoto 1978). Therefore, the present landsurface has been constructed during the last 1,000 years.

Relationships between the landforms and the plant communities found in this valley floor are shown in Fig. 4 through Fig. 8.

In an example of the uppermost part of the study area (Fig. 4), an emerged flood plain is covered with failure materials containing subangular to subround gravels, and the *Ulmus devidiana* community occurs on them. At a slump shown in Fig. 5, a scarpment is not yet covered with vegetation, while saplings and young trees of *Ulmus devidiana* already grow on deposits. Habitats of *Ulmus davidiana* community thus lie on depositional areas of failures, which are found in every part of the valley of which ages varys from rather old to very young (Miyagi 1976).

Fig. 6 shows a cross-section running through earthflow deposits, which were formed at a mouth of a small tributary, and a flood plain along the streamlet. Materials forming an angular gravel bed found at the lower part of the profile are thought to have been originated from comparatively large failures occurring at the upper part of the tributary. The *Ulmus davidiana* community occurs where this angular gravel bed is found. Along the terminal of the Iwana-zawa surface, however, a *Quercus serrata* forest is found. An *Alnus japonica-Miscanthus sinensis* community occupies a toe of the side slope and the part of the Iwana-zawa surface adjacent to it (Fig. 6). Differences in the condition of the surface materials between the habitat of the last two communities and that of the *Ulmus davidiana* community are not yet clear.

A flood plain is formed covering the Iwana-zawa surface in Fig. 7, an ex-

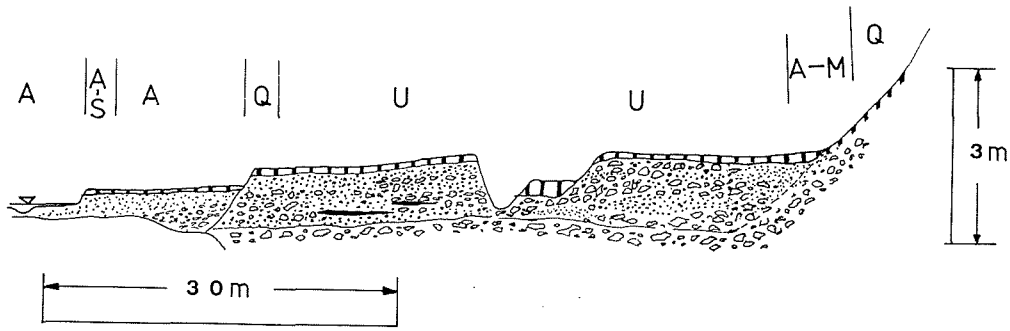

Fig. 6. Cross-section of flood plain and Iwana-zawa surface along the line C in Fig. 1. For keys to sediments and community types see Fig. 8.

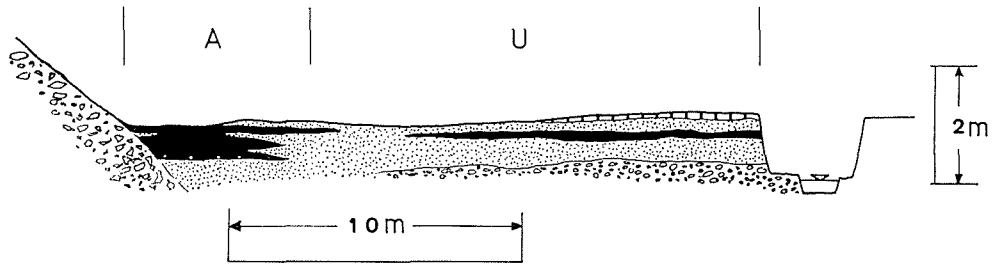

Fig. 7. Cross-section of flood plain along the line D. in Fig. 1. For keys to sediments and community types see Fig. 8.

ample from the middle part. There the *Ulmus davidiana* community occurs on a sandy flood plain and the *Alnus japonica-Carex fulta* community takes place on the thick muck accumulation on the point where an abandoned channel is supposed to run.

Fig. 8 is a cross section running from the brown gravel bed, which constitutes the ligulate mesic surface mentioned above, through the silty and clayey swampy area to the junction to the Tashiro River. The *Ulmus davidiana* community occurs on this gravel bed; however, the areas where thick humus accumulates are occupied by the *Alnus japonica-Carex fulta* community. Such areas are supposed to be abandoned channels that cut in the gravel bed (represented with an asterisk in the figure).

The *Alnus japonica-Carex fulta* community occurs broadly on the swampy area where the gravel bed is thin and black to brown humus accumulates thickly. *Phragmites communis* grows as an undergrowth where especially thick muck accumulates.

Slightly higher areas like small natural levee composed of fine sand are found along the channel, where the *Ulmus davidiana* community occurs.

Conclusion and summary

Stands of *Alnus japonica* and *Ulmus davidiana* occupy the humid and rather mesic habitats of the valley floor of this small tributary basin. Among the

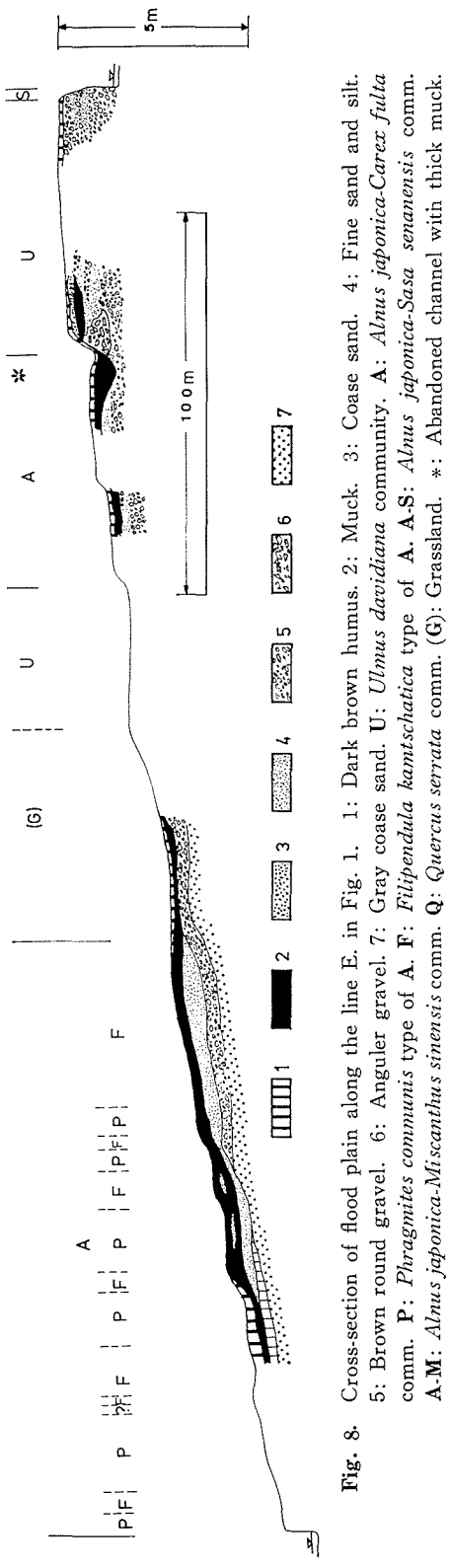

Fig. 8. Cross-section of flood plain along the line E. in Fig. 1. 1: Dark brown humus. 2: Muck. 3: Coase sand. 4: Fine sand and silt. 5: Brown round gravel. 6: Anguler gravel. 7: Gray coase sand. **U**: *Ulmus davidiana* community. **A**: *Alnus japonica-Carex fulta* comm. **P**: *Phragmites communis* type of **A. F**: *Filipendula kamtschatica* type of **A. A-S**: *Alnus japonica-Sasa senanensis* comm. **A-M**: *Alnus japonica-Miscanthus sinensis* comm. **Q**: *Quercus serrata* comm. (**G**): Grassland. *: Abandoned channel with thick muck.

three communities belonging to the former (Table 1), the *A. japonica-Carex fulta* community occupies the typical swampy habitats and far greater area than the others.

So far, studies on Japanese swamp forests have reported that *A. japonica* communities occur on wet habitats and *U. davidiana* communities on drier ones and the former take place as the earlier stage of the latter (e.g. Tatewaki 1967).

In the present study, however, it has been clarified that there is an obvious difference between their habitat conditions other than humidity of soils, i. e. the *A. japonica* community occurs on fluvial fine surface materials and the *U. davidiana* community on coaser ones deposited by fluvial or mass movement processes.

A depositional surface composed of mass movement materials or fluvial ones is found throughout the middle and the lower part of this basin. They are supposed to have been doposited several thousand years ago as contemporaneous heterotopic facies. However, the present landforms that constitute the habitats of the plant communities were caused by failures and fluvial processes which occurred in the older deposits, as mentioned above, in the last several hundred years. In the middle part of the valley, coarse deposits originated from mass movements are found broadly and finer ones are found along the present and abandoned channels. In the lower part, deposits are assumed to have been originated from large floods transporting the above mass movement deposits. Coarser materials are found mainly in the upper half of this part and finer ones in the lower half. Coaser and finer materials are thought to have been deposited as different facies in a same geomorphological epoch.

From these, it can be concluded that *A. japonica* forests and *U. davidiana* for-

ests occur on fine and coarser materials respectively, and not as two stages of a sere on a homogeneous surface material.

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