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# Seedling Morphology of *Lespedeza* (Leguminosae)

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**Seedling morphology was studied in 22 species of *Lespedeza*, of which six belong to subgenus *Macrolespedeza* and 16 to subgenus *Lespedeza*. Two seedling types were recognized: 1) those with opposite leaves at the first node; 2) those having the first and subsequent leaves alternate. The two types are distinguished in the number of leaf primordia in the plumule of the seed: the opposite type has two leaf primordia, but the alternate type has only one primordium. Most species exhibited one of the two types, but rarely both types were observed in several species. In species having two types, one type always far outnumbers the other. The opposite type was common in Asian species, while the alternate type was common in North American ones. Because seedlings are of the opposite type in *Kummerowia* which is the most closely related genus with *Lespdeza*, the alternate type is considered to be apomorphic in *Lespedeza*. The apomorphic seedling morphology is, therefore, dominantly occurred in North American species of *Lespedeza*. This fact may be an evidence which suggests a monophyletic origin for North American species from an Asian ancestor.**

**Key words: Desmodieae — Leguminosae — *Lespedeza* — Morphology — Seedling**

The genus *Lespedeza* comprises about 40 species and are distributed in Asia and North America. It is attributed to the subtribe Lespedezinae of the tribe Desmodieae. Species of *Lespedeza* can be segregated into two groups mainly on the basis of the presence or absence of cleistogamous flowers. These two groups have been treated taxonomically as sections (Maximowicz 1873; Schindler 1913; Nakai 1927; Akiyama 1988) or as subgenera (Ohashi 1982). The subgenus *Macrolespedeza* is distributed only in Asia and the other subgenus, *Lespedeza*, distributed in Asia and North America.

Seedlings of *Lespedeza* were described by de Candolle (1825), Lubbock (1892), Wassiltschenko (1937), Maekawa (1955), Ohashi (1968) and Akiyama (1988). Although leafy epigeal cotyledons are similarly described, the arrangement of the first one or two leaves subsequent to cotyledons has been reported differently. De Candolle (1825) and Wassiltschenko (1937) described these leaves as being alternate, while Maekawa (1955), Ohashi (1968) and Akiyama (1988) described them as being opposite. Only Lubbock (1892) recognized two kinds of seedlings in *Lespedeza*. The alternate seedling pattern was found in only two species, *L. polystachya* (=*L. hirta*) (de Candolle 1825) and *L. angustifolia* (Lubbock 1892; Wassiltschenko 1937). According to Ohashi *et al.* (1981), the oppositely arranged first true leaves are the prevalent feature of seedling morphology in the tribe Desmodieae.

Although seedling morphology has not been well investigated in *Lespedeza*, seedling patterns may be useful when considered from a systematic point of view. We therefore attempted to clarify the morphology and distribution of the two seedling patterns within *Lespedeza* and, also, to attempt a systematic evaluation of the seedling morphology of the genus.

## Materials and Methods

Of about 40 species recognized in *Lespedeza*, 22 species (six of subgenus *Macrolespedeza* and 16 of subgenus *Lespedeza*) were studied. The origin of seed samples is shown in Appendix 1. Voucher specimens cited are all kept in the Herbarium of the Biological Institute, Faculty of Science, Tohoku University (TUS).

To observe seedling morphology, the seeds were scarified by scratching the seed-coat with a needle or razor, kept in petri dishes filled with water for one day, and then transplanted to pots in the greenhouse of the Biological Institute.

To observe plumules in mature seeds, FAA was infiltrated into scratched seeds for fixation and softening. The softened seed-coats were stripped away and the embryos were exposed. The cotyledons of the exposed embryos were cut off and the embryos were dehydrated in an alcohol series, transferred to isoamyl acetate, dried in a critical point dryer, placed on aluminum stubs, coated with gold, and observed by a JEOL JSM-840 scanning electron microscope.

## Results

### *Morphology of seedlings*

All species studied have epigeal cotyledons, which are

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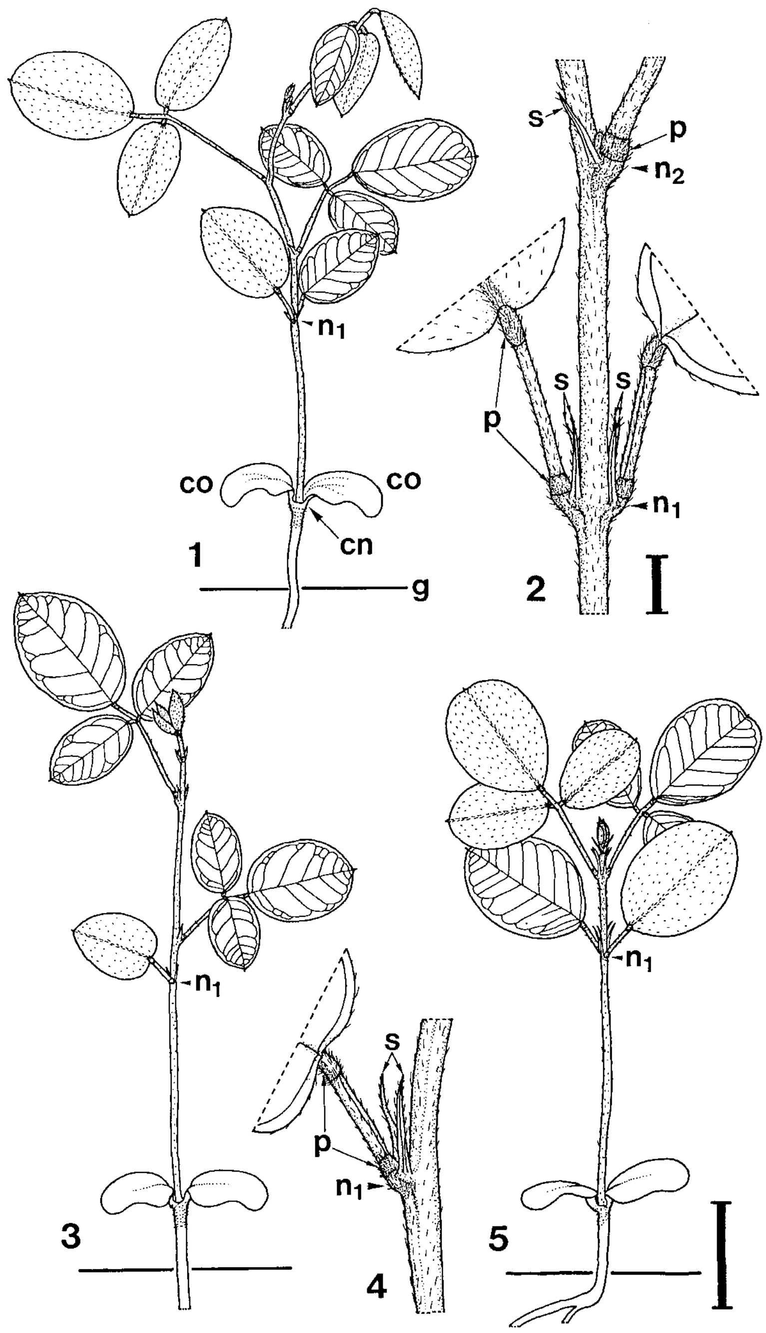
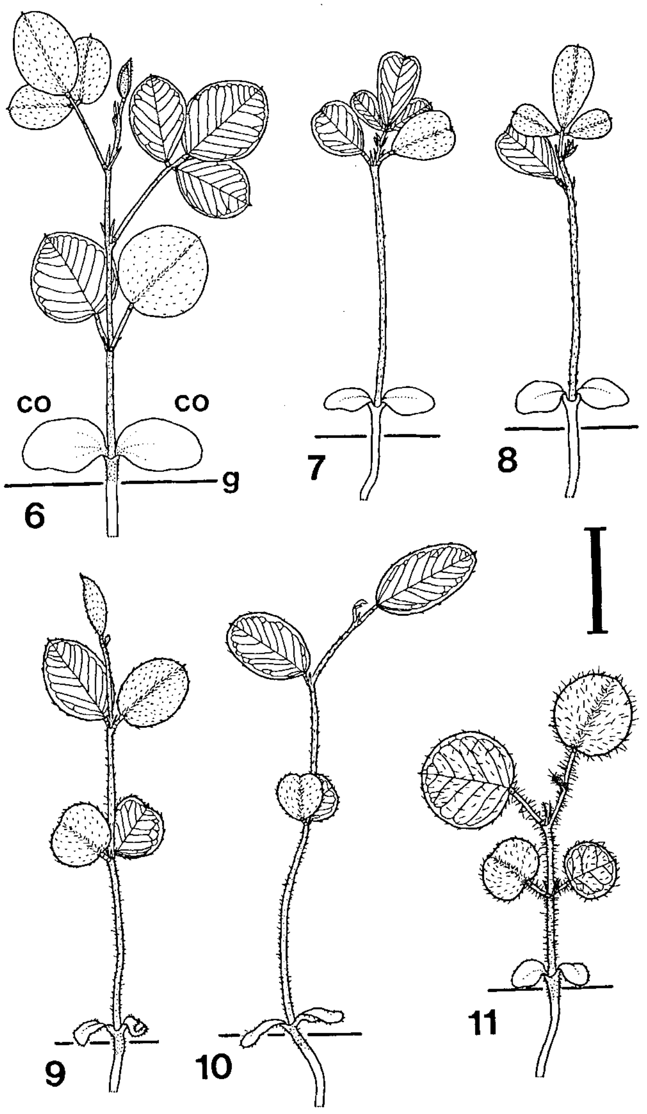


Figs. 1-5. Seedlings of Asian species of *Lespedeza* (subgenus *Macrolespedeza*). 1-4. *L. formosa* (*T. Nemoto 5852*). 2. First ($n_1$) and second ($n_2$) nodes of 1. 4. First node of 3. 5. *L. patens* (*T. Nemoto 4234*). Horizontal bars (g) under cotyledons show ground level. cn, cotyledonary node; co, cotyledon; $n_1$, first node; $n_2$, second node; p, pulvinus; s, stipule. Scale bars: 1 cm (1, 3, 5) and 1 mm (2, 4).

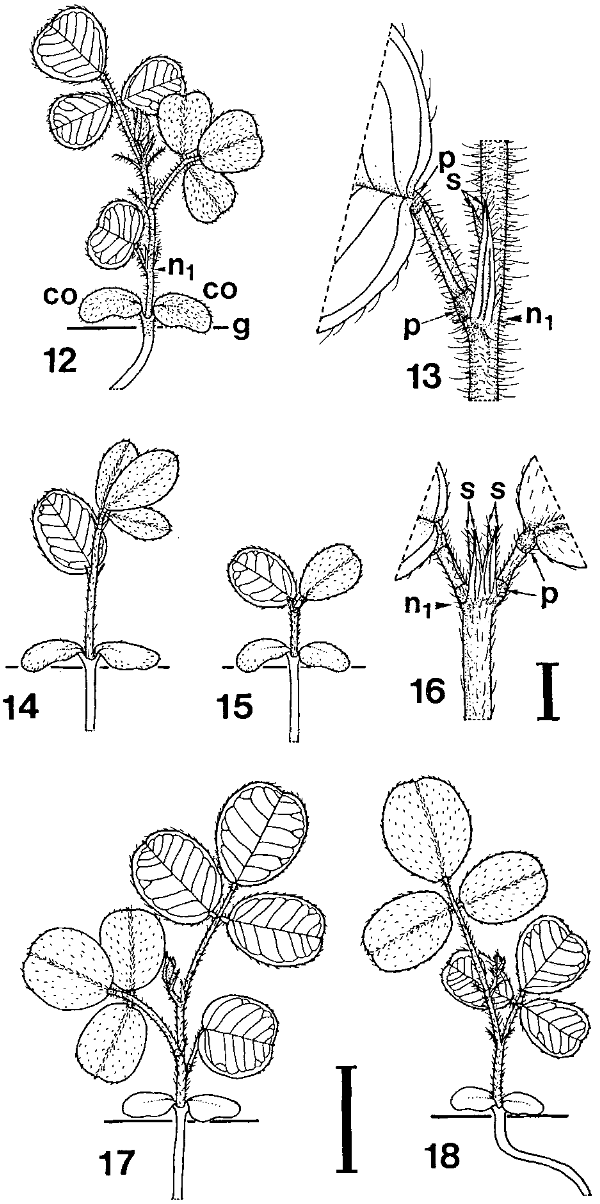
greenish, sessile, estipulate, foliate and opposite (Figs. 1, 3, 5, 6-11, 12, 14, 15, 17, 18). One to several foliage leaves subsequent to the cotyledons are usually 1-foliolate, whereas the usual adult leaves following the juvenile leaves are 3-foliolate. Pulvini are observed at the base of the petioles and at the joint of the leaflets in juvenile leaves, as in adult leaves (Figs. 2, 4, 13, 16). Two stipules are present at the base of each petioles.

The first two leaves subsequent to the cotyledons are oppositely (Figs. 1, 2, 5-7, 9-11, 15, 16) or alternately arranged (Figs. 3, 4, 8, 12-14, 17, 18). Seedlings of the former are called the "opposite type" and those of the latter the "alternate type". Some species exhibited one of these two types, and others both types (Table 1).

In the opposite type, the first two leaves are all 1-foliolate. A pair of stipules is at the base of each petiole



Figs. 6-11. Seedlings of Asian species of *Lespedeza* (subgenus *Lespedeza*). 6. *L. floribunda* (*T. Nemoto 5877*). 7, 8. *L. cuneata* (*T. Nemoto 5883*). 9, 10. *L. inschanica* (*T. Nemoto 8587*). 11. *L. pilosa* (*T. Nemoto 5861*). Horizontal bars (g) under cotyledons show ground level. co, cotyledon. Scale bar : 1 cm.



Figs. 12-18. Seedlings of North American species of *Lespedeza* (subgenus *Lespedeza*). 12, 13. *L. hirta* (*T. Nemoto 8589*). 13. First node of 12. 14-16. *L. capitata* (*T. Nemoto 5869*). 16. First node of 15. 17, 18. *L. procumbens* (*T. Nemoto 8590*). Horizontal bars (g) under cotyledons show ground level. co, cotyledon ; $n_1$, first node ; $n_2$, second node ; p, pulvinus ; s, stipule. Scale bars : 1 cm (12, 14, 15, 17, 18) and 1 mm (13, 16).

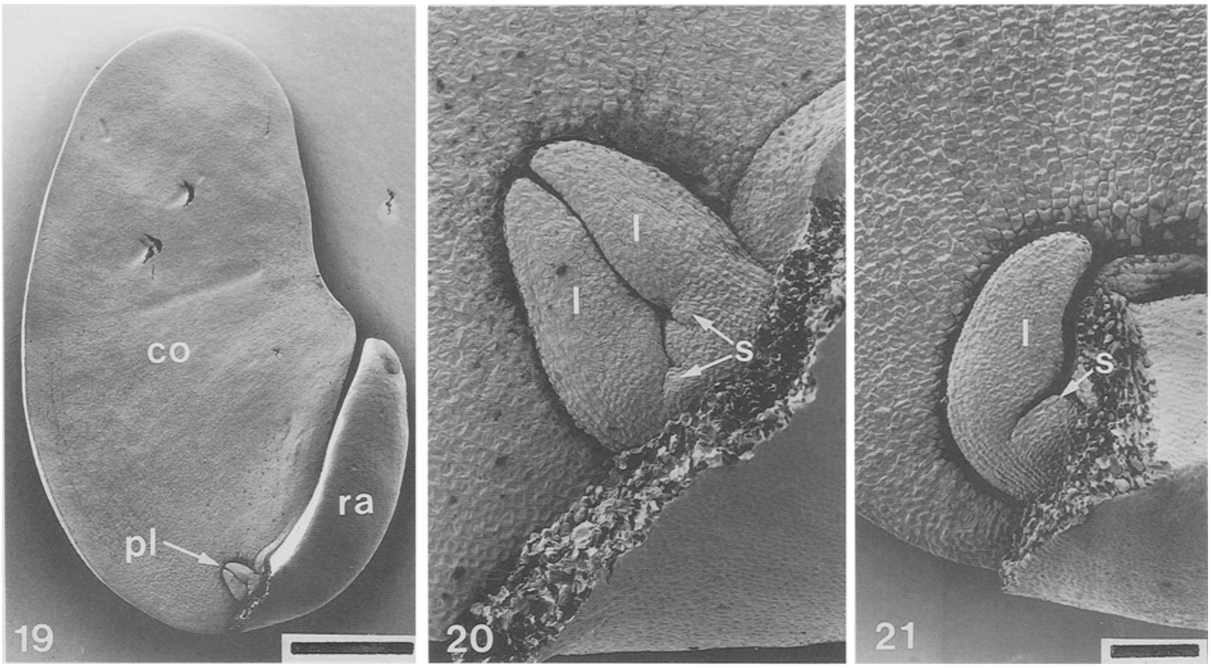
of the leaves in almost all seedlings of this type (Fig. 2), except for a seedling of *Lespedeza capitata* in which the adjacent two stipules of two opposite leaves were partly connate to each other (Fig. 16). The third and subsequent leaves vary in shape and arrangement. They are 3-foliolate in most species, but 1-foliolate in some species of subgenus *Lespedeza* such as *L. daurica, L. inschanica* (Figs. 9, 10), *L. pilosa* (Fig. 11) and *L. tomentosa*. In these species, the leaves are ultimately 3-foliolate, but occasionally 2-foliolate leaves are produced intermediate between the juvenile 1-foliolate and the adult 3-foliolate leaves. The third and subsequent leaves are usually alternate in all species. The third and fourth leaves, however, are infrequently opposite in *L. patens* (Fig. 5) of subgenus *Macrolespedeza* and *L. cuneata, L. daurica, L. inschanica* (Fig. 9), *L. juncea*, and *L. virgata* of subgenus *Lespedeza*.

In the alternate type, the first leaf is almost always 1-foliolate, and the second one always 3-foliolate (Figs. 3, 8, 12, 14, 17). In *L. procumbens*, however, the first foliage leaf is occasionally 3-foliolate (Fig. 18). The third and subsequent leaves are alternate and 3-foliolate in all species.

Table 1. Number and distribution of seedling types in *Lespedeza*. Origin of each seed sample is shown in Appendix 1.

| Species | Seedling types | | Origin | Voucher Specimen |
|---|---|---|---|---|
| | Opposite | Alternate | | |
| Subgen. *Macrolespedeza* | | | | |
| *L. bicolor* | 73 | 0 | Japan | *T. Nemoto 8592* |
| *L. buergeri* | 25 | 0 | Japan | *T. Nemoto 8593* |
| *L. cyrtobotrya* | 47 | 3 | Japan | *T. Nemoto 8594* |
| | 71 | 0 | Japan | *T. Nemoto 8595* |
| *L. formosa* | | | | |
| subsp. *formosa* | | | | |
| var. *formosa* | 128 | 3 | Taiwan | *T. Nemoto 5852* |
| subsp. *velutina* | | | | |
| var. *velutina* | 46 | 0 | Japan | *T. Nemoto 5853* |
| *L. homoloba* | 93 | 0 | Japan | *T. Nemoto 5854* |
| | 10 | 0 | Japan | *T. Nemoto 2415* |
| *L. patens* | 53 | 1 | Japan | *T. Nemoto 4235* |
| | 58 | 0 | Japan | *T. Nemoto 4234* |
| Subgen. *Lespedeza* (Asian species) | | | | |
| *L. caraganae* | 82 | 0 | China | *T. Nemoto 5876* |
| *L. chinensis* | 10 | 0 | Taiwan | *T. Nemoto 2404* |
| | 107 | 0 | Taiwan | *T. Nemoto 5855* |
| *L. cuneata* | 39 | 0 | Japan | *T. Nemoto 2399* |
| | 124 | 14 | Japan | *T. Nemoto 5883* |
| | 133 | 0 | Japan | *T. Nemoto 5882* |
| | 42 | 2 | Taiwan | *T. Nemoto 5880* |
| *L. daurica* | 28 | 0 | Korea | *T. Nemoto 5860* |
| | 30 | 0 | China | *T. Nemoto 5857* |
| | 104 | 0 | Taiwan | *T. Nemoto 5859* |
| | 69 | 0 | ? | *T. Nemoto 5858* |
| *L. floribunda* | 47 | 0 | China | *T. Nemoto 5877* |
| *L. inschanica* | 121 | 0 | Korea | *T. Nemoto 8587* |
| | 84 | 0 | Korea | *T. Nemoto 8588* |
| *L. juncea* | 57 | 0 | Japan | *T. Nemoto 5862* |
| | 53 | 0 | Japan | *T. Nemoto 4236* |
| *L. pilosa* | 92 | 0 | Japan | *T. Nemoto 5861* |
| *L. tomentosa* | 97 | 0 | Japan | *T. Nemoto 5863* |
| | 98 | 0 | Japan | *T. Nemoto 5864* |
| *L. virgata* | 62 | 0 | Japan | *T. Nemoto 5866* |
| | 93 | 0 | Japan | *T. Nemoto 5865* |
| (North American species) | | | | |
| *L. capitata* | 0 | 43 | Canada | *T. Nemoto 5868* |
| | 2 | 18 | U.S.A. | *T. Nemoto 5869* |
| | 1 | 35 | U.S.A. | *T. Nemoto 5867* |
| *L. hirta* | 1 | 27 | U.S.A. | *T. Nemoto 5871* |
| | 0 | 16 | U.S.A. | *T. Nemoto 5870* |
| | 0 | 119 | U.S.A. | *T. Nemoto 8589* |
| *L. intermedia* | 0 | 20 | U.S.A. | *T. Nemoto 5872* |
| *L. procumbens* | 0 | 143 | U.S.A. | *T. Nemoto 8590* |
| *L. stuevei* | 0 | 71 | U.S.A. | *T. Nemoto 8591* |
| *L. violacea* | 0 | 7 | U.S.A. | *T. Nemoto 5873* |

? Seeds were collected from cultivated plants in Hortus Botanicus Vacratot-Hungaria. Origin of the plants is unknown, but the species is known in Asia.



Figs. 19-21. Morphology of embryo (19) and plumules (20, 21). 19, 20. *L. patens* (*T. Nemoto 4234*). 21. *L. hirta* (*T. Nemoto 8589*). co, cotyledon ; l, leaf primordium ; pl, plumule ; ra, radicle ; s, stipule primordium. Scale bars : 1 mm (19) and 0.1 mm (20, 21).

*Distribution of the two types of seedlings*

Of six species observed in subgenus *Macrolespedeza*, seedlings of three species exhibited only the opposite type and the other three species exhibited both types (Table 1). In *Lespedeza cyrtobotrya* and *L. patens*, the observations were different in the two seed samples examined; one exhibited only the opposite type and the other both types. When both types occurred within a single sample, the opposite type was distinctly dominant in number over the other.

In subgenus *Lespedeza*, there were distinct differences between Asian and North American species (Table 1). Almost all Asian species, except *L. cuneata*, exhibited seedlings only of the opposite type (Table 1). One of three seed samples of *L. cuneata* exhibited only the opposite type, while two samples exhibited both types. In the latter two samples, seedlings of the opposite type distinctly exceeded the number of seedling with alternate leaves, as in *L. cyrtobotrya* and *L. patens* of subgenus *Macrolespedeza*.

In the North American species, only the alternate type of seedling morphology was seen in four of six species examined (Table 1). Two types of seedlings were observed in *L. capitata* and *L. hirta*. Two of three samples of the former species and one of three samples of the latter exhibited both types ; other samples of both species exhibited only the alternate type. In samples exhibiting both types, the alternate type always exceeded the opposite in number.

*Morphology of plumules in mature seeds*

Plumules were observed in *Lespedeza cuneata* (*T. Nemoto 5883*), *L. hirta* (*T. Nemoto 8589*), *L. patens* (*T. Nemoto 4234*), *L. stuevei* (*T. Nemoto 8591*) and *L. tomentosa* (*T. Nemoto 5863*). Seed samples of *L. hirta* and *L. stuevei* are of alternate type seedling, those of *L. patens* and *L. tomentosa* are of opposite type, and those of *L. cuneata* are of two types (Table 1). Fifteen seeds were examined in the former four species and 30 seeds examined in the latter one.

The plumule has two primordia of the first two opposite leaves in all seeds examined of *L. patens* (Figs. 19, 20) and *L. tomentosa*, while one primordium of the first foliage leaf in all seeds of *L. stuevei* and *L. hirta* (Fig. 21). In *L. cuneata*, the number of leaf primordia was two in 28 seeds and one in two seeds. From the result shown in Table 1, the former 28 seeds appear to be of the opposite type seedling and the latter two of the alternate type seedling. In *L. patens, L. tomentosa* and the 28 seeds of *L. cuneata*, moreover, two primordia of first two leaves were slightly different from each other in size (Fig. 20).

## Discussion

*Two types of seedling morphology*

The present study reports two patterns of seedling morphology in *Lespedeza* with respect to the arrangement of the first leaves subsequent to the cotyledons. The alternate type of seedling pattern was described previously in the genus by de Candolle (1825) and Wassiltschenko (1937). Maekawa (1955), Ohashi (1968) and Akiyama

(1988) reported the opposite type. Lubbock (1892) recognized the two kinds of seedling patterns, though he did not pay any attention to distribution of both patterns. According to these previous reports, however, the alternate type was described on North American species, while the opposite one described on Asian species. This is consistent with our result on distribution of the two seedling types.

Previous reports described only one seedling type in a species. However, the present study shows that two types occasionally occur in a species, although one type always far outnumbers the other (Table 1). The occurrence of the minor type is not constant but sporadic, whereas the dominant type is determined to be one of the two types in a species (Table 1).

The number of leaf primordia is different in the plumules between the opposite type and alternate one. In the opposite type, moreover, the size of the leaf primordia of the first two leaves differs from each. This evidence indicates that the primordia are produced alternately. Because the internode of the two leaves lacks the ability to elongate, the two leaves are arranged oppositely at later stages of germination. Seeds of the alternate type indicate that the second leaf primordium arises during germination and the internode of the first and second leaves evidently elongates. Thus, the difference in the two seedling types is considered to be mainly due to the stage of initiation of the second leaf primordium and the degree of elongation of the internode. The occasional variation in these two factors may induce the minor seedling type in a species.

### *Systematic considerations*

The genus *Lespedeza* can be divided into two groups by the dominant type of seedlings: one consists of Asian species belonging to subgenera *Macrolespedeza* and *Lespedeza*, and the other of North American species belonging to subgenus *Lespedeza*. Subgenus *Lespedeza* is, therefore, separable into two groups.

The interrelationships among species of subgenus *Lespedeza* have been shown by earlier authors as follows. Torrey and Gray (1840) divided North American species into two sections, *Lespedeza* (as *Eulespedeza*) and *Lespedezaria*. Maximowicz (1873) divided subgenus *Lespedeza* (as section *Eu-Lespedeza*) into four groups; series *Violaceae, Junceae, Lespedezaria* and *Pilosa*. In his treatment, the North American species were attributed to series *Violaceae* and *Lespedezaria*, while the Asian species were placed in all four series. The section *Lespedeza* and *Lespedezaria* of Torrey and Gray (1840) were attributed to series *Violaceae* and *Lespedezaria* of Maximowicz (1873), respectively. The treatment of Maximowicz (1873) was followed by Taubert (1894). Schindler (1913) proposed a scheme showing relationships among species of subgenus *Lespedeza* (as section *Eulespedeza*). In his scheme three main lines were derived from a common ancestor: the first line consists of all Asian species except *L. tomentosa*; the second consists of one group of North American species; the third consists of another group of North American species and *L. tomentosa*. Schindler (1913) distinguished North American species into two groups, as did Maximowicz (1873), but his treatment of the Asian species differed from Maximowicz's. Maximowicz (1873) regarded each of the two groups of North American species as being closely related with some Asian species, while Schindler (1913) completely separated the North American species from the Asian ones except *L. tomentosa*. The features of seedling morphology do not support the close relationship between species of North America and Asia proposed by Maximowicz (1873) and Taubert (1894), but rather substantiate the treatment of these species by Schindler (1913), except for the position of *L. tomentosa*. Although *L. capitata* and *L. hirta* are referable to one of the two groups previously recognized in North America and *L. intermedia, L. procumbens, L. stuevei* and *L. violacea* to the other, the seedling features of these species are the same.

*Kummerowia* and *Campylotropis*, both regarded to be most closely related to *Lespedeza* and attributed to the subtribe Lespedezinae (Ohashi *et al*. 1981), have the opposite type seedling morphology (Lubbock 1892; Maekawa 1955; Ohashi 1968). Because *Lespedeza* has been shown to be closer to *Kummerowia* than *Campylotropis* in morphological features of flowers and inflorescences (Nemoto and Ohashi 1988, 1990, 1993), *Kummerowia* appears to be the sister group of *Lespedeza*. The opposite type is, therefore, considered to be plesiomorphic in *Lespedeza* and the alternate one apomorphic. Although there is variation in seedling morphology within a species, the plesiomorphic seedling morphology is dominantly occurred in Asian species of *Lespedeza* and the apomorphic one dominantly occurred in North American species. This fact may be an evidence which suggests a monophyletic origin for North American species from an Asian ancestor.

We are indebted to Dr. D.E. Boufford of the Harvard University Herbaria and Dr. A. Hiratsuka of Tohoku University for collecting seed samples of North American species for our study, and to institutions cited in Appendix 1 for the kind gift of seeds from their collections. We thank Dr. Y. Tateishi of Tohoku University for helpful discussions and kindly providing some references. We are grateful to Dr. D.E. Boufford for his critical reading and improving English of the manuscript. This study is partly supported by a Grant-in-Aid for Scientific Research (0474039 to T.N.) from the Ministry of Education, Science and Culture of Japan.

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## Appendix 1: Origin of materials and voucher specimens.

***Lespedeza bicolor*** Turcz.

*T. Nemoto 8592,* 28 Nov. 1986. Japan, Yamagata Pref., Higashitagawa-gun, Asahi-mura.

***L. buergeri*** Miq.

*T. Nemoto 8593,* 2 Oct. 1987. Japan, Miyagi Pref., Sendaishi.

***L. caraganae*** Bunge

*T. Nemoto 5876,* 11 Feb. 1988. Cultivated plants in Exp. Gard. Tohoku Univ., grown from seeds sent from Hortus Botanicus Pekinensis, Instituti Botanici, Academiae Sinicae, China (seeds were misidentified as *L. hedysaroides*).

***L. capitata*** Michx.

*T. Nemoto 5868,* 27 Apr. 1988. Cultivated plants in Exp. Gard. Tohoku Univ., grown from seeds collected from Ontario, Canada and sent from Glendon Hall Laboratory and Garden, University of Toronto, Canada. *T. Nemoto 5869,* 27 Apr. 1988. Seeds sent from Chicago Bot. Gard., U.S.A. *T. Nemoto 5867,* 27 Apr. 1988. Seeds sent from Rivendell Bot. Gard., U.S.A.

***L. chinensis*** G. Don

*T. Nemoto 2404,* 14 Jan. 1988. Cultivated plant in Exp. Gard. Tohoku Univ., originated from Tailukohsia, Hualien Co., Taiwan. *T. Nemoto 5855,* 24 Mar. 1989. Taiwan, Taichung Co., Lishan.

***L. cuneata*** (Dum.-Cours.) G. Don

*T. Nemoto 2399,* 13 Mar. 1985. Cultivated plants in Exp. Gard. Tohoku Univ., originated from Sendai-shi, Miyagi Pref., Japan. *T. Nemoto 5883,* 14 Jan. 1988. Japan, Fukushima Pref., Futaba-gun, Katsurou-mura. *T. Nemoto 5882,* 14 Jan. 1988. Cultivated plant in Exp. Gard. Tohoku Univ., originated from Higashitsuno-mura, Takaoka-gun, Kouchi Pref., Japan. *T. Nemoto 5880,* 14 Jan. 1988. Cultivated plants in Exp. Gard. Tohoku Univ., originated from Chimei—Hsiehtewu, Hualien Co., Taiwan.

***L. cyrtobotrya*** Miq.

*T. Nemoto 8594,* 2 Oct. 1987. Japan, Yamagata Pref., Nishiokitama-gun, Iide-machi. *T. Nemoto 8595,* 2 Oct. 1987. Japan, Miyagi Pref., Shibata-gun, Kawasaki-machi.

***L. daurica*** (Laxm.) Schindl.

*T. Nemoto 5860,* 1 Dec. 1987. Cultivated plants in Exp. Gard. Tohoku Univ., originated from Kunja, Shihung-gun, Kyonggi Prov., Korea. *T. Nemoto 5857,* 18 Nov. 1987. Seeds sent from Hortus Botanicus Pekinensis, Instituti Botanici, Academiae Sinicae, China. *T. Nemoto 5859,* 1 Dec. 1987. Cultivated plants in Exp. Gard. Tohoku Univ., originated from Tachia, Taichung Co., Taiwan. *T. Nemoto 5858,* 18 Nov. 1987. Seeds sent from Hortus Botanicus Vacratot-Hangaria, Hungary.

***L. floribunda*** Bunge

*T. Nemoto 5877,* 8 Feb. 1988. Cultivated plants in Exp. Gard. Tohoku Univ., grown from seeds sent from Hortus Botanicus Pekinensis, Instituti Botanici, Academiae Sinicae, China.

***L. formosa*** (Vogel) Koehne
subsp. ***formosa*** var. ***formosa***

*T. Nemoto 5852,* 24 Mar. 1989. Taiwan, Taichung Co., Lishan.

subsp. ***velutina*** (Nakai) S. Akiyama et H. Ohba var.

***velutina***
*T. Nemoto 5853,* 24 Mar. 1989. Japan, Shiga Pref., Takashima-gun, Makino-machi.

***L. hirta*** (L.) Hornem.
*T. Nemoto 5871,* 10 Apr. 1988. Cultivated plants in Exp. Gard. Tohoku Univ., grown from seed collected from the specimen (*A.F. Clewell 816,* TUS) collected from Leon Co., Florida, U.S.A. *T. Nemoto 5870,* 27 Apr. 1988. U.S.A., New Hampshire, Cheshire Co., Walpole. *T. Nemoto 8589,* 26 May 1990. U.S.A., Florida, Bay Co., Western Lake.

***L. homoloba*** Nakai
*T. Nemoto 5854,* 24 Mar. 1989. Japan, Miyagi Pref., Sendai-shi. *T. Nemoto 2415,* 14 June 1985. Japan, Okayama Pref., Kawakami-gun, Bittchu-machi.

***L. inschanica*** (Maxim.) Schindl.
*T. Nemoto 8587,* 4-11 Sep. 1991. Cultivated plant (no. 8′) in Exp. Gard. Tohoku Univ., originated from Sunam-ri, Tong-myeon, Chonwon-gun, Chungchongnam Prov., Korea. *T. Nemoto 8588,* 4 Sep. 1991. Cultivated plant (no. 10), in Exp. Gard. Tohoku Univ., originated from Sunam-ri, Tong-myeon, Chonwon-gun, Chungchongnam Prov., Korea.

***L. intermedia*** (S. Wats.) Britt.
*T. Nemoto 5872,* 10 Apr. 1988. Cultivated plants in Exp. Gard. Tohoku Univ., grown from seeds collected from the specimen (*A.F. Clewell s.n., 1959 Sep. 28,* TUS) collected from Brown Co., Indiana, U.S.A.

***L. juncea*** (L. f.) Pers.
*T. Nemoto 5862,* 22 Oct. 1987. Japan, Miyagi Pref., Sendaishi. *T. Nemoto 4236,* 14 Dec. 1987. Japan, Okayama Pref., Akaiwa-gun, Seto-machi.

***L. patens*** Nakai
*T. Nemoto 4235,* 14 Dec. 1987. Japan, Yamagata Pref., Kitamurayama-gun, Ooishida-machi. *T. Nemoto 4234,* 14 Dec. 1987. Japan, Niigata Pref., Itoigawa-shi.

***L. pilosa*** (Thunb. ex Murray) Sieb. et Zucc.
*T. Nemoto 5861,* 22 Oct. 1987. Japan, Miyagi Pref., Sendaishi.

***L. procumbens*** Michx.
*T. Nemoto 8590,* 26 May 1990. U.S.A., Arkansass, Johnson Co., Ozark National Forest.

***L. stuevei*** Nutt.
*T. Nemoto 8591,* 26 May 1990. U.S.A., Florida, Bay Co., Western Lake.

***L. tomentosa*** (Thunb. ex Murray) Sieb. et Zucc.
*T. Nemoto 5863,* 10 Dec. 1987. Cultivated plant in Exp. Gard. Tohoku Univ., originated from Higashine-shi, Yamagata Pref., Japan. *T. Nemoto 5864,* 10 Dec. 1987. Cultivated plant in Exp. Gard. Tohoku Univ., originated from Takizawa-mura, Iwate Pref., Japan.

***L. violacea*** (L.) Pers.
*T. Nemoto 5873,* 7 Apr. 1988. Cultivated plant in Exp. Gard. Tohoku Univ., grown from seed collected from the specimen (*A.F. Clewell 1570,* TUS) collected from Brown Co., Indiana, U.S.A.

***L. virgata*** (Thunb. ex Murray) DC.
*T. Nemoto 5866,* 10 Dec. 1987. Cultivated plant in Exp. Gard. Tohoku Univ., originated from Wakuya-machi, Miyagi Pref., Japan. *T. Nemoto 5865,* 10 Dec. 1987. Japan, Okayama Pref., Takahashi-shi.