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A COMPARATIVE ANATOMICAL STUDY OF *ANEUROLEPIDIUM CHINENSE (TRIN.)* KITAG. FROM DIFFERENT ECOLOGICAL ENVIRONMENTS(*)

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The anatomy and structure of roots, stems and leaves from *Aneurolepidium chinense* (Trin.) Kitag. plants grown under different ecological environments were studied using scanning electron microscopy in this paper. The results showed that conspicuous diversities in this anatomical and histological structure existed in different ecological variants of this species. The structure of *A. chinense* in black calcium soil's structure is simple type. The saline meadow soil type's structure is complex, which have evolved the evolutional tissues (Gu *et al.*, 1993), i.e. aerenchyma, protective tissue parenchyma and conducting tissue etc. The results of this study showed that there are the most striking differences in the same species of *A. chinense* of different soil types. These differences indicated that different soil ecotypes of *A. chinense* can exist in natural conditions.

A. Chinense is a species widely distributed in grassland in the west part of northeast China and the east part of Inner Mongolia (Li De-xin, 1979; Jian-dong, 1964 and 1978; Yun-fei and Bao-tian, 1992). It usually forms the predominant population in grassland known as the *Aneurolepidium* grassland. This plant is an excellent herbage species with a high nutritional value and good suitability for animal feeding. It is also tolerant of high saline soil drought and trampling. The objective of this investigation was to elucidate its anatomical characteristics in its adaptation to saline environment (Cheng-lee, 1981). Observations were made comparing the anatomy of two C_3 plants in ecological variants. The results obtained through this investigation provide a basis for future studying the biological and ecological characteristics of this important herbage species.

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NATURAL SURVEY

This study site was on the southern plain of Song Nen (Yun-fei and Bao-tian, 1992). Its geographical position is on the longitude 120°31'-124°10' and latitude 44°31'-44°45', 140-160 metres above sea level. The height of small topography's changing is 5-20 metres. There are strips of sandy lands around it. In here, the species of *A. chinense* occupies a dominant position. The climate is half drought-half humid in the area. Average temperature a year are 4.6°-6.4°S10°. Accumulated temperature are 2848° -3374° per year. In the area, the highest temperature are 37.8°. The lowest temperature are -33.9°. The precipitation is 435 mm per year. There are 136-163 days without frost season. Soil is mainly saline meadow soil type, which contains 0.7-1.0% salt and 3.5-5% alkali. The soil's pH values are 9.5-10.5.

The comparative place is a plain in the suburbs of Changchun city and its geographical position is on the longitude 125°10'-126°12' and latitude 43°51'-44°20', 206-300metres above sea level. Its average temperature a year are 4.5°-4.7°. Accumulated temperature are 2978-3455° per year. The highest temperature are 36.8°, the lowest temperature are -35.7°. The precipitation is 644 mm. Without frost season there are 138-164 days. The soil is black calcium soil type, its pH values are 6.2-7.0, and no salt and alkali.

MATERIALS AND METHODS

The ecological variants of *A. chinense* were collected from the *Aneurolepidium* Grassland Protection Region, Changling County, Jilin province, China (the saline soil variant, Jingmei, and Jian-dong, 1994) and from the suburbs of Changchun city, China (the black soil variant, Jian-dong, 1978), respectively. The selected parts (toots, stems and leaves) were excised from the plants, and then cut into segments of 0.3 cm in length. The specimens were fixed in FAA fixative (5% formaldehyde, 5% acetic acid and 905 ethanol) for 48h. , washed in distilled water and dehydrated in an ethanol series (Jian-dong, 1964; Pan Rui-zhi, *et al.*, 1979). After the specimens hand been kept in 100% ethanol for a minimum of 30 min, they were transferred into iso-amylacetate for 20 min. The specimens were then critical-point dried, coated with gold at a thickness of 0.2 cm and finally viewed and photographed under an S-570 Scamming electron microscope. The stained sections viewed under the light microscope, which use the method of paraffining.

RESULTS

The Transverse View of The Saline-Soil Variant

Compared with the black-soil variant, roots of the saline-soil variant were thick. Its diameter is 675μm (average 10 roots). It can also be seen from (Fig. 1) that the cortex parenchymatous cells were quite uniform in size. Those cells' diameter averages 16.2um. The cortex occupies a large proportion (55%) of the total number of cells that constituted the whole root. The cells at the middle cortex tend to be disorganized to form extensive intercellular spaces (135×59μm), i.e. aerenchyma. The "U" shaped thickenings at the endodermis were also conspicuous, while the passage cells were not thickened. The pericycle sheath was composed of a layer of parenchymatous cells. The xylem was polyarch, containing relatively a large number of vessel elements. The diameter of vessels averages 28.2μm. (average 10 vessels) in metaxylem.

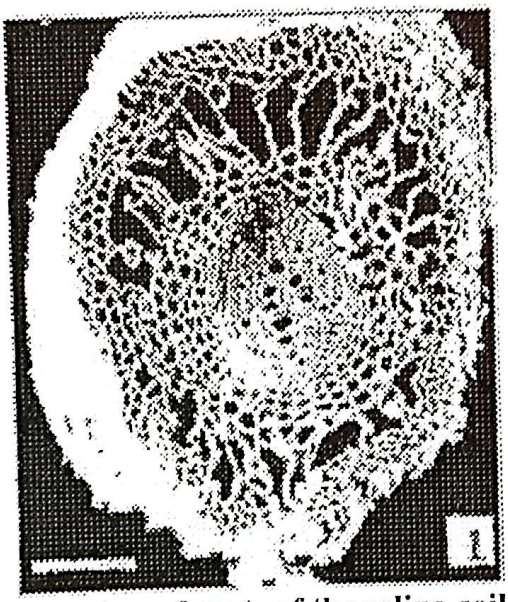

Fig. (1). The transverse view of roots of the saline-soil variant. This root was thick, the xylem was of the polyarch containing relatively a large number of vessel elements, ×260, bar=40um.

Transverse View of Roots of The Black-Soil Variant

Figure (2) is a scanning electron micrograph of transverse view of a root from the black-soil variant plant *of A. chinense*. The root of this variant was thin and its diameter is 240.8μm (average 10 roots). The parenchyma of cortex have not the aerenchyma in root (Fig. 2). The vessels element in metaxylem were a few with diameter averaging 24.9μm.

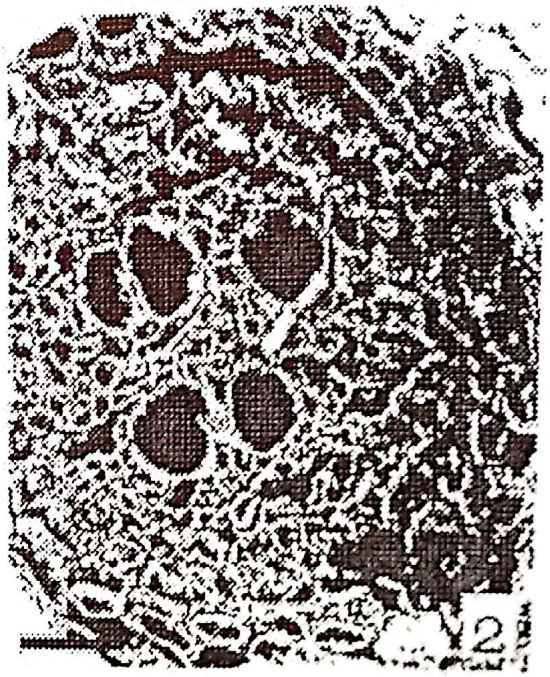

Fig. (2). The transverse view of roots of the black-soil variant. This root was relatively thin. The number of vessel elements in metaxylem was comparatively small, ×400, bar=30um.

The Transverse View of Stems of The Saline-Soil Variant

Fig. (3) is a scanning electron micrograph of the transverse view of a stem from the saline-soil variant. Its diameter is 1.118mm (average 10 stems). The diameters of vascular bundles at inner layer were bigger (172.1 μm) than of at outer layer (51.6μm). In contrast to the black-soil variant the vascular bundles were scattered within the parenchyma tissues, and the mechanical tissues were also present in small quantity, there were on sclerenchymatous cells between the bundles in this variant. Besides, the pith which comprised large thin-walled cells, which occupied a relatively small space of the stem. Pith's diameter was 38.7μm (average 10 stems), leaving less room for the pith cavity.

The Transverse View of Stems of The Black-Soil Variant

The scanning electron micrograph of the transverse view of a black-soil variant stem showed that its diameter was 1.075 mm (average 10 stems). The epidermis cells were small, and were tightly arranged, the outside periclinal walls possessed thick cuticle that is 4.1μm. The hypodermis cells were also small. A part of them were thick-walled (Fig. 4). The vascular bundles were arranged in two concentrical circular layers. The bundles in the outer layer were small in size. Its diameter is 45μm. And the spaces between the bundles, and hypodermis were rilled with sclerenchyma. The vascular

bundles in the inner layer were particularly big. Their diameters are 86.2μm (average 10 bundles). The pith cavity was large, which diameter is 645μm, its periphery being in close vicinity to the inner layer of vascular bundles (Fig. 4).

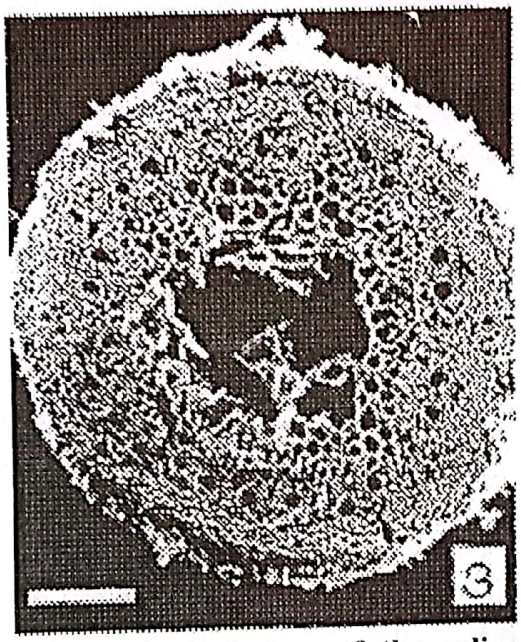

Fig. (3). The transverse view of stem of the saline-soil variant. The vessels are large, the pith cavity is small, ×70, bar=215μm.

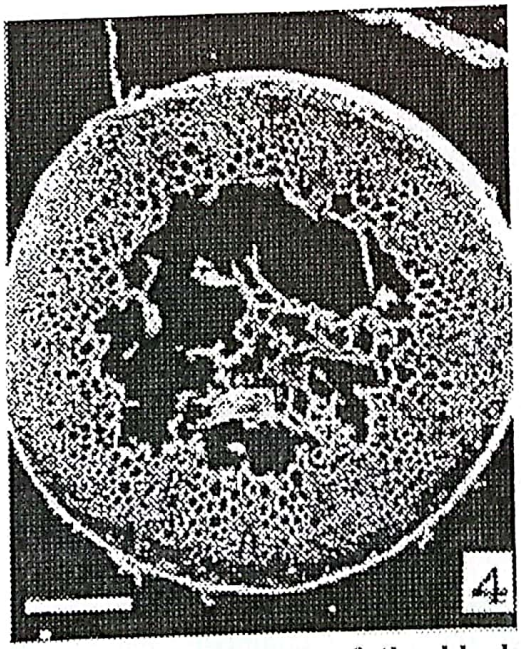

Fig. (4). The transverse view of stem of the black-soil variant. The

vessels are small, the pith cavity is large, ×70, bar=215μm.

The Transverse View of Leaves of The Saline-Soil Variant

This variant possessed relatively thick (243μm) leaf blades with dense, long (140-480μm) epidermis hairs at upper surface of leaf. Among the 5 bulliform cells, the 2 central ones were bigger (55-60μm) than the other 3 (15-19μm). Intercellular spaces were seen in the mesophyll tissue (Fig. 5). Besides, the mechanical tissues aside the parallel vascular bundles of veins were less developed. The bundle sheath was composed of two layers of cells with similar thickness of cell walls (Fig. 7).

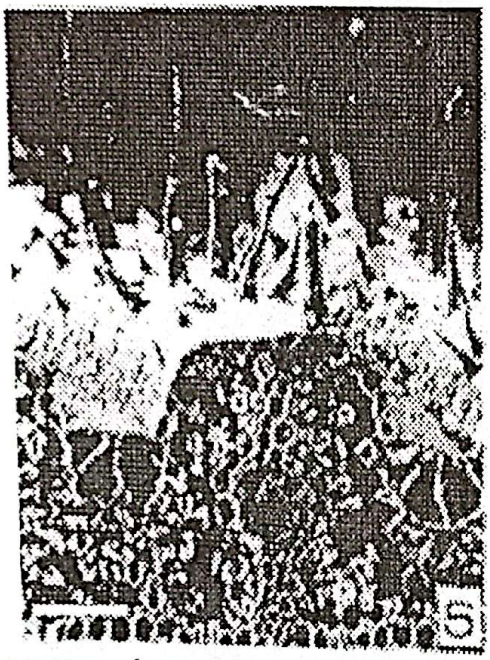

Fig. (5). The transverse view of leaves of the saline-soil variant. The bundle sheath of veins was composed of two layers cells with similar thickness of cell walls, ×200, bar=75μm.

The Transverse View of The Black-Soil Variant

As can be observed from (Fig. 6), leaves of black-soil variant were thin, which is 168μm, with sparsely distributed tiny coneshaped epidermis hairs at upper surface. The out side periclinal walls of epidermis were thick (4.6μm). The 5 bulliform cells were unform in size (average 22,4μm). The lower leaf surface was hairless and covered with cuticle. The mesophyll was composed of tightly packed parenchymatous cells with little intercellular spaces. The veins ran parallel, and the vascular bundles in veins were large (128μm), and connected with mechanical tissues at both sides. The bundle sheath in veins were outer layer comprised parenchymatous cells without chloroplasts, while the inner layer was composed of sclerenchymatous cells

(Fig. 8). These represented the typical characteristics of a C_3 plant.

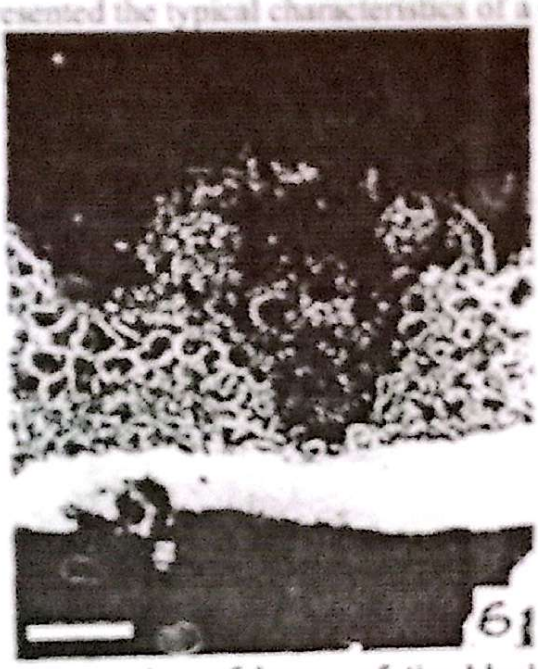

Fig. (6). The transverse view of leaves of the black-soil variant. The bundle sheath in veins was outer layer comprised parenchymatous cells, while the inner layer was composed of sclerenchymatous cells, ×250, bar=60μm.

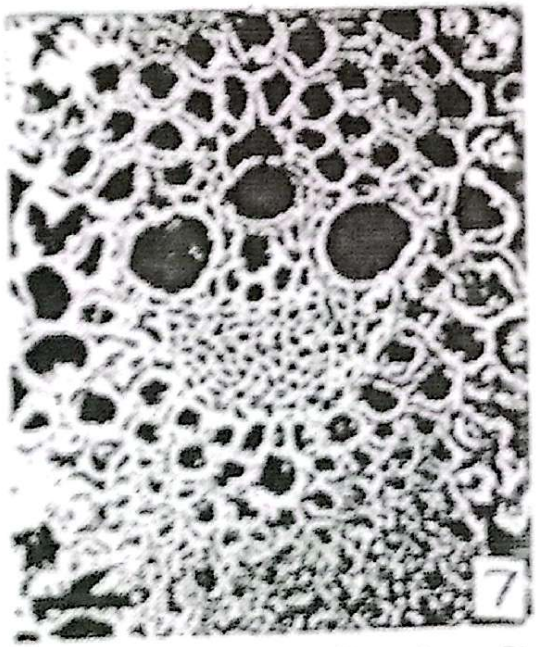

Fig. (7). A bundle of veins in saline-soil variant. Showing the bundle sheath of veins cell's walls ×500, bar=30μm.

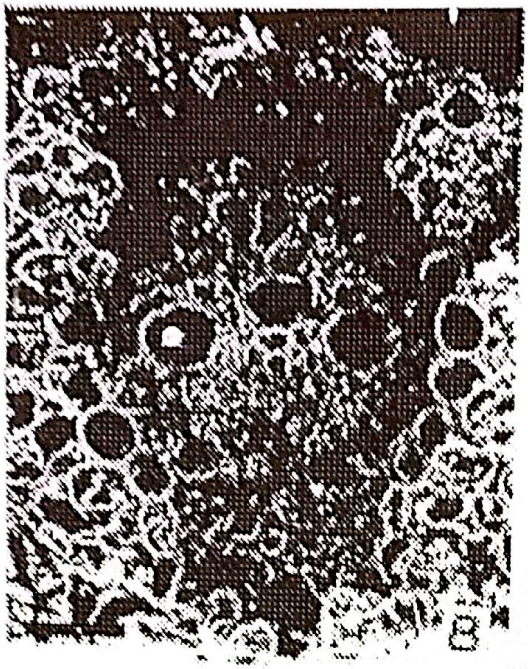

Fig. (8). A bundle of veins in black-soil variant. Showing the bundle sheath of veins cell's walls, ×500, bar=30μm.

DISCUSSION

Based on the observations on the anatomy and structure of roots, stems and leaves of different *A. chinense* ecological variants made on this investigation. It is concluded that in the saline-soil variant *of A. chinense* the resistances to high saline strength and drought are associated with certain structural characteristics, and these are summarized as follows:
The saline soil is hard and contains little holes, and hence is unfavorable for plants to root and grow (Hall, 1976; Johnson and Brown,1973).

The saline-soil variant *A. chinense* grows well in this soil condition because it has developed certain special to adapt to this environment (Li-zhu, 1992). As can be seen from fig. (1) some of the parenchymatous cells in the cortex break down to form aerenchymatous tissue. In addition, the roots of saline-soil variant are relatively thick, containing small and thick-walled cortex cells. All these result in the formation of a strong roots system in this environment to adapt the soil conditions (Xunling and Jing, 1989). In contrast, the black soil variant possesses thin root with fewer yet bigger cortex cells. Also, the cortex cells do not break down to form aerenchymatous tissue.

Comparative observations show that the different ecological variants of *A. chinense* possess different stem anatomical structure. The ground tissue of the saline-soil variant comprises mainly parenchymatous cells. Besides,

the pith cavity is much smaller than that in black-soil variant's. All these form a sharp contrast in structure between the two variants, which are associated with the adaptation to different environments under which they grow (Hall, 1976). The saline-soil variant contains large quantities of parenchymatous cells in its stem rendering the storage of sufficient water and nutrients. Also, the pith cavity is small and the number of pith cells is large. All these special structural characteristics facilitate the supply of materials and energy for the normal growth of this variant under the saline and drought conditions (Brown, 1975).

The structural differences in leaves between the two variants are also apparent. The black-soil variant possesses thin leaf blades, tiny sparse epidermis hairs and uniform bulliform cells, while the saline-soil variant has thick upper leaf surface cuticle with dense long hairs. These special leaf structures of saline-soil variant reduce the "heat damage" by strong sunlight Xunling and Jing, 1989; Li-zhu, 1992 and Zhan-chi and Zong-gui, 1995).

Another conclusion can be drawn from this comparative study is that the saline-soil variant *of A. chinense* does not represent the typical C_3 plant vein vascular bundle structure (Zhong-quan, 1987; Carolin *et al.*, 1973), rather it should be classified as a special intermediate type between C_3 and C_4 plant (Brown, 1975; Xunling and Jing, 1989). The basic evidence for this is that in all specimens collected, the leafstomata were all closed in saline-soil variant. The closure of stomata may be related to the strong activity ofphosphdenolpyrurate carboxylase and the low photorespiration by C_3 plants are less than that by C_4 plants, and when the stomata are closed under the drought condition, the plants can still utilize the CO_2 in intercellular spaces (Xunling and Jing, 1989). Therefore, it seems reasonable to assume that the anatomic structures of a plant may undergo certain changes in accordance with the growth conditions and environments (Jingmei and Jian-dong, 1994) The structural differences described in this report may be regarded as ecological variant-specific differences in *A. chinense.*

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دراسة تشريحية لمقارنة تأثير البيئات المختلفة على أنسجة نبات *ANEUROLEPIDIUM CHINENSE (TRIN.)*

لو جنجمى ، لى جانج
كلية العلوم الحياتية ، جامعة شمال شرق نورمال ، شانجشونج ، الصين ، ١٣٠٠٢٤

نبات *ANEUROLEPIDIUM CHINENSE (TRIN.)* ينمو فى منطقة السهول فى الجزء الغربى من شمال الصين وهو نبات ذات قيمة رعوية عالية علاوه على أنه مقاوم للملوحة العالية والجفاف – هذه الدراسة أظهرت تكيف النبات للبيئات المختلفة وخصوصاً أنواع التربة النامى منها الجيرية السوداء والتربة المالحة.