

# Branching pattern in the ontogenesis of *Nepeta manchuriensis* (Lamiaceae) individuals

Alexey Astashenkov<sup>1\*</sup>, Evgeniya Talovskaya, and Gul'noriya Denisova

<sup>1</sup> Central Siberian Botanical Garden of the SB RAS, 630090 Novosibirsk, Russia

**Abstract.** The features development and branching pattern of *N. manchuriensis* individuals in the conditions of the Far East were studied. It is established that ontogeny consists the ontogeny of the seed individual and the private ontogeny of the ramet. The seed individual pass through the following stages of development: primary shoot-main axis-primary bush-clump–system of partial shoots; ramet: system of partial shoots. Individuals develop according to the sympodial long shoot model of the shoot formation. Basis structure the whole plant is a consistent development of dicyclic rhizomatous-long shoots. The branching pattern is determined by the functioning the buds the first annual growth of the dicyclic shoot. The mechanism of branching occurs according to dichasial type. The geophilic parts of the shoots form a rhizome.

## 1 Introduction

The study of branching patterns of individuals in ontogenesis it possibly to reveal the mechanisms of morphological adaptation and trace a connection morphophylogenetic relationship of closely related taxa, which is especially relevant for the endemic plant species [1].

*N. manchuriensis* S. Moore (sect. *Macronepeta*) is the endemic of the far eastern flora, growing under the canopy of mixed forests on the pebbles of streams and rivers [2]. It is a mesophilic herbaceous polycarpic with long rhizome that develops according to the sympodial of long-shooted model of the shoot formation. The material was collected under the canopy the broad-leaved forest on the pebble in the Far East. The approaches adopted in plant biomorphology were used in the study of branching pattern [3].

## 2 Results

Individuals pass into a juvenile state a month after seed germination. The juvenile individual constitutes the plant with one shoot and a slightly pronounced epicotyl. In the axils of all the leaves buds are laid which develop differently usually one of opposite ones is developed better. The bud laid in the cotyledons is the largest with a large number of the primordial leaves. The bud is covered with two scales, the upper scales is winged. At the

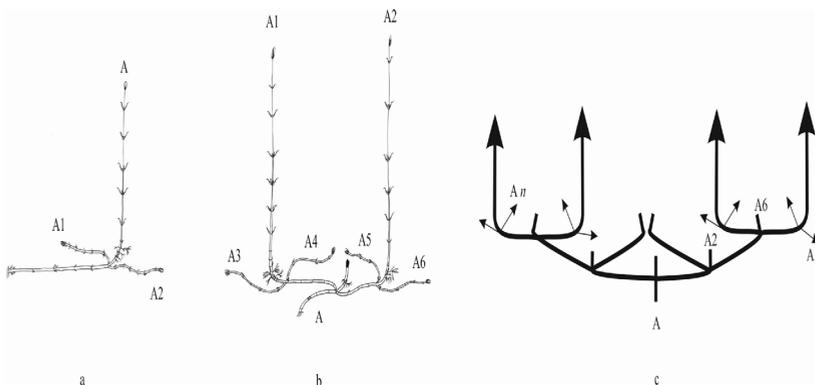
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<sup>1</sup>Corresponding author: [astal@bk.ru](mailto:astal@bk.ru)

end of vegetation, the vegetative part of the shoot lies down and dies down to the cotyledon node. Contractile activity of the main root leads to retraction of the remaining part of the shoot. The main root is more than 5 cm long.

In the second year, the plants pass into an immature state. The long anisotropic monocyclic shoot develops from most mature bud. Its aboveground part reaches 10-15 cm in height, plagiotropic geophilic part of shoot becomes a rhizome. The rhizomatous part of shoot consists of 4-5 long metameres with scaly leaves while the aboveground part consists of 6-8 long metameres with green leaves. The leaf blade of green leaves is round-lancets 5.5–7cm long (with a petiole), 2.0–2.2 cm wide. The buds become more formed higher up the shoot axis. These buds consist of 2-3 primordial green leaves. At node 4 or 5 of the metamere one large innovation bud is formed – the innovation zone (IZ). The underlying buds are underdeveloped or do not form at all. At the end of the growing season the aboveground part of the shoot dies back. Surviving residuum becomes the first section of the long rhizome. Adventitious roots appear. In the third year, only one large bud is implemented. The innovation shoot is similar to last year’s shoot. The young rhizome consists from two sympodial articulated long residuum’s. The main root is developed well, branching and increasing to 20 cm long.

In the fourth year, the individuals pass into the virginal state and branch. The branching mechanism consists in the development of two dicyclic lateral shoots from the buds of the parent shoot innovation zone (Fig. 1a).



**Fig. 1.** Branching pattern of *N. manchuriensis* individuals. a) Structural unit: A - dicyclic shoot (parent), A1, A2 - lateral shoots (rhizomatous parts of the innovation shoots (first annual growth)). b) Branched shoot system: A1, A2 - formed dicyclic shoots; A3 – A6 growing shoots. c) Branched shoot complex: A n – innovation shoots of higher order.

The parent shoot (A) has a long (6-7 cm) plagiotropic rhizomatous and aboveground orthotropic (40-50 cm) parts. The geophilic part of the shoot (A) consists of 5-7 long metameres. At node 6 of the metamere, two large opposite-located innovation buds are formed. Unrealized buds of underlying metameres become dormant and eventually die off. In the same year simultaneously with the vegetation of the parent shoot two opposite innovation buds start to grow. During the first year the terminal bud of growing rhizomatous shoots (A1 and A2) separates 6-7 long metameres with scale leaves. In autumn, the aboveground part of the shoot (A) dies off. Simultaneously the terminal bud on each growing rhizome stops growing. At the same time, the tubercles of two buds of the next year are laid in the node 6 of the metamere of the rhizomatous part of each shoot. In this state young rhizomatous shoots (A1 and A2) overwinter. In the spring of the next year, each shoot (A1 and A2) continues its growth. Their terminal bud changes its direction of growth and shoots come to the surface of the substrate. Thus, according to the cycle of

development, the innovation shoots are dicyclic long-rhizomatous. Simultaneously with the release of shoots (A1 and A2) to the surface of the substratum, the buds of the metameres 6 of each shoot, laid in the previous year, increase in size and start growing, new long growing rhizomes are formed. This mechanism of shoot formation leads to the formation of a branched system of the shoots consisting of the different orders shoots (Fig. 1b). The set of shoots forms a branched shoot complex (BSC) (Fig. 1c). The structural unit of such a complex is a branched dicyclic shoot with two growing rhizomatous that appeared during on the first annual growth (Fig. 1a). Branching occurs on the dichasial type. The underground perennial structure of the entire plant is a long rhizome from the sympodial articulation of the residuum's. The main root begins to die off from the apical end.

At the age of 8, individuals bloom-this is a young generative state. The development of a branched complex of shoots (BSC) associated with the main root is accompanied by the formation of a clump. Each branched system includes a set of structural units. In this state, the innovation buds are usually laid in node of the metamer 8. The length of the first annual growth of the flowering shoot is 10-12 cm, it consists of 10-12 long metameres with scale leaves and the adventitious roots. The height of the second annual growth is 70-100 cm, consists of 12-15 long metameres with leaves up to 12-14 cm long and 3.5-4.0 cm wide. The shoot ends with an open thyrus of 5-7 metameres, in the nodes of which opposite dichasium develop.

Length growing lateral rhizomes reaches 6 to 8 cm. The perennial rhizome begins to rot and main root dies off starting from this state. The clump splits into separate independently living ramets as result of the destruction of connections – a loose clone is formed. The clone consists of a set of child ramets. The viability of ramets is provided by a well-developed system of the adventitious roots. Each ramet that is part of the clone has their own of BSC.

Hereafter the ontogeny of ramet of the mature generative state is described.

The separated ramet undergoes private ontogeny and destroys because of repeated particulation without rejuvenation of ramets of the next generation. The structure of ramet consists of a set of branched structural units connected to each other by perennial sections of long rhizome. In this state, the meristic length of rhizome increases in each structural unit. The generative shoot increases the number of realized buds of the first annual growth. Thus, the first annual growth may consist of 16 long metameres and its length can reach more than 25 cm. On the rhizomatous part from 3 to 4 buds are realized. As a result of their opening growing rhizomes of new long-rhizomatous innovation shoots are formed. Intensive shoot formation and rooting of shoots is accompanied by peripheral growth of the ramet and leads to its stable existence. The decay of the ramet leads to the appearance of ramets n-th order. They have the age of the parent ramet and continue own private ontogeny.

The ramet of the old generative state is a collection of a small number of generative shoots which have only one rarely two innovation buds. Dormant buds are rarely involved in shoot formation. Tissue necrosis leads to intensive death of the long rhizome which accelerates the aging process of ramet. In a result of disintegration, the parent ramet may immediately die out and isolated ramets of the postgenerative period are not viable. The ramets of subsenile and senile states complete their ontogenesis quickly.

### 3 Discussion

The shoot formation and branching mechanism of *N. manchuriensis* individuals differs from the species sect. *Macronepeta* studied in of Central Asia [4, 5]. Central Asian representatives are characterized by the development of monocyclic shoots from wintering innovation buds preserved based one the last year's annual growth. The formation of the

shoots from the buds of the first annual growth of the dicyclic shoots is a feature of *N. manchuriensis* individuals. This branching mechanism is the morphological adaptation of individuals associated with the divergent development of closely related species reflecting the mesophilic conditions of the Far East.

## 4 Conclusion

Thus, the ontogeny of *N. manchuriensis* individuals studied in the Far East is complex, consisting of the ontogeny of the seed individual and the private ontogeny of the ramets. The seed individual passes through the following stages of development: primary shoot-main axis-primary bush-clump-system of partial shoots; ramet - system of partial shoots. The branching pattern is determined by the functioning of two buds of the first annual growth of the dicyclic shoot with the formation of the rhizomatous part of the growing innovation shoot.

The work was carried out within the framework of scientific project of the State Assignment of Central Siberian Botanical Garden of the Siberian Branch of the Russian Academy of Sciences № AAAA-A17-117012610053-9.

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