

Growth and development of grenadilla plants.

II. Qualitative architectural aspects

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ABSTRACT

INTRODUCTION. According to literature, lianes, which are climbing plants, show a large number of morphological and physiological changes between juvenile and adult phase. In order to elucidate special aspects of passion fruit vine development, the plant growth stages were analyzed. **MATERIALS AND METHODS.** In addition to methods previously used by the authors (MACIEL et al, 1997), some aspects of the adult stage were studied using punctual observations of vines at different ages on the supporting trellis. Some results of literature were also taken into account for the variable choice. **RESULTS.** The seedling develops through a phanerocotyledonary and epigeal germination with two opposed foliaceous cotyledons. During the juvenile phase, the plant grows as an orthotropic axis which is a monopodium of radial symmetry and continuous growth. From the initiation of the transition phase, the axis adopts dorsiventral symmetry by internode enlargement and secondary leaf orientation giving rise to the climbing form. The adult vine has a monopodial, continuous growth and lateral flowering. The branching attains fourth order and proceeds from the basal to the distal portion of the axis. **DISCUSSION.** The vine architecture, determined by a set of monopodial axis of continuous growth, lateral flowering and basitonic branching, would correspond to the model proposed by CREMERS (1974) for lianes with a juvenile orthotropic form and an adult climbing form of monopodial axis not interrupted by flowering or other structural modifications.

KEYWORDS

Venezuela, *Passiflora edulis*, plant developmental stages.

Croissance et développement du plant de grenadille. II. Aspects qualitatifs de l'architecture du plant.

RÉSUMÉ

INTRODUCTION. D'après la littérature, les plantes grimpantes appelées lianes présentent de nombreux changements morphologiques et physiologiques entre les phases juvénile et adulte. Pour mieux connaître certains aspects du développement du plant de grenadille, sa croissance a été observée. **MATÉRIEL ET MÉTHODES.** En plus des méthodes déjà publiées par les auteurs (MACIEL et al, 1997), des observations ponctuelles, sur treille, de plants d'âges divers ont permis d'étudier le stade adulte. Le choix des caractères observés s'est également appuyé sur les résultats d'autres travaux publiés par la littérature. **RÉSULTATS.** Les plantules ont une germination phanérocotylédonaire et épigée à deux cotylédons foliacés opposés. Pendant la phase juvénile, le plant croît de façon continue selon un axe orthotrope qui est un monopode à symétrie radiale. À partir du début de la phase de transition, l'axe adopte une symétrie dorsiventrals avec élongation des entre-nœuds et orientation secondaire des feuilles aboutissant à l'observation du port grimpant. La tige adulte présente une croissance monopodiale continue et une floraison latérale. La ramification va jusqu'au quatrième rang et évolue de la base de l'axe vers son sommet. **DISCUSSION.** L'architecture de la plante, déterminée par un ensemble – axe monopodial à croissance continue, floraison latérale, ramification partant de la base –, correspondrait au modèle proposé par CREMERS (1974) pour des lianes orthotropes au stade juvénile, puis grimpantes lorsque adulte, la croissance de l'axe monopodial n'étant interrompue ni par la floraison ni par d'autres modifications structurales.

MOTS CLÉS

Venezuela, *Passiflora edulis*, stade de développement végétal.

Received 19 September 1995
Accepted 26 November 1996

Fruits, 1997, vol 52, p 93-97
© Elsevier, Paris

RESUMEN ESPAÑOL, p. 97

● introduction

The development and architecture of lianes remains as a part of an incomplete knowledge about these plants. The lianes are climbing plants that are characterized by presenting stems with elongated internodes of rapid growth but they are come unable to support themselves. According to CREMERS (1973) the lianes show a large number of morphological and physiological changes between juvenile and adult phase. They also present a distinctive structure and some devices by which they may climb.

CREMERS (1973, 1974) was able to differentiate architecturally two large groups of lianes within 20 tropical African species. One group of species corresponded to 13 of the architectural models already described by HALLÉ and OLDEMAN (1970) for trees. These lianes were different from trees by the length of the internodes, less formation of supporting tissues and other minor modifications. The other group permitted CREMERS (1973, 1974) to recognize three original architectural categories for tropical lianes.

Generally, the juvenile form of lianes is erect, slow-growing and moderately sized while the transitional form presents important morphological changes in form and size of the leaves, internodal length and climbing structures. The adult form is lianescent of great dimensions and requires support (CREMERS, 1973). According to HALLÉ et al (1978), lianes develop a highly efficient tub-like axis that functions as translocation pipe.

Although DELANOE (1992) had studied some aspects of developmental morphology of passion fruit vine, some architectural aspects have not been yet elucidated. In this work, some special aspects about organization and architectural categorization of the vine are analyzed.

● materials and methods

Materials and methods used in this part of the work are basically the same as already

described in a previous paper (MACIEL et al, 1997). In addition, punctual observations of vines at different ages on the supporting trellis were performed in order to characterize some aspects of the adult stage.

The variables used correspond to those developed by HALLÉ and OLDEMAN (1970) and HALLÉ et al (1978), and to the criteria established by CREMERS (1973, 1974) for architectural features of lianes. In addition, methodological aspects used by NICOLINI (1991) in Rutaceae in order to schematically present the consecutive stages of development, were taken into account.

● results

The development of the vine was characterized by undergoing a change from an erect form to a decumbent and climbing form which remained for the rest of plant life. The erect and the climbing form had been recognized as characteristic for some tropical lianes by CREMERS (1973, 1974). The erect form was distinctive of the juvenile phase and the climbing form to the transitional and adult phases (MACIEL et al, 1997).

the seedling

The actually emerged seed consists of an axis formed by an erect hypocotyl and an unmacrovisible epicotyl. The seedling develops through a phanerocotyledonary and epigeal germination with two opposed foliaceous cotyledons (fig 1a).

juvenile phase

This phase is characterized by the developing of a branchless, continuous-growing orthotropic axis which originates from the epicotyl. During this period, the stem presents radial symmetry, short internodes and 2/5 spiral-disposed unlobed leaves with an axillar vegetative bud. After the two first phyllotactic turns (ten leaves) were completed, the juvenile phase came to an end and the transition phase started (fig 1b). This generally occurs in about 80 d (MACIEL et al 1997).

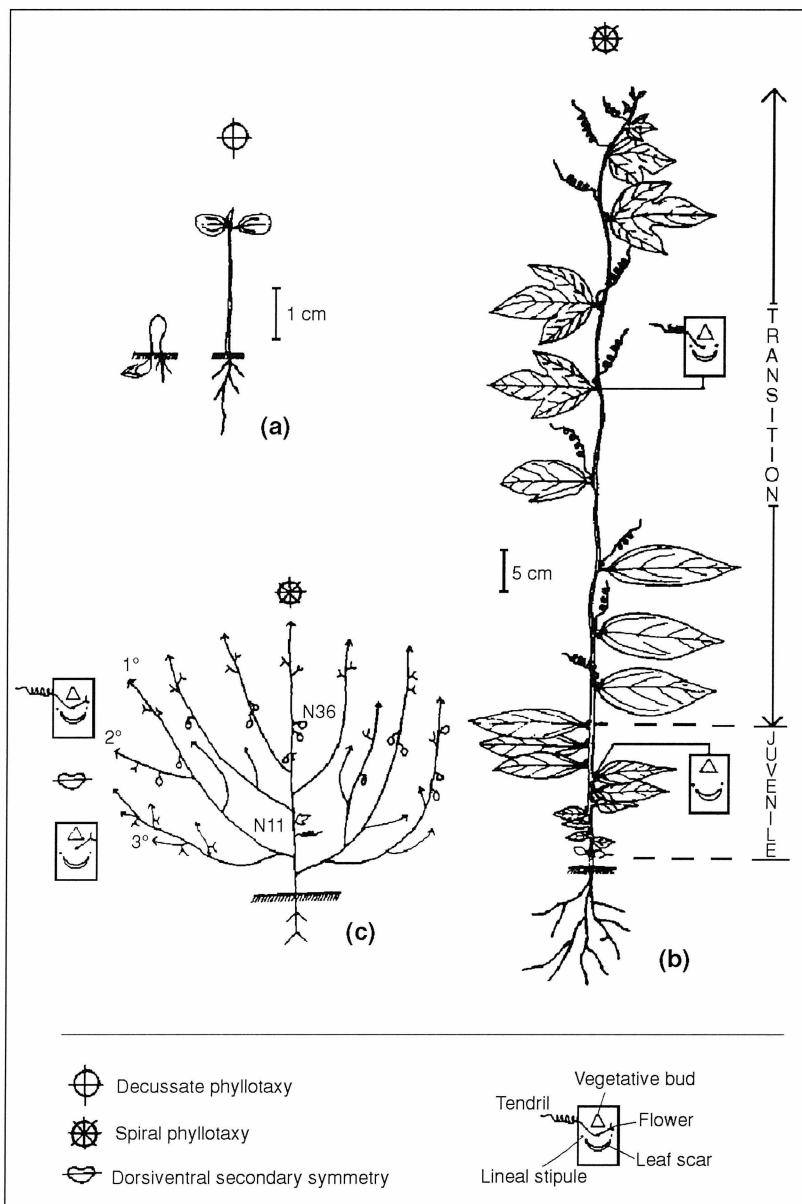
The above mentioned developmental sequence resembled the erect juvenile phase described by CREMERS (1974) for *Crossostemma laurifolium* Planchon ex Benthian, Passifloraceae of African origin. According to DELANOE (1991), the passion fruit vine differed from *Passiflora glandulosa* Cavanilles during this phase, because the latter presented a sympodial and rhythmic growth. The monopodial and continuous-growth of the epicotylar axis of the passion fruit vine is a characteristic phenomenon of many tropical species, according to TOMLINSON (1978).

transition phase

Once the second phyllotactic turn was completed, the appearance of trilobate leaves and long and flexible internodes that made the axis to take a climbing form became evident. During this transitional period, the leaf lamina attained a dorsiventral polarity by rearrangement and the leaves turned to a relative distichous position in order to capture light more efficiently (fig 1b). The secondary leaf arrangement resulting from the torsion of the petiole was imposed and acquired during internode elongation and leaf expansion. Observation showed that spiralled phyllotaxis of 2/5 remained at the apices of the plagiotropic axes. In some cases, several consecutive leaves were arranged toward the same side.

The first tendril appeared between the nodes 11 and 20 of the epicotylar axis (MACIEL et al, 1997). After the appearance of this first tendril, each foliar axile showed two longitudinal aligned growing points; the most basal corresponded to the primordium that gave rise to the tendril and the upper one to the vegetative bud that gave rise to the lateral branch (fig 1b inset). Then, after the first tendril, the formation of tendrils was consecutive on the axis.

Branching started at the orthotropic portion of the axis and proceeded acropetally and continuously. The branches arising from axillar buds had no stipules and its first internode was well developed, therefore, the shoots were sylleptic.



The transitional phase took place during the formation of at least five phyllotactic turns above the two already accumulated turns formed in the juvenile phase. The period during which the transitional phase occurred took approximately 3.5 months under the experimental conditions.

Figure 1
Development stages of *Passiflora edulis* f. *flavicarpa*.
a: seedling;
b: juvenile and transition phases;
c: adult plant.

Figure 2 gives an schematic representation of the development of the vine from seedling to the initiation of adult phase according to MACIEL et al (1997): the changes of stages, the developmental phases, the morphogenetic units and the evolution of the

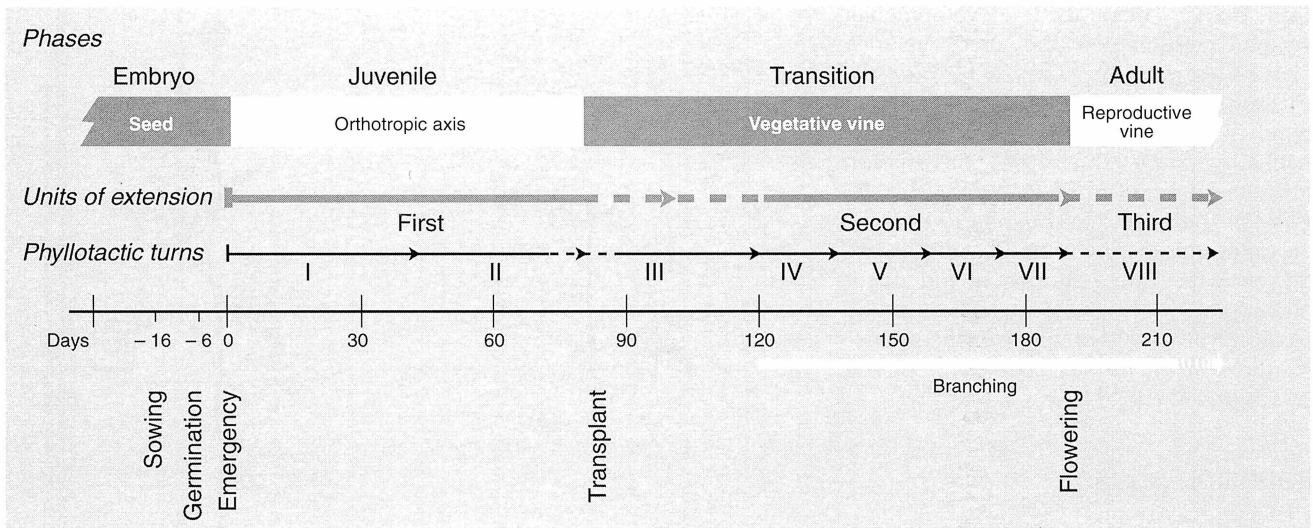


Figure 2
Growth and development
of epicotylar axis from
germination to adult in
Passiflora edulis f. *flavicarpa*.

epicotylar axis are chronologically indicated in relation to the phyllotactic turns.

adult phase

The adult phase started when floral primordia appeared by the first time at the nodes of the distal portion of epicotylar axis and branches. The floral primordium was found in the axil at the right side and same level of the tendril (fig 1c). The parental axis and lateral branches grew continuously and branching proceeded sequentially from the base to the apex. However, some buds did not break on time although they did it later following the acropetal sequence and giving rise to proleptic shoots. The vine showed three orders of branching.

In a short time, the adult vine showed a large vegetal mass as a result of the active process of branching. The most basal first order branches were remarkably lengthy and tended to reiterate parental morphologic characteristics. The first tendril on the first order branches appeared in the seventh node on basal branches and at the fourth node on distal ones. The appearance of the first tendril tended to be more basal on its axis as the branching order increased or the branches were more distal. The morphological changes ordinarily took place according to the branching order and to the nodal position of the lateral shoots on their parental axis.

The third order and some of the second order shoots located on the most distal parts of the vine were short and branchless. On these shoots, the first flower may appear on the basal node preceding the first tendril. Such shoots are similar to those known in other species as brachyblasts which function as reproductive structures.

Adult vines might show flexible shoots that could adopt orthotropic or plagiotropic positions on the same axis. Those shoots of mixed symmetry were recognized because the orthotropic portion of axis presented radial symmetry and the plagiotropic portion became dorsiventral by rearrangement.

discussion

The passion fruit vine did not correspond to the architectural models described by HALLÉ and OLDEMAN (1970). However, it followed the first architectural category proposed by CREMERS (1974) for lianes (fig 1). *Passiflora edulis* f. *flavicarpa* was characterized by presenting an orthotropic branchless juvenile form of a very slow growth followed by a lianescent faster growing form. The appearance of the lianescent form coincided with the transitional phase during which changes occurred in internodal length, size and shape of leaves, appearing of tendrils and starting of branching.

The adult was recognized by appearance of lateral flowers on the main axis as well as on the lateral ones. The adult vine showed monopodial and continuous growth, basitonic branching and lateral flowering. Main axes were equivalent and behaved as monopodia of continuous growth.

note

Research partially supported by CDCHT, Universidad Centroccidental Lisandro Alvarado.

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Crecimiento y desarrollo de la planta de pasionaria. II. Aspectos cualitativos de la arquitectura de la plántula.

RESUMEN

INTRODUCCIÓN. Según la literatura, las plantas enredaderas denominadas bejucos, o lianas, presentan numerosos cambios morfológicos y fisiológicos entre las fases juvenil y adulta. Para conocer mejor algunos aspectos del desarrollo de la plántula de granadilla, se observó su crecimiento. **MATERIAL Y MÉTODOS.** Además de los métodos ya publicados por los autores (MACIEL et al, 1997), las observaciones específicas de diversas plantas, realizadas en entramado, permitieron estudiar el estado adulto. La elección de los caracteres observados también se basó en los resultados de otros trabajos publicados. **RESULTADOS.** Las plántulas tienen una germinación fanerocotiledónea y epígea con dos cotiledones foliáceos opuestos. Durante la fase juvenil, la planta crece de manera continua según un eje ortótropo que es un monopodio de simetría radial. A partir del comienzo de la fase de transición, el eje adopta una simetría dorsoventral con elongación de los entrenudos y orientación secundaria de las hojas que llevan a la observación del porte trepador. El tallo adulto presenta un crecimiento monopódico continuo y una florescencia lateral. La ramificación va hasta el cuarto rango y evoluciona de la base del eje hacia su cima. **DISCUSIÓN.** La arquitectura de la planta, determinada por un conjunto de eje monopódico de crecimiento continuo, florescencia lateral y ramificación que parte de la base corresponde probablemente al modelo propuesto por CREMERS (1974) para las lianas ortótropas en el estado juvenil y trepadoras en el estado adulto, pues el crecimiento del eje monopódico no es interrumpido ni por la florescencia ni por otras modificaciones estructurales.

PALABRAS CLAVES

Venezuela, *Passiflora edulis*, etapas de desarrollo de la planta.