

BIOSYSTEMATIC STUDIES IN *Martynia annua* Linn.

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Key words : *Martynia annua*, Biosystematics, Martyniaceae.

Biosystematic studies of three populations of *Martynia annua* have been undertaken in the present investigation. Morphological and anatomical characteristics support the placing of *Martynia annua* in the family Martyniaceae. Cytological studies indicate low half chiasma per chromosome which is supposed to show greater reproductive efficiency in the species. It also indicates that populations are outbreeders.

INTRODUCTION

The credit of introducing the term biosystematics goes to Camp and Gilly (1943) who prescribed two aims of biosystematics (i) to delimit the natural biotic units and (ii) to apply these units a system of nomenclature. In this context definition of Clausen *et al.* (1945) may be quoted, according to which "the data provided by morphology, cytology, genetics and ecology make the science known as biosystematics".

According to modern biosystematists, the preliminary survey, variation pattern, local adaptations, cytological aspects, and the analysis of breeding system form part of biosystematics and so this discipline is concerned with the evolution of a species along with taxonomic treatment (Radford *et al.*, 1974 and Grant, 1984).

According to Bentham and Hooker, *Martynia annua* is a member of family Pedaliaceae but later taxonomists like Engler and Prantl, Hutchinson, Takhtajan, Cronquist, Dahlgren & Thorne (Mondal, 2005) have put the species in a separate family called Martyniaceae.

Keeping all these points under consideration, three populations of *Martynia annua* Linn have been studied from biosystematics point of view.

MATERIALS AND METHODS

Three populations of *Martynia annua* have been identified and studied biosystematically. Details of populations and place of collection of materials have been given in Table- 1.

TABLE- 1

Populations	Locality	Period of collection
Ma 0814	White House Camp, Gaya	12 Aug, 2014
Ma' 0814	Near Mangla Gauri, Gaya	16 Aug, 2014
Ma'' 0814	Near Maranpur, Gaya	19 Aug, 2014

Morphological characters of all the populations were studied. Besides morphology, internodal anatomy of the plant from the three populations was seen using double staining technique. Meiotic studies in all the three populations were carried out in detail, using squash technique. Aceto-carmine was used as a staining material. Slides were made permanent following Celarier's (1956) method.

OBSERVATIONS

Morphology : The plant was found to be stout and pubescent herb. Leaves were simple cordate and extraordinarily large (Fig.-A). Flowers were pink in colour. Number of sepals and petals was five. Two fertile stamens and three sterile stamens (staminodes) were reported (Fig - B). Out of three staminodes, two were of one size while the third was very small. Number of carpel was two with syncarpous condition and parietal placentation. Fruit was green in color with black seed. The fruit was found to be drupaceous sculptured structure having two sharp and curved apical spines. Qualitatively the three populations did not show any variation. However, quantitatively the populations differed in characters like height of plant, number of nodes, length of internode and length and breadth of leaf. Quantitative variations have been presented in Table-2.

TABLE-2

Characters	Population	Range	Mean	Variance	Standard deviation	Standard error
Height of plant	Ma 0814	94 - 109	100.95	25.55	5.05	1.59
	Ma' 0814	99 - 119	107.94	40.98	6.40	2.02
	Ma'' 0814	93 - 124	107.31	137.60	11.73	3.70
No. of Nodes	Ma 0814	20 - 26	22.7	4.23	2.05	0.65
	Ma'0814	16 - 20	18.1	9.12	3.02	0.30
	Ma'' 0814	16 - 24	19.0	6.66	2.58	0.81
Length of internode	Ma 0814	5-11.3	7.82	4.23	2.05	0.65
	Ma' 0814	4-11.6	7.66	6.04	2.45	0.77
	Ma'' 0814	4.5 - 14	9.06	10.00	3.16	1.00
Length of leaf	Ma0814	18 - 28	23.60	10.01	3.16	1.00
	Ma'0814	18 - 29	23.30	10.26	3.20	1.01
	Ma''0814	23 - 28.5	25.51	3.60	1.89	0.60
Breadth of leaf	Ma 0814	20 - 28	24.05	6.54	2.55	0.80
	Ma'0814	20 - 29.4	24.85	8.40	2.89	0.91
	Ma''0814	20 - 28.5	25.56	5.15	2.27	0.71

Anatomy : The outline of the stem was found to be circular. The trichomes were of two types. One type was characterised by brush-shaped apex while the other type showed only tapering end. The cortical zone consisted of upper five to six-layered chlorenchyma and the lower zone consisted of three to four-layered parenchyma. Vascular bundle was conjoint and collateral. Xylem layers were arranged in systematic manner and enclosed a bigger region as compared to phloem. Pith cells were mostly hexagonal (Fig - C).

Cytology :

Ma0814

This population was small and consisted of only six plants. The plants were growing in wasteland area on a soil mixed with ashes and were directly exposed to sunlight. Flower buds for meiotic studies were collected at 11 am. Detailed meiotic studies revealed the chromosome number as n = 16. The division was found to be highly non-synchronized. At metaphase I sixteen bivalents were found to be arranged on equatorial plate (Fig. 1). Most of the pollen mother cells were found to be normal. However, certain abnormalities were also reported. Clumping of chromosome, formation of univalents and multivalents were noticed in some of the pollen mother cells. Details of chromosomal association have been given in Table-3 and nature and frequency of chiasma formation have been summarized in Table-4.

At anaphase I, sixteen univalents were found at both the poles (Fig.2). Anomalies at this stage included simple chromosomal bridge, chromosomal laggard and clumping of chromosome. Metaphase II was found to be normal (Fig.3). Subsequent stages were found to be almost normal. Some spore tetrads were of unusual type. Some "T" shaped spore tetrads were noticed (Fig.4). Pollen sterility was calculated to be 5.6 per cent (Table-5).

Ma' 0814

This was also a small population like Ma0814 and consisted of five plants only. In this case also the plants were growing in the wasteland area under the direct influence of sunlight.

Meiotic studies confirmed the earlier finding regarding gametic number as n = 16. Diakinesis & Metaphase I stages were found to be normal in most of the pollen mother cells (Fig 5). In this case, abnormalities reported included precocious separation of chromosome also, besides clumping of chromosomes and formation of univalents and multivalents (Fig 6). Details of chromosomal association and chiasma frequency are given in Table 3 & 4 respectively.

Besides normal anaphase I (Fig - 6), it showed anomalies like clumping of chromosomes, unequal segregation of chromosome and chromosomal laggard. At anaphase II clumping of chromosomes at four poles was noticed (Fig 7). Rest pollen mother cells were normal. Pollen grains were found to be of one size and the outer wall was a little wavy. In some pollen grains mitotic division was noticed (Fig 8). Pollen sterility was calculated to be 6.1 per cent (Table 5).

Ma''0814

This was a large population consisting approximately one hundred plants. Plants were placed in such a way that some were getting direct sunlight while others were getting diffused sunlight. Flower buds were collected from most of the plants at 11:30 am.

In this population also the gametic number was found to be n = 16. Division was nonsynchronised like previous cases. At metaphase I, abnormalities were reported in some pollen mother cells. Fragmented chromosomes were noticed in a few pollen mother cells (Fig 9). In some pollen mother cells group of clustered bivalents was noticed (Fig 10). Multivalent and univalent formation were also common in this population. Details of chromosome association and chiasma frequently have been summarized in Tables 3 & 4 respectively.

At anaphase I, clumping of chromosomes (Fig 11) and chromosomal laggard were recorded in some of the pollen mother cells besides normal anaphase I. A few pollen mother cells were found to be closely associated in which clumped chromosome were variously arranged (Fig 12).

TABLE - 3

Nature and frequency of chromosome association at metaphase I of the three Populations : Ma0814, Ma' 0814 and Ma'' 0814.

Chromosomal Association						Frequency of PMCs	Populations
VI	V	IV	III	II	I		
0	0	2	0	10	4	5	Ma 0814
0	0	3	0	8	4	3	
1	0	1	0	11	0	2	
0	0	0	0	16	0	30	
0	0	3	0	8	4	5	Ma' 0814
1	0	0	0	12	2	2	
0	0	2	0	12	0	5	
0	0	0	0	16	0	28	
0	0	2	0	12	0	5	Ma'' 0814
1	0	1	0	10	2	1	
0	0	2	0	11	2	5	
0	0	0	0	16	0	29	

TABLE - 4

Chromosome pairing and chiasma frequency at metaphase I of studied populations : *Ma0814*, *Ma'0814* and *Ma''0814*.

Population	No. of PMCs Studied	No. of bivalents per PMC		Rod		T 0 T A L	Chiasmata per PMC	Terminalised chiasmata	Half chiasma per chromosome	Term Coeff		
		Range	Mean	Range	Mean							
Ma0814	50	8-10	9.0	6-8	7	16	18-25	21.5	18-24	21	0.0671	0.976
Ma'0814	50	8-9	8.5	7-8	7.5	16	17-25	21	17-24	20.5	0.656	0.976
Ma''0814	50	9-10	9.5	6-7	6.5	16	19-26	22.5	19-24	21.5	0.073	0.955

TABLE - 5

Pollen analysis of *Ma0814*, *Ma'0814* and *Ma''0814*

Populations	No. of Pollen Studied	No. of normal pollen	No. of sterile pollen	Percentage of sterile pollen
Ma 0814	1000	944	56	5.6
Ma' 0814	1000	939	61	6.1
Ma''0814	1000	934	66	6.6

Spore pentad and hexads were also noticed, though very few in number. Pollen sterility was found to be 6.6 per cent (Table 5).

DISCUSSION

We know that morphological characters provide the taxonomic evidence for natural classification and evolutionary classification also to a great extent (Davis and Heywood, 1991). In the present investigation, qualitative and five quantitative characters have been considered for analyzing the variations. No qualitative variation was reported. However, following morphological characters reported during study clearly support the contention of modern taxonomists in putting *Martynia annua* in a separate family Martyniaceae and not in the family Pedaliaceae as was done by Bentham and Hooker (1883).

1. Leaves cordate and extraordinarily large
2. Number of stamens two
3. Presence of staminodes
4. Parietal placentation
5. Presence of two curved apical spines on the surface of fruit.

Quantitatively, the populations showed variations in height of plant, number of nodes, length of internode, length of leaf and breadth of leaf (Table-2). Such phenotypic variations may be attributed to the plastic response of the individual to the factors of the environment (Trivedi, 1985).

Anatomically, the stem showed the characters of typical dicot stem. However, presence of two types of trichomes, one with brush like apex and the other with tapering end showed uniqueness of the species (Kumar, 1994).

In the similar fashion three different populations of *Martynia annua* were studied meiotically. Meiotic studies showed the gametic number in all cases as $n = 16$. In such populations also the meiotic division was highly non-synchronised and the abnormalities included precocious separation of chromosomes, clumping of chromosomes and

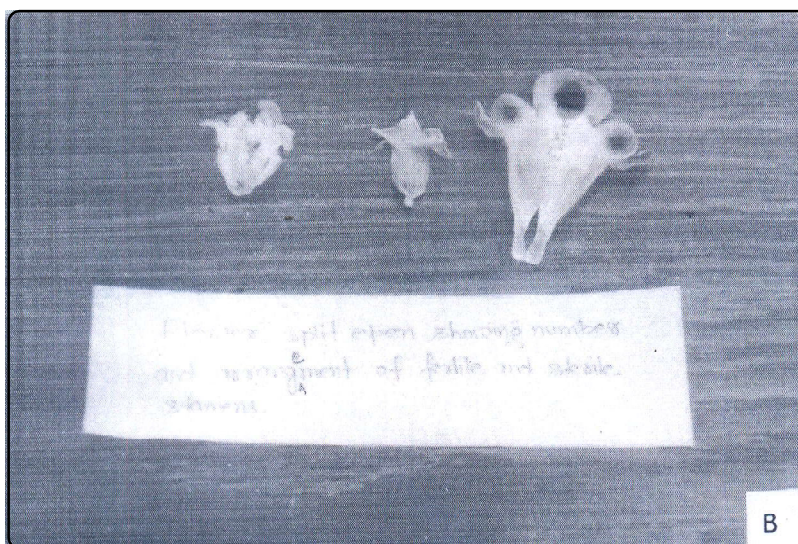
formation of univalents and multivalents at metaphase I. In some of the pollen mother cells in the plants of population *Ma''0814* fragmented chromosomes were also observed. At anaphase I, however, the anomalies were chromosomal laggards, simple chromosomal bridges, clumping of chromosomes, etc. Some pollen grains were reported to be T-shaped. The half chiasma per chromosome showed lower trend. It was 0.671 in *Ma 0814*, 0.656 in *Ma'0814* and 0.703 in *Ma''0814*. Pollen sterility varied from 5.6 to 6.6 per cent.

The trends found in chiasma frequency of different populations of *Martynia annua* indicate greater reproductive efficiency with a reduction in the recombination index (Vijayavalli and Mathew, 1992 and Sinha, 2014). The low chiasma frequency in different populations suggest that the population consists of mainly outbreeders. It is a well established fact that natural hybridization frequently occurs specifically among the outbreeders. Disturbed habitats are responsible for the origin of new type. Extensive hybridization has been noted among the species of *Rumex*, *Tragopogon*, *Sonchus* and *Lepidium* (Mulligan, 1965). The mass hybridization perhaps imparts the heterotic vigor and heterozygosity and the open and disturbed habitats continuously provide opportunities for hybridization. This situation might have been existing in different populations of *Martynia annua*.

The presence of low chiasma in different populations also indicates that the individuals possessed more degree of heterozygosity. This cytological character may be useful for biosystematists (Kumar, 1994). When we look to the half chiasma per chromosome of the three different populations, we find maximum degree of heterozygosity in *Ma'0814* and lesser degree of heterozygosity in *Ma 0814* and *Ma''0814* respectively. This indicates that the plants of the population *Ma''0814* must have colonized first in comparison to other populations.

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Martynia annua

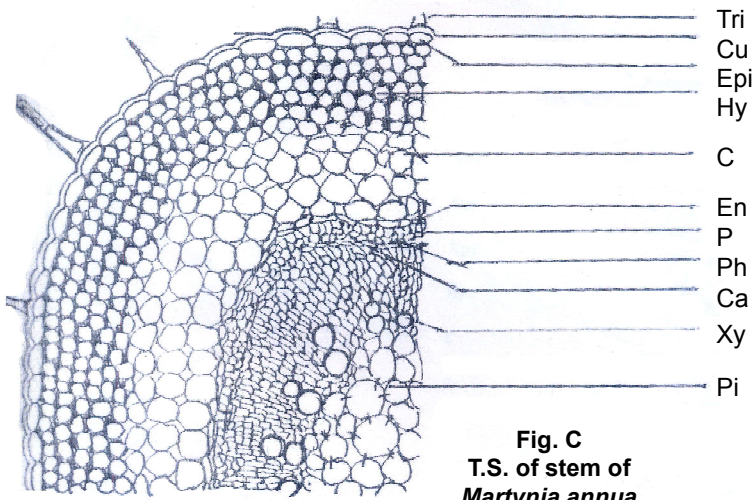
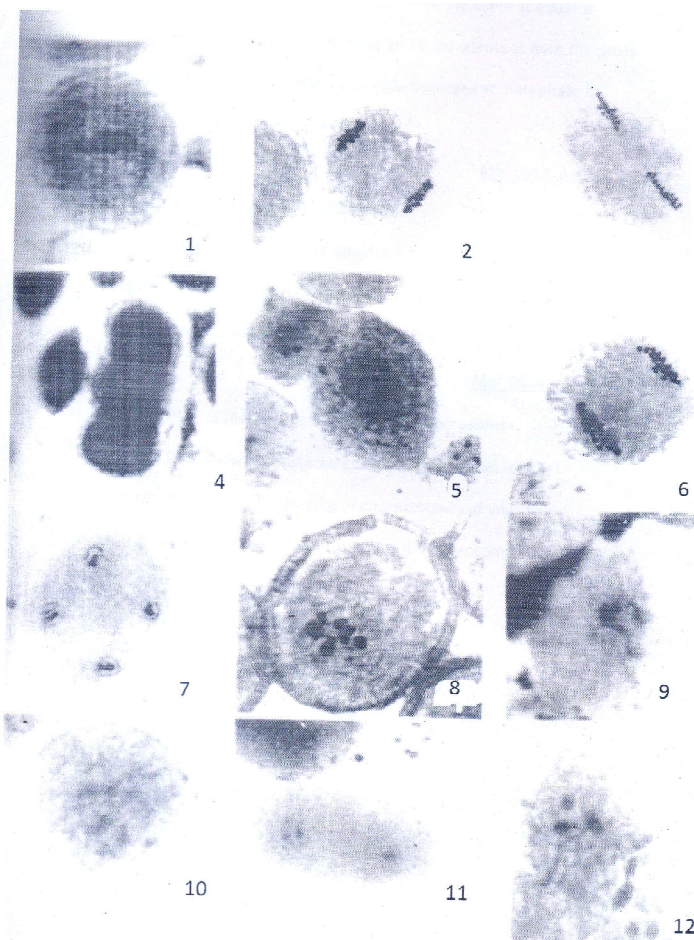


Fig. C
T.S. of stem of
Martynia annua

Details of Abbreviated Words

Tri	-	Trichome
Cu	-	Cuticle
Epi	-	Epidermis
Hy	-	Hypodermis
C	-	Cortex
En	-	Endodermis
P	-	Pericycle
Ph	-	Phloem
Ca	-	Cambium
Xy	-	Xylem
Pi	-	Pith



Martynia annua, n=16

Ma 0814, n = 16

- Fig 1 - PMC at metaphase showing sixteen bivalents at equator.
- Fig 2 - PMC at anaphase I showing 16:16 univalents at both the poles.
- Fig 3 - PMC showing clumping of chromosomes at metaphase II.
- Fig 4 - 'T' shaped pollen grain.

Ma' 0814, n =16

- Fig 5 - PMC showing normal diakinesis.
- Fig 6 - PMC showing normal anaphase I.
- Fig 7 - PMC showing clumping of chromosome at anaphase II.
- Fig 8 - Pollen grain showing mitotic division.

Ma'' 0814, n =16

- Fig 9 - PMC at metaphase I fragmented chromosomes.
- Fig 10 - PMC showing clustered chromosomes at metaphase I.
- Fig 11 - PMC showing clumping of chromosomes at anaphase I.
- Fig 12 - PMC showing various clumping of chromosome.