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Characterization of cultivated varieties of *Capsicum* from three districts of West Bengal, India

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Abstract

The cultivated varieties of *Capsicum* from three southern districts of West Bengal have been characterised on the basis of gross morphological characters. At first the species of cultivated varieties have been roughly identified as *C. annuum*, *C. frutecens* and *C. chinense*. The gross morphological variable characters among the studied specimens are examined critically. Using morphological variable characters a dendrogram is produced. Fruit shapes variability of the *Capsicum* varieties are studied by Geometric Morphometric Analysis method. All these studies indicate that the selected *Capsicum* varieties cultivated in West Bengal are actually inter-specific or inter-varietal fertile hybrids. Therefore clear cut morphological distinct characters for discrimination of species is absent in the studied varieties of *Capsicum*.

Key words : *Capsicum,* morphological variation, hybridization, geometric morphometric analysis

INTRODUCTION

Capsicum or chilli is an important vegetable in our daily life as a source of rich vitamin. It was used as food and medicine in tropical America from pre-historic time. Spanish, Portuguese and Turks were diffused the Mesoamerican *Capsicum* in the old world after its discovery by Spanish in the trip of Columbus. Soon it was spread rapidly throughout the world. In India capsicum was introduced by Portuguese about 400 years ago[1].

The genus *Capsicum* of the family Solanaceae contains 20 to 30 species which are native to the New World tropics and subtropics and one species *C. anomalum* is native to Japan[2]. Only five species among them are cultivated, viz. *C. annuum* L., *C. baccatum* L., *C. chinense* Jacq., *C. frutecens* L. and *C. pubescens* Ruiz and Pav. and at least three to five are semi-cultivated[3].

The taxonomic revisions on cultivated species of *Capsicum* are few and very old. The name *C. annuum* and *C. frutesens* were published by Linnaeus in Species Plantarum (1753) though *C. frutesens* is now considered as a synonym of *C. annuum* based on World Checklist of Selected Plant Families (WCSP) provided by 'The Plant List' www.theplantlist.org. Nevertheless WCSP data on *Capsicum* yet not totally peer reviewed. Linnaeus also gave the name *C. baccatum* in 1763. Nicholas J. Jacquin gave the name *Capsicum chinense* in 1776. Ruiz and Pavon published the name *Capsicum pubescens* in 1799. Therefore the identity of *C. annuum*, *C. baccatum*, *C. chinense* and *C. pubescens* are confirmed but identity of *C. frutecens* is still in doubt.

'The Plant List' provides thirty one sub-species, variety and forma level names of *C. annuum* which indicates its high variability. In several instance the wrong identifications caused *Capsicum* taxonomy more complicated. Irish[4] in her reversionary work described 56 garden varieties of *Capsicum* under *C. annuum* and *C. frutescens*. Bailey[5], however, recognised only one cultivated species in the name of *C. frutecens*. Smith and Heiser[6] recognised five distinct species of cultivated *Capsicum*, viz. *C. annuum*, *C. frutecens*, *C. pendulum*, *C. pubescences* and *C. sinense*. Latter Eshbaugh[7] treated *C. pendulum* as *C. baccatum* var. *pendulum* (Willdenow) Eshbaugh, where *C. pendulum* became the synonym of *C. baccatum*. Shaw and Khan[8] reported that in India *C. annuum*, an annual form and *C. frutecens*, a perennial form are cultivated. Thereafter critical taxonomic work on *Capsicum* of India was not conducted by any one. Though, various molecular level works[9], [10] and cytological work[11] have been carried out in recent years.

Several gross morphological characters are used for identification of *Capsicum* [6]. Pedicel numbers per node and petal colour are two frequently used characters for species delimitation. Indices generated from leaf and fruit shape were also used to characterize the varieties of *Capsicum*[12]. The present study deals with the characterization of some cultivated varieties of *Capsicum* available in three southern districts (North & South 24 Pags. and Hoogly) of West Bengal. The aim of this study is to find out the morphological significant character(s) for identification and to know the actual status of cultivated varieties of *Capsicum* in West Bengal. Also, to know the variability within the cultivated varieties of *Capsicum*, geometric morphometric analysis technique has been applied on fruit shapes.

MATERIALS AND METHODS

Capsicum specimens for present study were collected from North 24 Pgs., South 24 Pgs. and Hoogly of West Bengal from agricultural field and home gardens. A total of fourteen specimens were collected and worked out for the present study. A list of collected specimens is given in table 1. Herbarium specimens were prepared from each collection with proper voucher information. After completion of work the herbarium specimens were deposited in Barasat Govt. College Herbarium for future references and verifications.

Gross morphological study-

Gross morphological sketches were made from live specimens by free hand drawing. All parts of the plant body were carefully measured. An identification key (available online) provided by NBPGR (National Bureau of Plant Genetic

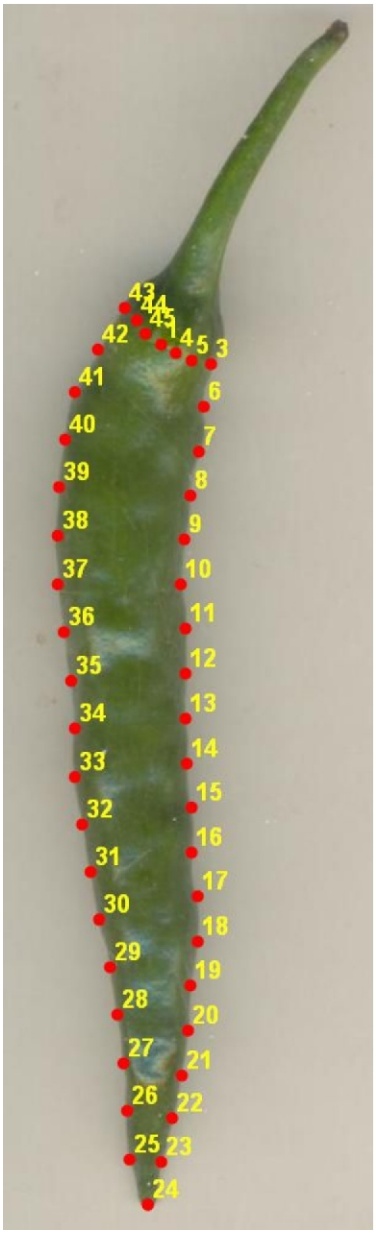

Figure 1 : Image of a mature Capsicum fruit with landmark and semi-landmark points for Geometric Morphometric Analysis.

Resources) was followed for identification. The identifications were further confirmed following Haiser and Smith[13].

Comparison and Character Coding for Phenetic Study-

The *Capsicum* specimens were compared based on gross morphology. Only the variable characters among the specimens were considered for creating a dendrogram to show the relationship among them. A total of twenty nine variable characters (Table 2) were identified and states of these characters (Table 3) were coded by binary numbers (0 and 1). The dendrogram was created by Past software following UMGMA method and Jaccard Similarity Coefficient was used.

Geometric Morphometric Analysis of fruit shapes-

To reveal the amount of variability within the studied specimens, Geometric Morphometric Analysis (GMA) tool was applied. The results of GMA are surprising in several occasions but not very widely applied tool like molecular base characterizations. The principle of GMA is that shape is unique for each and every living organisms and organs and it is a hereditary character[14].

A series of freely available software from web were used for GMA. Before hand, images of *Capsicum* fruits were captured under a scanner. All jpg format images were gathered under a single tps file using tpsUtil software. tpsDig2 software was then used to create a series of landmarks and semi-landmarks around the periphery of each fruit shapes (Fig. 1). Using the coordinate data of landmarks and semi-landmarks as variables the Principal Component Analysis was performed in PAST software. The result was visualized by plotting of shape specimens in a 2D scatter plot considering PC I and II as X and Y axis, respectively.

RESULTS

The gross morphology of studied specimens of *Capsicum* is presented in Table 3. The characters which are variable among the specimens are presented here. (Figure 2)

The first two Principal Components (PCs) are responsible for more than 90% of total fruit shapes variation. Fruit shape variables are plotted against PC 1 (causes 73.56% variation) and PC 2 (causes 19.27 % variation). The shape variables of *C. annuum* show a wide scattering in 2D scatted plot. One shape variable of *C. frutecens* and the sole shape variable of *C. chinense* fall within the range of *C. annuum* shape variables. But the

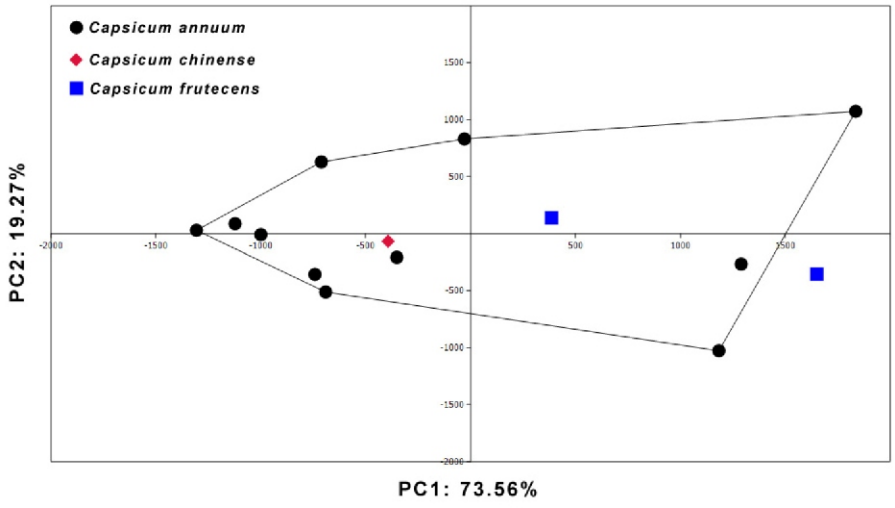

Figure 2 : 2D scatter plot showing *Capsicum* fruit shape variation. Specimens are plotted against their score with PC 1 and PC 2. Fruit shape specimens of *C. annuum* overlap with the fruit shapes of *C. frutecens* and *C. chinense*.

Table 1: List of studied specimens of *Capsicum*

Sl. No.	Specimen No	Identification	Locality	Collection No
1	Specimen-A	***Capsicum** annuum*	Sonarpur Natunpally, South 24 Parganas	C61
2	Specimen-B	*Capsicum annuum*	Maslandapur, North 24 Parganas	C62
3	Specimen-C	*Capsicum chinense*	Dakuria, Kolkata	C64
4	Specimen-D	*Capsicum frutecens*	Horischok, Hoogly	C66
5	Specimen-E	*Capsicum frutecens*	Horischok, Hoogly	C68
6	Specimen-F	*Capsicum annuum*	Horischok, Hoogly	C70
7	Specimen-G	*Capsicum annuum*	Habra, North 24 Parganas	C72
8	Specimen-H	*Capsicum annuum*	Maslandapur, North 24 Parganas	C74
9	Specimen-I	*Capsicum annuum*	Maslandapur, North 24 Parganas	C76
10	Specimen-J	*Capsicum annuum*	Maslandapur, North 24 Parganas	C78
11	Specimen-K	*Capsicum annuum*	Maslandapur, North 24 Parganas	C80
12	Specimen-L	*Capsicum annuum*	Maslandapur, North 24 Parganas	C82
13	Specimen-M	*Capsicum annuum*	Horischok, Hoogly	C84
14	Specimen-N	*Capsicum annuum*	Sonarpur Natunpally, South 24 Parganas	C86

Table 2: List of studied specimens of *Capsicum*

Sl. No.	Characters		Character states
1.	Habit	:	Suffruticose (0); herbaceous (1)
2.	Stem in cross section	:	Round (0); square (1)
3.	Node	:	Slightly swollen (0); swollen (1)
4.	Node colour	:	No purple spots at nodes (0); Purple spots present at each node (1)
5.	Petiole length	:	Petiole short (0); Petiole long (1);
6.	Lamina shape	:	Lanceolate (0); deltoid (1)
7.	Lamina apex	:	Acute (0); acuminate/ cuspidate (1)
8.	Lamina margin	:	Entire (0); undulate (1)
9.	Lamina length: breadth ratio	:	> 2 (0), <2 (1)
10.	Pedicel length	:	Short (0); long (1)
11.	Calyx surface	:	Lightly pubescent (0); pubescent (1)
12.	Calyx colour	:	Greenish (0); greenish white (1)
13.	Calyx length	:	=0.8 (0); >0.8 (1)

14.	Corolla colour	:	White/ whitish/ greenish white (0); purple/ purplish (1)
15.	Corolla with more than one colour	:	No (0); yes (1)
16.	Striations on corolla tube	:	Absent (0); present (1)
17.	Corolla length	:	<1 cm (0); =1 cm (1)
18.	Stamens position against petals	:	Placed vertically at the junction of petals (0), Placed horizontally at the junction of petals (1);
19.	Filament length	:	Short (0); long (1)
20.	Filament colour	:	Filament colour- white/ whitish/ hyaline (0); purple/ yellowish purple (1);
21.	Immature anther colour	:	Greenish (0); purplish (1)
22.	Mature anther colour	:	Mature anther colour- greenish/ greenish white/ greenish black (0); light purplish/ light violate (1)
23.	Ovules per chamber of ovary	:	Many ovules (0); 3-6 ovules (1)
24.	Style colour	:	Style white (0), purplish (1);
25.	Fruit stalk	:	Pendent/ Slightly pendent (0); Upright (1)
26.	Fruit shape	:	Curved/ Elongated (0); Rounded (1)
27.	Fruit apex	:	Pointed (0); Blunt (1)
28.	Immature fruit colour	:	Green (0); Other than green (1)
29.	Length: Breadth ratio of fruits	:	= 15 (0); >16 (1)

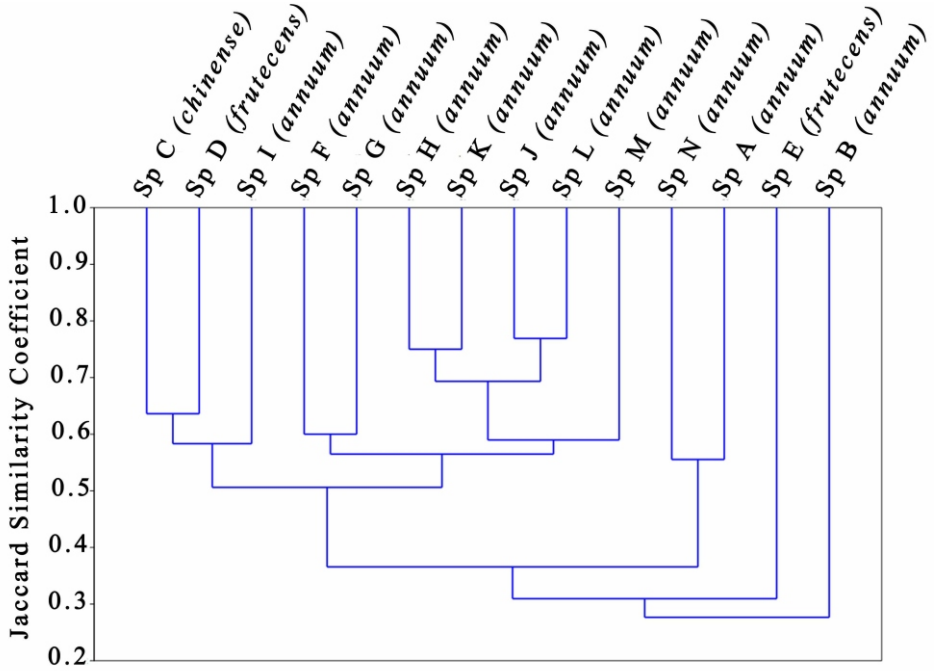

Fig 3 : A. Dendrogram showing the relationships among the Capsicum specimens.

remaining shape variable of *C. frutecens* falls out side the range of *C. annuum*.

Dendrogram shows that the two specimens of *C. frutecens* (D and E) are distantly related. Similarly some specimens of *C. annuum* are also very different, for example specimen B and I. The maximum similarity is observed between specimens H-K and J-L. All these specimens were identified as *C. annuum*.

Table 3: Comparisons of *Capsicum* specimens on the basis of gross morphology. Numbers in parentheses indicate character coding given in Table 2.

Sl. No.	Character	Specimen A (*C. annuum*)	Specimen B (*C. annuum*)	Specimen C (*C. chinense*)	Specimen D (*C. frutecens*)	Specimen E (*C. frutecens*)	Specimen F (*C. annuum*)	Specimen G (*C. annuum*)
1	Habit	Herbaceous (1)	Herbaceous (1)	Herbaceous (1)	Suffruticose (0)	Suffruticose (0)	Herbaceous (1)	Herbaceous (1)
2	Stem in cross section	Round (0)	Round (0)	Round (0)	Round (0)	Square (1)	Round (0)	Round (0)
3	Node	Swollen (1)	Swollen (1)	Slightly swollen (0)	Slightly swollen (0)	Slightly swollen (0)	Slightly swollen (0)	Slightly swollen (0)
4	Node colour	No purple spots at nodes (0)	No purple spots at nodes (0)	No purple spots at nodes (0)	Purple spots present at each node (1)	No purple spots at nodes (0)	No purple spots at nodes (0)	Purple spots present at each node (1)
5	Petiole length	Long, c. 3-4 cm (1)	Long, c. 2 cm (1)	Very short, c. 0.5 cm (0)	Short, c. 1.5 cm (0)	Short, c.1 cm (0)	Long, c.4 cm (1)	Long, c.2 cm (1)
6	Lamina shape	Lanceolate (0)	Lanceolate (0)	Lanceolate (0),	Lanceolate (0),	Deltoid (1)	Lanceolate (0)	Lanceolate (0)
7	Lamina apex	Acuminate (1)	Acuminate (1)	Acute (0)	Acute (0)	Cuspidate (1)	Acuminate (1)	Acute (0)
8	Lamina margin	Entire (0)	Entire (0)	Undulate (1)	Undulate (1)	Entire (0)	Entire (0)	Entire (0)
9	Lamina length: breadth ratio	c. 3.33 (0)	c. 3.60 (0)	c. 2.28 (0)	c. 2.40 (0)	c. 1.57 (1)	c. 2.80	c. 1.85 (1)
10	Pedicel length	Short (0)	Long (1)	Long (1)	Long (1)	Long (1)	Short (0)	Short (0)
11	Calyx surface	Lightly pubescent (0)	Lightly pubescent (0)	Pubescent (1)	Pubescent (1)	Pubescent (1)	Pubescent (1)	Pubescent (1)
12	Calyx colour	Greenish (0)	Greenish (0)	Greenish (0)	Greenish (0)	Greenish white (1)	Greenish (0)	Greenish (0)
13	Calyx length	c. 0.5 cm (0)	c. 0.4 cm (0)	c. 0.3 cm (0)	c. 0.4 cm (0)	c. 0.6 cm (0)	c. 0.5 cm (0)	c. 0.4 cm (0)
14	Corolla colour	Deep purplish (1)	Milky whitish, yellowish at base (0)	Light greenish (0)	Greenish white (0)	Greenish (0)	White (0)	White (0)
15	Corolla with more than one colour	No (0)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)
16	Striations on corolla tube	Present (1)	Absent (0)	Present (1)	Present (1)	Absent (0)	Present (1)	Present (1)
17	Corolla length	c.1 cm (1)	c.1 cm (1)	c.1 cm (1)	c.1 cm (1)	c.1 cm (1)	c.1.2 cm (1)	c.1 cm (1)
18	Stamens position against petals	Placed vertically at the junction of petals (0);	Placed vertically at the junction of petals (0);	Placed horizontally at the junction of petals (1);	Placed present horizontally at the junction of petals (1);	Placed present vertically at the junction of petals (0);	Placed horizontally at the junction of the petals (1);	Placed horizontally at the junction of petals (1);
19	Filament length	Short (0)	Long (1)	Short (0)	Short (0)	Short (0)	Short (0)	Short (0)
20	Filament colour	Purplish (1)	White (0)	White (0)	White (0)	Whitish (0)	White (0)	Hyaline (0)
21	Immature anther colour	Purplish (1)	Purplish (1)	Purplish (1)	Purplish (1)	Purplish (1)	Purplish (1)	Purplish (1)
22	Mature anther colour	Greenish (0)	Greenish white (0)	Greenish (0)	Greenish (0)	Greenish (0)	Greenish (0)	Greenish (0)
23	Ovules per chamber of ovary	4 ovules (1)	Many ovules (0)	Many ovules (0)	4-6 ovules (1)	3-4 ovules (1)	3-4 ovules (1)	3-4 ovules (1)
24	Style colour	Purplish (1)	Whitish (0)	Whitish (0)	Whitish (0)	Whitish (0)	Whitish (0)	Whitish (0)
26	Fruit shape	Curved (0)	Elongated (0)	Slightly curved (0)	Elongated (0)	Rounded (1)	Elongated (0)	Rounded (1)
27	Fruit apex	Blunt (1)	Pointed (0)	Pointed (0)	Pointed (0)	Blunt (1)	Blunt (1)	Blunt (1)
28	Immature fruit colour	Blackish (1)	Green (0)	Green (0)	Green (0)	Green (0)	Green (0)	Green (0)
29	Length:Breadth ratio of fruits	c. 6 (0)	c. 11 (0)	c. 8 (0)	c. 12 (0)	c. 8 (0)	c. 22.5 (1)	c. 6.66 (0)

Table 3: Comparisons of *Capsicum* specimens on the basis of gross morphology. Numbers in parentheses indicate character coding given in Table 2.

Sl. No.	Character	Specimen H (*C. annuum*)	Specimen I (*C. annuum*)	Specimen J (*C. annuum*)	Specimen K (*C. annuum*)	Specimen L (*C. annuum*)	Specimen M (*C. annuum*)	Specimen N (*C. annuum*)
1	Habit	Herbaceous (1)	Herbaceous (1)	Herbaceous (1)	Herbaceous (1)	Herbaceous (1)	Herbaceous (1)	Herbaceous (1)
2	Stem in cross section	Round (0)	Round (0)	Round (0)	Round (0)	Round (0)	Round (0)	Round (0)
3	Node	Slightly swollen (0)	Slightly swollen (0)	Slightly swollen (0)	Slightly swollen (0)	Slightly swollen (0)	Slightly swollen (0)	Slightly swollen (0)
4	Node colour	Purple spots present at each node (1)	No purple spots at nodes (0)	Purple spots present at each node (1)	Purple spots present at each node (1)	Purple spot present at each node (1)	No purple spots at nodes (0)	No purple spots at nodes (0)
5	Petiole length	Short, c.1 cm (0)	Short, c. 0.5 cm (0)	Short, c.0.7 cm (0)	Short, c.1.5 cm (0)	Short, c.0.5 cm (0)	Long, c. 1-4cm (1)	Long, c.3cm (1)
6	Lamina shape	Lanceolate (0)	Lanceolate (0)	Lanceolate (0)	Lanceolate (0)	Lanceolate (0)	Lanceolate (0)	Lanceolate (0)
7	Lamina apex	Acuminate (1)	Acute (0)	Acuminate (1)	Acuminate (1)	Acuminate (1)	Acuminate (1)	Acuminate (1)
8	Lamina margin	Entire (0)	Entire (0)	Entire (0)	Entire (0)	Entire (0)	Entire (0)	Entire (0)
9	Lamina length: breadth ratio	c. 4.00 (0)	c. 3.40 (0)	c. 3.14 (0)	c. 3.42 (0)	c. 3.11 (0)	c. 2.50 (0)	c. 3.70 (0)
10	Pedicel length	Short (0)	Long (1)	Short (0)	Long (1)	Long (1)	Long (1)	Short (0)
11	Calyx surface	Pubescent (1)	Pubescent (1)	Pubescent (1)	Pubescent (1)	Pubescent (1)	Pubescent (1)	Pubescent (1)
12	Calyx colour	Greenish (0)	Greenish (0)	Greenish (0)	Greenish (0)	Greenish (0)	Greenish (0)	Greenish (0)
13	Calyx length	c. 0.3 cm (0)	c. 1 cm (1)	c. 0.4 cm (0)	c. 0.5 cm (0)	c. 0.4 cm (0)	c. 0.3 cm (0)	c. 0.3 cm (0)
14	Corolla colour	Milky whitish (0)	Yellowish white (0)	Whitish (0)	Pale whitish (0)	White (0)	Yellowish white (0)	Purplish white, yellowish at base (1)
15	Corolla with more than one colour	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)
16	Striations on corolla tube	Present (1)	Present (1)	Present (1)	Present (1)	Present (1)	Present (1)	Present (1)
17 18	Corolla length Stamens position against petals	c.1 cm (1) Placed horizontally at the junction of petals (1);	c. 1 cm (1) Placed horizontally at the middle portion of petals (1);	c.1 cm (1) Placed horizontally at the junction of petals (1);	c.1 cm (1) Placed horizontally at the middle portion of petals (1);	c.1cm (1) Placed horizontally at the middle portion of petals (1);	c. 0.7 cm (0) Placed horizontally at the junction of the petals (1);	c.0.8 cm (0) Placed horizontally at the junction of petals (1);
19	Filament length	Short (0)	Short (0)	Short (0)	Short (0)	Short (0)	Short (0)	Short (0)
20	Filament colour	Whitish (0)	Whitish (0)	White (0)	Whitish (0)	Whitish (0)	Whitish (0)	Yellowish purple (1)
21	Immature anther colour	Greenish (0)	Purplish (1)	Purplish (1)	Purplish (1)	Purplish (1)	Purplish (1)	Deep purplish (1)
22	Mature anther colour	Light purplish (1)	Greenish black (0)	Greenish (0)	Greenish black (0)	Mature light violet (1)	Greenish (0)	Light purplish (1)
23	Ovules per chamber of ovary	3-4 ovules (1)	4-6 ovules (1)	3-4 ovules (1)	3-4 ovules (1)	3-4 ovules (1)	3-4 ovules (1)	Many ovules (0)
24	Style colour	Whitish (0)	Whitish (0)	White (0)	Whitish (0)	Whitish (0)	Whitish (0)	Purplish (1)
25	Fruit stalk	Pendent (0)	Pendent (0)	Pendent (0)	Pendent (0)	Upright (1)	Pendent (0)	Upright (1)
26	Fruit shape	Curved (0)	Elongated (0)	Elongated (0)	Elongated (0)	Elongated (0)	Elongated (0)	Elongated (0)
27	Fruit apex	Pointed (0)	Pointed (0)	Blunt (1)	Pointed (0)	Blunt (1)	Pointed (0)	Blunt (1)
28	Immature fruit colour	Red (1)	Green (0)	Green (0)	Greenish black (1)	Green (0)	Greenish white (1)	Whitish violet (1)
29	Length: Breadth ratio of fruits	c. 14 (0)	c. 17.5 (1)	c. 12.5 (0)	c. 15 (0)	c. 10 (0)	c. 4.58 (0)	c. 4.28 (0)

DISCUSSION

Gross morphologically, the studied specimens of *Capsicum* showed several shared characters therefore it creates difficulty for proper identification. Following the key provided by NBPGR and Haiser & Smith[13] the specimens have been roughly identified. Among the fourteen studied specimens of *Capsicum* eleven are identified as *C. annuum*, two as *C. frutecens* and one as *C. chinense*. The specimens of *C. frutecens* are characterized by suffruticose habit whereas all others are herbaceous. One specimen of *C. frutecens* has shown square shape in stem cross section while in others it is round. Slightly swollen to swollen internodes appear in all specimens. Purple spots on internode are found in almost half of the specimens. Petiole length varies from short to long. Deltoid leaf shape appears in one specimen of *C. frutecens* whereas lanceolate shape is common to the remaining specimens. The deltoid leaf shape of *C. frutecens* is also characterized by cuspidate leaf apex though during character coding it is coded equal with acuminate tip due their near similarity. In *C. annuum* the leaf apex varies from acute to acuminate. The specimen of *C. chinense* and one specimen of *C. frutecens* show undulated leaf margin but entire leaf margin is common to all others. The lamina length:breadth ratios are variable even within the specimens with lanceolate leaf shape. Pedicel length ranges from short to long. In general the calyx surfaces are pubescent but in two specimens of *C. annuum* a further categorization is made as slightly pubescence. One specimen of *C. frutecens* shows light green calyx in compare to usual green calyx of remaining specimens. Except one specimen of *C. annuum* the calyx length is not much significantly variable among the specimens. Corolla colour is significant in this study due to a variety of colours are visible which ranges from milky white to deep purple. Sometimes admixture of more than one colour is appeared in a corolla and colour striations are also visible. Several works gave importance on the corolla colour for identification of species of *Capsicum*[13], [15], [16]. However, the present study shows that in *C. annuum*, milky white, yellowish white, deep purple and other colours of corolla are present. This is perhaps the result of inter-specific or inter-varietal hybridization among the cultivated varieties. Corolla length is not much variable but considered for creating dendrogram by phenetic analysis.

Position of stamens (epipetalous) on petals is notable. In some cases it is positioned horizontally while in others it is vertical to petals. Filament length varies from short to long. Filament colour is also variable among *Capsicum* specimens though in majority it is whitish. Another notable feature in gross morphology is the variable colour in both immature and mature anthers. Usually the purplish immature anthers turn into greenish after maturity but in some instances the colour remains unchanged or slightly changed. Ovules per ovary chamber, varies from many to few (3 to 6). Notably, the specimens of *C. annuum* show both many to few ovule containing ovary chambers. Style colour is also variable.

The most important gross morphological character of *Capsicum* is their fruits. Diverse kind of fruit morphology is seen in *Capsicum*. Fruits are variable is shape, size, colour, fruit apex and base, curvature in fruits etc. In some morphological descriptor *C. frutecens* is characterized by small, erect fruits but in the present study one specimen of *C. frutecens* shows different kind of fruit shape. The 2D scatted plot (Fig. 2) which is generated by geometric morphometric analysis of fruit shapes of studied specimens of *Capsicum* depicts that a wide rang of fruit shape is found within the species. The diversity in fruit shapes is tremendous in *C. annuum* and its shapes are overlapped with the shapes of *C. frutecens* and *C. chinense* which again indicates an intense inter-specific hybridization. Several works showed that hybridizations among the cultivated varieties as well as among wild and cultivated species of *Capsicum* are a common phenomenon and often produce fertile hybrid[2], [17]. Similarly, the inter-varietal hybridization is also true[18]. Therefore the dendogram from phenetic analysis (Fig. 3) is unable to distinguish clearly the species of *Capsicum*.

CONCLUSION

Thus, the common varieties of *Capsicum* found in West Bengal are actually hybrids. Morphological descriptions are not able to distinguish them clearly result a dilemma to the taxonomist; those are in general followed the morphological descriptors for primary identification. In the cultivation history of *Capsicum* several crossings were taken place within the species and varieties cause the merges of many gross morphological characters. In the present scenario molecular characterization, in particular from conserve DNA sequences, is needed to understand the history of hybridizations where the morphological characters will serve as supporting evidence and then we have to ascertain which morphological character(s) are significant for identification and phylogenetic analyses.

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