DETERMINATION OF GENETIC DIVERSITY IN WATERMELON (*Citrullus lanatus* (Thunb.) Matsum & Nakai) GERMPLASMS

A Thesis Submitted to
the Graduate School of Engineering and Sciences of
İzmir Institute of Technology
in Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE

in Molecular Biology and Genetics

by
Zehra İpek ULUTÜRK

December 2009
İZMİR

ACKNOWLEDGEMENTS

I am heartily thankful to my advisor, Prof. Dr. Anne FRARY, whose encouragement, guidance, excellent advice and support from the initial to the final level of this study enabled me to develop an understanding of the subject.

My sincere thanks to my coadvisor Assoc. Prof. Dr. Sami DOĞANLAR for giving me the opportunity to study and supporting me during the completion of the project.

I also thank my colleagues of the department of Molecular Biology and Genetics. Discussions and cooperation with all of my colleagues have contributed substantially to this study.

Finally, I owe special gratitude to my family for their patience and continuous support of all my undertakings, scholastic and otherwise.

ABSTRACT

DETERMINATION OF GENETIC DIVERSITIY IN WATERMELON (*Citrullus lanatus* (Thunb.) Matsum & Nakai) GERMPLASMS

With 1.4 million tons of production, Turkey ranks second behind China in worldwide production of watermelon. Watermelon is grown at different times throughout the country with highest consumption during the summer and fall. Watermelon is an economically and socio-economically important crop throughout the country and especially in coastal regions where much of the cultivation occurs.

In this research, 90 watermelon accessions collected from different regions of the world by the USDA were molecularly characterized using 40 SRAP marker combinations based on the UPGMA (Unweighted Pair Group Method) and Neighbor Joining methods.

According to this molecular analysis, genetic diversity between all watermelon accessions was very low. However, SRAP markers showed high polymorphism (97%) so these markers were determined to be suitable for studies of genetic diversity in crops like watermelon.

ÖZET

KARPUZ (*Citrullus lanatus* (Thunb.) Matsum & Nakai) GERMPLAZMLARINDA GENETİK ÇEŞİTLİLİĞİN BELİRLENMESİ

Türkiye 1.4 milyon ton üretim miktarıyla Çin den sonra en çok karpuz üreten ülkedir. Karpuz ülkemizin hemen her yöresinde değişik zamanlarda yetiştirilmektedir ve özellikle yaz ve sonbahar aylarında yoğun bir şekilde tüketilmektedir. Özellikle kıyı bölgelerimizde yetiştiriciliğinin yoğun yapıldığı yörelerimizde ekonomik öneminin yanısıra sosyo ekonomik önemide olan bir ürün durumundadır.

Bu araştırmada, USDA tarafından dünyanın farklı bölgelerinden toplanan 90 karpuz genetik kaynağı 40 SRAP primer kombinasyonu kullanılarak, UPGMA (Unweighted Pair Group Method) ve Neighbor Joining methoduna dayalı olarak karakterize edilmiştir.

Moleküler analize göre tüm karpuz hatları arasındaki genetik çeşitlilik çok düşüktür. Ancak bu çalışmada SRAP işaretleyicileri yüksek polimorfizm (97%) göstermiş ve böylece bu işaretleyicilerin karpuz gibi bitkilerin genetik çeşitliliğinin belirlenmesi çalışmaları için uygun oldukları tespit edilmiştir.

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Page**

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1. General Characteristics of Watermelon (*Citrullus lanatus* (Thunb.) Matsum & Nakai)

The *Citrullus* genus belongs to the *Cucurbitaceae* family which includes about 118 genera and 825 species. *Citrullus* is a member of the subfamily *Cucurbitoidae*, tribe *Benincaseae,* subtribe *Benincasinae* (Dane and Liu 2007). The genus has four diploid species (2n=22) that are grown in Africa, Asia and the Mediterranean (Levi, et al. 2001). *Citrullus lanatus* (Thunb.) Matsum. et Nakai. is found in tropical and subtropical climates worldwide and consists of two cultivated watermelons: *C. lanatus* var. *lanatus* and *C. lanatus* var. *citroides* (Bailey) Mansf. which is known as preserving melon or citron because of its fruit rind. The rind is used in preserves, jellies and conserves and also used to make pickles (Dane, et al. 2004, Dane and Liu 2007). *Citrullus colocynthis* (L.) Schrad. grows in northern Africa, southwestern Asia and the Mediterranean. The species is a wild perennial and is also known as bitter gourd because the fruit of this species is bitter and even poisonous. A drug is produced from the dried pulp of immature fruit (Dane, et al. 2004). The other two wild species are *Citrullus eccirrhosus* Cogn. and *Citrullus rehmii* De Winter. which are endemic to the Namid Desert and are annual plants (Sarı, et al. 2008, Solmaz and Sarı 2009). *Citrullus rehmii* is similar to *Citrullus lanatus* but it is differentiated from this species by its pink to orange speckled rind. *Citrullus lanatus* and *Citrullus ecirrhosus* also resemble each other more than *C. colocynthis* (Goda 2007). All *Citrullus* species originated from Africa with the origin of *Citrullus lanatus* in the Kalahari Desert. Watermelon has been cultivated for a long time in Africa and in the Middle East and Egypt. Also it has been a domesticated for at least 4000 years (Huh, et al. 2008, Gichimu, et al. 2009). By the 10^{th} and 12^{th} century, watermelon was introduced in China and today China is the biggest producer and consumer of watermelon in the world. By the 13^{th} century, watermelon was produced and dispersed in Europe. It reached North America in the 17^{th} century and has been cultivated ever since in the Western Hemisphere (Levi and Thomas 2001).

Acccording to FAO (Food and Agriculture Organization), China has the first place in watermelon production with 71% of world production followed by Turkey and Iran, respectively (Huh, et al. 2008). The major countries in the world for watermelon production are presented in table 1.1.

Table 1.1. Ten main countries producing watermelon throughout the world.

Countries	**Mt/Year**
China	**63,238,000**
TURKEY	**3,445,541**
Iran	3,300,000
Brazil	1,947,000
USA	1,944,490
Egypt	1,630,000
Mexico	980,000
Spain	796,300
Korea	785,000
Italy	500,000

1.2. The importance of watermelon for Turkey

Turkey is one of the world's important centres for plant genetic resources and its flora displays a remarkable diversity. In 2008 total vegetable production of Turkey approximately 27.2 million tons and also an important product group of vegetables, tomatoes 10.5%, cucumber 0.3%, marrow squash 4,6%, 5% head cabbage, at 5.3% melon and watermelon has increased at a rate of 5.4% (Turkish Statistical Institute 2008). Thus, the Cucurbitaceae family has an important place in vegetable cultivation in Turkey. Cultivated species of this family in Turkey are *Citrullus lanatus* (watermelon), *Cucumis sativus, Cucumis melo, Cucumis flexuosus, Cucurbita maxima, Cucurbita moschata* and *Cucurbita pepo.* Watermelon is cultured almost all over Turkey. Turkey has many watermelon genetic resources from different regions: the Southeast, Aegean, Marmara, Mediterrenean and central Anatolia.

With 3,8 million ton/year of production over 137,000 hectares, Turkey ranks second behind China in worldwide production of watermelon. Watermelon is grown at different times throughout the country with highest consumption during the summer and fall. Watermelon is an economically and socio-economically important crop thoughout the country especially in coastal regions where much of the cultivation occurs. Watermelon has been called different names according to morphological characteristics of different varieties. These names include Tat Karpuzu, Sürme Hırsızı, Beyaz Kışlık Karpuz, Siyah Kışlık Karpuz, Gelin Karpuzu, Komando Karpuzu and Halep Karpuzu. These types are grown in Diyarbakır, Şanlıurfa, Mardin, Adıyaman, Adana, Hatay, and Çanakkale (Solmaz and Sarı 2009).

1.3 Morphology and Physiology

Watermelon requires a warm and long season for optimum growth. Citrullus can grow in different types of soil, however it prefers sandy and free draining soils. It is planted by seed in the field around April and May and harvested in August and September **(**Razavi and Milani. 2006**).** The best temperature for germinating seeds is 17 °C at night, 32 °C during the day or a constant temperature of 22 °C. Seeds are not able to germinate below 15 °C, and also light has an inhibitory effect (Goda 2007).

At high temperature and light, watermelon's flowers and fruits grow and develop. It is possible for the stems to branch up to 10 m and for plants with shorter stems, there are two dwarf types which contain dwarfing genes, dw1 and dw2. After 8 weeks, the flowering stage begins. Watermelon's flowers may be all of three types: female (pistillate), male (staminate), or hermaphroditic (perfect). The common types are monoecious. Andromonoecious (staminate and perfect) types are the older varieties. The important flowers are the pistillate flowers, because they have an interior ovary. The ovary is correlated with final fruit size and shape. Fruits of wild plants range between 1.5-20 cm in diameter, they are sub-globes which are greenish and mottled with dark green. In contrast, fruits of cultivated plants are up to 30x60 cm. Fruits also vary in morphology. For example wild forms have small round fruits, the cultivated forms are large oblong fruits. Fruit color can be pale yellow or light green (wild forms) to dark green (cultivars) and with or without stripes. The pulp varies from yellow or

green (wild forms) to dark red for cultivars. Seeds of watermelon (7-20 seeds/g) are larger than those of melon and cucumber.

1.4. Uses and Nutritional Composition

Citrullus lanatus (watermelon) includes domesticated and wild forms. Wild and semi-wild fruits of watermelon are used as a source of water during the dought season in the Kalahari region. Some cultivars are used as a food for humans but some are not. For example in Africa, some types of watermelon are too bitter for human consumption. However, their pulp is cooked and seeds are eaten in Sudan, Nigeria and Egypt (Goda 2007). Imperfect fruit are used as livestock feed. In addition watermelon seeds are important for the oil derived from them. For example in Nigeria, a high oil content is produced from Egusi-type watermelon seeds (Dane, et al 2004). This oil is used in cooking, cosmetics and pharmaceutical industries.

Watermelons are relatively rich in protein, lipids, and carbohydrates. Used mostly as a snack food, their total contribution to nutrition is also relatively small. Table 1.2 shows the primary metabolites and many minerals of watermelon. Also watermelons are low in calories and very high in lycopene, which is a very heart-healthy phytochemical. Watermelons also have high content of vitamin A and beta carotene.

Table 1.2. List of nutrients in watermelon and their content. Nutrient values and weights are for edible portion of watermelon (USDA National Nutrient Database for Standard Reference 2006).

Nutrients	Units	Nutrient content per 100 grams
Water	g	91.45
Energy	kcal	30
Protein	g	0.61
Total lipid (fat)	g	0.15
Carbohydrate, by difference	g	7.55
Fiber, total dietary	g	0.4
Sugars, total	g	6.20
Calcium, Ca	Mg	7
Iron, Fe	Mg	0.24
Magnesium, Mg	Mg	10
Phosphorus, P	Mg	11
Potassium, K	Mg	112
Sodium, Na	Mg	1
Vitamin C, total ascorbic acid	Mg	8.1
Thiamin	Mg	0.033
Riboflavin	Mg	0.021
Niacin	Mg	0.178
Pantothenic acid	Mg	0.221
Vitamin B-6	Mg	0.045
Vitamin A, IU	IU	569
Lipids		
Fatty acids, total saturated	g	0.016
Fatty acids, total monounsaturated	g	0.037
Carotene, beta	Mcg	303
Cryptoxanthin, beta	Mcg	78
Lycopene	Mcg	4532

1.5. Biological Diversity

Conservation of the diversity of species and variation of living organisims, their habitats and ecosystems is defined as biological diversity. Biodiversity reflects uniqueness. Within species, there is often considerable diversity related to environmental influences, genetic differences, or a combination of both. For example, a

species may contain two or more subspecies that typically have some genetic differences from one another. This genetic variability is responsible for the different traits in species and has enabled living beings to adapt to the variety of environments that exist in the world. It also provides the raw materials by which new species arise through evolution. However biodiversity is declining rapidly due to factors such as destruction of traditional landscapes, climate change, invasive species, overexploitation, and pollution. In addition, biodiversity is affected by human activity due to irresistible and continuous demand for new genes and chemicals because mankind needs food, fiber, medicines and new products. Future generation are at risk because of the loss of biological diversity. So conservation of biological diversity is a very important consideration for the future of mankind. Conservation and preservation methods can be in-situ or ex-situ (Waldman and Shevah 2000). In in-situ systems, native plants are conserved together with the associated animals, birds and other biological resources. These systems also include wild relatives to preserve genetic polymorphism. Ex-situ conservation includes seed storage and vegetative propagule collection in seed gene banks. Collected seeds can remain viable during the long term. For example 2223 accessions of the cucurbitaceae family are preserved in the Turkish National Gene Bank (AARI) (Sarı, et al. 2008). Ex-situ systems also include storage of material using tissue culture techniques which make it possible to store large numbers of genotypes in a small area.

1.6 Marker Systems

Diversity among organisms is a result of variations in DNA sequences and of environmental effects. Two types of marker systems are used for determination of genetic diversity, mapping and breeding. These are morphological and molecular markers. Morphological markers reflect phenotypic changes such as fruit shape and colour, dwarfism, and leaf veins. Earlier studies showed that morphological markers may not be reliable and sufficient because these markers can be affected by environmental factors (Wang, et al 2008). Also because morphological markers consist of mutant forms of wild types, plant health may be at risk.

Differences at the gene or DNA sequence level can be detected by various molecular marker systems (isozymes, RFLP, AFLP, RAPD, SSR, SRAP, CAP). With

these markers, gene identification, genetic diversity determination, and chromosome and trait mapping can be done. In order to determine polymorphism between plant accessions or species; molecular markers are used. Polymorphism detection is important for breeding of new plant cultivars.

Molecular marker systems are more effective than morphological marker systems to define genetic relationship among watermelon cultivars. In early work, isozymes were used to determine genetic diversity and phylogenetic relatedness among watermelon cultivars. As a result of this study, monomorphic bands were observed and genetic diversity was narrow (Levi and Thomas 2001). Studies using random amplified polymorphic DNA (RAPD) also indicated polymorphism and RAPDs were found to be better than isozymes for analysis of genetic diversity in watermelon (Levi, et al. 2001). Guerra-Sanz (2002) used simple sequence repeat (SSR) markers in watermelon varieties and found 18 polymorphic SSR loci so polymorphism were observed successfully. In 2006, Tahi showed the existence of distinct genetic groups in a unique accession in *Citrullus lanatus* using inter simple sequence repeat markers (ISSR).

1.6.1. Sequence-Related Amplified Polymorphism (SRAP)

The SRAP technique is based on amplification of open reading frames (ORFs) using PCR (Li and Quiros 2001, Ferriol, et al. 2003). Two types of primers are employed. The forward primer is 17 bp long, and contains a fixed sequence of 14 nucleotides rich in C and G, and three selective bases at the 3' end. This primer amplifies exonic regions, which tend to be rich in these nucleotides. The reverse primer with 18 bp, contains a sequence of 15 nucleotides, rich in A and T, and three selective bases at the 3' end. This primer preferentially amplifies intronic regions and regions with promoters, rich in these nucleotides. The observed polymorphism basically originates in the variation of the length of these introns, promoters and spacers, both among individuals and among species.

SRAP markers have many advantages compared with other marker systems. The SRAP marker system is a simple and efficient system that can be adapted for different purposes such as map construction, gene tagging, genomic and cDNA fingerprinting, and map-based cloning. For example, in recent work, this marker system has been used to perform analysis of phylogenetic relationship, for map construction and comparative

genetics (Sun, et al. 2006, Wang, et al. 2008). SRAP markers also allow easy isolation of bands for sequencing (Li and Quiros 2001). For example, Levi and Thomas (2007) tested sequence-related amplified polymorphism markers for polymorphisim among watermelon cultivars. The SRAP markers indicated effective polymorphism and represented different linkage regions of the watermelon genome.

In this study, the aim was to determine the relationships among watermelon accessions using SRAP markers and genetic similarity analysis. This information will be useful to establish a core collection by eliminating redundant accessions and to identify lines that may be useful for watermelon breeding.

CHAPTER 2

MATERIALS AND METHODS

2.1. Materials

2.1.1. Plant Materials

A total of 90 watermelon accessions collected from different regions of Turkey by the USDA-ARS Plant Germplasm Inspection Station, Beltsville, Maryland, USA were molecularly characterized for this study. These accessions taken from the US gene bank were self pollinated to remove potential heterogenity because of the probable risk of seed mixtures. Each accession was then given new pedigree numbers by Yuksel Seeds Ltd. Co. All watermelon accessions studied are shown in table 2.1 with pedigree number, accession name, location of collection and source of each watermelon accession. In addition this table indicates that 59 of the accessions were from Turkey, 11 accessions were from United State, four accessions were from India, five accessions each were from Japan and West Africa, two accessions were from South Africa, and one accession each was from West Azerbaijan, Iran, Philippines, Guatamala and Zaire.

Ten seeds of each accession were planted in a peat and perlite mixture in seedling plates and germinated under optimal condition in a growth chamber at the İzmir Institute of Technology, Urla, İzmir, Turkiye for molecular analysis.

Table 2.1. Watermelon accessions from USDA-ARS with pedigree number, accession name, collection location and source.

Pedigree No	**Accesion Name**	**Collected In**	**Source**
PI 344066	*Citrullus lanatus var. lanatus* Amerikan	Gaziantep, Turkey	USDA-ARS
PI 344300	*Citrullus lanatus var. lanatus*	Muş, Turkey	USDA-ARS
PI 278061	*Citrullus lanatus var. lanatus*	Yozgat, Turkey	USDA-ARS
PI 249010	*Citrullus lanatus var. Lanatus*	Kaduna, Nigeria	USDA-ARS
PI 189316	*Citrullus lanatus var. lanatus*	Nigeria	USDA-ARS
PI 169240	*Citrullus lanatus var. lanatus* Kaymakam	Antalya, Turkey	USDA-ARS
PI 169245	*Citrullus lanatus var. lanatus*	Burdur, Turkey	USDA-ARS
PI 595200	*Citrullus lanatus var. lanatus*	Georgia, United States	USDA-ARS
PI 172793	*Citrullus lanatus var. lanatus* Cit	Van, Turkey	USDA-ARS
PI 169278	*Citrullus lanatus var. lanatus*	Canakkale, Turkey	USDA-ARS
PI 163572	*Citrullus lanatus var. lanatus*	Jutiapa, Guatemala	USDA-ARS
PI 179240	*Citrullus lanatus var. lanatus* Egusi	Edirne, Turkey	USDA-ARS
PI 169253	*Citrullus lanatus var. lanatus*	Aydin, Turkey	USDA-ARS
PI 278045	*Citrullus lanatus var. lanatus*	Mus, Turkey	USDA-ARS
PI 169290	*Citrullus lanatus var. Lanatus* Kurba Alaca	Bursa, Turkey	USDA-ARS
PI 164539	*Citrullus lanatus var. lanatus* TINDA	Rajasthan, India	USDA-ARS
PI 177325	*Citrullus lanatus var. lanatus*	Hakkari, Turkey	USDA-ARS
PI 278024	*Citrullus lanatus var. lanatus*	Kayseri, Turkey	USDA-ARS
PI 229806	*Citrullus lanatus var. lanatus* Takii Gem	Kyoto, Japan	USDA-ARS
PI 279461	*Citrullus lanatus var. lanatus* Strain II	Japan	USDA-ARS
PI 172787	*Citrullus lanatus var. lanatus*	Trabzon, Turkey	USDA-ARS
PI 171579	*Citrullus lanatus var. lanatus*	Zonguldak, Turkey	USDA-ARS
PI 227202	*Citrullus lanatus var. lanatus* Shin-yamato	Shizuoka, Japan	USDA-ARS
PI 175653	*Citrullus lanatus var. lanatus*	Diyarbakir, Turkey	USDA-ARS
PI 171585	*Citrullus lanatus var. lanatus*	Tokat, Turkey	USDA-ARS
PI 278023	*Citrullus lanatus var. lanatus*	Kars, Turkey	USDA-ARS
PI 270550	*Citrullus lanatus var. lanatus*	Ghana	USDA-ARS
PI 227205	*Citrullus lanatus var. lanatus* Shin-yamato	Aichi, Japan	USDA-ARS
PI 169287	*Citrullus lanatus var. lanatus* Kurba Alaca	Bursa, Turkey	USDA-ARS
PI 172789	*Citrullus lanatus var. lanatus* Dize	Kars, Turkey	USDA-ARS
PI 270306	*Citrullus lanatus var. lanatu*	Philippines	USDA-ARS
PI 169263	*Citrullus lanatus var. lanatus*	Izmir, Turkey	USDA-ARS
PI 169264	*Citrullus lanatus var. lanatus* Yenidunya	Istanbul, Turkey	USDA-ARS
PI 167219	*Citrullus lanatus var. lanatus* Karpuz	Icel, Turkey	USDA-ARS
PI 169232	*Citrullus lanatus var. lanatus*	Izmir, Turkey	USDA-ARS
PI 595201	*Citrullus lanatus var. lanatus*	Georgia, United States	USDA-ARS
PI 595203	*Citrullus lanatus var. lanatus*	Georgia, United States	USDA-ARS
PI 595218	*Citrullus lanatus var. lanatus* Charleston	California, United States	USDA-ARS
PI 227206	*Citrullus lanatus var. lanatus* Asahi-yamato	Aichi, Japan	USDA-ARS
PI 185636	*Citrullus lanatus var. lanatus*	Ghana	USDA-ARS
PI 277996	*Citrullus lanatus var. lanatus*	Bitlis, Turkey	USDA-ARS
PI 278045	*Citrullus lanatus var. lanatus*	Mus, Turkey	USDA-ARS
PI 175657	*Citrullus lanatus var. lanatus*	Urfa, Turkey	USDA-ARS
PI 278031	*Citrullus lanatus var. lanatus*	Kirsehir, Turkey	USDA-ARS
PI 494530	*Citrullus lanatus var. lanatus* Egusi	Oyo, Nigeria	USDA-ARS
PI 278046	*Citrullus lanatus var. lanatus*	Nigde, Turkey	USDA-ARS
PI 278049	*Citrullus lanatus var. lanatus*	Sinop, Turkey	USDA-ARS
PI 278030	*Citrullus lanatus var. lanatus*	Kirsehir, Turkey	USDA-ARS
PI 278038	*Citrullus lanatus var. lanatus*	Mugla, Turkey	USDA-ARS
PI 278047	*Citrullus lanatus var. lanatus*	Sakarya, Turkey	USDA-ARS

(cont. on next page)

Table 2.1. (cont.)

Pedigree No	Accesion Name	Collected In	Source
PI 277997	*Citrullus lanatus var. lanatus*	Bingol, Turkey	USDA-ARS
PI 222711	*Citrullus lanatus var. lanatus* Hendevaneh	West Azerbaijan, Iran	USDA-ARS
PI 172801	*Citrullus lanatus var. lanatus* Kural	Urfa, Turkey	USDA-ARS
PI 172786	*Citrullus lanatus var. lanatus*	Turkey	USDA-ARS
PI 172789	*Citrullus lanatus var. lanatus* Dize	Kars, Turkey	USDA-ARS
PI 172788	*Citrullus lanatus var. lanatus*	Trabzon, Turkey	USDA-ARS
PI 167124	*Citrullus lanatus var. lanatus* Ala Topak Karpuz	Adana, Turkey	USDA-ARS
PI 167126	*Citrullus lanatus var. lanatus* Beyaz Topak Karpuz	Adana, Turkey	USDA-ARS
PI 169259	*Citrullus lanatus var. lanatus* Dilimli	Manisa, Turkey	USDA-ARS
PI 177326	*Citrullus lanatus var. lanatus* Cegisdegi	Hakkari, Turkey	USDA-ARS
PI 277986	*Citrullus lanatus var. lanatus*	Aydin, Turkey	USDA-ARS
PI 278021	*Citrullus lanatus var. lanatus*	Kars, Turkey	USDA-ARS
PI 278022	*Citrullus lanatus var. lanatus*	Kars, Turkey	USDA-ARS
PI 600792	*Citrullus lanatus var. lanatus* DOMEK	Michigan, United States	USDA-ARS
PI 600790	*Citrullus lanatus var. lanatus* PEROLA	Michigan, United States	USDA-ARS
PI 612145	*Citrullus lanatus var. lanatus* DIXIE QUEEN	California, United States	USDA-ARS
PI 608047	*Citrullus lanatus var. lanatus* Illiniwek Red Seeded Watermelon	Illinois, United States	USDA-ARS
PI 629105	*Citrullus lanatus var. lanatus* Cream of Saskatchewan	North Carolina, United States	USDA-ARS
PI 278025	*Citrullus lanatus var. lanatus*	Kirklareli, Turkey	USDA-ARS
PI 479704	*Citrullus lanatus var. lanatus* Blue Frost	United States	USDA-ARS
PI 165002	*Citrullus lanatus var. lanatus* KARPUZ	Ankara, Turkey	USDA-ARS
PI 165024	*Citrullus lanatus var. lanatus* KARAKARPUZ	Ankara, Turkey	USDA-ARS
PI 174103	*Citrullus lanatus var. lanatus* Capli	Mardin, Turkey	USDA-ARS
PI 174106	*Citrullus lanatus var. lanatus* Kilis	Gaziantep, Turkey	USDA-ARS
PI 278000	*Citrullus lanatus var. Lanatus*	Burdur, Turkey	USDA-ARS
PI 278062	*Citrullus lanatus var. Lanatus*	Zonguldak, Turkey	USDA-ARS
PI 278005	*Citrullus lanatus var. lanatus*	Çanakkale, Turkey	USDA-ARS
PI 278006	*Citrullus lanatus var. Lanatus*	Gaziantep, Turkey	USDA-ARS
PI 277973	*Citrullus lanatus var. Lanatus*	Adıyaman, Turkey	USDA-ARS
PI 203551	*Citrullus lanatus var. Lanatus*	New Mexico, United States	USDA-ARS
PI 248178	*Citrullus lanatus var. lanatus* Mangara	Zaire	USDA-ARS
PI 174101	*Citrullus lanatus var. lanatus* Mercan	Mardin, Turkey	USDA-ARS
PI 164636	*Citrullus lanatus var. Lanatus* PUSHANI	Karnataka, India	USDA-ARS
PI 165523	*Citrullus lanatus var. lanatus* TARBUZA	India	USDA-ARS
PI 164570	*Citrullus lanatus var. lanatus* PUSHANI	Tamil Nadu, India	USDA-ARS
PI 175655	*Citrullus lanatus var. lanatus*	Çanakkale, Turkey	USDA-ARS
PI 176915	*Citrullus lanatus var. lanatus* Konya Buz	Konya, Turkey	USDA-ARS
PI 164977	*Citrullus lanatus var. lanatus* BURSA	İstanbul, Turkey	USDA-ARS
PI 271779	*Citrullus lanatus var. Citroides*	Transvaal, South Africa	USDA-ARS
PI 299379	*Citrullus lanatus var. citroides*	Cape Province, South Africa	USDA-ARS

2.2. Methods

2.2.1. DNA Extraction

Total genomic DNA was extracted from young leaves with CTAB-DNA extraction protocol (Fulton, et. al. 1995) and Promega Wizard Genomic DNA Purification Kit. The DNAs were quantified on the Nanodrop ND-1000 spectrophotometer. All genomic DNAs were stored at -20 °C temperature with TE buffer. Table 2.2 shows DNA concentration of all watermelon accessions with Abs 260/280 (nm) and Abs 260/230 (nm).

Table 2.2. Quantity and quality of watermelon accession DNAs.

Accession Number	DNA Concentration (ng/µ)	Abs 260/280 (nm)	Abs 260/230 (nm)
PI 278000	134.34	1.80	1.50
PI 278062	53.43	1.85	3.32
PI 278005	61.87	1.85	3.68
PI 278006	38.05	1.85	2.55
PI 277973	103.27	1.83	1.87
PI 203551	147.30	1.79	1.60
PI 248178	79.13	1.83	2.37
PI 174101	156.14	1.79	1.24
PI 164636	147.04	1.87	1.82
PI 165523	106.32	1.67	1.11
PI 164570	108.20	1.87	2.08
PI 175655	70.04	1.85	2.48
PI 176915	114.07	1.86	1.94
PI 164977	65.55	1.89	2.33
PI 344066	60.17	1.90	1.97
PI 344300	68.71	1.83	1.99
PI 278061	61.69	1.85	1.94
PI 247010	129.94	1.86	1.86
PI 189316	58.55	1.93	2.34
PI 169240	137.15	1.84	1.72
PI 169245	59.06	1.86	2.12
PI 595200	74.82	1.85	2.00
PI 172793	45.49	1.88	3.09
PI 169278	52.78	1.91	2.82
PI 163572	49.74	1.87	2.51
PI 179240	101.22	1.85	1.67
PI 169253	141.10	1.88	2.37
PI 278045	58.03	1.89	3.51
PI 169290	129.43	1.83	2.18
PI 164539	96.03	1.85	1.76

(cont. on next page)

Table 2.2. (cont.)

Accession Number	DNA Concentration (ng/µ)	Abs 260/280 (nm)	Abs 260/230 (nm)
PI 177325	89.84	1.82	2.55
PI 278024	64.30	1.89	2.26
PI 229806	43.83	1.74	4.10
PI 279461	125.39	1.79	1.23
PI 172787	129.39	1.85	2.06
PI 171579	87.61	1.81	2.42
PI 227202	92.30	1.81	2.61
PI 175653	126.71	1.74	1.52
PI 171585	123.69	1.82	2.22
PI 278023	124.99	1.83	2.41
PI 270550	85.3	1.80	2.09
PI 227205	42.37	1.80	3.16
PI 169287	51.19	1.78	2.42
PI 172789	69.19	1.46	2.03
PI 270306	77.33	1.78	2.51
PI 271779	139.80	1.75	1.91
PI 169263	126.51	1.83	2.08
PI 169264	125.97	1.91	1.40
PI 167219	397.75	1.83	2.08
PI 169232	214.70	1.87	2.13
PI 595201	210.21	1.67	1.45
PI 595203	333.32	1.84	1.75
PI 595218	194.11	1.82	1.71
PI 227206	59.21	1.67	1.21
PI 185636	84.96	1.82	1.30
PI 277996	89.73	1.78	1.16
PI 278045	64.48	1.77	1.27
PI 175657	64.85	1.75	1.33
PI 278031	73.22	1.72	1.22
PI 494530	120.54	1.76	1.37
PI 165523	84.30	1.80	1.45
PI 278046	158.08	1.81	1.61
PI 278049	86.84	1.85	1.33
PI 278030	69.33	1.79	3.06
PI 278038	67.35	1.77	1.30
PI 278047	66.99	1.87	1.44
PI 277997	84.35	1.80	1.43
PI 222711	33.43	1.92	1.00
PI 172801	45.16	2.06	1.87
PI 172786	71.57	1.97	1.69
PI 172789	154.76	1.92	1.72
PI 172788	138.31	1.88	1.50
PI 167124	112.71	1.90	1.91
PI 167126	174.03	1.88	1.62
PI 169259	51.42	1.86	2.30
PI 177326	217.00	1.72	1.41
PI 277986	67.47	1.83	2.48
PI 278021	42.22	1.70	4.24
PI 278022	79.90	1.94	1.81
PI 600792	63.82	1.79	2.22
PI 600790	51.68	1.77	2.08

(cont. on next page)

Table 2.2. (cont.)

Accession Number	DNA Concentration (ng/µ)	Abs 260/280 (nm)	Abs 260/230 (nm)
PI 612145	64.10	1.89	2.13
PI 608047	45.98	1.96	1.71
PI 629105	76.77	1.89	2.12
PI 278025	66.43	1.91	1.88
PI 479704	66.04	1.83	2.35
PI 165002	33.69	1.96	4.03
PI 165024	29.43	1.87	2.86
PI 174103	93.54	1.81	2.23
PI 174106	46.13	1.91	2.53
PI 271779	21.64	1.69	0.98
PI 299379	38.85	1.88	1.61

2.2.2. SRAP Analysis

PCR amplifications were carried out using 40 SRAP markers. SRAP marker forward and reverse primers are shown in table 2.3 (Zhongxu, et al. 2003, Li and Quiros 2001, Lin, et al. 2005). Each 20 mL PCR mixture consisted of 2 µl 10X PCR buffer, 20-50 ng DNA templates, 2 µl Mg^{2+}, 0.7 µl dNTP, 2µl forward primer, 2 µl reverse primer and 0.3 µl Taq DNA polymerase. Amplifications were made in a ABI 9700 Thermocycler with following PCR program: 5 minutes of initial denaturation at 94°C, five cycles of three steps: 1 minute of denaturation at 94°C, 1 minute of annealing at 35°C and 1 minute of elongation at 72°C. In the following 35 cycles the annealing temperature was increased to 55°C, with a final elongation step of 10 min at 72°C and hold at 4°C. Amplification fragments were segregated on a 2% agarose and metaphor agarose mixture.

Table 2.3. Characteristics of SRAP markers with Forward and Reverse primers.

	Marker Name	Forward Primer	Reverse Primer
1	**Me3-Em1**	5′-TGAGTCCAAACCGGAAT-3′	5′-GACTGCGTACGAATTAAT-3′
2	**Me2-Em7**	5′-TGAGTCCAAACCGGAGC-3′	5′-GACTGCGTACGAATTATG-3′
3	**Me9-Em2**	5′-TGAGTCCAAACCGGTCA-3′	5′-GACTGCGTACGAATTTGC-3′
4	**Me2-Em5**	5′-TGAGTCCAAACCGGAGC-3′	5′-GACTGCGTACGAATTAAC-3′
5	**Me8-Em1**	5′-TGAGTCCAAACCGGTGT-3′	5′-GACTGCGTACGAATTAAT-3′
6	**Me2-Em14**	5′-TGAGTCCAAACCGGAGC-3′	5′-GACTGCGTACGAATTCAG-3′
7	**Me8-Em4**	5′-TGAGTCCAAACCGGTGT-3′	5′-GACTGCGTACGAATTTGA-3′
8	**Me14-Em14**	5′-TGAGTCCAAACCGGCTA-3′	5′-GACTGCGTACGAATTCAG-3′
9	**Me1-Em3**	5′-TGAGTCCAAACCGGATA-3′	5′-GACTGCGTACGAATTGAC-3′
10	**Me2-Em6**	5′-TGAGTCCAAACCGGAGC-3′	5′-GACTGCGTACGAATTGCA-3′
11	**Me5-Em5**	5′-TGAGTCCAAACCGGAAG-3′	5′-GACTGCGTACGAATTAAC-3′
12	**Me3-Em7**	5′-TGAGTCCAAACCGGAAT-3′	5′-GACTGCGTACGAATTATG-3′
13	**Me3-Em9**	5′-TGAGTCCAAACCGGAAT-3′	5′-GACTGCGTACGAATTACG-3′
14	**Me5-Em4**	5′-TGAGTCCAAACCGGAAG-3′	5′-GACTGCGTACGAATTTGA-3′
15	**Me4-Em2**	5′-TGAGTCCAAACCGGACC-3′	5′-GACTGCGTACGAATTTGC-3′
16	**Me10-Em10**	5′-TGAGTCCAAACCGGGAC-3′	5′-GACTGCGTACGAATTTAG-3′
17	**Me8-Em2**	5′-TGAGTCCAAACCGGTGT-3′	5′-GACTGCGTACGAATTTGC-3′
18	**Me4-Em3**	5′-TGAGTCCAAACCGGACC-3′	5′-GACTGCGTACGAATTGAC-3′
19	**Me3-Em2**	5′-TGAGTCCAAACCGGAAT-3′	5′-GACTGCGTACGAATTTGC-3′
20	**Me4-Em6**	5′-TGAGTCCAAACCGGACC-3′	5′-GACTGCGTACGAATTGCA-3′
21	**Me6-Em5**	5′-TGAGTCCAAACCGGTAG-3′	5′-GACTGCGTACGAATTAAC-3′
22	**Me8-Em9**	5′-TGAGTCCAAACCGGTGT-3′	5′-GACTGCGTACGAATTACG-3′
23	**Me8-Em13**	5′-TGAGTCCAAACCGGTGT-3′	5′-GACTGCGTACGAATTGGT-3′
24	**Me14-Em15**	5′-TGAGTCCAAACCGGCTA-3′	5′-GACTGCGTACGAATTCTG-3′
25	**Me7-Em8**	5′-TGAGTCCAAACCGGTTG-3′	5′-GACTGCGTACGAATTAGC-3′
26	**Me1-Em2**	5′-TGAGTCCAAACCGGATA-3′	5′-GACTGCGTACGAATTTGC-3′
27	**Me5-Em3**	5′-TGAGTCCAAACCGGAAG-3′	5′-GACTGCGTACGAATTGAC-3′
28	**Me5-Em1**	5′-TGAGTCCAAACCGGAAG-3′	5′-GACTGCGTACGAATTAAT-3′
29	**Me1-Em4**	5′-TGAGTCCAAACCGGATA-3′	5′-GACTGCGTACGAATTTGA-3′
30	**Me7-Em10**	5′-TGAGTCCAAACCGGTTG-3′	5′-GACTGCGTACGAATTTAG-3′
31	**Me6-Em1**	5′-TGAGTCCAAACCGGTAG-3′	5′-GACTGCGTACGAATTAAT-3′
32	**Me5-Em6**	5′-TGAGTCCAAACCGGAAG-3′	5′-GACTGCGTACGAATTGCA-3′
33	**Me14-Em16**	5′-TGAGTCCAAACCGGCTA-3′	5′-GACTGCGTACGAATTCGG-3′
34	**Me14-Em17**	5′-TGAGTCCAAACCGGCTA-3′	5′-GACTGCGTACGAATTCCA-3′
35	**Me2-Em1**	5′-TGAGTCCAAACCGGAGC-3′	5′-GACTGCGTACGAATTAAT-3′
36	**Me4-Em5**	5′-TGAGTCCAAACCGGACC-3′	5′-GACTGCGTACGAATTAAC-3′
37	**Me4-Em4**	5′-TGAGTCCAAACCGGACC-3′	5′-GACTGCGTACGAATTTGA-3′
38	**Me4-Em1**	5′-TGAGTCCAAACCGGACC-3′	5′-GACTGCGTACGAATTAAT-3′
39	**Me5-Em2**	5′-TGAGTCCAAACCGGAAG-3′	5′-GACTGCGTACGAATTAAC-3′
40	**Me1-Em1**	5′-TGAGTCCAAACCGGATA-3′	5′-GACTGCGTACGAATTAAT-3′

2.2.3. Data Analysis

SRAP primer combinations were used for determination of genetic diversity in watermelon accessions. In this study total genomic DNA fragments were scored as present (1) and absent (0). In order to constuct dendrograms and distance matrices the NTSYS-pc version 2.2 (Numerical Taxonomy Multivariate Analysis System, Exeter Software, Setauket, N.Y.) software program was used.

First DICE similarity index was used to compute simmilarity coefficient. Then UPGMA (Unweighted Pair Group Method with Arithmetic Averages) and SHAN clustering programs were used to produce genetic distances dendrogram.

In order to analyze correlation between the data and the dendrogram, a Mantel test (1967) was done. Also principal component analysis (PCA) was performed and used to produce 2D and 3D plots.

In addition DARWIN (Dissimilarity Analysis and Representation for Windows) software program was used for determination of genetic relationships between watermelon accessions. The dendrogram was constructed based on DICE matrix and Neighbor Joining method.

CHAPTER 3

RESULTS AND DISCUSSION

3.1. SRAP Results

A total of 40 SRAP primer combinations were used for determination of genetic variation in 90 watermelon accessions. Table 3.1 shows which primer combinations were amplified, and which ones were polymorphic and nonpolymorphic. According to this table, nine primer combinations (represented by black boxes) showed poor amplification and 30 primer combination (represented by green boxes) were polymorphic. Only one primer combination, indicated by a red box, was nonpolymorphic. In addition the general characteristic of SRAP combinations are shown in table 3.2. The table shows that 30 primer combinations were polymorphic from 40 SRAP primer combinations and a total of 201 bands were obtained. However, only 87 bands showed polymorphism so the percentage of polymorphic bands was 43%. Also the number of polymorphic bands for each SRAP primer combination is indicated in table 3.3. An average of 2.9 polymorphic bands were obtained for each primer combination.

Table 3.1. Characteristics of the 40 SRAP Primer Combinations used for determination of genetic diversity among watermelon accessions.

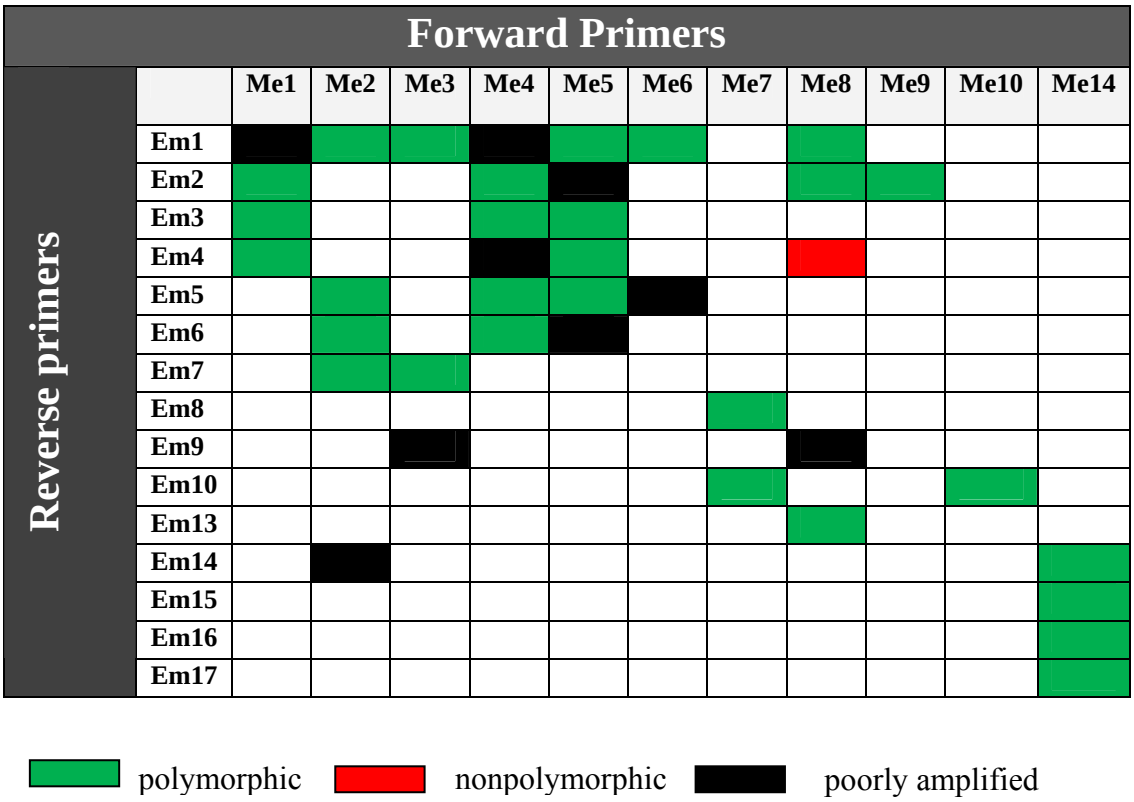

Table 3.2. General characteristics of SRAP primer combinations.

	Total number of primers	Number of polymorphic primers	Percentage of primers with good amplification	Total number of bands	Number of polymorphic bands	Percentage of polymorphic bands
SRAP	**40**	**30**	**75 %**	**201**	**87**	**43%**

Table 3.3. Number of polymorphic bands for each SRAP primer combination.

SRAP Primer Combination	Number of Polymorphic Bands
Me1-Em2	3
Me1-Em3	1
Me1-Em4	4
Me2-Em1	4
Me2-Em5	4
Me2-Em6	3
Me2-Em7	3
Me3-Em1	3
Me3-Em2	3
Me3-Em7	2
Me4-Em2	2
Me4-Em3	3
Me4-Em5	3
Me4-Em6	5
Me5-Em1	1
Me5-Em3	1
Me5-Em4	3
Me5-Em5	1
Me6-Em1	3
Me7-Em8	2
Me7-Em10	5
Me8-Em1	5
Me8-Em2	3
Me8-Em13	2
Me9-Em2	3
Me10-Em10	1
Me14-Em14	3
Me14-Em15	4
Me14-Em16	2
Me14-Em17	5

3.1.1 Analysis of SRAP Results using NTSYS Software Program

A genetic distance dendrogram of the 90 watermelon accessions was constructed using the DICE matrix and UPGMA (Unweighted Pair Group Method) based on NTSYS-pc version 2.2 (Figure 3.1). To analyze the correlation between genotypic data and the dendrogram, Mantel test was done. According to the Mantel test, the correlation r value was 0,973 which means that the correlation between the data and the dendrogram was very high. According to the dendrogram, the 90 watermelon accessions fell into five groups. These are A, B, C, D and E (Table3.4.). The dendrogram scale varied from 0.68 to 1.00. Groups A, B and C were very similar and minimum similarity among these groups was approximately 95%. Group D was more different from groups A, B and C. Minimum similarity between groups A, B, C and D was ~83%. Group E was a very distant group and minimum similarity was 63% with the rest.

Group A including 60 accessions was the major group. These 60 accessions were very closely related with each other and minimum similarity between these accessions was ~97%. In group B, 11 accessions clustered together and were very closely related to each other with ~96% minimum similarity. Group C also had 11 accessions and these were very similar to each other. Minimum similarity among these accessions in group C was ~95%. Group D consisted of 7 accessions. Minimum similarity between these accesions was ~83% so these 7 accessions were closely related. Group E included only one accession (PI 299379). Also this accession was very distant because of its 68% similarity with the rest of the accessions in Groups A, B, C and D. In addition, Principal component analysis (PCA) was carried out and 2D and 3D plots are shown in figure 3.2 and figure 3.3. In 2D and 3D plots, watermelon accessions were separated into two main groups and five accessions were located outside of the groups. The first, second and third axes for PCA explained 51%, 4% and 3% of the total variance, respectively.

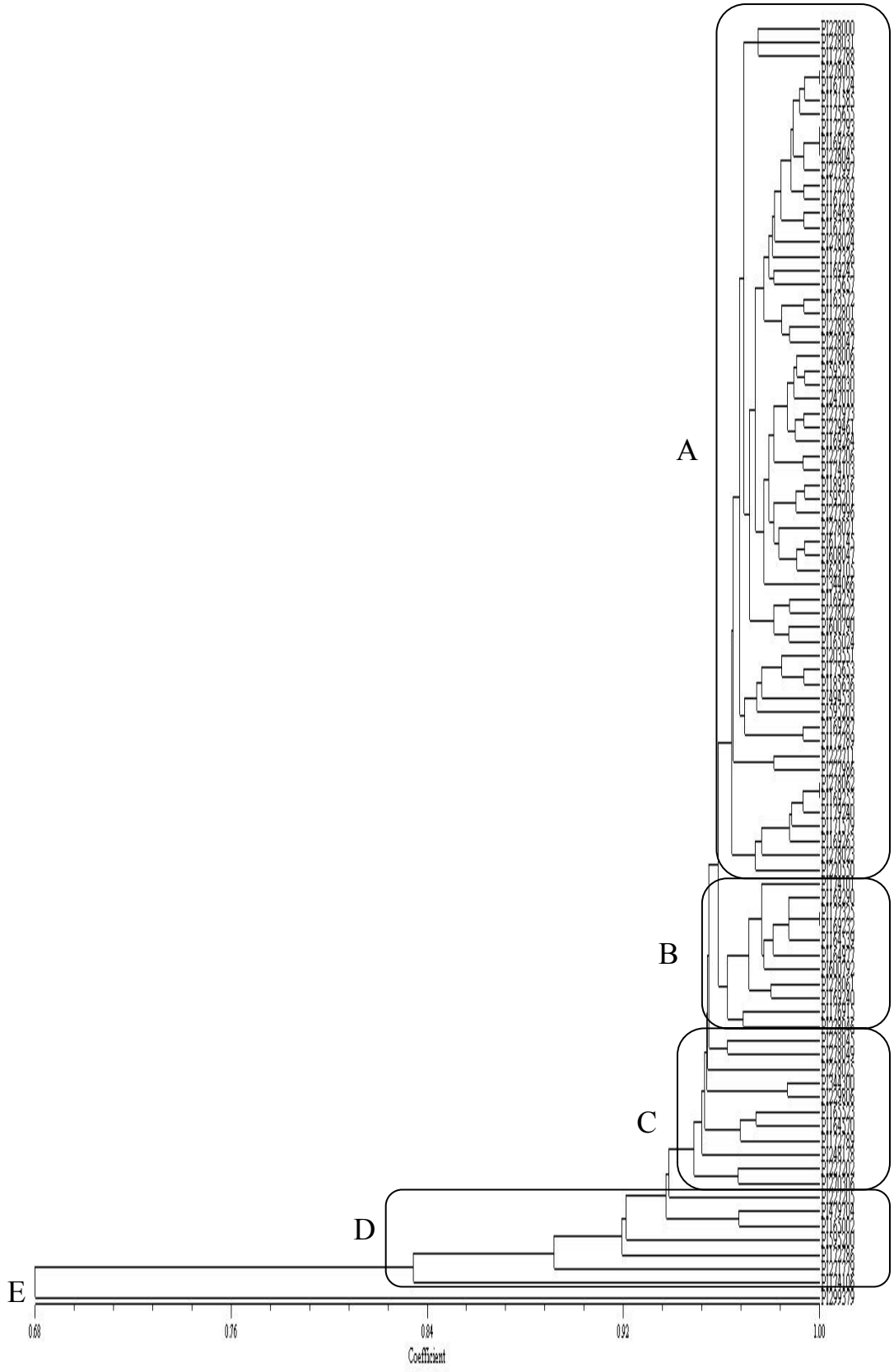

Figure 3.1. The dendrogram of 90 watermelon accessions using UPGMA in NTSYS-pc version 2

Tablo 3.4. Characteristics of 90 accessions in group A, B, C, D and E.

GROUP A	LOCATION	ACCESSION NAME
PI 278000	Burdur, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278031	Kırşehir, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 172788	Trabzon, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278005	Çanakkale, Turkey	*Citrullus lanatus* var. *lanatus*
PI 167124	Adana, Turkey	*Citrullus lanatus* var. *lanatus*
PI 171585	Tokat, Turkey	*Citrullus lanatus* var. *lanatus*
PI 175655	Çanakkale, Turkey	*Citrullus lanatus* var. *lanatus*
PI 172793	Van, Turkey	*Citrullus lanatus* var. *lanatus*
PI 169278	Canakkale, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278045	Mus, Turkey	*Citrullus lanatus* var. *lanatus*
PI 277997	Bingol, Turkey	*Citrullus lanatus* var. *lanatus*
PI 172787	Trabzon, Turkey	*Citrullus lanatus* var. *lanatus*
PI 167219	Icel, Turkey	*Citrullus lanatus* var. *lanatus*
PI 164636	Karnataka, India	*Citrullus lanatus* var. *lanatus*
PI 167126	Adana, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278024	Kayseri, Turkey	*Citrullus lanatus* var. *lanatus*
PI 177326	Hakkari, Turkey	*Citrullus lanatus* var. *lanatus*
PI 169245	Burdur, Turkey	*Citrullus lanatus* var. *lanatus*
PI 175657	Urfa, Turkey	*Citrullus lanatus* var. *lanatus*
PI 163572	Jutiapa, Guatemala	*Citrullus lanatus* var. *lanatus*
PI 172801	Urfa, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278038	Mugla, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278047	Sakarya, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278006	Gaziantep, Turkey	*Citrullus lanatus* var. *lanatus*
PI 595218	California, USA	*Citrullus lanatus* var. *lanatus*
PI 278030	Kirsehir, Turkey	*Citrullus lanatus* var. *lanatus*
PI 249010	Kaduna, Nigeria	*Citrullus lanatus* var. *lanatus*
PI 277973	Adıyaman, Turkey	*Citrullus lanatus* var. *lanatus*
PI 279461	Japan	*Citrullus lanatus* var. *lanatus*
PI 169264	Istanbul, Turkey	*Citrullus lanatus* var. *lanatus*
PI 227206	Aichi, Japan	*Citrullus lanatus* var. *lanatus*
PI 174103	Mardin, Turkey	*Citrullus lanatus* var. *lanatus*
PI 189316	Nigeria	*Citrullus lanatus* var. *lanatus*
PI 595201	Georgia, USA	*Citrullus lanatus* var. *lanatus*
PI 277996	Bitlis, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278021	Kars, Turkey	*Citrullus lanatus* var. *lanatus*
PI 612145	California, USA	*Citrullus lanatus* var. *lanatus*
PI 608047	Illinois, USA	*Citrullus lanatus* var. *lanatus*
PI 629105	North Carolina, USA	*Citrullus lanatus* var. *lanatus*
PI 344066	Gaziantep, Turkey	*Citrullus lanatus* var. *lanatus*
PI 169259	Manisa, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278022	Kars, Turkey	*Citrullus lanatus* var. *lanatus*
PI 600790	Michigan, USA	*Citrullus lanatus* var. *lanatus*
PI 165024	Ankara, Turkey	*Citrullus lanatus* var. *lanatus*
PI 203551	New Mexico, USA	*Citrullus lanatus* var. *lanatus*
PI 175653	Diyarbakir, Turkey	*Citrullus lanatus* var. *lanatus*
PI 185636	Ghana	*Citrullus lanatus* var. *lanatus*
PI 494530	Oyo, Nigeria	*Citrullus lanatus* var. *lanatus*
PI 595203	Georgia, United States	*Citrullus lanatus* var. *lanatus*
PI 169287	Bursa, Turkey	*Citrullus lanatus* var. *lanatus*

(cont. on next page)

Tablo 3.4 (Cont.)

GROUP A	**LOCATION**	**ACCESSION NAME**
PI 172789	Kars, Turkey	*Citrullus lanatus* var. *lanatus*
PI 222711	West Azerbaijan, Iran	*Citrullus lanatus* var. *lanatus*
PI 277986	Aydin, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278062	Zonguldak, Turkey	*Citrullus lanatus* var. *lanatus*
PI 169253	Aydin, Turkey	*Citrullus lanatus* var. *lanatus*
PI 179240	Antalya, Turkey	*Citrullus lanatus* var. *lanatus*
PI 171579	Zonguldak, Turkey	*Citrullus lanatus* var. *lanatus*
PI 169263	Izmir, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278023	Kars, Turkey	*Citrullus lanatus* var. *lanatus*
PI 270550	Ghana	*Citrullus lanatus* var. *lanatus*
GROUP B		
PI 174101	Mardin, Turkey	*Citrullus lanatus* var. *lanatus*
PI 169290	Bursa, Turkey	*Citrullus lanatus* var. *lanatus*
PI 177325	Hakkari, Turkey	*Citrullus lanatus* var. *lanatus*
PI 169232	Izmir, Turkey	*Citrullus lanatus* var. *lanatus*
PI 164539	Rajasthan, India	*Citrullus lanatus* var. *lanatus*
PI 164977	İstanbul, Turkey	*Citrullus lanatus* var. *lanatus*
PI 600792	Michigan, USA	*Citrullus lanatus* var. *lanatus*
PI 278061	Yozgat, Turkey	*Citrullus lanatus* var. *lanatus*
PI 169240	Antalya, Turkey	*Citrullus lanatus* var. *lanatus*
PI 176915	Konya, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278046	Nigde, Turkey	*Citrullus lanatus* var. *lanatus*
GROUP C		
PI 278045	Mus, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278049	Sinop, Turkey	*Citrullus lanatus* var. *lanatus*
PI 278025	Kirklareli, Turkey	*Citrullus lanatus* var. *lanatus*
PI 344300	Muş, Turkey	*Citrullus lanatus* var. *lanatus*
PI 229806	Kyoto, Japan	*Citrullus lanatus* var. *lanatus*
PI 165523	India	*Citrullus lanatus* var. *lanatus*
PI 164570	Tamil Nadu, India	*Citrullus lanatus* var. *lanatus*
PI 172789	Kars, Turkey	*Citrullus lanatus* var. *lanatus*
PI 248178	Zaire	*Citrullus lanatus* var. *lanatus*
PI 227202	Shizuoka, Japan	*Citrullus lanatus* var. *lanatus*
PI 270306	Philippines	*Citrullus lanatus* var. *lanatus*
GROUP D		
PI 227205	Aichi, Japan	*Citrullus lanatus* var. *lanatus*
PI 479704	USA	*Citrullus lanatus* var. *lanatus*
PI 165002	Ankara, Turkey	*Citrullus lanatus* var. *lanatus*
PI 595200	Georgia, USA	*Citrullus lanatus* var. *lanatus*
PI 172786	Turkey	*Citrullus lanatus* var. *lanatus*
PI 271779	Transvaal, South Africa	*Citrullus lanatus* var. *citroides*
PI 174106	Gaziantep, Turkey	*Citrullus lanatus* var. *lanatus*
GROUP E		
PI 299379	Cape Province, South Africa	*Citrullus lanatus* var. *citroides*

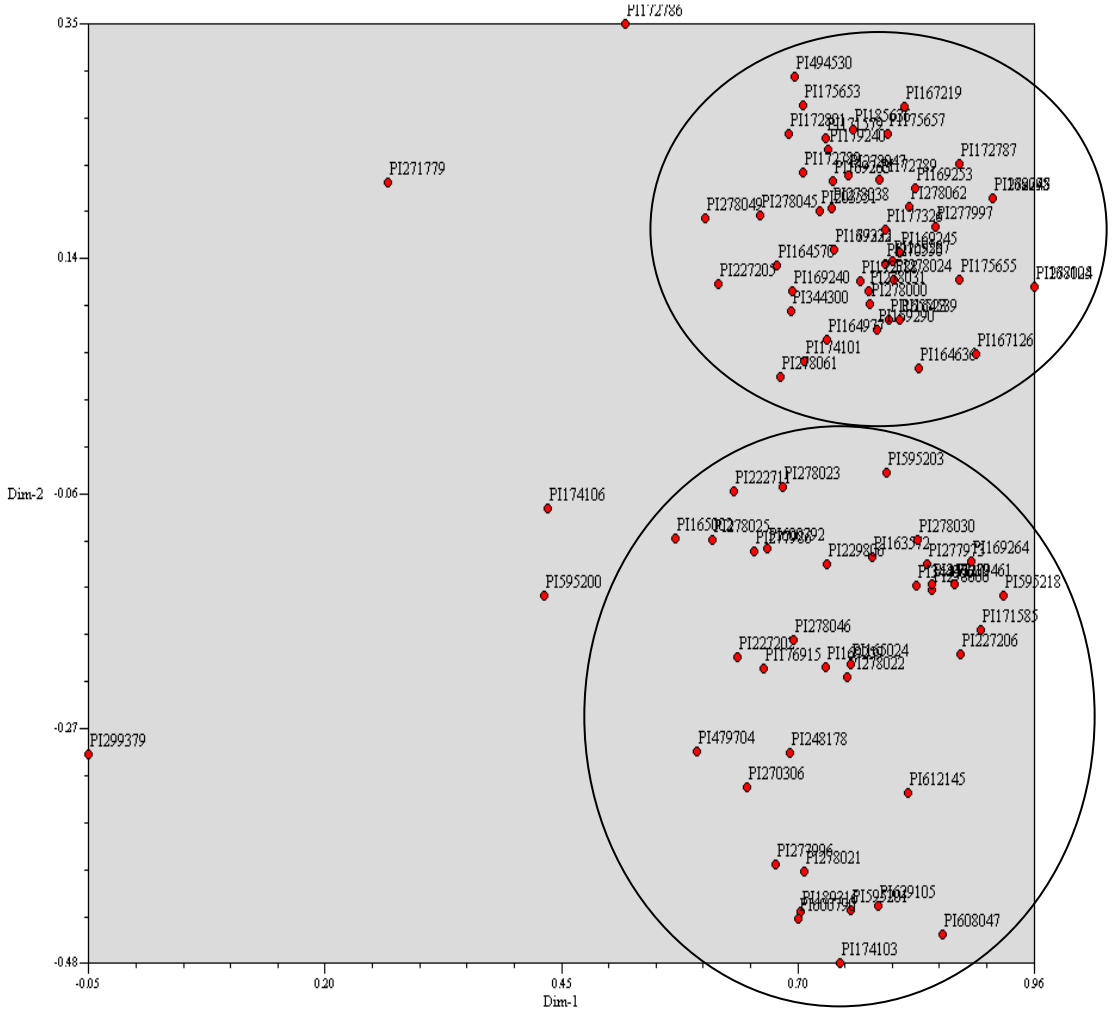

Figure 3.2. 2D Plot of 90 watermelon accessions using UPGMA in NTSYS-pc version 2.2.

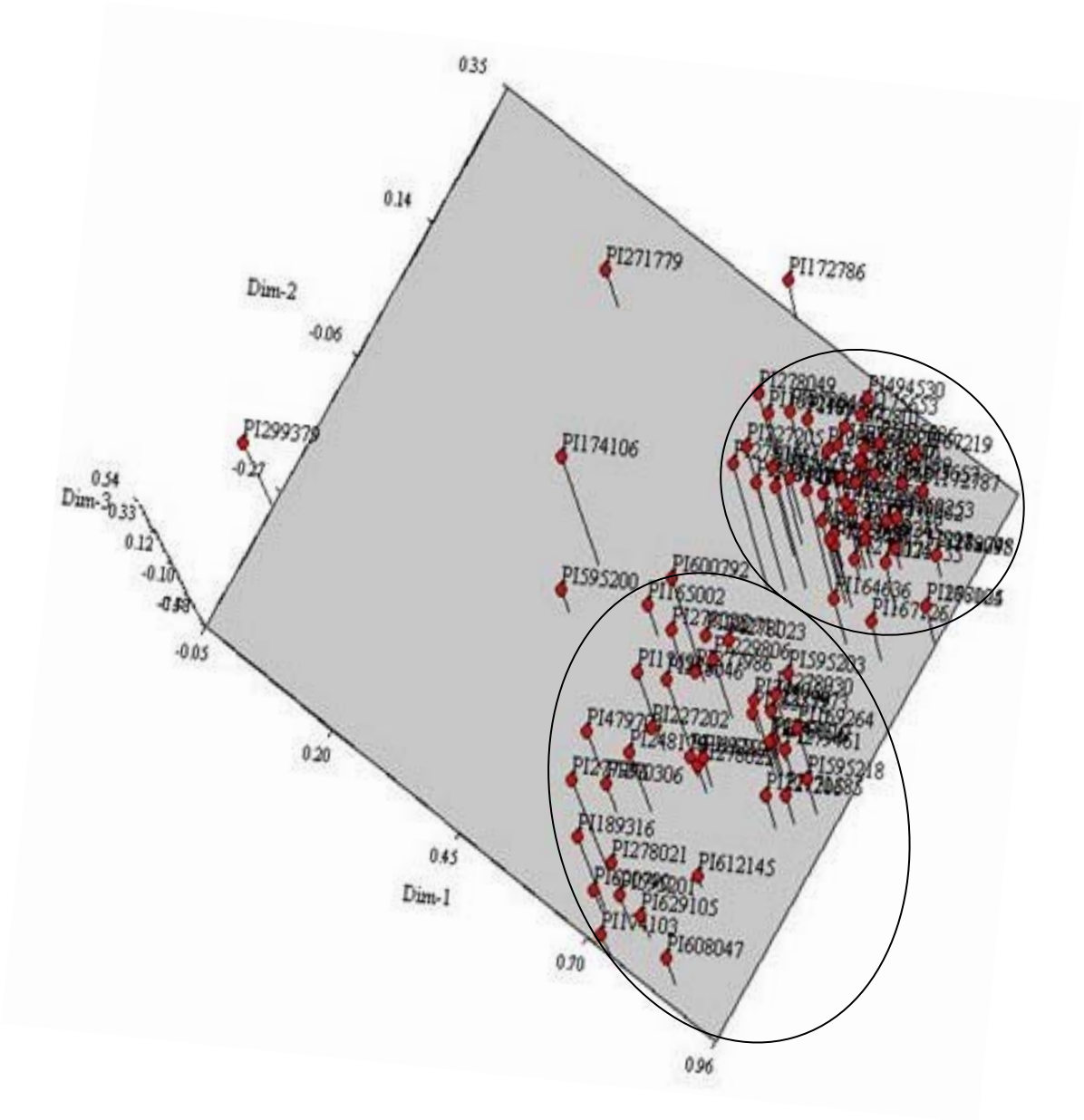

Figure 3.3. 3D Plot of 90 watermelon accessions using UPGMA in NTSYS-pc version 2.2.

3.1.2 Analysis of SRAP Results using DARWIN Software Program

A dendrogram of the 90 watermelon accessions analyzed with the SRAP marker system was also drawn based on the DICE matrix and Neighbour joining using DARWIN (Dissimilarity Analysis and Representation for Windows) software program (Figure 3.4.).

According to this dendrogram, the watermelon accessions fell into seven groups and the dendrogram scale varied from 0 to 0.1. The characteristic of these groups are shown in table 3.5. Group A contained 14 accessions and these accessions were closely related to each other. Group B included 19 accessions and also these accessions were very similar. In this group the accession PI 595200 showed most diversity from the others. Group C contained 18 accessions and showed the most genetic diversity. In this group, two accessions (PI 299379 and PI 271779) showed the most differences with the rest. Both of these accessions originated from South Africa which may explain why they are so distantly related to the other genetic material used in this study. Group D contained five accessions and these showed high similarity with each other. Group E contained 15 accessions and these accessions were also very closely related to each other. Group F consisted of five accessions and Group G contained 14 accessions. In group G the accession PI 172786 was most different from the other accessions in group G. The accessions within groups F and G were also very closely related to each other. When all groups are considered, the most distant accessions were PI 174106 in group A and PI 299379 in group C. Dissimilarity between these accessions was about 47%. Also comparing accession PI 299379 with PI 595200 and PI 172786, the dissimilarity values are 38% and 42%, respectively (Appendix A).

In this study many watermelon accessions belonging to the *Citrullus lanatus* var. *lanatus* subspecies were collected from different parts of the world, however, genetic diversity was limited. This may be because domestication of watermelon occurred outside of its center of origin and so genetic variation is narrow. In general, genetic variation did not depend on location in these watermelon acccessions. However, two watermelon accessions, PI 299379 and PI 271779 from South Africa, were most different from the other accessions using both UPGMA and neighbor-joining analysis. The accession PI 299379 from South Africa also grouped in a distinct cluster (E) in the dendrogram which was constructed based on UPGMA (Figure 3.1.). These two

watermelon accessions belong to *Citrullus lanatus* var. *citroides* subspecies and therefore, it was expected that genetic similarity would be lower. Previous studies also indicated a lack of genetic diversity among watermelon cultivars. For example in 2001, Levi and Thomas determined low genetic diversity among 46 watermelon accessions of *Citrullus lanatus* var. *lanatus* and 12 U.S. *Citrullus* sp. using RAPD markers. They detected high genetic similarity values among watermelon cultivars (92% to 99%) and *Citrullus lanatus* var. *lanatus* (88% to 95%) and also detected lower similarity values among *Citrullus lanatus* var. *citroides* (65% to 82.5%). In addition our study showed that SRAPs were very suitable markers for genetic diversity studies in watermelon because of their high polymorphism (97%). In another previous study, Levi and Thomas (2007) tested 41 SRAP markers. In this study, 33 of 41 SRAP markers produced high polymorphism (80.5%) among 24 watermelon cultivars. So our results were in agreement with previous studies.

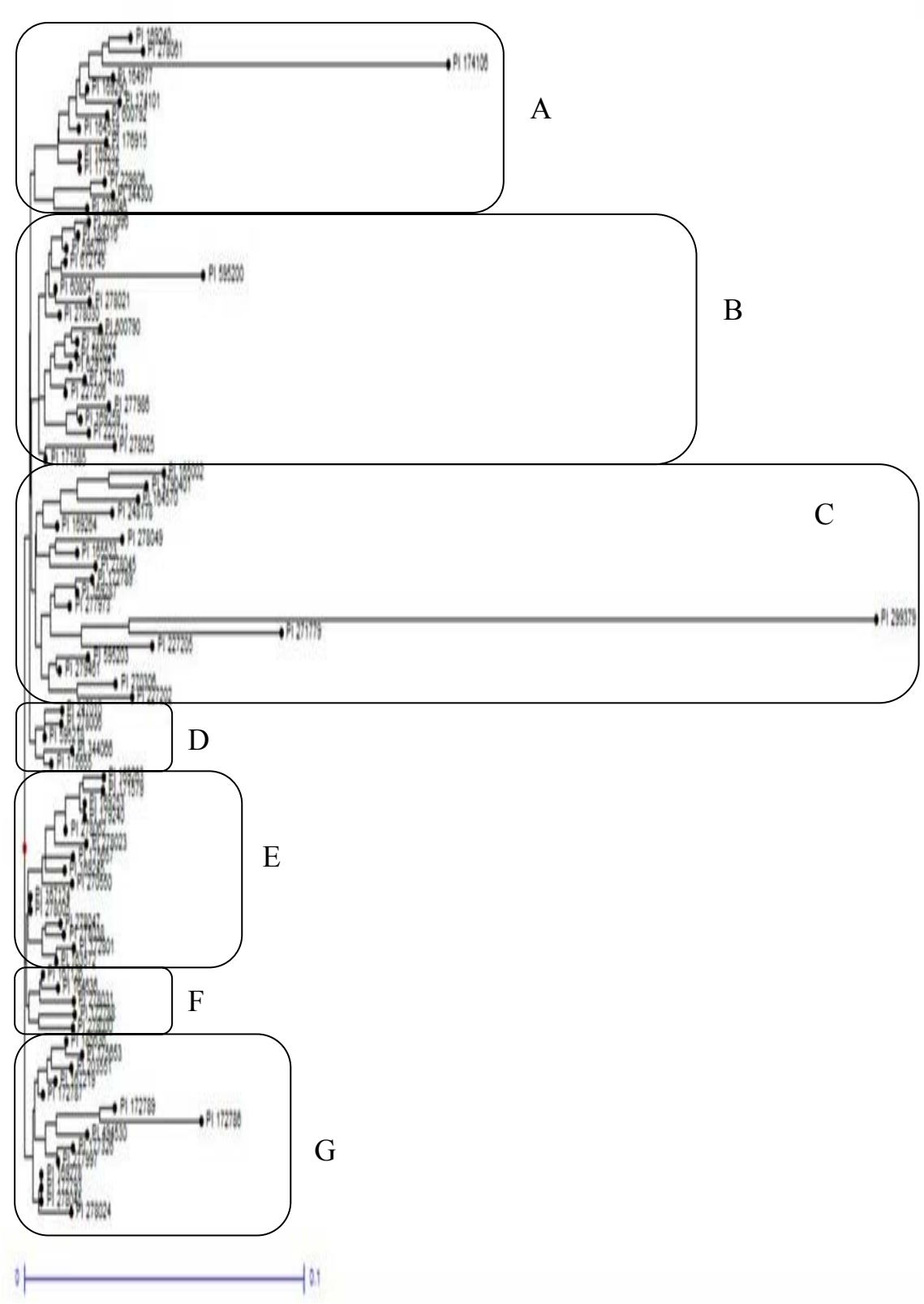

Figure 3.4. The dendrogram of 90 watermelon accessions based on Neighbour Joining using DARWIN.

Table 3.5. Characteristics of 90 watermelon accessions in Group A, B, C, D E, F and G.

GROUP A	**LOCATION**	**ACCESSION NAME**
PI 169240	Antalya, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278061	Yozgat, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 174106	Gaziantep, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 164977	İstanbul, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 169290	Bursa, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 174101	Mardin, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 600792	Michigan, USA	*Citrullus lanatus* var. *lanatus*
PI 164539	Rajasthan, INDIA	*Citrullus lanatus* var. *lanatus*
PI 176915	Konya, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 169232	İzmir, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 177325	Hakkari, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 229806	Kyoto, JAPAN	*Citrullus lanatus* var. *lanatus*
PI 344300	Muş, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278046	Niğde, TURKEY	*Citrullus lanatus* var. *lanatus*
GROUP B		
PI 277996	Bitlis, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 189316	NIGERIA	*Citrullus lanatus* var. *lanatus*
PI 595201	Georgia, USA	*Citrullus lanatus* var. *lanatus*
PI 612145	California, USA	*Citrullus lanatus* var. *lanatus*
PI 595200	Georgia, USA	*Citrullus lanatus* var. *lanatus*
PI 608047	Illınois, USA	*Citrullus lanatus* var. *lanatus*
PI 278021	Kars, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278030	Kırşehir, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 600790	Michigan, USA	*Citrullus lanatus* var. *lanatus*
PI 278022	Kars, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 165024	Ankara, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 629105	Nort Carolina, USA	*Citrullus lanatus* var. *lanatus*
PI 174103	Mardin, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 227206	Aichi, JAPAN	*Citrullus lanatus* var. *lanatus*
PI 277986	Aydın, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 169259	Manisa, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 222711	West Azerbaijan, Iran	*Citrullus lanatus* var. *lanatus*
PI 278025	Kırklareli, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 171585	Tokat, TURKEY	*Citrullus lanatus* var. *lanatus*

(cont. on next page)

Table 3.5. (Cont.)

GROUP C	**LOCATION**	**ACCESSION NAME**
PI 165200	Ankara, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 479704	USA	*Citrullus lanatus* var. *lanatus*
PI 164570	Tamil Nadu, INDIA	*Citrullus lanatus* var. *lanatus*
PI 248178	Zaire	*Citrullus lanatus* var. *lanatus*
PI 169264	İstanbul, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278049	Sinop, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 165523	INDIA	*Citrullus lanatus* var. *lanatus*
PI 278045	Muş, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 172789	Kars, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 169287	Bursa, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 277973	Adıyaman, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 299379	Cope Province, SOUTH	*Citrullus lanatus* var. *citroides*
PI 271779	Transvaal, SOUTH AFRICA	*Citrullus lanatus* var. *citroides*
PI 227205	Aichi , JAPAN	*Citrullus lanatus* var. *lanatus*
PI 595203	Georgia, USA	*Citrullus lanatus* var. *lanatus*
PI 279461	JAPAN	*Citrullus lanatus* var. *lanatus*
PI 270306	PHILIPPINES	*Citrullus lanatus* var. *lanatus*
PI 227202	Shizuoka, JAPAN	*Citrullus lanatus* var. *lanatus*
GROUP D		
PI 249010	NIGERIA	*Citrullus lanatus* var. *lanatus*
PI 278006	Gaziantep, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 595218	California, USA	*Citrullus lanatus* var. *lanatus*
PI 344066	Gaziantep, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 175655	Çanakkale, TURKEY	*Citrullus lanatus* var. *lanatus*
GROUP E		
PI 169263	İzmir, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 171579	Zonguldak, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 169253	Aydın, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 179240	Edirne, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278062	Zonguldak, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278023	Kars, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 175657	Urfa, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 169245	Burdur, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 270550	GHANA	*Citrullus lanatus* var. *lanatus*
PI 278005	Çanakkale, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 167124	Adana, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278047	Sakarya, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278038	Muğla, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 172801	Urfa, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 163572	Jutiapa, GUATEMALA	*Citrullus lanatus* var. *lanatus*

(cont. on next page)

Table 3.5. (Cont.)

GROUP F	**LOCATION**	**ACCESSION NAME**
PI 167126	Adana, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 164636	INDIA	*Citrullus lanatus* var. *lanatus*
PI 278031	Kırşehir, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 172788	Trabzon, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278000	Burdur, TURKEY	*Citrullus lanatus* var. *lanatus*
GROUP G		
PI 185636	GHANA	*Citrullus lanatus* var. *lanatus*
PI 175653	Diyarbakır, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 203551	New Mexico, USA	*Citrullus lanatus* var. *lanatus*
PI 167219	İçel, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 172787	Trabzon, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 172789	Kars, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 172786	TURKEY	*Citrullus lanatus* var. *lanatus*
PI 494530	Oyo, NIGERIA	*Citrullus lanatus* var. *lanatus*
PI 177326	Hakkari, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 277997	Bingöl, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 169278	Çanakkale, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 172793	Van, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278045	Muş, TURKEY	*Citrullus lanatus* var. *lanatus*
PI 278024	Kayseri, TURKEY	*Citrullus lanatus* var. *lanatus*

CHAPTER 4

CONCLUSION

Watermelon (*Citrullus lanatus*) is an important crop all over the world. It has been cultivated and domesticated for at least 4000 years. Also watermelon is an economically important crop for Turkey. In this study, the main goal was genetic characterization of watermelon accessions. This information can be used for generation of a core collection of watermelon by elimination of redundant accessions and for watermelon breeding by identifying useful lines. In this respect, 90 watermelon accessions from the USDA (United States Department of Agriculture) collection were studied using 40 SRAP marker combinations. A total of 201 fragments were obtained and 87 of 201 bands showed polymorphism (43%). These numerical data were obtained to determined genetic relationship using UPGMA (Unweighted Pair Group Method) and Neighbor Joining methods. As a result, genetic diversity among the 90 watermelon accessions was found to be very low with 68% minimum similarity. Also 30 of 31 SRAP marker combinations were polymorphic (97%) so these are very useful for analysing genetic diversity in low diversity crops like watermelon.

REFERENCES

Dane, F. and J. Liu. 2007. Diversity and Origin of Cultivated and Citron Type Watermelon (*Citrullus lanatus*). *Genet Resour Crop Evol* 54:1255-1265.

Dane, F., P. Lang, R. Bakhtiyarova. 2004. Comparative Analysis of Chloroplast DNA Variability in Wild and Cultivated *Citrullus* Species. *Theor Appl Genet* 108: 958-966.

Gichimu, B.M., B.O. Owuor, G.N. Mwai, M.M. Dida. 2009. Morphological Characterization of Some Wild and Cultivated Watermelon (*Citrullus sp*.) Accession in Kenya. *Arpn Journal of Agricultural and Biological Science* 4: 1990-6145.

Goda, M. 2007. Diversity of Local Genetic Resources of Watermelon *Citrullus lanatus* (Thunb.) Matsum and Nakai, in Sudan. Swedish Biodiversity Centre. Master Thesis, No:35.

Guerra-Sanz, j.M. 2002. *Citrullus* Simple Sequence Repeats Markers from Sequence Databases. *Molecular Ecology Notes* 2 :223-225.

Huh, Y.C., I. Solmaz, N. Sarı. 2008. Morpholojical Characterization of Korean and Turkish Watermelon Germplasm. In: Cucurbitaceae 2008, Proceedings of the IXth EUCARPIA meeting on genetics and breeding of Cucurbitaceae (Pitrat M, ed), INRA, Avignon (France), May 21-24th, 2008.

Levi, A. and C.E. Thomas, 2007. DNA Markers from Different Linkage Regions of Watermelon Genome Useful in Differentiating among Closely Related Watermelon Genotypes. *Hortscience* 42:210-214.

Levi, A. and C.E. Thomas. 2001. Low Genetic Diversity Indicates the Need to Broaden the Genetic Base of Cultivated Watermelon. *Hortscience* 36(6): 1096-1101.

Levi, A., C.E. Thomas, A.P. Keinayh, T.C. Wehner. 2001. Genetic Diversity Among Watermelon (*Citrullus lanatus and Citrullus colocynthis*) Accessions. *Genetic Resources and Crop Evolution* 48: 59-566.

Li, G. and C.F. Quiros. 2001. Sequence- Related Amplified Polymorphism (SRAP), A New Marker System based on A Simple PCR Reaction. *Theor Appl Genet* 103: 455-461.

Lin, Z., D. He, X. Zhang, Y. Nie, X. Guo, C. Feng, MCD.J. Stewart. 2005. Linkage Map Construction and Mapping QTL for Cotton Fibre Quality Using SRAP, SSR and RAPD. *Plant Breeding* 124: 180-187.

Razavi, S.M.A. and E Milani. 2006. Some Physical Properties of the Watermelon Seeds. *African Journal of Agricultural Research* 1(3):065-069.

Sarı, N., A. Tan, R. Yanmaz, H. Yetişir, A. Balkaya, I. Solmaz, L. Aykas. 2008. General Status of Cucurbit Genetic Resources in Turkey. In: Cucurbitaceae 2008, Proceedings of the IXth EUCARPIA meeting on genetics and breeding of Cucurbitaceae (Pitrat M, ed), INRA, Avignon (France), May 21-24th, 2008.

Solmaz, I. and N. Sarı. 2009. Characterization of Watermelon (*Citrullus lanatus*) Accessions Collected from Turkey for Morphological Traits. *Genet Resour Crop Evol*. 56: 173-188.

Sun, S.J., W. Gao, S.Q. Lin, J. Zhu, B.G. Xie, Z.B. Lin. 2006. Analysis of Genetic Diversity in Ganoderma Population with A Novel Molecular Marker SRAP. *Appl Microbiol Biotechnol* 72: 537–543.

Tahi, G. 2006. Genetic structure of African Edible Seeds *Citrullus lanatus* (Thunberg) Matsumara & Nakai var. *citroides* Using SSR Molecular Markers. Universite catholique de Louvain, Faculte d'ingenierie biologique, agronomique et environnementate. Master Thesis, 45pp.

Waldman, M. and Y Shevah. 2000. Biological Diversity- An Overview. *Water, Air and Soil Pollution* 123:299-310.

Wang, J., J. Yao, W. Li. 2008. Construction of A Molecular Map for Melon (*Cucumis melo* L.) Based on SRAP. *Front. Agric. China* 2(4): 451–455.

Zhongxu, L., Z. Xranlong, N. Yichun, H. Daohua, W. Maoqing. 2003. Construction of A Genetic Lincage Map for Cotton Based on SRAP. *Chinese Science Bulletin* 48: 2064-2068.

APPENDIX A

DISSIMILARITY VALUES OF 90 WATERMELON ACCESSIONS USING NEIGHBOR JOINING IN DARWIN SOFTWARE PROGRAM

Table A.1. Dissimilarity values of 90 watermelon accessions using Neighbour Joining in DARWIN software program

	PI 278000	PI 278062	PI 278005	PI 278006	PI 277973	PI 203551	PI 248178	PI 174101	PI 164636	PI 165523	PI 175655	PI 176915
PI 278062	0,0314											
PI 278005	0,0186	0,0123										
PI 278006	0,0314	0,025	0,0123									
PI 277973	0,0379	0,0314	0,0186	0,0188								
PI 203551	0,0375	0,031	0,0184	0,031	0,025							
PI 248178	0,0513	0,0573	0,044	0,0445	0,0256							
PI 174101	0,0389	0,0451	0,0318	0,0451	0,0519	0,0506						
PI 164636	0,0322	0,0256	0,0126	0,0256	0,0322	0,0512	0,0526					
PI 165523	0,0379	0,0314	0,0186	0,0314	0,0253	0,0318	0,0457	0,0331				
PI 175655	0,025	0,0186	0,0061	0,0186	0,025	0,0375	0,0512	0,0519	0,0193			
PI 176915	0,0379	0,044	0,031	0,044	0,0506	0,0123	0,0506	0,0384	0,0191	0,025		
PI 344066	0,0263	0,0326	0,0193	0,0196	0,0263	0,05	0,0512	0,0389	0,0322	0,0379	0,0375	
PI 344300	0,0512	0,0445	0,0314	0,0445	0,0384	0,0259	0,04	0,0405	0,0335	0,0394	0,0129	0,0394
PI 278061	0,0519	0,058	0,0445	0,058	0,0519	0,0379	0,0649	0,0657	0,0322	0,0384	0,0253	0,0641
PI 247010	0,0314	0,025	0,0123	0,0125	0,0188	0,0512	0,0526	0,0266	0,0331	0,0389	0,0384	0,0389
PI 189316	0,031	0,037	0,0244	0,0246	0,031	0,031	0,0445	0,0451	0,0256	0,0314	0,0186	0,044
PI 169240	0,0451	0,0512	0,0379	0,0512	0,0451	0,0306	0,0314	0,0445	0,0379	0,0434	0,0306	0,031
PI 169245	0,0314	0,0125	0,0123	0,025	0,0314	0,0445	0,0588	0,0331	0,0526	0,0322	0,0318	0,0451
PI 595200	0,0666	0,0861	0,0719	0,0728	0,08	0,031	0,0573	0,0451	0,0256	0,0314	0,0186	0,044
PI 172793	0,025	0,0186	0,0061	0,0186	0,025	0,0657	0,081	0,1095	0,0872	0,0933	0,0657	0,0933
PI 169278	0,025	0,0186	0,0061	0,0186	0,025	0,0246	0,0379	0,0384	0,0191	0,025	0,0123	0,0375
PI 163572	0,0256	0,0256	0,0126	0,0256	0,0322	0,0246	0,0379	0,0384	0,0191	0,025	0,0123	0,0375
PI 179240	0,04	0,0133	0,0263	0,04	0,0469	0,0318	0,0457	0,0457	0,0263	0,0322	0,0191	0,0322

(cont. on next page)

Table A.1. (cont.)

	PI 278000	PI 278062	PI 278005	PI 278006	PI 277973	PI 203551	PI 248178	PI 174101	PI 164636	PI 165523	PI 175655	PI 176915
PI169253	0,0326	0	0,0128	0,0259	0,0326	0,0463	0,0748	0,0612	0,041	0,0469	0,0331	0,0604
PI 278045	0,044	0,0375	0,0247	0,0375	0,0314	0,0322	0,0596	0,0469	0,0266	0,0326	0,0193	0,0457
PI 169290	0,0253	0,0314	0,0186	0,0314	0,0379	0,031	0,0573	0,058	0,0384	0,0314	0,031	0,0566
PI 164570	0,0649	0,058	0,0445	0,058	0,0519	0,0375	0,0512	0,0129	0,0322	0,0379	0,025	0,0253
PI 164539	0,0253	0,0314	0,0186	0,0314	0,0253	0,0641	0,0526	0,0666	0,0331	0,0259	0,0512	0,0649
PI 177325	0,025	0,031	0,0184	0,031	0,0375	0,0375	0,0384	0,0259	0,0322	0,0253	0,025	0,0379
PI 278024	0,0379	0,0314	0,0186	0,0314	0,0379	0,0246	0,0506	0,0256	0,0318	0,0375	0,0246	0,0375
PI 229806	0,0512	0,0445	0,0314	0,0318	0,0256	0,0506	0,0519	0,0657	0,0322	0,0384	0,0379	0,0641
PI 279461	0,0314	0,025	0,0123	0,0125	0,0062	0,0186	0,0318	0,0451	0,0256	0,0314	0,0186	0,044
PI 172787	0,0188	0,0188	0,0062	0,0188	0,0253	0,0125	0,0512	0,0384	0,0193	0,0253	0,0125	0,0379
PI 171579	0,0476	0,0135	0,0266	0,0405	0,0476	0,0469	0,0758	0,062	0,0416	0,0476	0,0335	0,0612
PI 227202	0,0533	0,0331	0,0457	0,0463	0,04	0,0526	0,054	0,0821	0,0612	0,0666	0,0526	0,0666
PI 175653	0,044	0,0375	0,0246	0,0375	0,0314	0,0186	0,0445	0,058	0,0384	0,044	0,031	0,0566
PI 171585	0,0246	0,0184	0,006	0,0184	0,0246	0,0243	0,0375	0,0379	0,0188	0,0246	0,0121	0,0246
PI 278023	0,044	0,025	0,0246	0,0375	0,044	0,0434	0,0573	0,058	0,0384	0,044	0,031	0,044
PI 270550	0,0253	0,0188	0,0186	0,0314	0,0379	0,0375	0,0512	0,0389	0,0322	0,0379	0,025	0,0379
PI 227205	0,0649	0,058	0,0445	0,058	0,0519	0,0641	0,0789	0,08	0,0526	0,0519	0,0512	0,0779
PI 169287	0,0379	0,0314	0,0186	0,0314	0,0126	0,025	0,0384	0,0519	0,0322	0,0253	0,025	0,0506
PI 172789	0,0469	0,04	0,0263	0,04	0,0201	0,0331	0,034	0,062	0,041	0,0335	0,0331	0,0604
PI 270306	0,0573	0,0506	0,0375	0,0379	0,0318	0,044	0,0451	0,0718	0,0519	0,0573	0,044	0,0573
PI 271779	0,1066	0,0933	0,0921	0,1066	0,1006	0,0993	0,1156	0,1172	0,0884	0,114	0,0993	0,1275
PI 169263	0,041	0,0136	0,027	0,041	0,0482	0,0405	0,0769	0,0489	0,0422	0,0482	0,027	0,062
PI 169264	0,0326	0,0259	0,0128	0,0129	0,0065	0,0322	0,0331	0,0469	0,0266	0,0196	0,0193	0,0457
PI 167219	0,0318	0,0253	0,0125	0,0253	0,0318	0,0188	0,0451	0,0457	0,0259	0,0318	0,0188	0,0445

(cont. on next page)

Table A.1. (cont.)

	PI 278000	PI 278062	PI 278005	PI 278006	PI 277973	PI 203551	PI 248178	PI 174101	PI 164636	PI 165523	PI 175655	PI 176915
PI 169232	0,025	0,031	0,0184	0,031	0,0375	0,0246	0,0506	0,0256	0,0318	0,0375	0,0246	0,0375
PI 595201	0,037	0,0306	0,0181	0,0184	0,0246	0,0243	0,0375	0,0506	0,0314	0,037	0,0243	0,037
PI 595203	0,0451	0,0384	0,0253	0,0256	0,0193	0,0318	0,0326	0,0596	0,0394	0,0451	0,0318	0,058
PI 595218	0,025	0,0186	0,0061	0,0062	0,0125	0,0246	0,0379	0,0384	0,0191	0,025	0,0123	0,0375
PI 227206	0,0322	0,0256	0,0126	0,0128	0,0193	0,0318	0,0457	0,0463	0,0131	0,0193	0,0191	0,0322
PI 185636	0,0375	0,031	0,0184	0,031	0,025	0,0123	0,0379	0,0512	0,0318	0,0375	0,0246	0,05
PI 277996	0,0389	0,0451	0,0318	0,0322	0,0259	0,0384	0,0263	0,0533	0,0451	0,0389	0,0384	0,0389
PI 278045	0,025	0,0186	0,0061	0,0186	0,025	0,0246	0,0379	0,0384	0,0191	0,025	0,0123	0,0375
PI 175657	0,0379	0,0188	0,0186	0,0314	0,0379	0,0375	0,0512	0,0451	0,0322	0,0379	0,025	0,0506
PI 278031	0,0253	0,0314	0,0186	0,0314	0,0379	0,0375	0,0641	0,0519	0,0193	0,0253	0,025	0,0379
PI 494530	0,0326	0,0389	0,0256	0,0389	0,0457	0,0322	0,0596	0,0604	0,04	0,0457	0,0322	0,0588
PI 278046	0,0314	0,0375	0,0246	0,0375	0,044	0,0434	0,0445	0,0451	0,0318	0,044	0,031	0,0314
PI 278049	0,0573	0,0506	0,0375	0,0506	0,0318	0,0314	0,058	0,0718	0,0519	0,0318	0,044	0,07
PI 278030	0,031	0,0246	0,0121	0,0123	0,0186	0,0184	0,044	0,0445	0,0253	0,031	0,0184	0,0434
PI 278038	0,031	0,0246	0,0121	0,0246	0,031	0,0306	0,0566	0,0445	0,0253	0,031	0,0184	0,0434
PI 278047	0,031	0,0246	0,0121	0,0246	0,031	0,0306	0,0566	0,0445	0,0253	0,031	0,0184	0,0434
PI 277997	0,0314	0,025	0,0123	0,025	0,0314	0,031	0,0445	0,0451	0,0256	0,0314	0,0186	0,044
PI 164977	0,0384	0,0445	0,0314	0,0445	0,0384	0,0506	0,0519	0,0263	0,0457	0,0384	0,0379	0,0384
PI 222711	0,0434	0,037	0,0243	0,037	0,0434	0,0429	0,044	0,0573	0,0379	0,0434	0,0306	0,0434
PI 172801	0,025	0,031	0,0184	0,031	0,0375	0,037	0,0632	0,0445	0,0318	0,0375	0,0246	0,05
PI 172786	0,0821	0,0748	0,0738	0,0884	0,0821	0,081	0,0972	0,1048	0,0833	0,0684	0,081	0,1095
PI 172789	0,0451	0,0512	0,0379	0,0512	0,0451	0,0573	0,0588	0,0728	0,0526	0,0322	0,0445	0,0709
PI 172788	0,0253	0,0314	0,0186	0,0314	0,0379	0,0375	0,0641	0,0389	0,0256	0,0379	0,025	0,0506
PI 167124	0,0186	0,0123	0	0,0123	0,0186	0,0184	0,044	0,0318	0,0126	0,0186	0,0061	0,031

(cont. on next page)

Table A.1. (cont.)

	PI 278000	PI 278062	PI 278005	PI 278006	PI 277973	PI 203551	PI 248178	PI 174101	PI 164636	PI 165523	PI 175655	PI 176915
PI 167126	0,025	0,0186	0,0061	0,0186	0,025	0,0246	0,0506	0,0384	0,0063	0,0125	0,0123	0,025
PI 169259	0,0375	0,031	0,0184	0,031	0,0375	0,037	0,0506	0,0384	0,0318	0,0375	0,0246	0,0375
PI 177326	0,0379	0,0314	0,0186	0,0314	0,0379	0,0375	0,0512	0,0519	0,0256	0,0379	0,025	0,0506
PI 277986	0,0506	0,044	0,031	0,044	0,0506	0,05	0,0512	0,0519	0,0451	0,0506	0,0375	0,0506
PI 278021	0,044	0,0375	0,0246	0,025	0,0314	0,0434	0,0445	0,058	0,0384	0,044	0,031	0,044
PI 278022	0,0375	0,031	0,0184	0,031	0,0375	0,037	0,0506	0,0384	0,0191	0,025	0,0246	0,025
PI 600792	0,0379	0,044	0,031	0,044	0,0506	0,05	0,0512	0,0259	0,0451	0,0506	0,0375	0,0253
PI 600790	0,0506	0,044	0,031	0,0314	0,0379	0,05	0,0512	0,0519	0,0322	0,0379	0,0375	0,0379
PI 612145	0,0375	0,031	0,0184	0,0186	0,025	0,037	0,0253	0,0512	0,0318	0,0375	0,0246	0,0375
PI 608047	0,031	0,0246	0,0121	0,0123	0,0186	0,0306	0,0314	0,0445	0,0253	0,031	0,0184	0,031
PI 629105	0,0375	0,031	0,0184	0,0186	0,025	0,037	0,0379	0,0512	0,0318	0,0375	0,0246	0,0375
PI 278025	0,0379	0,044	0,031	0,044	0,0506	0,05	0,0641	0,0649	0,0451	0,0506	0,0375	0,0506
PI 479704	0,0709	0,0512	0,0506	0,0512	0,0451	0,07	0,0457	0,0728	0,0526	0,058	0,0573	0,0709
PI 165002	0,0779	0,0709	0,0573	0,0709	0,0649	0,0769	0,0526	0,08	0,0463	0,0519	0,0641	0,0649
PI 165024	0,0375	0,031	0,0184	0,031	0,0375	0,037	0,0506	0,0512	0,0191	0,025	0,0246	0,025
PI 174103	0,0463	0,0394	0,0259	0,0263	0,0263	0,0389	0,04	0,0612	0,027	0,0331	0,0326	0,0331
PI 174106	0,1703	0,1764	0,1594	0,1532	0,1407	0,1678	0,1492	0,1515	0,1492	0,1407	0,1678	0,1555
PI 299379	0,3228	0,3281	0,3076	0,3125	0,2913	0,3178	0,28	0,3333	0,312	0,3228	0,3178	0,3228
	PI 344066	**PI 344300**	**PI 278061**	**PI 247010**	**PI 189316**	**PI 169240**	**PI 169245**	**PI 595200**	**PI 172793**	**PI 169278**	**PI 163572**	**PI 179240**
PI 344300	0,04											
PI 278061	0,0405	0,0526										
PI 247010	0,0196	0,0445	0,058									
PI 189316	0,0193	0,0566	0,0573	0,0246								
PI 169240	0,0335	0,0457	0,0198	0,0512	0,0506							

(cont. on next page)

39

Table A.1. (cont.)

	PI 344066	PI 344300	PI 278061	PI 247010	PI 189316	PI 169240	PI 169245	PI 595200	PI 172793	PI 169278	PI 163572	PI 179240
PI 169245	0,0326	0,0445	0,058	0,025	0,037	0,0512						
PI 595200	0,0694	0,08	0,1095	0,0728	0,0588	0,102	0,0728					
PI 172793	0,0259	0,0379	0,0512	0,0186	0,0306	0,0445	0,0186	0,0657				
PI 169278	0,0259	0,0379	0,0512	0,0186	0,0306	0,0445	0,0186	0,0657	0			
PI 163572	0,0335	0,0457	0,0596	0,0256	0,0253	0,0526	0,0256	0,0675	0,0191	0,0191		
PI 179240	0,0344	0,0612	0,0758	0,04	0,0526	0,0684	0,0266	0,0985	0,0331	0,0331	0,0389	
PI169253	0,0326	0,0463	0,0604	0,0259	0,0384	0,0533	0,0129	0,0896	0,0193	0,0193	0,0266	0
PI 278045	0,0457	0,0445	0,058	0,0375	0,037	0,0512	0,0375	0,086	0,031	0,031	0,0384	0,0533
PI 169290	0,0263	0,0512	0,0259	0,0314	0,031	0,0193	0,0314	0,0933	0,025	0,025	0,0322	0,0469
PI 164570	0,0604	0,0657	0,0533	0,058	0,07	0,0596	0,058	0,1095	0,0384	0,0384	0,0596	0,062
PI 164539	0,0263	0,0384	0,0259	0,0314	0,031	0,0193	0,0314	0,0933	0,025	0,025	0,0322	0,0469
PI 177325	0,0259	0,0506	0,0384	0,031	0,0184	0,0318	0,031	0,0789	0,0246	0,0246	0,0318	0,0463
PI 278024	0,0394	0,0512	0,0519	0,0314	0,0434	0,058	0,0314	0,08	0,0125	0,0125	0,0322	0,0469
PI 229806	0,04	0,0129	0,0657	0,0318	0,044	0,0588	0,0445	0,08	0,0379	0,0379	0,0457	0,0612
PI 279461	0,0196	0,0445	0,058	0,0125	0,0246	0,0512	0,025	0,0728	0,0186	0,0186	0,0256	0,04
PI 172787	0,0263	0,0384	0,0519	0,0188	0,0186	0,0451	0,0188	0,0596	0,0125	0,0125	0,0188	0,0326
PI 171579	0,0422	0,062	0,0769	0,0405	0,0533	0,0694	0,027	0,1079	0,0335	0,0335	0,04	0,0138
PI 227202	0,0533	0,081	0,0958	0,0463	0,0457	0,0884	0,0463	0,0845	0,0526	0,0526	0,0405	0,0277
PI 175653	0,0389	0,0573	0,0709	0,0375	0,037	0,0641	0,0375	0,0728	0,0186	0,0186	0,0384	0,04
PI 171585	0,0256	0,0375	0,0506	0,0184	0,0181	0,044	0,0184	0,0649	0,0121	0,0121	0,0062	0,0326
PI 278023	0,0322	0,0573	0,0709	0,0375	0,037	0,0641	0,025	0,086	0,031	0,031	0,0256	0,0266
PI 270550	0,0263	0,0512	0,0519	0,0314	0,031	0,0451	0,0188	0,0933	0,025	0,025	0,0322	0,0335
PI 227205	0,0675	0,0526	0,08	0,058	0,07	0,0728	0,058	0,1095	0,0512	0,0512	0,0596	0,0758
PI 169287	0,0394	0,0384	0,0519	0,0314	0,0434	0,0451	0,0314	0,0933	0,025	0,025	0,0322	0,0469

(cont. on next page)

Table A.1. (cont.)

	PI 344066	PI 344300	PI 278061	PI 247010	PI 189316	PI 169240	PI 169245	PI 595200	PI 172793	PI 169278	PI 163572	PI 179240
PI 172789	0,0489	0,0476	0,062	0,04	0,0526	0,0547	0,04	0,0845	0,0198	0,0198	0,041	0,0571
PI 270306	0,0463	0,0709	0,0849	0,0379	0,0375	0,0779	0,0506	0,0872	0,044	0,044	0,0389	0,0675
PI 271779	0,1188	0,1156	0,131	0,1066	0,1184	0,1369	0,0933	0,1549	0,0993	0,0993	0,0945	0,1126
PI 169263	0,0354	0,0555	0,0704	0,034	0,054	0,0629	0,0273	0,0935	0,034	0,034	0,0405	0,014
PI 169264	0,0196	0,0331	0,0469	0,0129	0,0256	0,04	0,0259	0,0758	0,0193	0,0193	0,0266	0,0273
PI 167219	0,0331	0,0451	0,0588	0,0253	0,025	0,0519	0,0253	0,0604	0,0062	0,0062	0,0259	0,0405
PI 169232	0,0259	0,0506	0,0384	0,031	0,0184	0,0318	0,031	0,0789	0,0246	0,0246	0,0318	0,0463
PI 595201	0,0256	0,05	0,0632	0,0184	0,006	0,0566	0,0306	0,0519	0,0243	0,0243	0,0188	0,0457
PI 595203	0,0335	0,0588	0,0728	0,0256	0,0379	0,0657	0,0318	0,0675	0,0191	0,0191	0,0394	0,0547
PI 595218	0,0129	0,0379	0,0512	0,0062	0,0184	0,0445	0,0186	0,0657	0,0123	0,0123	0,0191	0,0331
PI 227206	0,0201	0,0457	0,0463	0,0128	0,0253	0,0526	0,0256	0,0748	0,0191	0,0191	0,0263	0,041
PI 185636	0,0389	0,0506	0,0641	0,031	0,0306	0,0573	0,031	0,0657	0,0123	0,0123	0,0318	0,0463
PI 277996	0,027	0,0322	0,0533	0,0322	0,0063	0,0463	0,0451	0,0666	0,0384	0,0384	0,0331	0,062
PI 278045	0,0259	0,0379	0,0512	0,0186	0,0306	0,0445	0,0186	0,0657	0	0	0,0191	0,0331
PI 175657	0,0394	0,0512	0,0649	0,0314	0,0434	0,058	0,0188	0,08	0,0125	0,0125	0,0256	0,0266
PI 278031	0,0394	0,0512	0,0519	0,0314	0,0434	0,058	0,0314	0,08	0,025	0,025	0,0191	0,0331
PI 494530	0,0457	0,0596	0,0738	0,0389	0,0384	0,0666	0,0389	0,062	0,0193	0,0193	0,0331	0,034
PI 278046	0,0326	0,0318	0,058	0,0375	0,0246	0,0512	0,0375	0,0718	0,031	0,031	0,0256	0,0533
PI 278049	0,0596	0,058	0,0718	0,0506	0,05	0,0519	0,0506	0,1006	0,044	0,044	0,0519	0,0675
PI 278030	0,0193	0,044	0,0573	0,0123	0,0121	0,0506	0,0246	0,0588	0,0184	0,0184	0,0253	0,0394
PI 278038	0,0322	0,044	0,0573	0,0246	0,0365	0,0506	0,0246	0,0849	0,0184	0,0184	0,0126	0,0394
PI 278047	0,0322	0,044	0,0573	0,0246	0,0365	0,0506	0,0246	0,0849	0,0184	0,0184	0,0126	0,0394
PI 277997	0,0326	0,0445	0,058	0,025	0,037	0,0512	0,025	0,0728	0,0062	0,0062	0,0256	0,04
PI 164977	0,04	0,0519	0,0263	0,0445	0,044	0,0196	0,0445	0,1081	0,0379	0,0379	0,0457	0,0612

(cont. on next page)

Table A.1. (cont.)

	PI 344066	PI 344300	PI 278061	PI 247010	PI 189316	PI 169240	PI 169245	PI 595200	PI 172793	PI 169278	PI 163572	PI 179240
PI 222711	0,0451	0,0566	0,07	0,037	0,0365	0,0632	0,037	0,0718	0,0184	0,0184	0,0126	0,0526
PI 172801	0,0389	0,0506	0,0641	0,031	0,0429	0,0573	0,031	0,0789	0,0246	0,0246	0,0062	0,0326
PI 172786	0,0958	0,0833	0,1126	0,0884	0,0872	0,0909	0,0884	0,1079	0,0675	0,0675	0,0684	0,0563
PI 172789	0,0533	0,0588	0,0728	0,0512	0,0632	0,0526	0,0512	0,0884	0,0318	0,0318	0,0457	0,0476
PI 172788	0,0394	0,0384	0,0649	0,0314	0,0434	0,058	0,0314	0,0728	0,025	0,025	0,0256	0,04
PI 167124	0,0193	0,0314	0,0445	0,0123	0,0243	0,0379	0,0123	0,0718	0,0061	0,0061	0,0126	0,0263
PI 167126	0,0259	0,0379	0,0384	0,0186	0,0306	0,0445	0,0186	0,0789	0,0123	0,0123	0,0191	0,0331
PI 169259	0,0389	0,0506	0,0641	0,031	0,0306	0,0573	0,031	0,0789	0,0246	0,0246	0,0191	0,0463
PI 177326	0,0394	0,0384	0,0649	0,0314	0,0434	0,058	0,0314	0,0728	0,0125	0,0125	0,0322	0,0469
PI 277986	0,0526	0,0641	0,0779	0,044	0,0434	0,0709	0,044	0,08	0,025	0,025	0,0322	0,0604
PI 278021	0,0326	0,0573	0,0709	0,025	0,0246	0,0641	0,0375	0,0728	0,031	0,031	0,0256	0,0533
PI 278022	0,0389	0,0506	0,0512	0,031	0,0306	0,0573	0,031	0,0789	0,0246	0,0246	0,0191	0,0463
PI 600792	0,0394	0,0641	0,0389	0,044	0,031	0,0322	0,044	0,0933	0,0375	0,0375	0,0322	0,0604
PI 600790	0,0394	0,0641	0,0649	0,0314	0,031	0,0709	0,044	0,08	0,0375	0,0375	0,0322	0,0604
PI 612145	0,0259	0,0506	0,0641	0,0186	0,0184	0,0573	0,031	0,0526	0,0123	0,0123	0,0191	0,0463
PI 608047	0,0193	0,044	0,0573	0,0123	0,0121	0,0506	0,0246	0,0588	0,0184	0,0184	0,0126	0,0394
PI 629105	0,0259	0,0506	0,0641	0,0186	0,0184	0,0573	0,031	0,0657	0,0246	0,0246	0,0191	0,0463
PI 278025	0,0526	0,0641	0,0779	0,044	0,0434	0,0709	0,044	0,08	0,0375	0,0375	0,0256	0,0533
PI 479704	0,0533	0,0718	0,0728	0,0512	0,0506	0,0789	0,0512	0,102	0,0573	0,0573	0,0526	0,0547
PI 165002	0,0738	0,0789	0,0666	0,0709	0,07	0,086	0,0709	0,1095	0,0512	0,0512	0,0596	0,0758
PI 165024	0,0389	0,0506	0,0512	0,031	0,0306	0,0573	0,031	0,0789	0,0246	0,0246	0,0191	0,0463
PI 174103	0,0344	0,0604	0,0612	0,0263	0,0259	0,0675	0,0394	0,0769	0,0326	0,0326	0,027	0,0563
PI 174106	0,1627	0,1729	0,1363	0,1617	0,1594	0,1363	0,1764	0,2187	0,1678	0,1678	0,1818	0,2063
PI 299379	0,3223	0,312	0,3333	0,3125	0,2923	0,3387	0,3281	0,3833	0,3178	0,3178	0,312	0,3613

(cont. on next page)

Table A.1. (cont.)

	PI 169253	PI 278045	PI 169290	PI 164570	PI 164539	PI 177325	PI 278024	PI 229806	PI 279461	PI 172787	PI 171579	PI 227202
PI 278045	0,0389											
PI 169290	0,0326	0,044										
PI 164570	0,0533	0,058	0,0649									
PI 164539	0,0326	0,0314	0,0126	0,0519								
PI 177325	0,0322	0,031	0,0125	0,0641	0,0125							
PI 278024	0,0326	0,044	0,0379	0,0259	0,0379	0,0375						
PI 229806	0,0463	0,0445	0,0512	0,0657	0,0384	0,0506	0,0512					
PI 279461	0,0259	0,0375	0,0314	0,058	0,0314	0,031	0,0314	0,0318				
PI 172787	0,0196	0,0188	0,0253	0,0519	0,0253	0,0125	0,0253	0,0384	0,0188			
PI 171579	0,0069	0,054	0,0476	0,0769	0,0476	0,0469	0,0476	0,062	0,0405	0,0335		
PI 227202	0,0331	0,0728	0,0666	0,0748	0,0666	0,0657	0,0533	0,0675	0,0331	0,0463	0,0428	
PI 175653	0,0322	0,0375	0,044	0,058	0,044	0,031	0,0314	0,0573	0,025	0,0188	0,0405	0,0526
PI 171585	0,0191	0,0306	0,0246	0,0506	0,0246	0,0243	0,0246	0,0375	0,0184	0,0123	0,0331	0,0389
PI 278023	0,0128	0,05	0,044	0,0709	0,044	0,0434	0,044	0,0573	0,0375	0,0314	0,027	0,0326
PI 270550	0,0196	0,044	0,0253	0,0649	0,0253	0,025	0,0379	0,0512	0,0314	0,0253	0,0204	0,0533
PI 227205	0,0604	0,058	0,0649	0,0666	0,0519	0,0641	0,0519	0,0526	0,058	0,0519	0,0629	0,0821
PI 169287	0,0326	0,0314	0,0379	0,0519	0,0253	0,0375	0,0379	0,0384	0,0188	0,0253	0,034	0,0533
PI 172789	0,0416	0,04	0,0469	0,0482	0,0335	0,0463	0,0335	0,0476	0,0266	0,0335	0,0434	0,0638
PI 270306	0,0526	0,0632	0,0573	0,0718	0,0573	0,0566	0,0445	0,058	0,0253	0,0445	0,0547	0,0335
PI 271779	0,0972	0,12	0,114	0,131	0,114	0,1125	0,114	0,1156	0,0933	0,0993	0,1014	0,1126
PI 169263	0,007	0,0547	0,0482	0,078	0,0482	0,0476	0,0482	0,0629	0,041	0,0335	0,0144	0,0359
PI 169264	0,0259	0,0259	0,0326	0,04	0,0196	0,0322	0,0326	0,0198	0,0129	0,0196	0,0349	0,0463
PI 167219	0,0263	0,0253	0,0318	0,0457	0,0318	0,0188	0,0191	0,0451	0,0253	0,0063	0,041	0,0604
PI 169232	0,0322	0,031	0,0125	0,0641	0,0125	0	0,0375	0,0506	0,031	0,0125	0,0469	0,0657

(cont. on next page)

Table A.1. (cont.)

	PI 169253	PI 278045	PI 169290	PI 164570	PI 164539	PI 177325	PI 278024	PI 229806	PI 279461	PI 172787	PI 171579	PI 227202
PI 595201	0,0318	0,0306	0,037	0,0632	0,037	0,0243	0,037	0,0375	0,0184	0,0123	0,0463	0,0389
PI 595203	0,04	0,0512	0,0451	0,0596	0,0451	0,0445	0,0322	0,0457	0,0128	0,0322	0,0555	0,0476
PI 595218	0,0193	0,031	0,025	0,0512	0,025	0,0246	0,025	0,0253	0,0062	0,0125	0,0335	0,0394
PI 227206	0,0266	0,0384	0,0322	0,0463	0,0322	0,0318	0,0193	0,0326	0,0128	0,0193	0,0416	0,0476
PI 185636	0,0322	0,031	0,0375	0,0512	0,0375	0,0246	0,025	0,0506	0,0186	0,0125	0,0469	0,0526
PI 277996	0,0469	0,0322	0,0389	0,0666	0,0259	0,0256	0,0519	0,0193	0,0322	0,0259	0,0629	0,0547
PI 278045	0,0193	0,031	0,025	0,0384	0,025	0,0246	0,0125	0,0379	0,0186	0,0125	0,0335	0,0526
PI 175657	0,0196	0,044	0,0379	0,0519	0,0379	0,0375	0,0253	0,0512	0,0314	0,0188	0,027	0,0533
PI 278031	0,0326	0,044	0,0379	0,0519	0,0379	0,0375	0,0253	0,0512	0,0314	0,0188	0,0405	0,0533
PI 494530	0,0389	0,0389	0,0457	0,0533	0,0457	0,0322	0,0326	0,0596	0,0389	0,0129	0,0489	0,0596
PI 278046	0,0389	0,05	0,0314	0,0709	0,0314	0,031	0,044	0,0318	0,0375	0,0314	0,054	0,0596
PI 278049	0,0526	0,0379	0,0573	0,0588	0,0445	0,044	0,0573	0,058	0,0379	0,0318	0,0684	0,0738
PI 278030	0,0256	0,0246	0,031	0,0573	0,031	0,0184	0,031	0,0314	0,0123	0,0062	0,04	0,0457
PI 278038	0,0256	0,037	0,031	0,0573	0,031	0,0306	0,031	0,044	0,0246	0,0186	0,04	0,0588
PI 278047	0,0256	0,037	0,031	0,0573	0,031	0,0306	0,031	0,044	0,0246	0,0186	0,0266	0,0588
PI 277997	0,0259	0,0375	0,0314	0,0451	0,0314	0,031	0,0188	0,0445	0,025	0,0188	0,0405	0,0596
PI 164977	0,0463	0,0445	0,0128	0,0657	0,0128	0,0253	0,0512	0,0519	0,0445	0,0384	0,062	0,081
PI 222711	0,0384	0,0493	0,0434	0,0573	0,0434	0,0429	0,031	0,0566	0,037	0,031	0,0533	0,0588
PI 172801	0,0322	0,0434	0,0375	0,0641	0,0375	0,037	0,0375	0,0506	0,031	0,0123	0,04	0,0526
PI 172786	0,0748	0,0748	0,0958	0,0769	0,0821	0,081	0,0821	0,0833	0,0884	0,054	0,0579	0,0972
PI 172789	0,0463	0,0512	0,058	0,0331	0,0451	0,0573	0,0451	0,0588	0,0512	0,0384	0,0694	0,0675
PI 172788	0,0326	0,044	0,0379	0,0649	0,0379	0,0375	0,0379	0,0384	0,0314	0,0188	0,0476	0,0533
PI 167124	0,0128	0,0246	0,0186	0,0445	0,0186	0,0184	0,0186	0,0314	0,0123	0,0062	0,0266	0,0457
PI 167126	0,0193	0,031	0,025	0,0384	0,025	0,0246	0,0125	0,0379	0,0186	0,0125	0,0335	0,0526

(cont. on next page)

Table A.1. (cont.)

	PI 169253	PI 278045	PI 169290	PI 164570	PI 164539	PI 177325	PI 278024	PI 229806	PI 279461	PI 172787	PI 171579	PI 227202
PI 169259	0,0322	0,0434	0,0375	0,0641	0,0375	0,037	0,0375	0,0506	0,031	0,025	0,0469	0,0526
PI 177326	0,0326	0,044	0,0379	0,0519	0,0379	0,0375	0,0253	0,0384	0,0314	0,0253	0,0476	0,0666
PI 277986	0,0457	0,0566	0,0506	0,0649	0,0506	0,05	0,0379	0,0641	0,044	0,0379	0,0612	0,0666
PI 278021	0,0389	0,05	0,044	0,0709	0,044	0,0434	0,044	0,0445	0,025	0,0314	0,054	0,0463
PI 278022	0,0322	0,0434	0,0375	0,0512	0,0375	0,037	0,025	0,0506	0,031	0,025	0,0469	0,0526
PI 600792	0,0457	0,0566	0,0126	0,0779	0,0253	0,025	0,0506	0,0641	0,044	0,0379	0,0476	0,0666
PI 600790	0,0457	0,0566	0,0506	0,0649	0,0506	0,05	0,0379	0,0512	0,0314	0,0379	0,0612	0,0533
PI 612145	0,0322	0,0434	0,0375	0,0512	0,0375	0,037	0,025	0,0379	0,0186	0,025	0,0469	0,0394
PI 608047	0,0256	0,037	0,031	0,0573	0,031	0,0306	0,031	0,0314	0,0123	0,0186	0,04	0,0326
PI 629105	0,0322	0,0434	0,0375	0,0641	0,0375	0,037	0,0375	0,0379	0,0186	0,025	0,0469	0,0394
PI 278025	0,0457	0,0566	0,0506	0,0779	0,0506	0,05	0,0506	0,0641	0,044	0,0314	0,0612	0,0533
PI 479704	0,0463	0,0641	0,0709	0,0596	0,058	0,07	0,0709	0,0588	0,0512	0,058	0,0694	0,054
PI 165002	0,0666	0,0709	0,0779	0,04	0,0649	0,0769	0,0519	0,0789	0,0709	0,0649	0,0909	0,0884
PI 165024	0,0322	0,0434	0,0375	0,0512	0,0375	0,037	0,025	0,0506	0,031	0,025	0,0469	0,0526
PI 174103	0,041	0,0526	0,0463	0,0612	0,0463	0,0457	0,0331	0,0469	0,0196	0,0331	0,0571	0,0416
PI 174106	0,1846	0,1764	0,1407	0,1666	0,1407	0,1532	0,1703	0,1578	0,147	0,1703	0,1935	0,1968
PI 299379	0,3442	0,3281	0,3228	0,3495	0,307	0,3178	0,3385	0,296	0,2968	0,3228	0,3445	0,3445
	PI 175653	**PI 171585**	**PI 278023**	**PI 270550**	**PI 227205**	**PI 169287**	**PI 172789**	**PI 270306**	**PI 271779**	**PI 169263**	**PI 169264**	**PI 167219**
PI 171585	0,0306											
PI 278023	0,0375	0,0184										
PI 270550	0,044	0,0246	0,0314									
PI 227205	0,0709	0,0506	0,0709	0,0519								
PI 169287	0,0314	0,0246	0,044	0,0253	0,0389							
PI 172789	0,0266	0,0326	0,0533	0,0335	0,041	0,0067						

(cont. on next page)

Table A.1. (cont.)

	PI 175653	PI 171585	PI 278023	PI 270550	PI 227205	PI 169287	PI 172789	PI 270306	PI 271779	PI 169263	PI 169264	PI 167219
PI 270306	0,0506	0,031	0,0506	0,0445	0,0588	0,0318	0,0405					
PI 271779	0,1066	0,098	0,1066	0,0872	0,0896	0,0872	0,0921	0,1081				
PI 169263	0,041	0,0335	0,0273	0,0344	0,078	0,0482	0,0588	0,0694	0,1159			
PI 169264	0,0322	0,0191	0,0256	0,0326	0,0469	0,0196	0,0277	0,0394	0,1111	0,0354		
PI 167219	0,0126	0,0186	0,0379	0,0318	0,0588	0,0318	0,027	0,0512	0,1081	0,0416	0,0263	
PI 169232	0,031	0,0243	0,0434	0,025	0,0641	0,0375	0,0463	0,0566	0,1125	0,0476	0,0322	0,0188
PI 595201	0,0306	0,012	0,0306	0,037	0,0632	0,037	0,0457	0,031	0,1111	0,0469	0,0191	0,0186
PI 595203	0,0256	0,0314	0,0512	0,0451	0,0728	0,0322	0,0273	0,0389	0,0958	0,0563	0,0266	0,0259
PI 595218	0,031	0,0121	0,031	0,025	0,0512	0,025	0,0331	0,0314	0,0993	0,034	0,0064	0,0188
PI 227206	0,0384	0,0188	0,0384	0,0322	0,0596	0,0322	0,041	0,0389	0,1095	0,0422	0,0133	0,0259
PI 185636	0,0062	0,0243	0,0434	0,0375	0,0641	0,025	0,0198	0,044	0,0993	0,0476	0,0322	0,0062
PI 277996	0,0451	0,0253	0,0451	0,0389	0,0596	0,0389	0,0482	0,0457	0,1232	0,0638	0,0201	0,0326
PI 278045	0,0186	0,0121	0,031	0,025	0,0512	0,025	0,0198	0,044	0,0993	0,034	0,0193	0,0062
PI 175657	0,0314	0,0246	0,0314	0,0253	0,0649	0,0379	0,0335	0,0573	0,1006	0,0273	0,0326	0,0191
PI 278031	0,044	0,0246	0,044	0,0379	0,0649	0,0379	0,0469	0,0573	0,1066	0,034	0,0326	0,0318
PI 494530	0,0193	0,0318	0,0384	0,0457	0,0738	0,0457	0,0416	0,0657	0,1034	0,0422	0,0389	0,0131
PI 278046	0,05	0,0184	0,0375	0,0314	0,0709	0,044	0,0533	0,0506	0,12	0,0547	0,0389	0,0379
PI 278049	0,0379	0,0434	0,0632	0,0573	0,0718	0,0318	0,0405	0,0512	0,1081	0,0694	0,0394	0,0384
PI 278030	0,0246	0,0181	0,037	0,031	0,0573	0,031	0,0394	0,0375	0,1052	0,0405	0,0128	0,0125
PI 278038	0,037	0,0181	0,037	0,031	0,0573	0,031	0,0326	0,05	0,0921	0,0405	0,0256	0,025
PI 278047	0,037	0,0181	0,037	0,0186	0,0445	0,0186	0,0263	0,0375	0,0789	0,0405	0,0256	0,025
PI 277997	0,025	0,0184	0,0375	0,0314	0,058	0,0314	0,0266	0,0506	0,1066	0,041	0,0259	0,0126
PI 164977	0,0573	0,0375	0,0573	0,0384	0,0657	0,0384	0,0476	0,0709	0,1292	0,0629	0,0331	0,0451
PI 222711	0,037	0,0181	0,037	0,0434	0,07	0,0434	0,0394	0,05	0,1052	0,054	0,0384	0,025

(cont. on next page)

Table A.1. (cont.)

	PI 175653	PI 171585	PI 278023	PI 270550	PI 227205	PI 169287	PI 172789	PI 270306	PI 271779	PI 169263	PI 169264	PI 167219
PI 172801	0,0434	0,0243	0,0434	0,0375	0,0641	0,0375	0,0463	0,0566	0,0921	0,0335	0,0322	0,0314
PI 172786	0,0675	0,08	0,0872	0,0821	0,0985	0,0684	0,0656	0,1034	0,1594	0,0656	0,0748	0,062
PI 172789	0,0512	0,044	0,0641	0,058	0,0728	0,0451	0,041	0,0779	0,1292	0,0629	0,0331	0,0389
PI 172788	0,044	0,0246	0,044	0,0379	0,0649	0,0379	0,0469	0,0573	0,1066	0,0273	0,0326	0,0318
PI 167124	0,0246	0,006	0,0246	0,0186	0,0445	0,0186	0,0263	0,0375	0,0921	0,027	0,0128	0,0125
PI 167126	0,031	0,0121	0,031	0,025	0,0512	0,025	0,0331	0,044	0,0993	0,034	0,0193	0,0188
PI 169259	0,0434	0,0121	0,031	0,0375	0,0641	0,0375	0,0463	0,044	0,1125	0,034	0,0322	0,0314
PI 177326	0,0314	0,0246	0,044	0,0379	0,0649	0,0379	0,0335	0,0573	0,114	0,0482	0,0326	0,0191
PI 277986	0,044	0,0246	0,044	0,0506	0,0779	0,0506	0,0469	0,0573	0,1275	0,0482	0,0457	0,0318
PI 278021	0,05	0,0184	0,0375	0,044	0,0709	0,044	0,0533	0,0379	0,1066	0,0547	0,0259	0,0379
PI 278022	0,0434	0,0121	0,031	0,0375	0,0641	0,0375	0,0463	0,044	0,1125	0,034	0,0322	0,0314
PI 600792	0,0566	0,0246	0,044	0,0253	0,0649	0,0379	0,0469	0,0445	0,114	0,062	0,0457	0,0445
PI 600790	0,0566	0,0246	0,044	0,0506	0,0779	0,0506	0,0604	0,0445	0,1275	0,0482	0,0326	0,0445
PI 612145	0,031	0,0121	0,031	0,0375	0,0641	0,0375	0,0331	0,0314	0,1125	0,0476	0,0193	0,0188
PI 608047	0,037	0,006	0,0246	0,031	0,0573	0,031	0,0394	0,025	0,1052	0,0405	0,0128	0,025
PI 629105	0,0434	0,0121	0,031	0,0375	0,0641	0,0375	0,0463	0,0314	0,1125	0,0476	0,0193	0,0314
PI 278025	0,0566	0,0246	0,044	0,0506	0,0779	0,0506	0,0604	0,0573	0,12	0,0547	0,0457	0,0445
PI 479704	0,0769	0,044	0,0512	0,058	0,086	0,058	0,0684	0,0649	0,1232	0,0704	0,0331	0,0649
PI 165002	0,0709	0,0506	0,0709	0,0779	0,0933	0,0649	0,062	0,0849	0,1448	0,0921	0,0533	0,0588
PI 165024	0,0434	0,0121	0,031	0,0375	0,0641	0,0375	0,0463	0,044	0,1125	0,0476	0,0322	0,0314
PI 174103	0,0457	0,0193	0,0394	0,0463	0,0748	0,0394	0,0489	0,0263	0,1188	0,0579	0,0273	0,04
PI 174106	0,1764	0,1654	0,1911	0,1555	0,145	0,1407	0,1406	0,1492	0,2125	0,2131	0,1538	0,1791
PI 299379	0,3281	0,2977	0,3281	0,3228	0,317	0,307	0,3277	0,3174	0,322	0,3739	0,3114	0,3125

(cont. on next page)

Table A.1. (cont.)

	PI 169232	PI 595201	PI 595203	PI 595218	PI 227206	PI 185636	PI 277996	PI 278045	PI 175657	PI 278031	PI 494530	PI 278046
PI 595201	0,0243											
PI 595203	0,0445	0,0314										
PI 595218	0,0246	0,0121	0,0191									
PI 227206	0,0318	0,0188	0,0263	0,0063								
PI 185636	0,0246	0,0243	0,0191	0,0246	0,0318							
PI 277996	0,0256	0,0126	0,0463	0,0256	0,0331	0,0384						
PI 278045	0,0246	0,0243	0,0191	0,0123	0,0191	0,0123	0,0384					
PI 175657	0,0375	0,037	0,0322	0,025	0,0322	0,025	0,0519	0,0125				
PI 278031	0,0375	0,037	0,0451	0,025	0,0193	0,0375	0,0519	0,025	0,0379			
PI 494530	0,0322	0,0318	0,0266	0,0322	0,04	0,0193	0,0469	0,0193	0,0326	0,0326		
PI 278046	0,031	0,0306	0,0512	0,031	0,0384	0,0434	0,0191	0,031	0,044	0,044	0,0519	
PI 278049	0,044	0,0434	0,0389	0,044	0,0519	0,0314	0,0457	0,044	0,0573	0,0573	0,0394	0,0632
PI 278030	0,0184	0,006	0,0253	0,0061	0,0126	0,0184	0,0191	0,0184	0,031	0,031	0,0256	0,037
PI 278038	0,0306	0,0303	0,0379	0,0184	0,0253	0,0306	0,0445	0,0184	0,031	0,031	0,0384	0,037
PI 278047	0,0306	0,0303	0,0379	0,0184	0,0253	0,0306	0,0445	0,0184	0,031	0,031	0,0384	0,037
PI 277997	0,031	0,0306	0,0256	0,0186	0,0256	0,0186	0,0451	0,0062	0,0188	0,0314	0,0259	0,0375
PI 164977	0,0253	0,05	0,0588	0,0379	0,0457	0,0506	0,0394	0,0379	0,0512	0,0512	0,0596	0,0445
PI 222711	0,0429	0,0303	0,0379	0,0306	0,0314	0,0306	0,0445	0,0184	0,031	0,0434	0,0384	0,037
PI 172801	0,037	0,0365	0,0445	0,0246	0,0318	0,037	0,0512	0,0246	0,025	0,025	0,0322	0,0434
PI 172786	0,081	0,08	0,0909	0,081	0,0909	0,0675	0,0769	0,0675	0,0684	0,0684	0,0612	0,0884
PI 172789	0,0573	0,0566	0,0526	0,0445	0,0526	0,0445	0,0596	0,0318	0,0451	0,0451	0,0331	0,0641
PI 172788	0,0375	0,037	0,0451	0,025	0,0322	0,0375	0,0451	0,025	0,0379	0,0253	0,0326	0,0314
PI 167124	0,0184	0,0181	0,0253	0,0061	0,0126	0,0184	0,0318	0,0061	0,0186	0,0186	0,0256	0,0246
PI 167126	0,0246	0,0243	0,0318	0,0123	0,0063	0,0246	0,0384	0,0123	0,025	0,0125	0,0322	0,031

(cont. on next page)

Table A.1. (cont.)

	PI 169232	PI 595201	PI 595203	PI 595218	PI 227206	PI 185636	PI 277996	PI 278045	PI 175657	PI 278031	PI 494530	PI 278046
PI 169259	0,037	0,0243	0,0445	0,0246	0,0253	0,037	0,0384	0,0246	0,0375	0,0375	0,0451	0,031
PI 177326	0,0375	0,037	0,0322	0,025	0,0322	0,025	0,0451	0,0125	0,0253	0,0379	0,0326	0,0314
PI 277986	0,05	0,037	0,0451	0,0375	0,0384	0,0375	0,0519	0,025	0,0379	0,0506	0,0457	0,044
PI 278021	0,0434	0,0184	0,0256	0,0186	0,0256	0,0434	0,0322	0,031	0,044	0,044	0,0389	0,0375
PI 278022	0,037	0,0243	0,0445	0,0246	0,0191	0,037	0,0384	0,0246	0,0375	0,025	0,0451	0,031
PI 600792	0,025	0,037	0,058	0,0375	0,0451	0,05	0,0389	0,0375	0,0506	0,0506	0,0588	0,0314
PI 600790	0,05	0,0246	0,0451	0,025	0,0193	0,05	0,0389	0,0375	0,0506	0,0379	0,0588	0,044
PI 612145	0,037	0,0121	0,0191	0,0123	0,0191	0,0246	0,0256	0,0123	0,025	0,0375	0,0322	0,031
PI 608047	0,0306	0,006	0,0253	0,0061	0,0126	0,0306	0,0191	0,0184	0,031	0,031	0,0384	0,0246
PI 629105	0,037	0,0121	0,0318	0,0123	0,0191	0,037	0,0256	0,0246	0,0375	0,0375	0,0451	0,031
PI 278025	0,05	0,037	0,058	0,0375	0,0451	0,05	0,0519	0,0375	0,0506	0,0379	0,0457	0,044
PI 479704	0,07	0,044	0,0657	0,0445	0,0526	0,07	0,0463	0,0573	0,058	0,0709	0,0728	0,0641
PI 165002	0,0769	0,0632	0,0728	0,0641	0,0596	0,0641	0,0666	0,0512	0,0649	0,0649	0,0666	0,0709
PI 165024	0,037	0,0243	0,0445	0,0246	0,0191	0,037	0,0384	0,0246	0,0375	0,025	0,0451	0,031
PI 174103	0,0457	0,0193	0,0335	0,0196	0,0067	0,0389	0,034	0,0326	0,0463	0,0331	0,0547	0,0394
PI 174106	0,1532	0,1654	0,1666	0,1532	0,1515	0,1678	0,1515	0,1678	0,1851	0,1703	0,2	0,1617
PI 299379	0,3178	0,2977	0,3225	0,3023	0,3015	0,3178	0,28	0,3178	0,3385	0,3385	0,3606	0,2968
	PI 278049	**PI 278030**	**PI 278038**	**PI 278047**	**PI 277997**	**PI 164977**	**PI 222711**	**PI 172801**	**PI 172786**	**PI 172789**	**PI 172788**	**PI 167124**
PI 278030	0,0375											
PI 278038	0,05	0,0243										
PI 278047	0,05	0,0243	0,0121									
PI 277997	0,0506	0,0246	0,0246	0,0246								
PI 164977	0,058	0,044	0,044	0,044	0,0318							
PI 222711	0,0625	0,0365	0,0243	0,0243	0,0246	0,0566						

(cont. on next page)

Table A.1. (cont.)

	PI 278049	PI 278030	PI 278038	PI 278047	PI 277997	PI 164977	PI 222711	PI 172801	PI 172786	PI 172789	PI 172788	PI 167124
PI 172801	0,0566	0,0306	0,0184	0,0184	0,031	0,0506	0,0306					
PI 172786	0,0758	0,0738	0,0872	0,0738	0,0612	0,0833	0,0872	0,0675				
PI 172789	0,0519	0,0506	0,0506	0,0506	0,0256	0,0457	0,0506	0,0445	0,0416			
PI 172788	0,0573	0,031	0,031	0,031	0,0314	0,0512	0,0434	0,025	0,0684	0,0451		
PI 167124	0,0375	0,0121	0,0121	0,0121	0,0123	0,0314	0,0243	0,0184	0,0738	0,0379	0,0186	
PI 167126	0,044	0,0184	0,0184	0,0184	0,0186	0,0379	0,0306	0,0246	0,081	0,0445	0,025	0,0061
PI 169259	0,0566	0,0306	0,0306	0,0306	0,031	0,0506	0,0184	0,037	0,0945	0,0573	0,025	0,0184
PI 177326	0,0573	0,031	0,031	0,031	0,0062	0,0384	0,031	0,0375	0,0547	0,0322	0,0253	0,0186
PI 277986	0,07	0,0434	0,0434	0,0434	0,0314	0,0641	0,0186	0,05	0,0958	0,058	0,0379	0,031
PI 278021	0,0506	0,0246	0,037	0,037	0,0375	0,0573	0,037	0,0434	0,102	0,0641	0,044	0,0246
PI 278022	0,0566	0,0306	0,0306	0,0306	0,031	0,0506	0,0306	0,037	0,0945	0,0573	0,025	0,0184
PI 600792	0,07	0,0434	0,0434	0,031	0,044	0,0256	0,0434	0,05	0,0958	0,0709	0,0506	0,031
PI 600790	0,07	0,031	0,0434	0,0434	0,0314	0,0512	0,0434	0,05	0,0958	0,058	0,0379	0,031
PI 612145	0,0566	0,0184	0,0306	0,0306	0,0186	0,0506	0,0184	0,037	0,081	0,0445	0,0375	0,0184
PI 608047	0,05	0,0121	0,0243	0,0243	0,0246	0,044	0,0243	0,0306	0,0872	0,0506	0,031	0,0121
PI 629105	0,0566	0,0184	0,0306	0,0306	0,0186	0,0379	0,0306	0,037	0,081	0,0445	0,0375	0,0184
PI 278025	0,07	0,0434	0,0434	0,0434	0,044	0,0641	0,0434	0,0375	0,0958	0,058	0,0379	0,031
PI 479704	0,0779	0,0506	0,0632	0,0632	0,0641	0,0718	0,0632	0,07	0,1111	0,0657	0,0709	0,0506
PI 165002	0,0849	0,07	0,07	0,07	0,0451	0,0657	0,0573	0,0769	0,0909	0,0463	0,0779	0,0573
PI 165024	0,0566	0,0306	0,0306	0,0306	0,0186	0,0379	0,0306	0,037	0,081	0,0445	0,0375	0,0184
PI 174103	0,0526	0,0259	0,0389	0,0389	0,0394	0,0604	0,0259	0,0457	0,1079	0,0675	0,0463	0,0259
PI 174106	0,1492	0,1594	0,1739	0,1594	0,1764	0,1428	0,1884	0,1824	0,2032	0,1818	0,1703	0,1594
PI 299379	0,3333	0,3076	0,323	0,323	0,3281	0,328	0,3076	0,3333	0,426	0,3548	0,3385	0,3076

(cont. on next page)

Table A.1. (cont.)

	PI 167126	PI 169259	PI 177326	PI 277986	PI 278021	PI 278022	PI 600792	PI 600790	PI 612145	PI 608047	PI 629105	PI 278025
PI 169259	0,0246											
PI 177326	0,025	0,0375										
PI 277986	0,0375	0,0125	0,0379									
PI 278021	0,031	0,031	0,044	0,044								
PI 278022	0,0123	0,0123	0,0375	0,025	0,031							
PI 600792	0,0375	0,0375	0,0506	0,0506	0,044	0,0375						
PI 600790	0,025	0,025	0,0379	0,0379	0,0314	0,0125	0,0506					
PI 612145	0,0246	0,0246	0,025	0,025	0,0186	0,0246	0,0375	0,025				
PI 608047	0,0184	0,0184	0,031	0,031	0,0123	0,0184	0,031	0,0186	0,0061			
PI 629105	0,0246	0,0246	0,025	0,0375	0,0186	0,0246	0,0375	0,0125	0,0123	0,0061		
PI 278025	0,0375	0,0375	0,0506	0,0506	0,044	0,0375	0,0506	0,0506	0,0375	0,031	0,0375	
PI 479704	0,0573	0,0573	0,0709	0,0709	0,0512	0,0573	0,0709	0,058	0,0445	0,0379	0,0445	0,0709
PI 165002	0,0512	0,0641	0,0519	0,0649	0,0709	0,0512	0,0779	0,0519	0,0512	0,0573	0,0512	0,0779
PI 165024	0,0123	0,0246	0,025	0,0375	0,031	0,0123	0,0375	0,0125	0,0246	0,0184	0,0123	0,0375
PI 174103	0,0196	0,0196	0,0463	0,0331	0,0263	0,0196	0,0463	0,0198	0,0196	0,0129	0,0196	0,0463
PI 174106	0,1532	0,1824	0,1703	0,2	0,1764	0,1678	0,1407	0,1703	0,1678	0,1594	0,1678	0,2
PI 299379	0,3178	0,3023	0,3385	0,3228	0,2968	0,3178	0,3228	0,3228	0,3023	0,2923	0,3023	0,3228

	PI 479704	PI 165002	PI 165024	PI 174103	PI 174106
PI 165002	0,0331				
PI 165024	0,0573	0,0384			
PI 174103	0,054	0,0612	0,0196		
PI 174106	0,1729	0,1818	0,1678	0,1538	
PI 299379	0,3225	0,3495	0,3178	0,2845	0,4666