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Domestic Livestock Resources of Turkey – Silkworm (Bombyx mori)

Yilmaz O.
Ardahan University, Vocational High School of Technical Sciences, 75000, Ardahan, Turkey

Review Article

***Corresponding author**
Orhan Yilmaz

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Abstract: The purpose of this article is to review silkworm *(Bombyx mori)* as a genetic resources of Turkey. Sericulture which gave the name "The Silk Road" to the old world's trade routes between east and west, has an important role at financial activities for centuries. Journey of the silkworm from cocoon to fibre, fiber to fabric and fabric to clothes has affected the culturel dimension of social life. Sericulture has affected some traditional believes and practices. Some customs and believes have important role on every stage of conventional sericultural applications. Such as incensing at pupa's room, not allowing anyone to enter pupa's room against evil eye. The belongings of girls who will be bride such as dowry and bridal dresses have been made from silk. Dowry that includes handkerchief, clothing and underclothing, prayerrug, Quran case, curtain, sofa coat, scarf, "yazma", bath clothing, and muslin used to be made from silk. A lot of poems and folk songs of folk artists include silk motifs. Some traditional believes and practices of sericulture that exist from ancient ages are examined in this rewiev.

Keywords: Sericulture, native breed, genetic resource, The Silk Road, cocoon, disease

INTRODUCTION

Some animal species and breeds had important place in history of some countries such as Merino sheep in Spain, Angora Goat in Turkey and sericulture in China [1, 2]. Sericulture in the World is generally made in Asian countries. In the World production percentages of China and India are 80% and 15% respectively [3]. The production of fresh cocoon is about 134 in 2012 (Table 1).

Silk has some unique characteristics in kinds of fabric. It is shiny, soft, strong, and has a fabric can be dyed. It is so sensitive, therefore it is effected by noise, smell, wind, temperature change, even carers hygiene [4]. Generally four kinds of silkworm which are Mulberry, Eri, Tasar and Muga are reared in the World. Mulberry silkworm (Bombyx mori) (Table 2) has the majority in them which percentage is about 95% [5]. In Turkish society silkworm seem cute. A survey study was realized in primary school students. According to study between 9 and 40% of students in different levels rear insects. Students rear silkworm, ant, ladybug and grasshopper which showed that silkworm was one the loveable insect in insect groups [6].

Table-1: Production of apiculture and sericulture [7, 8].

Year	Number of Villages Engaged in Sericulture	Number of Families Engaged in Sericulture	Number of Egg Boxes Produced	Production of Fresh Cocoons (tonnes)
1936	2.201	49.338	56.278	2.135
1940	2.422	63.498	73.045	3.014
1950	3.013	69.354	62.927	2.501
1960	2.530	60.370	50.865	2.444
1970	1.559	43.589	64.340	1.461
1980	1.601	43.025	66.042	1.707
1990	1.916	44.541	80.544	2.171
2000	230	2.210	3.147	60
2012	342	2.572	5.576	134

Table-2: Scientific classification of the silkworm [5].

Phyluym	Artropoda
Class	Insecta/Hexapoda
Ordo	Lepidoptera
Subordo	Macro Lepidoptera-Heterocera
Super Family	Bomycoiden
Family	Bomycidae
Genus	Bombyx
Species	B. mori

Origin

Silk is known in Turcoman communities for thousands years. Some archeological ruins in Sapalli Hill, Kampir Hill and Surhanderya near Syr Darya (Seyhun) River showed that sericulture was an important business in this territory. Silk is called as 'ipek' in Turkish, 'yipek' in Mameluke and Kipchak Turkish and 'cipek' in other Asian Turcoman communities [4]. The silk was always a symbol of status political, social, and richness in human history [9]. Before Ottoman Empire, silk was an expensive material in Byzantium Empire lands. Justinien who was an emperor of Byzantium Empire sent two Nestorian monks to China to search about sericulture A.D. 552 [10, 11, 12]. The monks learned how to produce silkworm and silk and brought some silkworm eggs inside of their bamboo walking sticks [11]. There were not too much references and information about sericulture in Byzantium Empire period which showed sericulture is not widespread in empire lands. After Byzantium, Turks ruled in Anatolia and they developed sericulture. Schiltberger reported that there was a developed silk textile industry in beginnig of 15th century. Broauiere mentioned about plenty of fabric made from silk in Bursa bazaars in 1432 [13].

The Silk Road

The Silk Road was first named by a German geographer, von Richtofen and generally used by western people as this name. The first known person who journeyed on the Silk Road was a Macedonian merchant of Maies Titianus [10]. The Silk Road was opened for service of humanity in early preiod of history [14]. The silk was the most important strategic tool in Chinese economy starting from B.C. 200. The silk was kept like gold and used like money in Chinse life. In East Turkestan (Xinjiang in China) there lived Hun Turks (there live Uygur Turks at the present time). Chinese sent some silk fabric to Hun Turks to trade, so then the Silk Road started to be created [10]. Silk, perfumery, jewellery, pelage, spices and slaves were used as trade material. There were lots of wars because of getting to control the silk road in history. Main nations who contended each others for The Silk Road were Chinese, Turk, Indian, Persian, Roman and Arap people [14, 15]. The Silk Road was about 7.500 km as the crow flies and about 10.000 km on the earth surface. When first Selcuks, later than Ottomans came to Anatolia (Asian part of Turkey) they built lots of caravanserais on the Silk Road. Caravanserais were far away about 30-40 km from each others which maked 7-8 hours of camel walking. For example there were 24 caravanserais just only between Sivas and Kayseri which is 200 km the distance between two cities [10]. In the second part of 14th century Ottomans intended to conquer some cities which were on the Silk Road such as Ankara (1353-1362), Osmancik (1392), Amasya (1392), and Erzincan (1401) [16, 17]. The Ottoman King of Murat II and Turkish-Mongol Empire King of Timur the Lame had a war near Ankara in 1402. The reason of the war was The Silk Road of the struggle for [17]. In this century floss silk was brought from Iran to seashore cities of Efes and Milet via the Silk Road of Tebriz-Konya-Denizli. Rudolf von Suchen reported that floss silk was exported from Efes together with cotton and wheat [15, 17].

History

In Middle Age (during Byzantium period) Lyon was the most important floss silk trade centre in Europe.Ottoman Empire and Iran were a most important sericulture producers in the World [11, 13]. In Ottoman Empire lands, sericulture was one of the most important sector in economy together withwheat, raisin, angora hair and opium [18]. On the other hand Bursa was the most important city not only on sericulture, but also on floss silk trade between Iran and Europe [19]. Hence Bursa was a stopover between Iran and Europe [11].Main sericulture centres were Bursa, Erzincan, Tokat, Diyarbakir, Amasya (Figure 1) and Aleppo [20, 21, 22, 23]. Ottoman Archive presented two books dated in 1531 and 1575 which mentioned about some mulberry trees in Demirci county of Manisa Province [24]. Fehim-i Kadim Divan which is a famous ancient book on animals mentioned about silkworm and sericulture [25].

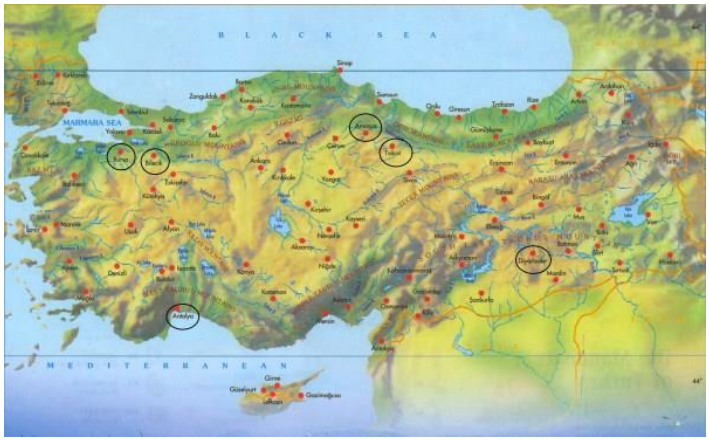

Fig-1. Map of Turkey by showing main sericulture centres.

During Ottoman Empire silk was impotant material because of three process which are producing cocoons, filature, and textile [26]. After Turks conquered Bursa in 1326, they experienced sericulture in this region. First Turks ignored sericulture and focused on floss silk trade, because it provided high income because of taxes. In this period silk fabric was equal to gold as a trade material [11]. In late 16th century there were some wars between Ottomans and Iran which affected a decreasing trade between two countries. In 17th century the floss silk was one of the most important import material for European countries together with Ottoman Empire [9].

Until 1824 filature industry was realized by human power by using some tools, but in 1824 a steam engine invented in Lyon which led high production numbers in filature industry [27]. In 1938 there was a Balta Port Free Trade Agreement between Ottoman-English governments. After this agreement Ottomans gave some trade privilidges to English merchants which caused development of sericulture in Ottoman lands. English consul of Bursa, D. Sandison, the Earl of Aberdeen, reported lots of information about life and sericulture in Bursa [28]. Ottoman King of Abdulmecid provided to be opened a filature factory, Harir Fabrika-i Humayun, in Bursa in 1852. The factory had 80 cocoon spinning wheels [28, 29]. In middle of 19th century sericulture industry went worse becuase of two reasons. First diseases of Pebrine and Flacherie spread out to Ottoman Empire lands from France and Italy [12, 27, 28]. Secondly Suez Canal was opened in 1869 and European merchants started to import floss silk from China and Japan by using the Suez Canal [9]. In 1881 sericulture industry increased again because of establishment of Public Debts (Duyun-i Umumiyye) Institution (PDI). PDI started to collect sometaxes related with sericulture, therefore it supported to sericulture industry (Table 3) [9, 28]. In late 19th century there was not only floss silk export but also silkworm egg export. 3.212 kg silkworm egg produces and 508 kg exported in 1892. Export number increased up to 5.547 kg in 1889 [9]. Before 1st World War, Ottomans had a good level about sericulture but during 1st World War between 1914-1918 and Independence War between 1919-1923, sericulture production decreased again because huge amount of men lost in the wars (Table 4) [30].

Table-3:**Numbers of fresh cocoon and tax between 1888-1919 [9].**

Year	Fresh Cocoon (tonnes)	Tax (Otoman Lira)
1888	4.104	45.593
1890	7.485	90.096
1895	8.860	84.138
1900	10.580	116.379
1905	16.500	206.343
1910	10.812	184.851
1915	2.942	41.254
1919	1.510	181.090

Table-4: **Numbers of floss silk in some countries before 1st World War [9].**

Country	Floss Silk (tonnes)
Japan	10.818
China	7.282
Italy	4.100
Ottoman	1.200
Iran	500
France	500
Caucasian (Region)	400
Austria-Hungary	300
Balkan (Region)	200
India	180
Spain	80

Kevork Torkomyan was sent to Lyon by Ottoman King of Abdulhamid II to learn sericole. An Institute of Sericicole (Harir Darut Talimi) (Figure 2) opened in 14 April 1988 in Bursa by leading Kevork Torkomyan [9, 31, 32, 88]. He also wrote a book of 'Ipekbocegi Beslemek ve Ipekbocegi Tohumu Islah Etmek Usul ve Kavaidi' (Methods and Rules of Silkworm Feeding and Breeding) in 1898 [31]. Also some articles related with sericulture were published in Journal of Asri Ciftci between 1927-1928 [33].

Fig-2: Institute of Sericicole (Harir Darut Talimi) (Photo by M. Ersevinc)

After Republic of Turkey was established by following Ottoman Empire, there was a people exchange between Turkey and Greeceunder the Exchange Agreement dated 1924. Some Turks who lived in eastern Greece and some Greeks who lived in western Turkey were swapped by two governments [32]. After the exchange, there was a deficiency of sericulture business because of experienced Greeks who knew sericulture business. The Turks who came from eastern Greece to Bursa region knew tobacco cultivationinstead of sericulture busines. They cut all mulberry trees and started to cultivate tobacco. Hence sericulture production decreased sharply in this time [30, 32]. Although 122.000 acres of mulberry gardens were in Bursa before the Exchange Agreement, there were only 58.000 acres of mulberry gardens after the Exchange Agreement. 44 silk filature factories worked in Bursa before the Exchange Agreement, but there were only 13silk filature factories after the Exchange Agreement [32]. the Exchange Agreement also changed worker profile. Before the Exchange Agreement, mainly women workers worked (94%) in sericulture busines (Figure 3) but after the Exchange Agreement, generally men workers worked (4%) in sericulture busines in Bursa region [30, 34, 35, 36].During Ottoman period owners and operators of factory were generally non-Turkish Ottoman citizens such as Armenian, Greek or non-muslim Ottoman citizens such as Jewish [16, 30, 36]. Jewish people were not in floss silk or silk fabric production, but they dealt with floss silk and silk fabric trade [16].

Fig-3. Women workers in sericulture busines in 1890 (Photo by J. D. S. Papazyan).

After Republic of Turkey was established instead of Ottoman Empire in 2913, sericulture got worse year by year. The crisis of 1929 reduced prices thus sericulture, later than sericulture continiued to worsen in 1930s because of starting to import artificial silk fabrics from far east countries. In 1940s government supported to rear polyhiyrid eggs instead of native monohybrid eggs. In 1970s and 1980s fresh cocoon trade was supported by governments to develop sericulture [12].

Genetic Resources

There are three registered silkworm breed by Turkish Standard Institution called as White of Bursa (Bursa Beyazi) (Figure 4 and 7), Piebald White of Bursa (Bursa Beyazi Alaca) (Figure 5 and 8), and Yellow of Hatay (Hatay Sarisi) (Table 5) (Figure 6 and 9) [37]. In a study genetic variation was searched those three breeds by using method of RAPD based on PCR. According to results 68 of RAPD band were invastigated and the highest ration of polymorphic locus was 55,9 % in Yellow of Hatay.The ratios of White of Bursaand Piebald White of Bursa were 44,1%. Nei's genetic distance for White of Bursa-Piebald White of Bursa, White of Bursa-Yellow of Hatay, and Piebald White of Bursa-Yellow of Hatay were 0,0637, 0,1012, and 0,0793 respectively [38].

Table-5: Some traits of three silkworm breeds of Turkey [37].

Trait	White of Bursa (Bursa Beyazi)	Piebald White of Bursa (Bursa Beyazi Alaca)	Yellow of Hatay (Hatay Sarisi)
Voltinism	Univoltin	Univoltin	Univoltin
Moultinism	4	4	4
Egg shape	Elliptic	Elliptic	Elliptic
Egg colour	Gray	Gray	Gray
Egg yield	390-590	439-656	303-545
Cocoon shape	Elliptic	Elliptic	Groundnut
Cocoon colour	White	White	Orange
Single cocoon weight (gr)	1,25-2,16	1,6-2,1	1,4-2,1
Ratio of Cocoon/Shell	11,9-15,8	13,3-15,7	10,9-13,5

Fig-4: Larvas of White of Bursa (Bursa Beyazi) (Photo by S. Isik)

Fig-5: Larvas of Piebald White of Bursa (Bursa Beyazi Alaca) (Photo by S. Isik)

Fig-6: Larvas of Yellow of Hatay (Hatay Sarisi) (Photo by S. Isik)

Fig-7. Cocoons of White of Bursa (Bursa Beyazi) (Photo by S. Isik)

Fig-8. Cocoons of Piebald White of Bursa (Bursa Beyazi Alaca) (Photo by S. Isik)

Fig-9: Cocoons of Yellow of Hatay (Hatay Sarisi) (Photo by S. Isik)

Production

Silkworm production is made in April in west and south of Turkey. In the other regions it is reared in May. If mulberry garden is near to rearing place, it reduces workmanship. Another important point is that mulberry garden must be far away from agricultural spraying areas, because silkworms are badly affected by pesticids [5, 27, 39]. Silkworm rearing is performed in three ways including 'tepsi' (tray) feeding, 'kerevet' (bunk) feeding and 'yer' (ground) feeding systems. The bunk feeding (Figure 10) is the best for producers [5, 39]. A box of eggs called as 'kutu' is about between 10 and 18 gr which contains about 18.000-20.000 eggs in [40].

Fig-10: Kerevet system production (Photo by I. Yasayanlar)

When silkworms hatch from eggswhich is called as 'inficar', they are in 3-4 mm length. In this age mulberry leaves must be given by cutting in small pieces, otherwise tiny larvas can not eat the leaves. Hence mulberry leaves are cut by using special knives called as 'tagra'. In second age larvas are taken to special trays called as 'kerevet'. Under kerevet there is put special cloth called as 'kune' to collect skin and feces of larvas. Kune must be changed between ages. In this age mulberry leaves can be given uncut. In third age mulberry leaves can be given on mulberry branches. In fifth age they have maximum length and they are called as 'halat' or 'aladi' in this age. The most mulberry consuming is in this age.The silkworm producers is described this situation as like 'In this age silkworms eat like waterbuffalos' [27, 41]. After 5th age, silkworms look for a place to make cocoon which is called as 'aski arama'. They are put branchy places, which is called in Turkish as 'aski' (Figure 11) to begin making cocoon. Farmers use different kinds of aski including plastic or vegetable. Vegetable aski can be wooden scaffolding or branches of different trees or plants [5, 39] (Akbay 1981, Anon 2014[a]).Plants of mustard or broom and leafy branches of common oak, or pirnal (holm oak) are used as aski [27] (Yasayanlar 2013). Cocoon making process can last about 8-9 days [5, 39]. After cocoons are got they are put in 'kufe'(basket) or 'harhar' (large gunny sack). Cocoons are sold in Koza Han (Cocoon Market) in June [22, 27, 42].

Fig-11: Cocoons on plastic aski (Photo by I. Yasayanlar)

Mulberry Tree

In Turkish culture trees generallyseem as cult and holy such as beech, pine, aspen, juniper, oak, cypress, cedar,oak, willow, and apple trees. Rather than forest or a group of tree, they like a single tree and seem it as holy. Mulberry tree also seemas cult and holy. Mulberry tree is called as 'spirit of home' by Turks. Mulberry tree seem as peace, future and fertility of the home [43]. In Sapalli Hill excavations a women corpse dated B.C. 2nd century was found. There was a piece of mulberry tree branch on her chest. Askarov the Archeologist believed that this mulberry branch pointed that Turks were involved in sericulture in Middel Asia. It is showed that Turks planted mulberry trees for thousands years. Turks also like planting mulberry trees in graveyards. When a corpse is burrried, a mulberry tree seedlings is planted near to top of corpse's head. They are hoped that when mulberry tree seedlings grow up, the corpse rest in peace under shadow of the mulberry tree [4, 43]. 'Saz' or 'Baglama' is one of the authentic Turkish music play. It is believed in Turks that the best saz is made from mulberry trees. Also Turks who live in Middle Asia use 'kopuz' made from mulberry tree. Kopuz also looks like saz instrument [43]. Mulberry tree is the only and essential food of silkworm [43]. Sometimes silkworm producers give lettuce to silkworms in case of scarcity of providing mulberry leaves, but lettuce reduces the quality of cocoons thus silk [27]. In Turkey there are about 2.210.000 mulberry trees and 55.000 tonnes of mulberry are yielded from those trees These data were 4.150.000 mulberry trees and 95.000 tonnes of mulberry in 1980 [44]. Is is showed that mulberry trees reduce parallel with sericulture in Turkey. At the present time a native mulbery breed of 'Sari Asi' is cultivated in Bursa region. Sari asi mulberry tree has very tiny leaves which is fondly eaten by silkworms. It has not too muc branch but has plenty of leaves. Sari asi mulberry tree leaves makes high quality of silk [45].

Sericulture in Bursa

Importance of Bursa in sericulture happened in 14th century during Ottoman Empire [17, 19, 41, 46, 47] but before there was a weaving industry before Bursa conquered in 1326 by Ottomans [12]. The second important bazaar of floss silk trade was in Aleppo apart from Bursa. Persian merchants brought floss silk to Bursa and bought woollen from Europe, pearl from Persian Gulf, sugar from Egypt and Cyprus, and even spices from India. Even in 16th century Persian merchants used to sell floss silk in Bursa and bought tin, woollen and spices. Florence silk market used to decide prices depending on Bursa silk market [15, 17, 19]. Schiltberger, Clavijo, Pero Tafur, and B. De le

Broqiere reported that Bursa was one the most important floss silk bazaar in the World. After floss silk was imported to Bursa, it was drawn in filature factories and woven textile factories, after than it was exported to Europe. In history of Bursa lots of travellers, writer, scientist and tourist visited the city and mentione about sericulture in Bursa (Table 6). For example Heat Lowry mentioned in his book of 'Seyyahlarin Gozuyle Bursa' (Bursa from Travellers Eyes) about 60 travellers who visited Bursa [46].

Table-6: Travellers, writer, scientist and tourist visitors to Bursa and arrival dates [48].

Name	Year of arrival	Name	Year of arrival
Ibni Batuta	1333	George Keppel	1830
Johann Hans Schiltberger	1397	Charles Texier	1833
Bertrandon de La Broquiere	1432	Richard Burgess	1834
Pero Tafur	1437	Duc de Raguse	1834
Benedetto Dei	1470	Charles Greenstreet Addison	1835
Bonsignore Bonsignore	1498	Aucher-Eloy	1835
Bernardo Michelozzi	1498	William J. Hamilton	1935
Arnold von Harf	1496	Julia Pardoe	1836
Maringhi of Medici	Early 16th century	Robert Walsh	1836
Pierre Belon	1546	Edmund Spencer	1836
Hans Dernschwam	1555	M. Baptistin Poujoulat	1837
Stephan Gerlach	1576	Eliza C. A. Schneider	1830-1840
John Newberie	1581	Serafeddin Magmumi	1894
George Chritoph Fedrenberger	1588	Hayrullah İbni Abdulhak	1844, 1851, 1863
Reinhold Lubenau	1588	G. W. Frederick Howard	1853
Vincent Stochove	1630	Lean Henry Abdolone Ubicini	1855
Evliya Celebi	1640	Kevork Keresteciyan	1855
Jean-Baptiste Tavernier	Several times in his life	Sandison	1855
Thevenot	1666	Charles James Monk	1855
Spon	1675	Cyrus Hamlin	1855
Covel	1675	Georges Perrot	1856, 1857
Wheler	1675	Journal de Constantinople	issue of Nov. 1863
Smith	1683	Sir Hubert E. H. Jerningham	1870
Edmund Chishull	at the end of 17th century	Maling	betw. 1869-1872
Aubry de La Motraye	1701	Georgina Adelaide Muller	1873
Joseph Pitton de Tournefort	1701	Henry C. Barkley	1878
Paul Lucas	1702 and 1705	Nikola Nachov	1879
Richard Pococke	1738	Edmond Dutemple	1880
Carsten Niebuhr	1767	Marie de Launay	1880
Dominique Sestini	1779	Omer Suphi	1889
Andre-Joseph Lafitte-Clave	1786	Ibnulcemal Abdul Tevfik	1890s
Le Chevalier	1786	Clement Imbalt Huart	1891
William Hunter	1792	Mehmet Ziya	1892-1893
Guillaume Antoine Olivier	1790	Fatma Fahrunnisa	1895
Von Ignatz von Brenner	1793	Paul Lindau	1897
James Dallaway	1794	Vasil Kinchev	1899
Antonie Galland	at the beginnig of 18th century	Osmanzade Huseyin Vassaf	1901
William George Browne	1802	Regis Delbauf	1905
Joseph von Hammer-Purgstall	1804	Richard Davey	1906
Lady Hester Stanhope	1811	Hasan Taib	1907
Christophe Aubin	1812	Paul Fesch	1907
John MacDonald Kinneir	1813 and 1814	P. N. Daskalov	1909
John Fuller	1818	Kethy Brown	1911
Charles MacFarlene	1820s	Andre Gide	1914
Victor Fontainer	1821	Ewald Banse	1918
William Martin Leake	1824	Grace M. Ellison	1924
Joseph-Marie Jouannin	1825	Clare Consuelo Sheridan	1924-1925
Marie-Theodore de Bussierre	1827		

There were some special profession on this sector. 'Hamcilar' used to draw silk fibres from cocoon by using tool of 'mancinik' and after thansilk fibres are made silk thread by using tool of 'dolap' [49]. Silk thread was dyed by 'boyacilar' and later than dyed silk tread was woven by 'dokumacilar' [46, 50]. By depending on their work experience, dokumacilar were into three groups called as 'cirak', 'kalfa', and 'usta'. Cirak which meant apprentice was a beginner. If a cirak works 1001 days in this work, they are promoted as kalfawhich meant headworker. After a kalfa worked several years, he was tested by a commission and became an usta which meant 'master' [12]. Women generally used to work in filature factories rather that weaving factories. Girlscommonly used to work until they mary to gain dowry money. After girls mary, they leave the job [16, 22].

The various kinds of woven fabric were named in different names such as 'arsin, dip, seraser, dosemelik, carsaflik, cekme, sestari, hakir, keyfiye, ipekli abani, ipek hayten, sacak, serit, oya, puskul, kemha, atlas, kutnu, futa, kadife (velvet), tafta, cifte tafta, yigit tafta, and vale [50, 51]. Bursa Olgunlasma Enstitusu (Maturation Institute of Bursa)is established in Bursa in 2007 to educate girls on native cultural items. In the school girls are educated on lots of kinds of woven silk fabric mentioned above [52, 53] Florentiner Maringhi reported that quality of silk fabric definitely much more better than silk fabric made in China [51]. In order to obtain different kinds of colours, silk fabric was dyed. There were used plenty of plants to dye fabric. Yellow colour was obtained from 'Altin agac, Katirtirnagi (Spartium - *Spartium junceum*), sumak (sumac), gence, and safran (saffron)'. Brown colour was obtained from 'mazi' (thuja), 'mese' (oak), 'ceviz ve yapragi' (walnut and walnut leaves).Red was obtained from 'pine bark' and 'kokboya' (madder), green colour from 'yabani nane' (wild mint), blue colour from 'Hint bitkisi', gray colour from sutlegen (spurge, *Euphorbia*)', black colour from combination of 'karpuz otu' and 'kara dal otu' [50].

After steam engine invented in Lyon in 1824, a French family, Glaizal Family, built a filature factory in Bursa in 1837 but after for a while this factory went bankrupt [34, 54]. Austrian consul of Falkheisen bought the factory. He reopened the factory in 1945 together with Tasciyan who was a Ottoman Empire citizen and work in British consulate as a translator. After this filature factory, sericulture industry developed in Bursa region [28, 29, 54]. For example in 19th centurythere were 130.000 families who reared silkworm. This number increased to 150.000 families in 1900s. Also about 19.000 employee worked in filature sector and 2.000 employee in textile sector [55]. Steam engine filature factories used to need high amount of firewood. This firewood was brought from Ulu Mountain which was the nearest mountain in Bursa region via Nilufer River. In late 19th century although firewood requirement was about 15.000 tonnes for filature factories, it was just about 5.000 tonnes for whole Bursa people at homes [54].

In Bursa there were lots of spesific bazaars or markets depending on goods sold such asBakircilar Carsisi (for coppersmiths), Oduncular Pazari (for firewood), Yemeniciler Carsisi (for shoes), (Pirinc Han (for rice), Tahil Han (for grains), and Tuz Han (for salt). Ipek Han (for floss silk), and Koza Han (for cocoon) were two of those spesific places [56].

Sericulture in Amasya

Apart from Bursa, Amasya region is one the most important sericulture centres in Turkey [23, 57]. Amasya is also hometown of Strabon (B.C. 64/63 - A.D. 24) who was a famous historian, geographer and philosopher [58]. Climate conditions of Amasya is very eligible for sericulture and looks like Bursa climate. On the other hand Amasya had a strategic position on way of Anatolian roads in Ancient time and still has. Amasya was on way of the Silk Road from Iran to Bursa [15, 57]. There is a village named as Ipek Koy (Silk Village in English) which is 9 km far from Amasya city centre [57]. It can be said that history of sericulture in Amasya is old as history of sericulture in Ottoman Empire [23]. During Ottoman King of Selim I there was a war between Ottomans and Iran. The King Selim I put into action of embargo for silk trade between Ottomans and Iran. During this embargo Amasya was one of the most important sericulture centre for export silk material in Bursa silk market. In different times Amasya sent some sericulture experts to other cities. For example Bor county demanded 8-10 families who were expert on sericulture and Amasya approved this wish. Ispir county demanded some experts for sericulture [57]. In Amasya there was established a Sericulture Station in 1921 [59].

Sericulture in Mugla

The Province of Mugla is located at southeast of Anatolia. It has a mild climate and eligible for mulberry cultivation and sericulture. Textile industry was based on sericulture and it had important for economy of Mugla. There are made famous 'duven' fabric in Yesilyurt town and Mugla city centre. Sericulture in Mugla is a tradational family business. Mugla region used to be a closed economy because of some deficiencies about transport and geographic conditions. Sericulture is generally made by women, so they invest to buy gold jevelry for theirself income of sericulture. After 1950s, economy of Mugla opened to outer bazaars. People started to deal with different kinds of business, so then sericulture business decreased. In 1970s tobacco cultivation started to be supported by governments and people cut mulberry trees and started to cultivate tobacco like Bursa immagrants who came from Greece in 1924 [59].

Utilization

Sericulture is related with agriculture and industrial sectors. Cultivating mulberry trees is agriculture part because silkworm is only fed by mulberry leaves. Rearing silkworm, producing cocoons, and later than filature and textile are industrial part [11]. Apart from fabric production, silk was used as wire for music tool, surgical thread, and fishing rod [4]. Silkworm pupas are get as a by-product of silk drawing process from cocoons. It is searched that whether silkworm pupas can be used as fish food in aquaculture industry [20]. Richter made a intra uterine device (IUD) from intestine of silkworm to preventpregnancy in 1909. According to some results published in 1930 there was only 1.6% pregnancy in 2000 cases. IUDs from intestine of silkworm were largely used in Japan in during 20th century [60]. Silk also is largely used to sew incisions during surgecical operations or after a injury. Silk is occured from natural protein, therefore it is difficult to be rejected by the body [61]. The main utilization area of sericulture product is tu use as fabric in textile industry. The fabric made from silk is largely used in Turkish textile industry. For example there are some local textile products in Aegean Region including Odemis (Izmir), Tire-Beledi (Izmir), Buldan (Denizli), Babadag (Denizli), Kizilcaboluk (Denizli), Yesilyurt (Mugla),and Uzumlu (Mugla) [62]. The shape of a silkworm was inspired for tram engineers by designing mirrors like antennas and doors like eyes of a silkworm. Tram system was built in city of Bursa in 2013 and tramcars were manufactured a shape of silkworm. Also trams were named as 'Ipekbocegi' (Silkworm) (Figure 12 and 13) [40, 63].

Fig-12: Ipekbocegi (Silkworm) Tram of Bursa (Photo by E.Kaplan)

Fig-13: Ipekbocegi (Silkworm) Tram of Bursa (Photo by E.Kaplan)

Folklore

Silk, silk fabric and silkworm can often be seen in Turkish culture, because Turks deal with sericulture for thousands years. In Turkish culture Dede Korkut is a wise and omniscient legendary character and Dede Korkut Sagas are very famous in all Turkoman communities. In Dede Korkut Sagas, important guest/s used to be offered to sit down on a silk carpet, to show hospitality the guest/s. Sometimes important guest/sused to be offered to stay in a silk tent for the same reason [64]. Silkworm is often involved in riddles [65]. Some quatrain riddles can also be seen in Turkish culture. For examplea quatrain riddle from Azerbaijan Turks;Bir gusum var alaca (I have a pied bird) Getdi gondu agaca (It perched on a tree) Ozune yuva tikdi (It built a home itself) Ne gapi goydu, ne baca (But it did

not make any door or chinney) (Answer is silkworm) [66]

A Karachay-Balkar song was mentioned about silk and it says 'Ipek gibi olsun kecem'. According to song it meant 'I wish my felt like silky soft' [67]. In another song, hair of women likend silkfrom Cossack Turks culture [68]. Silkworm was named in various words such as 'boce, bocek, bocu, kurtcuk, and tirtil' [69].

People of Bursa is called silkworms after every sleep as 'aladi'. After 1st sleep, silkworms are in 1st age and they are called as 'birinci aladi', (1staladi) after 2nd sleep and in 2nd age called as 'ikinci aladi' (2ndaladi), in 3rd age called as 'kucuk aladi' (little aladi), in 4th age called as 'buyuk aladi' (big aladi) [12]. After silkworms finish making cocoon, household organize a celebration. It is called as 'Koza yolma dugunu' (Cocoon harvest gala). Women cook various kinds of meals. They also cook a special desert and it is called as 'Koza yolum helvasi' (Cocoon harvest desert) or 'Gaziler helvasi' (Veteran's dessert). Household is very happy because cocoons will be sold soon and men buy some gifts for houselhold. Men used to buy gold jevelry or dowry itemsfor girls [12, 22] and some guns or horse equipments for boys [12]. Girls make lots of dowry items (Figure 14 and 15) by embellishing silk fabric. They make 'mendil' (handkerchief), 'bohca' (bundle for clothes), 'burumcuk goynek' (A kind of traditional tunic), 'basortusu' (scarf), 'yazma oya' (A kind of traditional scarf), 'para kesesi' (purse), 'seccade' (prayer rug), 'carsaf' (linen sheet), 'hamam havlusu' (A kind of large bath towel for body), 'peskir' (A kind of small bath towel for hands and face), 'yatak ortusu takimi' (bedspreads), 'pestemal' (peshtemal), 'burgu' (A kind of tradational large scarf which covers upper part of the body), 'sal' (shawl), 'gecelik' (nightgown) and 'ipek giyecek' (silk clothing) (Figure 16 and 17) [22].

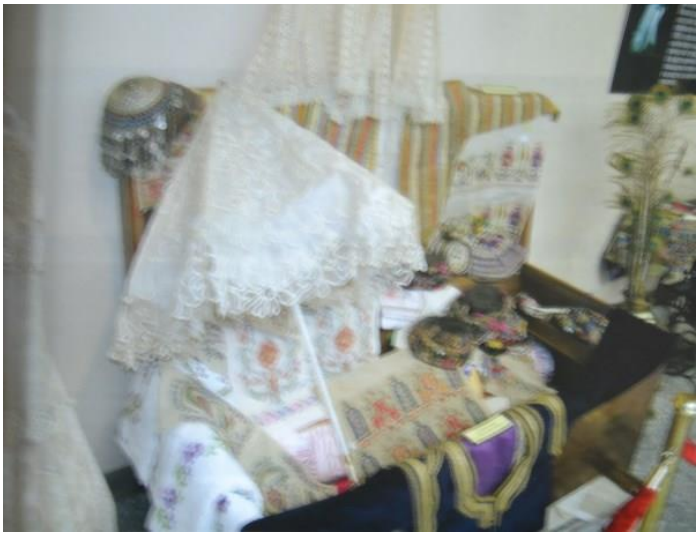

Fig-14: Dowry items for girls (Photo by A. Soysaldi)

Fig-15: A silk shawl made in Bursa (Photo by A. Z. Gerceksoz)

Fig-16: Queen Elizabeth II checking silk fabric items in Koza Han (Cocoon Khan) in Bursa on 15 May 2008 (Photo by A. Z. Gerceksoz)

Fig-17: Tradational Turkish Woman clothes in Uluumay Museum of Bursa (Photo by P. Yilmaz)

Misuses and Misbeliefs

In Turkish culture there are also some misuse and misbelief in sericulture. For example in Bursa sericulture places are fumigated by using cayenne pepper smoke fordisinfection. After silkworm production, household never bring to home beetroot to prevent to prevent from 'Pancar kesti' disease. Doings of sewing and prick with a needle are strickly prohibited. Household never let anybody to visit silkworm production rooms to protect from whammy, because people believe that some people especially person who has blue eyes has whammy effect against to animals or human. While mulberry leaves being brought to silkworm production rooms, people pray on a piece of nettle and put that nettle plant together with mulberry leaves. In Turkish culture 6th May is a holiday because peopel believe that 6th May winter ends and summer starts. This day is called 'Hidirellez Gunu' and celebrate in almost all Turkoman communities. Silkworm eggs put ona a cloth and hang on a branch of rose tree one day beforeHidirellez Gunu and those eggs are taken back by a little girl and carry to hatching room on the day of Hidirellez Gunu. This ceremony is called as 'Hidirellez Kamcisi'. Women go to tomb Karinca Dede Evliyasi (Saint of Grandfather of Ant) and fetch a piece of soil from the tomb. They put the piece of soil into production rooms to prevent silkworms from all kinds of insects. Some women go to some holy persons who knows some effective prays agains to rats and mice. The holy person takes a piece of leafless mulberry branch and shaped into a circle and some prays on it. The women put this leafless mulberry branch into silkworm production rooms to prevent silkworms from rats and mice. Sometimes silkworms were got il by Flacherie Disease. Women get some 'ayran' (buttermilk) and pray 'Yasin Duasi' (A significant pray in Holy Quran)on it, after than they sprinkle the ayran prayed on silkworms to be prevent from Flacherie Disease instead of any treatment. When silkworms stop eating and intend to make cocoon, they look for a special place and swing their heads. It is a sign of starting cocoon construction. It is called as 'kilavuz vermek'. When silkworms are in kilavuz vermek stage, people make noise by playing drums and cans, thus people believe that silkworms make cocoon faster by

scaring from the noise. On the other hand some old women pray for better yield [12].

Morphology

As like other Lepidoptera insects silkworm has four various life cycles (Table 7). It has 2n=56 chromosomes. Polyvoltine breeds can give 300-400 eggs [5]. Silkworm is a monofag creature [70] and it is only fed by eating mulberry leaves [5, 39, 71]. Apoptosis is a programmed cell death and Lockshin proved in 1964 that silkworms have apoptosis in their metamorphosis process [72]. Pheromone is a secreted or excreted chemical factor that triggers a social response in members of the same species [73]. The first invented pheromone was bombykol in silkworms. Female silkworm excretes bombykol to influence males [74].

Table-7: Life cysles of silkworm in polyvoltine breeds [5, 27].

Cycle	Duration	Mulberry leaves requirement (kg/per egg box)	Condition of heat and humidity
1st Age	3 days	1-2	27^0C heat and 85% humidity
1st Sleep	20 hours		
2nd Age	2 days	5-6	
2nd Sleep	20 hours		
3rd Age	3 days	20-25	
3rd Sleep	1 day		
4th Age	5 days	80-90	$22\text{-}24^0$C heat and 75% humidity
4th Sleep	1 day		
5th Age	9-10 days	450-475	$20\text{-}23^0$C heat
Total	26-27 days		

Fibre of silk is composed from two fibres of silk made from fibroin protein. Those two fibres are covered by sericin protein. Percentages of fibroins and sericin in silk fibre are 75% and 25% respectively. After silk fibres are woven, layer of sericin should be removed from fibre. This process should be made after silk fibres are woven but before silk fibres are dyed. After sericin removed from silk fibres, the fabric becomes brighter, softer and elastic. For this operation some acid, neutral or basic protease materials are used. In a study those three different materials were invastigated and results showed that the best cleaning material is based on basic proteases [75].

In a study six days application of Juvenile Hormone Analogue Fenoxycarb (JHAF) was searched on major hemolymph proteins of silkwormduring last larval instar. According to observed results JHAF application extended the last larval instar in first five days. There was no difference in 6th day application for last larval instar [76]. Tufan et al. [77] investigated brains at developmental stages of silkworms histologically. The study showed that there were three different kinds of cells types (NSH-1, NSH-2,NSH-3) in pars intercerebralis but one kind of cell type (NSH-L) in pars lateralis. Malay [78] analyzed different forms of silk fibroin films for iontophoretic medicines by using methods of high temperature, dehydration by freezing, metanol and glutaraldehit. According to results using glutaraldehit extended durability of iontophoretic medicines. [79] carried out a study to define effect of juvenile and ecdysone hormones treatments in growing stages of silkworms. Those two different hormones applied to silkworms by ugiving two different doses. The results showed that juvenile and ecdysone hormones treatments caused different cocoon weight, diameter and length. It could be said that silk and cocoonstructures were affected by juvenile hormones, but weight of pupa was affected by ecdysone hormones. Izzetoglu and Karacali [80] studied out to determine salic acids in hematopoietic organ of silkworm. It was clear that hematopoietic organ of silkworm had of N-acetylneuraminic acid (Neu5Ac) and N-glycolyl neuramic acid (Neu5Gc) types of sialic acids. Falakali and Turgay [81] searched role of rectal sac for going out silkworm mots from cocoons. According to results place, shape and content of the rectal sac affected the puncture of cocoon. Batir *et al.* [82] carried out a project to define expression pattern of ecdysone receptor B1 (EcR-B1) in prothoracic glands of silkworm during last larval instar and early pupal stage. The results proved that ecdysone application reduced immunoreactivity in silkworms.In a study development differences in the first (feeding 20gr) and second groups (feeding 10gr) were studied by designating the development of control group feeding normal nutrition quantity (30gr). According to results the second group opposite of first group appears to extend of larval period and to knit the behavior of late cocoon. It could be sait that the difference of among groups can bind up nutrition-hormone relation [83].

Pathology

Some diseases of silkworm can be groupped under four titles (Table 8). In middle of 19th century diseases of Pebrine and Flacherie emerged first in France and then in Italy. Those diseases destroyed sericulture in Europe [9, 12, 13, 27, 28, 31]. Fresh cocoon production decreased from 26.000 tonnes to 8.000 tonnes between 1853-1856 in France [28]. After

several years those diseases spread to Bursa region [9, 31]. Cocoon production decreased from 4.000 tonnes to 400 tonnes in 10 years which causes silk production decreased from 600 tonnes to 100 tonnes [9]. Louis Pasteur invented the cure in 1867 [9, 31]. The cure way was to examine silkworm butterflies in microscope and define healthy silkworm butterflies and use them their eggs for next generation [19, 26]. A study showed that silkworm pupas can cause disease of *Hypersensitivity pneumonitis* in human lungs [84]. In silkworms *Nosema bombycis* (Naegeli, 1857) causes disease of Pebrine. A survey study carried out to define spread of *N. bombycis* in provinces of Bilecik, Bursa, and Hatay. According to results *N. bombycis* were found in those regions [85].

Table-8: **Some diseases of silkworm [5, 71].**

Protozoon	Bacterial	Virus	Fungal
1. Pebrine	1. Flacherie 2. Septisemi 3. Sotto 4. Court	1. Grasserie 2. Sytoplasma Plihedrozis 3. Spreadable Flacherie 4. Gattine	1. Muscardine (Calcino) 2. White Muscardine 3. Green Muscardine 4. Japanise Green Muscardine 5. Yellow Muscardine 6. Aspergillus 7. Nosema bombycis 8. Botrytis bassiana

Conservation Measures

A project, entitled as "In Vitro Conservation and Preliminary Molecular identification of some Turkish Domestic Animal Genetic Resources (TURKHAYGEN-I)" was prepared byGenetic Engineering and Biotechnical Institute (GEBI), Marmara Research Centre (MRC) Gebze, Kocaeli. Consequent on several iterations the project was approved by Scientific and Technological Research Council of Turkey (STRCT)in 2007 with a budget of 9.1 million Turkish Lira (about US$ 4.2 million). The implementation period was 4.5 years with the project and it was completed at the end of 2011. The breeds of White of Bursa (Bursa Beyazi), Piebald White of Bursa (Bursa Beyazi Alaca), and Yellow of Hatay (Hatay Sarisi) were covered by the project. Those breeds were started to be conserved in Province Directorate of Ministry of Food, Agriculture and Livestock (MFAL) [1, 2, 86]. Also sericulture is supported by the goverment. Silkworm producers get 30 TL/per egg box and 20 TL/per kg of 1st class fresh cocoon [87]. Also Silk Cocoon Sales Cooperatives Union pays extra 4,5 TL/per kg of 1st class fresh cocoon [45].

CONCLUSİONS

In Turkey the silk used to be an important trade material which was struggled for domination of main trade routes for centuries. During Ottoman Empire the city of Bursa was not only a textile centre for silk but it was also main silk trade centre. Raw silk was provided from Bursa to Europe because of being Bursa was a city where the best quality silk was produced there. Besides that raw silk which was imported from Iran helped to increase income both people of Bursa and people who lived near to the Silk Road [9]. The silk textile ındustry was developed in middle of 16th century. Besides city of Bursa, cities of Istanbul, Edirne, Amasya, Denizli, Izmir and Konya were important sericulture centres. Silkworm egg production, silkworm care and feed were protected under the Law of 859 in 1926 after the Republic of Turkey has built in 1923. Some cooperative unions were built in Bursa, Bilecik and Adapazari in 1940 to protect and increase cocoon production. Later than those cooperatives were unified and they built Cocoon Sale Cooperatives Union of Bursa in 11 May 1940. Silkworm Egg Production Management of Cocoon Union which produced silkworm eggs was built in 1963 (Anon, 2013b). Even though sericulture is made in small quantity at present, sericulture is still a traditional, historical and economical statute in Turkey.

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