

Part One: General Overview

Chapter 1

WILLOW SYSTEMATICS IN RUSSIA AND ADJACENT COUNTRIES: A BRIEF HISTORICAL ESSAY

1. EPOCH OF LINNAEUS

C. Linnaeus established 29 species of willows in 1753, and only one of these, *S. babylonica*, was of non-European origin. Later C. Linnaeus described three more species: *S. depressa* (Fl. Suecica, ed. 2, 1755), *S. aegyptiaca* (Centuria plantarum 1, 1755), and *S. retusa* (Species pl., ed. 2, 1763). However, *S. depressa* was treated as a synonym of *S. lanata* by the author himself (1763). Thus, there remained 31 species in all publications during C. Linnaeus' lifetime.

C. Linnaeus was keenly aware of special problems within the systematics of the genus *Salix* and was very careful with it. In his "Species plantarum", an important note follows the description of the genus: "Species huius generis difficillime extricantur. Solum palustre, arenosum, alpestre, calidum mutavit mira metamorphosi species, ut de iisdem hesitarint saepius Botanici... Incipienda itaque harum historia e novo..." (Linnaeus 1753: 1022). He was extremely cautious in recognizing species absent from Scandinavia. There were eight: *S. triandra*, *S. babylonica*, *S. helix*, *S. rosmarinifolia*, *S. aegyptiaca*, *S. retusa*, *S. vitellina*, and *S. purpurea*. However, he had an opportunity to observe the latter two in cultivation in Sweden. In fact, Linnaeus used numerous Russian specimens of willows while writing his "Species plantarum". He also constantly referred to Russian "floras", mainly, "Flora Sibirica" by J. Gmelin. C. Linnaeus established intensive correspondence with J. Gmelin and claimed that he received specimens of each of J. Gmelin's species (compare Stern 1957: 106). Still, he recognized only 7 out of 15 species described by J. Gmelin, just those previously found in Europe. That is to say, C. Linnaeus approved none of J. Gmelin's Siberian species. Even the most distinct of them, *S. berberifolia*, was not included in "Species plantarum", although it had been depicted by J. Gmelin. C. Linnaeus cultivated some of the willows in order to study them more thoroughly, for instance, *S. depressa*, which had been brought by him from Lapland.

Of 31 species described by C. Linnaeus, 7 are now treated as synonyms, leaving a total of 24 species. He recognized all but two of the Scandinavian species he had at his disposal. These two were *S. starkeana* and *S. myrsinifolia*. Therefore, one can consider C. Linnaeus' efforts to gain understanding of willows and build "harum historia e nova" as being generally successful.

C. Linnaeus' authority and principles dominated European botany for some time after his death. The last third of the 18th century was a time of intensive development in botanical research and publication of numerous new "floras". Nevertheless, the number of willow species in these "floras" remained rather modest. They were mostly Linnaean species. In Western Europe, J. Scopoli (1772), M. Villars (1776–1789), and G. Hoffmann (1785–1791) made the most important contributions to the willow studies of that period. "Historia Salicum" by G. Hoffmann was the first monograph on the genus *Salix* planned on a grand scale (up to three color plates for each species). However, less than half of that work was completed, and only 15 species were described.

The most important floristic work of the Linnaean period in Russia was "Flora Rossica" by P. Pallas (1788). There were 35 willow species presented, 26 of which were described by C. Linnaeus. (At present, there are at least 65–70 willow species known for the same territory, and 21 of them are Linnaean ones.) In his travels, P. Pallas paid little attention to willows. He himself collected only a small portion of the species he described. The majority of willows, including almost all the Siberian species, were collected for him by V. Zuyev, N. Sokolov, and others. P. Pallas also used collections of J. Gmelin. Confusion and inconsistency mark P. Pallas' descriptions and designations of species. His identification of those specimens, which have survived to the present, appears also insufficient. For instance, there are at least three different species under the name of "*Salix fusca*": *S. saxatilis*, *S. rectijulis*, and *S. sphenophylla*. *S. viminalis* and *S. alba* are both under the name of "*S. serotina*". There are also two different *S. arbuscula* with two different descriptions in "Flora Rossica" (p. p. 80 and 83). Due to the carelessness of P. Pallas, almost all of his new species remained obscure and dubious for a long time. "Omnes fere Salices Pallasii sunt dubiae", as C. Willdenow mentioned (1806: 683). Therefore, one would not say that P. Pallas opened a new page in the study of the Russian willows, although he was much more successful with other genera, such as *Astragalus*.

2. LATE 18th—FIRST THIRD OF 19th CENTURY IN WESTERN EUROPE: NUMEROUS DESCRIPTIONS OF NEW SPECIES.

One can notice a drift away from Linnaean concepts and weakening of C. Linnaeus' authority over the European botany starting from the end of the 18th century. This tendency could be clearly traced as early as G. Hoffmann's works. By the beginning of the 19th century, C. Willdenow became the most authoritative figure for the majority of European botanists, as if he himself had written "Species plantarum". One more characteristic feature of that period was determination of botanists to describe the diversity of willows to the greatest possible extent. This effort resulted in numerous descriptions of new species, as at that time any morphological differences were considered to be taxonomical ones.

J. Scopoli used to disagree with the ideas of C. Linnaeus. In the first edition of his "Flora Carniolica" (1760), he accepted neither the system nor nomenclature created by C. Linnaeus. In the foreword to the second edition of the "Flora" (1772), J. Scopoli wrote: "I retained the species' names by Linnaeus, although the majority of them are arbitrary, many are obscure, and only some are didactic." Nevertheless, J. Scopoli's work couldn't avoid C. Linnaeus' influence and obviously reflected the epoch. Thus, J. Scopoli claimed his approach to species in the sense stated by C. Linnaeus: "Laboravi equidem ut limites invenirem et numerosas varietates ad suas species reducerem" (1772, vol. 2: 252). — "Indeed, I worked to find the limits and reduce numerous varieties to appropriate species." Later, the adage "work to search for limits" and "reduce

12 varieties to species" became unpopular. Descriptions of new species began to multiply at an incredible rate. While in "Flora Anglica" by W. Hudson (ed. 3, 1798) there were only 16 Linnaean species, there were already 45 species in "Flora Britannica" published by J. Smith just six years later (1804). Of these 45 species, 19 were proposed by J. Smith himself. Later, he continued describing new willow species in the illustrated "English Botany", which he edited. In 1806, C. Willdenow could already mention 116 species (including non-European ones), of which 30 were those described by him. By 1828, according to W. Koch (1828), there were 182 willow species described, 165 of which originated from Europe. In 1835, there were 71 species of willows mentioned just for the territory of the British Isles (Hooker 1835). At present, only 19 species are recognized for the British Isles.

Along with the dramatic increase of species numbers in the "floras", there was total a decrease in the number of varieties. No varieties were mentioned by C. Willdenow within the 116 species and almost none were recognized by J. Smith.

J. Schleicher appeared to be the most extravagant splitter of species. He published a large set of exsiccatae on the willows of Switzerland with 120 new species named. Indeed, he did not formally describe any of these species, they were just *nomina nuda* in his catalogues (Schleicher 1807, 1821). Fortunately, we can pay them no attention now. However, that was not possible some 150 years ago, when the rule to ignore *nomina nuda* did not yet exist. The majority of J. Schleicher's "species" were actually forms of *S. myrsinifolia*. Later on, people tried to explain that outburst of "species-creation". There were suspicions that J. Schleicher had done this purposefully, in order to profit from selling more of his exsiccatae, but this is probably not true. J. Schleicher's approach was an extreme one, but it was not accidental. His treatment of species had much in common with that of J. Smith. It lasted and emerged later in works by A. Jordan and especially those by M. Gandoger in the later half of the century (see section 3).

Of course, there were also attempts to divide the genus. C. Rafinesque (1817, 1831) and P. Opiz (1852) both introduced whole new series of genera instead of taking *Salix* in the broad sense. A. Kerner (1860) had less pretension, as he only segregated *S. reticulata* in the genus *Chamitea*.

As a result of intensive studies on willows, a number of new monographs were published during the period under consideration including those by W. Wade (1811), which was a bulky, yet weak compilation, by N. Seringe (1815), N. Host (1828), W. Koch (1828), J. Forbes (1829), J. Sadler (1831), and E. Fries (1832). N. Seringe's monograph was rather modest in terms of species-splitting. As it came together with the author's 88 exsiccatae (1805–1814), it still retains its value. The book by N. Host was ambitious, yet unfinished work with 108 color plates in folio. The author intended to do something similar to G. Hoffmann, but on an even larger scale. Yet even at the time the book was published, its scientific value was definitely not that great in comparison with more unassuming works by N. Seringe and W. Koch. As for J. Forbes' monograph, which included color plates and diagnoses for each of 140 clones of willows cultivated in Woburn, it was valuable for purposes of a rare book collector rather than taxonomist.

Works by Scandinavian authors of that period, primarily those of G. Wahlenberg (1812, 1816) and E. Fries (1825, 1828, 1832, 1840) were also overloaded with new species. Nevertheless, those monographs were of importance, as they fixed the particular understanding of the Linnaean species.

3. STABILIZATION OF SPECIES NUMBER IN WESTERN EUROPE: FROM KOCH TO WIMMER AND BUSER

Numerous new species with slight variations were described despite Linnaeus' warnings not to treat each difference as one between species. Inevitably, opponents to that approach soon appeared. It was W. Koch, one of the most attentive and precise early 19th century European researchers, who first opposed splitting of willow species (Koch 1820). Reasoning from his own observations of willows in nature, W. Koch emphasized that willows had a wide ranges of variability. In the same work, he was also determined to abolish J. Schleicher's "species". In his review of the European willows (1828), he proceeded even further and, in spite of the authority of J. Smith and C. Willdenow, resolutely reduced the number of the European species to 48. (Currently, we would eliminate 13 more species from these 48, treating them either as synonyms or hybrids.)

I. Tausch (1832) was another opponent of splitting species. He studied the willows thoroughly in C. Willdenow's Herbarium, compared them with what was written about them by C. Willdenow, and highlighted many contradictions, noncompletions, and superfluous species. Both W. Koch and I. Tausch broke the tendency of species-splitting, although they were unable to stop it completely. Indeed, I. Tausch himself published a few superfluous species' diagnoses and included even more of them in his exsiccatae "Plantae selectae Bohemicae" and "Dendrotheca Bohemica". In 1837, when Koch's principal and authoritative work, the "Synopsis" was published (Koch 1837), his approach became ultimately dominant in Central Europe.

A. Kerner (1860) made the next progressive step towards the understanding of the European willows, yet it was F. Wimmer who finally reviewed and clarified the European species. Both A. Kerner and F. Wimmer published sets of excellent exsiccatae along with their monographs (Wimmer, Krause, "Herbarium Salicum", fasc. 1–11, 1849–1857; A. Kerner, J. Kerner, "Herbarium österreichischer Weiden", decades 1–9, 1863–1869). The last one of F. Wimmer's publications, "Salices Europaeae" (1866), summarized all of his previous contributions to the willow research. The breadth, accuracy, and detail of that monograph surpassed all previous works published on willows. It was a final landmark in a hundred years' research on the willows since the time of C. Linnaeus. Naturally, it became the standard in the willow systematics for many years. F. Wimmer reduced the number of the European species still more, to 34. (Presently, 58 species are recognized in Europe, but one must keep in mind that F. Wimmer had almost none of southern and northeastern European specimens at his disposal.)

F. Wimmer gave very detailed descriptions of all plant parts, habitats, and geographical distribution. He paid special attention to infraspecific variability depicting it by means of description as well as recognizing varieties. F. Wimmer's main achievement was that he managed to reveal hybrid nature of many "species" proposed earlier by others. Of course, even before F. Wimmer there had been some assumptions and even confident statements about the existence of willow hybrids. The earliest one was made by J. Scopoli (1760: 111), who noted a possibility of pollination by alien willow species: "fecundae ex alieno mare feminae a me plures observatae". A. P. De Candolle (1832) also mentioned the ability of willows to form hybrids, although his remark was rather obscure. A. Kerner, too, treated some of forms as hybrids. Yet it was F. Wimmer, who succeeded in cleaning the heavy ballast of hybrids from the list of the European willow species. There are descriptions of 57 hybrids in "Salices Europaeae". Making decisions about hybrid nature of specimens, F. Wimmer not only relied upon his own keen eye of

14 a morphologist and taxonomist, but also enlisted assistance of M. Wichura, who was working on artificial crossings of willows under F. Wimmer's leadership in Breslau (Wichura 1854, 1865). Of course, only a part of proposed hybrid combinations could be verified in experiments. Some willows were mistakenly treated by F. Wimmer as hybrids. For example, he considered *S. laggerii* to be the hybrid *S. glauca* × *S. appendiculata*, although he himself had described *S. laggerii* as a species. We now know that it is a perfectly distinct species. In any event, those occasional errors by no means diminish F. Wimmer's achievements.

A contemporary of F. Wimmer, N. Andersson, who lived in Sweden, also devoted a large part of his life to the study of willows. N. Andersson's early work on the Lapland willows (1845) was not very important in comparison to the studies by G. Wahlenberg and E. Fries. It is of no interest now. His later works on the willows of India (1851, 1860) and North America (1858) are much more valuable. N. Andersson's treatment became the groundwork for the presentation of the genus *Salix* in J. Hooker's "Flora of British India" (Hooker 1890). All later authors referred to J. Hooker when speaking about the Himalayan willows. Therefore, the concept of the Himalayan willows has not changed much since the time of N. Andersson. N. Andersson also presented the genus *Salix* in "Prodromus" by A. P. De Candolle (1868). There were 160 willow species included in the world flora. Along with this brief review, N. Andersson planned to publish a detailed monograph, but he completed only half (1867). Although N. Andersson was able to embrace the vast diversity of the genus, his treatment was not that precise, keen, or fundamental in comparison with F. Wimmer's work. F. Wimmer's influence was obvious in N. Andersson's monographs of 1867 and 1868.

R. Buser in Switzerland was as thorough an expert on willows as F. Wimmer. Perhaps, R. Buser was even more acute. In 1883, he prepared an excellent, broad review of the willows of Switzerland, but it was left unpublished for unknown reasons. It only became available to readers many years after R. Buser's death (Buser 1940). Inevitably, it was already partially out of date. During his life, R. Buser succeeded in publishing only a few very short articles (1881, 1887, 1894, 1897, 1909). However, he had an excellent understanding of willows. As for limits of the Central European willow species, one would hardly object to his treatment today. R. Buser used geographical distribution along with other data to make decisions about species distinctness. Some of the species abolished by F. Wimmer were admitted by R. Buser.

R. Buser's observations on hybrids were also of importance. Following F. Wimmer's treatment, willow hybrids became fashionable. They were found everywhere, including many cases that had nothing to do with hybrids. R. Buser was the first to vigorously protest against hybridomania (Buser 1887, 1909). He was also the first to conclude that hybrids between closely related species of willows occur much more rarely than those between remote species. Thus, one most often finds hybrids between representatives of different sections (Buser 1940). Unfortunately, during R. Buser's lifetime all of his publications had restricted distribution. Dealing only with some special issues, they did not have significant impact upon the development of willow systematics.

At the end of the 19th century, there appeared a curious product of botanical literature: the "Flora of Europe" by M. Gandoger. It consisted of 28 volumes; volume 21 was dedicated to the genus *Salix*. There were 1,600 species of European willows, 1,576 of which were proposed by M. Gandoger (1890) himself. He divided *S. purpurea* into 62 species, *S. reticulata* into 67, and *S. caprea* into 76 species! M. Gandoger considered his concept of species to be theoretically justified by A. Jordan.

Obviously, there is no need to discuss our attitude towards these "species" by M. Gandoger. Still, the question remains: how should one treat M. Gandoger's published binary names from the formal, purely nomenclatural point of view? H. Fuchs (1960) stated that from the formal point of view M. Gandoger's specific names were as good as names published by any other author. W. Rothmaler (1962) sharply objected to H. Fuchs' opinion saying that taxonomists were already suffering from an enormous load of synonyms. Hence, it was absolutely impossible to take a few more thousands plant names into consideration merely because of the existence of a bizarre book that no one treated seriously. Actually, this problem can be resolved rather easily, and without any emotional outbursts. M. Gandoger himself created a reason for us to reject his species names. The point is that his small "species" (micro species) were included in species of normal size. Thus, binary names were superior to other binary names. However, the modern rules of nomenclature do not allow for existence of any taxon inside another taxon of the same rank. Neither binary names for infraspecific taxa are allowed by the rules. Therefore, none of the 1576 species names by M. Gandoger mentioned in his "Flora of Europe" have any validity at any rank.

15

4. LATE 19th—THE END OF THE 30's OF 20th CENTURY IN WESTERN EUROPE: IN SEARCH OF HYBRIDS. UNDERSTANDING SPECIES IN THE SENSE OF ASCHERSON

In his fundamental and influential work, F. Wimmer claimed the number of European species to be finally fixed and rather modest. At the same time, he emphasized the polymorphism of willow species as well as considerable opportunities for them to form hybrid combinations. Following this observation by F. Wimmer, researchers rushed to recognize and describe new varieties, forms, and hybrids in the genus *Salix*. That approach became common practice during the period of the late 19th—early 20th century, after the publication of the "Synopsis" by P. Ascherson and P. Graebner. A multilevel infraspecific taxa hierarchy was elaborated in this book to an extreme extent. In fact, that period also saw the establishment of the so-called "morpho-geographical" direction of the research in both the West European and Russian systematics. The new approach meant treating a species not only as a structural unit, but also ecological and geographical entity consisting of many individuals and occupying its own niche in nature. As to P. Ascherson's school, it still retained its purely typological approach to taxonomical units describing them from the formal point of view. Researchers of that school stayed far away from considering geographical and ecological features of species. They also never realized that morphological differences of specimens did not always indicate taxonomical differentiation of species.

P. Ascherson's approach prevailed in studies of the genus *Salix* during the period under consideration. The most prominent work on the European willows after the publication of Wimmer's book was a large review of the genus in P. Ascherson's and P. Graebner's "Synopsis" written by O. Seemen (1908–1910). There, according to the concept of the entire "Synopsis," the infraspecific subdivisions were elaborated for each species on a regular basis. The number of hybrids described was enormous: there were 213 simple hybrids and 59 triparental and tetraparental ones. (F. Wimmer had none of triplets or quadruplets). It is a curious fact that O. Seemen had two absolutely different approaches to European and exotic species. His understanding of European species was broad, and he would describe many varieties, forms, and hybrids between species. At the same time, while treating exotic Asian and African willows, he would describe every couple of specimens as a new species, mentioning neither varieties nor hybrids, as if he was converted to another faith. One should mention also that the first monograph on the willows of Japan was written by O. Seemen (1903).

16

The next prominent figure in the European willow studies after O. Seemen was a Swedish botanist S. Enander. His two major works were exsiccatae of the Scandinavian willows (Enander 1905–1910), thoroughly collected and accurately commented, and also an investigation on the willows in C. Linnaeus' Herbarium (Enander 1907). Later, S. Enander did not publish anything of significance, and only annotations on herbarium labels indicate his activities. S. Enander was a dedicated, accurate, and authoritative researcher, so that even R. Görz and B. Floderus considered themselves to be his pupils; yet one should frankly say that he did not understand willows properly. The main issue, consideration of species limits, was desperately lost in his work amidst endless numbers of varieties, subvarieties, forms, subforms, and even subsubforms along with all kinds of double, triple, and quadruple hybrids that one could imagine. S. Enander's treatment of the Siberian willows was most characteristic for his approach. Although he undertook a trip to Siberia in 1913 with the only purpose to gain better knowledge of willows, he did not succeed in understanding any of the Siberian species treating them as hybrid combinations of European species familiar to him. For instance, S. Enander considered the most distinct species from Kamchatka collected by V. Komarov, *S. sphenophylla*, to be "*S. arctica* × *lanata* × *reptans*". Other species were treated by him in a similar manner.

Following the historical sequence, we have to discuss an input made by A. Toepffer next. Essentially, it was an enormous set of exsiccatae ("Salicetum Exsiccatum", fasc. 1–15) published in 1906–1929. The number of exsiccatae was as large as 772. From the very beginning, these were mostly casual forms growing in the Freising Nursery near München. However, later on, A. Toepffer started to publish material specially collected in the Balkans, Alps, and even in Africa and Asia. As for Asiatic specimens, these were often presented on large-sized photographs. In his comments to these exsiccatae, A. Toepffer appeared to be an Ascherson's follower, although he was much more moderate in describing new forms and species. Also, the biological approach was not alien to him. He was the author of a detailed monograph on the willows of Bavaria (Toepffer 1914, 1915) as well as an excellent essay on the genus *Salix* for the famous "Lebensgeschichte der Blütenpflanzen Mitteleuropas" by O. Kirchner, E. Loew, and C. Schröter (Toepffer 1925).

R. Görz started by describing innumerable subforms and triple hybrids. He followed S. Enander, however, not losing his "sense of species" that much (Görz 1922; see also his exsiccatae "Salices Brandenburgenses Selectae"). Later, when his attention was drawn to Caucasian and Asiatic willows, he switched to another extreme describing superfluous species in exactly the same way as O. Seemen had done before him. Strange though it may seem, at the same time, he considered a number of new, perfectly distinct Caucasian and Chinese species at his disposal to be hybrids. Indeed, the majority of "hybrids" in his Brandenburg Exsiccatae did not actually exhibit any signs of hybridity. Another series of exsiccatae by Görz, "Salicaceae Asiaticae" (1931–1934), which consisted of 75 entries, appears to be much more valuable.

The latest outstanding personality among P. Ascherson's followers and hybrid-describers was that of B. Floderus. He published monographs on the willows of the Novaya Zemlya (1912), Greenland (1923), and Scandinavia (1931) along with a large series of articles on the European, Siberian, and even some East Asiatic willows. He started as a follower of S. Enander describing endless numbers of hybrids. Distinct species were literally lost among them. B. Floderus resolutely claimed that "pure" species were rare and hybrids absolutely dominated the willows on the territories of the Novaya Zemlya, Greenland, Kamchatka, and to some extent even northern Scandinavia. Yet in his latest works, he changed his attitude towards hybrids and moved

somewhat away from the hybridomania. In these works, we see him as an experienced and often keen researcher.

A few more works of the period under consideration are worth mentioning as they stood apart from the major, *Aschersonian* trend of the research. These were two monographs on the willows of the British Islands by F. White (1890) and E. Linton (1913). Along with his monograph, E. Linton published a hundred of exsiccatae of British willows. A. Camus and E.-G. Camus (Camus, Camus 1904, 1905) also wrote a bulky monograph on the European willows (two volumes and an atlas); yet it was just a cursory compilation that does not appear ingenious.

5. IN RUSSIA AND THE USSR: FROM TRAUTVETTER TO NAZAROV

During the post-Linnaean period, the study of the willows in Russia had some peculiarities as compared to the West European research process. Therefore, we would consider it separately. An article by F. Bray (1818) is hardly worth mentioning here, since it only contained some "new" species descriptions weakly written in J. Smith's style. Two monographs by E. Trautvetter, "De Salicibus Livonicis" and "De Salicibus Frigidis", both published in 1832, became the first really important works on the subject since the time of P. Pallas. E. Trautvetter was a very accurate researcher and attentive to detail. He luckily escaped the species-splitting fashion of that period and treated species close to W. Koch's sense. Immediately, he became the best willow expert in the country. For nearly 60 years, most of treatments on willows published in Russia belonged to him. His next work after those of 1832 was an overview of the genus *Salix* in C. Ledebour's "Flora Altaica" (1833). One must admit that there E. Trautvetter generally followed C. Ledebour's outline and approach. Then came his "Salicetum", which was an unfinished review of the willows of the world, as well as a series of treatments in numerous Siberian "florulas" published by the Academy of Sciences and St. Petersburg Botanical Garden (Trautvetter 1847, 1877, 1878, etc.; Trautvetter, Meyer 1856).

Besides these works by E. Trautvetter, the most important treatments of willows with new species descriptions were made by C. Ledebour (for the whole Russian territory, 1834, 1850), N. Turczaninow (for East Siberia and Transbaykalia, 1854), Fr. Schmidt (for the Yenisei and Sakhalin, 1869, 1872), and E. Regel (for Middle Asia, 1880, 1882). All of these works shared a common spirit, close to that of E. Trautvetter's. They depicted a general concept and approach to species typical for the Russian taxonomy and floristics, which became fully developed by the 19th century. New species were described very accurately and with caution. Sometimes, there was even too much caution, so that some distinct species from Siberia and the Far East were left undistinguished. The number of new species named in the 19th century was not even larger than that named in the 20th century (of course, if synonyms were not taken into account).

Along with Russian authors, a large contribution to the study of willows in this country was made by N. Andersson, whose name has been already mentioned. He treated the collections accumulated by 1850–1855 at the St. Petersburg Botanical Garden and described a number of new species.

The hybridomania had not yet spread among Russian salicologists of the 19th century. They were still concentrating on distinguishing species. A drift towards the new approach became evident in 1875, when J. Schmalhausen published his study of natural hybrids in St. Petersburg Government. However, the hybridological trend developed in full only when E. Wolf gained the

18 major authority in the willow research after E. Trautvetter's death. E. Wolf, a professor of the St. Petersburg Forest Institute, was a good dendrologist and horticulturist; nevertheless, as a taxonomist, he was rather poor. His bulky work on the willows of the European Russia (1900) was quite within Ascherson's concept. All his effort was concentrated on naming new varieties and hybrids. At the same time, he left many species misunderstood or obscure. Indeed, there was hardly anything valuable in his treatments that added to the knowledge of the European willows. Yet he did a much better job treating the genus *Salix* for the "Flora of the Southeast" (1930). After 1900, E. Wolf's attention was driven to the willows of Asiatic Russia, mostly those of Middle Asia. His approach to the Middle Asiatic willows was quite opposite to that towards European taxa. Much alike O. Seemen before him, he was inclined to distinguish numerous varieties and forms when considering the willows of European Russia. At the same time, treating plants from Middle Asia, he was ready to see a new species nearly in every new specimen he received. He segregated 18 new species (Wolf 1903a, 1903b, 1905, 1906, 1907, 1908, 1909, 1911, 1912, 1929), of which only 5 are left; the others turned out to be either synonyms or hybrids.

P. Lakschewitz was E. Wolf's contemporary. However, his approach towards describing new varieties and forms in Europe as well as new species in Asia was much more moderate. There is no doubt, he was a keener eye, and his decisions were more correct in comparison with those made by E. Wolf. Unfortunately, P. Lakschewitz did not write much. His notes to the exsiccatae for the "Herbarium of the Russian Flora" (1911, 1914) were his only work published. He also treated willows for "Flora Caucasica critica" by N. Kuznetsov, N. Bush, and A. Fomin, but that treatment was never published, because the "Flora" itself was discontinued. (Actually, it is unknown if the part on willows was ever ready to be published.) According to numerous annotations left by P. Lakschewitz in the St. Petersburg Herbarium, he also worked on an overview of the Siberian willows, but neither this work was ever brought to an end. P. Lakschewitz made many collections, particularly, in the Baltic States, but these collections of his are presumably lost (Rasinš 1959: 84).

There is nearly nothing left written by F. Teploukhov. As a dendrologist and forest scientist, he had a particularly keen interest in the willows and maintained a vast herbarium collection, mainly of willows from Pre-Uralia, and also some from Central Europe. That collection has survived, at least in part, in St. Petersburg. F. Teploukhov's treatments and opinions were important for many of his contemporaries (for example, see Petunnikov 1901), although he did not consider himself to be a taxonomist and avoided any written statements on taxonomical topics.

Among those Russian botanists of the pre-revolutionary period who made a considerable input to the study of willows, one should also name P. Siuzev. Although he did not leave any major works, he was a prominent willow collector, who worked mostly in the Urals, Central Russia, and the Far East. It is also important to mention the names of K. Kupffer, who studied the willows in the Baltic States and published a number of samples in the "Herbarium of the Russian Flora", and D. Syreishchikov, who depicted and described the willows of Moscow Government with great accuracy (Syreishchikov 1907). V. Dobrovlyanskiy (1891) undertook a detailed comparative study of the willow (and poplar) leaf anatomy. Unfortunately, his work was not illustrated, hence it actually could never be used for the systematic purposes.

In the 20's and early 30's, a large portion of Russian willow collections was sent to Germany, for R. Görz's treatment, and also to Sweden, to B. Floderus. B. Floderus also had at his disposal much of material collected by Swedish expeditions in the Yenisei and Lena basins, Kamchatka,

and other regions. Both authors published a number of works, either entirely or to a large extent devoted to the Russian willows (Floderus 1926a, 1930, 1933a, 1936, 1939, 1941; Görz 1928, 1930, 1933, 1934a, 1934b, 1934c, 1936, 1937). Yet these works by R. Görz and B. Floderus made little progress in understanding of the Russian willows. Part of the problem was that neither B. Floderus nor R. Görz had a chance to observe Russian willows in nature. Another drawback was their purely typological approach to species. 19

Rather than seeking help from abroad, some Russian researchers of the 20's and 30's preferred to treat their willow collections themselves. For example, V. Komarov in his "Flora of Kamchatka" and "Key to Species of the Far East" relied mainly upon his own identification of species. The same is true for the "Flora of West Siberia" by P. Krylov. Also, B. Gorodkov and A. Tolmachev examined arctic willow collections of their own with great care.

M. Nazarov started his observations of willows as early as the pre-revolutionary years. His excellent collections of the willows from Vladimir Government are now kept in Moscow and St. Petersburg. In the 20's and 30's, Nazarov studied the willows of Prebaykalia. He came along with his first publication on willows only in 1933. When there appeared a need for a treatment of the willows for the "Flora of the USSR," it happened that M. Nazarov was the only person able to handle the project. He only had two or three years to complete the entire task, a time too short to review the material available in Leningrad alone. As one can see from many of M. Nazarov's annotations in herbaria, he was a very conscientious worker and managed to go through all material available in Moscow and the Botanical Institute in Leningrad. He succeeded in identifying those particular plants which had been implied by his predecessors when they had described species. These data were correctly presented in the "Flora of the USSR". Yet M. Nazarov was hardly able to revise the species and decide which of them were worthy of recognition. The only way out of that situation was to accept primarily all the species previously described. Hence, it was a compilation of data in the literature verified against herbarium material, which was prepared for the "Flora of the USSR". It contained only insignificant fragments of critical analysis. Nevertheless, M. Nazarov's review, in the way he managed to prepare it, fitted well enough with the general approach to species in the "Flora", since in its early volumes there was a trend towards distinguishing "small" species as well as towards prompt, not necessarily critical treatments. M. Nazarov also made reviews of the genus for the "Flora of Transbaykalia", "Flora of the Ukrainian SSR", "Flora of the Byelorussian SSR" (the latter two were published after the World War II). He pursued the studies of willows of the entire USSR territory with special emphasis on the Caucasus and East Siberia. However, he never published any corrections or additions to the "Flora of the USSR".

6. JAPANESE SCHOOL

Since the late 19th century, taxonomists native of Japan joined the studies of the East Asiatic flora and soon started to play a prominent role. Japanese authors who made the largest input into willow studies were, first of all, T. Makino, G. Koidzumi, T. Nakai, and A. Kimura. T. Makino's major credit was the establishment of a very large herbarium, where willows were excellently represented (the main collection is preserved in Tokyo, although some duplicates can be found in other herbaria, for instance, in St. Petersburg). T. Makino's approach to species was rather conservative. However, due to this approach, all the willow species in his "Flora of Japan" (1956) were consistently revised from the same critical point of view, whereas in the "Flora" by J. Ohwi

(1965) there was more of compilation. As for G. Koidzumi, T. Nakai, and A. Kimura, none of them ever published a full list of Japanese willows which would be in accordance with their own concepts. After T. Makino with his conservative approach, both G. Koidzumi and A. Kimura appeared to be "species-splitters" in Japan, much alike O. Seemen and E. Wolf in Europe and Russia. Of course, on their lists of newly described species there were some real ones, which was quite natural when dealing with rich and poorly explored floras of Japan, Sakhalin, and the Kurils. Yet the majority of "new" species by G. Koidzumi and A. Kimura were merely synonyms. Abundance of newly-described species along with restricted availability of original material make it extremely difficult to understand these species and compare them with the continental willows. Types and sometimes entire herbarium material on the majority of species by A. Kimura are preserved in his private collection. Exsiccatae of Japanese willows are only represented by a few numbers published by R. Görz (1931) and also the "Japanese Flora" series by the Museum of Natural History in Tokyo. One must admit, however, that diagnoses by A. Kimura are very detailed, precise, and often accompanied by excellent photos (though one would not say the same about species descriptions by G. Koidzumi).

T. Nakai had a more realistic attitude to species: he would not hesitate to assign to synonyms even species he himself had described before. His major achievement was a publication of a voluminous "Flora sylvatica Koreana". The part treating willows was very well written there (Nakai 1930). One can gain good understanding of species even without referring to the herbarium thanks to excellent quality of descriptions and illustrations.

A cytotaxonomical research of the genus *Salix* has been carried by Y. Suda, a pupil of A. Kimura (Suda 1958–1960, 1963).

7. AFTER WORLD WAR II: THE USSR AND WESTERN EUROPE

The main feature of the taxonomy during the post-war decades was a slow, gradual shift from the purely typological to biological concept or, to be more precise, the populational concept of species. This caused a drift away from the purely formal, *Aschersonian* infraspecific systematics. Any interest in morphological descriptions of interspecific hybrids was disengaged. Descriptions of hybrids were removed from texts to footnotes or merely disappeared from the majority of "floras" and monographs.

Some perfect, distinct European species had been long hiding under names of hybrids. Understanding of this fact was attributed to a more realistic approach to species and rejection of *Aschersonian* intricate hierarchy of infraspecific taxa. This led to rehabilitation of a number of West European species, which had been misunderstood and mistakenly considered to be either hybrids or varieties. Besides, ranges and limits of many of the West European species were clarified. A number of significant publications on the systematics and geography of the West European willows appeared during these years (Almeida 1944; Chmelař 1963a, 1963b; Fijałkowski 1958a, 1958b; Franco 1949; Neumann 1955; Pawłowski 1946; Rechinger 1938, 1947; Vicioso 1951). Some treatments published as parts of "floras" deserve special attention (Stoyanov, Stefanov 1948; Beldie 1952; Chassagne 1956; Dostál, 1950; Lawalrée 1952; Pawłowski 1956; Rechinger 1957, 1964).

Unfortunately, the most recent of K. Rechinger's treatments in "Flora Europaea" (1964) is not wholly satisfactory. Following B. Floderus, the author considered a number of forms with obscure morphological characteristics and indefinite geographical ranges to be species.

Moreover, he added a few unclear species of his own. There are also some significant faults regarding species distribution.

J. Wilkinson (1944) published detailed data on willow chromosomes. The results of that investigation made it clear that the willow systematics cannot benefit very much from the chromosome research.

During the post-war decades, many new works on willows were published in the USSR, 21 mostly within regional "floras". A number of new botanical research centers, which had been organized before the World War II, became active after the War, generating new regional "floras". These "floras" were created neither in Moscow, nor in Leningrad, as it had been before, but right in the areas of investigation. A. Grossheim (1945) conducted a new survey of the Caucasian willows, which constituted a considerable improvement in comparison with the previous research by R. Görz. R. Shlyakov (1957) wrote a very detailed and accurate review of the willows from the Kola Peninsula. Unfortunately, he trusted B. Floderus too much and consequently accepted a number of superfluous species. Due to that and also because he admitted the idea of hybridization on a mass scale, species limits appear to be rather vague in the "Flora of Murmansk Oblast". Both V. Drobov (1941a, 1941b, 1953) and P. Polyakov (1960) devoted their research to the willows of Middle Asia and Kazakhstan. V. Drobov would not clarify the species described earlier; instead he added still more superfluous ones to the list of the Middle Asiatic willows, which had already been overloaded. P. Polyakov's treatment was much more realistic and definitely made a progress, although it was not free from confusion in understanding of some willows and the number of species was still too large there. M. Popov (1959) primarily followed N. Turczaninow and M. Nazarov in his treatment of the genus *Salix* for the "Flora of Central Siberia". Although M. Popov made numerous observations on his own, he never managed to bring them into a system. Besides, he would exaggerate the role of hybridization in nature, in accordance with his theoretical notions. L. Malyshev's approach was much more neat (Malyshev 1965).

One should also mention here reviews of the Ukrainian willows (Nazarov, Kotov, Gerzhedovich 1952), the willows of Leningrad Oblast (Korchagin 1957), Estonia (Krall, Viljasoo 1965), and Latvia (Rasinš 1959).

However, in spite of these numerous treatments, no considerable general progress was achieved during the period after the war in comparison with the "Flora of the USSR", except some special occasions and particular regions. Indeed, the least progress was made in understanding of the systematics and geography of willows in the largest and richest areas of their distribution in this country: Siberia, the Far East, and Middle Asia. The Caucasian willows also remained insufficiently clarified. There were still many discrepancies even in the knowledge of the European Russian willows. Hence, when the volume of the review "Trees and Shrubs of the USSR" (Pravdin 1951) containing the survey of willows was to be published some 15 years later than the appropriate volume of the "Flora of the USSR", the taxonomical part still had to be borrowed from M. Nazarov's treatment in the "Flora". As for data on species geographical ranges, these were taken from a rather cursory compilation by Th. Schmucker (1942).

All attempts to build a natural system of the genus *Salix* have been concentrating so far on revealing of groups of close filiation, that is, sections. This research is still going on and is far from being completed, especially in regard of the entire genus. Since the major units of relation remain obscure, it is certainly impossible to interpret the relation itself. Therefore, evolutionary concepts have been hardly approached in the literature on *Salix*. So far there has been not enough data to rely upon, it has been too early to start.