COMMUNICATIONS

DE LA FACULTÉ DES SCIENCES
DE L'UNIVERSITÉ D'ANKARA

Série C: Sciences naturelles

TOME 18 C ANNÉE 1974

The Taxsonomy Of The Section PERSICARIA (Tourn.) L. In The Genus POLYGONUM (TOURN.) L. (Polygonaceae) In The United States East Of The Rocky Mountains

By

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Ankara, Turquie

Communications de la Faculté des Sciences de l'Université d'Ankara

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The Taxsonomy Of The Section PERSICARIA (Tourn.) L. In The Genus POLYGONUM (TOURN.) L. (Polygonaceae) In The United States East Of The Rocky Mountains

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SUMMARY

Taxonomy of the members of section *Persicaria* (Torn.) L. involved collection and analyses of specimens from 167 sites in 26 states in the eastern and central United States. A total of 1305 dry specimens were sorted by aspect into 12 different groups. Detailed morphological analyses were conducted on 97 or more specimens in six of these taxa. Eighteen to twenty-two vegetative or floral characters were measured on each specimen. Three different computer programs (NUTAL, GOCOR, and HYBEX) were used to analyze the data. The results of the morphological analyses did not indicate evindence of introgressive hybridization between any taxa.

Growth studies, clonal studies, and genetic work were done in a greenhouse and a growth chamber. Self-pollination was very common in all the taxa studied. All attempts at artificial crosspollination failed. There was no segregation into suspected parental types in the progenies from self-pollinated plants. Specimens in each progeny showed phenotypic and genotypic variation, but all of them were similar to the parental specimen.

In the absence of evidence for interspecific hybridization as a cause of variation, such variation had to be explained as the result of natural selection operating on mutations, crossovers, chance combinations of chromosomes in meiosis, and chance combination of gametes in syngamy. Also in the absence of genetic evidence it was reasonable to suppose that distinct groups arose from a central germ plasm by divergence, and different genic combinations have been selected in different environments.

The following twelve variable species were recognized in the present study area. *Polygonum amphibium* L., *P. pensylvanicum* L.,

P. lapathifolium L., *P. glabrum* Willd., *P. careyi* Olney,
P. *hirsutum* Walt., *P. persicaria* L., *P. hydropiperoides* Michx.,
P. punctatum Ell., *P. hydropiper* L., *cespitosum* Blume, and
P. orientale L.

This study was done under the supervision of Prof. J.F. DAVIDSON at the University of Nebraska, U.S.A. (Ph. D. Dissertation).

INTRODUCTION

Small (1895) treated the section *Persicaria* (Tourn.) L. as a subgenus in his study and recognized 25 species in North America. Britton (1913) mentioned the presence of about 125 widely distributed species in this section. In the days when its authors undertook to evaluate the validity of newly proposed species, Index Kewensis recognized not more than 50 species in this section, and they reduced over 150 binomials to synonymy.

Hybrids have been reported between the members of different species by European authors whose names are listed in Timson (1965). Mitchell (1971) mentioned that more than fifty percent of the specimens in many herbaria were misidentified. The number of synonyms, and the high percentage of misidentifications may indicate the extent of confusion in this section.

The present study is an attempt to find the nature of variation in natural populations, and determine the valid names for each entity in the study area.

The sampling area was intentionally chosen as the one which was most likely to include environmental and geographical extremes, to represent the distribution area of different recognized entities and also to include areas where intergradation and hybridization had been reported.

Anderson (1949) developed a method of analyzing a hybrid swarm derived from two parental species. Fuller (1969) in her study programmed Anderson's methods of calculating the hybrid index of each specimen for use in a computer. These programs were successfully used by Fuller and Van Haverbeke (1968), which encouraged the present author to apply Anderson's methods and Fuller's computer programs to study the possitility of introgressive hybridization as a cause of variation between different species.

The information about the growth studies, clonal and genetic work is not given in this paper because of limited space.

MATERIAIS AND METHODS

Collections

Specimens for use in this study were collected from 167 sites (see figure 1), during two main trips (1970–1971) with a small number of specimens included from the collection in 1968.

During the collection trips the intention was to sample populations of *Polygonum*, from the section Persicaria throughout their geographical and environmental extremes. Hence populations of *Polygonum* from randomly chosen sites were examined for the extent of variation present. After the selection of extremes, plants falling between these extremes were sampled at random. The size of each sample depended on the size of the stands.

Aspect Sorting and Measurement of Characters

After the specimens were dried, they were sorted into different groups. Specimens which appeared to be different merely by inspection were placed in different piles, and the ones which appeared to be alike were put together. This process was continued until there were several groups of specimens, in place of the one large collection. In the next step, by contrasting each group of specimens with each other group, a list of characters common to each specimen within each group was prepared. When no valid distinguishing character could be found between the groups they were recombined. The various groups were rechecked to make sure that each specimen within each group showed the combination of characters common for the group.

The characters which had previously been used by other workers to delimit the taxa were intentionally included in the list of characters whenever possible.

The same measurement unit was used for the same character in all groups. Minute characters were measured under a magnification of 20 diametres with an ocular micrometer and recorded as "a unit". Later this unit was calibrated in mm (1 unit= .07 mm). Some of the vegetative characters were large enough to measure

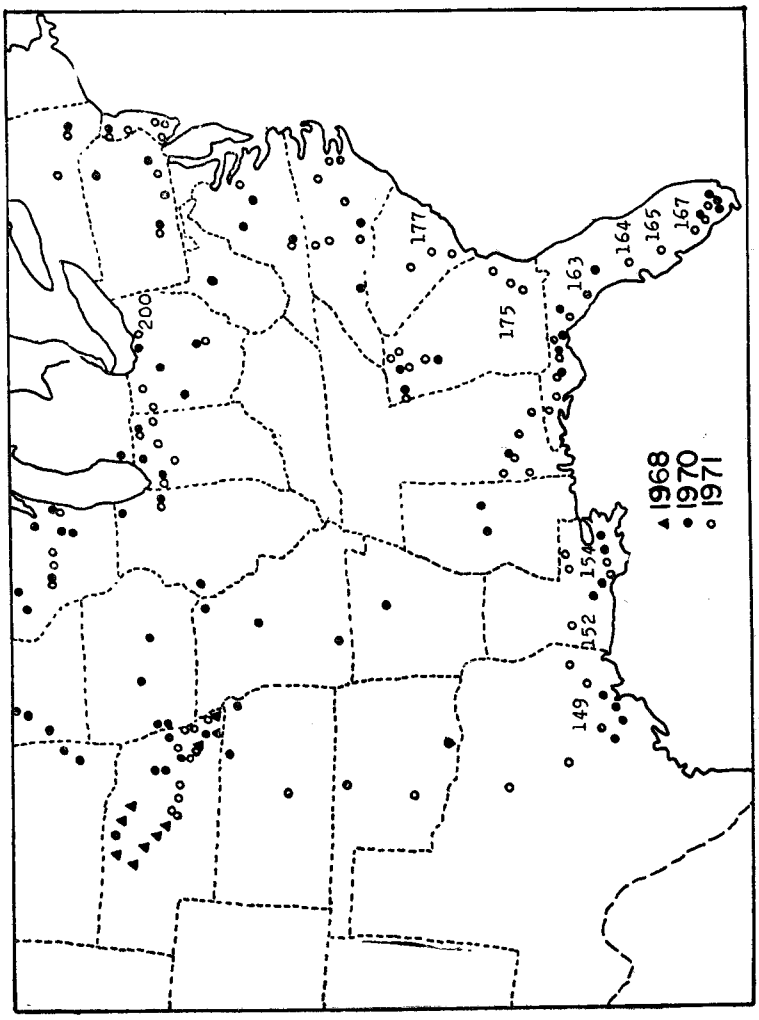

Figure 1. Collection sites

to the nearest mm. Density counts were also made under a magnification of 20 diameters by using an ocular micrometer with rectangular unit on it and the unit was later calibrated in mm^2 (1 unit = $2.5mm^2$).

Morphological Analyses

Programs Used and the Results

The University of Nebraska's IBM 360 Computer was employed for the analyses. The data were punched on standart 80–column cards and analyses were done by the following programs:

NUTAL program: This program is similar to Fuller's (1969) TAL program which is a standard statistical program, and is possibly more efficient than TAL. This program determines for each character, the frequency distribution on the basis of number of cases per class and prints the mean, maximum and minimum for each character.

For the present study the number of classes used was fifteen, which was an arbitrary number, chosen merely to break the variation of each character into fifteen classes, so that a moderately smooth curve might be obtained.

The computer output of the above program is studied and evaluated. Most of the variables exhibited a normal or essentially normal distribution with varying degree of skewness mostly to the left. Empty classes in the Nutal results are due to the mechanics of the computer program, not to discontinuities in the variable.

Normal distribution suggested either an inbreeding variable species or a hybrid swarm. If several sets of variables show consistent correlation the possibility must be considered that these correlated characters are due to previous hybridization.

GOCOR program: This program is essentially the same as CORCO used by Fuller (1969) which is also a standard statistical program, computing partial and multiple correlations for all character pairs and the mean and standard deviation

Correlation coefficients were established for each of the six different taxa and were used to find if characters were correlated. This was done in place of scatter diagrams, and it appeared to be a more efficient method of arriving at the same result.

If the value of one character increases when the value of second character decreases these two characters are negatively correlated. If the value of a third character increases with the first one, i.e., if these two characters are positively correlated, it might be expected that the third character would be negatively correlated with the second character. If this is the case, the correlations are consistent and if the third character is positively or negatively correlated with both first and second characters, its correlatation would be inconsistent. When all consistently correlated characters are separeted into their respective "positive" and "negative" groups, all "positive" characters must show a negative correlation with each of the "negative" character. The "negative" characters would show positive correlation with each other and must show negative correlation with each of the "positive" characaters. In the present stuy this was established by the following procedures:

For each taxon, correlation coefficients for each character were ranked in terms of decreasing value. Then beginning with the highest coefficient and considering each succeeding coefficient, the characters were separated into "positive" and "negative" characters. When all characters have been assigned to either the "positive" or the "negative" they would show the fewest number of inconsistencies in their respective side and no character would show more than one–half of the total number of characters as inconsistencies. All inconsistently correlated characters were eleminated starting with the character with the highest number of inconsistencies. The consistently correlated characters were used in HYBEX program to calculate the hybrid index values.

HYBEX program: This program is also similar to the HYBIX program designed dy Fuller (1969) to calculate the hybrid index of each specimen. The hybrid indices produced by the HYBEX program were transferred to histograms.

Possibilities Of Hyridization As A Cause Of Variation In Section PERSICARIA (Tourn.) L.

A considerable number of hybrids in section *Persicaria* have been reported by various authors, both in Europe and in America. In Europe almost all other species except *P. amphibium* were considered to hybridize. The criteria in the detection of hybrids have usually been a demonstrable blending of the characters of supposed parents, and a greater degree of defective pollen grains and empty fruits.

Timson (1965) concluded that in the European annual species pollination occurred before the flower bud opened. He reported that about 40 reciprocal crosses between *P. lapathifolium* and *P. persicaria* failed to produce seed. Timson indicated that incompatibility barriers might be the cause of the failure of cross fertilization. He also mentioned that the search for hybrids in this section had been stimulated by the frequent occurence of well–established hybrids in the related genus *Rumex* L.

Fernald (1922) described *P. hydropiperoides* x *robustius* Fernald, from Nova Scotia. Accoriding to Fernald the specimens exactly combined the aspect and characters of the two species, and the fruits were all empty.

In the present study it appeared that perennial specimens of *Polygonum puctatum* Ell. were described as *P. robustius* (Small) Fernald, which was a synonym of *P. punctatum*. Distribution of *P.punctatum* and *P. hydropiperoides* overlaps mainly in the south and southeastern United States and in this region both species behave as perennials. Many vegetative and floral characters of these two species are very similar and their ranges of variation overlap. During the first sorting of dried specimens it was not possible to assign some specimens to either species merely by inspection with the naked eye. Under X20 magnification it was found that there were two different kinds of glands on the leaves and/or on the calyx; *P. hydropiperoides* was glandless or had superficial bluishgreen glands while *P. punctatum* possessed imbedded honeycolored glands. It was possible to refer each specimen except 175–F (Ga.) and 175–J (Ga.) according to the above types

of glands to either *P. punctatum*, or *P. hydropiperoides*. Specimens numbered 175–F and 175–J were doubtful because inconspicious intermediate–looking glands were present on the basal portion of the calyx. Both species occurred together in only three collection sites (165, Fla.; 167, Fla; 175, Ga.). Specimens from the collection sites in Florida and Georgia appeared to intergrade from one species to the other in many characters, whether or not both species were represented at the same site. There were some specimens of *P. hydropiperoides* with very small anthers, bearing few or no pollen grains and with mostly empty fruits. Defective pollen and very small anthers were found on some specimens in *P. hydropiperoides* collected from sites 149, 152, 154, 163, 164, 165, 175, 177, and 200 (see figure 1). This shows that poor pollen was not restricted to the sites where both species were represented. Howerver, the intergradation of characters and poor pollen production might indicate previous hybridization. These two species which had been separated according to the presence of imbedded glands on the calyx and leaves were recombined for analysis by the computer programs.

The following characters were measured on the longest leaf or at the node to which the longest leaf attached.

1. Clasping (used) part of petiole to ocrea, 1 unit = .07 mm.
2. Petiole length, 1 unit = .07 mm.
3. Blade length, 1 unit = 1.0 mm.
4. Leaf width, 1 unit = 1.0 mm.
5. Ratio of character 4/character 3. This ratio is a measurement of leaf shape from linear to rotund.
6. Distance of maximum leaf width from leaf base, 1 unit = 1.0 mm.
7. Ratio of character 6/character 3. This is a measurement of leaf shape, e.g., from lanceolate to oblanceolate.
8. Ocrea tube length, 1 unit = 1.0 mm.

9. Ocrea cilia length, 1 unit = .07 mm.
10. Longest hair length at the middle of the ocrea, 1 unit = .07 mm.
11. Andnated part of the hair mentioned in 10, 1 unit = .07 mm.
12. Ration of character 11 /character 10. This measures the percentage of adnation.
13. Hair density on the lower surface of the leaf in hairs per unit area, 1 unit = 2.5 mm^2.
14. Internode length, 1 unit = 1.0 mm.
22. Hair density on the upper surface in hairs per unit area, 1 unit = 2.5 mm^2.

The following characters were measured on the lowest ocreolae or on the largest flower in the lowest ocreolae on the largest inflorescence.

15. Ocreolae length, 1 unit = .07 mm.
16. Ocreolae–bristle length, 1 unit = .70 mm.
17. Number of flowers in the ocreolae.
18. Pedicel length, 1 unit = .07 mm.
19. Sepal length, 1 unit = .07 mm.
20. Fused part of the calyx (calyx tube length), 1 unit = .07 mm.
21. Filament length, 1 unit = .07 mm.

Gland density was recorded but not included in the Gocor program because the intergradation between the two kinds of glands was doubtful. See Table 1 for computer output from Nutal program. Fraquency distributions were prepared for each character from the figures given on Table 1, as histograms. The characters numbered 1, 3, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21 and 22 exhibited a normal or essentially normal distribution. This might indicate either an inbreeding variable species or a hybrid swarm. From the output of Gocor program (see Table 2 for the output) the consistently correlated characters were estab-

Table 1. Frequency distribution

CHARACTER

	1	2	3	4	5	6	7	8	9	10	11	12
1	4	82	4	12	49	1	1	1	4	34	11	10
2	13	109	15	64	101	13	0	3	16	62	35	31
3	17	113	34	96	32	36	0	7	28	42	100	13
4	37	39	40	41	53	49	10	29	45	49	32	3
5	68	52	72	67	34	71	17	60	78	79	32	11
6	74	22	77	56	55	66	15	66	69	75	53	32
7	73	20	58	45	28	54	38	76	56	54	55	66
8	40	9	58	23	45	72	42	60	57	21	35	82
9	60	8	45	20	21	37	86	72	37	24	51	84
10	50	3	21	22	24	25	73	43	25	3	19	90
11	18	2	15	12	10	20	65	26	12	17	23	26
12	4	5	17	1	10	14	75	17	25	5	12	12
13	3	3	8	4	22		23	7	12	2	4	5
14	4	1	3	3	2	5	13	1	3	1	13	
15	4	1	2	3	3	4	11	1	2	1	4	3

	13	14	15	16	17	18	19	20	21	22	23
1	303	14	282	11	25	3	1	6	2	6	36
2	17	25	26	11	63	41	4	21	23	1	51
3	33	49	29	34	63	148	14	66	76	17	66
4	23	53	25	21	79	0	22	42	60	13	84
5	30	73	37	84	70	117	63	95	93	46	108
6	14	79	22	45	48	74	71	45	79	99	47
7	14	54	17	95	42	0	63	41	26	53	30
8	7	58	9	31	23	44	70	62	26	115	12
9	8	38	8	73	19	14	71	25	50	70	10
10	5	8	6	10	16	0	38	38	8	17	10
11	2	10	3	31	11	15	28	13	19	21	3
12	3	3	1	6	4	6	18	6	4	4	5
13	6	2	2	11	4	0	5	5	0	0	2
14	2	2	1	2	1	6	0	2	2	0	3
15	2	1	1	4	1	1	1	2	1	1	2

TABLE 2

Correlation coefficients

	1	2	3	4	5	6	7	8	9	10	11
1	1.0000										
2	−0.0357	1.0000									
3	0.2206	0.3616	1.0000								
4	−0.0386	0.6406	0.4256	1.0000							
6	−0.1968	0.3637	−0.2704	0.7159	1.0000						
6	0.1665	0.4082	0.8242	0.5406	−0.0372	1.0000					
7	−0.0033	0.2442	0.1295	0.3729	0.2901	0.6523	1.0000				
8	0.7338	0.1339	0.4236	0.0745	−0.2183	0.3476	0.0467	1.0000			
9	0.4074	−0.0379	0.1876	0.1048	−0.0577	0.1135	−0.0669	0.4250	1.0000		
10	0.3299	−0.3703	0.1594	−0.1599	−0.2897	0.0921	−0.0710	0.3092	0.6036	1.0000	
11	0.1149	−0.3996	0.2481	−0.5341	−0.7166	0.1205	−0.1125	0.2264	−0.2264	0.4136	1.0000
12	−0.2005	0.0616	0.1378	−0.2178	−0.3246	0.0993	0.0170	−0.090	−0.5786	−0.5562	0.4377
13	0.2017	−0.1772	0.1434	−0.1903	−0.3230	0.0689	−0.0776	0.2416	0.2757	0.3598	0.2992
14	0.0195	0.628	0.0955	0.0604	−0.0223	0.1411	0.1166	−0.0089	−0.0077	0.0781	0.0372
15	0.0309	0.1229	0.0954	0.1040	0.0829	0.0554	−0.0405	0.1684	0.1206	0.0412	0.0702
16	0.2718	−0.2116	0.2593	−0.1328	−0.3230	0.1615	−0.0626	0.3415	0.5005	0.6704	0.3332
17	0.0254	−0.0959	0.1293	−0.1448	−0.2284	0.191	−0.0191	0.0804	−0.0363	0.0929	0.1863
18	−0.0037	0.2768	0.0030	0.3684	0.3825	0.0126	−0.0015	0.0601	0.2061	−0.1138	−0.3795
19	−0.2152	0.4157	−0.0325	0.4510	0.4848	0.0831	0.1887	−0.1797	0.0525	−0.3192	−0.4588
20	−0.2620	0.4885	−0.0449	0.4832	0.5298	0.0724	0.1881	−0.2532	−0.0584	−0.4629	−0.5161
21	−0.0315	0.1753	0.0299	0.1322	0.1444	0.0191	0.0065	−0.0414	−0.0779	−0.2282	−0.2004
22	0.1096	−0.1561	−0.0557	−0.2630	−0.3002	−0.1274	−0.1608	0.1176	0.2260	0.1200	0.1469

	12	13	14	15	16	17	18	19	20	21	22
12	1.0000										
13	−0.1385	1.0000									
14	−0.0122	−0.0952	1.0000								
15	−0.0061	0.0279	−0.0465	1.0000							
16	−0.3357	0.4404	0.0193	0.2179	1.0000						
17	0.0731	0.0965	−0.0160	0.1232	0.1516	1.0000					
18	−0.2046	0.0063	0.0245	0.2813	0.0204	−0.1917	1.0000				
19	−0.0435	−0.1918	−0.0016	0.2449	−0.1986	−0.1646	0.5554	1.0000			
20	0.0318	−0.2524	0.0380	0.1404	−0.3053	−0.2101	0.4719	0.8785	1.0000		
21	0.0726	−0.0226	0.0168	0.1103	−0.1110	−0.0852	0.3928	0.4155	0.3896	1.0000	
22	−0.0632	0.5516	−0.1547	−0.0019	0.2291	0.0623	0.0103	−0.1202	−0.1541	−0.0572	1.0000

lished by ranking correlation coefficients for each character pair as shown on Table 3 and then separating the characters into "positive" and "negative" characters (see Table 4). When all inconsistently correlated caharacters were eliminated the following characters remined as consistently correlated.

"Positively" correlated characters.

2. Petiole length (free part).
4. Leaf width.
5. Ratio of leaf width /blade length.
7. Ratio of distance of maximum leaf width from base /blade length.
19. Sepal length.
20. Fused part of the calyx (calyx tube).
21. Filament length.

TABLE III

Highest correlation coefficients for all characters ranked in decreasing order.

Character pair	Correlation coefficient	Character pair	Correlation coefficient
19–20	+.8785	11–19	—.4588
3–6	+.8242	4–19	+.4510
1–8	+.7338	13–16	+.4404
5–11	—.7166	11–12	+.4377
4–5	+.7159	3–4	+.4256
10–16	+.6704	8–9	+.4250
6–7	+.6523	3–8	+.4236
2–4	+.6406	2–19	+.4157
10–9	+.6036	19–21	+.4155
9–12	—.5786	10–11	+.4136
10–12	—.5562	2–6	+.4082
18–19	+.5554	1–9	+.4074
13–22	+.5516	2–11	—.3996
4–6	+.5406	18–21	+.3928
4–11	—.5341	20–21	+.3896
5–20	+.5298	5–18	+.3825
11–20	—.5161	11–18	-.3795
9–16	+.5005	4–7	+.3729
2–20	+.4885	2–10	—.3703
5–19	+.4848	4–18	+.3684
4–20	+.4832	2–5	+.3637
18–20	+.4719	2–3	+.3616
10–20	—.4629		

TABLE IV

"Positive" or "negatiye" characters with their inconsistencies.

Character number	Inconsistently correlated characters
"Positive"	
2	8
3	1, 5, 8, 9, 10, 11, 13, 16, 17, 19, 20
4	8, 9, 12
5	3, 6, 12, 14
6	1, 5, 8, 9, 10, 11, 13, 16, 17
7	8, 15, 18
12	4, 5, 11, 14, 15, 17, 18, 19
14	1, 5, 10, 11, 12, 15, 16, 19
15	1, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17
18	7, 8, 9, 12, 13, 22
19	3, 9, 12, 14
20	3
21	—
"Negative"	
1	3, 6, 14, 15
8	2, 3, 4, 6, 7, 15, 18
9	3, 4, 6, 11, 15, 18, 19
10	3, 6, 14, 15
11	3, 6, 9, 12, 14, 15
13	3, 6, 15, 18
16	3, 6, 14, 15
17	3, 6, 9, 12, 15
22	18

"Negatively" correlated characters.

1. Clasping (fused) part of petiole to ocrea.
10. Longest hair length at the middle of the ocrea.
11. Adnated part of the hair mentioned in 10.
13. Hair density on the lower surface of the leaf.
16. Ocreolea–bristle length.
17. Number of flowers in the ocreolae.
22. Hair density on the upper surface of the leaf.

Consistent correlation between several sets of characters might indicate the presence of more than one germ plasm or grups of genes with a tendency to appear together. It should be pointed out that the analytical evindence does not distinguish between different germ plasms coming together through hybridization or segregating through divergence. The final interpretation depends on other evindence, mainly plant distribution and results of artificial hybridization.

As further evindence the consistently correlated characters were used in the Hybex program. The histogram in Figure 2 which was produced from the hybrid indices, is essentially a normal curve. If there had been introgressive hybridization between these two species one might find only a few F1 types in a supposedly random sample and the distribution of hybrid indices would show bimodality. The precise habitat appeared to influence the variation in each population. Throughout the whole range, each taxon follows a different variation pattern.

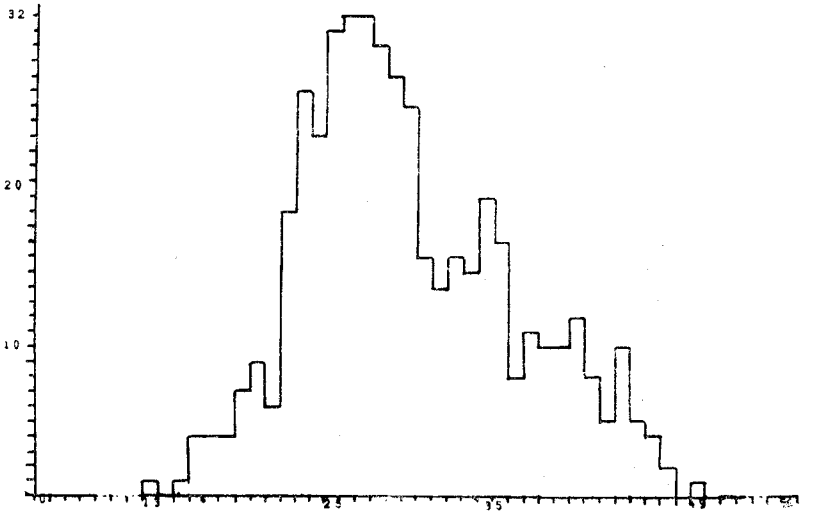

Figure 2. Frequency distribution of hybrid indices of 469 specimens.

The hybrid index values of *P. punctatum* and *P. hydropiperoides* were separated and showm as two overlapping histograms in Figure 3. These histograms indicate that these two species possibly are very closely related and many characters are strongly overlapping but there is no evidence to indicate hybridization from the above hybrid index. On the other hand, growth studies and genetic work showed that chasmogamous flowers withered away within a few days and fruits were produced only in the self–pollinated cleistogamous flowers.

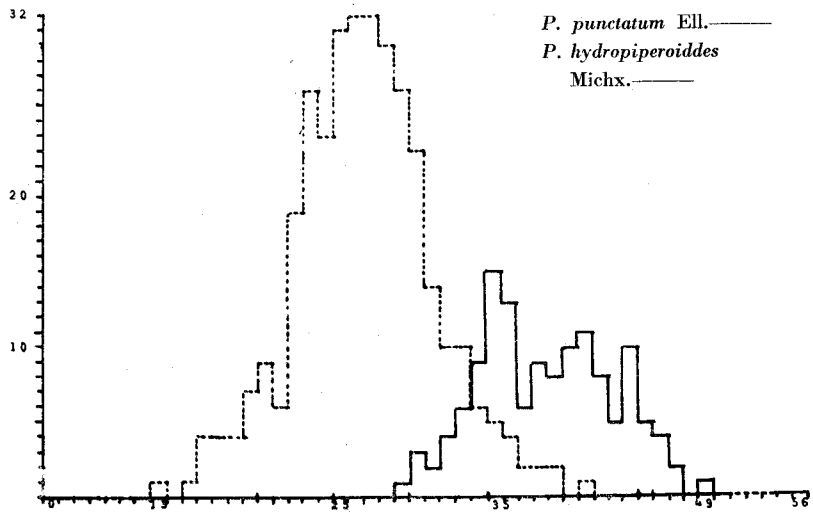

Figure 3. Comparison of P. *hydropiperoides* Michx. and *P. punctatum* Ell. using hybrid indices.

In natural populations when members of the two species grow together, some cross–pollination might be accomlished by insect visitors. For a list of insect visitors in section *Persicaria* see Knuth (1909). Such pollination, however, will normally be ineffective as the flower will already have been self–pollinated. If this has not happened the fertilization may still fail because of incompatibility barriers All the above evidence indicates that there is no blending between the two germ plasms, and imbeded, consipicuous, honey–colored glands on the calyx can be considered diagnostic in *P. punctatum.*

Under X20 or higher magnifications it is possible to see some inconspicuous intermediate looking glands at the basal part of the calyx in *P. hydropiperoides*, which are not the same kind of gland found in *P. punctatum.*

There was no reasonable morphological evidence to hypothesize hybridization between any other recognized taxa in the present study. However, keeping in mind that parental types might completely disappear and that the population might rep-

resent a hybrid swarm the same analytical programs were applied to 6 different taxa. Tehere was no indication of introgressive hybridization.

Twelve variable species were recognized in the present study area. *Polygonum amphibium* L., *P. glabrum* Willd., and *P. hirsutum* walt., behave as perennials throughout their range.

P. hydropiperoides Michx., and *P. punctatum* Ell. behave as perennial in the south and southeastern part of the United States, but behave as annuals further north. *P. lapathifolium* L.,

P. pensylvanicum L., *P. hydropiper* L., *P. persicaria* L.,

P. cespitosum Blume, *P. careyi* Olney, and *P. orientale* L. behave as annuals throughout the present study area.

In *P. hydropiperoides*, *P. pensylvanicum*, and *P. persicaria* two subspecies were recognized.

P. persicaria L. Sp. Pl. 1: 361. 1753

P. persicaria L. Subsp. *persicaria*

P. persicaria L. Subsp. *puritanorum* (Fernald) Comb. nov.

P. hydropiperoides Michx, Fl. Bor. Am. 1: 239. 1803

P. hydropiperoides Michx. Subsp. *hydroperoides*

P. hydropiperoides Michx. Subsp. *setaceum* (Baldwin) Comb. nov.

P. pensylvanicum L. Sp. Pl. 1: 362. 1753

P. pensylvanicum L. Subsp. *pensylvanicum*

P. pensylvanium L. Subsp. *bicorne* (Raf.) Comb. nov.

These subspecies were recognized with the sense that the term subspecies includes a group of plants that some botanist might wish to receognize as species, but by treating them under the same specific epithet the close relationship that appears to be exist emphasized.

Key to species in section PERSİCARİA (Tourn.) L.

(x20 maginification is recommended to use this key)

Larger leaves lanceolate, narrowly lanceolate to almost linear; blades 1/3 as wide as long or narrower.

Ocrea with horizontally divergent herbaceous flange (flaring ocrea)

1. *P. amphibium*

Ocrea without herbaceous flange.

Ocrea without cilia, or only the upper ocrea with cilia; cilia shorther than 1 mm.

Calyx without honey colored imbedded glands.

Calyx without recognizable vein pattern; sepals 5.

Ocrea opaque (not translucent) at the basal part, upper portion of the ocrea almost inseparably covers the internode above the halfway point....

1. *P. amphibium*

Ocrea completely translucent, almost dissappeasr on mature specimens; does not cover the internode above the halfway.

2. *P. pensylvanicum*

Calyx (outer 2 or 3 sepals) three veined and each vein ends with an anchor-shaped fork ( ); sepals 4, or 4 and occasionally 5 on the same inflorescence .....

3. *P. lapathifolium*

Calyx with honey colored imbedded glans.....

4. *P. glabrum*

Ocrea with cilia at most nodes, and cilia longer than 1 mm.

Peduncle with stipitate glands.

Stem glabrous or with hairs parallel to the stem (appressed hairs)

1. *P. amphibium*

Stem with spreading hairs (hairs attached nearly perpendicular to stem ..... 5. *P. careyi*

Peduncle without stipitate glands.

Stem covered with spreading hairs (hairs attached nearly perpendicular to stem) ..... 6. *P. hirsutum*

Stem glabrous or some appressed hairs mainly on upper internodes.

Calyx and/or leaves with imbedded or supperficial glands.

Glands supperficial (removable), bluish-green or yellowish on the calyx and/or on the leaves.

Carpels 2 and 3 on the same specimen; yellowish superficial glands on the calyx and/or on the leaf .... 7. *P. persicaria*
Carpels always 3; bluish-green superficial glands on the calyx and/or on the leaf ..... 8. *P. hydropipero-ides*

Glands imbedded and honey colored on the calyx and/or on the leaf.

Axillary flowers absent; inflorescences not interrupted with small leaves.

Racemes 3 or more in a forking terminal panicle (rarely fewer than three); leaves not acrid or peppery to taste. ..... 4. *P. glabrum*
Racemes terminal (not more than 3) and on lateral branches leaves acrid or peppery to taste ..9. *P. punctatum*

Axillary flowers present and enclosed in ocrea; inflorescence interrupted with small leaves ..... 10. *P. hydropiper*

Calyx and/or leaves without imbedded or supficial glands.

Carpels 2, or 2 and 3 on the same specimen..
7. *P. persicaria*

Carpels 3.

Ocrea not longer than 9 mm; ocrea-tube/ocrea-cilia ratio not larger than 1.33; no spreading hairs on the ocrea; flowers always greenish pink to dark pink. .....
11. *P. cespitosum*

Ocrea longer than 9 mm, if occasionally shorter than 9 mm the ocrea–tube/ocrea–cilia ratio larger than 1.33; spreading or appressed hairs on the ocrea; greenish white to pinkish or dark pink flowers...
8. *P. hydropiperoides*

Larger leaves ovate; blades almost 1/2 as wide as long.....
12. *P. orientale*

DISCUSSION AND CONCLUSIONS

The enormous variation and intergradation of some characters in the members of section *Persicaria* had been interpreted by interspecific hybridization and many specimens had been designated as hybrids both in Europe and in America. In the present study it became evident that self–pollination was very common and artificial cross–pollinations failed between the members of all taxa studied. There may be cross–incompatibility barriers between different species.

In the light of the present study the interspecific exchange of germ plasm could not be used as the only explanation of the variation. Growth studies indicated that the variability within individual progenies was not exclusively environmental or developmental but that much of it could be attributed to genetic variation. Because of cross–incompatibility barriers any genetical changes which occured would, unless they were disadvantageous, become rapidly established. The mosaic pattern of populations which frequently occurs in relatively narrow areas might be an indication of the above possibility.

The results from morphological analyses were in agreement with the results from growth studies and genetic study. There was no indication of introgressive hybridization. Even though it could not be demonstrated in all taxa in the greenhouse, it appears that a low level of outcrossing may occur between the members of natural populations, and this would increase the recombination potential and would be expected to produce considerable infraspecific variation.

Consequently, the variation encountered in the field appears to be due not to interbreeding but to the accumulation of mutations, cross–overs, chance combinations of chromosomes in the gametes, chance mating of gametes and possibly to the occurrence of low levels of outcrossing. It appears that all recognized categories have been produced through divergence of plants from the centers of variations into various environments, and selection by these environments for certain genic combinations.

Defective pollen grains and low seed viability, which were in some locations mostly on plants behaving as perennial, might be the result of accumulation, of mutations. This type of mutations might not be detrimental to perennial plants because of rapid vegetative propagation after the new germ plasm had been established locally.

In the present study if all the diagnostic characters of a supposed species or an infraspecific category are found in the surrounding populations such a species or infranspecific category has been reduced to synonymy. However, this does not deny the existence of variation in the populations, but only the taxonomic significance of such variation. Thus, 12 variable species were recognized in the present study area.

ÖZET

Persicaria (Tourn.) L. sekşınının taksonomisi üzerindeki bu çalışma, A.B.D.nin orta ve doğubölgelerini içine alan 26 eyaletin, farklı örnekleme sahasından toplanan numunelerin analizini içine almaktadır. Toplam olrak 1305 kurutulmuş numune, genel görünüşlerine göre 12 farklı gruba ayrılmıştır. Doksanyedi veya daha fazla numune ihtiva eden altı grup üzerinde detaylı morfolojik analiz yapılmıştır. Her numune üzerinde 18–22 vegetatif veya çiçek karekteri ölçülmüştür. Analizlerin yapılmasında, üç ayrı istatistiki elektronik beyin (Computer) programı (NUTAL, GOCOR ve HYBEX) kullanılmıştır. Morfolojik analizlerin neticeleri, gruplar arasında introgresif hibridizasyon olduğuna dair hiçbir delil göstermemiştir.

Büyütme çalışmaları, çelikleme ve genetik araştırmalar serada ve bir büyütme odasında yapılmıştır. İncelenen gruplarda kendi kendine tozlaşmanın çok yaygın olduğu görülmüştür. Bütün çapraz tozlaştırma teşebbüsleri netice vermemiştir. Self–polinasyon sonucu meydana gelmiş tohumlardan büyütülen nesillerde, muhtemel cedler istikametinde bir farklılaşma olmamıştır. Her nesilde, bireyler fenotipik ve genotipik farklılaşmalar göstermiş fakat, bütün bireylerin tohumların alındığı numuneye benzedikleri dikkati çekmiştir.

Türler arasında hibridizasyon olduğuna dair hiçbir delil bulunamadığı için, hibridizasyon farklılaşmaya sebep olarak gösterilememiştir. Gruplar arasında ve gruplar içinde farklılaşmaların meydana gelmesinde, mutasyonlar, krosingover, meiosis esnasında meydana gelen tesadüfi kromozom kombinasyonları ve gametlerin tesadüfi birleşmeleriyle hasıl olan farklı genetik yapıdaki fertler üzerinde faaliyet gösteren doğal seçim, izah yolu olarak düşünülmüştür. Genetik delil olmadığı için, farklı grupların bir gen merkezinden (germ plasm) farklılaşma yoluyla hasıl olduklarını ve değişik çevre şartları altında farklı gen kombinasyonlarının seçildiğini kabul etmek uygun görülmüştür.

Çalışma sahasında, oldukça farklılaşma gösteren, aşağıdaki oniki tür tesbit edilmiştir. *Polygonum amphibium* L.,

P. pensylvanicum L., *P. lapathifolium* L., *P. glabrum* Willd.,

P. *careyi* Olney, *P. hirsutum* Walt., *P. persicaria* L.,

P. hydropiperoides Michx., *P. punctatum* Ell., *P. hydropiper* L.,

P. cespitosum Blume, and *P. orientale* L.

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Prix de l'abonnement annuel

Turquie : 15 TL; Étranger: 30 TL.

Prix de ce numéro : 5 TL (pour la vente en Turquie).

Prière de s'adresser pour l'abonnement à : Fen Fakültesi Dekanlığı Ankara, Turquie.

Ankara Üniversitesi Basımevi. Ankara – 1974