KARYOTAXONOMICAL STUDIES ON *VICIA*

I. ON THE KARYOTYPE AND CHARACTER OF SOME ANNUAL SPECIES OF *VICIA*

KIYOSHI YAMAMOTO

Faculty of Agriculture, Kagawa University,
Miki-Machi, Kagawa-Ken 761-07

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Studies on the interspecific hybridization of *Vicia* have made it necessary to clarify the genetic relationships between the species of this important genus.

The genus *Vicia* is comprised of more than 170 species and is subdivided into four sections i.e., *Cracca*, *Ervum*, *Euvicia* and *Faba* (Ehara 1950; Plitmann 1967).

Most of these species are annuals but a few of them belonging to the section *Cracca* are perennials. The basic chromosome numbers are 5, 6 and 7 (Darlington and Wylie, 1955). Many of them are diploid species but some representatives of the section *Cracca* are polyploid.

The karyotypes of *Vicia* species were reported by Sveschnikova (1927, 1940), Mettin (1958, 1961, 1962), Mettin and Hanelt (1964), Hanelt and Mettin (1970a, b), Cincura (1962), Zertova (1962), Huziwarra and Kondo (1963), Plitmann (1967) and Yamamoto (1966, 1968, 1971). The lack of information on the relationships between the characters and the karyotypes of the species of *Vicia* prompted the author to make this study.

MATERIALS AND METHODS

The sources of the *Vicia* species from which the karyotypes were observed are listed in Table 1. As indicated in the table, the *Vicia* species were introduced from many countries, as wild or cultivated types. The root tips used for karyotype observation were pretreated at a low temperature (0-1°C) for about 8-24 hours, then fixed in acetic alcohol (3 parts 95% ethanol : 1 part acetic acid), stained with acetic orcein and observed using the squash method. The karyotype was indicated by Sinotô's (1944) method, and the chromosome length was determined from the mean length value of the chromosomes in 10 cells.

RESULTS AND DISCUSSION

The karyotype, total length of the haploid chromosomes and the number of pairs of submedian chromosomes are indicated in Table 2. As shown in the table, for all species of this genus, one pair of satellite chromosomes was observed, and in some species of sec. *Euvicia* a pair of chromosomes which has a secondary constriction was

Table 1. Source of *Vicia* species

No.	Species	Seed source
1	<i>V. atropurpurea</i> Desf.	from Dr. Barnard, Australia, 1963
2	<i>V. villosa</i> Roth	" Mettin, East Germany, 1960
3	<i>V. eriocarpa</i> (Haussken) Hal.	" Lehmann, East Germany, 1966
4	<i>V. dasycarpa</i> Ten.	" Barnard, Australia, 1963
5	<i>V. varia</i> Host.	" Barnard, Australia, 1963
6	<i>V. tenuifolia</i> Roth.	" Arne Rousi, Finland, 1965
7	<i>V. neglecta</i> Hanelt et Mettin	" Lehmann, East Germany, 1966
8	<i>V. ervilia</i> Willt	" Barnard, Australia, 1963
9	<i>V. hirsuta</i> S. F. Gray	Collected from the field of Fac. Agr. K. Univ. Japan, 1960
10	<i>V. tetrasperma</i> Moench.	from Dr. Barnard, Australia, 1963
11	<i>V. tenuissima</i> (M.B.) Schinz et Thell.	" Lehmann, East Germany, 1966
12	<i>V. biennis</i> L.	" Lehmann, East Germany, 1966
13	<i>V. monantha</i> Desf.	" Lehmann, East Germany, 1966
14	<i>V. leganyana</i>	" Barnard, Australia, 1963
15	<i>V. cordata</i> Wulf.	" Lehmann, East Germany, 1966
16	<i>V. incisa</i> M.B.	" Lehmann, East Germany, 1966
17	<i>V. grandiflora</i> Scop.	" Mettin, East Germany, 1959
18	<i>V. pannonica</i> Crantz	" Barnard, Australia, 1963
19	<i>V. hyrcanica</i> Fish. et Mey.	" Lehmann, East Germany, 1966
20	<i>V. michauxii</i> Sprang.	" Lehmann, East Germany, 1966
21	<i>V. melanops</i> Sibth. et Sm.	" Lehmann, East Germany, 1966
22	<i>V. lutea</i> L.	" Mettin, East Germany, 1962
23	<i>V. peregrina</i> L.	" Mettin, East Germany, 1960
24	<i>V. hybrida</i> L.	" Mettin, East Germany, 1960
25	<i>V. bithynica</i> L.	" Lehmann, East Germany, 1966
26	<i>V. narbonensis</i> L.	" Barnard, Australia, 1963

also observed. In almost all the species, submedian chromosomes were observed while in the others, the chromosomes were subterminal.

The total chromosome length, shape of the satellite chromosome as the length of the satellite, and the connection of the satellite with a long or short arm and the shape of submedian chromosomes were different between the closely related species in this genus. In *Vicia sativa* and its related species of section *Euvicia* a gradual change in shape of the submedian and the shortest subterminal chromosome was reported (Sveschnikova 1940; Mettin and Hanelt 1964, 1966; Yamamoto 1966, 1968, 1971). The same inclination was also observed in the other related species groups.

The chromosome number for all species of sec. *Cracca* was $2n=14$, except for *V. neglecta* ($2n=12$). In *Ervum*, the chromosome number was $2n=14$, but in *Euvicia* it varied $2n=10, 12$ and 14 . The total chromosome length was the shortest in sec. *Cracca* among the annuals, and in sec. *Ervum*. In sec. *Euvicia*, the chromosome length varied from long to short, with a wide range while in sec. *Faba* the longer to be found.

The number of pairs of submedian chromosomes in the genus varied from 0 to 6.

Table 2. Karyotypes of some annual *Vicia* species

Section	No.	Species	2n	Karyotype	Total length (μ)	No. of sm pair
Cracca	1	<i>V. atropurpurea</i>	14	$2_tA_1^{st} + 2A_2^{sm} + 2B_1^{sm} + 2B_2^{st} + 2B_3^{st} + 2B_4^{st} + 2C^{sm}$	25.10	3
	2	<i>V. villosa</i>	14	$2A^{st} + 2B^{st} + 2C_1^{sm} + 2C_2^{st} + 2C_3^{st} + 2^tC_4^{st} + 2D^{sm}$	22.75	2
	3	<i>V. eriocarpa</i>	14	$2A_1^{st} + 2A_2^{sm} + 2B_1^{st} + 2B_2^{st} + 2B_3^{sm} + 2C_1^{st} + 2^tC_2^{st}$	23.45	2
	4	<i>V. dasycarpa</i>	14	$2A^{st} + 2B^{st} + 2C^{st} + 2^tD_1^{st} + 2D_2^{st} + 2D_3^{st} + 2E^{sm}$	28.25	1
	5	<i>V. varia</i>	14	$2A^{st} + 2B^{st} + 2C_1^{sm} + 2C_2^{sm} + C_3^{sm} + 2^tC_4^{st} + 2D^{sm}$	28.15	4
	6	<i>V. tenuifolia</i>	14	$2A^{st} + 2B^{st} + 2C^{sm} + 2D_1^{sm} + 2D_2^{sm} + 2D_3^{sm} + 2^tE^{st}$	31.30	4
	7	<i>V. neglecta</i>	12	$2A^{sm} + 2B^{st} + 2C_1^{st} + 2^tC_2^{st} + 2C_3^{st} + 2D^{sm}$	24.65	2
Ervum	8	<i>V. ervilia</i>	14	$2A^{sm} + 2B^{sm} + 2C_1^{st} + 2C_2^{sm} + 2D^{st} + 2E^{sm} + 2^tF^{st}$	24.90	4
	9	<i>V. hirsuta</i>	14	$2^tA^{st} + 2B_1^{sm} + 2B_2^{sm} + 2B_3^{sm} + 2C^{sm} + 2D_1^{sm} + 2D_2^{sm}$	35.75	6
	10	<i>V. tetrasperma</i>	14	$2^tA^{st} + 2B_1^{sm} + 2B_2^{sm} + 2C_1^{st} + 2C_2^{st} + 2D_1^{sm} + 2D_2^{sm}$	30.50	4
	11	<i>V. tenuissima</i>	14	$2A^{st} + 2B^{sm} + 2^tC^{sm} + 2D_1^{st} + 2D_2^{st} + 2E^{sm} + 2F^{sm}$	32.90	4
	12	<i>V. biennis</i>	14	$2A^{st} + 2^tB_1^{sm} + 2B_2^{st} + 2B^{sm} + 2D_1^{sm} + 2D_2^{sm}$	25.45	5
	13	<i>V. monantha</i>	14	$2A^{sm} + 2B_1^{sm} + 2_tB_2^{st} + 2C^{sm} + 2D^{sm} + 2E_1^{sm} + 2E_2^{sm}$	21.05	6
Euvicia	14	<i>V. leganyana</i>	12	$2A_1^{st} + 2A_2^{st} + 2A_3^{sm} + 2A_4^{sm} + 2_tB^{st} + 2C^{st}$	19.60	1
	15	<i>V. cordata</i>	10	$2A^{st} + 2B_1^{st} + 2B_2^{st} + 2_tC^{st} + 2D^{st}$	24.60	0
	16	<i>V. incisa</i>	14	$2A^{st} + 2B_1^{st} + 2^tB_2^{st} + 2C_1^{sm} + 2C_2^{st} + 2D_1^{st} + 2D_2^{st}$	28.05	1
	17	<i>V. grandiflora</i>	14	$2A^{st} + 2^tB^{st} + 2C_1^{st} + 2C_2^{st} + 2D_1^{st} + 2D_2^{st} + 2E^{st}$	35.55	0
	18	<i>V. pannonica</i>	12	$2A^{st} + 2^tB_1^{st} + 2B_2^{st} + 2C^{st} + 2D^{st} + 2E^{st}$	36.15	0
	19	<i>V. hyrcanica</i>	12	$2A^{st} + 2^tB_1^{sm} + 2B_2^{st} + 2B_3^{st} + 2B_4^{st} + 2C^{st}$	37.50	1
	20	<i>V. michauxii</i>	14	$2^{cs}A^{st} + 2_tB^{st} + 2C^{st} + 2D_1^{st} + 2D_2^{st} + 2E_1^{st} + 2E_2^{st}$	39.65	0
	21	<i>V. melanops</i>	10	$2^{cs}A^{st} + 2B_1^{st} + 2_tB_2^{sm} + 2C^{st} + 2D^{st}$	48.30	1
	22	<i>V. lutea</i>	14	$2A^{st} + 2B^{st} + 2^tC_1^{st} + 2^{cs}C_2^{st} + 2D_1^{st} + 2D_2^{st} + 2D_3^{st}$	47.20	0
	23	<i>V. peregrina</i>	14	$2A^{sm} + 2B_1^{st} + 2B_2^{st} + 2B_3^{st} + 2B_4^{st} + 2_tC^{st} + 2D^{st}$	41.75	1
	24	<i>V. hybrida</i>	12	$2A^{st} + 2_tB^{st} + 2C_1^{st} + 2C_2^{st} + 2C_3^{st} + 2D^{st}$	42.70	0
Faba	25	<i>V. bithynica</i>	14	$2A^{st} + 2B^{st} + 2C^{st} + 2D_1^{st} + 2^tD_2^{st} + 2D_3^{st} + 2E^{st}$	32.95	0
	26	<i>V. narbonensis</i>	14	$2A^{sm} + 2B^{sm} + 2C_1^{sm} + 2C_2^{st} + 2D_1^{st} + 2_tD_2^{st} + 2E^{sm}$	39.15	4

Note. *st*: subterminal chromosome, *sm*: submedian chromosome, *t*: trabant (satellite), *cs*: secondary constriction.

In general, sec. *Ervum* contained from 4 to 6, sec. *Cracca* contained from 1 to 4, sec. *Euvicia* 0 to 1, and sec. *Faba* 0 to 4.

Photomicrographs of the somatic chromosomes are shown in Fig. 1 and ideograms of the karyotypes of 26 species are also shown in Fig. 2. In both Figures, each species number agree with the species indicated in Table 1. Each chromosome pairs of species were named as I, II, III, IV, V, VI and VII according to length.

The karyotype formula using Sinotô's method is shown in Table 2, and the characteristics of karyotype in each species were as follows.

1. *V. atropurpurea* (2n=14)

The total chromosome length was comparatively short. The satellite chromosome was the longest measured, the satellite being connected to the long arm. There were

Fig. 1. (1~15) Photomicrographs of somatic chromosomes in some annual species of *Vicia*.

three submedian chromosomes. The karyotype of this species was similar to that described by Mettin and Hanelt (1968).

2. *V. villosa* ($2n=14$)

The total chromosome length was short. The satellite was connected to the short arm of the satellite chromosome. The karyotype was the same as that described by Cincura (1962) and was also similar to that of *V. atropurpurea* except for the shape of

Fig. 1. (16~26) Photomicrographs of somatic chromosomes in some annual species of *Vicia*.

satellite chromosome.

3. *V. eriocarpa* ($2n=14$)

The total chromosome length was short. The satellite was connected to the short arm of the smallest chromosome. Two submedian chromosomes were also observed. This description differed from Mettin's (1961) data regarding the number of submedian chromosomes.

4. *V. dasycarpa* ($2n=14$)

The total chromosome length was longer than that of the above mentioned species. The length of the satellite chromosome was intermediate among the other chromosomes, the satellite being connected to the short arm. The number of submedian chromosomes was 1 pair.

5. *V. varia* ($2n=14$)

The total length was similar to that of *V. dasycarpa*. The satellite was short and it

Fig. 2. (1~15) Idiogram of the karyotypes in some annual species of *Vicia*.

Fig. 2. (16~26) Idiogram of the karyotypes in some annual species of *Vicia*.

was connected to the short arm of the satellite chromosome. Four submedian chromosomes were observed. The length of these chromosomes was intermediate or short.

6. *V. tenuifolia* ($2n=14$)

The total chromosome length was considerably long. The satellite chromosome was short and the satellite was connected to the short arm. The 4 submedian chromo-

somes were all short. The chromosome number and karyotype of the same species was reported by Darlington and Wylie (1955), Rousi (1961) and Cincura (1962). They reported chromosome numbers of $2n=24$, 23-25 and 12 respectively, and their karyotypes were mutually dissimilar. In my material, the chromosome number was $2n=14$ and annual. The above reported data was based on perennials. For this reason, it is necessary for us to identify this species more clearly.

7. *V. neglecta* ($2n=12$)

This was the only species observed to have a chromosome number of $2n=12$ in the section *Cracca*. The total chromosome length was intermediate. The satellite was connected to a short arm of a subterminal chromosome. Two submedian chromosomes were observed, one long and the other short. The karyotype of this species was reported by Hanelt and Mettin (1962, 1970b), and is in agreement with my observations.

8. *V. ervilia* ($2n=14$)

There were four pairs of submedian chromosomes. The satellite chromosome was the shortest, and the satellite being connected to the short arm of the subterminal chromosome. This number of submedian chromosomes is characteristic of section *Ervum*. The karyotype of this species was investigated by Sveschnikova (1927), but she did not report the presence of a satellite chromosome.

9. *V. hirsuta* ($2n=14$)

The satellite was connected to the short arm of the longest subterminal chromosome. Six pairs of submedian chromosomes were observed. The total chromosome length was also long. The karyotype in this species was reported by Sveschnikova (1927), Cincura (1962) and Huziwara and Kondo (1963). In Cincura's data, the satellite chromosome was not observed, and 5-6 comparatively long submedian chromosomes were observed. Huziwara and Kondo observed four pairs of submedian and one median chromosome, but no satellite chromosome. The presence of the satellite chromosome in my observations differs from the above reports.

10. *V. tetrasperma* ($2n=14$)

The total chromosome length of this species was short when compared with that of *V. hirsuta* while in the number and shape of satellite, submedian and subterminal chromosomes of this species were similar to that of *V. hirsuta*.

11. *V. tenuissima* ($2n=14$)

The satellite was connected to the short arm of the comparatively long subterminal chromosome. Four pairs of submedian chromosomes were observed.

12. *V. biennis* ($2n=14$)

The total chromosome length was comparatively short. The short satellite was connected to the short arm of the long subterminal chromosome. Five pairs of submedian chromosomes were observed. The karyotype of this species was reported by Hanelt and Mettin (1962), and is in agreement with my observations.

13. *V. monantha* ($2n=14$)

The total chromosome length was comparatively short. All the chromosomes were submedian except for the satellite chromosome which had the satellite connected to the long arm. The karyotype was similar to that of *V. hirsuta*. The same karyotype was also observed by Sveschnikova (1927).

14. *V. leganyana* ($2n=12$)

Only one pair of submedian chromosome was observed. The satellite chromosome was comparatively short and its satellite being connected to the long arm. These results were similar to those for *V. sativa* (Mettin 1958; Yamamoto 1966; Sveschnikova 1927, 1940; Hanelt and Mettin 1966). The external morphological characters of this species were found to be almost the same as those of *V. sativa*. This close relationship of both species was discussed by Plitmann (1967).

15. *V. cordata* ($2n=10$)

The somatic chromosome number was 10, and the karyotype was similar to that of *V. leganyana* except that the smallest subterminal chromosome was not observed. This karyotype was similar to that of *V. amphicarpa* $2n=10$ (Yamamoto 1966). On the other hand, Plitmann (1967) reported that the somatic chromosome number of *V. amphicarpa* was $2n=14$, which differs from the data on this species reported by Sveschnikova (1940). More careful identification of this species is necessary.

16. *V. incisa* ($2n=14$)

The satellite chromosome was of intermediate length having the satellite being connected to the short arm. All the chromosomes were subterminal except for a single submedian chromosome. The total chromosome length was intermediate. This is in agreement with that reported by Mettin (1961).

17. *V. grandiflora* ($2n=14$)

Three subterminal chromosomes were identified in this karyotype. One of them was a satellite chromosome with the satellite connected to the short arm. One of them had an enlarged short arm and the other was the shortest chromosomes. The length of the other chromosomes was intermediate between the chromosomes of this species. Submedian chromosomes were not observed. In Cincura's (1962) result, the satellite chromosome was not observed.

18. *V. pannonica* ($2n=12$)

The total chromosome length was long. All of the chromosomes were subterminal; the satellite chromosome was observed to have the satellite connected to the short arm. The karyotype of this species was reported on by Hanelt and Mettin (1970) and Cincura (1962). In the data of the former two satellite chromosomes were observed, while the latter reported on the presence of a long submedian chromosome.

19. *V. hyrcanica* ($2n=12$)

The total chromosome length was long. One long subterminal chromosome and one middle sized submedian chromosome which had a long satellite connected to the short arm were observed. The rest of the chromosomes were all subterminal.

20. *V. michauxii* ($2n=14$)

One long subterminal chromosome with a secondary constriction and another subterminal chromosome which had the satellite connected to the long arm were observed. These chromosomes were different from those of *V. pannonica* and *V. hyrcanica* mentioned above. The other chromosome were subterminal with short arms.

21. *V. melanops* ($2n=10$)

The total chromosome number was $2n=10$. The total chromosome length was extremely long, the length of the shortest chromosome being equal in length to the

longest chromosome of the other species. One subterminal chromosome with a secondary constriction and one shorter submedian satellite chromosome which had the long satellite connected to the long arm was observed. The karyotype of this species was also reported on by Mettin (1961) and Kolev and Terzijski (1964). In both of these reports a chromosome which had a secondary constriction was observed.

22. *V. lutea* ($2n=14$)

The total chromosome length was extremely long, there being little difference in the length of the chromosomes. The satellite chromosome was medium sized, the satellite being connected to a short arm. A shorter subterminal chromosome which had a secondary constriction was also observed. In this species, the karyotype was also reported by Cincura (1962) and Sveschnikova (1927). In the data given by Cincura and Sveschnikova, the satellite chromosome was not observed.

23. *V. peregrina* ($2n=14$)

The total chromosome length was comparatively long. A submedian chromosome and 4 middle sized subterminal chromosome were observed. In addition a satellite chromosome with the satellite connected to the long arm and a smaller subterminal chromosome were observed. This observation is in close agreement with the data given by Mettin and Hanelt (1968).

24. *V. hybrida* ($2n=12$)

The total chromosome length was long in this species. A series of long, middle and short sized subterminal chromosomes were observed. One of the middle sized chromosomes had a satellite connected to the long arm.

25. *V. bithynica* ($2n=14$)

Only subterminal chromosomes were observed in this species and a large difference in each chromosome length was not observed. A satellite connected to a short arm was observed on a middle sized chromosome.

26. *V. narbonnensis* ($2n=14$)

The total chromosome length was considerably long. Three long submedian and one short submedian chromosomes were observed. A short satellite chromosome was also observed having the satellite connected to a short arm. The karyotype of this species was investigated by Sveschnikova (1927). The data compares favorably to my observations.

The taxonomy of the species of the genus *Vicia* was investigated by Plitmann (1967), etc. The key-points of the characters were shape of leaflets, the number of compound leaves, the shape of the stipule, the length of the peduncle, the number of flowers in the inflorescence, the shape of the pod, the color of the pod, etc. And there were some differences in some critical features by investigators.

On the other hand, many investigations on the karyotype of the genus *Vicia* were reported, but they have not thoroughly investigated on the karyotypes of many species in whole sections. And also, no clear relationship between the morphological characters and the karyotype has been found.

An analysis of the karyotypes of 26 species above mentioned, indicated the presence of some critical characteristics between the species; noted features were the gradual change as found in the total chromosome length, the shape of the satellite chromo-

some, the number of pairs of subterminal chromosome, presence or absence of the smallest chromosome and the chromosome with secondary constriction. And the external morphological characteristics of these species were in agreement with the characteristic of the karyotype among the related species or species groups. For this reason, it is more reasonable to consider along with their karyotype besides the morphological characteristics. Therefore, the present author has arranged the species or species groups according to the arrangement of Plitmann (1967) and added to the characteristic of the karyotype. The result is indicated in Table 3.

From the table, the relationship between the closely related species can be deduced more clearly than only from the morphological characteristics.

Table 3. Karyotaxonomical analysis of annual *Vicia* species

-
- I. Peduncle conspicuous, usually many flowered
1. Total chromosome length short, 2-4 submedian chromosomes
 - i. Pod broad, yellowish brown color,
 - a. Large leaflets, reddish purple flower color, satellite conneted with long arm to subterminal chromosome
1 *V. atoropurprea*
 - b. Small leaflets, reddish purple flower color, satellite connected to short arm
2 *V. villosa*, 3 *V. eriocarpa*, 4 *V. dasycarpa*, 5 *V. varia*, 6 *V. tenuifolia*
 - ii. Pod somewhat broad, flower small, brownish yellow pod color, $2n=12$, satellite connected to short arm of subterminal chromosome
7 *V. neglecta*
- Species No. 1 to 7 belong to section *Cracca*.
- II. Peduncle length intermediate, flowers less than 10 per axil, somewhat small sized. reddish purple flower color, many submedian chromosomes
2. Total chromosome length short, 4 submedian chromosomes, leaflet truncate or retuce, leaves with many (10-20) pairs, pod torulose, brown color
8 *V. ervilia*
 3. Total chromosome length intermediate, many (4-6) submedian chromosomes, leaflets linear or oblong, small sized, less than 10 pairs
 - i. Black, torulose, bearded pod
9 *V. hirsuta*
 - ii. Pod linear, subtorulose, glabrescent and brown
10 *V. tetrasperma*, 11 *V. tenuissima*
- III. Flowers few per axil, peduncle short, many submedian chromosomes
4. Leaflets oblong, pod broad, brown color
12 *V. biennis*, 13 *V. morantha*
- Species No. 8 to 13 belong to section *Ervum*.
- IV. Peduncle short, short pedicelled, 1-3 flowers per axil, few (0-2) submedian chromosomes
5. Leaflets retuce, reddish purple flower, intermediate size, pod tubular of somewhat compressed, total chromosome length comparatively short, satellite connected to a long arm, $2n=12$
 - i. Yellowish brown pod, compressed
14 *V. leganyana*
 - ii. Terete dark brown pod, $2n=10$

15 *V. cordata*

6. Leaflets usually wide, some or all dentate or incised at margins or towards apex, pod small, terete, satellite connected to short arm of subterminal chromosome

16 *V. incisa*

7. Total chromosome length comparatively long, yellow flower, elliptic leaflets, entire leaf
i. Pod black, long terete, glabrous, seed compressed, yellowish, satellite connected to a short arm

17 *V. grandiflora*

- ii. Compressed, large, yellow, bearded pod, satellite connected to short arm of subterminal chromosome

18 *V. pannonica*

- iii. Satellite connected to long arm of subterminal chromosome, flowers 1-2 per axil

19 *V. hyrcanica*

8. Total chromosome length long, secondary chromosome constriction

- i. Long subterminal chromosome with secondary constriction, satellite connected to long arm of subterminal chromosome, leaflet oblong, pod broad, compressed, bearded

a. $2n=14$ 20 *V. michauxii*b. $2n=10$ 21 *V. melanops*

- ii. Satellite connected to short arm, large pod covered with long hair

22 *V. lutea*

9. Total chromosome length long, satellite connected to long arm of long subterminal chromosome

- i. Linear leaflet, reddish purple flower

23 *V. peregrina*

- ii. Leaflets oblong, yellow flower

24 *V. hybrida*

Species No. 14 to 24 belong to section *Euvicia*.

- V. Large, oblong leaflets, compound leaf with 2 pairs of leaflets, flower few per axil, long peduncle, bluish purple flower, pod large, semi-terete, only subterminal chromosomes, short satellite connected to short arm

25 *V. bithynica*

- VI. Flowers few per axil, peduncle capped by leaves, leaflets large, compound leaf with 2 pairs of leaflets, leaflets elliptic, tendril, 4 pairs of submedian chromosomes, satellite connected to long arm of subterminal chromosome

26 *V. narbonensis*

Species No. 25 and 26 belong to section *Faba*.

SUMMARY

The karyotypes of 26 species of *Vicia* were observed and the relationships of the external morphological character and the karyotypes were discussed. For all species, one pair of satellite chromosomes was observed, and in some species of sec. *Euvicia* a pair of chromosomes with a secondary constriction was also observed. In almost all the species, some submedian chromosomes were observed, while in the others, the chromo-

somes were subterminal. The total chromosome length and the shape of satellite chromosome were also characteristic in respective species. From this standpoint, the 26 species were arranged in an order taking into consideration the external morphological characteristics and karyotypes.

LITERATURE CITED

- Cincura, F., 1962 Bemerkungen zur Zytologie der *Vicia* L. Arten aus den slovakischen Fundarten. Acta F.R.N. Univ. Comen 7 (6-7) (Botan.): 349-388.
- Darlington, C. D., and A. P. Wylie, 1955 Chromosome Atlas of Flowering Plants. George Allen & Unwin, London, 2nd Ed. 154-155.
- Ehara, K., 1950 Forage Crops I. Yokendo, Tokyo 355-359.
- Hanelt, P., und D. Mettin, 1962 Die Typisierung von *Vicia biennis* L. sowie systematische und cytologische Beobachtungen an *Vicia neglecta*. Kulturpflanze 10: 46-62.
- Hanelt, P., und D. Mettin, 1966 Cytosystematische Untersuchungen in der Artengruppe um *Vicia sativa* L. II. Kulturpflanze 14: 137-161.
- Hanelt, P., und D. Mettin, 1970a Zur systematischen Stellung von *Vicia oroboides* Wulf. Kulturpflanze 18: 179-188.
- Hanelt, P., und D. Mettin, 1970b Über die systematische Stellung temperater und meridionaler Sippen der Gattung *Vicia* L.. Feddes Repertorium 81 (1-5): 141-161.
- Huziwar, Y., and S. Kondo, 1963 Studies on the karyotype of *Vicia*. Bot. Mag. 76: 324-331.
- Kolev, I., und D. Terzijski, 1964 Karyologische und Embryologische Charakteristik von *Vicia melanops* S. S.. Plant Growing 1 (7): 43-49.
- Mettin, D., 1958 Zur Morphologie der Chromosomen von *Vicia sativa* L. Kulturpflanze 6: 116-122.
- Mettin, D., 1961 Die Chromosomenzahlen einiger bisher nicht untersuchter *Vicia*-Arten. Kulturpflanze 4: 37-44.
- Mettin, D., und P. Hanelt, 1964 Cytosystematische Untersuchungen in der Arten-Gruppe um *Vicia sativa* L. Kulturpflanze 12: 163-225.
- Mettin, D., und P. Hanelt, 1968 Bemerkungen zur Karyologie und systematik einiger Sippen der Gattung *Vicia* L. Feddes Repertorium 77 (1): 11-30.
- Plitmann, U., 1967 Biosystematical study of *Vicia* of the middle-east. Private publication 1-128.
- Rousi, A., 1961 Cytotaxonomical studies on *Vicia cracca* L. and *V. tenuifolia* Roth I. Chromosome numbers and karyotype evolution. Hereditas 47: 81-110.
- Sveschnikova, I. N., 1927 Karyological studies on *Vicia*. Bull. Appl. Bot. Gen. Plant-Breed. 17 (3): 63-72.
- Sveschnikova, I. N., 1940 Cytological of heterosis in hybrids of *Vicia*. J. Hered. 31: 349-360.
- Shinotô, Y., 1944 Method of indication of karyotype. Kagaku 14: 76-78.
- Yamamoto, K., 1966 Studies on the hybrids between the *Vicia sativa* L. and its related species. Mem. Fac. Agr. Kagawa Univ. 21: 1-104.
- Yamamoto, K., 1968 On the interspecific hybrid between *Vicia sativa* and *V. macrocarpa*. Japan. J. Breeding 18 (3): 156-166.
- Yamamoto, K., 1971 On the secondary balanced Karyotypes of $M-m_4+s_1M-m_4+s_1$ and $M-m_4+a_4M-m_4+a_4$. Tech. Bull. Fac. Agr. Kagawa Univ. 22 (1): 1-8.
- Zertova, A. C., 1969 Bemerkungen zur Taxonomie von *Vicia sepium* L. Folia Geobiologia et Phytotaxonomica 4: 303-311.