The Male Genitalia in *Culex pipiens* Collected in Taegu, South Korea

by
Sohn Suck Rak[1] and Takashi Ishii[2]

ABSTRACT. *Culex pipiens pipiens* L. was found, for the first time in South Korea, among light trap collections. The seasonal change of the shape of the male genitalia in the *Cx. pipiens* complex of South Korea was studied and morphological comparisons were made between South Korean and Japanese specimens.

INTRODUCTION

Cx. pipiens pipiens has not previously been reported from South Korea (Yamaguti and LaCasse 1950, Kim et al. 1971, Tanaka et al. 1979). The last-mentioned authors stated: "The nominal subspecies, *Cx. pipiens pipiens* Linnaeus, and one or more other subspecies do not occur in this region (Japan and the Korean Peninsula)".

However, we found 10 adult male *Cx. p. pipiens* clearly identifiable as such by the shape of the genitalia, among the mosquitoes collected by light traps in Taegu, South Korea in 1983 and 1984 (Sohn and Ishii 1987). The seasonal change in the shape of the dorsal and ventral arms of the male genitalia was also studied and the morphology was compared with that of Japanese specimens collected in Nagoya.

MATERIALS AND METHODS

We examined 1321 adult male mosquitoes collected by light traps set in two houses (HR and HP; 415 and 574), a pigpen (PP; 266) and a stable (ST; 66) in Taegu (35°53'N; 128°37'E) in 1983 and 1984. The details of the trap operation were described in a previous paper (Sohn and Ishii 1987). For comparison, 100 male adults of *Cx. p. pallens* collected by Drs. K. Makiya and H. Ito in Nagoya (35°10'N; 136°58'E), Japan in 1981 were examined.

1,2 College of General Education, University of Tokushima, 1-1 Minamijosanjima, Tokushima 770, Japan.

1 Present address: Biology Department, Taegu National Teacher's College, 1797-5, Daemyeong-2dong, Namgu, Taegu 634, Korea.

The male genitalia were mounted in Canada balsam by the usual routine methods. Measurements V (the distance between the points of the ventral arms) and D (the distance between the outer margins of the tips of the dorsal arms) were made by a direct-reading micrometer for calculation of DV/D ratios (= (V-D)/2D) (Fig. 1).

RESULTS AND DISCUSSION

As already reviewed in an earlier paper (Ishii 1980), there is wide variation in the shape of the male genitalia of *Cx. pipiens*. We have recognized 13 types (types A to K, Z_1 and Z_2) of dorsal arms, 7 types (types a to g) of ventral arms (DA-type and VA-type) and 3 postural types (types I to III) relative to the positioning of the arms (DVP-type), in specimens of *Cx. p. pipiens*, *Cx. p. pallens*, *Cx. p. quinquefasciatus* and *Cx. p. molestus* collected all over the world (Fig. 1). Types A to C and a and b are common in *Cx. p. pipiens*, types D to H and c and d are common in *Cx. p. pallens* and types I to K and e to g are common in *Cx. p. quinquefasciatus*. Types Z_1 and Z_2 were found in laboratory reared hybrids between *Cx. p. pallens* and *Cx. p. quinquefasciatus*. All DVP-types can be recognized in the subspecies mentioned above, although the illustration in Fig. 1 is limited to *Cx. p. pipiens* (details of these types will be discussed in a separate paper).

Among 1321 specimens collected in Taegu, 10 were identified as *Cx. p. pipiens* based on DV/D and the VA-type by following the keys of Tanaka et al. (1979) and the description of Harbach et al. (1985); 1309 were considered as *Cx. p. pallens* (Fig. 2). Examples like No. 1 in Fig. 2 were identified as *Cx. p. pipiens*. Those like No. 2 with 0.05 DV/D were not so considered, but because of their possession of broad ventral arms were identified as *Cx. p. pallens*. Specimens like Nos. 3 and 4 were identified as *Cx. p. pallens*, and one abnormal type (No. 5) was found.

Similar types of genitalia were recognized in the Taegu and Nagoya specimens: 10 DA-types (A to H, Z_1 and Z_2), 3 VA-types (b, d and e), and all 3 DVP-types in the former; 11 VA-types (A to I, Z_1 and Z_2), 3 VA-types (c, d and f), and the 3 DVP-types in the latter (Fig. 3). However, there are significant differences in the distribution patterns of the DA-, VA-, and DVP-type (x^2 = 56.37, 27.25 and 60.43; $P < 0.01$, respectively) between the Taegu and Nagoya specimens. Types A, B, C, and D are abundant in the Taegu sample while type E is predominant in the Nagoya one. Type e is abundant in the former, but most of Nagoya are referable to type d. Type II is less frequent than type III from Taegu while the order is reversed in specimens from Nagoya. This tendency means that the percentage of the specimens of *Cx. p. pallens* that are close to *Cx. p. pipiens* in the form of the genitalia is larger in Taegu specimens than in Nagoya specimens.

DV/D of 9 *Cx. p. pipiens* out of 10 (solid circles in Fig. 4) were smallest in each catch. However, some of them like No. 2 in Fig. 2 (collected at a house in paddy field (HP) in late June (6L) 1983) was smaller than or equivalent to the *Cx. p. pipiens* specimens.

The mean DV/D of the Taegu collection is slightly but significantly ($P < 0.01$) larger than that of the Nagoya specimens (Fig. 3). Some workers (e.g., Barr 1957, Tabachnick and Powell 1983) consider all specimens possessing DV/D less than 0.2 to be *Cx. p. pipiens;* between 0.2 to 0.4, intermediates (= *Cx. p. pallens);* and greater than 0.4, *Cx. p. quinquefasciatus.* If these criteria were applied, more than half of the Taegu specimens are intermediate and only 36% are *Cx. p. pipien,* while more than half of the Nagoya specimens are *Cx. p. pipiens.* In both collections, *Cx. p. quinquefasciatus* was found less frequently. This suggests that the origin of *Cx. p. pallens* (the intermediate form) is not by hybridization between *Cx. p. pipiens* and *Cx. p. quinquefasciatus* as formerly believed (Spielman 1967). As reviewed before (T.Ishii 1980), the variation is nothing more than a morphological cline between the two extremities, that are now usually given the standing of species or subspecies.

There were no significant differences at P=0.05, tested by the Anova and Duncan's test (S.Ishii 1983) in the mean DV/D among the four Taegu trap collections and in the seasonal changes of the mean DV/D within the four trap collections (Fig. 4). A similar result was also obtained with *Cx. p. pallens* of Isahaya (Kyushu, Japan) (Kamura 1958). *Cx. p. pipiens* appeared randomly in the Taegu light trap collections.

Among the combinations of the DA-, VA-, and DVP-types, combination E-d followed by D-d, prevails in Taegu and Nagoya (Table 1). However, the frequency of occurrence of the combinations of the types is significantly different ($x^2 = 66.33$, $P < 0.01$) between the two localities. Many combinations were observed in Taegu. Both E-d and D-d are typical in *Cx. p. pallens.*

Cx. p. pipiens has never been recorded from Japan because it has been held until recently that autogenous *Cx. pipiens* should be identified as *Cx. p. molestus,* all immature stages of which were believed to live only in ecologically isolated underground-pools. It is now known that this is not so, for Makiya (1974) collected the *Cx. p. pipiens*-like specimens in open fields. Moreover, such examples are not always autogenous (T.Ishii 1983). The criteria previously used in Japan to separate *Cx. p. molestus* from *Cx. p. pipiens* (Sasa et al. 1976) therefore has lost its reliability and the occurrence of *Cx. p. pipiens* in Japan must now be recognized. According to Harbach et al. (1984), *Cx. p. molestus* has no taxonomic status, therefore, this subspecific name should be abandoned to refer the autogenous populations of the *Cx. pipiens* group in Japan.

There is no way of knowing whether or not our *Cx. p. pipiens* specimens from South Korea were produced autogenously. Since *Cx. p. molestus* has not been reported from South Korea and the possibility of an invasion of autogenous *Cx. p. pipiens* from elsewhere (e.g., Japan) into South Korea has never been considered, the above specimens are considered indigenous to South Korea.

ACKNOWLEDGEMENTS

We would like to express our sincere thanks to D. M. Laird, University of Aukland and Dr. A. R. Barr, School of Public Health, University of California, Los Angeles, for critical reading of the manuscript. Thanks are also extended to Dr. K. Makiya, Department of Medical Zoology, University of Occupational and Environmental Health and Dr. H. Ito, Nagoya City Health Research Institute for kindly supplying the material discussed herein. Also appreciation is expressed to the Ministry of Education, Science and Culture, Government of Japan for a research grant to the senior author while staying at the University of Tokushima.

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EXPLANATION OF FIGURES

Fig. 1. Types of the dorsal and ventral arms (DA- and VA-type) and of the relative position of the two arms (DVP-type) occurring in *Cx. pipiens* specimens collected all over the world.

Fig. 2. Male genitalia of *Cx. p. pipiens* (1), *Cx. p. pallens* (3 and 4), intermediates between the two (2) and an abnormal (5) specimen collected in Taegu, South Korea. St, stable; HP, house in paddy fields; HR, house in residential area. Date of collection in parentheses. E, early; L, late.

Fig. 3. Frequency of DV/D and DA-, VA- and DVP-types observed in specimens from Taegu, South Korea, and Nagoya, Japan.

Fig. 4. Seasonal change of DV/D in four light trap collections made at Taegu, South Korea. Solid circle indicates a value of *Cx. p. pipiens*.

Table 1. Frequency (>5%) of various combinations of the DA-, VA- and DVP-types occurring at Taegu, South Korea, and Nagoya, Japan.

Samples	n	Combinations	%
Taegu	1004	D-d-III	18.9
		E-d-III	14.8
		E-d-II	12.4
		D-d-II	5.2
		B-d-III	5.2
		others*	43.5
Nagoya	100	E-d-II	41.2
		E-d-III	16.0
		D-d-III	10.0
		D-d-II	8.0
		others**	25.0

* 43 combinations.

** 25 combinations.

Figure 1

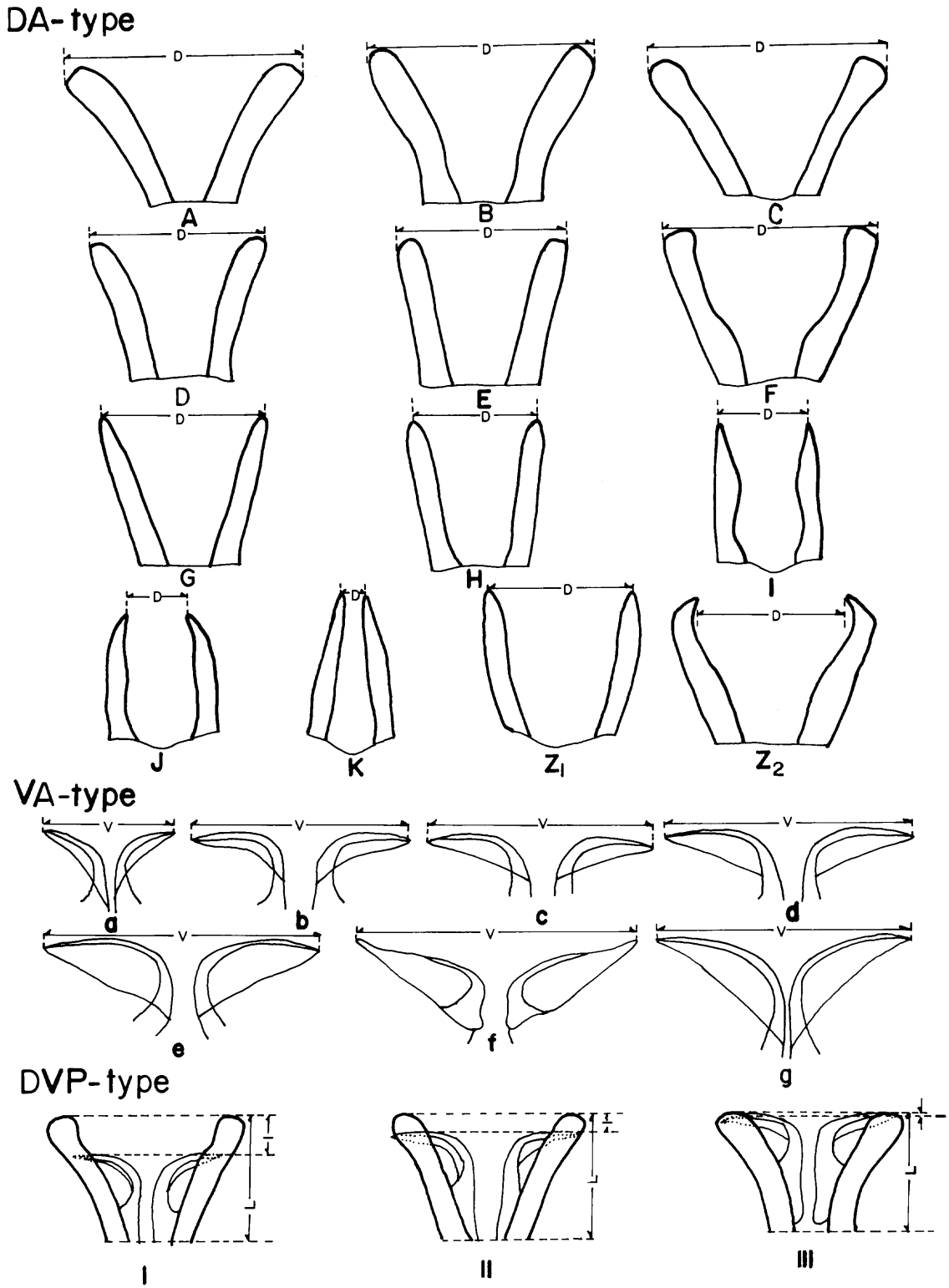
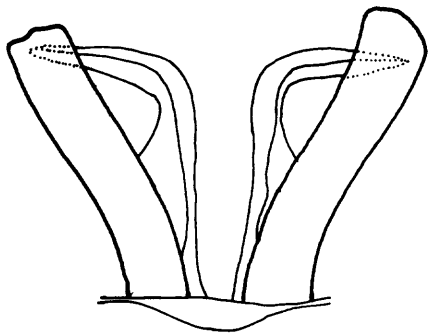
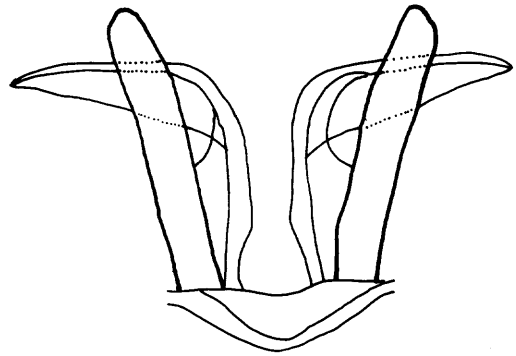


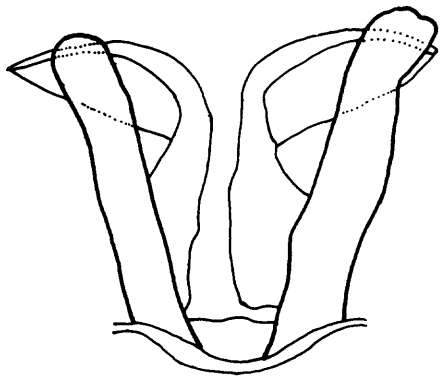
Figure 2



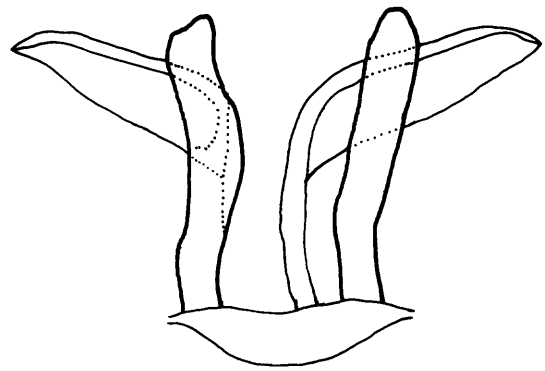
1. ST (84,8E)
DV/D = -0.05



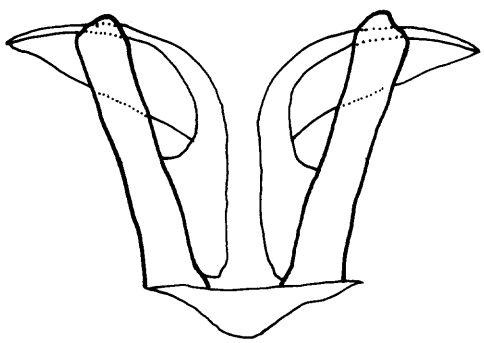
4. HP(83,6L)
DV/D = 0.27



2. HP(83,6L)
DV/D = 0.05



5. ST(84,9L)
DV/D = 0.59



3. HP(83,7L)
DV/D = 0.21

Figure 3

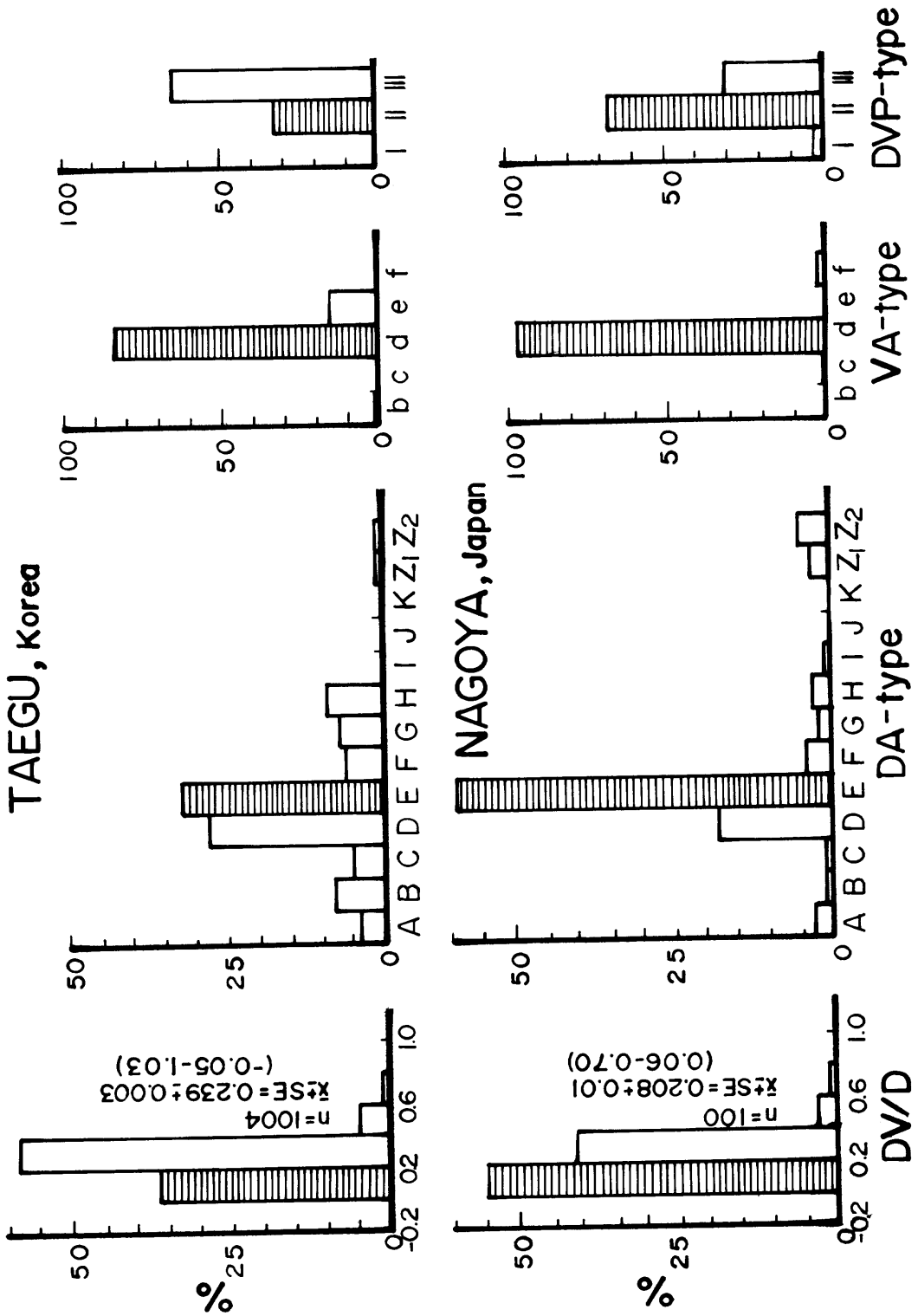
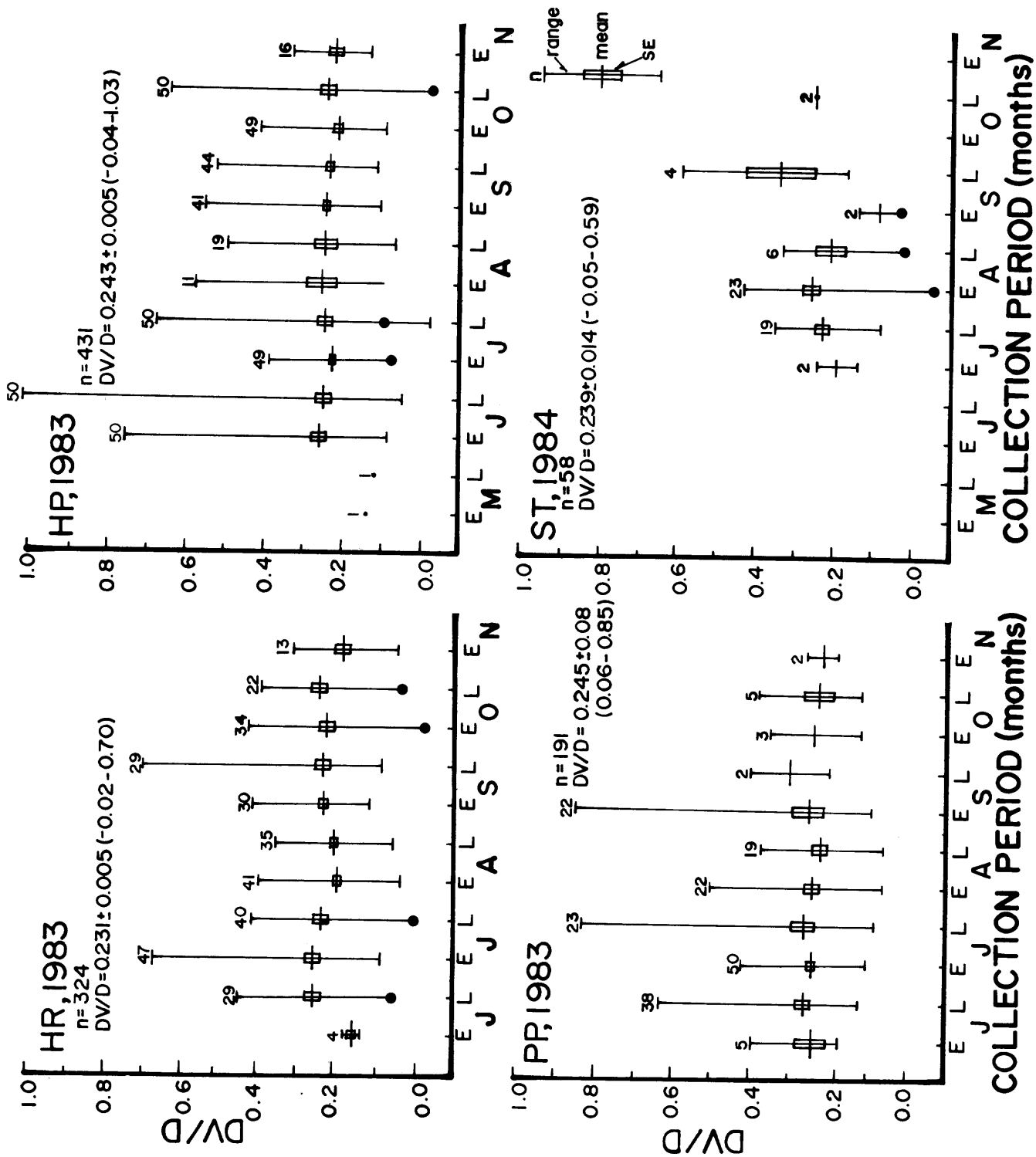

TAEGU, Korea
NAGOYA, Japan
DA-type
VA-type
DVP-type
DV/D
%
A B C D E F G H I J K Z1 Z2
a b c d e f
I II III
n=1004
x̄±SE=0.239±0.003
(-0.05-1.03)
n=100
x̄±SE=0.208±0.01
(0.06-0.70)

Figure 4


HP, 1983
n=431
DV/D=0.243±0.005(-0.04-1.03)
HR, 1983
n=324
DV/D=0.231±0.005(-0.02-0.70)
ST, 1984
n=58
DV/D=0.239±0.014(-0.05-0.59)
PP, 1983
n=191
DV/D= 0.245±0.08
(0.06-0.85)
n range mean SE
DV/D
M J J A S O N
COLLECTION PERIOD (months)