



## **Geographic Variation in the Two Smooth Skinks, *Scincella boettgeri* and *S. formosensis* (Squamata: Scincidae), in the Subtropical East Asian Islands**

Authors: Chen, Szu-Lung, Ota, Hidetoshi, and Hikida, Tsutomu

Source: Zoological Science, 18(1) : 115-130

Published By: Zoological Society of Japan

URL: <https://doi.org/10.2108/zsj.18.115>

---

BioOne Complete ([complete.BioOne.org](https://complete.BioOne.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](https://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

# Geographic Variation in the Two Smooth Skinks, *Scincella boettgeri* and *S. formosensis* (Squamata: Scincidae), in the Subtropical East Asian Islands

Szu-Lung Chen<sup>1\*†</sup>, Hidetoshi Ota<sup>2</sup> and Tsutomu Hikida<sup>1</sup>

<sup>1</sup>Department of Zoology, Graduate School of Science, Kyoto University, Sakyo, Kyoto 606-8502 Japan and

<sup>2</sup>Tropical Biosphere Research Center, University of the Ryukyus, Nishihara, Okinawa 903-0213 Japan

**ABSTRACT**—*Scincella boettgeri* and *S. formosensis* are two small lygosomine skinks endemic to the southern Ryukyus and Taiwan, respectively. Taxonomic separation of these two species depends on only a few external characters that are seemingly more or less variable within each species. To investigate the geographic pattern of their morphological variations, multivariate analyses were performed for 23 meristic and 16 morphometric characters in 680 specimens of *S. boettgeri* from 12 islands of the Miyako and Yaeyama Groups and 193 specimens of *S. formosensis* from ten localities in Taiwan. The canonical discriminant analysis (CDA) for samples representing local populations using meristic data completely separated the southern Ryukyu and Taiwanese assemblages, supporting their assignments to different taxa. On the other hand, the analyses using morphometric data remained their variations partially overlapping each other. Of the samples of *S. boettgeri* examined, the Haterumajima sample markedly varied from the others, whereas the Kaohsiung sample was somewhat divergent among the *S. formosensis* samples. Neighbor-joining phenograms derived from Mahalanobis distances among the samples showed branching patterns apparently inconsistent with the topographical (for *S. formosensis*) or putative geohistorical relationships of their localities (for *S. boettgeri*). This suggests that in these species external quantitative characters often rapidly vary under the influence of localized environments rather than of the passage of time after geographical isolations.

## INTRODUCTION

*Scincella boettgeri* (Van Denburgh, 1912) and *S. formosensis* (Van Denburgh, 1912) are two small lygosomine skinks endemic to the Miyako and Yaeyama Groups of the southern Ryukyus, and Taiwan, respectively. Van Denburgh (1912a, b) described both of these taxa as subspecies of *Leiolopisma laterale* (Say, 1823) (= *Scincella lateralis*) from North America. He diagnosed them from each other, as well as from the nominotypical subspecies, on the basis of relative positions of prefrontals, the numbers of scales around the middle and along the middorsal line of body, and the degree of distinctness in the lower border of the dorso-lateral dark stripe. Van Denburgh's (1912b) account was followed by most subsequent authors. However, Schmidt (1927a, b) considered that the East Asian populations of *Scincella* are morphologically distinct from

North American *S. lateralis* and that they deserve status as two separate species. Nakamura and Uéno (1963), on the other hand, treated *boettgeri* and *formosensis* as subspecies of *Lygosoma reevesii* (Gray, 1838) (= *S. reevesii*) from the continental China.

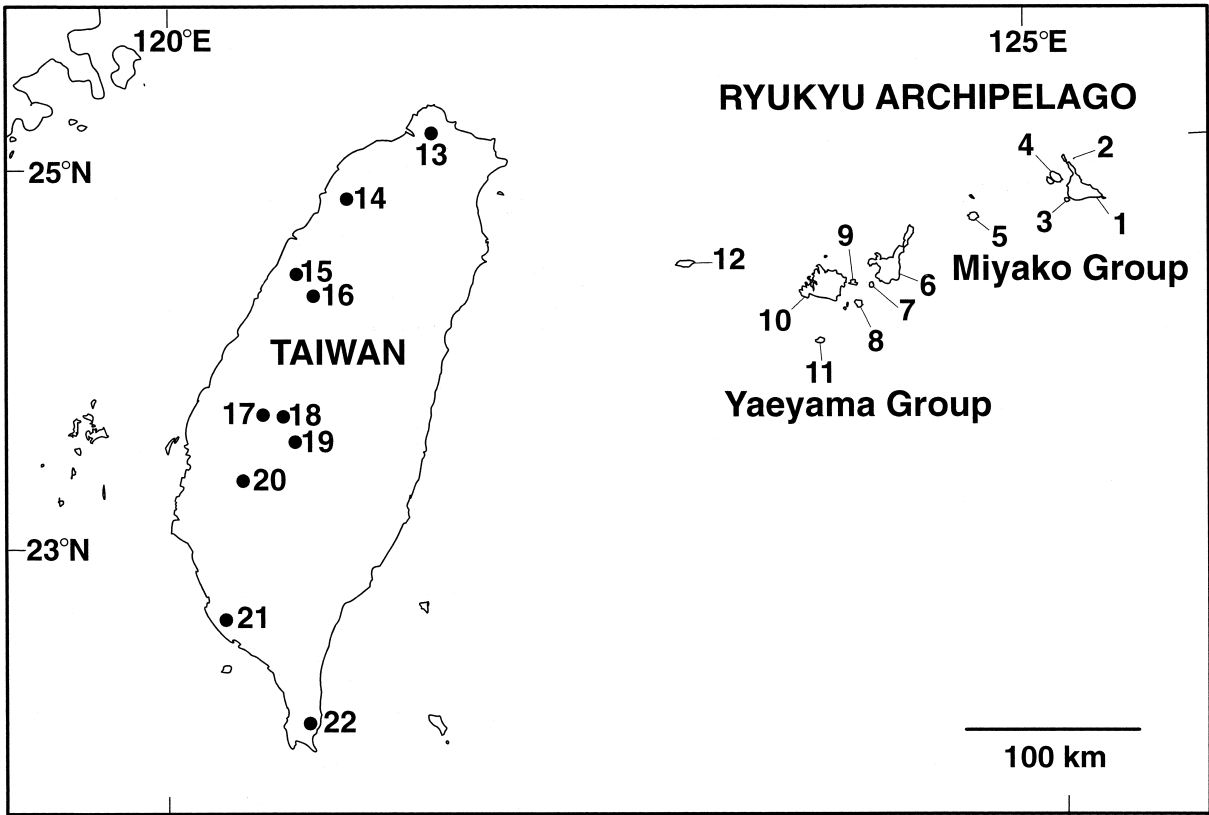
Based on the external and osteological comparisons, Greer (1974) accepted Schmidt's (1927a, b) view and recognized the two taxa from subtropical East Asian islands as distinct from *S. lateralis* or *S. reevesii* at the specific level. He, on the other hand, suspected *boettgeri* and *formosensis* to be conspecific, but deferred the conclusion in this regard. In his revision of the Asian *Scincella*, Ouboter (1986) assigned populations from the whole East Asia, including those from the Korean Peninsula, Taiwan, the Ryukyu Archipelago, and the Tsushima Islands, to *S. modesta* (Günther, 1864), a species originally described from continental China (Günther, 1864), without recognizing validities of *boettgeri*, *formosensis*, and a few other East Asian nominotypical taxa. However, he apparently examined only a few, very small samples from that region, failing to access to even a single representative for either Ryukyu or Taiwanese populations (Ota, 1991b; Matsui

\* Corresponding author: Tel. +81-98-895-8937;

FAX. +81-98-895-8966.

E-mail: skink@zoo.zool.kyoto-u.ac.jp

† Present Address: Tropical Biosphere Research Center, University of the Ryukyus, Nishihara, Okinawa 903-0213 Japan



**Fig. 1.** A map of the southern Ryukyus and Taiwan showing the sampling localities of *Scincella boettgeri* and *S. formosensis*. Sample numbers correspond to those in Table 1.

**Table 1.** Specimens of *Scincella boettgeri* and *S. formosensis* used for the present study.

Species	Locality	Female		Male		Total
		Adult	Juvenile	Adult	Juvenile	
<i>S. boettgeri</i>	Miyako Group					
	1. Miyakojima	38	51	46	82	217
	2. Ohgamijima	4	11	0	13	28
	3. Kurimajima	18	51	6	55	130
	4. Irabujima	18	5	16	6	45
	5. Taramajima	18	25	24	18	85
	Yaeyama Group					
	6. Ishigakijima	5	0	3	0	8
	7. Taketomijima	7	0	20	0	27
	8. Kuroshima	23	0	36	0	59
	9. Kohamajima	3	0	2	0	5
	10. Iriomotejima	6	0	25	0	31
<i>S. formosensis</i>	11. Haterumajima	4	0	7	0	11
	12. Yonagunijima	19	1	14	0	34
	13. Taipei	2	0	1	0	3
	14. Hsinchu	8	0	10	0	18
	15. Miaoli	18	5	9	7	39
	16. Taichung	4	0	15	0	19
	17. Yunlin	1	0	3	0	4
	18. Nantou	17	0	40	0	57
	19. Chiayi	2	0	4	0	6
	20. Tainan	1	13	2	16	32
	21. Kaohsiung	6	0	7	0	13
	22. Pingtung	0	0	1	1	2
Total		222	162	291	198	873

and Ota, 1995).

Besides being an important taxonomic subject by itself, the East Asian *Scincella* also seems to be a suitable material to examine historical biogeography in this region. The herpetofauna of the southern Ryukyus is considered to be close to that of Taiwan (Ota, 2000), with most of its endemics supposedly split from Taiwanese counterparts through relatively recent vicariance events (Ota, 1998). However, very few studies have actually been conducted to assess geographic pattern of variation in lineages common to the southern Ryukyus and Taiwan. Moreover, most of the relevant studies hitherto carried out only used univariate analyses and qualitative comparisons (Ota, 1988, 1991a; Ota and Toyama, 1989; Ota *et al.*, 1997), and thus failed to evaluate the pattern of quantitative variation in more appropriate manner (e.g., Willig *et al.*, 1986; Thorpe, 1987; Wüster *et al.*, 1992; but see Matsui [1994], and Yasukawa and Ota [1999]). The southern Ryukyu-Taiwan *Scincella* populations are expected to be a suitable material to investigate continuity and discontinuity of variation in a terrestrial vertebrate lineage in this region, because (1) they commonly occur almost throughout this region, including small islets in the southern Ryukyus; and (2) the Taiwanese and southern Ryukyu populations are obviously closely related to each other (see above).

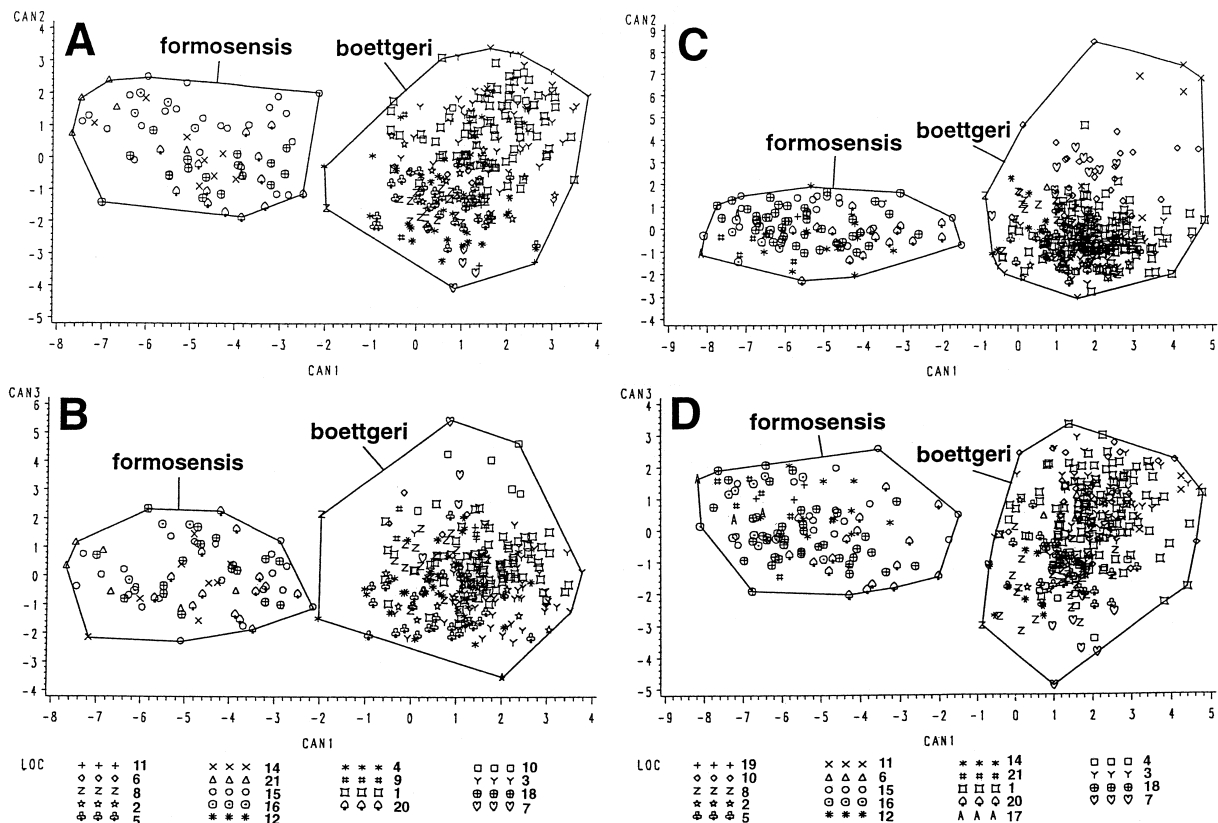
In this study we made quantitative analyses of morphological variation among the local populations of *Scincella* from

the southern Ryukyus and Taiwan on the basis of large samples. Our purposes are: (1) to elucidate the comprehensive geographic pattern of their variation; (2) to assess the adequacy of taxonomic arrangements of those populations by the previous authors (see above); (3) to investigate historical biogeography of the southern Ryukyu-Taiwan area as illustrated by the pattern of their variation; and (4) to infer factors causing the quantitative morphological variation in the local lizard populations.

## MATERIALS AND METHODS

In the following sections, we tentatively refer to the southern Ryukyu and Taiwanese populations of *Scincella* as *S. boettgeri* and *S. formosensis*, respectively, for convenience.

A total of 873 specimens, including 680 of *S. boettgeri* from 12 islands of the Miyako and Yaeyama Groups, southern Ryukyus, and 193 of *S. formosensis* from ten localities within Taiwan, were examined (see Fig. 1, Table 1, and Appendix 1 for locations of sampling localities in the southern Ryukyus and Taiwan, sample sizes, and information regarding voucher specimens, respectively). Each specimen was examined for 39 quantitative characters (23 meristic and 16 morphometric characters) including all of those meristic characters so far used in the classification of the genus *Scincella*. The 23 meristic characters (symmetrical ones examined on the right side) included the numbers of: nuchals (N), supralabials (SL), infralabials (IL), supraciliars (SC), ciliars (C), presuboculars (PRSO), postoculars (PO), postsuboculars (PSO), suboculars (SBO), scales between secondary temporal and ear opening (SBTE), temporals in contact with pari-



**Fig. 2.** Two-dimensional plots of scores of canonical variables for 23 meristic characters in *Scincella boettgeri* and *S. formosensis*: A, the first against the second variables in females; B, the first against the third variables in females; C, the first against the second variables in males; D, the first against the third variables in males. Sample numbers correspond to those in Fig. 1 and Table 1.

etal (TCP), gular and ventral scales (GVS, counted from mental to preanals), dorsal scales (DS, counted from parietals to the just posterior margin of hindlimbs), midbody scale rows (MBSR, counted around midbody), subdigital scales of finger IV and toe IV (F4S and T4S, respectively; counted only for specimens having undamaged tips of finger IV and toe IV), scale rows between dorso-lateral stripes (SRBDLS), scale rows covered by dorso-lateral stripe (SRB), and small scales between tail base and the first enlarged subcaudal (UESC); condition of prefrontals (PF); and the presence or absence of dark spots on dorsal part of body (DSD), gular (DSG), and ventral part of tail (DSVT). The latter four characters were coded before the analyses as follows: prefrontals contacting at certain breadth, contacting at a point, and separated as 0, 1, and 2, respectively; absence and presence of dark spots as 0 and 1, respectively. The 16 morphometric characters (measured in 70% ethanol preservation condition; to nearest 0.1 mm by dial calipers or ocular micrometer; on the right side for symmetrical ones) included snout-vent length (SVL), axilla to groin length (AGL), snout to forelimb length (SFL), snout to eye length (SEL), snout to ear opening length (SEOL), eye to ear opening length (EEL), forelimb length (FLL), hindlimb length (HLL), toe IV length (T4L), head length (HL), head width (HW), head depth (HD), eye length (EL), ear opening length (EOL), ear opening width (EOW), and length of transparent disc on lower eyelid (TDL). Data for all these morphometric characters were log-transformed in advance of CDA. Sex and maturity of each specimen were determined on the basis of gonadal investigations: a given specimen was defined as an adult if it had enlarged testes and/or epididymides (male), or yolked follicles and/or expanded oviducts (female) (Okada *et al.*, 1992).

Specimens from a same island of the southern Ryukyus or from a same locality in Taiwan were designated as constituting a single operational taxonomic unit (OTU) for multivariate analyses under an

*a priori* assumption that they belong to a same breeding population. To assess inclusive variation in quantitative characters among OTUs, canonical discriminant analysis (CDA) was performed using correlation matrix and the CANDISC procedure of SAS (1990). Mahalanobis distances ( $D^2$ ) among OTUs were obtained, and were subjected to cluster analysis by the neighbor-joining (NJ) method (Saitou and Nei, 1987) using the NEIGHBOR program in PHYLIP 3.41 (Felsenstein, 1989). This method, being free from most of the unfavorable attributes common to other clustering methods (de Queiroz and Good, 1997), was first devised for the construction of phylogenetic trees on the basis of genetic distance matrices, but has turned out to be useful in constructing phylograms using morphological distance matrices as well (e.g., Hikida, 1993; Ota *et al.*, 1995, 1999).

In the preliminary analyses of covariance, most morphometric characters proved to allometrically vary in more or less size-related (and hence age-related) fashion. Moreover, some morphometric and meristic characters showed significant differences between male and female samples of single OTUs (i.e., putative representatives of single populations: see above) (details not given: relevant data are available from the senior author on request). We thus excluded morphometric data for juveniles and analyzed data for females and males separately to minimize the influences of age- and sex-related within-population variations and sampling biases on results of the present analyses. Furthermore, to minimize the risk of overall shrinkage of canonical variation among samples, we processed data only for samples each consisting of more than three specimens. Consequently, one male sample of *S. boettgeri* (i.e., that from Kohamajima Island), and four female and two male samples of *S. formosensis* (i.e., those from Taipei, Yunlin, Chiayi, and Pingtung, and from Taipei and Pingtung, respectively) were excluded from meristic analyses. Also, two male samples of *S. boettgeri* (i.e., those from Ohgamijima and

**Table 2.** Standardized coefficients for the first three canonical axes of variation in 23 meristic characters (CAs I, II, and III). See MATERIALS AND METHODS for abbreviations of characters.

Characters	Females			Male		
	CA I	CA II	CA III	CA I	CA II	CA III
N	-0.0532	-0.0024	-0.1936	0.0620	-0.0254	0.1128
SL	-0.0567	-0.1200	-0.0990	0.0487	-0.1229	0.1246
IL	0.0845	0.1925	-0.1230	0.0027	-0.1194	0.0878
SC	-0.3625	0.1572	-0.0512	-0.2570	0.0631	0.0895
C	-0.0228	-0.0237	0.0070	-0.1178	-0.1314	0.1480
PRSO	0.1560	-0.0237	-0.0107	0.0187	-0.0045	-0.2393
PO	0.0062	0.0185	0.0016	-0.0411	-0.0653	0.0970
PSO	-0.0273	-0.2060	0.1292	0.1989	0.6302	0.1744
SBO	0.0345	-0.0114	-0.0119	0.0827	-0.1031	-0.0449
SBTE	-0.0719	-0.2450	-0.1023	-0.0767	0.1234	-0.1829
TCP	-0.0192	0.0072	-0.0445	-0.0939	-0.0891	0.0591
GVS	-0.4230	-0.2289	0.3775	-0.3281	0.1578	-0.1240
DS	0.0992	-0.1468	0.5611	0.2624	0.5827	-0.1831
MBSR	-0.2640	0.0011	0.3330	-0.1767	0.2340	0.1801
F4S	-0.3265	0.3442	0.3575	-0.2750	0.5770	0.3354
T4S	0.2073	0.6400	-0.3999	0.0163	-0.4574	0.4886
SRBDLS	0.5199	0.7333	0.4812	0.2961	0.1402	0.5219
SRB	1.6833	-0.1908	0.1592	2.4898	0.1421	-0.2668
UESC	-0.1462	0.0218	0.0238	0.1052	0.0648	0.0097
PF	0.3662	-0.0352	-0.0687	0.2430	0.0022	0.0762
DSD	-0.1055	0.0727	0.1868	0.0648	0.1574	0.0228
DSG	-0.0788	0.3362	-0.3611	0.1001	-0.4126	0.1630
DSVT	0.2499	0.2984	0.2020	0.2757	-0.0493	0.6466
Eigenvalue	6.6546	1.2960	0.6584	10.5086	1.2282	0.8997
Difference	5.3586	0.6376	0.1349	9.2805	0.3285	0.0557
Proportion	0.6263	0.1220	0.0620	0.6982	0.0816	0.0598
Cum. proportion	0.6263	0.7482	0.8102	0.6982	0.7798	0.8396

Kohamajima Islands), and five female and three male samples of *S. formosensis* (i.e., those from Taipei, Yunlin, Chiayi, Tainan, and Pingtung, and from Taipei, Tainan, and Pingtung, respectively) were excluded from morphometric analyses.

## RESULTS

### Comparisons of *S. boettgeri* and *S. formosensis* by meristic characters.

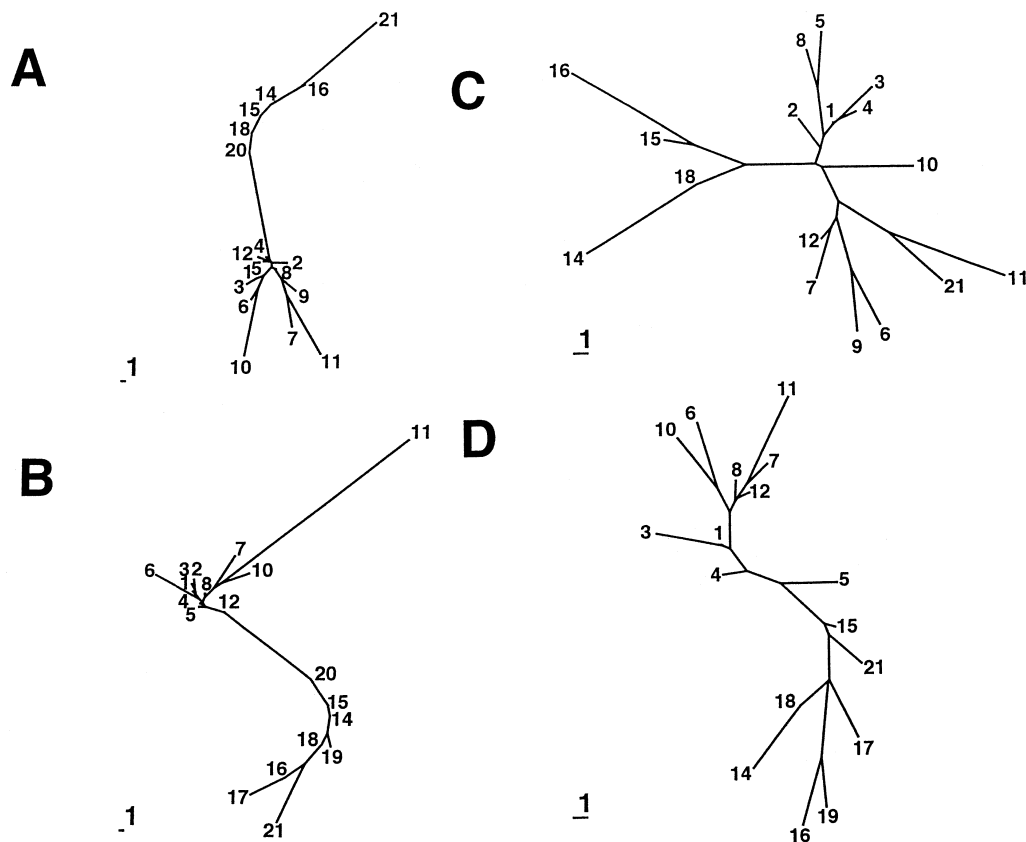
The CDA of 23 meristic characters (Appendix 2) revealed that 81.0% and 84.0% of the total variations in females and males were expressed by the first three canonical variables, respectively (Table 2). In both females and males, scores of the first canonical variable were distinctly greater in the samples of *S. boettgeri* than in those of *S. formosensis* (Fig. 2). By contrast, scores of the second and the third variables almost completely overlapped between the species in both sexes. Values of standardized coefficients (Table 2) indicated that in females the greatest proportion of variance on the first canonical axis was expressed by differences in the relative value of the number of scale rows covered by dorso-lateral stripe (SRB) (positive), and then by those of the number of scale rows between dorso-lateral stripes (SRBDLS) (positive). In males, the greatest proportion of variance on the first canonical axis was also expressed by differences in the relative value of SRB (positive), and then by those of the number of

gular and ventral scales (GVS) (negative).

Figs. 3A and B present phenograms depicting results of NJ analyses of Mahalanobis distances from meristic variations in females and males, respectively (distance values not given). In both sexes, samples of *S. boettgeri* and *S. formosensis* constituted two separate clusters in the phenogram.

### Comparisons of *S. boettgeri* and *S. formosensis* by morphometric characters.

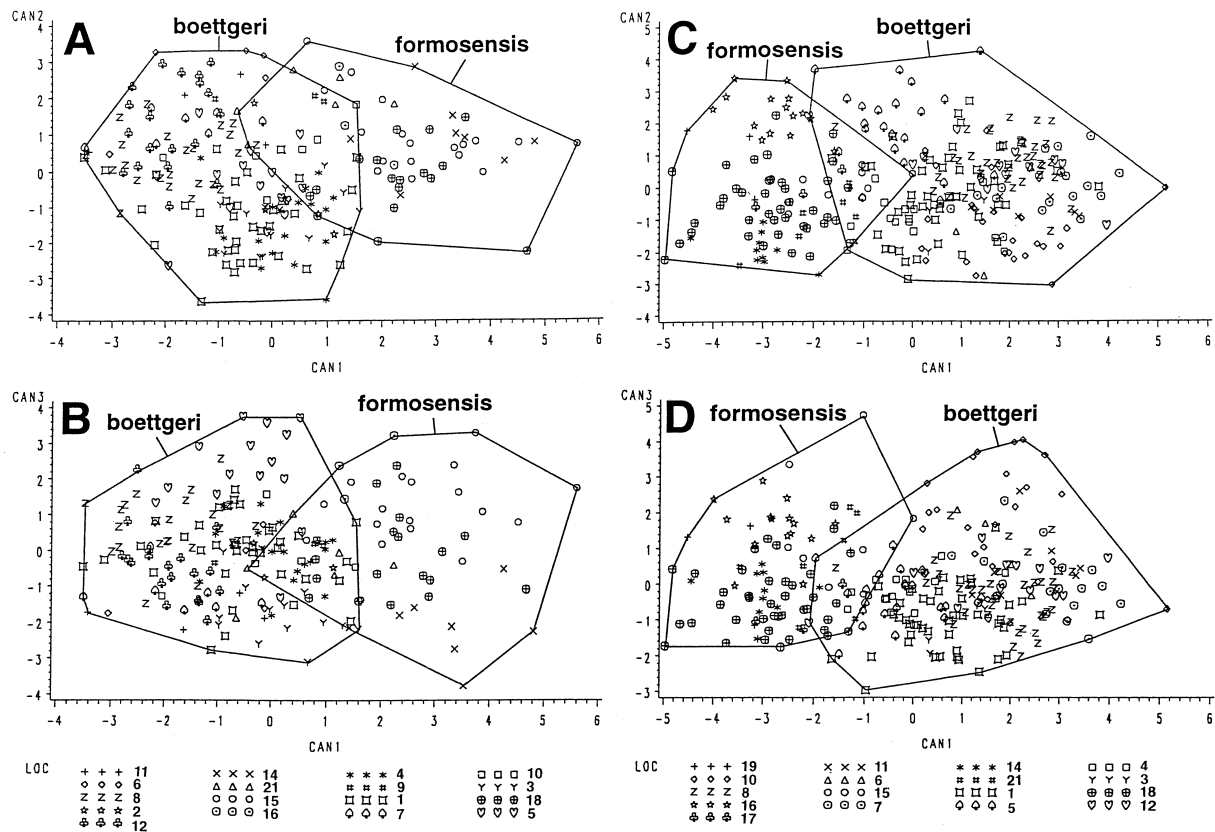
The CDA of 16 morphometric characters (Appendix 3) revealed 75.2% and 78.2% of the total variations in females and males expressed in the first three canonical variables, respectively (Table 3). In females, scores of the first canonical variable were largely greater in the *S. formosensis* samples than in the *S. boettgeri* samples, but with a substantial range overlap. In males, scores of the first canonical variable were generally greater in the *S. boettgeri* samples than in the *S. formosensis* samples, but also with a partial range overlap. Ranges of scores of the second and the third variables almost completely overlapped between the two species in both sexes (Fig. 4). Values of standardized coefficients (Table 3) indicated that in females the greatest proportion of variance on the first canonical axis was expressed by differences in the relative value of head depth (HD) (negative) and then by those of snout-vent length (SVL) (negative). In males, the



**Fig. 3.** Unrooted phenograms depicting the results of cluster analyses of Mahalanobis distances by the neighbor-joining method for 23 meristic characters of females (A) and males (B), and 16 morphometric characters of females (C) and males (D) of *Scincella boettgeri* and *S. formosensis*. Sample numbers correspond to those in Fig. 1 and Table 1.

**Table 3.** Standardized coefficients for the first three canonical axes of variation in 16 morphometric characters (CAs I, II, and III). See MATERIALS AND METHODS for abbreviations of characters.

Characters	Females			Males		
	CA I	CA II	CA III	CA I	CA II	CA III
SVL	−1.1690	−0.1533	−1.0513	2.9670	−2.6233	0.6904
AGL	0.6679	−1.3060	−0.6056	0.3212	−0.0784	−0.5510
SFL	−0.2623	1.2026	−0.0637	0.5596	0.1079	0.2225
SEL	0.5040	−0.4538	0.3181	−0.3449	0.0890	1.3506
SEOL	−0.2633	0.2976	−0.0812	−0.6340	1.4949	−1.0170
EEL	0.0182	0.0747	−0.0082	0.3394	−0.1713	0.2913
FLL	0.3454	0.4800	0.2315	−0.5372	0.1835	0.6364
HLL	0.3485	0.4437	−0.9791	−0.7759	−0.6016	−0.2660
T4L	0.7825	0.2016	0.1784	−0.1607	−0.4629	0.7280
HL	0.4917	−0.6596	0.7401	−1.3883	−0.2900	−0.7767
HW	−0.1122	0.1075	−0.3748	−0.1768	0.2020	−0.4042
HD	−1.1789	1.0638	0.5684	0.9481	1.3224	0.7659
EL	−0.4060	−0.1856	−0.1459	0.2572	0.2578	−1.0169
EOL	−0.1018	0.0647	0.8491	0.0335	0.3214	−0.0159
EOW	−0.5020	−0.4654	−0.1322	0.4535	0.1891	−0.1026
TDL	−0.0480	0.0081	0.0551	−0.0188	−0.1689	−0.1186
Eigenvalue	2.6534	1.4989	1.1411	4.1046	1.1720	0.7629
Difference	1.1546	0.3578	0.6631	2.9326	0.4091	0.2411
Proportion	0.3767	0.2128	0.1620	0.5311	0.1516	0.0987
Cum. proportion	0.3767	0.5895	0.7515	0.5311	0.6828	0.7815



**Fig. 4.** Two-dimensional plots of scores of canonical variables for 16 morphometric characters in *Scincella boettgeri* and *S. formosensis*: A, the first against the second variables in females; B, the first against the third variables in females; C, the first against the second variables in males; D, the first against the third variables in males. Sample numbers correspond to those in Fig. 1 and Table 1.

greatest proportion of variance on the first canonical axis was expressed by differences in the relative value of SVL (positive) and then by those of head length (HL) (negative).

Figs. 3C and D present phenograms depicting results of NJ analyses of Mahalanobis distances from morphometric variations in females and males, respectively (distance values not given). In both sexes, samples of *S. boettgeri* and *S. formosensis* constituted two separate clusters in the phenogram, except for the female sample of *S. formosensis* from Kaohsiung (21) which was located within the cluster of *S. boettgeri*.

#### Comparisons among populations of *S. boettgeri* by meristic characters.

The current assignments of the southern Ryukyu and Taiwanese populations to *S. boettgeri* and *S. formosensis*, respectively, were supported by the analyses of meristic characters, and, though not so strictly, also by those of morphometric characters. So, we also subjected meristic data sets for the two species separately to the analyses to maximize the discrimination of and clarify phenetic relationships among populations within each taxon.

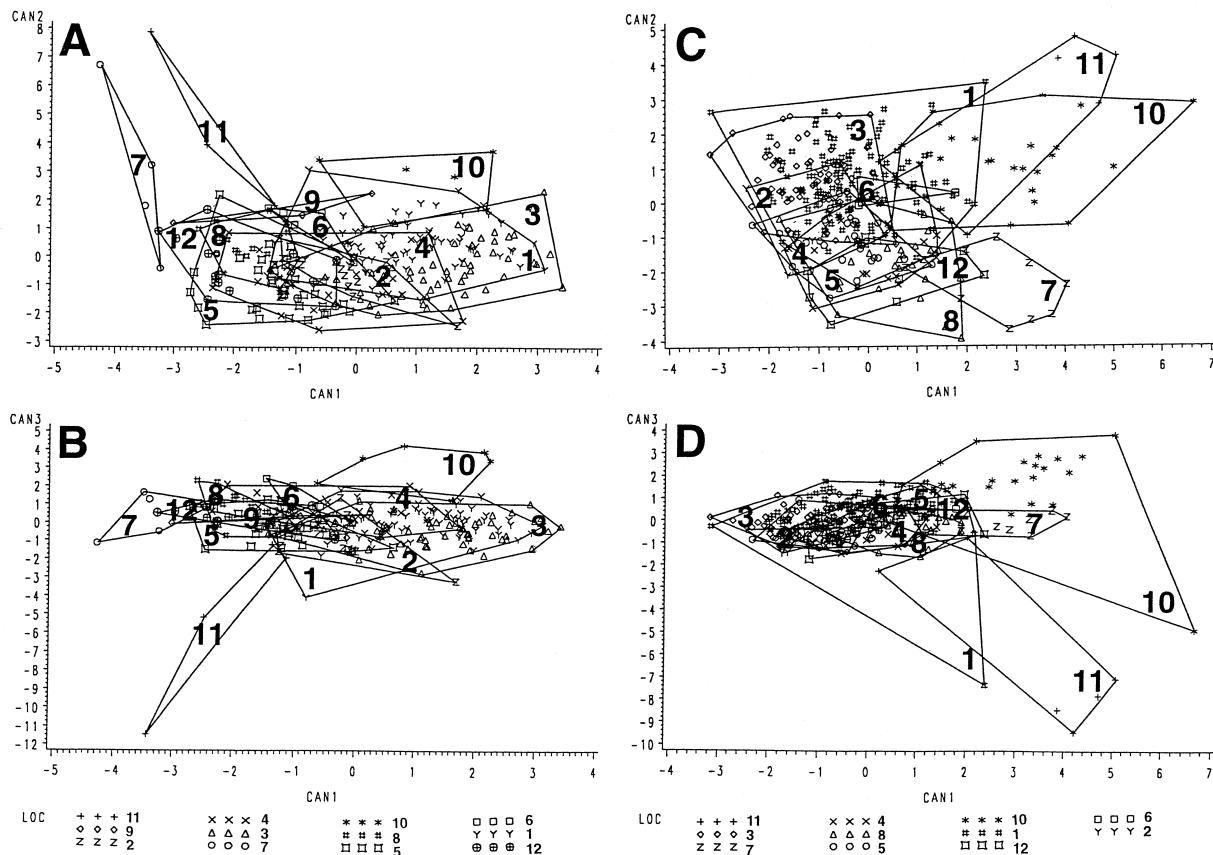
The CDA of 23 meristic characters revealed 74.2% and 78.8% of the total variations in females and males of *S. boettgeri* expressed in the first three canonical axes, respec-

tively (details not given). In females, two-dimensional plots of scores of the first two canonical variables discriminated the Taketomijima (7) and Haterumajima (11) samples from the others (Fig. 5A). The Haterumajima sample, as well as the Iriomotejima (10) sample, was also largely deviated from the remaining samples in the plots of the first against the third variables (Fig. 5B). In males, two-dimensional plots of scores of the first two canonical variables more or less differentiated the Taketomijima, Iriomotejima, and Haterumajima samples from the others but with substantial range overlaps (Fig. 5C). The Haterumajima sample was most prominently differentiated from the remainder in the plots of the first against the third variables (Fig. 5D).

Figs. 6A and B present phenograms depicting results of NJ analyses of Mahalanobis distances from meristic variations in females and males, respectively (distance values not given). It is noteworthy that, in both sexes, the Haterumajima sample was most divergent, and that in females, the Taramajima (5) and Yonagunijima (12) samples were apparently closest to the samples from Miyakojima and adjacent islands.

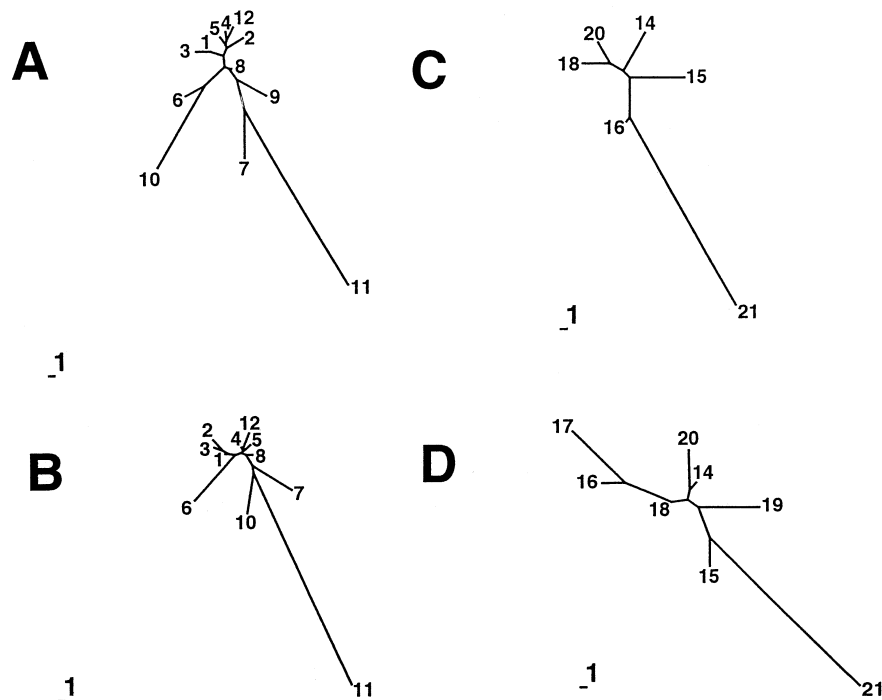
#### Comparisons among populations of *S. formosensis* by meristic characters.

The CDA of 23 meristic characters revealed 88.8% and 79.4% of the total variations in females and males of *S.*

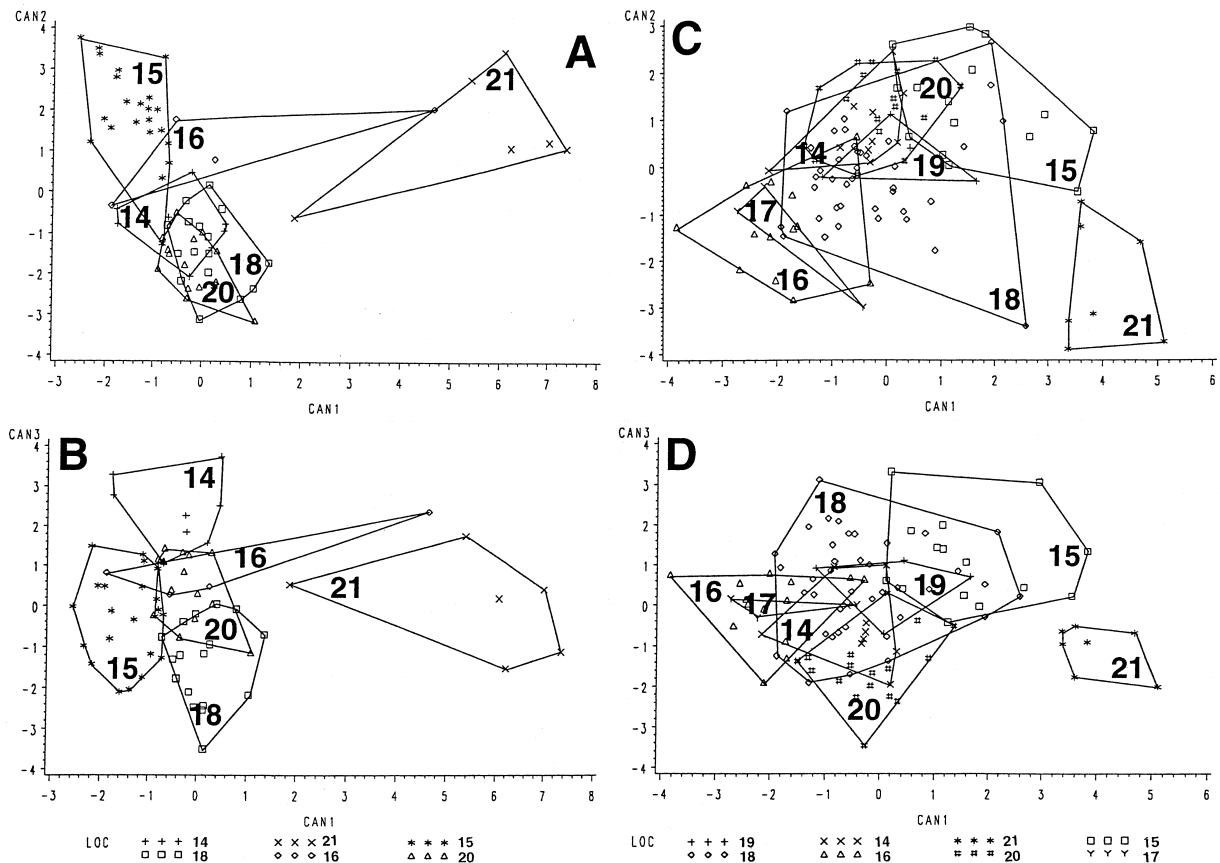


**Fig. 5.** Two-dimensional plots of scores of canonical variables for 23 meristic characters in *Scincella boettgeri*: A, the first against the second variables in females; B, the first against the third variables in females; C, the first against the second variables in males; D, the first against the third variables in males. Sample numbers correspond to those in Fig. 1 and Table 1.

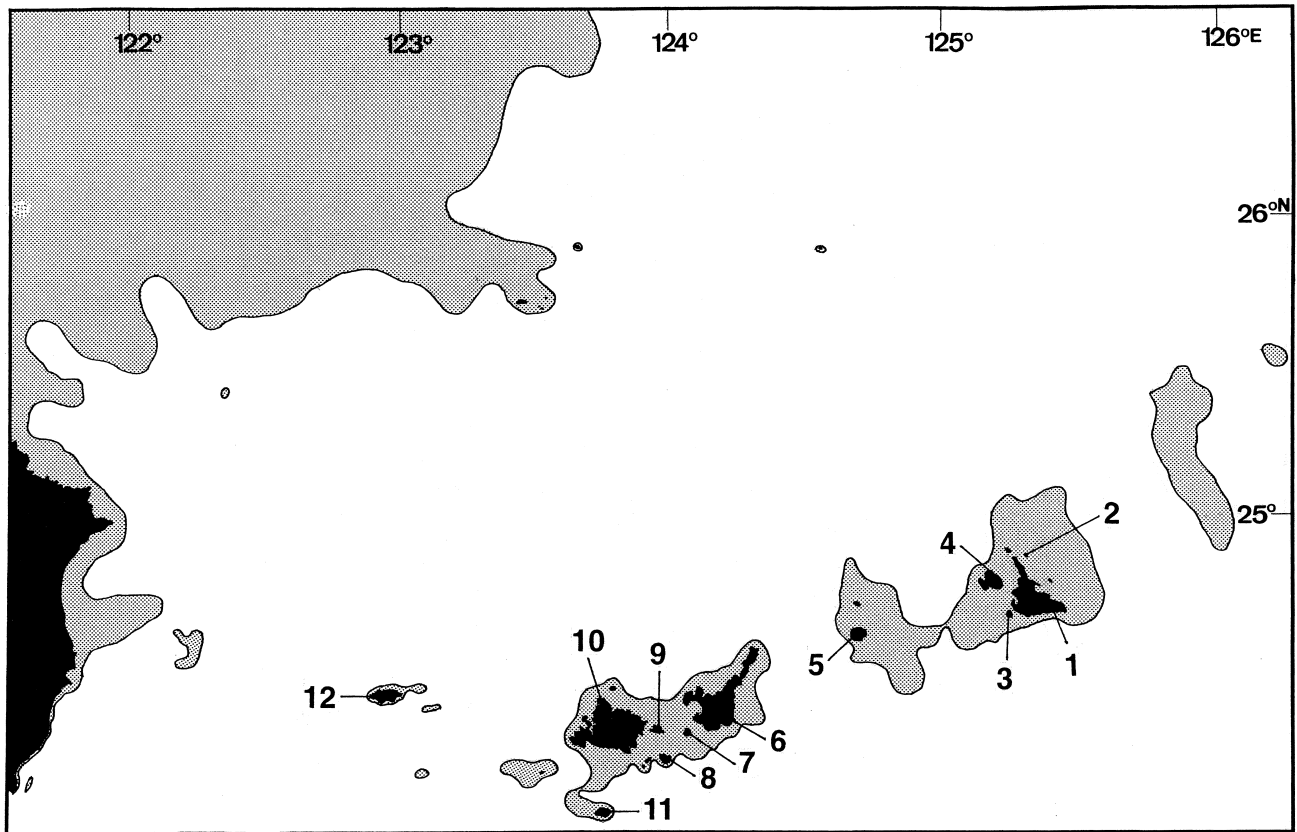




**Fig. 6.** Unrooted phenograms depicting the results of cluster analyses of Mahalanobis distances by the neighbor-joining method for 23 meristic characters of females (A) and males (B) of *S. boettgeri*, and of females (C) and males (D) of *Scincella formosensis*. Sample numbers correspond to those in Fig. 1 and Table 1.



**Fig. 7.** Two-dimensional plots of scores of canonical variables for 23 meristic characters in *Scincella formosensis*: A, the first against the second variables in females; B, the first against the third variables in females; C, the first against the second variables in males; D, the first against the third variables in males. Sample numbers correspond to those in Fig. 1 and Table 1.



**Fig. 8.** Map of the southern Ryukyus and a part of Taiwan, showing the current land areas (darkened portions) and minimally estimated additional land areas exposed above sea level during the late Pleistocene (currently submerged by the sea but as deep as, or shallower than, 120 m [Fairbanks, 1989] as delimited on the basis bathymetric chart by the Maritime Safety Agency [1978]: stippled portions). Sample numbers correspond to those in Fig. 1 and Table 1.

*formosensis* expressed in the first three canonical axes, respectively (details not given). Scores of the first canonical variable tended to be greater in the Kaohsiung (21) sample than in the others in both sexes. In the second and the third canonical variables, ranges of scores of most samples more or less overlapped with each other. Two-dimensional plots of scores of the first against the second or third variables clearly discriminated the Kaohsiung sample from the others, whereas the remaining samples showed substantial range overlaps (Fig. 7). Values of standardized coefficients (details not given) indicate that in females and males the greatest proportions of the variance on the first canonical axis were expressed by differences in the relative values of the number of dark spots on dorsal part (DSD) (positive) and of dark spots on gular part (DSG) (positive), respectively.

Figs. 6C and D present phenograms depicting results of NJ analyses of Mahalanobis distances from meristic variations for females and males, respectively (distance values not given). The Kaohsiung sample was most divergent in both sexes.

## DISCUSSION

### Canonical discriminant analysis for meristic characters

clearly discriminated *S. boettgeri* from *S. formosensis* in the current geographic delimitations. The analyses for morphometric characters also differentiated them, although it was expressed in a grosser manner. The clear discrimination of *S. boettgeri* from *S. formosensis* supports the recognition of the southern Ryukyu and Taiwanese populations as two separate taxa, invalidating Ouboter's (1986) assignments of all these and other East Asian populations to *S. modesta* without even recognizing subspecies therein as a practice of underestimation of *taxonomic* diversity in the East Asian herpetofauna. For the appropriate evaluation of the status of *boettgeri* and *formosensis* (i.e., as two separate full species or two conspecific subspecies), analyses incorporating samples representing other congeneric taxa, such as *S. modesta* and *S. reevesii* from the continent, are indispensable. We would like to propose to temporarily treat these allopatric taxa as two separate species following the most prevailing view (Ikehara *et al.*, 1984; Ota, 1991b, 1998; Sengoku *et al.*, 1996) until such more comprehensive studies, using not only morphological approach but also biochemical and molecular approaches, provide an unambiguous conclusion.

Great contributions of the numbers of scale rows covered by the dorso-lateral stripe on each side (SRB) and the dorsal interspace between the left and right stripes (SRBDS)

to the separation of *S. boettgeri* and *S. formosensis* along the first canonical axis may be associated with the apparent differences of the two taxa in each of these characters (SRB ranged from 2–4 in *S. boettgeri* and from 0.5–2.5 in *S. formosensis*, and SRBDLS from 6–8 in *S. boettgeri* and from 5–7 in *S. formosensis*; Appendix 2). Even so, however, it is obvious that neither of these can be regarded as a diagnostic character for the complete separation of the two taxa by itself. These results seem to lend limited supports to Van Denburgh (1912a, b), who argued that the relative breadth of the dorso-lateral stripe is useful in separating *S. boettgeri* from *S. formosensis*. A few other diagnostic characters used by Van Denburgh, such as the numbers of middorsal scales (DS), midbody scale rows (MSR), and the relative position of prefrontals (PF), though making relatively large contributions to some canonical variables in both males and females (Table 2), also failed to discriminate *S. boettgeri* from *S. formosensis* clearly (Appendix 2).

The distribution of *S. boettgeri*, confined to the Miyako and Yaeyama Groups of the southern Ryukyus, is similar to those of several other reptile taxa that are also broadly distributed in but endemic to these two island groups (e.g., *Eumeces kishinouyei*, *Japalura polygonata ishigakiensis*, and *Dinodon rufozonatum walli*) (Ota, 1998, 2000). Such a geographic pattern of endemism is considered to be a direct consequence of vicariance events between the southern Ryukyus and Taiwan sometime after the middle Pleistocene (e.g., Hikida *et al.*, 1989; Ota, 1998; Hikida and Motokawa, 1999; Toda *et al.*, 1999; Yasukawa and Ota, 1999), and thus does not support Kimura's (1996) hypothesis which assumes the land-bridge connection of the whole Ryukyus to Taiwan during the middle to the late Pleistocene (0.2–0.02 Ma). The low divergence between *S. boettgeri* of the Miyako and Yaeyama Groups does not support Ota's (1998) paleogeographical picture, either, in which the current Miyako Group is assumed to have been first isolated from the Yaeyama Group while the latter was still connected to Taiwan in the middle Pleistocene. From the present results, as well as currently available distributional data for other taxa (see above), we consider that there was a large island in the area from Yonagunijima to Miyakojima sometime in the middle-late Pleistocene, which was more recently fragiled into the current Miyako and Yaeyama islands. Presence of a few species, which ranges are confined to one of the two island groups only, may reflect their original localized occurrences on the Miyako-Yaeyama super island, or their partial extinction subsequent to the collapse of this super island due to the reduction in habitat diversity on each of the resultant much smaller islands (Ota, 2000).

Several previous authors reported that the NJ clustering of Mahalanobis distance matrices yields phenograms, in which historical relationships among conspecific island populations are reflected by the branching topology (e.g., Hikida, 1993; Ota *et al.*, 1995, 1999). However, branching pattern in phenograms for the *S. boettgeri* samples obtained in our analyses (Figs. 6A, B) does not seem to be consistent with geohistorical relationships of the islands from which those

samples were collected (compare these phenograms and the putative late Pleistocene land configuration of the southern Ryukyus given as Fig. 8). For example, in the phenograms, the Yonagunijima sample was located close to samples from some islands of the Miyako Group rather than to those from other Yaeyama islands lying between Yonagunijima Island and the Miyako Group. The branching pattern in the phenograms for the *S. formosensis* samples is not consistent with their topographical relationships (Fig. 1), either. Moreover, remarkably large phenetic divergences were recognized for the Haterumajima sample among the *S. boettgeri* samples, and for the Kaohsiung sample among the *S. formosensis* samples, despite great geohistorical and topographical proximities of the two samples to some other conspecific samples. These may suggest that in either of the two species, external quantitative characters have rapidly changed under the operations of differential selective pressures from some localized environmental factors, as was experimentally demonstrated for the Caribbean lizards by Malhotra and Thorpe (1991). Operation of the bottleneck effect after the isolation of populations in small islands, such as Haterumajima Island (12.75 km<sup>2</sup>), may be also responsible for some of such discrepancies. Analyses of biochemical and molecular genetic data for the lizard populations, as well as of environmental variables of their habitats, are desired to examine these possibilities in detail.

## ACKNOWLEDGMENTS

We thank the following persons for the loan of materials under their care: A. G. Kluge and G. Schneider (UMMZ); H. Endo (NSMT); and K. Hatoaka and Y. Shibata (OMNH). We are also much indebted to H.-H. Chang, C.-W. Hsu, K. Kinjo, H.-T. Lee, W.-J. Lee, S.-M. Lin, S. Nohina, G. Shang, K. Shimamura, M. Toda, M.-C. Tu, and T. Yamasaki for provision of some of the materials examined, and to M. Matsui, K. Araya, and an anonymous reviewer for various constructive criticisms on an early draft. S.-L. Chen is also much indebted to C.-F. Chen, S. Nohina, M.-C. Teng, M. Toyama, and Y. Yasukawa for their help during the field work in the Miyako Islands and Taiwan. Statistical analyses were made through the facility of the Data Processing Centers of Kyoto University. This research was partially supported by a grant from the Fujiwara Natural History Research Foundation (to H. Ota), and a Grant-in-Aid from the Japan Ministry of Education, Science, Sports and Culture (B-11480152 to M. Izawa).

## REFERENCES

- de Queiroz K, Good DA (1997) Phenetic clustering in biology: a critique. *Q Rev Biol* 72: 3–30
- Fairbanks RG (1989) A 17,000-year glacio-eustatic sea level record: influence of glacial melting rates on the Younger Dryas event and deep-ocean circulation. *Nature* 342: 637–642
- Felsenstein J (1989) PHYLIP—Phylogeny inference package (Version 3.2). *Cladistics* 5: 164–166
- Greer AE (1974) The generic relationships of the scincid lizard genus *Leiopisma* and its relatives. *Austr J Zool (Suppl)* 31: 1–67
- Günther A (1864) The reptiles of British India. Ray Society, London
- Hikida T (1993) Phylogenetic relationships of the skinks of the genus *Eumeces* (Scincidae: Reptilia) from East Asia. *Jpn J Herpetol* 15: 1–21
- Hikida T, Motokawa J (1999) Phylogeographical relationships of the

- skinks of the genus *Eumeces* (Reptilia: Scincidae) in East Asia. In "Tropical Island Herpetofauna: Origin, Current Diversity, and Conservation" Ed by H Ota, Elsevier Science, Amsterdam, pp 231–247
- Hikida T, Ota H, Kuramoto M, Toyama M (1989) Zoogeography of amphibians and reptiles in East Asia. In "Current Herpetology in East Asia" Ed by M Matsui, T Hikida, RC Goris, Herpetol Soc Japan, Kyoto, pp 278–281
- Ikehara S, Yonashiro Y, Miyagi K, Toyama M (1984) A Guide to Animals of the Ryukyu Archipelago. Vol 1 Terrestrial Vertebrates. Shinsei-tosho, Naha (in Japanese)
- Kimura M (1996) Quaternary paleogeography of the Ryukyu Arc. J. Geogr. 105: 259–285 (in Japanese with English abstract)
- Leviton AE, Gibbs JR, Heal E, Dawson CE (1985) Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Copeia 1985: 802–832
- Malhotra A, Thorpe RS (1991) Experimental detection of rapid evolutionary response in natural lizard populations. Nature 353: 347–348
- Maritime Safety Agency (ed.) (1978) Depth charts of East China Sea. Maritime Safety Agency, Tokyo
- Matsui M (1994) A taxonomic study of the *Rana narina* complex, with description of three new species (Amphibia: Ranidae). Zool J Linn Soc 111: 385–415
- Matsui M, Ota H (1995) On Chinese herpetology. Herpetologica 51: 234–250
- Nakamura K, Uéno SI (1963) Japanese Reptiles and Amphibians in Colour. Hoikusha, Osaka (in Japanese)
- Okada S, Ota H, Hasegawa M, Hikida T, Miyaguni T, Kato J (1992) Reproductive traits of seven species of lygosomine skinks (Squamata: Reptilia) from East Asia. Nat Hist Res 2: 43–52
- Ota H (1988) Taxonomic notes on *Lycodon ruhstrati* (Colubridae: Ophidia) from East Asia. J Taiwan Mus 41: 85–91
- Ota H (1991a) Taxonomic redefinition of *Japalura swinhonis* Günther (Agamidae: Squamata), with a description of a new subspecies of *J. polygonata* from Taiwan. Herpetologica 47: 280–294
- Ota H (1991b) Systematics and biogeography of terrestrial reptiles of Taiwan. In "Proceedings of the First International Symposium on Wildlife Conservation, ROC" Ed by YS Lin, KH Chang, Council of Agriculture, Taipei, pp 47–112
- Ota H (1998) Geographic patterns of endemism and speciation in amphibians and reptiles of the Ryukyu Archipelago, Japan, with special reference to their paleogeographical implications. Res Popul Ecol 40: 189–204
- Ota H (2000) The current geographic faunal pattern of reptiles and amphibians of the Ryukyu Archipelago and adjacent regions. Tropics 10: 51–62
- Ota H, Toyama M (1989) Taxonomic re-definition of *Achalinus formosanus* Boulenger (Xenodermidae: Colubridae: Ophidia), with description of a new subspecies. Copeia 1989: 597–602
- Ota H, Shiroma M, Hikida T (1995) Geographic variation in the endemic Ryukyu green snake *Cyclophiops semicarinatus* (Serpentes: Colubridae). J Herpetol 29: 44–50
- Ota H, Miyaguni H, Hikida T (1999) Geographic variation in the endemic skink, *Ateuchosaurus pellopleurus* from the Ryukyu Archipelago, Japan. J Herpetol 33: 106–118
- Ota H, Lin JT, Hirata T, Chen SL (1997) Systematic review of colubrid snakes of the genus *Pareas* in the East Asian islands. J Herpetol 31: 79–87
- Ouboter PE (1986) A revision of the genus *Scincella* (Reptilia: Sauria: Scincidae) of Asia, with some notes on its evolution. Zool Verhand 229: 1–66
- Saitou N, Nei M (1987) The neighbor-joining method: a new method for reconstructing phylogenetic trees. Mol Biol Evol 4: 406–425
- SAS (1990) SAS/STAT User's Guide (Version 6). SAS Institute Inc, Cary, North Carolina.
- Schmidt KP (1927a) The reptiles of Hainan. Bull Amer Mus Nat Hist 54: 395–465
- Schmidt KP (1927b) Notes on Chinese reptiles. Bull Amer Mus Nat Hist 54: 467–551
- Sengoku S, Hikida T, Matsui M, Nakaya K (eds.) (1996) The Encyclopedia of Animals. Vol 5: Amphibians, Reptiles, Chondrichthyes. Heibonsha, Tokyo (in Japanese)
- Thorpe RS (1987) Geographic variation: a synthesis of cause, data, pattern and congruence in relation to subspecies, multivariate analysis and phylogenesis. Boll Zool 54: 3–11
- Toda M, Nishida M, Tu MC, Hikida T, Ota H (1999) Genetic variation, phylogeny and biogeography of the pit vipers of the genus *Trimeresurus* sensu lato (Reptilia: Viperidae) in the subtropical East Asian islands. In "Tropical Island Herpetofauna: Origin, Current Diversity, and Conservation" Ed by H Ota, Elsevier Science, Amsterdam, pp 249–270
- Van Denburgh J (1912a) Advance diagnoses of new reptiles and amphibians from the Loo Choo Islands and Formosa. Privately published by author. 8 pp
- Van Denburgh J (1912b) Concerning certain species of reptiles and amphibians from China, Japan, the Loo Choo Islands, and Formosa. Proc California Acad Sci (4th Ser) 3: 187–258
- Willig MR, Owen RD, Colbert RL (1986) Assessment of morphometric variation in natural populations: the inadequacy of the univariate approach. Syst Zool 35: 195–203
- Wüster W, Otsuka S, Thorpe RS, Malhotra A (1992) Morphological variation in Russell's viper in Burma and Thailand. Herpetol J 2: 99–101
- Yasukawa Y, Ota H (1999) Geographic variation and biogeography of the geoemydine turtles (Testudines: Bataguridae) of the Ryukyu Archipelago, Japan. In "Tropical Island Herpetofauna: Origin, Current Diversity, and Conservation" Ed by H Ota, Elsevier Science, Amsterdam, pp 271–297

(Received June 29, 2000 / Accepted September 27, 2000)

**APPENDIX 1.** Specimens examined in this study. Catalogue numbers of specimens deposited in the herpetological collection of the Department of Zoology, Kyoto University, are preceded by KUZ. The other institutional acronyms are those suggested by Leviton *et al.* (1985).

#### *Scincella boettgeri*:

Haterumajima (n = 11), KUZ 287–8, 464, 13138–40, 50356–60; Irabujima (n = 45), KUZ 39236–80; Iriomotejima (n = 31), KUZ 26–7, 95, 136–7, 139, 143, 163, 216, 227–8, 231, 246, 629–30, 950, 1372, 13142–50, 45237, NSMT H2021–2, H2042, OMNH R1668; Ishigakijima (n = 8), NSMT H801, H2427 (paratype), KUZ 10, 226, 908, 916, 13137, 50352; Kohamajima (n = 5), KUZ 701, 13128–31; Kurimajima (n = 130), KUZ 38729–32, 38782, 39110–1, 39463–585; Kuroshima (n = 59), KUZ 221–3, 537–9, 550–1, 13008–9, 13012, 13020–30, 13032–7, 13040–63, 13167, 46296–7, 50362–5; Miyakojima (n = 217), KUZ 967, 13098–127, 38733, 38739–42, 38745–6, 38750–81, 38787–91, 38797–880, 39100–4, 39121–207, 39299, 39428–62, 46732–41; Ohgamijima (n = 28), KUZ 39208–35; Taketomijima (n = 27), KUZ 930, 13038, 13074–97, 50552; Taramajima (n = 85), KUZ 45028–60, 45915–9, 46742–88; Yonagunijima (n = 34), KUZ 412–3, 444, 1364–6, 13052–73, 13132–6, 47494

#### *Scincella formosensis*:

Chiayi (n = 6), KUZ 36103, 36107, 36111–3, 46901; Hsinchu (n = 18), KUZ 45088–92, 46559–71; Kaohsiung (n = 13), KUZ 45074–85, 46902; Miaoli (n = 39), KUZ 36100–2, 36114–6, 37400–17, 37496–7, 37511–24; Nantou (n = 57), KUZ 36104–5, 36108–9, 37502–4, 37506–10, 45093–120, 45123–33, 46553–8; Pingtung (n = 2), KUZ 36106, UMMZ 199856; Taichung (n = 19), KUZ 36126–9, 39587–99, 45002–3; Tainan (n = 32), KUZ 37330–61; Taipei (n = 3), KUZ 36110, UMMZ 143715, 199857; Yunlin (n = 4), KUZ 36117, 37505, 45121–2

**APPENDIX 2.** Variation in meristic characters (mean±SD, followed by ranges in parentheses) of *Scincella boettgeri* and *S. formosensis*. See MATERIALS AND METHODS for abbreviations of characters.

1. Miyakojima: female (n = 89), N 3.12±0.69 (1–5) / SL 6.98±0.15 (6–7) / IL 6.00±0.00 (–) / SC 6.17±0.40 (6–8) / C 9.92±0.77 (8–12) / PRSO 2.24±0.43 (2–3) / PO 3.12±0.33 / PSO 1.01±0.10 (1–2) / SBO 3.19±0.42 (2–4) / SBTE 2.28±0.45 (2–3) / TCP 1.84±0.37 (1–2) / GVS 64.48±2.58 (60–71) / DS 62.16±2.13 (57–67) / MBSR 27.92±0.93 (26–30) / F4S 10.11±0.60 (9–11) / T4S 15.65±0.89 (14–18) / SRBDLS 6.71±0.53 (6–8) / SRB 2.90±0.29 (2–3.5) / UESC 5.28±0.96 (4–8) / PF 0 (65.2%) 1 (16.8%) 2 (18.0%) / DSD 0 (11.2%) 1 (88.8%) / DSG 0 (70.8%) 1 (29.2%) / DSVT 0 (66.7%) 1 (33.3%); male (n = 128), N 3.09±0.63 (1–4) / SL 6.99±0.09 (6–7) / IL 6.00±0.00 (–) / SC 6.30±0.46 (6–7) / C 9.79±0.85 (8–12) / PRSO 2.23±0.42 (2–3) / PO 3.29±0.47 (2–4) / PSO 1.01±0.09 (1–2) / SBO 3.20±0.40 (3–4) / SBTE 2.25±0.43 (2–3) / TCP 1.84±0.38 (1–3) / GVS 62.10±2.49 (56–69) / DS 58.70±2.49 (52–66) / MBSR 27.88±0.93 (26–30) / F4S 10.16±0.60 (9–12) / T4S 16.21±0.85 (14–18) / SRBDLS 6.45±0.52 (6–8) / SRB 2.99±0.29 (2.5–4) / UESC 5.76±1.38 (3–9) / PF 0 (62.5%) 1 (22.7%) 2 (14.8%) / DSD 0 (8.6%) 1 (91.4%) / DSG 0 (66.4%) 1 (33.6%) / DSVT 0 (79.2%) 1 (20.8%)
2. Ohgamijima: female (n = 15), N 3.07±0.46 (2–4) / SL 6.93±0.26 (6–7) / IL 6.00±0.00 (–) / SC 5.93±0.46 (5–7) / C 9.60±0.74 (8–11) / PRSO 2.27±0.46 (2–3) / PO 3.07±0.26 (3–4) / PSO 1.00±0.00 (–) / SBO 3.13±0.35 (3–4) / SBTE 2.60±0.51 (2–3) / TCP 1.93±0.26 (1–2) / GVS 63.80±3.00 (59–68) / DS 62.60±3.14 (58–71) / MBSR 27.33±0.98 (26–28) / F4S 9.87±0.52 (9–11) / T4S 15.93±0.96 (14–17) / SRBDLS 6.13±0.35 (6–7) / SRB 2.80±0.32 (2–3) / UESC 5.40±1.12 (4–7) / PF 0 (53.4%) 1 (33.3%) 2 (13.3%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (73.3%) 1 (26.7%) / DSVT 0 (38.5%) 1 (61.5%); male (n = 13), N 3.15±0.55 (2–4) / SL 6.92±0.28 (6–7) / IL 6.00±0.00 (–) / SC 6.08±0.28 (6–7) / C 10.15±0.55 (9–11) / PRSO 2.38±0.51 (2–3) / PO 3.23±0.44 (3–4) / PSO 1.00±0.00 (–) / SBO 3.38±0.51 (3–4) / SBTE 2.54±0.52 (2–3) / TCP 1.77±0.44 (1–2) / GVS 61.00±2.38 (57–66) / DS 59.85±2.48 (56–65) / MBSR 27.08±1.04 (26–28) / F4S 10.00±0.58 (9–11) / T4S 16.46±0.97 (15–19) / SRBDLS 6.08±0.28 (6–7) / SRB 2.81±0.25 (2.5–3) / UESC 5.54±1.66 (2–9) / PF 0 (53.8%) 1 (15.4%) 2 (30.8%) / DSD 0 (7.7%) 1 (92.3%) / DSG 0 (92.3%) 1 (7.7%) / DSVT 0 (41.7%) 1 (58.3%)
3. Kurimajima: female (n = 69), N 3.13±0.62 (1–4) / SL 6.94±0.24 (6–7) / IL 5.98±0.12 (5–6) / SC 6.06±0.45 (4–7) / C 9.96±0.98 (8–12) / PRSO 2.12±0.32 (2–3) / PO 3.20±0.40 (3–4) / PSO 1.00±0.00 (–) / SBO 3.29±0.46 (3–4) / SBTE 2.38±0.49 (2–3) / TCP 1.88±0.32 (1–2) / GVS 63.13±2.29 (57–69) / DS 60.39±2.09 (57–65) / MBSR 28.28±0.86 (26–30) / F4S 9.98±0.50 (9–12) / T4S 16.09±0.82 (14–18) / SRBDLS 6.58±0.55 (6–8) / SRB 2.92±0.24 (2.5–3.5) / UESC 5.38±1.50 (3–11) / PF 0 (76.8%) 1 (7.2%) 2 (16.0%) / DSD 0 (1.4%) 1 (98.6%) / DSG 0 (78.3%) 1 (21.7%) / DSVT 0 (61.9%) 1 (38.1%); male (n = 61), N 2.93±0.63 (1–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.15±0.40 (5–7) / C 10.20±0.87 (9–13) / PRSO 2.28±0.45 (2–3) / PO 3.43±0.50 (3–4) / PSO 1.00±0.00 (–) / SBO 3.15±0.36 (3–4) / SBTE 2.28±0.45 (2–3) / TCP 1.88±0.32 (1–2) / GVS 61.34±2.14 (58–67) / DS 58.23±2.36 (52–64) / MBSR 28.03±0.77 (26–30) / F4S 10.10±0.30 (10–11) / T4S 16.59±0.87 (15–18) / SRBDLS 6.31±0.47 (6–7) / SRB 2.97±0.24 (2.5–3.5) / UESC 5.75±1.51 (2–10) / PF 0 (78.7%) 1 (6.6%) 2 (14.7%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (88.5%) 1 (11.5%) / DSVT 0 (68.4%) 1 (31.6%)
4. Irabujima: female (n = 23), N 3.35±0.65 (2–4) / SL 6.91±0.29 (6–7) / IL 6.00±0.00 (–) / SC 6.17±0.49 (5–7) / C 9.52±1.08 (8–12) / PRSO 2.04±0.21 (2–3) / PO 3.09±0.29 (3–4) / PSO 1.00±0.00 (–) / SBO 3.26±0.45 (3–4) / SBTE 2.61±0.50 (2–3) / TCP 1.78±0.42 (1–2) / GVS 65.39±2.31 (61–69) / DS 61.78±2.97 (56–67) / MBSR 27.56±1.04 (26–30) / F4S 9.91±0.42 (9–11) / T4S 15.91±0.85 (14–18) / SRBDLS 6.22±0.52 (6–8) / SRB 2.83±0.29 (2.5–3.5) / UESC 5.39±1.20 (3–7) / PF 0 (39.2%) 1 (30.4%) 2 (30.4%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (26.1%) 1 (73.9%) / DSVT 0 (23.8%) 1 (76.2%); male (n = 22), N 3.32±0.65 (2–5) / SL 6.95±0.21 (6–7) / IL 6.00±0.00 (–) / SC 6.18±0.39 (6–7) / C 9.86±0.77 (8–12) / PRSO 2.27±0.46 (2–3) / PO 3.18±0.39 (3–4) / PSO 1.04±0.21 (1–2) / SBO 3.18±0.39 (3–4) / SBTE 2.36±0.49 (2–3) / TCP 1.73±0.46 (1–2) / GVS 63.32±2.73 (59–69) / DS 59.18±2.63 (53–64) / MBSR 27.36±1.14 (26–30) / F4S 9.76±0.77 (8–11) / T4S 15.76±0.83 (14–18) / SRBDLS 6.09±0.29 (6–7) / SRB 2.93±0.28 (2–3.5) / UESC 5.73±0.98 (4–7) / PF 0 (50.0%) 1 (31.8%) 2 (18.2%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (22.7%) 1 (77.3%) / DSVT 0 (30.0%) 1 (70.0%)
5. Taramajima: female (n = 43), N 3.19±0.59 (2–4) / SL 6.98±0.15 (6–7) / IL 6.00±0.00 (–) / SC 6.21±0.46 (6–8) / C 9.98±0.77 (8–12) / PRSO 2.18±0.39 (2–3) / PO 3.12±0.32 (3–4) / PSO 1.00±0.00 (–) / SBO 3.21±0.46 (2–4) / SBTE 2.49±0.50 (2–3) / TCP 1.91±0.29 (1–2) / GVS 64.32±2.38 (59–69) / DS 60.95±2.52 (56–66) / MBSR 27.77±1.00 (26–30) / F4S 9.68±0.69 (8–11) / T4S 15.20±0.64 (14–16) / SRBDLS 6.02±0.15 (6–7) / SRB 2.81±0.31 (2–3.5) / UESC 4.83±1.38 (3–10) / PF 0 (72.0%) 1 (14.0%) 2 (14.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (44.2%) 1 (55.8%) / DSVT 0 (7.7%) 1 (92.3%); male (n = 42), N 3.12±0.63 (2–4) / SL 6.98±0.15 (6–7) / IL 6.00±0.00 (–) / SC 6.31±0.47 (6–7) / C 9.81±0.83 (8–11) / PRSO 2.28±0.46 (2–3) / PO 3.40±0.50 (3–4) / PSO 1.00±0.00 (–) / SBO 3.31±0.47 (3–4) / SBTE 2.28±0.46 (2–3) / TCP 1.83±0.38 (1–2) / GVS 61.98±2.58 (56–67) / DS 57.57±2.61 (52–63) / MBSR 27.62±1.01 (26–30) / F4S 10.00±0.53 (9–11) / T4S 15.75±0.93 (14–18) / SRBDLS 6.05±0.22 (6–7) / SRB 2.90±0.23 (2.5–3.5) / UESC 5.28±1.04 (3–8) / PF 0 (69.0%) 1 (14.3%) 2 (16.7%) / DSD 0 (2.4%) 1 (97.6%) / DSG 0 (50.0%) 1 (50.0%) / DSVT 0 (14.7%) 1 (85.3%)
6. Ishigakijima: female (n = 5), N 3.20±0.45 (3–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.40±0.55 (6–7) / C 10.80±0.45 (10–11) / PRSO 2.00±0.00 (–) / PO 3.20±0.45 (3–4) / PSO 1.00±0.00 (–) / SBO 3.40±0.55 (3–4) / SBTE 2.80±0.45 (2–3) / TCP 1.80±0.45 (1–2) / GVS 68.80±1.30 (67–70) / DS 65.00±2.55 (62–69) / MBSR 29.60±0.89 (28–30) / F4S 10.20±0.84 (9–11) / T4S 15.40±1.82 (13–18) / SRBDLS 6.40±0.55 (6–7) / SRB 3.00±0.35 (2.5–3.5) / UESC 7.00±3.94 (4–13) / PF 0 (100.0%) 1 (0.0%) 2 (0.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (60.0%) 1 (40.0%) / DSVT 0 (80.0%) 1 (20.0%); male (n = 3), N 2.33±0.57 (2–3) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.33±0.57 (6–7) / C 11.00±1.00 (10–12) / PRSO 2.00±0.00 (–) / PO 3.00±0.00 (–) / PSO 1.00±0.00 (–) / SBO 3.00±0.00 (–) / SBTE 3.00±0.00 (–) / TCP 2.00±0.00 (–) / GVS 64.67±3.21 (61–67) / DS 58.33±3.78 (54–61) / MBSR 28.67±1.15 (28–30) / F4S 10.33±0.58 (10–11) / T4S 16.33±1.53 (15–18) / SRBDLS 6.33±0.58 (6–7) / SRB 3.00±0.00 (–) / UESC 7.00±1.73 (6–9) / PF 0 (100.0%) 1 (0.0%) 2 (0.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (0.0%) 1 (100.0%) / DSVT 0 (100.0%) 1 (0.0%)
7. Taketomijima: female (n = 7), N 3.19±0.59 (2–4) / SL 6.98±0.15 (6–7) / IL 6.00±0.00 (–) / SC 6.21±0.46 (6–8) / C 9.98±0.77 (8–12) / PRSO 2.19±0.39 (2–3) / PO 3.12±0.32 (3–4) / PSO 1.00±0.00 (–) / SBO 3.21±0.46 (2–4) / SBTE 2.49±0.50 (2–3) / TCP 2.00±0.00 (–) / GVS 67.57±2.99 (62–72) / DS 67.57±5.09 (61–73) / MBSR 29.14±1.07 (28–30) / F4S 9.57±0.53 (9–10) / T4S 14.28±0.95 (13–15) / SRBDLS 6.43±0.53 (6–7) / SRB 3.00±0.00 (–) / UESC 5.28±0.76 (4–6) / PF 0 (100.0%) 1 (0.0%) 2 (0.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (0.0%) 1 (100.0%) / DSVT 0 (0.0%) 1 (100.0%); male (n = 20), N 3.05±0.82 (1–4) / SL 6.85±0.37 (6–7) / IL 5.95±0.22 (5–6) / SC 6.35±0.49 (6–7) / C 9.90±0.91 (9–12) / PRSO

- 2.70±0.57 (1–3) / PO 3.50±0.61 (3–5) / PSO 1.00±0.00 (–) / SBO 3.20±0.41 (3–4) / SBTE 2.95±0.22 (2–3) / TCP 1.85±0.37 (1–2) / GVS 65.45±2.54 (60–70) / DS 62.50±2.33 (59–67) / MBSR 28.30±0.98 (26–30) / F4S 10.26±0.56 (9–11) / T4S 15.06±1.16 (13–17) / SRBDLS 6.00±0.00 (–) / SRB 3.08±0.24 (2.5–3.5) / UESC 6.40±2.06 (4–14) / PF 0 (65.0%) 1 (15.0%) 2 (20.0%) / DSD 0 (10.0%) 1 (90.0%) / DSG 0 (5.0%) 1 (95.0%) / DSVT 0 (11.1%) 1 (88.9%)
8. Kuroshima: female (n = 23), N 3.00±0.74 (1–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.13±0.46 (5–7) / C 9.83±0.89 (8–12) / PRSO 2.13±0.34 (2–3) / PO 3.22±0.42 (3–4) / PSO 1.00±0.00 (–) / SBO 3.13±0.46 (2–4) / SBTE 2.43±0.51 (2–3) / TCP 1.78±0.42 (1–2) / GVS 66.39±3.97 (55–73) / DS 63.65±2.69 (58–70) / MBSR 28.43±0.84 (28–30) / F4S 10.04±0.64 (9–11) / T4S 14.91±0.67 (14–16) / SRBDLS 6.00±0.00 (–) / SRB 2.93±0.17 (2.5–3) / UESC 5.61±2.10 (4–14) / PF 0 (60.9%) 1 (17.4%) 2 (21.7%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (26.1%) 1 (73.9%) / DSVT 0 (22.2%) 1 (77.8%); male (n = 36), N 2.72±0.61 (1–4) / SL 7.03±0.17 (7–8) / IL 6.06±0.23 (6–7) / SC 6.11±0.32 (6–7) / C 9.89±0.85 (8–11) / PRSO 2.47±0.51 (2–3) / PO 3.30±0.47 (3–4) / PSO 1.00±0.00 (–) / SBO 3.08±0.37 (2–4) / SBTE 2.42±0.50 (2–3) / TCP 1.86±0.42 (1–3) / GVS 63.17±2.71 (58–69) / DS 59.30±2.48 (54–65) / MBSR 27.78±0.93 (26–30) / F4S 10.19±0.58 (9–11) / T4S 15.30±0.79 (14–17) / SRBDLS 6.00±0.00 (–) / SRB 2.93±0.21 (2.5–3.5) / UESC 5.36±1.07 (3–8) / PF 0 (61.1%) 1 (16.6%) 2 (22.2%) / DSD 0 (2.8%) 1 (97.2%) / DSG 0 (27.8%) 1 (72.2%) / DSVT 0 (26.1%) 1 (73.9%)
9. Kohamajima: female (n = 3), N 3.33±0.58 (3–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.00±0.00 (–) / C 10.00±0.00 (–) / PRSO 2.33±0.58 (2–3) / PO 3.33±0.58 (3–4) / PSO 1.00±0.00 (–) / SBO 3.00±0.00 (–) / SBTE 2.33±0.58 (2–3) / TCP 2.00±0.00 (–) / GVS 65.67±1.53 (64–67) / DS 67.33±1.53 (66–69) / MBSR 28.67±1.15 (28–30) / F4S 10.67±0.58 (10–11) / T4S 15.00±1.00 (14–16) / SRBDLS 6.33±0.58 (6–7) / SRB 2.67±0.29 (2.5–3) / UESC 6.33±2.08 (4–8) / PF 0 (100.0%) 1 (0.0%) 2 (0.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (33.3%) 1 (66.7%) / DSVT 0 (33.3%) 1 (66.7%); male (n = 2), N 3.00 (–) / SL 7.00 (–) / IL 6.00 (–) / SC 6.00 (–) / C 9.50 (9–10) / PRSO 2.50 (2–3) / PO 3.50 (3–4) / PSO 1.00 (–) / SBO 3.00 (–) / SBTE 2.50 (2–3) / TCP 1.50 (1–2) / GVS 60.50 (60–61) / DS 63.00 (–) / MBSR 28.00 (–) / F4S 10.50 (10–11) / T4S 15.50 (15–16) / SRBDLS 6.50 (6–7) / SRB 3.00 (–) / UESC 5.00 (–) / PF 0 (100.0%) 1 (0.0%) 2 (0.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (0.0%) 1 (100.0%) / DSVT 0 (50.0%) 1 (50.0%)
10. Iriomotejima: female (n = 6), N 2.83±0.98 (1–4) / SL 6.83±0.41 (6–7) / IL 6.00±0.00 (–) / SC 6.00±0.00 (–) / C 10.00±0.63 (9–11) / PRSO 2.17±0.41 (2–3) / PO 3.00±0.00 (–) / PSO 1.00±0.00 (–) / SBO 3.33±0.52 (3–4) / SBTE 2.67±0.52 (2–3) / TCP 2.00±0.00 (–) / GVS 71.00±2.19 (69–75) / DS 66.33±2.58 (64–70) / MBSR 30.00±1.26 (28–32) / F4S 10.67±0.52 (10–11) / T4S 16.33±0.82 (15–17) / SRBDLS 7.50±0.55 (7–8) / SRB 3.08±0.20 (3–5) / UESC 5.00±1.55 (3–7) / PF 0 (66.7%) 1 (0.0%) 2 (33.3%) / DSD 0 (16.7%) 1 (83.3%) / DSG 0 (33.3%) 1 (66.7%) / DSVT 0 (50.0%) 1 (50.0%); male (n = 25), N 3.12±0.52 (2–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.40±0.50 (6–7) / C 10.04±0.84 (9–12) / PRSO 2.32±0.48 (2–3) / PO 3.48±0.51 (3–4) / PSO 1.04±0.20 (1–2) / SBO 3.08±0.28 (3–4) / SBTE 2.68±0.48 (2–3) / TCP 1.92±0.28 (1–2) / GVS 67.56±4.17 (58–74) / DS 63.72±3.23 (58–70) / MBSR 29.64±1.11 (28–32) / F4S 11.04±0.35 (10–12) / T4S 16.40±0.91 (15–18) / SRBDLS 7.01±0.50 (6–8) / SRB 3.20±0.43 (2.5–4.0) / UESC 6.56±2.71 (3–16) / PF 0 (68.0%) 1 (12.0%) 2 (20.0%) / DSD 0 (20.0%) 1 (80.0%) / DSG 0 (28.0%) 1 (72.0%) / DSVT 0 (68.0%) 1 (32.0%)
11. Haterumajima: female (n = 4), N 3.00±0.82 (2–4) / SL 6.75±0.50 (6–7) / IL 5.75±0.50 (5–6) / SC 5.75±0.50 (5–6) / C 8.50±1.73 (7–11) / PRSO 2.25±0.50 (2–3) / PO 3.00±0.00 (–) / PSO 1.25±0.50 (1–2) / SBO 3.00±0.00 (–) / SBTE 2.25±0.50 (2–3) / TCP 2.00±0.00 (–) / GVS 63.00±2.83 (61–67) / DS 66.25±3.50 (61–68) / MBSR 27.50±1.00 (26–28) / F4S 9.50±0.58 (9–10) / T4S 14.25±0.96 (13–15) / SRBDLS 6.00±0.00 (–) / SRB 3.00±0.00 (–) / UESC 5.75±0.50 (5–6) / PF 0 (75.0%) 1 (0.0%) 2 (25.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (75.0%) 1 (25.0%) / DSVT 0 (75.0%) 1 (25.0%); male (n = 7), N 2.86±0.69 (2–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.14±0.69 (5–7) / C 9.42±0.79 (9–11) / PRSO 2.14±0.38 (2–3) / PO 3.00±0.00 (–) / PSO 1.57±0.53 (1–2) / SBO 2.86±0.38 (2–3) / SBTE 2.71±0.49 (2–3) / TCP 1.71±0.49 (1–2) / GVS 60.28±3.64 (55–66) / DS 61.86±2.41 (58–66) / MBSR 28.00±0.00 (–) / F4S 10.57±0.53 (10–11) / T4S 15.00±0.58 (14–16) / SRBDLS 6.14±0.38 (6–7) / SRB 3.00±0.00 (–) / UESC 7.57±1.90 (5–10) / PF 0 (100.0%) 1 (0.0%) 2 (0.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (71.4%) 1 (28.6%) / DSVT 0 (71.4%) 1 (28.6%)
12. Yonagunijima: female (n = 20), N 3.30±0.47 (3–4) / SL 6.85±0.37 (6–7) / IL 6.00±0.00 (–) / SC 6.05±0.22 (6–7) / C 10.05±1.00 (9–12) / PRSO 2.30±0.47 (2–3) / PO 3.10±0.31 (3–4) / PSO 1.00±0.00 (–) / SBO 3.10±0.45 (2–4) / SBTE 2.80±0.41 (2–3) / TCP 1.70±0.47 (1–2) / GVS 66.15±2.58 (60–70) / DS 62.20±3.24 (57–68) / MBSR 27.80±0.62 (26–28) / F4S 9.55±0.89 (8–11) / T4S 14.70±0.73 (14–16) / SRBDLS 6.00±0.00 (–) / SRB 2.92±0.24 (2.5–3.5) / UESC 5.32±1.06 (4–8) / PF 0 (50.0%) 1 (20.0%) 2 (30.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (25.0%) 1 (75.0%) / DSVT 0 (14.3%) 1 (85.7%); male (n = 14), N 3.23±0.44 (3–4) / SL 6.93±0.27 (6–7) / IL 6.00±0.00 (–) / SC 6.36±0.50 (6–7) / C 9.64±0.84 (9–11) / PRSO 2.14±0.36 (2–3) / PO 3.21±0.42 (3–4) / PSO 1.00±0.00 (–) / SBO 3.14±0.36 (3–4) / SBTE 2.86±0.36 (2–3) / TCP 1.93±0.27 (1–2) / GVS 64.57±2.74 (60–69) / DS 58.93±2.27 (55–63) / MBSR 27.43±0.94 (26–28) / F4S 9.86±0.66 (9–11) / T4S 15.50±1.02 (14–17) / SRBDLS 6.00±0.00 (–) / SRB 2.89±0.35 (2.5–3.5) / UESC 6.07±1.14 (4–8) / PF 0 (21.4%) 1 (42.9%) 2 (35.7%) / DSD 0 (7.1%) 1 (92.9%) / DSG 0 (42.9%) 1 (57.1%) / DSVT 0 (25.0%) 1 (75.0%)
13. Taipei: female (n = 2), N 3.00 (–) / SL 7.00 (–) / IL 6.00 (–) / SC 6.00 (–) / C 10.00 (–) / PRSO 2.00 (–) / PO 3.00 (–) / PSO 1.00 (–) / SBO 3.50 (3–4) / SBTE 2.50 (2–3) / TCP 2.00 (–) / GVS 65.50 (63–68) / DS 58.00 (55–61) / MBSR 28.00 (–) / F4S 10.00 (–) / T4S 13.00 (–) / SRBDLS 6.00 (–) / SRB 1.00 (–) / UESC 4.50 (4–5) / PF 0 (0.0%) 1 (0.0%) 2 (100.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (0.0%) 1 (100.0%) / DSVT 0 (0.0%) 1 (100.0%); male (n = 1), N 3.00 (–) / SL 7.00 (–) / IL 6.00 (–) / SC 7.00 (–) / C 10.00 (–) / PRSO 2.00 (–) / PO 3.00 (–) / PSO 1.00 (–) / SBO 4.00 (–) / SBTE 3.00 (–) / TCP 2.00 (–) / GVS 63.00 (–) / DS 55.00 (–) / MBSR 28.00 (–) / F4S 11.00 (–) / T4S 15.00 (–) / SRBDLS 5.00 (–) / SRB 1.00 (–) / UESC 6.00 (–) / PF 0 (0.0%) 1 (0.0%) 2 (100.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (100.0%) 1 (0.0%) / DSVT 0 (100.0%) 1 (0.0%)
14. Hsinchu: female (n = 8), N 3.25±0.71 (2–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 7.00±0.00 (–) / C 9.75±0.46 (9–10) / PRSO 2.38±0.52 (2–3) / PO 3.25±0.46 (3–4) / PSO 1.00±0.00 (–) / SBO 2.88±0.35 (2–3) / SBTE 2.88±0.35 (2–3) / TCP 2.12±0.35 (2–3) / GVS 70.12±2.64 (65–73) / DS 61.75±2.19 (58–65) / MBSR 28.50±0.92 (28–30) / F4S 11.00±0.53 (10–12) / T4S 15.88±1.12 (15–18) / SRBDLS 6.00±0.00 (–) / SRB 1.69±0.53 (0.5–2) / UESC 6.00±1.07 (5–8) / PF 0 (0.0%) 1 (12.5%) 2 (87.5%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (100.0%) 1 (0.0%) / DSVT 0 (0.0%) 1 (100.0%); male (n = 10), N 3.20±0.63 (2–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.80±0.42 (6–7) / C 10.20±0.92 (9–12) / PRSO 2.10±0.32 (2–3) / PO 3.30±0.48 (3–4) / PSO 1.00±0.00 (–) / SBO 3.00±0.00 (–) / SBTE 2.70±0.48 (2–3) / TCP 2.10±0.32 (2–3) / GVS 64.90±3.41 (59–71) / DS 57.10±2.42 (53–60) / MBSR 28.00±0.00 (–) / F4S 11.20±0.63 (10–12) / T4S 17.20±1.32 (15–20) / SRBDLS 6.00±0.00 (–) / SRB 1.40±0.32 (1–2) / UESC 5.80±1.69 (4–8) / PF 0 (0.0%) 1 (10.0%) 2 (90.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (80.0%) 1 (20.0%) / DSVT 0 (10.0%) 1 (90.0%)
15. Miaoli: female (n = 23), N 2.91±0.51 (2–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.70±0.56 (5–7) / C 10.09±0.92 (8–12) / PRSO 2.07±0.29 (2–3) / PO 3.09±0.29 (3–4) / PSO 1.00±0.00 (–) / SBO 3.09±0.42 (2–4) / SBTE 2.65±0.49 (2–3) / TCP 1.74±0.45 (1–2) / GVS 69.17±2.96 (65–75) / DS 61.61±2.12 (58–66) / MBSR 28.70±0.97 (28–30) / F4S 10.77±0.92 (10–13) / T4S 16.39±1.03 (15–19) / SRBDLS 6.30±0.47 (6–7) / SRB 1.54±0.58 (0.5–2) / UESC 6.65±1.75 (4–12) / PF 0 (4.3%) 1 (0.0%) 2 (95.7%) / DSD 0 (4.3%) 1 (95.7%) / DSG 0 (91.3%)

1 (8.7%) / DSVT 0 (21.7%) 1 (78.3%); male (n = 16), N 2.88±0.72 (2–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.88±0.62 (6–8) / C 10.06±0.85 (8–11) / PRSO 2.13±0.34 (2–3) / PO 3.38±0.50 (3–4) / PSO 1.00±0.00 (–) / SBO 3.13±0.34 (3–4) / SBTE 2.75±0.45 (2–3) / TCP 2.06±0.44 (1–3) / GVS 66.38±3.16 (62–75) / DS 59.44±3.48 (53–65) / MBSR 28.88±1.02 (28–30) / F4S 11.31±0.70 (10–12) / T4S 16.19±1.05 (15–17) / SRBDLS 6.19±0.40 (6–7) / SRB 1.31±0.63 (0.5–2.5) / UESC 6.00±1.03 (4–7) / PF 0 (0.0%) 1 (0.0%) 2 (100.0%) / DSD 0 (12.5%) 1 (87.5%) / DSG 0 (100.0%) 1 (0.0%) / DSVT 0 (37.5%) 1 (62.5%)

16. Taichung: female (n = 4), N 2.75±0.50 (2–3) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 7.00±0.00 (–) / C 10.25±0.96 (9–11) / PRSO 2.00±0.00 (–) / PO 3.25±0.50 (3–4) / PSO 1.00±0.00 (–) / SBO 3.00±0.00 (–) / SBTE 2.75±0.50 (2–3) / TCP 2.00±0.00 (–) / GVS 71.00±2.94 (68–74) / DS 60.50±3.51 (57–64) / MBSR 28.50±1.00 (28–30) / F4S 11.75±0.96 (11–13) / T4S 16.25±1.26 (15–18) / SRBDLS 6.50±0.58 (6–7) / SRB 1.50±0.41 (1–2) / UESC 6.25±0.96 (5–7) / PF 0 (0.0%) 1 (0.0%) 2 (100.0%) / DSD 0 (25.0%) 1 (75.0%) / DSG 0 (75.0%) 1 (25.0%) / DSVT 0 (0.0%) 1 (100.0%); male (n = 15), N 2.73±0.70 (2–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.87±0.35 (6–7) / C 10.27±0.96 (9–12) / PRSO 2.13±0.35 (2–3) / PO 3.33±0.49 (3–4) / PSO 1.00±0.00 (–) / SBO 3.07±0.26 (3–4) / SBTE 2.47±0.52 (2–3) / TCP 1.73±0.46 (1–2) / GVS 63.93±2.12 (60–69) / DS 55.73±2.66 (52–60) / MBSR 27.87±1.19 (26–30) / F4S 11.20±0.41 (11–12) / T4S 16.60±0.91 (15–18) / SRBDLS 6.20±0.41 (6–7) / SRB 0.81±0.36 (0.5–1.5) / UESC 5.60±1.30 (4–9) / PF 0 (6.7%) 1 (0.0%) 2 (93.3%) / DSD 0 (6.7%) 1 (93.3%) / DSG 0 (6.7%) 1 (93.3%) / DSVT 0 (0.0%) 1 (100.0%)

17. Yunlin: female (n = 1), N 3.00 (–) / SL 7.00 (–) / IL 6.00 (–) / SC 7.00 (–) / C 12.00 (–) / PRSO 3.00 (–) / PO 3.00 (–) / PSO 1.00 (–) / SBO 3.00 (–) / SBTE 2.00 (–) / TCP 2.00 (–) / GVS 69.00 (–) / DS 61.00 (–) / MBSR 30.00 (–) / F4S 12.00 (–) / T4S 15.00 (–) / SRBDLS 6.00 (–) / SRB 2.00 (–) / UESC 5.00 (–) / PF 0 (100.0%) 1 (0.0%) 2 (0.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (100.0%) 1 (0.0%) / DSVT 0 (0.0%) 1 (100.0%); male (n = 3), N 3.33±0.58 (3–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 7.00±0.00 (–) / C 9.67±1.15 (9–11) / PRSO 2.00±0.00 (–) / PO 4.00±0.00 (–) / PSO 1.00±0.00 (–) / SBO 3.00±0.00 (–) / SBTE 2.33±0.57 (2–3) / TCP 2.00±0.00 (–) / GVS 65.00±1.00 (64–66) / DS 56.67±2.52 (54–59) / MBSR 28.00±0.00 (–) / F4S 11.33±0.58 (11–12) / T4S 17.00±1.00 (16–18) / SRBDLS 6.00±0.00 (–) / SRB 0.67±0.29 (0.5–1) / UESC 5.00±1.00 (4–6) / PF 0 (0.0%) 1 (0.0%) 2 (100.0%) / DSD 0 (33.3%) 1 (66.7%) / DSG 0 (33.3%) 1 (66.7%) / DSVT 0 (0.0%) 1 (100.0%)

18. Nantou: female (n = 17), N 2.82±0.53 (2–4) / SL 7.00±0.00 (–) / IL 5.94±0.24 (5–6) / SC 6.59±0.62 (5–7) / C 10.24±0.97 (9–12) / PRSO 2.06±0.24 (2–3) / PO 3.24±0.56 (2–4) / PSO 1.12±0.33 (1–2) / SBO 3.18±0.39 (3–4) / SBTE 2.65±0.49 (2–3) / TCP 1.82±0.53 (1–3) / GVS 67.94±2.75 (62–73) / DS 61.29±1.83 (57–63) / MBSR 28.47±0.87 (28–30) / F4S 10.88±0.78 (10–13) / T4S 15.88±0.78 (15–18) / SRBDLS 6.06±0.24 (6–7) / SRB 1.62±0.42 (1–2) / UESC 6.24±2.46 (4–15) / PF 0 (0.0%) 1 (17.6%) 2 (82.4%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (29.4%) 1 (70.6%) / DSVT 0 (0.0%) 1 (100.0%); male (n = 40), N 2.75±0.71 (1–4) / SL 7.00±0.00 (–) / IL 6.03±0.16 (6–7) / SC 6.90±0.30 (6–7) / C 10.30±0.85 (9–13) / PRSO 2.20±0.40 (2–3) / PO 3.33±0.47 (3–4) / PSO 1.00±0.00 (–) / SBO 3.08±0.27 (3–4) / SBTE 2.45±0.50 (2–3) / TCP 2.03±0.28 (1–3) / GVS 65.33±2.54 (58–71) / DS 57.00±2.44 (50–63) / MBSR 27.90±1.10 (26–30) / F4S 11.03±0.70 (10–13) / T4S 15.83±0.81 (14–18) / SRBDLS 6.08±0.27 (6–7) / SRB 1.19±0.46 (0.5–2) / UESC 6.00±1.91 (4–15) / PF 0 (10.0%) 1 (20.0%) 2 (70.0%) / DSD 0 (5.0%) 1 (95.0%) / DSG 0 (30.0%) 1 (70.0%) / DSVT 0 (7.5%) 1 (92.5%)

19. Chiayi: female (n = 2), N 3.50 (3–4) / SL 7.00 (–) / IL 6.00 (–) / SC 7.00 (–) / C 11.50 (11–12) / PRSO 2.00 (–) / PO 3.00 (–) / PSO 1.50 (1–2) / SBO 3.00 (–) / SBTE 3.00 (–) / TCP 2.00 (–) / GVS 69.50 (67–72) / DS 65.50 (63–68) / MBSR 28.00 (–) / F4S 11.00 (–) / T4S 16.00 (15–17) / SRBDLS 6.50 (6–7) / SRB 0.50 (–) / UESC 6.00 (–) / PF 0 (0.0%) 1 (0.0%) 2 (100.0%) / DSD 0 (50.0%) 1 (50.0%) / DSG 0 (100.0%) 1 (0.0%) / DSVT 0 (0.0%) 1 (100.0%); male (n = 4), N 3.25±0.96 (2–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.50±0.58 (6–7) / C 10.00±0.82 (9–11) / PRSO 2.25±0.50 (2–3) / PO 3.50±0.58 (3–4) / PSO 1.00±0.00 (–) / SBO 3.00±0.00 (–) / SBTE 2.75±0.50 (2–3) / TCP 2.00±0.00 (–) / GVS 65.00±4.24 (61–71) / DS 57.50±3.78 (52–60) / MBSR 27.50±1.00 (26–28) / F4S 11.75±0.96 (11–13) / T4S 16.25±1.26 (15–18) / SRBDLS 6.25±0.50 (6–7) / SRB 1.00±0.41 (0.5–1.5) / UESC 6.25±1.50 (5–8) / PF 0 (50.0%) 1 (25.0%) 2 (25.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (75.0%) 1 (25.0%) / DSVT 0 (0.0%) 1 (100.0%)

20. Tainan: female (n = 14), N 3.36±0.63 (2–4) / SL 6.93±0.27 (6–7) / IL 5.93±0.27 (5–6) / SC 6.78±0.42 (6–7) / C 10.14±0.86 (9–12) / PRSO 2.00±0.00 (–) / PO 3.14±0.36 (3–4) / PSO 1.00±0.00 (–) / SBO 3.00±0.00 (–) / SBTE 2.93±0.27 (2–3) / TCP 2.00±0.00 (–) / GVS 69.50±2.50 (63–71) / DS 62.57±3.23 (58–69) / MBSR 28.28±1.32 (26–30) / F4S 10.43±0.65 (10–12) / T4S 15.64±0.74 (15–17) / SRBDLS 6.00±0.00 (–) / SRB 1.78±0.26 (1.5–2.0) / UESC 4.78±0.89 (3–6) / PF 0 (14.3%) 1 (28.6%) 2 (57.1%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (71.4%) 1 (28.6%) / DSVT 0 (0.0%) 1 (100.0%); male (n = 18), N 2.89±0.47 (2–4) / SL 7.00±0.34 (6–8) / IL 6.00±0.00 (–) / SC 6.61±0.61 (5–7) / C 10.22±1.00 (8–12) / PRSO 2.06±0.42 (1–3) / PO 3.28±0.40 (3–4) / PSO 1.00±0.00 (–) / SBO 3.00±0.00 (–) / SBTE 2.89±0.32 (2–3) / TCP 2.00±0.00 (–) / GVS 64.39±2.99 (58–69) / DS 58.17±1.89 (55–61) / MBSR 27.78±0.94 (26–30) / F4S 10.33±0.48 (10–11) / T4S 16.39±0.98 (15–18) / SRBDLS 6.00±0.00 (–) / SRB 1.61±0.32 (1–2) / UESC 5.17±1.29 (4–8) / PF 0 (5.6%) 1 (5.6%) 2 (88.8%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (50.0%) 1 (50.0%) / DSVT 0 (0.0%) 1 (100.0%)

21. Kaohsiung: female (n = 6), N 3.00±0.63 (2–4) / SL 7.00±0.00 (–) / IL 6.00±0.00 (–) / SC 6.83±0.41 (6–7) / C 11.00±1.26 (9–12) / PRSO 2.17±0.41 (2–3) / PO 3.00±0.00 (–) / PSO 1.17±0.41 (1–2) / SBO 3.17±0.41 (3–4) / SBTE 3.00±0.00 (–) / TCP 2.00±0.00 (–) / GVS 66.83±0.75 (66–68) / DS 58.67±2.58 (55–62) / MBSR 28.67±1.03 (28–30) / F4S 10.17±1.17 (8–11) / T4S 15.33±0.52 (15–16) / SRBDLS 6.83±0.41 (6–7) / SRB 0.83±0.60 (0.5–2) / UESC 5.67±1.21 (5–8) / PF 0 (0.0%) 1 (33.3%) 2 (66.7%) / DSD 0 (83.3%) 1 (16.7%) / DSG 0 (100.0%) 1 (0.0%) / DSVT 0 (0.0%) 1 (100.0%); male (n = 7), N 3.00±0.58 (2–4) / SL 7.00±0.00 (–) / IL 6.29±0.76 (6–8) / SC 7.00±0.00 (–) / C 10.00±1.53 (8–12) / PRSO 2.00±0.00 (–) / PO 3.00±0.00 (–) / PSO 1.00±0.00 (–) / SBO 3.00±0.00 (–) / SBTE 3.00±0.00 (–) / TCP 1.86±0.38 (1–2) / GVS 63.43±2.64 (59–67) / DS 54.86±3.02 (51–59) / MBSR 27.71±0.76 (26–28) / F4S 10.43±0.79 (9–11) / T4S 15.29±0.76 (14–16) / SRBDLS 6.57±0.53 (6–7) / SRB 0.57±0.19 (0.5–1) / UESC 5.86±0.90 (5–7) / PF 0 (14.3%) 1 (0.0%) 2 (85.7%) / DSD 0 (71.4%) 1 (28.6%) / DSG 0 (0.0%) 1 (100.0%) / DSVT 0 (14.3%) 1 (85.7%)

22. Pingtung: male (n = 2), N 3.00 (–) / SL 7.00 (–) / IL 6.00 (–) / SC 6.50 (6–7) / C 9.50 (9–10) / PRSO 2.00 (–) / PO 3.00 (–) / PSO 1.00 (–) / SBO 3.00 (–) / SBTE 2.00 (–) / TCP 2.00 (–) / GVS 62.50 (62–63) / DS 54.50 (54–55) / MBSR 28.00 (–) / F4S 11.00 (–) / T4S 15.50 (15–16) / SRBDLS 6.00 (–) / SRB 1.00 (–) / UESC 5.00 (4–6) / PF 0 (50.0%) 1 (0.0%) 2 (50.0%) / DSD 0 (0.0%) 1 (100.0%) / DSG 0 (100.0%) 1 (0.0%) / DSVT 0 (50.0%) 1 (50.0%)

**APPENDIX 3.** Variation in morphometric characters (mean±SD, followed by ranges in parentheses for SVL, and medians, followed by ranges in parentheses for other characters given as ratios to SVL) of *Scincella boettgeri* and *S. formosensis*. See MATERIALS AND METHODS for abbreviations of characters.

1. Miyakojima: female (n = 38), SVL 42.14±2.75 (35.2–46.9) / AGL 56.58 (53.77–61.28) / SFL 33.18 (31.78–35.51) / SEL 7.04 (6.60–7.95) / SEOL 18.20 (17.40–19.89) / EEL 7.16 (6.64–8.24) / FLL 23.18 (20.52–26.38) / HLL 32.61 (30.28–36.43) / T4L 10.33 (8.97–11.65) / HL 17.94

- (16.74–19.60) / HW 12.44 (11.75–14.40) / HD 8.74 (7.52–11.14) / EL 5.09 (4.65–5.71) / EOL 2.71 (2.21–3.02) / EOW 2.24 (1.59–2.66) / TDL 2.01 (1.12–2.42); male (n = 46), SVL 44.18±3.16 (34.7–49.0) / AGL 53.26 (50.46–55.90) / SFL 35.64 (32.97–37.53) / SEL 7.33 (6.72–7.95) / SEOL 19.59 (18.74–20.39) / EEL 7.86 (7.13–8.67) / FLL 25.36 (23.47–27.96) / HLL 35.35 (32.35–37.47) / T4L 11.37 (10.41–12.58) / HL 18.88 (17.55–20.17) / HW 13.46 (12.36–14.70) / HD 9.60 (8.13–11.61) / EL 5.48 (4.90–6.07) / EOL 2.93 (2.44–3.46) / EOW 2.32 (1.86–2.67) / TDL 2.07 (1.75–2.54)
2. Ohgamijima: female (n = 4), SVL 44.05±2.60 (41.2–47.5) / AGL 58.46 (55.38–59.82) / SFL 34.11 (32.63–36.16) / SEL 7.08 (6.74–7.28) / SEOL 18.51 (17.26–18.93) / EEL 7.29 (6.95–7.32) / FLL 23.54 (21.68–24.27) / HLL 32.46 (31.58–34.55) / T4L 10.42 (10.19–10.96) / HL 18.29 (16.84–18.45) / HW 12.46 (12.00–12.86) / HD 8.77 (8.50–9.61) / EL 5.03 (4.63–5.10) / EOL 2.74 (2.43–2.75) / EOW 2.06 (1.94–2.10) / TDL 1.76 (1.60–1.89)
3. Kurimajima: female (n = 18), SVL 43.86±2.10 (39.9–47.1) / AGL 57.69 (54.59–60.14) / SFL 32.79 (31.89–34.06) / SEL 6.83 (6.54–7.35) / SEOL 18.10 (17.43–18.68) / EEL 7.29 (6.94–7.64) / FLL 23.01 (22.13–25.06) / HLL 32.54 (29.94–34.49) / T4L 10.16 (8.84–11.28) / HL 17.66 (16.78–18.14) / HW 12.56 (12.10–13.44) / HD 8.57 (7.52–9.27) / EL 5.01 (4.56–5.51) / EOL 2.47 (2.19–2.94) / EOW 1.97 (1.57–2.51) / TDL 1.82 (1.60–2.05); male (n = 6), SVL 46.68±1.48 (45.3–49.1) / AGL 54.90 (53.36–55.82) / SFL 33.97 (32.97–35.01) / SEL 7.30 (6.84–7.53) / SEOL 19.17 (18.54–19.56) / EEL 7.84 (7.28–8.10) / FLL 24.52 (24.28–25.21) / HLL 34.56 (32.59–36.03) / T4L 10.89 (10.66–11.13) / HL 18.25 (17.88–18.90) / HW 13.14 (12.47–13.65) / HD 8.97 (8.40–10.02) / EL 5.48 (4.81–5.52) / EOL 2.81 (2.65–2.86) / EOW 2.16 (1.97–2.52) / TDL 1.90 (1.77–2.20)
4. Irabujima: female (n = 18), SVL 40.33±2.66 (36.7–45.6) / AGL 57.28 (53.93–59.2) / SFL 33.90 (32.64–35.33) / SEL 7.34 (6.79–7.71) / SEOL 18.42 (17.76–19.12) / EEL 7.43 (7.01–7.90) / FLL 23.61 (22.41–24.87) / HLL 33.26 (32.35–35.42) / T4L 10.53 (9.72–11.30) / HL 18.06 (17.20–19.02) / HW 12.50 (11.52–13.30) / HD 8.86 (8.35–9.90) / EL 5.08 (4.63–5.43) / EOL 2.66 (2.40–2.86) / EOW 2.18 (1.85–2.54) / TDL 1.92 (1.53–2.39); male (n = 16), SVL 42.79±1.31 (40.5–45.6) / AGL 53.87 (51.46–56.47) / SFL 34.95 (33.18–36.41) / SEL 7.41 (7.03–8.11) / SEOL 19.34 (18.22–20.22) / EEL 7.62 (7.29–8.76) / FLL 25.41 (24.00–26.91) / HLL 36.32 (33.71–37.77) / T4L 11.63 (10.66–12.14) / HL 18.84 (18.14–19.55) / HW 12.80 (11.84–13.56) / HD 9.22 (8.98–10.12) / EL 5.34 (4.96–5.62) / EOL 2.76 (2.42–3.21) / EOW 2.32 (1.84–2.84) / TDL 1.96 (1.43–2.27)
5. Taramajima: female (n = 18), SVL 38.14±2.88 (34.3–42.0) / AGL 55.49 (49.85–57.77) / SFL 34.92 (32.69–37.90) / SEL 7.54 (7.09–8.72) / SEOL 19.24 (17.92–20.64) / EEL 7.77 (7.14–8.72) / FLL 24.91 (21.79–26.24) / HLL 34.67 (29.30–37.61) / T4L 10.95 (9.09–11.95) / HL 18.66 (17.62–20.41) / HW 12.97 (12.59–13.99) / HD 9.92 (8.33–10.73) / EL 5.34 (4.89–5.83) / EOL 3.03 (2.42–3.21) / EOW 2.30 (1.94–2.62) / TDL 2.04 (1.70–2.62); male (n = 24), SVL 38.01±3.17 (33.5–44.7) / AGL 52.46 (48.14–56.21) / SFL 36.73 (34.77–39.77) / SEL 7.99 (7.38–8.66) / SEOL 20.33 (19.18–21.69) / EEL 8.44 (7.49–8.78) / FLL 26.07 (23.89–29.01) / HLL 36.71 (33.33–39.44) / T4L 11.64 (10.30–13.52) / HL 19.86 (18.46–20.60) / HW 13.68 (12.75–15.21) / HD 10.57 (9.20–12.68) / EL 5.62 (5.02–6.20) / EOL 3.25 (2.81–3.66) / EOW 2.46 (2.25–2.84) / TDL 2.02 (1.51–2.83)
6. Ishigakijima: female (n = 5), SVL 46.48±3.31 (41.1–49.0) / AGL 56.33 (53.77–57.79) / SFL 34.95 (32.65–37.96) / SEL 6.59 (6.53–7.30) / SEOL 18.03 (17.14–19.46) / EEL 7.55 (7.03–8.12) / FLL 24.49 (21.98–24.80) / HLL 32.65 (31.21–36.50) / T4L 10.20 (9.45–11.19) / HL 16.70 (16.53–18.98) / HW 12.30 (11.87–13.62) / HD 9.79 (9.02–9.98) / EL 5.05 (4.69–5.35) / EOL 2.86 (2.42–2.92) / EOW 1.84 (1.63–2.20) / TDL 1.70 (1.63–1.98); male (n = 3), SVL 48.97±4.54 (43.8–52.3) / AGL 54.34 (53.35–54.88) / SFL 36.30 (34.99–36.42) / SEL 7.28 (7.26–7.30) / SEOL 18.95 (18.55–19.29) / EEL 7.87 (7.26–8.22) / FLL 26.00 (25.11–26.18) / HLL 34.42 (34.25–36.81) / T4L 11.47 (11.42–11.81) / HL 18.11 (17.21–18.72) / HW 13.70 (13.39–13.96) / HD 10.24 (8.99–10.96) / EL 4.78 (4.72–5.71) / EOL 2.74 (2.29–2.76) / EOW 2.16 (2.10–2.28) / TDL 1.91 (1.83–1.97)
7. Taketomijima: female (n = 7), SVL 47.08±1.86 (44.2–49.8) / AGL 57.51 (53.30–59.71) / SFL 32.73 (31.87–35.84) / SEL 6.71 (6.42–7.08) / SEOL 17.38 (16.98–18.10) / EEL 7.29 (7.08–7.52) / FLL 22.64 (21.46–24.01) / HLL 32.19 (29.58–32.91) / T4L 9.91 (9.39–10.27) / HL 16.91 (16.26–17.62) / HW 12.74 (11.85–13.22) / HD 10.02 (8.58–10.63) / EL 4.84 (4.79–5.66) / EOL 2.50 (2.08–2.64) / EOW 1.81 (1.46–2.20) / TDL 1.88 (1.61–2.36); male (n = 20), SVL 48.05±1.70 (45.0–51.4) / AGL 52.89 (47.01–57.00) / SFL 35.54 (34.00–37.71) / SEL 7.06 (6.78–7.54) / SEOL 18.92 (18.26–19.56) / EEL 8.02 (7.71–8.32) / FLL 25.16 (23.43–26.85) / HLL 33.74 (30.50–36.21) / T4L 10.60 (10.10–11.48) / HL 18.22 (17.55–19.02) / HW 13.39 (12.35–13.85) / HD 10.55 (9.92–12.31) / EL 5.39 (4.86–5.61) / EOL 2.75 (2.14–3.12) / EOW 2.13 (1.85–2.59) / TDL 1.91 (1.46–2.30)
8. Kuroshima: female (n = 23), SVL 41.6±2.97 (35.0–47.3) / AGL 56.38 (53.19–61.18) / SFL 34.57 (32.33–36.41) / SEL 7.12 (6.42–7.65) / SEOL 18.16 (17.13–20.00) / EEL 7.45 (6.85–8.02) / FLL 23.73 (21.41–25.75) / HLL 33.10 (29.98–36.29) / T4L 10.24 (8.89–11.51) / HL 17.96 (16.70–19.71) / HW 12.97 (12.21–14.07) / HD 10.17 (8.99–11.00) / EL 5.16 (4.50–6.00) / EOL 2.84 (2.48–3.32) / EOW 2.18 (1.82–2.50) / TDL 1.91 (1.65–2.57); male (n = 36), SVL 44.73±2.45 (37.5–48.5) / AGL 53.08 (48.61–56.54) / SFL 36.01 (33.18–39.20) / SEL 7.30 (6.79–8.00) / SEOL 19.31 (18.00–21.07) / EEL 8.00 (7.24–8.80) / FLL 25.27 (23.24–27.73) / HLL 35.02 (32.70–40.00) / T4L 11.17 (10.44–13.33) / HL 18.59 (16.98–20.27) / HW 13.67 (11.86–14.76) / HD 10.71 (9.40–11.73) / EL 5.41 (4.91–5.93) / EOL 3.06 (2.66–3.37) / EOW 2.30 (1.78–2.73) / TDL 1.94 (1.57–2.40)
9. Kohamajima: female (n = 3), SVL 45.8±7.19 (41.5–54.1) / AGL 57.83 (56.94–58.96) / SFL 35.42 (33.27–36.12) / SEL 7.23 (7.02–7.42) / SEOL 18.80 (17.93–18.90) / EEL 7.47 (7.39–7.66) / FLL 24.10 (22.00–26.08) / HLL 35.42 (31.61–35.88) / T4L 11.57 (9.24–11.72) / HL 17.59 (17.01–17.94) / HW 13.16 (13.01–13.31) / HD 9.80 (9.57–9.88) / EL 4.82 (4.62–5.26) / EOL 2.87 (2.77–2.89) / EOW 1.93 (1.66–2.15) / TDL 1.91 (1.85–2.17); male (n = 2), SVL 45.30±2.40 (43.6–47.0) / AGL 50.82 (9.57–52.06) / SFL 36.04 (34.47–37.62) / SEL 7.18 (7.02–7.34) / SEOL 19.44 (19.15–19.72) / EEL 8.39 (8.30–8.49) / FLL 25.04 (24.54–25.53) / HLL 35.98 (35.78–36.17) / T4L 11.27 (11.06–11.47) / HL 18.12 (17.66–18.58) / HW 13.48 (12.98–13.99) / HD 10.47 (10.09–10.85) / EL 4.97 (4.89–5.04) / EOL 2.76 (2.75–2.77) / EOW 2.10 (2.06–2.13) / TDL 1.99 (1.91–2.06)
10. Iriomotejima: female (n = 6), SVL 45.53±5.78 (35.3–51.0) / AGL 55.78 (54.39–59.79) / SFL 32.58 (30.46–37.68) / SEL 7.08 (6.18–7.36) / SEOL 17.56 (16.50–19.26) / EEL 7.34 (6.60–7.65) / FLL 22.98 (22.47–24.35) / HLL 33.04 (28.66–36.17) / T4L 10.54 (9.28–12.06) / HL 16.65 (16.08–19.26) / HW 11.86 (10.31–13.31) / HD 9.14 (8.66–9.69) / EL 4.68 (4.31–5.10) / EOL 2.79 (2.27–3.12) / EOW 1.96 (1.68–2.55) / TDL 1.97 (1.47–2.13); male (n = 25), SVL 49.67±5.78 (33.8–55.7) / AGL 52.95 (48.54–56.65) / SFL 35.05 (31.54–37.87) / SEL 7.29 (6.46–7.86) / SEOL 18.60 (17.61–19.84) / EEL 7.77 (6.90–8.28) / FLL 25.15 (23.44–27.27) / HLL 34.69 (31.38–37.48) / T4L 11.59 (8.62–12.53) / HL 17.68 (16.70–19.53) / HW 12.64 (11.50–13.92) / HD 10.02 (8.00–11.41) / EL 4.94 (4.18–5.62) / EOL 2.94 (2.51–3.37) / EOW 2.07 (1.67–2.66) / TDL 1.94 (1.55–2.37)
11. Haterumajima: female (n = 4), SVL 44.45±3.22 (41.5–48.1) / AGL 56.18 (54.26–58.22) / SFL 33.52 (32.47–35.71) / SEL 6.90 (6.49–7.23) / SEOL 17.71 (16.84–18.57) / EEL 7.26 (7.07–7.47) / FLL 23.34 (21.64–23.86) / HLL 32.24 (30.74–34.29) / T4L 9.73 (8.94–10.48) / HL 16.78 (16.01–17.14) / HW 12.31 (12.05–12.55) / HD 9.94 (9.15–10.17) / EL 4.76 (4.57–4.82) / EOL 2.33 (2.17–2.38) / EOW 1.92 (1.66–1.95) / TDL



- 1.68 (1.66–1.95); male (n = 7), SVL 44.70±3.97 (40.2–49.3) / AGL 54.42 (51.54–56.31) / SFL 34.83 (31.85–36.16) / SEL 7.10 (6.78–7.46) / SEOL 18.46 (18.20–18.93) / EEL 7.80 (7.28–8.39) / FLL 24.52 (23.82–26.70) / HLL 34.47 (32.65–36.51) / T4L 10.58 (9.94–11.65) / HL 17.91 (17.01–18.07) / HW 12.62 (11.65–13.59) / HD 10.17 (8.96–11.34) / EL 4.98 (4.85–5.22) / EOL 2.72 (2.43–3.04) / EOW 2.18 (1.62–2.28) / TDL 1.94 (1.64–2.07)
12. Yonagunijima: female (n = 19), SVL 45.54±2.99 (38.1–51.0) / AGL 56.25 (52.98–60.37) / SFL 33.54 (30.69–35.31) / SEL 6.79 (6.25–7.61) / SEOL 17.88 (16.47–18.72) / EEL 7.40 (6.47–7.87) / FLL 23.23 (21.18–26.30) / HLL 32.48 (30.20–34.66) / T4L 9.73 (9.17–10.82) / HL 17.20 (16.08–18.37) / HW 12.67 (10.73–14.17) / HD 9.92 (9.19–12.07) / EL 4.88 (4.38–5.52) / EOL 2.69 (2.29–3.15) / EOW 2.00 (1.86–2.47) / TDL 1.81 (1.46–2.09); male (n = 14), SVL 45.41±4.84 (35.0–52.0) / AGL 55.00 (48.57–57.48) / SFL 35.66 (33.85–40.57) / SEL 7.37 (6.92–8.28) / SEOL 19.46 (17.69–21.43) / EEL 8.15 (7.31–8.71) / FLL 25.86 (23.60–26.83) / HLL 34.96 (32.69–37.43) / T4L 10.92 (9.81–12.86) / HL 18.48 (17.31–20.86) / HW 13.75 (12.37–15.43) / HD 10.70 (9.62–11.44) / EL 5.29 (4.81–6.00) / EOL 2.86 (2.60–3.14) / EOW 2.25 (1.91–2.86) / TDL 1.94 (1.69–2.40)
13. Taipei: female (n = 2), SVL 39.05±1.48 (38.0–40.1) / AGL 55.20 (54.61–55.79) / SFL 34.87 (33.41–36.32) / SEL 7.43 (7.23–7.63) / SEOL 18.58 (17.96–19.21) / EEL 7.82 (7.48–8.16) / FLL 25.63 (24.94–26.32) / HLL 35.21 (35.16–35.26) / T4L 10.63 (10.47–10.79) / HL 18.07 (17.46–18.68) / HW 12.94 (12.72–13.16) / HD 9.72 (9.47–9.98) / EL 5.26 (4.99–5.53) / EOL 2.69 (2.63–2.74) / EOW 1.92 (1.74–2.10) / TDL 1.92 (1.84–2.00); male (n = 1), SVL 43.60 (–) / AGL 51.61 (–) / SFL 34.86 (–) / SEL 7.80 (–) / SEOL 18.35 (–) / EEL 7.34 (–) / FLL 22.71 (–) / HLL 35.55 (–) / T4L 9.63 (–) / HL 18.58 (–) / HW 12.38 (–) / HD 9.63 (–) / EL 4.82 (–) / EOL 2.98 (–) / EOW 2.52 (–) / TDL 1.83 (–)
14. Hsinchu: female (n = 8), SVL 42.82±3.34 (38.3–47.3) / AGL 56.21 (53.61–57.27) / SFL 33.72 (32.14–34.54) / SEL 6.95 (6.55–7.57) / SEOL 18.19 (17.47–19.32) / EEL 7.07 (6.77–7.57) / FLL 25.20 (23.47–27.27) / HLL 36.68 (34.88–39.56) / T4L 11.73 (10.78–13.76) / HL 17.61 (16.91–18.80) / HW 12.54 (11.79–13.84) / HD 8.35 (7.64–9.03) / EL 4.93 (4.58–5.67) / EOL 2.52 (2.18–2.87) / EOW 1.89 (1.54–2.31) / TDL 1.89 (1.75–2.06); male (n = 10), SVL 39.50±1.52 (37.1–42.5) / AGL 53.61 (50.40–55.77) / SFL 36.18 (34.99–37.47) / SEL 7.70 (7.42–7.92) / SEOL 20.05 (19.60–20.84) / EEL 7.72 (7.53–8.09) / FLL 28.23 (26.38–28.84) / HLL 39.90 (37.62–41.24) / T4L 12.98 (11.88–14.29) / HL 19.34 (18.61–19.95) / HW 13.40 (12.63–15.00) / HD 8.62 (7.92–9.16) / EL 5.47 (5.21–5.66) / EOL 2.68 (2.51–2.98) / EOW 2.33 (1.73–2.73) / TDL 1.98 (1.76–2.25)
15. Miaoli: female (n = 18), SVL 38.88±4.06 (34.1–45.8) / AGL 55.56 (51.90–63.20) / SFL 34.66 (31.48–38.30) / SEL 7.63 (6.86–8.50) / SEOL 19.25 (17.65–20.76) / EEL 7.72 (7.08–8.80) / FLL 26.50 (22.79–29.33) / HLL 36.70 (32.69–41.06) / T4L 12.38 (10.70–14.37) / HL 18.92 (16.59–20.76) / HW 12.85 (12.16–14.82) / HD 9.42 (8.55–10.92) / EL 5.21 (4.37–5.70) / EOL 2.88 (2.43–3.22) / EOW 1.92 (1.21–2.63) / TDL 1.94 (1.31–2.56); male (n = 9), SVL 40.23±2.62 (35.6–45.1) / AGL 53.03 (49.89–55.31) / SFL 36.77 (35.70–39.61) / SEL 7.88 (7.60–8.65) / SEOL 19.86 (19.19–20.79) / EEL 8.20 (7.75–8.87) / FLL 27.25 (24.70–27.78) / HLL 38.50 (35.48–39.51) / T4L 12.32 (11.31–14.04) / HL 19.42 (18.85–20.22) / HW 13.83 (12.83–14.33) / HD 10.35 (9.31–11.38) / EL 5.43 (4.66–5.85) / EOL 3.09 (2.66–3.32) / EOW 2.20 (1.77–2.81) / TDL 1.96 (1.52–2.44)
16. Taichung: female (n = 4), SVL 36.83±1.20 (35.7–38.4) / AGL 54.90 (53.64–57.70) / SFL 35.87 (34.45–37.20) / SEL 7.92 (7.55–8.40) / SEOL 20.01 (19.41–20.45) / EEL 8.20 (8.07–8.40) / FLL 27.34 (26.82–27.98) / HLL 36.70 (36.46–38.23) / T4L 12.60 (12.24–13.30) / HL 19.46 (18.87–20.45) / HW 14.16 (13.48–14.40) / HD 11.07 (10.16–11.48) / EL 5.50 (5.39–5.60) / EOL 2.91 (2.80–3.05) / EOW 2.02 (1.89–2.22) / TDL 1.91 (1.82–2.80); male (n = 15), SVL 37.15±2.02 (34.4–41.4) / AGL 51.93 (48.91–54.25) / SFL 37.90 (35.00–40.46) / SEL 8.54 (8.06–8.93) / SEOL 21.41 (20.43–22.51) / EEL 8.86 (8.06–9.18) / FLL 28.18 (26.80–31.05) / HLL 38.75 (37.23–42.16) / T4L 13.55 (12.47–14.41) / HL 20.64 (19.51–21.61) / HW 14.67 (14.04–15.38) / HD 11.68 (11.02–12.67) / EL 5.64 (5.31–6.27) / EOL 3.25 (2.75–3.80) / EOW 2.42 (1.90–2.85) / TDL 2.17 (1.88–2.56)
17. Yunlin: female (n = 1), SVL 36.2 (–) / AGL 55.25 (–) / SFL 36.74 (–) / SEL 8.01 (–) / SEOL 19.89 (–) / EEL 8.01 (–) / FLL 25.69 (–) / HLL 40.06 (–) / T4L 12.98 (–) / HL 19.61 (–) / HW 14.36 (–) / HD 8.84 (–) / EL 5.80 (–) / EOL 3.04 (–) / EOW 2.76 (–) / TDL 2.21 (–); male (n = 3), SVL 38.23±1.01 (37.3–39.3) / AGL 51.91 (51.21–52.49) / SFL 36.48 (35.88–37.00) / SEL 7.84 (7.77–7.89) / SEOL 20.38 (20.36–20.47) / EEL 8.04 (7.87–8.14) / FLL 26.51 (26.21–26.81) / HLL 38.34 (37.15–39.37) / T4L 12.87 (12.21–13.39) / HL 20.21 (19.85–20.38) / HW 12.87 (12.47–14.44) / HD 9.19 (9.12–9.92) / EL 5.77 (5.60–5.90) / EOL 3.22 (3.15–3.31) / EOW 2.36 (2.29–2.68) / TDL 2.10 (2.04–2.14)
18. Nantou: female (n = 17), SVL 39.98±3.28 (35.0–46.1) / AGL 55.34 (52.00–57.04) / SFL 34.57 (32.49–37.14) / SEL 7.32 (6.86–8.00) / SEOL 19.19 (17.75–20.29) / EEL 7.58 (6.86–8.57) / FLL 25.50 (23.34–27.76) / HLL 36.58 (33.62–38.92) / T4L 11.90 (10.63–13.19) / HL 18.67 (17.57–20.11) / HW 12.78 (11.67–13.60) / HD 8.58 (7.50–9.62) / EL 5.30 (4.77–6.00) / EOL 2.67 (2.39–3.30) / EOW 2.20 (1.74–2.55) / TDL 1.96 (1.60–2.47); male (n = 40), SVL 38.70±2.19 (34.2–42.9) / AGL 51.87 (48.2–54.87) / SFL 36.55 (34.62–39.37) / SEL 7.77 (7.31–8.50) / SEOL 20.53 (19.23–21.47) / EEL 8.05 (7.54–8.77) / FLL 27.22 (24.54–30.44) / HLL 38.65 (35.56–40.92) / T4L 12.76 (11.46–14.04) / HL 20.08 (18.46–21.05) / HW 13.63 (12.56–14.94) / HD 9.09 (8.01–11.60) / EL 5.60 (4.95–5.98) / EOL 2.95 (2.39–3.66) / EOW 2.35 (1.86–2.75) / TDL 2.04 (1.68–2.47)
19. Chiayi: female (n = 2), SVL 42.05±2.74 (40.3–43.8) / AGL 55.98 (53.65–58.31) / SFL 34.43 (33.25–35.62) / SEL 7.50 (7.30–7.69) / SEOL 18.55 (18.49–18.61) / EEL 7.62 (7.30–7.94) / FLL 24.14 (23.97–24.32) / HLL 35.45 (35.16–35.73) / T4L 10.80 (10.17–11.42) / HL 18.67 (18.61–18.72) / HW 12.74 (12.33–13.15) / HD 10.62 (9.82–11.41) / EL 4.74 (4.47–5.02) / EOL 2.86 (2.74–2.98) / EOW 1.66 (1.49–1.83) / TDL 1.53 (1.24–1.83); male (n = 4), SVL 38.6Å±2.28 (36.4–41.8) / AGL 52.69 (51.10–54.97) / SFL 36.61 (35.86–37.37) / SEL 8.01 (7.42–8.79) / SEOL 20.87 (19.86–21.98) / EEL 8.27 (7.66–8.79) / FLL 27.69 (25.36–28.27) / HLL 38.71 (35.88–39.84) / T4L 12.86 (11.48–13.19) / HL 20.47 (19.62–21.43) / HW 13.78 (12.68–14.29) / HD 10.88 (8.90–11.32) / EL 5.50 (4.78–5.53) / EOL 3.08 (2.87–3.16) / EOW 2.02 (1.67–2.62) / TDL 2.01 (1.83–2.20)
20. Tainan: female (n = 1), SVL 35.70 (–) / AGL 53.50 (–) / SFL 37.54 (–) / SEL 8.12 (–) / SEOL 19.89 (–) / EEL 8.12 (–) / FLL 28.01 (–) / HLL 40.90 (–) / T4L 13.16 (–) / HL 19.89 (–) / HW 13.72 (–) / HD 10.08 (–) / EL 5.88 (–) / EOL 3.36 (–) / EOW 2.24 (–) / TDL 1.96 (–); male (n = 2), SVL 41.70±1.98 (40.3–43.1) / AGL 51.70 (51.04–52.36) / SFL 36.83 (36.20–37.47) / SEL 7.56 (7.42–7.69) / SEOL 20.27 (20.19–20.35) / EEL 7.92 (7.66–8.19) / FLL 25.38 (22.97–27.79) / HLL 37.14 (34.57–39.70) / T4L 11.79 (10.67–12.90) / HL 19.31 (19.03–19.60) / HW 13.34 (12.53–14.14) / HD 9.61 (9.05–10.17) / EL 5.40 (5.34–5.46) / EOL 2.76 (2.55–2.98) / EOW 2.16 (2.09–2.23) / TDL 2.28 (2.09–2.48)
21. Kaohsiung: female (n = 6), SVL 42.85±3.38 (37.3–47.1) / AGL 55.98 (52.45–57.21) / SFL 34.21 (33.33–37.53) / SEL 6.92 (6.79–7.77) / SEOL 18.25 (17.41–21.81) / EEL 7.44 (7.01–8.09) / FLL 24.14 (21.66–27.35) / HLL 34.13 (31.64–37.74) / T4L 11.00 (9.98–12.01) / HL 17.80 (16.98–20.34) / HW 12.47 (11.90–13.72) / HD 9.60 (9.38–10.72) / EL 4.74 (4.46–5.36) / EOL 2.49 (2.12–2.68) / EOW 1.88 (1.57–2.45) / TDL 2.05 (1.60–2.29); male (n = 7), SVL 40.03±1.95 (36.0–41.7) / AGL 52.58 (48.47–55.42) / SFL 36.70 (34.46–38.01) / SEL 7.64 (7.43–7.78) / SEOL 19.90 (19.28–20.00) / EEL 7.91 (7.62–8.33) / FLL 27.52 (25.06–28.40) / HLL 37.84 (35.42–41.11) / T4L 12.24 (11.81–13.06) / HL 19.44 (18.94–19.70) / HW 13.33 (12.76–15.27) / HD 9.44 (8.37–11.60) / EL 5.17 (4.80–5.56) / EOL 2.78 (2.46–2.89) / EOW 2.17 (1.72–2.78) / TDL 1.97 (1.92–2.30)
22. Pingtung: male (n = 1), SVL 36.00 (–) / AGL 54.44 (–) / SFL 36.39 (–) / SEL 8.33 (–) / SEOL 20.00 (–) / EEL 8.33 (–) / FLL 25.00 (–) / HLL 37.22 (–) / T4L 11.11 (–) / HL 19.72 (–) / HW 13.06 (–) / HD 8.89 (–) / EL 5.56 (–) / EOL 2.50 (–) / EOW 2.22 (–) / TDL 1.94 (–)