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TAXONOMY OF NAKED-TOES GECKOS *Cyrtodactylus irregularis* COMPLEX OF SOUTH VIETNAM AND DESCRIPTION OF A NEW SPECIES FROM CHU YANG SIN NATURAL PARK (KRONG BONG DISTRICT, DAC LAC PROVINCE, VIETNAM)

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A new species of *Cyrtodactylus* of Gekkonidae family, assigned to the *Cyrtodactylus irregularis* complex on the basis of twelve specimens collected from the Chu Yang Sin National Park, Krong Bong District, Dac Lac Province, central Vietnam is described. Forms of *C. irregularis* complex inhabiting an extensive territory, covering the southern part of the Annamite Mountains and Central Highlands, their distribution and variation are discussed; a detailed description of the type specimens of *C. irregularis* complex and a description of a new species are given.

Keywords: Gekkonidae, *Cyrtodactylus*, *Cyrtodactylus irregularis* complex, a new species, Dac Lac, Lam Dong and Dong Nai provinces, South Vietnam.

INTRODUCTION

The number of species which the genus *Cyrtodactylus* is considered to include increased by more than 30% in the last decade (Batuwita and Bahir 2005, Bauer 2002, 2003; Bauer et al., 2002, 2003; David et al., 2004; Das and Lim, 2000; Grismer 2005; Grismer et. al., 2005; Kraus and Allison, 2006; Pauwels et. al., 2004; Youmans and Grismer, 2006). The rate of description of new species *Cyrtodactylus* is amazing.

The development of network of roads, widely adopted night excursions to regions difficult of access using new lighting equipment give a good chance to realize qualitatively new and more successful search and collecting of amphibians and reptiles, which permits us to look at biological diversity from a new angle, in particular at that of geckos in the tropical regions of Asia.

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Over the past two years the list of species of *Cyrtodactylus* of Vietnam — *C. condorensis* (Smith 1920), *C. intermedius* (Smith 1917), *C. irregularis* (Smith 1921), *C. paradoxus* (Darevsky et al. 1997), and *C. phongnhakebangensis* Ziegler et al. 2002) — was extended to include 6 new species: *C. badenesis* Nguyen et al. 2006; *C. caovansungi* Orlov et al. 2007; *C. cryptus* Heidrich et al. 2007; *C. chauquangensis* Hoang Xuan Quang et al. 2007; *C. nigrocularis* Nguyen et al. 2006; and *C.* sp. Rösler et al., in press.

Taxonomy of the complex of *C. irregularis* forms inhabiting an extensive territory, covering the southern part of the Annamite Mountains and Central Highlands appears to be very complicated and involved.

Variation of these forms is discussed; a detailed description of the type specimens of *C. irregularis* complex and a description of a new species from Dac Lac Province are given.

MATERIAL AND METHODS

Samples of members of *C. irregularis* complex, from the following localities were examined (Fig. 1): 1. Vietnam, Quang Tri Province, Huong Hoa Nature Reserve, Huong Hoa district, Huong Lap Community, Ban Cup Village, 16°56′15″ N 106°34′52″ E, elevation

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Fig. 1. Distribution of different forms of *Cyrtodactylus irregularis* complex: **1**. Vietnam, Quang Tri province, Huong Hoa Nature Reserve, Huong Hoa districts, Huong Lap Community, Ban Cup Village, 16°56′15″ N 106°34′52″ E, elevation 400 m a.s.l.; **2**. Central Vietnam, Thua Thien-Hue province, Bach Ma National Park, 16°05′16″ N 107°43′53″ E, 1300 m elevation, ZFMK 80080. (Ziegler et al., 2004); **3**. Laos, Champasak prov., Pakxog Dist., FMNH 258697; **4**. Central Vietnam, Kon Tum province Kon Plong districts, Mang Canh Village, 14°41′0.95″ N 108°12′0.95″ E, 1100 m elevation (*C.* sp. Rösler et al., in press); **5**. Central Vietnam, Gia Lai prov., An Khe district, Buon Luoi and Tram Lap villages — 40 km northwest from Kannack town, 14°26′24″ N 108°22′58″ E, 900 m elevation. ROM 30538; **6**. Central Vietnam, Gia Lai province, An Khe district, Kannack town, Krong Pa village; 14°20′29″ N 108°28′46″ E, 700 – 900 m elevation. ROM 32116; **7**. Cambodia, Ratanakiri prov., Ta Veng district, FMNH 262971; **8**. Vietnam, Gia Lai prov., An Khe district, FMNH 252194; **9**. Cambodia, Mondolkiri prov. Keo Seima district, FMNH 262988; **10**. Cambodia, Mondolkiri prov., O'Rang district, FMNH 262987; **11**. Vietnam, South part of Dac Lac Province, Krong Bong and Lak district, Chu Yang Sin National Park, 12°25′55.9″ N 108°20′83.9″ E, 900 m elevation. Type locality of *C. ziegleri* sp. nov.; **12**. Vietnam, Lam Dong province, Lac Duong district, Bi Doup – Nui Ba Reserve. 12°00′19″ N 108°21′44″ E, 1700 m elevation; **13**. Vietnam, Khanh Hoa prov., Baho cascade near Nha Trang City; **14**. Vietnam, Khanh Hoa prov., Hon Ba Reserve. 12°07″ N 108°56″ E, 1300 – 1500 m elevation; **15**. Type locality of *C. irregularis*, Camly. ~1100 m elevation; **16**. Vietnam, Lam Dong province, Da Lat Plateau, Rung Tong Da Lat; 11°49″ N 108°35″ E, 1400 m elevation; **17**. Vietnam, Dong Nai prov., Cat Tien National Park. 11°21′48″ N 107°10′34″ E, 659 m elevation; **18**. Vietnam, Dong Nai prov., Cat Tien National Park, Ma Da; **19**. Vietnam, Ba Ria-Vung Tau prov., Binh Chau-Phuoc Buu Nature Reserve. 10°28″ N 107°25″ E, 162 m elevation.

400 m a.s.l.; 2. Vietnam, Thua Thien-Hue Province, Bach Ma National Park; 16°05′16″ N 107°43′53″ E, 1300 m elevation, ZFMK 80080 (Ziegler et al., 2004); 3. Laos, Champasak Province, Pakxog district, FMNH 258697; 4. Vietnam, Kon Tum Province, Kon Plong district, Mang Canh Village, 14°41′0.95″ N 108°12′0.95″ E, 1100 m elevation (type locality of *C.* sp. Rösler et al., in press); 5. Vietnam, Gia Lai Province, An Khe district, Buon Luoi and Tram Lap villages, 40 km northwest from Kannack town, 14°26′24″ N, 108°22′58″ E, 900 m elevation, ROM 30538; 6. Vietnam, Gia Lai Province, An Khe district, Kannack town, Krong Pa village; 14°20′29″ N 108°28′46″ E, 700 – 900 m elevation, ROM 32116; 7. Cambodia, Ratanakiri Province, Ta Veng district, FMNH 262971 8. Vietnam, Gia Lai Province, An Khe district, FMNH 252194; 9. Cambodia, Mondolkiri Province, Keo Seima district, FMNH 262988; 10. Cambodia, Mondolkiri Province, O'Rang district, FMNH 262987; 11. Vietnam, South part of Dac Lac Province, Krong Bong and Lak district, Chu Yang Sin National Park, 12°25′55.9″ N 108°20′83.9″ E, 900 m elevation (type locality of *C. ziegleri* sp. nov.); 12. Vietnam, Lam Dong Province, Lac Duong district, Bi Doup – Nui Ba Reserve. 12°00′19″ N 108°21′44″ E, 1700 m elevation; 13. Vietnam, Khanh Hoa Province, Baho cascade near Nha Trang City; 14. Vietnam, Khanh Hoa Province, Hon Ba Reserve. 12°07′ N 108°56′ E, 1300 – 1500 m elevation; 15. Type locality of *C. irregularis*, Camly, ~1100 m elevation; 16. Vietnam, Lam Dong Province, Da Lat Plateau, Rung Tong Da Lat pine forest; 11°49′ N 108°35′ E, 1400 m elevation; 17. Vietnam, Dong Nai Province, Cat Tien National Park. 11°21′48″ N 107°10′34″ E, 659 m elevation; 18. Vietnam, Dong Nai Province, Cat Tien National Park, Ma Da; 19. Vietnam, Ba Ria-Vung Tau Province, Binh Chau-Phuoc Buu Nature Reserve. 10°28″ N 107°25″ E, 162 m elevation.

For description and comparison the main set of pholidosis characters traditional in recent studies of naked-toes geckos (Bauer, 2002, 2003; Bauer et al., 2002, 2003; Darevsky and Szczerbak, 1997; Ziegler et al., 2002; David et al., 2004; Orlov et al., 2007; Nguyen et al., 2006; Ziegler et al., 2002; Hoang et al., 2007) was used.

For morphological analysis the following characters were taken with caliper (to the nearest 0.1 mm): snout-vent length (SVL, from tip of snout to vent); tail length (TailL, from vent to tip of tail); head length (HeadL, distance between retroarticular process of jaw and snout-tip); head width (HeadW, maximum width of head); head height (HeadH, maximum height of head, from occiput to underside of jaws); orbital diameter (OrbD, greatest diameter of orbit); snout to eye distance (SnEye, distance between anteriormost point of eye and tip of snout); ear length (EarL, longest dimension of ear);

trunk length (TrunkL, distance from axilla to groin measured from posterior edge of forelimb insertion to anterior edge of hindlimb insertion); shoulder length (LS); forearm length (ForeaL, from base of palm to elbow); femur length (FemurL); crus length (Crus L, from base of heel to knee); length of IV finger (LD4A); length of IV toe (LD4P); eye to ear distance (EyeEar, distance from anterior edge of ear opening to posterior corner of eye); scales across the belly in the middle of the body (SAB); number of scales along the midbody from mental shield to anterior edge of cloaca (SLB), supralabials (SL); infralabials (IL); preanal pores (PP); femoral pores (PF); number of basal and distal subdigital lamellae under 4 fingers (SDL4A); number of basal and distal subdigital lamellae under 4 toes (SDL4P), number of longitudinal rows of enlarged tubercles in the middle of dorsum between ventrolateral folds (TubL); number of transversal rows of enlarged tubercles between occipital region and middle of sacrum along the middle of dorsum (TubW); number scales along middle of head, between occiput sinus and supranasales (SLH), scales across head, between top of ears opening (SAH).

Statistical processing of the data was conducted using Statistica 6.0 program. Position of specimens in the space of canonical variables was determined using the canonical discriminant analysis. Samples with the number of specimens more than 6 ($n > 6$) were used as grouping variables. Significance of size characteristics was tested also using Mann – Whitney criterion for independent variables.

Apart from the material collected by the authors during the expeditions to Vietnam and adjoining countries museum collections of ZMMU, ZISP, CAS, MVZ, BMNH, and IEBR were examined. In addition, information on collection catalogues from the Internet resource www.herpnet.org was used to form a comprehensive idea of distribution of *C. irregularis* complex in countries adjoining Vietnam.

Cyrtodactylus ziegleri sp. nov. (Figs. 2 and 3)

Holotype. ZISP 24492, an adult male, collected from Chu Yang Sin National Park, Krong Bong district, south part of Dac Lac Province, Vietnam, 12°25′55.9″ N, 108°20′83.9″′ E, 900 m elevation, in October 2007 by Nikolai Orlov, Nguyen Ngoc Sang and Ho Tu Cuc (Fig. 4)

Paratypes. ZMMU 12611-1, 12611-2; ZISP 24493 – 24497, ITBCZ 482 – 485, three adult males and four adult females, collected from Chu Yang Sin National Park, Krong Bong district, south part of Dac Lac Province, Vietnam, 12°25′55.9″ N, 108°20′83.9″ E, 900 m elevation, in October 2007 by Nikolai Orlov Nguyen Ngoc Sang and Ho Tu Cuc (Fig. 5).

Fig. 2. General view of *Cyrtodactylus ziegleri* sp. nov., night color.

Etymology. The species was named after the eminent zoologist from Cologne Zoo, Germany, Dr. Thomas Ziegler, who contributed greatly to the study of herpetofauna of Vietnam, in particular of the geckos fauna of Vietnam.

Diagnosis. A large size *Cyrtodactylus*, snout-vent length 84.6 – 93 mm, Lcd 95 – 107 mm; body slender, limbs and digits moderately long, original tail not thick and longer than the body. Two pair of postmental scales, first pair in broad contact with one another, size of the second pair are about half of first pair; nostrils round, each surrounded by supranasal, rostral, first supralabial, and three rare four small postnasals scales; dorsal scales consisting of 20 – 24 rows of enlarged roundish weakly keeled tubercles; 33 – 39 ventral scales between ventrolateral folds, 173 – 198 ventral scales between postmental scales and cloacae; male with 5 – 8 preanal pores in

Fig. 3. General view of *Cyrtodactylus ziegleri* sp. nov., day color.

Fig. 4. Holotype of *Cyrtodactylus ziegleri* sp. nov. ZISP 24492. (Fn 36309), an adult male: *a*, dorsal view; *b*, ventral view.

single Λ-shaped series, 8 – 10 enlarged femoral scales on each side, a few femoral pores sometimes can present on distal femoral scales (near bend of knee); midventral subcaudal scales uniform, granular, much larger then on the flanks, but without transversely enlarged plates; tail segments are developed only in basal part.

Dorsum coloration from light yellowish to light-brown with 4 – 6 dark-brown transverse irregular bands between limbs. Color in preservatives from light beige to brown.

The dark dorsal pattern without contrasting white bordering. U-shaped narrow occipital dark band extending anteriorly from ear to orbit usually present. Dorsal side of head can be markedly dark with irregular spots or uncertain designs pattern.

Tails with 8 – 11 dark transversal bands, with irregular edge, distance between bands is equal or more than bands width. Bands are not clear on the ventral side.

Description of holotype ZISP 24492 (Fig. 4). ZISP 24492, adult male. Snout-vent length 90 mm, Lcd 95 mm. Head relatively long (HeadL/SVL ratio 0.27),

Fig. 5. Type series of *Cyrtodactylus ziegleri* sp. nov.

not wide (HeadW/HeadL ratio 0.7), not depressed (HeadH/HeadL ratio 0.4), distinct from slender neck. Snout elongate (SnEye/HeadL ratio 0.4), pointed; longer than eye diameter (OrbD/SnEye ratio 0.49); scales on snout and forehead small, rounded, granular, homogeneous; scales on snout somewhat larger than those in occipital region.

Eye large (OrbD/HeadL ratio 0.19); pupil vertical with crenellated margins. External auricular opening is small (EarL/HeadL ratio 0.05) oval, vertical; eye to ear distance more than diameter of eye (EyeEar/OrbD ratio 1.3).

Rostral scale relatively high, width 4.2 mm and height 2.0 mm; it is divided up to the two thirds by longitudinal groove.

Supranasals are divided by one large scale (Fig. 6); rostral in contact with first supralabial, two supranasals and scale between them; nostrils round, each surrounded by supranasal, rostral, first supralabial, and three small postnasals scales, about three times smaller than the supranasals.

One-tow row of small scales separates orbit from supralabials. Mental triangular, width (3.0 mm) approximately equal to height (2.8 mm); two pairs of en-

Fig. 6. Head of holotype *Cyrtodactylus ziegleri* sp. nov., divided supranasal scales.

Fig. 7. Head of holotype *Cyrtodactylus ziegleri* sp. nov., mental scalation.

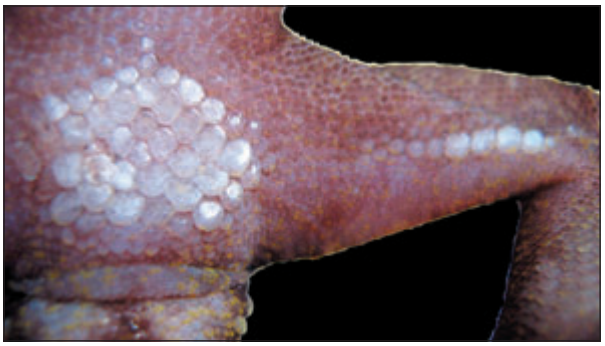

Fig. 8. Anal region with 8 preanal pores and enlarged femoral scales of holotype *Cyrtodactylus ziegleri* sp. nov.

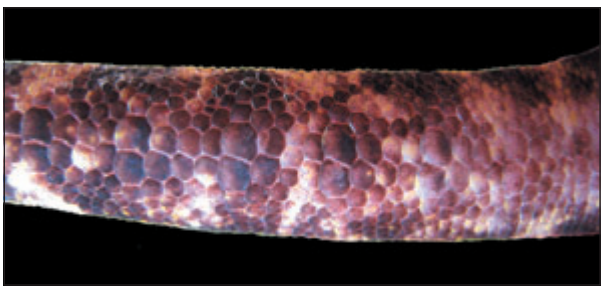

Fig. 9. Tail of holotype *Cyrtodactylus ziegleri* sp. nov., subcaudal scalation uniform granular, without transversely enlarged plates.

larged postmentals, first pair in broad contact (Fig. 7); supralabials 10; infralabials 7.

Trunk is slightly flattened and elongated (TrunkL/SVL ratio 0.4) with developed ventrolateral folds. Dorsal trunk surface is covered with small flat granular scales, among which are regularly distributed roundish weakly keeled tubercles (4 – 5 times larger than of adjacent scales) extending from occipital region to the back and tail base; tubercles form about 24 rows at midbody.

Ventral scales larger than dorsal, smooth, subimbricate, with rounded free margins; in precloacal region scales larger than on midbelly; 39 abdominal scale rows across middle of belly to base of ventrolateral folds; 194 midventral scales along belly; gular region covered by homogeneous, small and smooth scales.

Scales containing 8 small preanal pores about the same size as surrounding ones are situated in V-shaped row; 2 (left) and 2 (right) femoral pores in enlarged femoral scales, separated from preanal pores by smaller scales; no precloacal groove (Fig. 8).

Original tail long, slender, gently tapering to tip; some longer than snout vent length (TailL/SVL ratio 1.05); pronounced tail segments are only on the basal part, that were formed by flat weakly keeled tubercles; subcaudal scalation uniform granular, without transversely enlarged plates (Fig. 9). Midventral subcaudal scales considerably larger than flank scales.

Fore and hind limbs elongate and slender (ForeaL/SVL ratio 0.15; CrusL/SVL ratio 0.16); digits are moderately long and thin; on IV finger are 6 basal and 11 distal subdigital lamellae; on IV toe are 8 basal and 11 distal subdigital lamellae.

Measurements of holotypes. SVL 90, Lcd 95, TrunkL 36.3, LH 24.3, WH 17, HH 10, SnEye 9.8, OrbD 4.8, EarL 1.3, EyeEar 6.4, LS 14.7, ForeaL 13.4, FemurL 17.4, CrusL 14.5, LD4A 9, LD4P 11, SAB 39, SLB 194, TubL 24, TubW 43, SLH 103, SAH 87, SDL4A 6 + 11, SDL4P 8 + 11, PP 8, PF 4, SL 9, IL 8.

The measurements of type series are given in Table 1.

Distribution. A new species is known only from type locality, but is probably distributed also in the adja-

TABLE 1. Measurements of *Cyrtodactylus ziegleri* sp. nov. (in mm)

Character	Holotypes ZISP 24492 36309	Paratypes ZISP 24493 36306	Paratypes ZISP 24494 36304	Paratypes ZISP 24495 36426	Paratypes ZISP 24496 36468	Paratypes ZISP 24497 36265	Paratypes ZMMU R-12611-1 36298	Paratypes ZMMU R-12611-2 36422
	♂	♀	♀	♂	♀	♂	♂	♀
SVL	90	85.6	93	87.6	87.6	84.6	91	88.3
Lcd	95	95	90*	85*	60*	105	107	95
TrunkL	36.3	38	39	34.2	36.8	36.7	39.6	36.4
Head L	24.3	22.5	25	24.9	24.5	23	25.8	24.2
Head W	17	16.2	17.2	16.5	17.2	15.8	18	16.8
Head H	10	9.2	9.7	9.6	9.7	9.4	10	9.6
SnEye	9.8	9	10	9.6	9.4	8.7	10.3	9.8
OrbD	4.8	4.9	5	5	5	4.8	5	4.8
EarL	1.3	2	1.8	2	1.8	1.6	1.8	1.8
EyeEar	6.4			6.8				
LS	14.7	13	14.5	13.6	13, 6	13	15.3	14
ForeaL	13.4	12	13.5	12.5	12, 3	11.7	14.3	11.9
FemurL	17.4	15.6	18.3	17.5	17, 3	17	20	16
CrusL	14.5	12.4	13	13	13, 1	13.1	15.3	13.2
LD4A	9	8	8.5	8.8	8, 2	8.2	9	8
LD4P	11	9	10.5	10.4	9, 4	10.3	10.2	9
SAB	39	34	33	33	36	38	45	37
SLB	194	173	189	184	196	184	198	176
TubL/TubW	24/43	20/46	20/45	20/38	22/41	20/40	24/45	24/43
SLH/SAH	103/87	90/88	96/80	86/90	100/82	102/76	106/82	92/86
SDL4A	6 + 11	6 + 10	7 + 12	6 + 11	6 + 11	7 + 11	7 + 11	6 + 10
SDL4P	8 + 11	8 + 10	7 + 12	9 + 12	7 + 12	8 + 12	7 + 14	9 + 11
PP	8	0	6	6	5	8	5	8
PF	2 + 2	0	0	1 + 1	3 + 3	1 + 1	0	0
SL	9	12	12	9	9	11	9	9
IL	8	10	8	7	9	8	9	8

* Specimens with regenerated tail.

cent area. All localities of findings of *Cyrtodactylus irregularis* complex (Fig. 1) are indicated on the map.

DISCUSSION

Extended description of *Cyrtodactylus irregularis* (Smith 1921) type specimens. Comparison of morphological characters of *Cyrtodactylus irregularis* complex from central Vietnam and *C. ziegleri* sp. nov.

In order to discuss variation and taxonomic status of forms of geckos of *Cyrtodactylus irregularis* complex it is necessary to refine morphological characters of the species *Cyrtodactylus irregularis sensu stricto*. For that purpose we propose an extended description of this species.

Gymnodactylus peguensis var. *irregularis* was described by Malcolm Smith in 1921, by specimens from the Camly, Lang Bian, S. Annam (h = 3500 feet) [= C*yrtodactylus irregularis*; now Lang Bian Mountain, Lam Dong Province, Vietnam] (Figs. 10 and 11).

In the original description the author indicated the following basic diagnostic characteristics: SVL 79 mm, 5 – 7 pores, and 41 – 46 scales across middle of body, enlarged femoral scales is present.

On the basis of examination of the topotypes from Da Lat, Lang Bian plateau (Figs. 10 – 14) and type specimens available we give a broadened description of *C. irregularis*. The data on topotypes are given in Table 2.

Cyrtodactylus irregularis is a relatively large and robust gecko.

Body is cylindrical and slightly flattened in the dorso-ventral plane, limbs are relatively short and tail is thickened at the base, shorter than body. Triple-edged knobs at the base of tail are very large (pyramidal) and form 3 – 5 pronounced semi-rings of tail segments,

Fig. 10. Type specimens of *Cyrtodactylus irregularis* BMNH 1946.3.23.3, 1946.3.23.4, dorsal view. Photo by Dr. Colin McCarthy.

Fig. 11. Type specimens of *Cyrtodactylus irregularis* BMNH 1946.3.23.3, 1946.3.23.4, anal region with enlarged femoral scales. Photo by Dr. Colin McCarthy.

which disappear abruptly in the middle part of the tail (Fig. 15).

The pattern on the back is formed by 5 – 7 broad dark brown transversal bands with uneven margins in white binding. The distance between the transversal bands (or their elements) is smaller or is equal to the width of the bands proper. Some of those bands can fall into separate rounded spots. On the back white or light enlarged triple-edged knobs are scattered chaotically. On the tail there are 6 – 8 wide dark transversal bands, the gaps between them being much smaller than width of the bands. On the head a broad dark U-shaped band in white binding is pronounced, passing from the posterior edge of eyes above auricular openings and over the occipital part and neck. The pattern on head is reticulate, formed by small dark spots of irregular shape in white binding.

The high intraspecific variation makes it difficult to select diagnostic characters. We made an attempt to assess stability and value of characters traditionally used in diagnoses of *Cyrtodactylus irregularis* complex. A major character by which all *Cyrtodactylus* of Indo-China are divided into two groups is the character of scaly cover of the under surface of tail. One group has extended transversal plates, whereas the other group has the tail covered by small homogenous scales. By this character all Vietnamese species of *Cyrtodactylus* are split into two distinct groups: *irregularis*, *cryptus*, and *C.* sp. Rösler et al. with small subcaudal scales and the other species with extended subcaudal scales. We think that the small homogenous subcaudal scalation is an ancestral state of this character due to a tendency of increase (fusion, oligomerization) of subcaudal scales in this group. Thus, in *C. ziegleri* sp. nov. from Chu Yang Sin National Park, midventral subcaudal scales are notably larger than lateral scales of tail. Moreover, single transversely enlarged plates, formed as a result of fusion of subcaudal scales are noted.

A very important group of diagnostic characters for *Cyrtodactylus* is presence, number and topography of femoral and preanal pores and the character of pholidosis in the preanal and femoral region.

By presence or absence of enlarged femoral scales the complex *C. irregularis* is clearly split into northern or southern populations. Geckos from Kon Plong district, Kon Tum Province, and Huong Hoa district, Quang Tri Province, recently described as *C.* sp. Rösler et al., in press (Fig. 16), differ from populations from Central Highland by a complete absence of enlarged femoral scales, whereas they are present in the latter. Ziegler et al (2004) pointed to the absence of enlarged femoral scales in the population from Bach Ma National Park, Thua Thien-Hue Province. Stability of this character is very high (it is present in 100% of individuals in populations). The presence of enlarged femoral scales seems to increase the probability of appearance of femoral pores in all population of some species or only in a few indi-

Fig. 12. Topotype of *Cyrtodactylus irregularis* form Lam Dong province, Da Lat Plateau, Rung Tong Da Lat, live specimen.

Fig. 13. Topotypes of *Cyrtodactylus irregularis* (Smith, 1921) form Da Lat Plateau, dorsal view.

Fig. 14. Topotypes of *Cyrtodactylus irregularis* (Smith, 1921) form Da Lat Plateau, ventral view.

viduals. It is in the case of *C. ziegleri* sp. nov., where we found several weakly developed femoral pores in three of four studied males and in one of four females. The genus *Cyrtodactylus* is known to include species with pores well developed or completely reduced (e.g., *C. paradoxsus*, *C. oldhami*). The number of preanal pores and their development are subject to variation even within one population. The extent to which the pores are developed is also related to age and physiological state of animal, therefore, this character can be only used in adult specimens. In geckos from Cat Tien (6,3), Chu Yang Sin (6,8), Kon Tum (7,3) from 5 up to 8 preanal pores; in geckos from Hon Ba (4,2) from 3 to 6 pores are recorded (mean value is given in brackets). Females with perforated preanal scales are rare.

Fig. 15. Enlarged triangular tubercles in the basal of tail *Cyrtodactylus irregularis* (Smith, 1921).

TABLE 2. Measurements of *Cyrtodactylus irregularis* (M. A. Smith, 1921) from Type Series

Character	Female 36031	Female 36032	Female 36033	Female
SVL	84	86	80	72
Lcd	62*	74	66	
TrunkL	37.8	38.2	35.7	30.7
Head L	23.5	23, 7	21, 6	20
Head W	15.4	15.8	14.8	14.7
Head H	9.3	9.5	8.5	8.3
SnEye	9.0	9.1	8.2	7.9
OrbD	3.7	4.3	4	4
EarL	1.4	1.4	1.4	1.4
EyeEar	6.5	7	6.7	5.7
LS	12	12.2	11.2	10.9
ForeaL	11.8	12	10.5	10.4
FemurL	14.4	14.8	13.8	13.3
CrusL	12.5	13.2	11	11.2
LD4A	8	7.9	7.2	6.5
LD4P	9	8.8	8.7	8.4
SAB	43	39	39 – 45	38 – 41
SLB	170	166	180	159
TubL/TubW	24/42	24/38	22/48	22/43
SLH/SAH	87/67	81/79	82/74	85/70
SDL4A	6 + 10	6 + 9	6 + 9	6 + 9
SDL4P	9 + 11	8 + 10	9 + 9	9 + 10
PP	0	6	0	0
SL	10	10	9	12
IL	9	9	9	9

* Specimens with regenerated tail.

Morphologically the southern populations are heterogeneous (Fig. 17, **1 – 4**). In the description of *C. irregularis* Malcolm Smith (1921) apart from three type specimens indicated a fourth specimen (BMNH 1931.6.12.3) from Sui Kat, Lang Bian plateau (*h* = 3000

Fig. 16. *C.* sp. Rösler et al., in press, an adult male from Mang Canh village, Kon Plong district, Kon Tum province, Vietnam: **A**, dorsal view; **B**, ventral view.

feet), but he did not include this specimen into type series of *C. irregularis* because of some non-typical characteristics: "33 ventral scales; color pattern not so distinct, the dark markings duller and more confluent; the dark nuchal band is broken in the middle; the tail in this example is complete and is covered with small, flat juxtaposed scales and series of enlarged tubercles above, with large imbricate sales below, those on the medium line being large then the others" (Fig. 18).

Southern populations form two size groups (Fig. 19):

1. Populations from Rung Tong Da Lat and Bi Doup – Nui Ba Nature Reserve (Lam Dong Province), Chu Yang Sin National Park (*C. ziegleri* sp. nov.), Dac Lac Province, and Hon Ba (Khanh Hoa Province) are one group of forms and species that are close to *C. irregularis* (large robust geckos).

Fig. 17. Specimens of *Cyrtodactylus irregularis* complex from Vietnam: **1**, *Cyrtodactylus* sp., Dong Nai prov., Cat Tien National Park; **2**, *C.* sp., Kon Tum province; **3**, *C.* sp., Quang Tri province, Ban Cup village; **4**, C. sp. Lam Dong province, Bi Doup – Nui Ba Reserve; **5**, True *C. irregularis*, Lam Dong province, Da Lat Plateau; **6**, *Cyrtodactylus ziegleri* sp. nov., Dac Lac Province Chu Yang Sin National Park).

2. Populations from Cat Tien, Ma Da and Binh Chau Phuoc Buu are the second group (*Cyrtodactylus* sp.), which is apparently a separate species (smaller and slender lizards, inhabiting plain regions of South Vietnam).

To a much smaller extent variations of body sizes are expressed in northern populations.

An important characteristic of naked-toed geckos is the type of pattern of the dorsal surface of the body. Thus in 6 specimens of *C. irregularis* s. s. from Da Lat (a detailed description of the pattern is given above) variation of elements of the pattern is insignificant, which can be seen in Figs. 13 and 14. Stability of their pattern is distinctly shown by analysis of such elements as width and shape of transversal dorsal bands, their white (or light) binding and distinct contrast pattern on the head. Even when transversal bands partly disintegrate into separate spots the general contours of the pattern are retained. As a rule the distance between transversal bands (or their elements) in *C. irregularis* s. s. is smaller or is equal to width of the bands proper.

It is interesting to note here that geckos from Bi Doup – Nui Ba Nature Reserve possess a number of differences from *C. irregularis sensu stricto*, in the character of the pattern on the dorsal surface of the body (Fig. 17, **4**). Thus transversal bands are torn into separate spots, width of bands being approximately equal to width of gaps between them. Distinct contrasting white binding on the margins of dark bands and spots is lacking. Pattern of the head is poorly pronounced, formed by small dark spots of irregular shape. The general background color of the body is light. These geckos differ

Fig. 18. The specimens mentioned in original description of *C. irregularis* by M. A. Smith BMNH 1946.3.23.3, 1946.3.23.4, 1932.1.4.1, 1931.6.12.3. Photo by Dr. McCarthny.

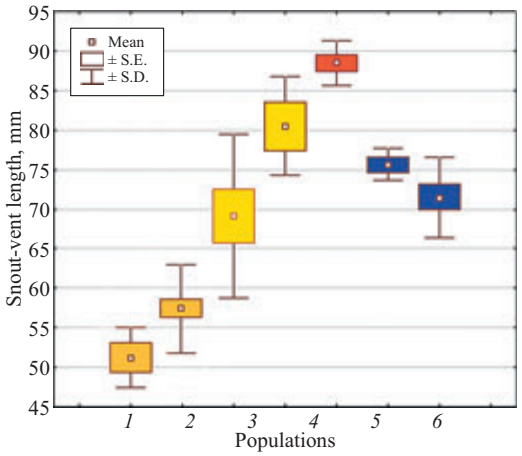

Fig. 19. Comparison of specimens of *Cyrtodactylus irregularis* complex by snout-vent length: *1*, *Cyrtodactylus* sp., Binh Chau-Phuoc Buu Nature Reserve; *2*, *Cyrtodactylus* sp., Cat Tien National Park; *3*, *Cyrtodactylus* sp., Hon Ba Reserve; *4*, true *C. irregularis*, Da Lat Plateau; *5*, *C. ziegleri* sp. nov., Chu Yang Sin National Park; *6*, *7*, *C.* sp. Rösler et al., in press, Kon Plong and Ban Cup Village.

from *C. irregularis* s. s. not only by the pattern, but by more slender and elongate body, longer limbs and tail. Unfortunately, at this stage, the insufficient amount of material does not allow us to make a final conclusion about the taxonomic status of the population from Bi Doup – Nui Ba Reserve. It is noteworthy that in the pattern populations from Bi Doup – Nui Ba and Hon Ba are similar, although these localities are situated relatively far from each other. The population from Chu Yang Sin, a territory neighboring Bi Doup – Nui Ba, is absolutely peculiar and possesses a number of differences from all the studied populations (Fig. 17, **6**).

Pattern and coloration of southern populations inhabiting flat areas is highly variable even within the limits of a small territory.

Apart from the patterns, the general coloration of the dorsal body surface is of great importance. In particular, presence of absence of light yellow colors is characteristic of some populations and is not characteristic of the others.

In the studied populations sexual dimorphism is displayed differently.

In southern plain populations males differ significantly from females by three indices HeadL/SVL, LS/ForeaL, LS/SVL. Males have shorter trunks (TrunkL) and toes (LD4P).

In the population of *C. ziegleri* sp. nov. from Chu Yang Sin sexual dimorphism has not been revealed on the material available. In geckos inhabiting Hon Ba slight difference between males and females has been revealed by two ratios LS/SVL LD4A/SVL.

By material from Kon Tum differences between males and females are only significant by the ratio LD4P/SVL, which may be due to the lack of comparative material.

When different populations were compared by morphometric indices most distant were populations from Chu Yang Sin (*C. ziegleri* sp. nov.), Kon Tum (*C.* sp. Rösler et al., in press), and Cat Tien (*Cyrtodactylus* sp.). These groups differed from each other by proportions of the head (HeadL /SVL, HeadW /SVL, HeadW/HeadL), body (TrunkL/SVL), and forelimbs (LS/SVL, LS/ForeaL). This confirms statistically existence as a minimum of three morphologically distant groups within *Cyrtodactylus irregularis* complex (one northern and two southern).

In Fig. 20, a number of samples are compared by 12 characters of pholidosis on the basis of discriminant analysis. Thus geckos from Chu Xang Sin (Dac Lac Province) form a separate group — *Cyrtodactylus* sp. nov. Southern plain populations from Cat Tien Nature Reserve (Dong Nai Province) and Binh Thuan Province form a second separate group. Both the first and second groups differ well also by a number of other characters.

Populations from Kon Tum Province and Hon Ba Reserve (Khan Hoa Province) appeared to be very similar by 12 characters of pholidosis, but nevertheless, as has been noted above, they differ distinctly by a number of other characters, such as coloration patterns, presence of enlarged femoral scales in some individuals and absence in the others.

The new species differs from *C. irregularis* s. s. also by larger SVL ($p = 0.016$) and respectively by body proportions. Width and height of head of *C. ziegleri* sp. nov. is much larger than in *C. irregularis* ($p = 0.004$ and 0.02), rostral part of snout is more protracted ($p = 0.02$), limbs are longer.

There are significant differences between these two species also by characters of pholidosis: *C. irregularis* has a larger number of scales across the belly SAB ($p = 0.04$) and a smaller number of scales along the midbody SLB ($p = 0.017$), a significantly smaller number of subdigital lamellae ($p = 0.006$). *Cyrtodactylus* sp. nov. has a larger number of scales on the dorsal surface of the head (SLH and SAH $p = 0.01$). Moreover, in Table 3 comparison of *Cyrtodactylus ziegleri* sp. nov. with 11 species of Vietnamese *Cyrtodactylus* by 22 characters is given.

By external appearance and pholidosis *Cyrtodactylus ziegleri* sp. nov. can be combined only with *Cyrtodactylus* sp. and *Cyrtodactylus irregularis*, which form a single complex of species with a number of populations from South Vietnam whose taxonomic status needs refining.

Taxonomic notes on some Vietnamese species of naked-toed geckos:

1. Having studied a sample *C. phongnhakebangnsis* Ziegler et al., 2002 ($n = 14$) from type locality we discovered some differences from type series (by original description, Ziegler et al., 2002). Thus in the diagnosis of *C. phongnhakebangnsis* the following data are given: SVL 78.5 – 96.3 mm, TailL 98 – 110 mm, in males 32 – 42 pore (Ziegler et al., 2002); whereas the data on the series studied by us differ significantly: SVL 52 – 74.6 mm; TailL 83 – 101 mm; in males 20 – 26 pores. Because the differences are relatively serious we considered it necessary to give all measurements of this sample (Table 4). Probably variation of this species is somewhat wider that the characters given in the original description. Recently one more species *C. cryptus* Hedrich et al., 2007 was described from Phong Nha – Ke Bang. It is noteworthy that some characters of our sample occupy an intermediate position between *C. phongnhakebangensis* and *C. cryptus*. Not questioning validity of species *C. phongnhakebangensis* and *C. cryptus*, we would like to pay attention to the necessity of further studies of geckos of Phong Nha – Ke Bang Nature Park (Quang Tri Province). It is possible that in Phong Nha – Ke Bang Nature Park naked-toed geckos are represented by a complex of cryptic species with so far unclear index of taxonomic diversity.

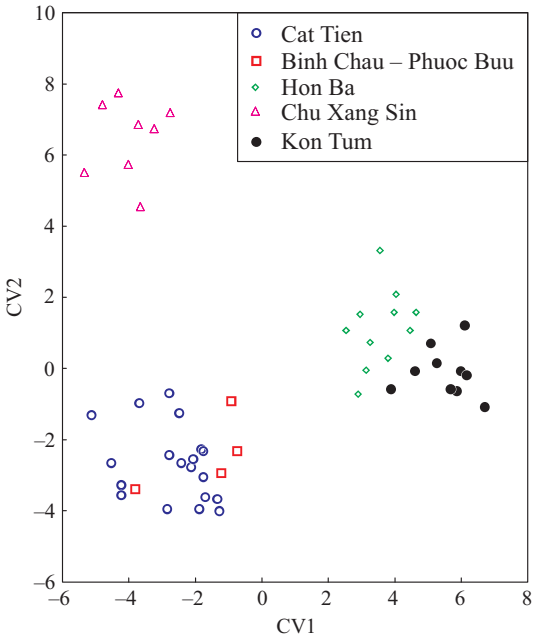

Fig. 20. Allocation a number of samples for four southern population of "*Cyrtodactylus irregularis* complex" are compared by 12 characters (SAB, SLB, SLH, SAH, LD4A, LD4P, SDL4A, SDL4P, SL, IL, TubL, TubW) of folidosis on the basis of discriminant analysis.

2. Concerning *C.* sp. Rösler et al., in press, it remains unclear why the authors so closely compare *C.* sp. Rösler et al. with *C. quadrivirgatus* Taylor 1962. We compared *C. quadrivirgatus* ($n = 9$) from Malaysia to *C.* sp. ($n = 13$) from Central Vietnam, Kon Tum Province, Kon Plong district and came to a conclusion that these species are very distant. *C. quadrivirgatus* are small slender geckos with elongate not wide head, with a small number (usually 3 – 4) of very small inconspicuous preanal pores; their enlarged femoral scales are not separated from preanal ones and form one continuous row.

C. buchardi David 2004, described from Laos adjoining Vietnam is similar to *C.* sp. Rösler et al., to judge by the description. Both the species lack enlarged femoral scales, patterns of *C.* sp. are so variable that can quite coincide with the pattern of *C. buchardi*. It is so far impossible to carry out a detailed comparison of these two species, because *C. buchardi* was described from a single juvenile specimen.

TABLE 3. Comparison of the Main Morphological Characters of *Cyrtodactylus* Species in Vietnam

Character	*Cyrtodactylus*										
	sp.	*irregularis*	*cryptus*	*chauquangensis*	*phongnhakebangensis*	*condorensis*	*intermedius*	*nigriocularis*	*badenensis*	*paradoxus*	*caovan sungi*
SVL	54.4 – 78.2	72 – 86	74 – 84.8	90.95 – 99.30	78.5 – 91	80	61 – 85	87.6 – 107.5	59.3 – 70.8	76 – 80	90.4 – 94
Lcd	59 – 78	66 – 74	63.5 – 88.42	97 – 108.3	98 – 110	100	80 – 110	89.2 – 121	76 – 82.4	95 – 111	115 – 120
Head L	16.5 – 22.8	20 – 23.7	19.6 – 22.7	26.8 – 29	18 – 26.4	—	17.4	27.3 – 35	18.4 – 21.8	19.3 – 23.5	25.4 – 26.1
Head W	10.4 – 14.3	14.7 – 15.8	13.8 – 15.8	18 – 19.7	10 – 18.6	—	10.8	17.3 – 22.8	11.5 – 13.9	13.2 – 15.3	17.6
Head H	6.1 – 8.5	8.3 – 9.5	8.7 – 9.7	10.8 – 12.1	5.4 – 11.2	—	—	9.8 – 13.1	7.5 – 8.3	—	10.3 – 10.7
SnEye	6.2 – 8.5	7.9 – 9.1	8.3 – 9.8	11.2 – 12.1	6.1 – 8.4	—	—	12.7 – 15.6	8 – 9.5	—	11.2
OrbD	3.1 – 4.7	3.7 – 4.3	4.4 – 5.3	6.2 – 6.7	3.2 – 4.6	—	—	7 – 9.1	5 – 5.7	—	5.1 – 5.4
EarL	1 – 1.2	1.4	0.75 – 1.1	1.8 – 2.7	1.2 – 2	—	—	2.4 – 3.2	1.3 – 1.9	—	2.5 – 3
EyeEar	3.8 – 6	5.7 – 7	5.3 – 6.8	7.4 – 8.7	4.2 – 5.5	—	—	5.7 – 7.4	4.6 – 5.2	—	6.5
LS	8.7 – 11.8	10.9 – 12.2	11.2 – 13.7	—	6.8 – 11.2	—	9	18	11.6	10.5 – 12.7	15
ForeaL	7.8 – 10.8	10.4 – 12	10.5 – 13	—	7.8 – 11.8	—	8	16.7	10.4	10 – 12	14
FemurL	10.7 – 13.9	13.3 – 14.8	13.1 – 16.7	—	11 – 16.5	—	12	21	15.3	13.4 – 16.9	18.2 – 19.2
CrusL	8.3 – 12.8	11 – 12.5	10.7 – 13	—	7.8 – 12.7	—	9.7	17.4	11.2	11.5 – 14.2	15 – 16.5
LD4A	5.2 – 7.3	6.5 – 8	7.2 – 7.5	—	6.2 – 7.2	—	6.2	8.8	6.5	6.3 – 7.9	9
LD4P	6.3 – 8.8	8.4 – 9	7.6 – 10.7	—	7 – 9.3	—	7.4	10.3	8	8.6 – 9.6	10 – 11.8
SAB	43 – 49	38 – 46	47 – 50	36 – 38	32 – 42	35 – 40	40 – 50	42 – 49	25 – 29	30 – 40	48 – 44
SLB	180 – 204	159 – 180	207	128 – 130	158 – 189	—	183	127 – 148	—	134 – 148	162 – 187
SDL4A	15 – 18	15 – 16	18 – 19	16 – 18	17 – 19	—	20	—	—	15 – 18	22
SDL4P	17 – 22	18 – 20	20 – 23	18 – 23	17 – 20	—	22	17 – 21	18 – 22	18 – 22	23 – 25
PP	5 – 8	5 – 7	9 – 11	6 – 7	32 – 42	—	8	2	0	0 – 4	9 + 6
SL	9 – 11	9 – 12	8 – 11	10	10 – 12	—	9	13 – 14	10 – 13	10 – 12	10
IL	6 – 9	9	6 – 10	9 – 10	7 – 10	—	12	13 – 15	8 – 10	8 – 11	9

TABLE 4. Measurements of *Cyrtodactylus phongnhakebangensis* Ziegler et al., 2002

Character	Males										Females			
	28865	28745	28749	28942	28743	28943					28744	28746		
SVL	66.2	69.2	61.5	52	65.2	62.6	67.6	65.2	71.3	73.5	71.3	74.6	63.5	74
TrunkL	25.7	29.3	24.3	21.4	26	25.2	27.7	26.1	27.8	30	29.8	30.6	28.2	31.7
Tail L	86	101	*	*	90	83	69*	*	67*	90	86	74*	*	65*
Head L	18.8	19	17.8	15.7	18	18	19	18.5	19.1	20.5	20.4	20.3	17.8	21
Head W	12.4	12.7	11.8	10	11.6	12	12.3	11.7	12.5	12.4	12.9	13.6	11.7	14.3
Head H	7.4	7.8	6.5	5.4	6.8	6.6	7	7.2	6.8	6.8	8	7.5	6.7	7.5
SnEye	7.4	7.5	7.3	6.1	7	7.3	7.3	7.3	7.2	8	8.3	8.2	6.7	8.4
OrbD	4	4.2	3.9	3.2	4	3.9	4.3	4	4.5	4.6	4.6	4.6	4.2	4.4
EarL	1.8	2	1.5	1.2	1.7	1.7	1.8	1.8	2	2	1.8	1.8	2	2
EyeEar	5.3	5.3	4.8	4.2	4.6	4.4	4.8	4.5	4.7	4.6	5	5.5	4.6	5.4
LS	11.4	11.7	10.6	7.8	11	10.2	11.4	11.2	11.2	11.8	11.7	11.8	10.8	12.3
ForeaL	10	10.7	9.4	6.8	9.6	9.4	10.2	10	10	9.9	10.7	11	9.2	11.2
FemurL	14.7	15.3	14.2	11	14.3	13.4	14.5	14.5	14.3	15.6	15.5	15.4	13.6	16.5
CrusL	11.6	11.7	10.4	7.8	11.1	11.1	10.8	11	11.8	12.2	12	12.5	10.6	12.7
LD4A	6.5	7	6.5	5.3	6.8	6.4	6.3	6.8	7	6.8	7.2	7	6.2	7.2
LD4P	8.8	8.3	8.7	7	8.6	8.3	9.1	8.5	8.4	8.7	9.2	9.3	8.3	8.8
SB	40	40	37	36	36	36	34	38	36	38	37	36	36	36
SLB	162	168	167	158	182	168	170	165	168	170	168	172	189	179
SDL4A	6 + 11	6 + 11	6 + 12	7 + 11	7 + 12	6 + 11	7 + 11	7 + 10	6 + 12	7 + 12	7 + 11	6 + 11	7 + 10	6 + 11
SDL4P	8 + 12	7 + 12	8 + 12	8 + 12	9 + 11	7 + 12	8 + 12	7 + 11	8 + 12	8 + 12	8 + 12	7 + 10	7 + 11	8 + 11
PP + PF	25	25	24	23	22	23	20	20	25	26	22	18	18	17
SL	11	11	10	10	10	10	11	11	10	12	11	12	10	12
IL	9	8	9	8	9	9	9	9	7	10	9	10	8	10

* Specimens with regenerated tail.

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