Asian Herpetological Research 2012, 3(3): 213–218
DOI: 10.3724/SP.J.1245.2012.00213

A New Species of the Genus *Protobothrops* (Squamata: Viperidae: Crotalinae) from the Dabie Mountains, Anhui, China

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Abstract During a biological survey in July 2011, a pit viper was collected from the Yaoluoping Nature Reserve in the Dabie Mountains, Anhui, China. The pit viper's the total length measured 836 mm with a dorsal ground color of yellow-brown, decorated by 56 dark-brown transverse bands. The 4th supralabial squama of the new species is separated from subocular by two squamae, and the tip of tail is orange; this combination of characters distinguish it from other species of the genus Protobothrops. Based on the body proportions, number of squamae, body color pattern, and comparing the data of its life history with those of other species of *Protobothrops*, we herein describe it as a new species, belonging to the genus of *Protobothrops*.

Keywords taxonomy, *Protobothrops dabieshanensis* sp. nov., snake, Yaoluoping Nature Reserve, Anhui

1. Introduction

The Old World pit vipers of the genus *Trimeresurus sensu lato* contained about 50 species (Yang *et al.*, 2011). Soon after, the genus *Protobothrops* was erected based on skull characters and scale ultrastructure (Hoge *et al.*, 1983). Currently, the Old World pit vipers of the genus *Trimeresurus sensu lato* contain *Ovophis* and *Protobothrops.* On the other hand, 4 genera are generally recognized within domestic *Trimeresurus sensu stricto*, that is, *Cryptelytrops*, *Popeia*, *Himalayophis* and *Viridovipera* (Luo *et al*., 2010).

The genus of *Protobothrops* contains approximately 13 species (Castoe *et al.*, 2006; David *et al.*, 2002; Grismer *et al.*, 2006; Guo *et al.*, 2009; Guo *et al.*, 2006; Orlov *et al.*, 2004; Rao *et al.*, 2005; Yang *et al.*, 2011; Zhao, 2006; Zhao *et al.*, 1987; Ziegler *et al.*, 2001), and the phylogenetic relationships among most of the species of the genus *Protobothrops* are well established (Castoe *et al.*, 2006; Guo *et al.*, 2011; Guo *et al.*, 2009; Guo *et al.*, 2007; Guo *et al.*, 2006; Malhotra *et al.*, 2010; Malhotra *et al.*, 2004; Orlov *et al.*, 2008). Among the 13 species of *Protobothrops*, there are 6 species occur in China (Luo *et al.*, 2010; Yang *et al.*, 2011).

Recently, we collected an adult female pit viper, which differs from all other species of *Protobothrops* in morphology and color pattern characters (Guo *et al.*, 2006; Hoge *et al.*, 1983). Herein, we describe this new species.

2. Material and Methods

During a herpetological survey in the Dabie Mountains, Anhui, China in July, 2011, a pit viper was collected from the Yaoluoping Nature Reserve in the Dabie Mountains (116°04′12″ N, 30°58′17″ E, 1210 m a. s. l.).

Using a dial caliper, measurements were made to the nearest 0.01 mm as: total length (TL, from snout tip to tail end), snout-vent length (SVL, from the cusp of snout to

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Received: 6 April 2012 Accepted: 4 September 2012

the anterior margin of cloacae opening), tail length (TaL, from the posterior margin of cloacae opening to the tip of tail), head length (HL, from snout tip to the posterior margin of mandible), head width (HW, at the widest part of the head), eye horizontal diameter (ED), snout length (SL, from snout tip to the anterior margin of eye), and the distance from eye to nostril (EN, from the anterior margin of eye to the posterior margin of nostril) (Table 1).

Squamae counts were taken, for the numbers of supraoculars (SO), preoculars (PrO), postoculars (PtO), suboculars (SubO), number of squamae between the supraoculars (SBSO), loreals (Lr), supralabials (SM), infralabials (SubM), temporals (TM), ventral squamae (VS), subcaudals (Scd), anterior body squama rows (Sq1) at the level of the 15th ventral squama from the head, number of mid-body squama rows (Sq2) halfway between rear of head and opening of cloacae, and number of posterior body squama rows (Sq3) at the level of the 15th ventral squama anterior to the opening of cloacae (Table 1). Comparative data for other species of *Protobothrops* were obtained from the literature (Chen *et al.*, 1991; Grismer *et al.*, 2008; Guo *et al.*, 2006; Ji *et al.*, 2002; Yang *et al.*, 2011; Zhao *et al.*, 1980; Zhao *et al.*, 1998).

Table 1 Measurements and squamae characters of the sample of *P. dabieshanensis* sp. nov.

Parameter	Measurement
TL	836 mm
SVL	696 mm
TaL	140 mm
TaL/SVL(ratio)	1.20
HL	28.1 mm
HW	20.3 mm
HW/HL	0.72
ED	4.1 mm
SL	7.7 mm
SL/HL	0.27
EN	6.2 mm
ED/HL	0.15
PrO	3/3
PtO	3/3
SBSO	8
Lr	1
SM	8/8
SubM	11/11
Scd	58 pairs
Sq1 : Sq2 : Sq3	21 : 21 : 15
Canthal squamae	1/1
Body bands	56

The abbreviations are indicated in Section 2, Material and Methods.

3. Results

3.1 Sample description Body is thin and laterally compressed; head elongate and triangular in shape, wider than neck; covered with very small, irregularly shaped and convex squamae, 0.73 times wider than long; dorsal head squamae smooth anteriorly, with 8 squamae medially between the supraoculars in a transverse line; snout elongate, SL/HL ratio 0.27, nearly twice ED; eyes convex, and pupil vertical.

Rostral triangular, the ratio of width to length being 1.4; two broader apical squamae bordered laterally by triangular internasals; internasal in contact with rostral directly; round nostrils located on each side of the internarial, located in the middle of nasal; 1/1 (Left and Right, hereafter) canthal squamae between supraocular and internarial, clearly larger than adjacent snout squamae; canthal squama, with smooth bordering, protruded from canthus rostralis; one loreal; supraocular large, elongate and wider than adjacent head squamae, pointed anteriorly and 0.56 times as wide as interspace between supraoculars and surrounded by 10/10 small squamae; three preoculars present, surrounding loreal pit, two of them being elongate upper-preoculars, the second one longer and slightly narrower than the first one.

The new snake has three small postoculars and two suboculars, with the posterior subocular being more elongate and wider than the anterior one; border of the anterior one sharp, but the bordering of the posterior round; two suboculars separated from lower preocular by two very small squamae; temporals numerous, all smooth, with the temporals near supralabials being larger than the remainder; anterior part of nasal broad extending into acute angle, turning over canthus rostralis and being visible above; 8/8 supralabials, the 2nd squama forming anterior margin of loreal pit, and separated from nasal squama by two equally small squamae; the 3rd squama being the largest one of the 8 supralabials; the 4th and 5th squamae separated from subocular squamae by a row of squamae; and 11/11 infralabials present, with the 1st pair in contact with each other, and the 1st three pairs in contact with anterior chin shield.

Dorsal squamae narrow, pointed, incised and strongly keeled, except the last row in contact with ventral squamae, and some in next to the last row not incised and strongly keeled; the squamae arranged in 21 rows on anterior body, 21 rows at midbody, and 15 rows at posterior of body; ventral squamae 187, anal squama

undivided; and subcaudals divided in 58 pairs (Table 1).

3.2 Coloration in life Dorsal ground color of the sample is yellow-brown. Moreover, there are 56 dark-brown transverse bands with discontinuous atrous rough edges across body and tail. Generally, most bands are diamond-shaped, some bands are transformed into two mismatched triangles, and several bands near head are nearly oval. The dark-brown bands are relatively big and wide, occupy about eight dorsal squama rows in width and 0.5–2.0 dorsal squamae in length, and are often broken into spots. The bands become gradually closer towards tail, and at the tip of tail, the background color of the bands changes from yellow brown to orange rapidly. The color of the abdomen is gray, with a series of pale orange blotches on both sides. It is worthwhile to note that ventral color of the abdomen turns dark orange rapidly at the end of the tail, and tail tip significantly differs from anterior body in color, which is the distinctive feature for this species. A postorbital, thin and dark brown stripe with discontinuous atrous edge, starts from posterior margin of eye, extends across upper temporal subsequently, and stops at the upper corner of lip with two squamae ultimately (Figure 1).

3.3 Comparisons This snake can be easily distinguished from *P. sieversorum* and *P. cornutus* by the different color patterns and the absence of horn-shaped projections on the supraocular squamae (David *et al.*, 2008). The snake differs from *P. mucrosquamatus* by its fewer mid-body dorsal squamae (21 *vs.* 23–27), fewer ventral squamae (187 *vs.* 194–233 in *P. mucrosquamatus*) and a different color pattern. It differs from *P. jerdonii* by slender body, a clearly different color pattern, and the 4th supralabial squama separated from subocular by two squamae on both sides in *P. dabieshanensis* (the 4th supralabial squama separated from subocular by only one squama or no squama in *P. jerdonii*). The color of the tail tip of this snake is dark orange and that of *P. jerdonii* is not. It differs from *P. flavoviridis* by having fewer mid-body dorsal squamae (21 *vs.* 33–40), fewer ventral squamae (187 *vs.* 222–237 in *P. flavoviridis*), and a different color pattern. It differs from *P. elegans* by having fewer mid-body dorsal squamae (21 *vs.* 23–25), the 4th and 5th supralabials separated from suboculars by one row of squamae (two in *P. elegans*) and a different color pattern. It differs from

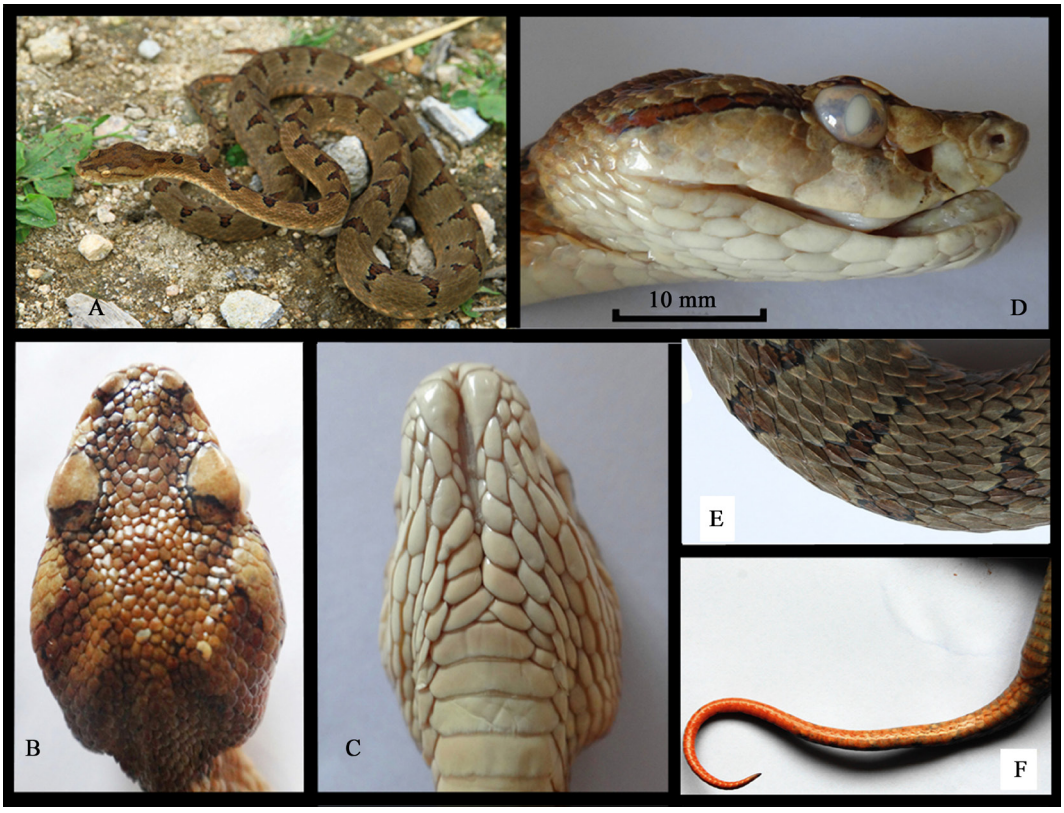

Figure 1 Holotype of *P. dabieshanensis* sp. nov. A: The snake in life; B: Dorsal view of head; C: Ventral view of head; D: Lateral view of head; E: Dorsal view of midbody (showing dark-brown bands and keeled squamae); F: Dark orange tip of tail. Photos by Xin HUANG, Baowei ZHANG and Demin HAN.

P. mangshanensis by its smaller size (largest TL of 2375 mm in *P. mangshanensis*), fewer infralabials, (11 *vs.* 13–16), fewer subcaudals (58 *vs.* 60–67), fewer mid-body dorsal squamae (21 *vs.* 25) and a different color pattern. It differs from *P. tokarensis* by having fewer mid-body dorsal squamae (21 *vs.* 31–32), fewer ventral squamae (187 *vs.* 203–208 in *P. tokarensis*) and a different color pattern. It differs from *P. trungkhanhensis* by having more dorsal squama rows on the anterior part of body (21 *vs.* 19), lower ED/HL ratio (0.15 *vs.* 0.23), higher HW/HL ratio (0.72 *vs.* 0.65–0.66), and fewer body bands (56 *vs.* 76–84). It differs from *P. xiangchengensis* by having fewer mid-body dorsal squamae (21 *vs.* 25), absence of a dark brown blotch under the loreal pit (present in *P. xiangchengensis*). It differs from *P. kaulbacki* by fewer mid-body dorsal squamae (21 *vs.* 25), fewer subcaudals (58 *vs.* 82–83), fewer ventral squamae (187 *vs.* 201–212 in *P. kaulbacki*) and a clearly different color pattern. It also differs from *P. maolanensis* by its larger size (TL of 609–805 mm in *P. maolanensis*), fewer anterior body squama rows (21 *vs.* 23-25), fewer body bands (56 *vs.* 68–72), outermost row of dorsal squamae smooth (dorsal squamae keeled throughout in *P. maolanensis*) and a clearly different color pattern.

3.4 Etymology This new species' name, *Protobothrops dabieshanensis* sp. nov., refers to the type locality, the Dabie Mountains, Anhui, China, with its English name being the Dabie Mountains Pit Viper.

3.5 Key to the species of *Protobothrops* This new key is established based on previous work (Boulenger, 1896; Bourret, 1936; Maki, 1931; Orlov *et al.*, 2004; Rao *et al.*, 2005; Smith, 1931; Stejneger, 1907; Yang *et al.*, 2011; Zhao, 2006; Zhao *et al.*, 1993; Zhao *et al.*, 1998):

1 Horn-shaped projection on supraocular present.....2
Horn-shaped projection on supraocular absent.....3
2 187–193 ventrals and 71–78 pairs of subcaudals.....
.....*P. cornutus*
2 28–235 ventrals and 79–82 pairs of subcaudals.....
.....*P. sieversorum*
3 Outermost row of dorsal squamae keeled.....4
Outermost row of dorsal squamae smooth.....5
4 Dorsal squama rows 19–19–17.....*P. trungkhanhensis*
Dorsal squama rows 25 (rarely 23) –19 (21) –15 (17)...
.....*P. maolanensis*
5 Dorsal squama rows at mid-body ⩽ 21.....6
Dorsal squama rows at mid-body ⩾ 23.....8
6 4th supralabial squama separated from subocular by two a bit big squamae and the tip of tail orange, differring from body color distinctly....*P. dabieshanensis* sp. nov.
4th supralabial squama separated from subocular by only one squama or no squama and the tip of tail not orange, similar with body color 7
7 160–173 ventrals and 44–57 pairs of subcaudals.....
.....*P. jerdoni jerdoni*
176–188 ventrals and 54–67 pairs of subcaudals.....
.....*P. jerdoni xanthomelas*
189–192 ventrals and 65–72 pairs of subcaudals.....
.....*P. jerdoni bourreti*
8 One loreal 9
Two loreals.....12
9 Dorsal squama rows at mid-body ⩾ 25.....10
Dorsal squama rows at mid-body ⩽ 25.....11
10 31–32 dorsal squama rows at mid-body (average 31) and 203–209 ventrals.....*P. tokarensis*
33–40 dorsal squama rows at mid-body (average 35) and 220–237 ventrals.....*P. flavoviridis*
11 6–9 squamae between supraoculars, dorsum with green background colour.....12
11–15 squamae between supraoculars, dorsum with yellow or red-brown background colour.....*P. elegans*
12 201–212 ventrals and 66–82 pairs of subcaudals.....
.....*P. kaulbacki*
187–198 ventrals and 60–67 pairs of subcaudals.....
.....*P. mangshanensis*
13 10–12 squamae between supraoculars, 175–194 ventrals, and 44–66 pairs of subcaudals.....
.....*P. xiangchengensis*
14–18 squama between supraoculars, 194–233 ventrals, and 70–108 pairs of subcaudals.....
.....*P. mucrosquamatus*

Note: Based on a same identification key (Yang *et al.*, 2011) , we establish the above key containing the new species with minor modifications.

4. Discussion

The new species *P. dabieshanensis* sp. nov. was found in the Dabie Mountains (Figure 2, Figure 3). The yellow brown coloration of the new species may help to hide itself easily in its habitat. According to the shape, permutation and texture of squamae, we can ascertain that the new pit viper is terrestrial. We believe that this new species may tend to use shrub-grassland and soil microhabitat as shelter, and it may be endemic to the Dabie Mountains. Based on body proportions, the number of squamae and color pattern of body, *P. dabieshanensis* sp. nov. has many prominent differences with other species of the genus. The Dabie Mountains possess

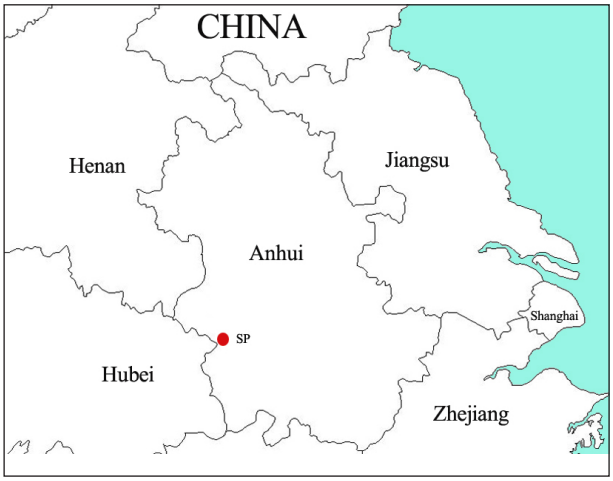

Figure 2 The type locality of *P. dabieshanensis* sp. nov. shown by red circle with SP in the Dabie Mountains, Anhui, China. Map made by Xin HUANG and Baowei ZHANG.

Figure 3 Habitat of *P. dabieshanensis* sp. nov. in its type locality in the Dabie Mountains, Anhui, China. Photo by Baowei ZHANG.

various landforms and different slopes, and so contain many types of microhabitats, such as river wetland, farmland, forest, shrub-grassland, caves of granite and gneiss, all of which are inhabited by numerous species of amphibians and reptiles. This discovery has the vital significance to add a new member to the genus *Protobothrops*.

Acknowledgements We thank Prof. Peng GUO and Mr. Jianhuan YANG for their help in searching literature on *Protobothrops* and their helpful suggestions. This project was funded by the Foundation for Young and Key Teachers, and the Talent Cultivation Project of Anhui University (02203104/04).

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