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HISTORY OF STUDY, TAXONOMY, DISTRIBUTION, AND ECOLOGY OF *Phrynocephalus nasatus* GOLUBEV ET DUNAYEV, 1995 (REPTILIA: AGAMIDAE)

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Herein we provide a historical overview of the study of *Phrynocephalus nasatus*, a species that has been known by poorly preserved type materials only, collected by A. I. Wilkins in Aksu region, China, in 1883. Information on species ecology and distribution is given for the first time in 130 years. The species range consists of disjunct areas which are divided by river valleys covering 4000 km^2, at the altitude of 2000 m a.s.l., in the eastern spurs of the Jengish Chokusu mountain. *Ph. nasatus* prefers clay-gravel biotopes with scattered vegetation. This species differs from *Ph. axillaris*, with which it was erroneously synonymized lately, by the utricular nasal scales (the trait is absent in all other species of this genera) and at least 23 other traits. The intravital coloration is described.

Keywords: toad-headed agama; *Phrynocephalus nasatus*; China; Wilkins; range; systematics; diagnostics; ecology.

INTRODUCTION

One of the most mysterious lizards of China, *Phrynocephalus nasatus*, was found in collections of the Zoological Museum of Moscow University and described as a new species twenty years ago (Golubev and Dunayev, 1995). Since that time, there have been no new findings of the species in nature or any additional information on the type material (Re-7614, 7615 ZMMU; Re-18 IZANU — two males, one female, and two juveniles), collected by A. I. Wilkinson in Aksu region, China, August, 1883. The taxonomic status of the lizard was disputed (Barabanov and Ananjeva, 2007), despite its rather unique morphological traits (distinctly utricular nasal scales with ventral nostrils), not typical for other species of the genus. An expedition in 2014 to the expected habitat of this lizard allowed to collect the material that expands our knowledge of the species.

MATERIAL AND METHODS

In the morphological analysis, I used 12 individuals of *Ph. nasatus* (Re-7614, 7615, 12183, 14317 ZMMU; Re-18 IZANU) and 156 individuals of *Ph. axillaries* (Re-14318 – 14322, 13087 ZMMU; R-5158, 5159, 6555 – 6557, 6636, 8164, 8257, 8272, 8293, 10032, 10044, 10046, 10047, 10050, 10054, 10060, 10062 – 10064, 10083 ZISP) of the Zoological Museum of Moscow University (ZMMU, Moscow, Russia), Zoological Institute in St. Petersburg (ZISP, St. Petersburg, Russia), and Schmalhausen Institute of Zoology of National Academy of Sciences of Ukraine (IZANU, Kiev, Ukraine).

The fieldwork was organized in August 23 – 26, 2014 near the Aksu city, the Xinjiang Uygur Autonomous Region, China. An area of 7000 km^2 has been examined from the foot of the Jengish Chokusu mountain and the southern spur of the Khalyktau range to Aksu and Baicheng cities between the Aksu and Muzart rivers.

RESULTS AND DISCUSSION

The history of the type material collecting

The appearance of *Ph. nasatus* in a collection of the Zoological Museum of Moscow University is closely related to political events in Russia in the last half of the 19th century. Treaties on the delimitation of disputable territories in Kokand and Ile regions were signed be-

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Fig. 1. Alexander Ilyich Wilkins was first collector of *Phrynocephalus nasatus*.

tween Russia and China in 1860 and 1881 years. Nonetheless, problems in other regions still existed. Conflicts with local populations that had nomadic lifestyle and did not acknowledge any leadership or borders arose after the annexation of Kazakh and Kyrgyz territories in numerous regions of the Chinese-Russian border. Preceding the demarcation, Russia and China attempted to strengthen their positions, setting military pickets in mountain passes, thus, increasing dissatisfaction of local authorities and each other. Prior to accurate determination of borders, Chinese drove Kazakhs away from the future Russian frontier territories to China. These incidents increased tensions in the relations between the two countries. Demarcation of the Fergana Region and Kashgaria began in summer 1882, supervised by the major general A. Y. Fride and the adjunct of the military governor of the Fergana Region V. Y. Medinsky. Other persons in the committee included the chief of staff of Western Siberian Military District I. F. Babkov, colonel of the General Staff I. V. Pevtsov, expert in oriental studies N. N. Pantusov, and a group of surveyors, translators, guides and security (Vavilova, 2010). One of the participants of the expedition was A. I. Wilkins, who collected and provided samples of *Ph. nasatus* and Kashgaria birds to the Zoological Museum of Moscow University. He also collected rocks, insects, and plants.

Alexander Ilyich Wilkins (August 15, 1845 – August 21, 1892) is known as a naturalist and explorer of Central Asia (Fig. 1). He was a professional biologist, graduated from the Natural Sciences and History Department, Faculty of Physics and Mathematics, Moscow University. He kept in close touch with famous zoologists of that period (S. A. Usov, N. A. Severtsov, G. E. Shurovsky, M. N. Bogdanov) who influenced his biological views. During his internship in Leipzig University (summers of 1870 and 1871, winter 1871 – 1872) for the famous Rudolf Leucart, Wilkins was offered to head the School of Sericulture in Tashkent. Since then, his fate was closely associated with the Turkestan region (Bogdanov, 1889). He proved to be a diligent and scrupulous worker everywhere. Wilkins visited Khujand, Samarkand, Ghulja, and Tbilisi, studied quicksand of Fergana and biology of domesticated animals (chicken, sheep, horse, domestic silkmoth). He published over 40 articles on entomology, soil science, agriculture, sericulture, forestry, and parasitology, and also several works on the wildlife of various places of Turkestan. He studied the feeding of birds, morphology of antlions, and biology of pests (e.g., the cotton bollworm). Moreover, he described a new species of beetles (*Lethurus dinotherium* Wilkins, 1885, later synonymized under *L. sulcipennis* Fraatz, 1883). Wilkins achieved acclimatization of the American cotton plant *Gossypium* in Central Asia. He was called a devoted "man of science", even though he was also a civil servant. Wilkins was a member of a diplomatic mission in Bukhara in February – April, 1876. Later he took a part in a famous expedition headed by A. N. Kuropatkin (Kuropatkin, 1879; Bogdanov, 1889; Moiseev, 2000). Wilkins was appointed as an adjutant of the Imperial Commissioner V. Y. Medinsky in the expedition organized to draw the borders between Russia and China (Bogdanov, 1889; Mushketov, 1915).

The expedition moved through uninhabited places, threatened by Kyrghyz tribes under the jurisdiction of China. Another hindrance was thin air in the mountains at high altitudes. Wilkins with his colleagues rode horses through narrow mountain passes between high cliffs, wading in the rivers, forced to hold on to the tails of the horses so they would not be knocked down by the strong flow. Now and again, members of the expedition took luggage with food, equipment, and weapons to give some rest to horses who, when tired, once in a while fell down from the cliffs. The weather was also challenging: the

Fig. 2. Mountain plain under the ridges of the Jengish Chokusu (7439 m) with dust storms (photo by E. A. Dunayev).

Fig. 3. Probable area (pink) and place of find (circle) of *Phrynocephalus nasatus*.

temperature at night regularly reached below zero centigrade, so people slept together, warming each other with the heat of their bodies. They had to wrap their boots and horses' legs, cut by sharp rocks, in leather soles (Vavilova, 2010). Going down mountain passes and moving into ravines and valleys, they encountered dust storms. M. V. Pestsov (2010, p. 445) with his group went through the same places in August 1889 and wrote that from

Fig. 4. Biotope of *Phrynocephalus nasatus* (photo by E. A. Dunayev).

Fig. 5. Dust pillar of Tornado in area of *Phrynocephalus nasatus* (photo by E. A. Dunayev).

10 a.m. to 5 p.m. everything there was "covered in light dusty mist" and, sometimes, that "such a thick dusty mist prevailed" that travelers could not see even the nearest mountains. Sven Hedin described these situations in mountains above Aksu in a more expressive way: "...The first outfliers of the storm burst upon us; the black buran followed close at their heels, striking us with terrific violence, swallowing us up in its impenetrable clouds of dust. The sand was swept along in eddying sheets, which trailed along the ground, putting me in mind of comets' tails. Track, trenches, storm — nothing was to be seen. In such a storm as that your head goes round; you imagine the earth, the atmosphere, everything is in commotion; you are oppressed by a feeling of anxiety lest the next moment you yourself should be caught up in the frenzied embrace of the wind... The air was so densely charged with dust, that we saw but little of our surroundings..."

(Hedin, 1898). Wilkins collected the type material of *Ph. nasatus* in exactly such places.

Distribution of *Ph. nasatus*

Wilkins documented extremely scarce information on the type locality. The name of the locality was written on the label as follows: "on the road to Aksu via Topa-Duvan". While searching for the mountain pass Topa-Duvan (also: Topa-Davan, Shoni-Duvan), I found a map of V. I. Roborovsky (1900), which shows a mountain range called Muzart (= Muzarat). It was the one crossed by Wilkins on a bridle path, the shortest pass from Ghulja to Aksu (Bogdanov, 1889; Mushketov, 1915). We found the location of the mountain range Topa-Duvan at one of the ranges of Muzart (Karaduvan) and determined its approximate coordinates (41°11′N 80°14′E = 41.183333°N 80.233333°E) (Golubev and Dunayev, 1995). The coordinates appeared to be south of the type locality of the samples that we collected in August 26, 2014 (41.743904°N 80.833080°E): 5.3 – 5.5 km east of the Norerik village (18 km west of the Boziduncun village), This place is a mountain plateau under the mountain ranges of the Jengish Chokusu (Fig. 2). Such landscapes are present to the west and to the east of the type locality, which allows us to assume that the species has a more extended range (Fig. 3), although the distribution itself is localized and, possibly, consists of disjunct areas at small territory (apparently, no more than 2000 – 4000 km^2) divided by river valleys. A detailed search of the species distribution is still problematic because of the border security regime of the territory and specifics of the local situation of the politically unstable region.

Biotope

The discovered locality of *Ph. nasatus* is a mountainous clay-gravel plateau with distinct alluvial fans of red-brown and blue-gray sandstone, in areas with crevices at the eastern spurs of the Jengish Chokusu. On the surface, there are crashed metamorphic rocks of small size (gneiss, epidote, and serpentinite), jasper, and minerals (quartz, and flint) 1 – 12 cm in diameter together with dense clay. Once in a while there are open clay areas (up to 100 × 20 m) with spots of salt and rare pebbles. Between alluvial fans, there are agroecosystems in river valleys (Fig. 4). Grazing is moderate. Sometimes, there is loess on top of the clay, which occasionally causes dust storms that appear as tornado-like columns or long fronts above the layer of open clay (Fig. 5). It is not without a reason that M. V. Pevtsov (2000, p. 441) names the mountain pass Topa-tag-davan "dusty mountains," with which Sven Hedin would have been very likely to agree

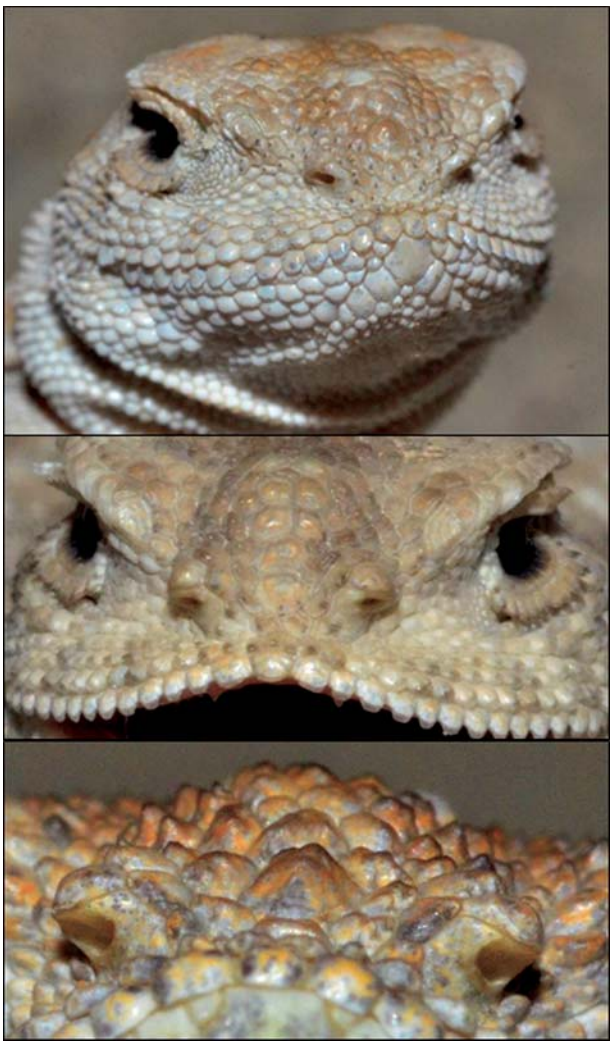

Fig. 6. Utricular ("swollen") nasal scales with ventral nostrils (location of the lower nasal openings) probably the nostrils protected from loess and sand (photo by E. A. Dunayev).

(see above). It is likely that the specific traits of *Ph. nasatus* (utricular nasal scales with ventral nostrils — Fig. 6) are a morphological adaptation to this environment. Vegetation is scattered, its density is higher on the slopes of crevices, where bushes of *Caragana* sp. and *Chondrilla* sp. up to 1.5 m in height are present (Fig. 7). *Artemisia* spp., *Acantholimon* spp., *Limonium* spp., *Reaumuria soongarica* (Pall.) Maxim., *Salsola* spp., *Nitraria pamirica* L., and other Chenopodioideae are dominant on the plateaus. *Orostachys* cf. *spinosa* (L.) Sw. and *Trisetum spicatum* (L.) K. Richt are rare. Spiders of the family Lycosidae, various ants and darkling beetles (Tenebrionidae) are abundant. In addition to toad-headed agamas, *Eremias* cf. *kokshaaliensis* Eremchenko et Panfilov are also present.

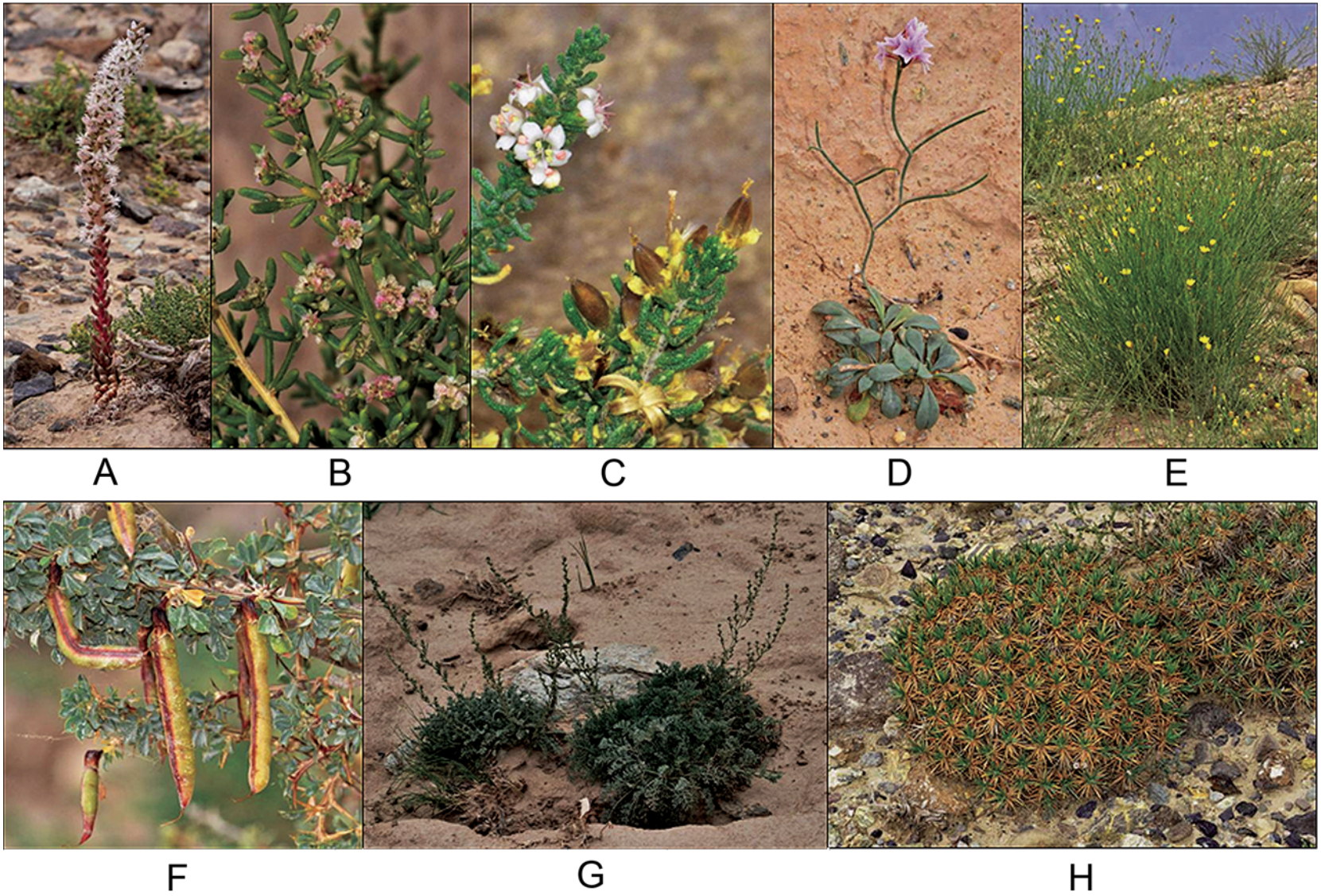

Fig. 7. Plants from habitat of *Phrynocephalus nasatus*: *A*, *Orostachys* cf. *spinosa*; *B*, *Salsola* sp.; *C*, *Reaumuria soongarica*; *D*, *Limonium* sp.; *E*, *Chondrilla* sp.; *F*, *Caragana* sp.; *G*, *Artemisia* sp.; *H*, *Acantholimon* sp. (photo by E. A. Dunayev).

Fig. 8. Thrush *Monticola saxatilis* with a lizard *Eremias* cf. *kokshaaliensis* (left, photo by E. D. Kalinin) and *Phrynocephalus nasatus* with an amputated tip of the tail (right, photo by E. A. Dunayev).

Fig. 9. *Phrynocephalus axillaris* (left) and *Phrynocephalus nasatus* (right) (photo by E. A. Dunayev).

TABLE 1. Comparative Characteristics of Two Species of Toad-Headed Agamas

Trait	*Ph. axillaris*		*Ph. nasatus*	
	expressiveness of trait	%	expressiveness of trait	%
Coloration and pattern traits				
Orange-pink axillary spot in adults	Present	100	Absent	100
Darkening of occipital area of head shield	Absent	100	Present	100
Coloration of proximal area of tail from below in juveniles	Light-yellow	100	Incarnate-pink	100
Males underside	White, if with middle darkening, then not reaching chest and lower part of head	100	With black middle oblong line (elongate spot) reaching chest and lower part of head	100
Distal part of tail ventrally	White	100	Black	100
White small spots on back	If present, framed with black line	100	Not framed with black line	100
Scalation of nasal region				
Direction of nostrils	Forward, visible frontally	100	Downward, visible ventrally only	100
Shape and location of supranasal shield	Arched, not covering infranasal shield dorsally	100	Subround, covering infranasal shield dorsally	100
Location of nostrils	On board between supra- and infranasal shield	100	In infranasal shield	100
Number of rows of internasal shield	(1) – 2 – (3)	100	5	100
Shape of internasal shield	Narrow, elongated lengthwise	100	Wide, width is almost same size with length at least in central row	100
Size of scales between nasal and front supraorbital in adults	Weakly differentiated by size from supraorbital that gradually becoming smaller towards nasal	85.0	Small, noticeably differentiated by size from nearest frontal supraorbital shield	100
Scalation of head				
Size of intermandibular shield	Slightly larger than supralabial	53.3	Same with supralabial	80.0
Lateral margins of chin shield	Straight or obtusely bended	100	With sharp outgrowths	55.5
Size of supralabial shield near to corner of mouth	Noticeably wider than supralabial scales of main row at least from one side	80.0	Usually not wider	90.0
Utricular forehead	No	100	Yes	100
Size of "vesicle" on interparietal (parietal) shield	Half or more of length of interparietal shield	90.0	Less than half (from 1/3 to 1/2 as long) of length of interparietal shield	90.0
Scalation of tail, legs and underside				
Number of scales along remnant of yolk sack	(11) 12 – 15	100	8 – 10	100
Thorn-like scales on lateral parts of basal part of tail in males	Absent (scales flat or weakly costate)	100	Present, with long thorns	100
Proportion of width of lamellae under fingers and scales of edge on finger IV of hindleg in adults	Former same with latter	100	Former wider than latter	100
Ecology, m a.s.l.	Less than 1400 m	100	more than 1900 m	100

Birds include the horned lark *Eremophila alpestris* (L.), *Alectoris chukar* (Gray), Turkestan shrike *Lanius phoenicuroides* Schalov, and common rock thrush *Monticola saxatilis* (L.). The hare *Lepus tolai* Pall. occurs in the ravines.

Ecology

Dense clouds, strong winds with thunderstorms and rains are common in August. This is a period when toad-headed agamas are inactive. They hide in their burrows, situated in clayey areas, but go outside with the first beams of sunlight. Four males and two females were recorded from 3 p.m. to 4 p.m. during route census of 0.5 km after strong rain. Predators feeding on this species are probably birds. We observed the common rock thrush feeding on lizards (e.g., *Eremias* cf. *kokshaaliensis*). One of the toad-headed agamas (16.7% of the recorded individuals) had a missing tip of the tail (Fig. 8).

Taxonomy

Ph. nasatus was synonymized under *Ph. axillaris* 13 years after the description without any argumentation (Barabanov and Ananjeva, 2007), and later it this synonymy was included in "The Reptile Database" (Uetz and

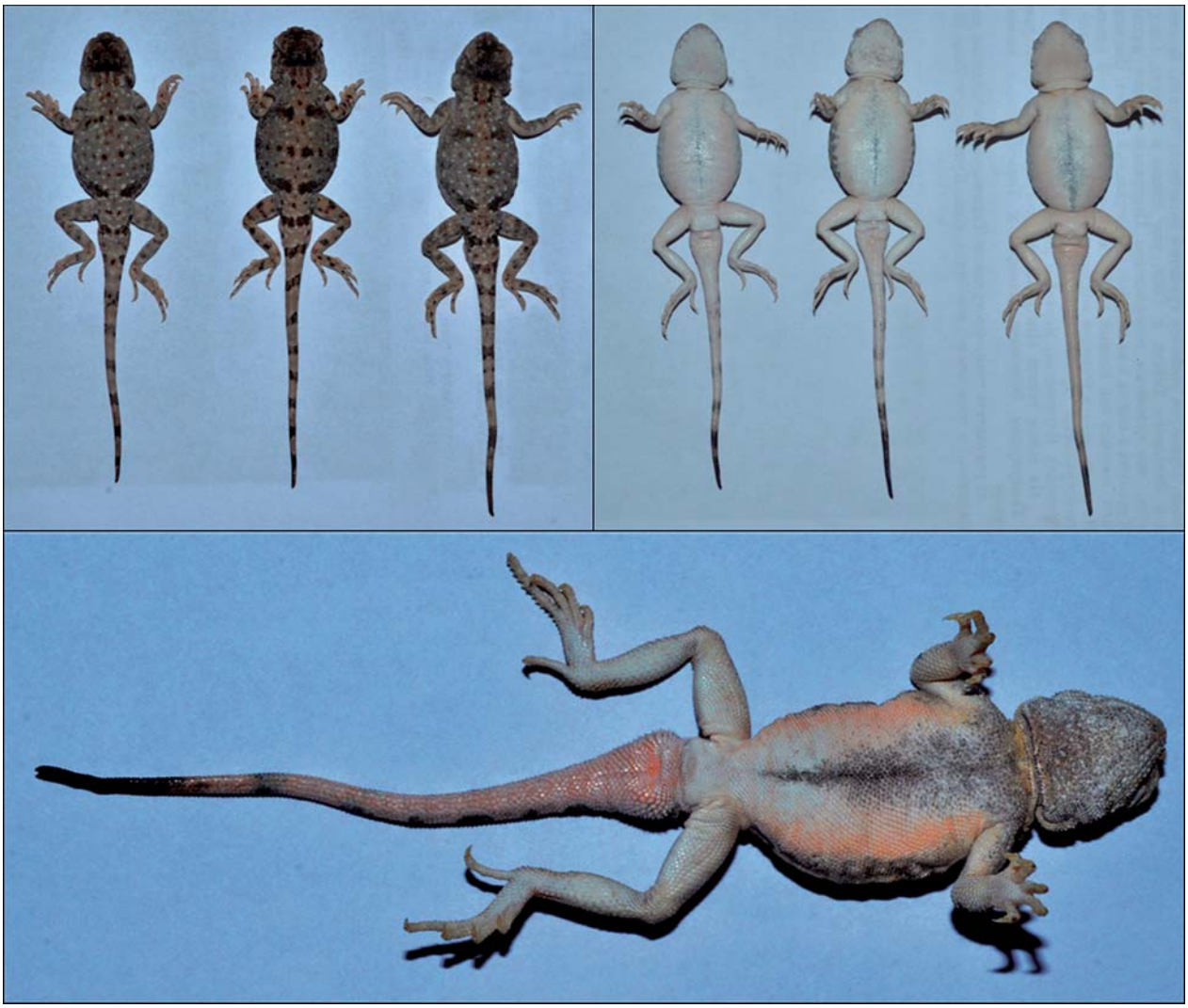

Fig. 10. Coloring of the upper (A) and lower (B, C) sides of the body *Phrynocephalus nasatus* (photo by E. A. Dunayev).

Hošek, 2015). This synonymy was probably based on the proximity of the type localities of these forms, although it is, of course, not enough to synonymize these two species.

Ph. nasatus and *Ph. axillaris* represent different phylogenetic lineages. Preliminary results of a genetic study (E. N. Solovyova, verbal message) showed that *Ph. nasatus* is related to the group of the Tibet toad-headed agamas (*Oreosaura*), as claimed by authors of the original description (Golubev and Dunayev, 1995), unlike *Ph. axillaris*, which is close to *Ph. helioscopus* (Solovyeva et al., 2014).

Ph. axillaris and *Ph. nasatus* are clearly distinguished from each other by morphological traits (coloration and scalation). Among all analyzed traits, 81% show 100% differences (Table 1), in most other cases (other traits) the differences are between about 80 – 90% of the studied individuals (Fig. 9). The habitats of the species are also different. *Ph. nasatus* is present only in the high-mountain plateaus (1922 – 2040 m a.s.l.), while *Ph. axillaris* prefers valleys at the feet of mountains (near the Turpan Depression), at 292 – 1367 m a.s.l.

Description of intravital coloration

Dorsal surface of body gray (murinus), more noticeable laterally with middle of back beige, sand-like (arenicolor). Scales on sides of body blackish (nigrescens), sometimes forming bended lines, and on legs dorsally forming transverse lines (Fig. 10A). Back with white small spots 2 – 8 scales in diameter and paired groups of

2 – 18 cone-shaped thickened brownish (fuscatus) scales with black tips. Some scales of these groups almost entirely black, and then these spots appearing black, and transversally elongate. More intense black paired spots in area of shoulder bones, above base of tail and middle of back. Middle paired black spots-lines smaller than supraspecular and supracaudal ones, frequently reduced to line of three or four subround small spots. Some individuals with almost disappearing spots-lines, and supraspcaular transverse lines appearing as transverse rows of two or three small spots. Tail with at most eight brown transverse lines, bordered with black lines dorsally and ventrally. Their shape different: from paired spots above base of tail to oblique, straight or bow tie-like. Paired black small spots sometimes noticeable between these lines. Dorsal surface of tip of tail sometimes blackish.

Upper scales of head dark (darker than back). Neck region with three noticeable oblong brown lines, sometimes forming horse-shoe like pattern. Supraorbital area with brown spot with vague borders. Two weak lines between nasal and supraorbital areas forming sometimes anchor-like pattern. Ventral surface of body white (Fig. 10B, C). Although ventral surface of head, sides of underside, femora and ventral surface of base of tail in active period terra cotta (testaceus), incarnate-pink (incarnatus) or dark incarnate (intense incarnatus). Ventral surface of head and middle longitudinal line of underside in dark specks, more intense expressed in males during excitement. Ventral surface of tail with 4 – 5 weak dark gray transverse lines, disrupted medially. Sometimes, only lines closest to distal black area well-expressed.

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