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THE RESULTS OF FOUR RECENT JOINT EXPEDITIONS TO THE GOBI DESERT: LACERTIDS AND AGAMIDS

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The National University of Mongolia, the Mongolian State University of Education, the University of Nebraska, and the University of Kansas conducted four collaborative expeditions between 2010 and 2014, resulting in accounts for all species of lacertid and agamid, except *Phrynocephalus kulagini*. These expeditions resulted in a range extension for *Eremias arguta* and the collection of specimens and tissues across 134 unique localities. In this paper we summarize the species of the Agamidae (*Paralaudakia stoliczkana*, *Ph. hispidus*, *Ph. helioscopus*, and *Ph. versicolor*) and Lacertidae (*E. argus*, *E. arguta*, *E. dzungarica*, *E. multiocellata*, *E. przewalskii*, and *E. vermiculata*) that were collected during these four expeditions. Further, we provide a summary of all species within these two families in Mongolia. Finally, we discuss issues of Wallacean and Linnaean shortfalls for the herpetofauna of the Mongolian Gobi Desert, and provide future directions for studies of community assemblages and population genetics of reptile species in the region.

Keywords: Mongolia; herpetology; biodiversity; checklist.

INTRODUCTION

Mongolia, situated between Russia and China, is one of the largest countries in Central Asia with an area of 1.565 million km^2. The country is well above sea level, with an average elevation of approximately 1600 m. Broadly, the country can be divided into three major environmental regions; the Gobi Desert, the Khangai Mountains, and the Manchurian Grasslands (Fig. 1). In the north are the Khangai Mountains, extend into Russia, with a maximum elevation of approximately 3500 m a.s.l., and temperatures that fluctuate seasonally from –15 to +15°C (Klimek and Starkel, 1980). Temperatures in the Gobi Desert fluctuate radically between extremes from –40°C to +40°C. Bisecting this desert are the Altai Mountains, a large fragmented mountain range that spans from southern Russia through northwestern Mongolia, south through northwestern China, and into central Mongolia; the highest peak of the Mongolian Altai is approximately 4300 m a.s.l. (Munkh-Khairkahan-Ula). Adding to the habitat complexity, sections of the Altai range are divided by deep canyons with permanent rivers and streams running through them. The flat barren expanses

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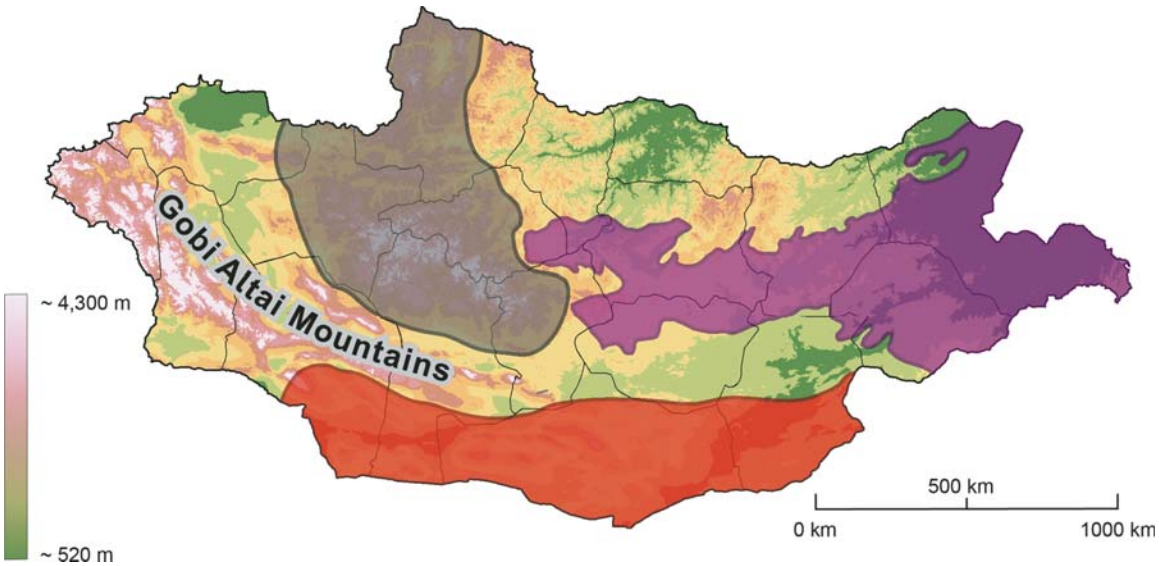

Fig. 1. Environmental regions of Mongolia: red, the Gobi Desert; purple, Manchurian Grasslands; gray, Khangai Mountains.

surrounding the Altai Mountains in Mongolia, make this system akin to an island archipelago, with mountain ranges isolated from one another by desert flats. The mountains of Mongolia comprise more than 40% of the country's total area. To the east of the Khanghai Mountains are the Manchurian Grasslands, which extend into Inner Mongolia and northeastern China. This biome constitutes approximately 88,700 km^2 of temperate grasslands and forest steppe (Zhao et al., 1990).

Although the Mongolian Gobi Desert has a diversity of geographical and geological features, the country is presumed to have low reptile and amphibian diversity due to extreme environmental conditions. Despite these conditions, the area has a rich diversity of animals, including several endemic species and subspecies of reptiles and mammals (Batsaikhan et al., 2010; Hilbig, 1995; Ulziihutag, 1989), including well-known and iconic species such as the Gobi Bear (*Ursus arctos*), Goitered Gazelle (*Gazella subgutturosa*), and Przewalski's Horse (*Equus ferus przewalskii*) (MacKinnon et al., 1996).

To date, the most comprehensive contributions to the advancement of our knowledge regarding the herpetofauna of the region are Ananjeva et al. (1997), Munkhbaatar (2009), Terbish et al. (2013), and Kuzmin et al. (2017). To build on the previous work in the region and overcome Linnaean and Wallacean shortfalls in Mongolia (Brown and Lomolino, 1998; Lomolino, 2004; Hortal et al., 2015), we conducted fieldwork, summarized here, to provide additional species occurrence data to improve our knowledge of species' distributions and community assemblages of Gobi Desert herpetofauna. A more detailed understanding of community assemblies will be instrumental to organizing conservation efforts in the face of climate change and habitat destruction brought about by urbanization and development in Mongolia.

Researchers from the National University of Mongolia, the Mongolian State University of Education, the University of Nebraska, and the University of Kansas participated in biodiversity surveys primarily in the Mongolian Gobi Desert in 2010, 2011, 2012, and 2014 (Table 1; Fig. 2). The 2010, 2011, and 2012 expeditions were collaborations between the National University of Mongolia, the University of Nebraska, and the University of Kansas, focusing on broad surveys of all vertebrate groups and their associated parasites. During these expeditions, reptile and amphibian species were among the vertebrate taxa targeted. In 2014, The National University of Mongolia, the Mongolian State University of Education, and the University of Kansas conducted an additional survey effort focusing on reptile and amphibian diversity and community assemblages. Collectively, these expeditions documented 17 species from 134 different localities (Fig. 2). In this report, we present the results of all four collections (resulting in 901 voucher specimens) and provide an updated checklist of the country's herpetofauna.

METHODS

Specimens were collected by hand or lasso during both day and night. Vouchers of males, females, and juveniles for each species were collected, when possible, and photographed in life before being fixed in 10% formalin. Tissue samples were taken from the liver and skel-

TABLE 1. Locality Data for Sites Sampled During the 2010, 2011, 2012, and 2014 Expeditions to Mongolia

Site Name	Latitude, °N	Longitude, °E	Aimag	Soum
2010 1	43.62	110.58	Dornogovi	Ulaanbadrakh
2010 2	42.53	106.79	Ömnögovi	Khanbogd
2010 3	42.46	106.25	Ömnögovi	Bayan-Ovoo
2010 4	42.48	105.25	Ömnögovi	Nomgon
2010 5	42.65	105.34	Ömnögovi	Nomgon
2010 6	43.44	103.41	Ömnögovi	Bayandalai
2010 7	43.58	100.07	Ömnögovi	Gurvan tes
2010 8	43.40	103.92	Ömnögovi	Khürmen
2010 9	45.82	96.90	Govi-Altay	Biger
2011 1	44.63	99.30	Bayanhongor	Shinejinst
2011 10	45.48	92.50	Hovd	Altai
2011 11	45.43	92.40	Hovd	Altai
2011 12	45.56	92.34	Hovd	Altai
2011 13	45.54	92.86	Hovd	Altai
2011 14	45.59	93.31	Govi-Altay	Tonkhil
2011 15	45.76	91.18	Hovd	Bulgan
2011 16	46.17	91.58	Hovd	Üyench
2011 17	45.13	92.16	Hovd	Altai
2011 18	45.24	91.08	Hovd	Bulgan
2011 19	45.17	91.41	Hovd	Üyench
2011 2	45.30	99.51	Bayanhongor	Baatsagaan
2011 20	45.59	90.97	Hovd	Bulgan
2011 21	46.68	91.40	Bayan-Ölgiy	Bulgan
2011 22	46.13	94.55	Govi-Altay	Tögrög
2011 23	46.15	94.91	Govi-Altay	Tögrög
2011 24	46.29	95.39	Govi-Altay	Sharga
2011 25	46.37	95.69	Govi-Altay	Sharga
2011 26	46.37	95.81	Govi-Altay	Sharga
2011 3	47.88	105.30	Töv	Lün
2011 4	43.25	98.99	Bayanhongor	Shinejinst
2011 5	42.88	98.82	Bayanhongor	Shinejinst
2011 6	44.17	99.26	Bayanhongor	Shinejinst
2011 7	44.93	96.25	Govi-Altay	Tsogt
2011 8	45.14	95.44	Govi-Altay	Altai
2011 9	45.99	93.13	Hovd	Altai
2012 01	45.26	90.94	Govi-Altay	Bugat
2012 02	45.26	93.64	Govi-Altay	Bugat
2012 03*	**45.36**	**93.20**	**Govi-Altay**	**Tonkhil**
2012 04*	**45.38**	**93.61**	**Govi-Altay**	**Bugat**
2012 05	45.51	93.59	Govi-Altay	Bugat
2012 06	45.53	92.15	Hovd	Altai
2012 07	45.54	93.07	Hovd	Altai
2012 08	45.71	91.11	Hovd	Bulgan
2012 09	45.73	93.23	Govi-Altay	Tonkhil
2012 10	45.75	92.50	Hovd	Altai
2012 11	46.03	91.26	Hovd	Bulgan
2012 12	46.10	91.11	Hovd	Bulgan
2012 13	46.10	91.11	Hovd	Bulgan
2012 14	46.14	91.07	Hovd	Bulgan
2012 15	46.14	95.51	Govi-Altay	Khaliun
2012 16	46.20	95.11	Govi-Altay	Sharga
2012 17	46.26	95.26	Govi-Altay	Sharga

TABLE 1 (continued)

Site Name	Latitude, °N	Longitude, °E	Aimag	Soum
2012 18	46.36	95.84	Govi-Altay	Yesönbulag
2012 19	47.74	92.42	Hovd	Chandmani
Gobi Site 111	47.40	103.64	Bulgan	Gurvanbulag
Gobi Site 112	47.41	103.70	Bulgan	Gurvanbulag
Gobi Site 113	46.11	108.71	Dornogovi	Dalanjargalan
Gobi Site 114	45.15	109.98	Dornogovi	Altanshiree
Gobi Site 115	44.79	110.14	Dornogovi	Örgön
Gobi Site 116	44.18	110.23	Dornogovi	Ulaanbadrakh
Gobi Site 117*	**43.33**	**109.15**	**Dornogovi**	**Khatanbulag**
Gobi Site 118	42.86	109.64	Dornogovi	Khatanbulag
Gobi Site 119	42.80	109.71	Dornogovi	Khatanbulag
Gobi Site 120	42.73	109.90	Dornogovi	Khatanbulag
Gobi Site 121*	**43.04**	**109.38**	**Dornogovi**	**Khatanbulag**
Gobi Site 122	43.08	109.15	Dornogovi	Khatanbulag
Gobi Site 123	43.00	108.91	Dornogovi	Khatanbulag
Gobi Site 124	43.11	107.48	Ömnögovi	Khanbogd
Gobi Site 125	43.19	107.20	Ömnögovi	Khanbogd
Gobi Site 126	43.30	106.09	Ömnögovi	Bayan-Ovoo
Gobi Site 127	43.22	105.80	Ömnögovi	Bayan-Ovoo
Gobi Site 128	43.35	105.01	Ömnögovi	Khan khongor
Gobi Site 129	43.55	104.04	Ömnögovi	Bayandalai
Gobi Site 130	43.55	103.02	Ömnögovi	Bayandalai
Gobi Site 131	43.49	102.94	Ömnögovi	Bayandalai
Gobi Site 132	43.48	102.91	Ömnögovi	Sevrei
Gobi Site 133	43.44	102.84	Ömnögovi	Sevrei
Gobi Site 134	43.38	102.51	Ömnögovi	Sevrei
Gobi Site 136	43.39	102.43	Ömnögovi	Sevrei
Gobi Site 137	43.28	102.16	Ömnögovi	Noyon
Gobi Site 138	43.16	102.02	Ömnögovi	Noyon
Gobi Site 139	43.18	102.00	Ömnögovi	Noyon
Gobi Site 140	43.09	101.56	Ömnögovi	Gurvan tes
Gobi Site 141	43.99	101.39	Bayanhongor	Bayanlig
Gobi Site 142	43.07	101.16	Ömnögovi	Gurvan tes
Gobi Site 143	43.23	101.05	Ömnögovi	Gurvan tes
Gobi Site 144	43.63	101.18	Ömnögovi	Gurvan tes
Gobi Site 146*	**43.75**	**100.94**	Ömnögovi	**Gurvan tes**
Gobi Site 147	43.72	100.95	Ömnögovi	Gurvan tes
Gobi Site 148	43.65	101.23	Ömnögovi	Gurvan tes
Gobi Site 149	43.48	101.24	Ömnögovi	Gurvan tes
Gobi Site 150	43.26	100.98	Ömnögovi	Gurvan tes
Gobi Site 151	43.44	100.57	Ömnögovi	Gurvan tes
Gobi Site 152	43.54	100.03	Ömnögovi	Gurvan tes
Gobi Site 153	43.98	99.73	Ömnögovi	Gurvan tes
Gobi Site 154	44.13	99.46	Bayanhongor	Shinejinst
Gobi Site 155	43.65	99.16	Bayanhongor	Shinejinst
Gobi Site 156	43.61	99.14	Bayanhongor	Shinejinst
Gobi Site 157	43.41	99.11	Bayanhongor	Shinejinst
Gobi Site 158	43.25	99.01	Bayanhongor	Shinejinst
Gobi Site 159	43.01	98.71	Bayanhongor	Shinejinst
Gobi Site 160	42.98	98.69	Bayanhongor	Shinejinst
Gobi Site 161	42.96	98.66	Bayanhongor	Shinejinst
Gobi Site 162	42.93	98.64	Bayanhongor	Bayan-Öndör
Gobi Site 163	42.87	98.66	Bayanhongor	Shinejinst

TABLE 1 (continued)

Site Name	Latitude, °N	Longitude, °E	Aimag	Soum
Gobi Site 164	42.95	98.09	Bayanhongor	Bayan-Öndör
Gobi Site 165	43.11	97.98	Bayanhongor	Bayan-Öndör
Gobi Site 166	43.21	97.87	Bayanhongor	Bayan-Öndör
Gobi Site 167	43.31	97.79	Bayanhongor	Bayan-Öndör
Gobi Site 168	43.52	97.91	Bayanhongor	Bayan-Öndör
Gobi Site 169	43.63	97.96	Bayanhongor	Bayan-Öndör
Gobi Site 171	43.68	97.95	Bayanhongor	Bayan-Öndör
Gobi Site 172	43.98	97.98	Bayanhongor	Bayan-Öndör
Gobi Site 173	44.13	97.98	Bayanhongor	Bayan-Öndör
Gobi Site 174	44.39	98.13	Bayanhongor	Bayan-Öndör
Gobi Site 175	44.56	98.17	Govi-Altay	Erdene
Gobi Site 176	44.73	97.56	Govi-Altay	Erdene
Gobi Site 177	44.81	97.32	Govi-Altay	Erdene
Gobi Site 178	44.93	96.78	Govi-Altay	Tsogt
Gobi Site 179*	**45.06**	**96.82**	**Govi-Altay**	**Tsogt**
Gobi Site 180	44.94	96.26	Govi-Altay	Tsogt
Gobi Site 181	44.66	94.92	Govi-Altay	Altai
Gobi Site 182	44.84	94.96	Govi-Altay	Altai
Gobi Site 183	44.89	94.98	Govi-Altay	Altai
Gobi Site 184	45.12	95.13	Govi-Altay	Altai
Gobi Site 185	45.14	95.45	Govi-Altay	Altai
Gobi Site 186	45.14	95.49	Govi-Altay	Altai
Gobi Site 187*	**45.21**	**95.94**	**Govi-Altay**	**Tseel**
Gobi Site 188	45.91	96.35	Govi-Altay	Khaliun
Gobi Site 189	46.68	96.76	Govi-Altay	Taishir
Gobi Site 190	45.82	99.26	Bayanhongor	Baatsagaan
Hugno Tarna Camp	47.48	103.76	Bulgan	Gurvanbulag
South of Sainshand	44.87	110.16	Dornogovi	Sainshand
South of Choyr	46.34	108.86	Govisumber	Choyr

Note. * Bold localities are explicitly mentioned in text.

etal muscle of each voucher specimen and stored in 95% ethanol. Voucher material and tissue samples collected in 2010, 2011, and 2012 are stored at the University of Kansas Biodiversity Institute (KU). The voucher material and tissues collected in 2014 are stored at the Mongolian State University of Education (MSUE), Ulaanbaatar, Mongolia.

The expeditions in 2010 and 2011 focused on collecting data on parasites of vertebrates. Sampling in 2010 focused on eastern regions of the Gobi Desert, whereas in 2011 sampling was concentrated in western Mongolia (Fig. 2). The sampling strategy of the 2014 expedition was to thoroughly sample southern Mongolia, to study population dynamics and community assemblages. This was done by revisiting localities that had been sampled during the 1980s and 1990s, as well as, targeting areas that had not been previously sampled.

RESULTS

Presented below are the species records from the four expeditions and a list for all lacertid and agamid species in Mongolia. Natural history observations were made by the authors in the field, as well as summarized from the Mongolian specific literature and from relevant adjacent countries (Munkhbayar and Terbish, 1991; Zhao and Adler, 1993; Ananjeva et al., 1997; Szczerbak, 2003; Sindaco, 2008; Baig et al., 2012; Terbish et al., 2006, 2013). We follow the taxonomy of the Reptile Database (http: //www. reptile-database. org/). Common names are from the IUCN checklist for Mongolian reptile and amphibians (Terbish et al., 2006). We list all specimens we examined in Table 2 and map all the localities explicitly mentioned in this checklist (Fig. 3). Species with an asterisk next to their name were collected during expeditions. Due to the limited availability of Terbish et al. (2013), species descriptions similar to those from the field guide are included in our accounts.

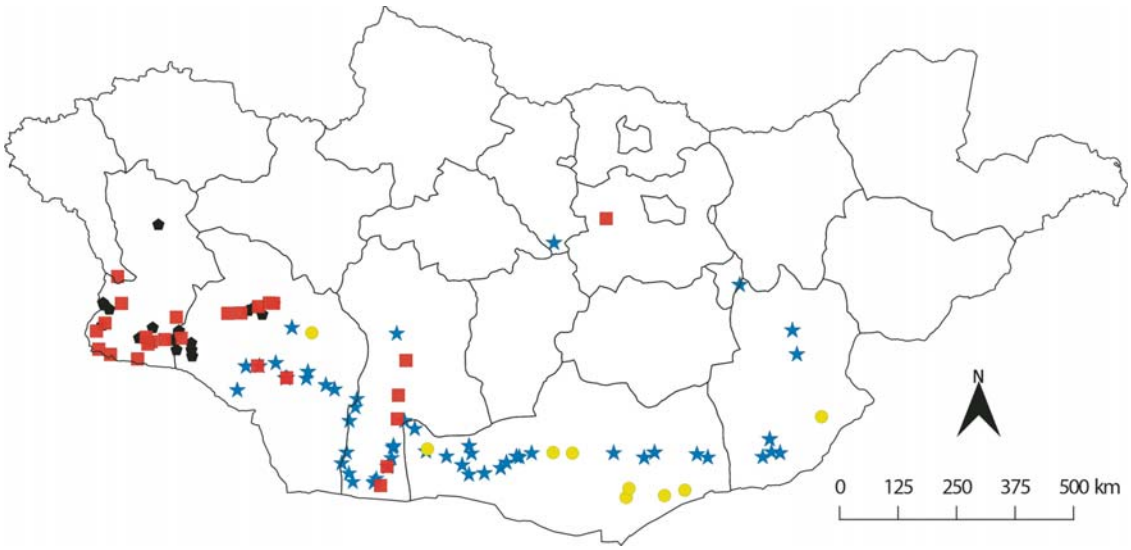

Fig. 2. Collecting sites from the 2010 (yellow circles), 2011 (red squares), 2012 (black pentagons), and 2014 (blue stars) expeditions. The outlines represent Aimag boundaries within Mongolia.

AGAMIDAE

Paralaudakia stoliczkana (Blanford, 1875) (Fig. 4*a – c*), Mongolian rock agama (English), Zamba gurvel (Mongolian)

Description. Adults up to 360 mm SVL; large bodied; scales spiny on throat with several gular folds; scapular region with transverse yellow and orange spots sometimes blending into stripes; granular scales on body; scales on tail spiny, overlap, in caudal whirls of four; tail tan at base and black at tip (Baig et al., 2012).

Natural history. *Paralaudakia stoliczkana* is a rock habitat specialist that is most commonly found basking on large boulders during mid-day. Individuals are known to live up to 9 or 10 years (Smirina and Ananjeva, 2007). Males were commonly observed in their territories with multiple females. When threatened all individuals would flee to either a nearby burrow, or into rock cracks. However, the females that were the first to emerge and situated themselves to bask after being threated, but the male would always be the last to emerge. Two populations were found to use burrows in the flats extending from the base of a rocky hillside, following the outflow from canyons (Gobi Sites 146 and 179; Fig. 3). A flatland population found at the base of a mountain range outside Noyon

TABLE 2. The List of Specimens Examined. Specimens Listed Only by Only Field Number Have Been Deposited at the Mongolian National University of Education (uncatalogued as of November 2020)

Species	Museum Number/Field Number
Paralaudakia stoliczkana	KU 331374 – 331395, KU 335282 – 335289 JLG 554 – 559, JLG 598, JLG 600, MDB 033 – 035, MDB 065 – 069, MDB 077 – 108
Phrynocephalus helioscopus	KU 335351 – 335361
Phrynocephalus hispidus	JLG 532 – 534, JLG 543 – 545, JLG 563, JLG 568, MDB 044 – 045
Phrynocephalus versicolor	KU 331406 – 331407, KU 331315, KU 331418 – 331420, KU 331423 – 331424, KU 331426 – 331433, KU 331437 – 331442, KU 331444 – 331447, KU 331449, KU 331451 – 331453, KU 331456 – 331457, KU 331459, KU 331463 – 331466 JLG 303 – 321, JLG 335 – 358, JLG 360 – 393, JLG 422 – 429, JLG 434, JLG 459 – 474, JLG 479 – 482, JLG 486 – 510, JLG 529 – 531, JLG 535 – 542, JLG 546 – 549, JLG 564 – 567, JLG 569 – 573, JLG 578 – 580, JLG 589 – 590, MDB 001 – 004, MDB 026 – 032, MDB 036 – 043, MDB 046 – 048, MDB 073 – 075, MDB 128 – 134
Eremias argus	KU 331053 – 54 JLG 366, JLG 442 – 444, JLG 550
Eremias arguta	KU 331339 – 331340, KU 335290 – 335298, KU 335302
Eremias multiocellata	KU 331052, KU 331227, KU 331334, KU 331337 – 331338, KU 335303 – 335304 JLG 408 – 414, JLG 441, JLG 445 – 458, JLG 475 – 478, JLG 483 – 484, JLG 511 – 517, JLG 574 – 577, MDB 122 – 123, MDB 135
Eremias przewalskii	KU 331055 – 331082, KU 331213, KU 331234 – 331262 JLG 394 – 407, JLG 439 – 440, JLG 518 – 527, JLG 551 – 552, MDB 059 – 063, MDB 124 – 127
Eremias vermiculata	KU 331226 MDB 009 – 010, MDB 072

Fig. 3. Localities from the 2014 expedition that are explicitly mentioned. Refer to Table 1 for exact coordinates. Blue crosses indicate the localities of new in country records for *Eremias arguta* from 2012.

Fig. 4. *a*, *Caragana arborescens* flower bush with multiple *Paralaudakia stoliczkana* feeding (Gobi Site 180); *b*, a male *Paralaudakia stoliczkana*; *c*, a female *Paralaudakia stoliczkana*. Photographed by L. Lee Grismer.

was found living in mammal burrows at the base of *C. arborescens* bushes. We followed the *C. arborescens* back up into a canyon in the mountain range and discovered many more individuals of *P. stoliczkana*. Interestingly, most individuals found in the flatlands were females feeding on vegetation, while males were generally found inside of deep canyons high up on the canyon walls. Females were also found in the canyons; however, they were almost always associated with a nearby male (Gobi Site 146; Fig. 3). The yellow flower *Caragana arborescens* was observed to be a staple of their diet (Fig. 4*a*) and we found populations new to science with nearly 100% accuracy by locating rock outcroppings with *C. arborescens*. When goats were present in the area, we found that *C. arborescens* was not an accurate predictor of *P. stoliczkana* presence (Gobi Sites 146 and 187; Fig. 3). These observations corroborate previous observations of *P. stoliczkana* occurring outside of the traditionally thought of rock habitat (Reading et al., 1999). *Paralaudakia stoliczkana* is oviparous. Mating likely occurs in the middle of May, while egg-laying starts in the middle of June and is finished in the first half of July, females typically lay 4 – 11 eggs.

Distribution. Populations have been reported throughout southwestern Mongolia, including the Great Gobi Strictly Protected Area and Gobi Gurvan Saikhan National Park (Reading et al., 1999; Terbish et al., 2006, 2013). Two subspecies are known: *P. s. stoliczkana* and *P. s. altaica* (Munkhbayar, 1971). Only the latter is known from western and southwestern Mongolian in the Govi-Altai, Bayankhongor, and Khovd Aimags (Ananjeva et al., 2006; Baig et al., 2012). Outside of Mongolia, this species is known from northern China. In the Xinjiang-Uyghur Autonomous Region, this species occurs in the Gansu Province and other regions of Kashgaria in the eastern Tien Shan. The southern and western extents of the species distribution in China pass south of the Tien Shan along the norther border of the Takla-Makan Desert. To the north and east its distribution is limited by the Mongolian Altai Mountains and Gobi Tien Shan, and portions of the Baitag mountain chain (Zhao and Adler, 1993; Ananjeva et al., 2006; Sindaco, 2008). Previous reports of *P. stoliczkana* from eastern Kyrgyzstan are erroneous (Ananjeva, personal communication).

Phrynocephalus helioscopus (Pallas, 1771), Sunwatcher toadhead agama (English), Toirmiin honin gurvel (Mongolian)

Description. Adults up to 70 mm SVL; small bodied; nostrils not visible from top; dorsal scales larger than dorsolateral scales; red or orange spots on scapular region; blue spots down dorsum; tail broad at base, abruptly narrow at tip, male tail tips pink during mating season (Ananjeva et al., 1997; Szczerbak, 2003; Terbish et al., 2013).

Natural history. In Mongolia, this species is usually found in desert steppe habitat and inhabits sandy areas with sparse vegetation, but also in clay soil areas in brown soil steppe habitats (Borkin et al., 1990). This species is oviparous; females lay 3 – 5 eggs in the second half of May. To thermoregulate and camouflage from predators *Ph. helioscopus* burrows itself into the sand using oscillatory motions (Bannikov et al., 1977). This species was listed as Rare in the Mongolian Governmental Act No. 7 in 2012.

Distribution. In Mongolia, the subspecies *Ph. helioscopus varius* (Solovyeva et al., 2011) occurs and has a limited distribution in the far west of the Khovd Aimag (Munkhbayar and Terbish, 1997; Terbish et al., 2006). The range includes Bulgan Gol National Park and Ikh Ongog National Park (Ananjeva et al., 1997; Terbish et al, 2013). *Phrynocephalus helioscopus* has an extensive distribution from Southern Russia (Astrakhan Oblast and Volgograd Oblast) and western Kazakhstan to northwestern China. It is found throughout all of Kazakhstan, and Central Asia. There are seven subspecies of *Ph. helioscopus* throughout the Palearctic (Uetz et al., 2020).

Phrynocephalus hispidus Bedriaga, 1909 (Fig. 5*a*), Spotted toadhead agama (English)

Description. Adults up to 60 mm SVL; body short and robust; pattern varies by population; at least some dorsal scales keeled; dark color patches on dorsum with keeled scales, red axillary spot; legs shorter than *Ph. versicolor.* This species may be distinguished from *Ph. versicolor* by the presence of keeled dorsal scales and yellow on the venter of the tail.

Natural history. Individuals were found in pure sandy areas when in the presence of *Ph. versicolor* (Fig. 5*b*), however, where *Ph. versicolor* was absent they would occupy the gravel-based and sandy substrates. When threatened individuals did not flick their tails as *Ph. versicolor* does, instead, they would flash the red axillary spot, and retreat to nearby bushes, burrows, or would burrow down into the sand barely exposing their dorsum. This species was found in sympatry with *Ph. versicolor*, however, in these instances males between the two species would not act aggressively with one another, unlike conspecific males. When two male *Ph. hispidus* were introduced to one another, they would flash their red axillary marking at one another. *Phrynocephalus hispidus* is an oviparous species, although the timing of reproduction and egg laying is unknown.

Distribution. Further work is needed to understand the complete range of this species in Mongolia. In Mongolia this species is recorded from southern Mongolia

Fig. 5. *a*, *Phrynocephalus hispidus*, note the keeled dorsal scales one of the main character distinguishing them from *Phrynocephalus versicolor*; *b*, an area with sand and gravel substrate intermixed, both *Phrynocephalus hispidus* and *Phrynocephalus versicolor* were found here, but partitioned by substrate type; *c*, a male *Phrynocephalus versicolor* posturing a flicking his tail to signal to other males; *d*, a flat gravel landscape, one of many habitat types that *Phrynocephalus versicolor* occupies. Photographed by L. Lee Grismer.

in Bayankhongor, Ömnögovi, and Khovd Aimags. The type locality for the species is in the Junggar Basin (Mongolia, Jungaria), in Xinjiang Uygur Autonomous Region, China. It is also known from Gansu Province in China.

Phrynocephalus kulagini Bedriaga, 1909, Tuva toadhead agama (English)

Description. Adults up to 52 mm SVL, or 125 total length; stout body; limbs short; tail long and rigid; base color gray-green or olive colored with 3 brownish or blackish bars down the back; sometimes reddish or yellowish spots on shoulders, or on the base of the tail.

Natural history. *Phrynocephalus kulagini* occurs in flat landscape with pebble substrates, and like other *Phrynocephalus* their diet to mainly comprised of ants, but also contains other small invertebrates and vegetation (Szczerbak, 2003). The thermo-regulatory behaviors of this species was recently studied in detail, and showed predictable patterns of behaviors to maintain an average body temperature of 33.7°C (Kropachev, 2013). Two clutches of eggs are laid in a single breeding season; the first clutch in mid-May and the second at the end of June; clutches contain 1 – 2 eggs.

Distribution. This species is restricted to northern Mongolia and the region of Tuva, Russia. This species was originally described as a sub-species of *Ph. versicolor*, however, recent taxonomic revisions by Solovyeya et al., 2018 elevated the status of the species based on genetic data.

Phrynocephalus versicolor (Strauch, 1876) (Fig. 5*c*), Variegated toadhead agama (English), Khonin gurvel (Mongolian)

Description. Adults up to 60 mm in body length; color pattern varies by population; transverse black bars

on dorsum across scapular and pelvic regions, dorsal scales smooth; elongate hind limbs; black bands on venter of tail. Juvenile's tail tips black, with no posterior banding; toes on hind limb frilled (Pope, 1935; Ananjeva et al., 1997; Szczerbak, 2003; Terbish et al., 2013).

Natural history. Individuals were found across the Mongolian Gobi Desert, and were observed in almost all types of habitat within the desert with individuals found at elevations up to 1760 m a.s.l. elevation (Borkin et al., 1990). This species can be encountered in rocky or flat areas with little to large amounts of vegetation (Fig. 5*b*, *d*), but always with a burrow in close proximity. At night individuals were found at the tops of bushes sleeping or in burrows. *Phrynocephalus versicolor* is the most common vertebrate in Mongolia, with population densities in areas ranging from 66 – 111 individuals per hectacre (Rogovin et al., 2001; Terbish et al., 2006; Murdoch et al., 2010). Behaviorally, this species is the opposite of *Ph. hispidus*; conspecific communication tends to be more conspicuous (e.g., males aggressively flick their tails in the open). Additionally, males will defend their territory by perching high in bushes or on rocks and flicking their tail. When provoked males will attack a challenger male in the open. One male was so aggravated it ran up and bit the toe of one of the authors (LLG) outside of Gurvantes. The most common species of lizard in Mongolia. Mating occurs throughout early summer until the end of July. Females lay a single clutch per season containing 1 – 5 eggs, which emerge starting at the of July.

Distribution. There are two recognized subspecies of *Ph. versicolor*; *Ph. v. versicolor* Strauch 1876 in Southern Mongolia and *Ph. v. doriai* Bedriaga, 1909 from Zingjiang Province in China. Given the recent elevation of *Ph. hispidus* and *Ph. kulagini* from subspecies of *Ph. versicolor*, there is a need for more studies to understand how each species is distributed within Mongolia and how the species partition niche space in areas where they are sympatric. Outside Mongolia, *Ph. versicolor* occurs in northern China in the Xinjiang Uyghur and Inner Mongolia (Nei Mongol) Autonomous Regions, as well as, Gansu and Ningxia Provinces.

LACERTIDAE
***Eremias argus* Peters, 1869 (Fig. 6*d*), Mongolian Racerunner (English), Mongol gurvel (Mongolian)**

Description. Specimens match description from Terbish et al. (2013) and Szczerbak (2003). Adults up to 71 mm SVL; dark brown, dots outlined in black running dorsally from head to base of tail, four rows of white dots outlined in black across the dorsum, black dots present laterally; males have a pink venter; dorsal scales small and granular, ventral scales plate like; hind legs with spots, femoral pores present, but do not extend beyond knee.

Natural history. Individuals were most commonly found in the semi-desert habitats with peashrubs. In desert habitats individuals, can be found in dried out riverbeds and hills with sandy substrate and short vegetation (Ananjeva et al., 1997; Fig. 7*c*). This species is active from the end of April to the beginning of September. This species is most active during the morning from 10:30 to 12:00. One individual was collected basking on large boulders along a sandy riverbed during the later hours of the morning (Gobi Site 121; Fig. 3). An oviparous species, *E. argus* mates during April and May, and lays between two and six eggs during the summer months (mid-June to August) (Szczerbak, 1974; Ananjeva et al., 1997).

Distribution. Outside of Mongolia this species is found in China (from the Lake Kukunor up to Shanghai city), in the western part of the Korean Peninsula and in Russia, in the southern Buryatia (to the north approximately up to Ulan-Ude city) and in the extreme southwest of the Chita region (Szczerbak, 1974; Szyndlar, 1984; Zhao and Adler, 1993; Ananjeva et al., 1997, 2006). *Eremias argus* occurs broadly across eastern Mongolia, both on the steppe habitats and in the northern regions of the Gobi Desert, these populations are considered *E. a. argus* Peters, 1869 (Munkhbayar, 1981; Ananjeva et al., 1997; Reading et al., 1999). Isolated populations are found throughout western Mongolia, and are identified as *E. a. barbouri* Schmidt, 1925.

***Eremias arguta* (Pallas, 1773), Stepperunner (English), Tolbot gurvel (Mongolian)**

Description. Adults up to 95 mm SVL; large bodied; light gray base coloration across the entire body, pairs of black blotches on the dorsum and tail; femoral pores present; dorsal scales small and granular, ventral scales plate like (Ananjeva et al., 1997; Szczerbak, 2003; Terbish et al., 2013).

Natural history. In the Gobi Desert individuals are found on gravel substrate with saxaul bushes or sand mounds with nitraria. In semi-desert environments this species is found with locoweeds and anabasis. *Eremias arguta* goes into hibernation in October and emerges in mid-April (Terbish et al., 2013; Ananjeva et al., 1997). In Mongolia, this species is rare; however, across the entire range it can be abundant, with up to 150 individuals in one hectacre (Szczerbak, 1974; Ananjeva et al., 1997). An oviparous species, mating occurs in April or May; fe-

Fig. 6. Four species of *Eremias* found during the 2014 expedition: *a*, *Eremias multiocellata*; *b*, *Eremias vermiculata* collected at Gobi Site 157; *c*, *Eremias multiocellata* collected south of Sainshand (Gobi Site 115); *d*, *Eremias argus* collected in Great Gobi, B Strictly Protected Area (Gobi Site 120). Photographed by L. Lee Grismer.

males lay between two and six eggs, newborns appear in the end of July – beginning of August. This species was listed as Rare in the Mongolian Governmental Act No. 7 in 2012.

Distribution. *Eremias arguta* has a limited distribution in western Mongolia in areas around Bulgan and Uyench (Khovd Aimag), however, an expedition by KU in 2012 collected several specimens from western Gobi-Altai, extending the range of the species further east than previously recorded (Munkhbayar and Terbish, 1997; Orlova and Terbish, 1986; Terbish et al., 2013; Poyarkov et al., 2014) (Table 1: site names 2012 01, 2012 03; Fig. 3: blue crosses). Populations of *E. arguta* from western China and Mongolia are regarded as *E. a. potanini*. Outside of Mongolia this wide-spread species has a very broad range: from the steppe zone of Romania and Moldova, the Ukraine and the European part of Russia including North Caucasus and the area of the Volga River in the west, to Kazakhstan, Turkmenistan, Tajikistan, Uzbekistan, and Kyrgyzstan in the east (Szczerbak, 1974; Shamakov, 1981; Ananjeva et al., 1997, 2006; Sindaco, 2008; Terbish et al., 2013). *Eremias arguta* has the largest range among other species of this genus: from in the Black Sea region from Romania to Ciscaucasia, Eastern Transcaucasia, and Middle Asia to the east as far as Chinese Dzhungaria and Dzhungar Gobi in Western Mongolia (Poyarkov et al., 2014). Disjunct populations of this species occur in the eastern Transcaucasia, within the limits of Azerbaijan, eastern Georgia and the basin of the Sevan Lake in Armenia. In the south it occurs in Turkey and Iran. The northern most isolated habitats are known in the Volga – Kama Territory from the Samara bend and Buzuluk coniferous forest (Ananjeva et al., 2006).

Eremias dzungarica Orlova, Poyarkov, Chirikova, Nazarov, Munkhbaatar, Munkhbayar et Terbish, 2017, Dzungarian Racerunner (English)

Description. Similar in appearance to *E. multiocellata*. Adults up to 64.5 mm SVL; tail approximately 1.5 times as long as body; subocular scale does not extend to the mouth; touches 6 – 8 supralabial scales; dorsolateral spots outlined with thick black markings; first 2 – 3

Fig. 7. *a*, Barren flat land strewn with pebbles where *Eremias multiocellata* were found in abundance, Gobi Site 128; *b*, a small sand dune system at the mouth of a canyon system near Gobi Site 155, where *Eremias przewalskii* were found; *c*, one of two sites where *Eremias argus* was collected in 2014, Gobi Site 121; *d*, typical *Eremias przewalskii* habitat, a flat landscape with nitraria bushes that provide protection for the lizards (Gobi Site 136). Photographed by L. Lee Grismer.

brightly colored on males; ventral ocelli greenish blue; venter with irregular black spots (Orlova et al., 2017).

Natural history. This species occupies similar habitats as *E. multiocellata*, however, it is found at higher elevations up to 2600 m a.s.l. This species prefers rocky substrate with low density vegetation consisting of *Haloxylon*, *Caragana*, *Nitraria*, and *Reaumuria*. Near Uyench Soum in Khovd aimag, *E. dzungarica* was found living in sympatry with *E. multiocellata*, but the two species remained ecologically separated into different microhabitats. *E. multiocellata* occupied low elevation sandy terrain, whereas, *E. dzungarica* was found in the rocky foothills of adjacent mountains. In Kazakhstan, *E. dzungarica* is found at lower elevations (400 – 600 m a.s.l.) and exclusively on sandy soils (Orlova et al., 2017). Ovoviviparous species.

Distribution. The type locality, located in Mongolia, is from the Khovd Aimag, 7 km west of Uyench Soum. *E. dzungarica* has been reported from Bulgan Soum in Khovd Aimag (Orlova et al., 2017). *Eremias dzungarica* is common in the foothills of the Mongolian Altai (Mongolian Dzungaria), in close vicinity of Uyench Sum, Khovd Aimaq (Orlova and Terbish, 1986), in the upstreams of the Bulgan-gol River from the elevations above 2000 m a.s.l., Khovd Aimaq, Bulgan Sum, Bayan-Mod, vicinity of Ikher-Toli (Orlova et al., 2017). Museum specimens of *E. dzungarica* previously identified as *E. multiocellata* indicate that this species occurs in the Eastern Kazakhstan Province on the Aigyrkum sands, as well as near Ulken-Karatal, the sandy banks of the Bukhtarma water reservoir, and Mt. Ashutas. This species is also expected to inhabit the northern part of the Xinjiang

Uyghur Autonomous Region north from Tian Shan Mountains (Chinese Dzungaria) and is reported as *E. multiocellata* in Chinese literature (Zhao and Adler, 1993). Further research utilizing museum specimens and field studies are needed to clarify the distribution of this species.

***Eremias multiocellata* Günther, 1872 (Fig. 6*a*, *c*), Multi-ocellated racerunner (English), Mogoi gurvel (Mongolian)**

Description. Specimens match description from Terbish et al. (2013). Adults up to 75 mm SVL; light tan base color on the dorsum; spots run in rows down dorsal and lateral surfaces; dorsal spots extend onto tail; lower lateral and venter white or cream colored; dorsal scales small and granular, ventral scales plate like.

Natural history. Most individuals were found in large open areas with pebble substrate and sparse vegetation (Fig. 7*a*, *d*) foraging from bush to bush, rarely spending time out in the open (Szczerbak, 1974; Reading et al., 1999). Individuals were frequently found near burrows at the base of saltwort bushes. When threatened, individuals would run to nearby saltwort bushes, or preexisting *Phrynocephalus* or mammal burrows. Individuals are very fast in short distances and are capable of changing directions abruptly. One population was found in an area that had no vegetation, and individuals seemed to have great spatial knowledge finding multiple burrows very quickly. Like most species of *Eremias* in Mongolia, *E. multiocellata* was only active during the late morning into the early afternoon (10:00 – 13:00). During the morning, individuals could be seen sitting at the mouth of their burrows basking. During the late afternoon temperatures are too high and this species moves underground, or to the base of saltwort bushes. A viviparous species, mating occurs in the end of April and beginning of May; 3 – 4 newborns are born in the end of July and first week of August.

A recent phylogenetic study of *Eremias*, based on mitochondrial locus cytochrome-oxidase I (COI), found that *E. multiocellata* populations living on sand substrate are genetically distinct from populations occupying rock substrates (Orlova et al., 2017). These authors report on the high genetic and morphological diversity of *E. multiocellata* in Mongolia and China, synonymize *E. m. bannikowi* with the nominative form *E. m. multiocellata* and provide new data on *E. m. tsaganbogdensis*.

Distribution. *Eremias multiocellata* is found throughout the Gobi Desert and northwestern Mongolia (Bayan-Ölgii, Khovd, Uvs, Zavkhan, Govi-Altai, Bayankhongor, Övökhangi, Ömnögovi, Dornogovi, and Dundgovi aimags), and into Tuva, Russia (Munkhbayar, 1976; Borkin et al., 1990; Ananjeva et al., 1997; Terbish et al., 2006, 2013). The majority of Mongolia (southern, central and western parts) and the adjacent areas of Tuva Republic in Russia are inhabited by the nominate form, *E. m. multiocellata*, with a narrow zone of sympatry with *E. dzungarica* reported from the vicinity of Uyench Sum (Khovd Aimaq) (Orlova et al., 2017). *Eremias multiocellata tsaganbogdensis* Munkhbayar et Borkin, 2010 has a restricted distribution in southwestern Mongolia at Tsagaan Bogd Uul Mountain in Great Gobi: A Strictly Protected Area. Orlova et al. (2017) discussed the complicated taxonomic status of *Eremias* populations from southern Mongolia and Central China; they believe that the populations from southwest Mongolia, corresponding to *E. multiocellata* var. *reticulata* Bedriaga, 1912, appear to be phylogenetically closely related to the *E. przewalskii* species complex sensu lato; tentatively they list them as *E.* cf. *reticulata*.

***Eremias przewalskii* (Strauch, 1876), (Fig. 8*a* – *c*), Gobi Racerunner (English), Goviin gurvel (Mongolian)**

Description. Adults up to 235 mm SVL; coloration varies from east to west (Fig. 8*a* – *c*) with populations in the east having reticulate a pattern, and in the west dark transverse bands run the length of the body. Populations in the south may have lateral blue spots outlined in black. All individuals have small and granular dorsal scales and large plate like ventral scales.

Natural history. Individuals are only found in sandy habitats with either continuous sand dunes, or fragmented sand mounds sparsely vegetated with *Nitraria siberica* (Szczerbak, 1974; Munkhbayar, 1976; Terbish, 1988; Ananjeva et al., 1997; Fig. 7*b*, *d*). Several individuals collected at Ergelyin Zoo, in southeastern Mongolia, were found on the edges of dried up flood basins sitting near saltwort bushes in the morning (Gobi Site 117, Fig. 3). A few individuals were found in the flood basins and would retreat out of the basin when startled to the base of bushes in the surrounding area. A viviparous species, mating has been observed during the beginning of May. Females give birth to 3 – 6 juveniles with body length 23.5 – 26.2 mm from the end of July till the beginning of August.

Distribution. *Eremias przewalskii* is found in a large portion of the Gobi Desert and into northwestern Mongolia (Uvs, Khovd, Zavkhan, Govi-Altai, Bayankhongor, Arkhangai, Ömnögovi, Dornogovi, Dundgovi aimags), and Tuva, Russia (Orlova, 1992; Rogovin et al., 2001; Terbish, 2006; Terbish et al., 2013). Populations from the flood plain of the Nariin-Gol river were previously regarded as *E. p. tuvensis*, however, recent phylogenetic studies have shown that the population is not genetically

Fig. 8. Geographic variation of *Eremias przewalskii*: *a*, *Eremias przewalskii* collected at Erigeyln Zoo (Gobi Site 117); *b*, *Eremias przewalskii* collected from south of Gobi Gurvan Saikhan (Gobi Site 136); *c*, *Eremias przewalskii* collected north of Great Gobi, A Strictly Protected Area (Gobi Site 177). Photographed by L. Lee Grismer.

distinct from other Mongolian *E. przewalskii*. As such, *E. p. tuvensis* is now considered a synonym of *E. przewalskii*. Outside of Mongolia this species is found in northern China (Inner Mongolia, Xinjiang-Uyghur Autonomous Region).

***Eremias vermiculata* Blanford, 1875, (Fig. 6*b*), Variegated racerunner (English), Zagalt gurvel (Mongolian)**

Description. Adults up to 71 mm SVL; slender bodied; light tan base color on dorsum; three dorsal stripes along body, stripe does not extend onto tail; snout pointed; ventral surface uniformly white; dorsal scales granular and small, ventral scales plate like (Szczerbak, 2003).

Natural history. Individuals were collected on sand dune systems with vegetation, they were observed near the edge of bushes sunning, but when startled retreated back into the vegetation. The feeding habits and activity patterns of this species are not well studied. An oviparous species, clutches typically contain 1 – 2 eggs. Mating probably in the end of April-May, hatchlings with body length appear in the end July – beginning of August (Szczerbak, 1974; Ananjeva et al., 1997).

Distribution. *Eremias vermiculata* is found in southern Mongolia south of the Mongolian Altai mountains, with populations reported from Govi-Altai, Bayankhongor and Ömnögovi Aimags (Borkin et al., 1990; Semenov and Munkhbayar, 1996; Ananjeva et al., 1997). This species can be found across northern China from Xianjang to Nanshan Mountain in Inner Mongolia, from the Kashi Region to Nanshan mountain in the north, and the Huáng Hé River in the south. The western and northern most populations are in the Zaissan Depression of Kazakhstan (Szczerbak, 2003; Ananjeva et al., 2006).

***Lacerta agilis* Linnaeus, 1758, Sand lizard (English), Gavshgai gurvel (Mongolian)**

Description. Specimens match description from Terbish et al. (2013). Adults up to 110 mm SVL; medium sized body; tail about 1.5 times as long as body; males dark green base color, with dark spots on dorsum; females gray/tan base color; two brown strips running dorsally from anterior to posterior onto tail; dark brown spots with white border around dorsal stripes.

Natural history. This species occurs along rocky hills with juniper bushes (Semenov and Munkhbayar, 1996). Additionally, it has been reported on hillsides along rivers and in mountain meadows, up to 1700 m a.s.l. (Terbish and Munkhbayar, 1988). As many as 1000 individuals may be found in one hectacre (Szczerbak, 2003). Individuals are active from March to September, depending on geographic location. Mating season and subsequent egg laying varies across the species large range (Yablokov, 1976; Bischoff, 1984; Ananjeva et al., 1997). The timing of reproductive behaviors in Mongolia has not been studied. This species was listed as Rare in the Mongolian Governmental Act No. 7 in 2012.

Distribution. Within Mongolia this species is distributed in the west at the headwaters of Songinot and Bayan rivers in Khovd Aimag (Semenov and Munkhbayar, 1996; Ananjeva et al., 1997; Terbish et al., 2006, 2013). *Lacerta a. exigua* Eichwald, 1831 is the subspecies found in Mongolia, as it is found throughout the entire eastern range of *L. agilis* (Kalyabina-Hauf and Ananjeva, 2004). The sand lizard is one of the most widely distributed Eurasian species; its distribution range covers the most part of Europe from western France and north of the Balkan Peninsula to Eastern Siberia, northwestern Mongolia and western China in the east (Chinese part of the Mongolian Altai). In northern Eurasia the species occurs from the western borders of Moldavia, the Ukraine, Belarus, the Baltic States and Russia in the west to northern areas adjacent to Lake Baikal and southern Trans-Baikal area in the east, more or less in parallel with the north border of taiga. It inhabits the Caucasus and Kazakhstan in the south.

***Zootaca vivipara* (Lichtenstein, 1823),**
Common lizard (English),
Zulzagalagch gurvel (Mongolian)

Description. Adults up to 70 mm SVL; base color brown; white spots down dorsal and lateral surfaces in rows, white spots surrounded by dark brown border; femoral pores present, extending to the knee (Terbish et al., 2013).

Natural history. This species occurs in deciduous and mixed forests along the banks of riparian systems, additionally they are capable of swimming and diving (Munkhbaatar and Tseveenmyadag, 2002; Terbish et al., 2013). Often individual will take shelter in root systems, under logs, and in mammal burrows. They are most active during the morning and shortly after rain (Terbish et al., 2013). Individuals emerge from hibernation in late March, in southern regions, and during the first half of June in the north; they return to hibernation between late August and October (Bannikov et al., 1977). Up to 75 individuals may be found in one hectacre, and populations have been reported at elevations up to 2900 m a.s.l. (Ananjeva et al., 1997). This species is viviparous throughout much of its range, however, populations from the extreme southwest part of its range are oviparous (Heulin et al., 1989). In the eastern part of distribution range, in Mongolia the lizards of the nominate subspecies are egg-laying. The reproductive mode of Mongolian populations is unknown, however, on the northern border of Mongolia in the Altai Nature Reserve (Russia) mating occurs in April – May, newborns appear from the July to midway through August. This species was listed as Rare in the Mongolian Governmental Act No. 7 in 2012.

Distribution. Within Mongolia, the nominate subspecies, *Z. v. vivipara* occurs in the north (Bayan-Ölgii, Khövsgöl, Selenge, Töv, and Dornod Aimags). Specifically, individuals have been collected from the Altai, Hentii, Huvsgul and Hyangan mountains (Ananjeva et al., 1997; Terbish et al., 2013). Outside of Mongolia this species is broadly distributed, its west to east distribution spans from Ireland and the Iberian Peninsula to the Shantarskie Islands, Sakhalin Islands, and Japan; from north to south Sweden to western Chinese Gobi (Xinjiang-Uyghur Autonomous Region) (Bannikov et al., 1977; Szczerbak and Szcherban, 1980; Ananjeva et al., 1997, 2006).

DISCUSSION

The results from these recent expeditions account for 134 locality records for nearly all species of lacertid and agamid (Table 1; Fig. 2). Our recent surveys, along with the previous literature on this unique herpetofauna, are beginning to illuminate interesting geographical distribution patterns, ecological patterns information, microhabitat preferences, and even associations among certain reptile and plant species (e.g., *Paralaudakia stolizckana* and *Caragana arborescens*). Here we discuss the natural history patterns and conservation concerns for the Mongolian Gobi Desert.

Linnean and Wallacean Shortfalls of Mongolian Herpetofauna

In recent years, the use of molecular phylogenetics and integrative taxonomy has allowed researchers to delimit cryptic reptile species in Mongolia. For example, *Eremias dzungarica* was previously recognized as *E. multiocellata*. However, genetic sampling across the range of *E.multiocellata* throughout central Asia, revealed that more genetic and species diversity within the species complex resided in Mongolia. It is possible that more species diversity exists in Mongolia, however, they are currently recognized as wide-ranging polymorphic species. In addition to identifying cryptic species using molecular data, studies utilizing genomic sampling would be useful for understanding how populations are interacting with one another across the landscape. Future studies of the population dynamics and phylogeography would be beneficial for identifying cryptic species and understanding how these species have evolved in concert with their environment.

In addition to the need for molecular studies of species diversity, ecological studies of the recently described new species are needed to understand how they occupy the landscape, and the extent of their ranges within Mongolia. Currently, our knowledge of the range of *E. dzun-*

garica, for example, is based on morphological identification of specimens in museum collections, and samples that have genetic sequences. Future surveys could be designed to generate a more holistic characterization of the natural history of Mongolian reptiles, by focusing on ecology, behavior, structural microhabitats, and geological substrates of resident species.. Further, assessments for new species within protected areas in southern Mongolia will help ensure that parks are protecting newly recognized species endemic to Mongolia.

Ecology of Select Mongolian Herpetofauna and Conservation Concerns

Throughout the 2014 expedition we documented the correlation between particular reptile and plant species. The pattern was strong enough to predict the species that would be found in a given, by first noting its dominant vegetation. For example, populations of *P. stoliczkana* were found in isolated rock outcroppings by looking for the flower species, *C. arborescens*, a staple of their diet. Using these flowers in conjunction with information gathered from local sheep herders we able to locate populations of *P. stoliczkana* reported in the early 20th Century, but were not confirmed by expeditions in the 1980s (Borkin et al., 1990). This correlation was not an isolated event; another population was found with a similar distribution pattern in a canyon north of Eej Khairkhan Uul (Gobi Site 179; Fig. 3). The distribution of these flowers in flatlands may allow for individuals of *P. stoliczkana* to migrate between populations facilitating gene flow across isolated rock outcroppings. The relationship between plant and reptile species may prove to be important for understanding how various species are able to disperse across the desert landscape, and how different reptile species coexist.

Another species distribution that appears to be closely linked to the distribution of a plant species is *E. przewalskii* to the *Nitraria sibirica*. Across the Mongolian Gobi Desert both *E. przewalskii* and *N. sibirica* bushes were always found in sand dune systems or sand dune bluffs. When startled, individuals would run into the thick branches of the bushes, which are covered with poisonous spines, for protection and cover. Not only do these bushes appear to provide formidable cover for the individuals, but many individuals were observed eating the berries, which has been documented as a primary food source (Terbish et al., 2013).

Given these correlations between plant and reptile species, potentially one of the biggest conservation challenges in Mongolia is finding a solution to the expansive conversion of land via agricultural development and mining. We observed overgrazing of *C. arborescens*, by goats, causing rapid habitat degradation in certain areas that may be limiting the dispersal abilities of species associated with this flower (e.g., *Paralaudakia* and *Picas*). North of Altai Soum on a 4000 m mountain, we found small groupings of *C. arborescens* at high elevations, however, we observed a large population of goats grazing on the flowers. This was one of the few times we did not find *P. stolizckana* with the flowers despite the habitat being suitable, from the base of the mountain to the top. It is probable that the effects of agricultural development extend beyond just rock adapted species and may influence widely distributed species as well.

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