

¹*Evolutionary Morphology of Vertebrates, Gent, Belgium;* ²*Rodentology Research Department, Ferdowsi University of Mashhad, Mashhad, Iran*

Geographic pattern of cranial differentiation in the Asian Midday Jird *Meriones meridianus* (Rodentia: Muridae: Gerbillinae) and its taxonomic implications

FATEMEH TABATABAEI YAZDI^{1,2}, DOMINIQUE ADRIAENS¹ and JAMSHID DARVISH²

Abstract

The existence of cryptic species in the midday jird (*Meriones meridianus*) has been suggested in literature, although based on little empirical data to support this hypothesis. In this study, a two-dimensional landmark-based geometric morphometric approach was used to investigate whether patterns in intraspecific variation in skull shape and size exist, using 110 skull specimens from more than 20 different localities along the distribution range of *M. meridianus*. This is the first study of morphological differences on such a big sample size and geographical range, and it tries to find whether skull shape variation in this species is best described as being clinal or rather reflecting cryptic diversity. The latter seems to be the case, as a dimorphic skull phenotype was found, reflecting a geographic disparity between the Middle East and the Far East specimens both in shape and in size. Distinct cranial differences were found in the overall cranial size and, also at the level of the inflation of the bulla, the elongation of the nasal, the length of the teeth row and the incisive foramen, as well as the distance in between the latter two. It thus seems that *M. meridianus* from Middle East is morphologically distinct from that of the Far East. Furthermore, our results also demonstrate that clinal variation could explain variation within Middle East populations, whereas a more heterogenous pattern is found for those of the Far East. The hypothesis that the observed phenotypic variation may reflect cryptic species is discussed, with the recommendation for a thorough taxonomical revision of the genus in the region.

Key words: Central Asia – geometric morphometrics – Iran – Muridae – skull morphology

Introduction

The midday jird (*Meriones meridianus* Pallas, 1773) is a rodent species distributed from the Northern Caucasus and eastern Iran [central desert of Kerman (Darvish 2009)] to Northern Afghanistan, Mongolia and Northern China (Lay 1967; Hassinger 1973; Sheng et al. 1999; Denys et al. 2001; Musser and Carleton 2005). Substantial intraspecific variation in morphological (external) characters, such as coat colour, body size and bone structure in populations coming from different geographical locations has been shown (Chaworth-Musters and Ellerman 1947; Wang and Yang 1983; Zhang 1997; Ito et al. 2010), leading to the description of many subspecies. Seven subspecies have been recognized from the Xinjiang of China (Ito et al. 2010), as well as a separate species (*Meriones dahlia*; Musser and Carleton 2005), whereas other species have been considered synonymous [e.g. *Meriones chengi* by Pavlinov et al. (1990, 1995) and Ito et al. (2010)]. In most keys and revisions on the genus *Meriones*, diagnostic features generally are ambiguous (Allen 1940; Chaworth-Musters and Ellerman 1947). Most of the studies on *M. meridianus* mainly provided external diagnostic features, rather than cranial characters, and are often based on local samples without covering the species' distribution range (e.g. Allen 1940). Especially in the arid habitat of the Iranian regions (especially the Iranian plateau), this species has remained poorly studied (Misonne 1975). As the midday jirds from the Iranian plateau are geographically most distinct from the Far East specimens, morphological differences resulting from clinal variation can be expected. To what degree *M. meridianus* intraspecific variation reflects a

continuous range of clinal variation requires comprehensive analyses of characters that allow a quantification of even subtle levels of phenotypic variation. Considering the taxonomic ambiguities related to this species, emerging patterns in this phenotypic variation may also reflect cryptic species diversity.

To test this hypothesis on clinal variation versus variation suggesting cryptic species diversity, *M. meridianus* from the Middle East are compared with those of the Far East (Fig. 1), by performing a landmark-based geometric morphometric analysis on the skull. Cranial differences, such as a cranial size difference between the specimens from Turkestan (Uzbekistan and Kazakhstan) and those from China (Far East populations), have already been reported in the past by Chaworth-Musters and Ellerman (1947). Specimens originate from the localities spanning the species distribution range, including specimens collected from the type localities, as for example, the topotype of *M. chengi* (Musser and Carleton 2005). Using the cranium is especially relevant for studying phenotypic variation, as it is both genetically and functionally relevant and hence subjected to a substantial amount of selective pressure (Caumul and Polly 2005; Cordeiro-Estrela et al. 2008).

As such, the aims of this study are to (1) reveal the patterns of intraspecific skull shape and size variation in *M. meridianus* along its distribution range; (2) test the hypothesis whether continuous clinal variation rather than cryptic phenotypic differentiation explains the observed patterns; and (3) find potential diagnostic cranial characters allowing further taxonomical clarification of this species. For the second aim, the congruence of shape variation in specimens from Iran with that of the Middle East is evaluated, where in the case of clinal variation, a more similar phenotype is expected with Middle East specimens that are geographically closest.

Corresponding author: Fatemeh Tabatabaei Yazdi (fatemeh.tabatabaei@ugent.be, fatemeh.tabata@gmail.com)

Contributing authors: Dominique Adriaens (dominique.adriaens@ugent.be), Jamshid Darvish (darvish_j2001@yahoo.com)