

## Occurrence and taxonomic significance of thigh-spurs in *Testudo marginata* SCHOEPPF, 1792 and *Testudo weissingeri* BOUR, 1995 (Testudines: Testudinidae)

Auftreten und taxonomische Bedeutung von Schenkelsporen  
bei *Testudo marginata* SCHOEPPF, 1792 und *Testudo weissingeri* BOUR, 1995  
(Testudines: Testudinidae)

JARMO PERÄLÄ

### KURZFASSUNG

Insgesamt wurden 71 Exemplare von *Testudo marginata* SCHOEPPF, 1792 und *T. weissingeri* BOUR, 1995 untersucht, um innerhalb beider Arten die taxonomische Bedeutung des Vorhandenseins oder Fehlens von Schenkelsporen aufzuklären. Tatsächlich sind Schenkelspore, die in beiden Taxa nicht oder nur selten vorkommen sollen, innerhalb beider Arten sehr häufig zu finden. Die Schenkelsporn-Frequenzen von männlichen und weiblichen Tieren unterscheiden sich weder innerhalb noch zwischen den beiden untersuchten Taxa signifikant voneinander. Das Vorhandensein oder Fehlen der Schenkelspore ist deshalb kein verlässliches taxonomisches Merkmal zur Charakterisierung von *T. marginata* beziehungsweise *T. weissingeri*.

### ABSTRACT

Seventy-one specimens of *Testudo marginata* SCHOEPPF, 1792 and *T. weissingeri* BOUR, 1995 were investigated to clarify the taxonomic significance of the presence or absence of spurs on the upper thigh region in both species. The results suggest that thigh-spurs, which are generally supposed to be absent or relatively infrequent in both taxa, are actually very common among both examined species. Males and females do not differ significantly by their thigh-spur frequencies within or between the investigated taxa. Thus the presence or absence of thigh-spurs cannot be reliably used as a taxonomic character to characterize *T. marginata* or *T. weissingeri*.

### KEY WORDS

Reptilia: Testudines: Testudinidae: *Testudo marginata*, *Testudo weissingeri*; systematics, taxonomy, systematic significance of presence/absence of thigh-spurs

### INTRODUCTION

*Testudo marginata* SCHOEPPF, 1792 – with a distribution in Greece and extreme southern Albania, and introduced to Sardinia according to, e.g., MERTENS (1946), WERMUTH & MERTENS (1961, 1977), ERNST & BARBOUR (1989) and BOUR (1995), and also to Central-Italy (BOUR 1995) – and the recently described species *T. weissingeri* BOUR, 1995 from SW Peloponnese in Greece are the only members of South European *Testudo* showing a combination of xiphiplastral kinesis and a lack of single conical tubercles on the upper thigh region, i.e., so called thigh-spurs, according to most authors (e.g., SIEBENROCK 1906; MERTENS 1946; PRITCHARD 1979; ERNST & BARBOUR 1989).

The presence of a hinged xiphiplastron in conjunction with the absence of thigh-spurs has been traditionally used to separate

taxonomically *T. marginata* and *T. kleinmanni* LORTET, 1883 (NE Africa to southern Levant) from *T. graeca* LINNAEUS, 1758 ("spur-thighed tortoise") with several currently recognised subspecies from eastern Mediterranean to Central Asia (IVERSON 1992). However, a moveable posterior plastron lobe and the lack of thigh-spurs is also a combination found in a new *Testudo* species from the Middle East (PERÄLÄ 2001). Also, the lack of spurs is among the diagnostic characters for the recently described "spur-thighed tortoise" taxon *T. graeca soussensis* of SW Morocco (PIEH 2000). WERNER (1985) has reported an individual *T. graeca* without spurs from Israel, and the same condition has been witnessed by the present author occurring (seemingly) irregularly among Turkish and Levantine *T. grae-*

ca (unpublished field observations), and in museum specimens of the same taxon from elsewhere (as yet unpublished data).

According to ERNST & BARBOUR (1989), and BUSKIRK (in BOUR 1995), spurs are occasionally found in *T. marginata*. BOUR (1995) reported that the so called typical condition of absence of spurs in *T. marginata* is not a constant feature in that taxon (spurs present in 2 out of 10 wild animals from Leonidion, and in several more from Sikea and Dimiovis on

Peloponnese). With respect to *T. weissingeri*, thigh-spurs were found in 11.7% of animals encountered in the field (BOUR 1995).

GMIRA (1993a, 1993b, 1995) and PERÄLÄ (1999, 2002 in press) have shown in their phylogenetic analyses that the presence of thigh-spurs (inclusive of aggregates) in *Testudo* (sensu lato) is clearly a product of convergent evolution and, that their absence is a character reversal (loss) in the highly derived species *T. marginata* and *T. kleinmanni*.

## MATERIALS AND METHODS

Sixty-nine museum specimens of *T. marginata* (42) and *T. weissingeri* (27), with the soft parts on the thigh region present, were examined in three scientific collections: Muséum national d'Histoire naturelle - Paris (MNHN), Naturhistorisches Museum - Wien (NMW), and Staatliches Museum für Tierkunde - Dresden (MTKD). In addition, R. BOUR (RB) of MNHN, gave kind permission to examine two living *T. weissingeri* from his personal collection.

### Specimens examined (all samples are from Greece unless stated otherwise)

*Testudo marginata*: NMW 1175, ♂, Kefallinia (= Cephalonia); NMW 18976, ♀, Delphi; NMW 19655:1, ♀, Pikermi bei Athen; NMW 19655:2, ♂, Pikermi bei Athen; NMW 19655:3, ♂, Akrokorinth; NMW 19655:4, ♀, Akrokorinth; NMW 19655:5, ♂, Akrokorinth; NMW 30059, ♀, Korinth; NMW 30061, ♂, Prevesa, Albanien (= modern NW Greece); NMW 30062, ♀, Pikermi bei Athen; NMW 30063:5, ♂, bei Athen; NMW 30066, ♂, Weg Athen-Hymenos; NMW 30068, ♀, Akrokorinth; NMW 30071:1, ♀, Akrokorinth; NMW 30071:2, ♂, Akrokorinth; NMW 30071:3, ♂, Ladha bei Taygetos; NMW 30073, ♂, Akrokorinth; NMW 30078, ♂, Cephalonia; NMW 31022, Kiaton, ♂, N-Peloponnes; NMW 31461, ♀, Prevesa, Albanien (= modern NW Greece); NMW 33194:1, ♀, Sardinien, Cap d'Orso; NMW 33194:19, ♀, Sardinien; NMW 33194:2, ♀, Sardinien, Cap d'Orso; NMW 33194:22, ♂, Neapoli; NMW 33194:23, ♀, Neapoli; NMW 33194:24, ♂, Tripoli (Peloponnes); NMW 33280, ♂, S-Euböa, bei Kasystos; NMW 33281, ♀, S-Euböa, bei Kasystos; NMW 33282, ♂, Pilon bei Lefkos; NMW 33283, ♀, West-Peloponnes, Killine Berg; NMW 33284, ♀, Pt. Teresa, Costa Smeralda, Sardinien; NMW 33289, ♂, Steinbruch bei Thessaloniki; NMW 33290, ♀, Steinbruch bei Thessaloniki; NMW 34234, ♂, Tripoli; NMW 34236, ♂, Barabisa, Sardinien; NMW 34238, ♀, Kosmas; NMW 34246, ♀, Plaka (= N Peloponnes); NMW 34247, ♀, Barabisa, Sardinien; NMW 34258, ♀, Tripoli; NMW 35442, ♀, Saloniki; NMW 35596, ♀, Tripoli; NMW 35599, ♀, Sardinien.

*Testudo weissingeri*: MNHN 1989-3317, ♂, Proastio or Neohori, Peloponnes; MNHN 1989-3318, ♂, Proastio or Neohori, Peloponnes; MNHN 1992-5285 (paratype), ♂, Proastio, Messenie, Peloponnes; MNHN 1992-5286, ♂, Neo Itilo, Laconie, Peloponnes (Vallon nord); MNHN 1994-4386, ♀, Leonidion, Arcadie, Peloponnes; MNHN 1995-2004, ♀, Proastio or Neohori, Peloponnes; MNHN 1995-2945, ♀, Proastio or Neohori, Peloponnes; MNHN 1995-9601, ♀, Proastio or Neohori, Peloponnes; MTKD D 40049, ♂, Peloponnes, Kardamyli; MTKD D 40517, ♂, Peloponnes, Mani-Halbinsel; MTKD D 40047, ♂, Peloponnes, Kardamyli; MTKD D 40518, ♀, Peloponnes, Mani-Halbinsel; NMW 33193:1, ♂, Griechenland; NMW 33193:10, ♀, N. Oplio; NMW 33193:2-3, ♂♂, Griechenland; NMW 33193:4, ♀, Griechenland; NMW 33193:5, ♂, Griechenland; NMW 33193:6, ♀, Griechenland; NMW 33193:9, ♂, Kardamyli; NMW 34235, ♀, Proastion-Exochorion, Peloponnes; NMW 34239, ♂, Otilio (Itilio); NMW 34248, ♀, Nikkon; NMW 34280, ♂, Proastion; NMW 34377, ♀, Otilio (Itilio); NMW 35488, ♀, Proastio; NMW 36077, ♀, Stonpa, Mani; RB 1, ♂, Proastio, Messenie, Peloponnes; RB 5, ♂, Agios Nikolaos.

A thigh-spur is defined here (for the purposes of this study) as an enlarged epidermal, horny, non-elastic, and normally conical tubercle, located on the upper thigh region - as opposed to an aggregate of spurs as found in *Testudo (Agrionemys) horsfieldii* GRAY, 1844. However, the conical shape is frequently being lost (apparently) because of mechanical abrasion. Therefore, the non-elasticity is a more reliable characteristics to identify a spur than merely the shape. A typical thigh-spur as found in several *Testudo* (s. l.) taxa is depicted, e.g., in NIKOLSKIJ (1915) and in WERNER (1985).

The presence or absence and number of thigh-spurs were catalogued with respect to species, sex, and both thighs for every examined specimen. These categorical variables were analysed for association (non-independence) using Chi-square ( $\chi^2$ ) tests with the significance level set at  $\alpha = 0.05$ .

## RESULTS

In *T. marginata*, spurs were present in 15 examined specimens (7 ♂♂; 8 ♀♀) (35.7% of examined specimens), and absent in 27 specimens (12 ♂♂; 15 ♀♀). Two specimens in this sample (a male and a female from Akrokorinth; NMW 30071:1-2) had a spur on one thigh only. Three additional specimens (NMW 33281, NMW 33194:1-2) showed a condition of having conspicuously enlarged single scales on both thighs ("semi-spurs"). These tubercles were however elastic ("leathery"), and were not considered to represent spurs as defined in Materials and Methods.

The traditionally accepted view that there are typically no spurs present in *T. marginata* can be confidently rejected, as spurs are very highly significantly more often present ( $\chi^2 = 18.261$ ,  $df = 1$ ,  $p < 0.0001$ ) than would be expected for a species which is supposed to lack spurs altogether. Additionally, there is no evidence to support a hypothesis that the character state "spurs absent" – even if it were not necessarily the standard – would be found significantly more often than the state "spurs present" ( $\chi^2 = 1.750$ ,  $df = 1$ ,  $p = 0.186$ ). Additionally in this taxon, spurs are not significantly more often present in one sex or the other ( $\chi^2 = 0.019$ ,  $df = 1$ ,  $p = 0.890$ ).

As for *T. weissingeri*, the situation looks identical to that of *T. marginata*. Spurs were present in 13 examined specimens (5 ♂♂; 8 ♀♀) (44.8%) and absent in 16 examined individuals (11 ♂♂; 5 ♀♀). This is very

highly significantly more than would be expected for a species lacking spurs as a general rule ( $\chi^2 = 16.756$ ,  $df = 1$ ,  $p < 0.0001$ ). There is no statistically significant difference between the condition of lacking or having spurs in *T. weissingeri* ( $\chi^2 = 1.556$ ,  $df = 1$ ,  $p = 0.212$ ). Five of the examined *weissingeri* specimens (3 ♀♀ and 2 ♂♂) had a spur on one thigh only (NMW 36077; MNHN 1995-2004; MNHN 1995-9601; MTKD 40049; RB 5), whereas one specimen (NMW 33193:2) had two double spurs (2 + 2 spurs), and one specimen (NMW 35488) had two on one thigh but only one on the other (2 + 1 spurs). Finally, there is no statistically significant difference with respect to the lack or presence of thigh-spurs between the sexes in *Testudo weissingeri* ( $\chi^2 = 2.660$ ,  $df = 1$ ,  $p = 0.103$ ). Two examined *T. weissingeri* specimens (NMW 34377, MTKD D 40517) had aggregates of enlarged and elevated tubercles on the upper thigh region, as found in many specimens of *T. (A.) horsfieldii* and some *T. hermanni* GMELIN, 1789. These aggregates were not taken to represent thigh-spurs in the sense as defined in Materials and Methods.

In a comparison between *T. marginata* and *T. weissingeri*, there is no significant difference between the occurrence of spurs between the species ( $\chi^2 = 0.597$ ,  $df = 1$ ,  $p = 0.440$ ), or, between males or females of both taxa (males:  $\chi^2 = 0.121$ ,  $df = 1$ ,  $p = 0.728$ ; females:  $\chi^2 = 2.408$ ,  $df = 1$ ,  $p = 0.121$ ).

## DISCUSSION

The results suggest that thigh-spurs are much more frequent in both investigated species than could be expected with respect to previously published accounts (ERNST & BARBOUR 1989; BOUR 1995). It is possible that in earlier investigations specimens have not been examined especially for the presence of spurs, and that many individuals showing this character state, or specimens which have had spurs worn by abrasion, have gone unnoticed. Also, spurs found in most but not all *T. marginata* and *T. weissingeri* are not as profound or massive as

seems to be generally the trend in specimens representing taxa currently classified as subspecies of *T. graeca*, though this speculative statement should be taken with caution and verified empirically.

Whereas the material examined is adequate enough to make the inferences described above in the 'Results', local (geographically restricted) sample sizes are however so relatively small that there is still a degree of uncertainty with respect to whether the frequencies of having or lacking thigh-spurs are geographically linked,

although this does not seem to be the case in either *T. marginata* or in *T. weissingeri*. Geographic localities or neighbouring areas with two or more examined specimens from each, from most parts of the species' distributions inclusive of Sardinia for *T. marginata*, tend to show a mix of animals with and without spurs, but the subsamples are too small to verify the constancy of this trend.

In conclusion, the results from this study do not support the wide-spread view that *T. marginata* or *T. weissingeri* would be typically spurless species, and that this char-

acter could be reliably used to distinguish or characterise these taxa (among other characters), as already hinted by BOUR (1995). In other words, both species should be seen as taxa showing a high degree of variation with respect to the presence or absence of thigh-spurs, and the one or the other condition as such should not be favoured as a taxonomic character in conjunction with either species, whereas on the other hand, the regularity of this variability (relatively stable dichotomy) could itself prove to be a useful character for phylogenetic reconstructions.

#### ACKNOWLEDGEMENTS

I thank the curators and staff at museums in Dresden, Paris and Vienna for their hospitality. I would individually like to thank R. BOUR (MNHN) for letting me inspect his living animals, and for his contagious enthusiasm. F. TIEDEMANN and R. GEMEL (NMW) receive my warmest thanks for their kind assistance and great patience during my long stays in Vienna. R.

GEMEL gave additionally relevant and constructive feedback on an earlier draft of this article. This research was supported by the Linnaeus Fund Award (Chelonian Research Foundation, Lunenburg, MA, USA), the Parsyst Programme (MNHN), the JPVs Memorial Fund (Töölö, Finland) and, a SOPTOM (Gonfaron, France) grant for 2000/2001.

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DATE OF SUBMISSION: February 1st, 2001

Corresponding editor: Richard Gemel

AUTHOR: BSc (Hons) Jarmo PERÄLÄ, School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, United Kingdom [e-mail: J.Perala@bristol.ac.uk].

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Autor(en)/Author(s): Perälä Jarmo

Artikel/Article: [Occurrence and taxonomic significance of thigh-spurs in \*Testudo marginata\* SCHOEPFF, 1792 and \*Testudo weissingeri\* BOUR, 1995 123-126](#)