

Mice of the Genus *Apodemus* in Jordan

MOHAMMAD A. ABU BAKER^{1, 2} & ZUHAIR S. AMR¹

¹ Department of Biology, Jordan University of Science and Technology, P.O. Box 3030, Irbid 22110, Jordan
amrz(at)just.edu.jo

² Department of Biological Sciences, University of Illinois at Chicago, 845, West Taylor St., Chicago, Illinois 60607, USA
mabuba2(at)uic.edu

Received on November 21, 2007, accepted on December 11, 2007.

Published online at www.vertebrate-zoology.de on May 12, 2008.

> Abstract

The present study provides additional data on the distribution of two species of the genus *Apodemus* in Jordan, the Eastern Broad-toothed Field Mouse, *A. mystacinus* and the newly recorded Yellow-necked Field Mouse, *A. flavicollis* and contributes to the taxonomy of the genus in Jordan. Distribution ranges with notes on habitat preference are provided for both species. Comparative external and cranial measurements as well as skull illustrations for both *Apodemus flavicollis* and *A. mystacinus* are provided. The status of *A. "hermonensis"* is briefly revised.

> Zusammenfassung

Die vorliegende Arbeit unterbreitet zusätzliche Daten über die Verbreitung von zwei Arten der Gattung *Apodemus* in Jordanien, *A. mystacinus* und der neu nachgewiesenen *A. flavicollis*, sowie zur Taxonomie der Gattung in Jordanien. Die Verbreitungsgrenzen und Bemerkungen zu den Habitatpräferenzen werden mitgeteilt. Von beiden Arten, *Apodemus flavicollis* und *A. mystacinus*, werden sowohl vergleichende Skelett- und Schädelmaße als auch Schädelabbildungen vorgestellt. Der Status von *A. "hermonensis"* wird revidiert.

> Key words

Apodemus flavicollis, *A. mystacinus*, Jordan, Rodentia, Muridae.

Introduction

Members of the Genus *Apodemus* KAUP, 1829, are well spread in the temperate woodlands and fields of the Palaearctic region. The systematics, evolutionary history and taxonomy of the genus have been extensively studied throughout most of its range (MUSSEY & CARLETON, 2005).

In Jordan, the genus is represented by two species, namely *A. mystacinus* and *A. hermonensis* (reported as *A. witherbyi* by MUSSEY & CARLETON, 2005). The latter species has been only recently recorded from Ajlun Mountain, northern Jordan, relying on the biometrical analysis of two subadult female specimens (BENDA & SADLOVA, 1999). *Apodemus mystacinus* has been reported from several localities within the forested eastern mountains, including Dibbin, Ajlun, Salt, Dana and Zubyia (ATALLAH, 1978; HARRISON & BATES, 1991; AMR & DISI, 1988; QUMSIYEH, 1996; AMR, 2000; YOUSEF & AMR, 2005). All these habitats enjoy

rich oak-dominated forests. BENDA & SADLOVA (1999) collected specimens of this species from Ajlun Mountain.

Here, we confirm the occurrence of the Yellow-necked Field Mouse, *Apodemus flavicollis* through morphological and cranial studies of specimens collected from northern Jordan. Skull, dental illustrations and craniometric measurements for *A. flavicollis* and *A. mystacinus* are presented.

Materials and methods

Specimens were collected from the northern Mediterranean region of Jordan from three locations (Fig. 1): Kufir Khall area (32° 22' N 35° 53' E), Dibbin Nature Reserve (32° 15' N 35° 50' E) and Birqish forests (32° 26' N 35° 44' E). These areas are dominated by

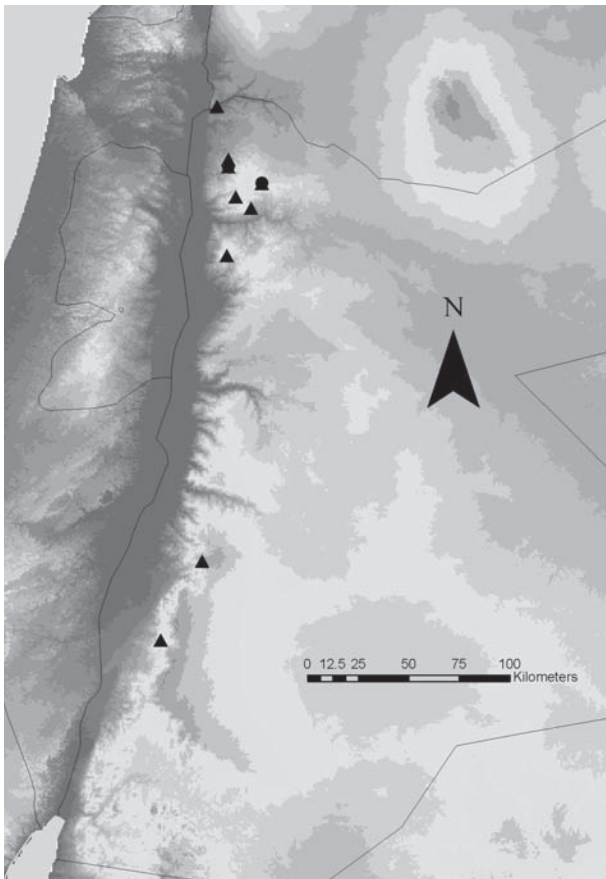


Fig. 1. Distribution of *Apodemus flavicollis* (■) and *Apodemus mystacinus* (▲) in Jordan.

oak (*Quercus calliprinos*, *Qu. ithaburensis*) and pistachio trees (*Pistacia palaestina*). Altitude ranges from 600 to 1000m a.s.l., annual rainfall reaches 600mm and *terra rosa* is the dominant soil type.

Animals were live-trapped using Sherman traps (23×9×7.5 cm) baited with oatmeal and peanut butter. Specimens were identified using external and cranial features and measurements. Four external measurements: Head-body length (HB), Total length (TL), Tail length (T), Hind foot length (HF) and Ear length (E). As well as fifteen cranial measurements: Greatest skull length (GSL), Condylbasal length (CBL), Basal length (BL), Braincase breadth (BB), Interorbital constriction (IC), Zygomatic breadth (ZB), Diastema length (DL), Maxillary tooth row length (MXT), Anterior palatal foramen (APF), Posterior palatal foramen (PPF), Tympanic bullae length (TBL), Tympanic bullae width (TBW), Mandibular diastema (MD), Mandible length (M) and Mandibular tooth row length (MDT), and body weight (Wt) were measured.

Cranial measurements were taken by a dial caliper (to the nearest 0.01 mm) and drawings of skulls and dentition were done under a dissecting microscope using a camera lucida. Morphological identification was based mainly on cranial and dental characters given by FILIPPUCCI *et al.* (1996)

Results

Between 1999 and 2004, a total of 88 specimens belonging to the genus *Apodemus* were collected from the study areas. 19 specimens were identified as *Apodemus flavicollis* and 69 as *A. mystacinus*. Measurements were taken for only adult specimens. All specimens were deposited at the Field Museum of Natural History (FMNH) in Chicago, USA.

Apodemus flavicollis (Melchior, 1834) Yellow-necked Field Mouse

FMNH 179099, 27 NOV 1999, m, sno, Kufr Khall; FMNH 179100, 1 DEC 1999, m, ssl, Kufr Khall; FMNH 179101, 31 MAR 2003, f, ssl, Kufr Khall; FMNH 179083, 25 APR 2004, f, ssk, Kufr Khall; FMNH 179084, 25 APR 2004, f, ssk, Kufr Khall; FMNH 179085, 25 APR 2004, f, ssk, Kufr Khall; FMNH 179086, 25 APR 2004, f, ssk, Kufr Khall; FMNH 179087, 25 APR 2004, f, ssk, Kufr Khall; FMNH 179088, 25 APR 2004, m, ssk, Kufr Khall; FMNH 179089, 2 MAY 2004, f, ssk, Kufr Khall; FMNH 179090, 2 MAY 2004, f, ssk, Kufr Khall; FMNH 179091, 2 MAY 2004, f, ssk, Kufr Khall; FMNH 179092, 2 MAY 2004, m, ssk, Kufr Khall; FMNH 179093, 2 MAY 2004, f, ssk, Kufr Khall; FMNH 179094, 2 MAY 2004, m, ssk, Kufr Khall; FMNH 179095, 2 MAY 2004, m, ssk, Kufr Khall; FMNH 179096, 2 MAY 2004, f, ssk, Kufr Khall; FMNH 179097, 13 JUN 2004, m, alc, Berqish; FMNH 179098, 13 JUN 2004, f, alc, Berqish. (m: male; f: female; sno. skin only, ssl. skull only, ssk. skin and skull, alc. specimen preserved in alcohol).

This species is relatively small in size, with head-body length between 89 and 106 mm and skull length of 25–27mm in adult specimens (Table 2). The skull and cheek-teeth are very similar in structure but smaller than those of *A. mystacinus* (Fig. 2); collected specimens exhibited a large tympanic bulla, ranging between 4.81 and 5.3mm (Table 2, Fig 5). Anterior palatal foramina are long 4.33–5.4mm (Table 2), APF exceeded the posterior line connecting the anterior margins of the M_1 alveoli in 8 specimens and was exactly on the line in 7 specimens. Posterior margin of the palatine and its passages into the medial pterygoid plates is rounded and narrow. The connecting ridges between the anterior and second cusp row on M_1 are missing in all specimens (see Fig. 2).

Dorsal fur coloration is pale buffy-brown to fulvous yellowish brown (Fig. 3), Hair basis is grey. Ventral colour is white with an orange fulvous to yellowish brown small spot on the neck. Chest spots varied in size; however no specimen showed a complete collar (Fig. 3). Young and immature specimens exhibit light yellow spot around the throat. Hind foot length aver-

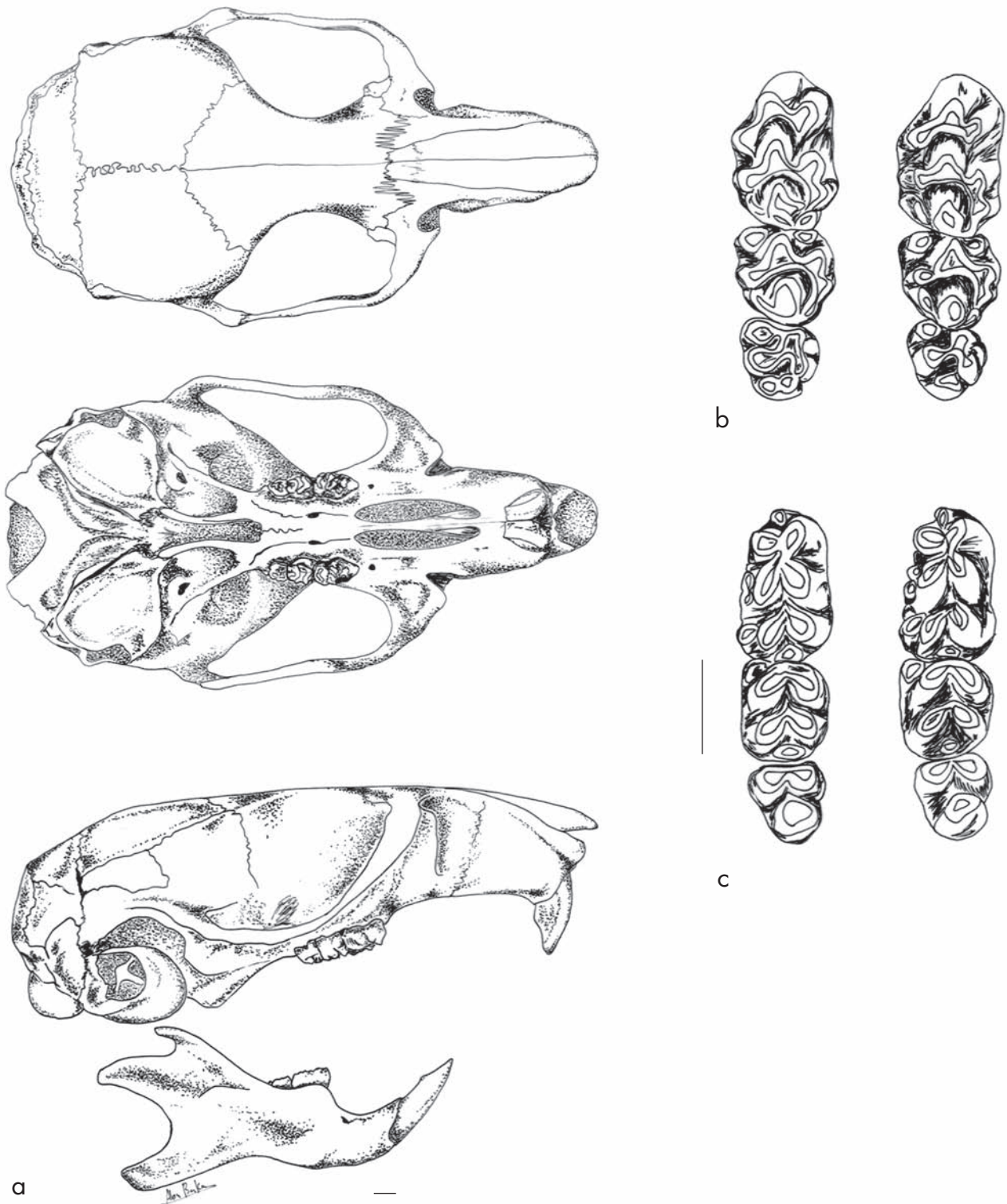


Fig. 2. a. Dorsal, ventral and lateral views of a skull and a lower jaw of *Apodemus flavicollis* from Jordan (specimen no. FMNH17 9101), b. maxillary and c. mandibular tooth row. Scale bar 1mm.

aged 22.8mm. Tail is longer than head and body length in ten specimens (same length or absent in the rest of the specimens).

A. flavicollis was trapped around Jarash and Berqish areas in some disconnected forest patches consisting of *Quercus calliprinos*, *Pistacia palaestina*, *Poterium*

spinosum and *Cistus* sp. It was found to coexist with *A. mystacinus* at higher altitudes, where tree-cover is less thicker. Its burrows were identified on open soils, under bushes of *Cistus* sp. or rocks. Juveniles were collected in May.



Fig. 3. *Apodemus flavicollis* collected from Bergish area, north of Jordan. On upper right side showing variation in size of pectoral spot.

***Apodemus mystacinus* (Danford & Alston, 1877) Eastern Broad-toothed Field Mouse**

FMNH 179147, 27 NOV 1999, m, ssl, Kufr Khall; FMNH 179148, 27 NOV 1999, f, ssl, Kufr Khall; FMNH 179149, 1 DEC 1999, f, ssl, Kufr Khall; FMNH 179150, 1 DEC 1999, f, ssl, Kufr Khall; FMNH 179151, 1 DEC 1999, m, ssl, Kufr Khall; FMNH 179152, 1 DEC 1999, m, ssl, Kufr Khall; FMNH 179153, 2 APR 2001, m, ssl, Hemmah, Yarmouk river bank; FMNH 179154, 18 OCT 2003, f, ssl, Zubya; FMNH 179155, 18 OCT 2003, f, ssl, Zubya; FMNH 179156, 18 OCT 2003, f, ssl, Zubya; FMNH 179157, 18 OCT 2003, f, ssl, Zubya; FMNH 179158, 18 OCT 2003, m, ssl, Zubya; FMNH 179159, 18 OCT 2003, m, ssl, Zubya; FMNH 179160, 18 OCT 2003, f, ssl, Zubya; FMNH 179161, 18 OCT 2003, m, ssl, Zubya; FMNH 179162, 18 JUN 2003, f, slo, Dibbin Nature Reserve; FMNH 179163, 18 JUN 2003, f, ssl, Dibbin Nature Reserve; FMNH 179164, 18 JUN 2003, m, ssl, Dibbin Nature Reserve; FMNH 179165, 18 JUN 2003, f, slo, Dibbin Nature Reserve; FMNH 179166, 18 JUN 2003, m, ssl, Dibbin Nature Reserve; FMNH 179167, 18 JUN 2003, m, ssl, Dibbin Nature Reserve; FMNH 179168, 18 JUN 2003, f, ssl, Dibbin Nature Reserve; FMNH 179169, 18 JUN 2003, f, ssl, Dibbin Nature Reserve; FMNH 179170, 2 APR 2001, m, ssl, Hemmah, Yarmouk river bank; FMNH 179171, 13 MAR 2003, f, ssl, Kufr Khall; FMNH 179172, 13 MAR 2003, f, slo, Kufr Khall; FMNH 179103, 25 MAR 2004, m, ssk, Berqish; FMNH 179104, 25 MAR 2004, f, ssl, Berqish; FMNH 179105, 25 MAR 2004, m, ssk, Berqish; FMNH 179106, 25 MAR 2004, f, ssl, Berqish; FMNH 179107, 25 MAR 2004, m, ssl, Berqish; FMNH 179108, 25 MAR 2004,

m, ssk, Berqish; FMNH 179109, 25 MAR 2004, m, slo, Berqish; FMNH 179110, 26 MAR 2004, f, ssk, Berqish; FMNH 179111, 26 MAR 2004, f, ssk, Berqish; FMNH 179112, 26 MAR 2004, m, ssk, Berqish; FMNH 179113, 2 MAY 2004, m, ssk, Kufr Khall; FMNH 179114, 2 MAY 2004, f, ssk, Kufr Khall; FMNH 179115, 2 MAY 2004, m, ssk, Kufr Khall; FMNH 179116, 2 MAY 2004, m, ssk, Kufr Khall; FMNH 179117, 25 MAR 2004, f, ssk, Berqish; FMNH 179118, 25 MAR 2004, f, ssk, Berqish; FMNH 179119, 25 MAR 2004, f, ssk, Berqish; FMNH 179120, 25 MAR 2004, f, ssk, Berqish; FMNH 179121, 25 MAR 2004, m, ssk, Berqish; FMNH 179122, 25 MAR 2004, f, ssk, Berqish; FMNH 179123, 25 MAR 2004, f, alc, Berqish; FMNH 179124, 31 MAR 2003, m, alc, Kufr Khall; FMNH 179125, 31 MAR 2003, m, alc, Kufr Khall; FMNH 179126, 31 MAR 2003, m, alc, Kufr Khall; FMNH 179127, 31 MAR 2003, f, alc, Kufr Khall; FMNH 179128, 13 JUN 2004, m, alc, Berqish; FMNH 179129, 13 JUN 2004, m, alc, Berqish; FMNH 179130, 13 JUN 2004, f, alc, Berqish; FMNH 179131, 13 JUN 2004, f, alc, Berqish; FMNH 179132, 13 JUN 2004, m, alc, Berqish; FMNH 179133, 13 JUN 2004, f, alc, Berqish; FMNH 179134, 13 JUN 2004, f, alc, Berqish; FMNH 179135, 13 JUN 2004, m, alc, Berqish; FMNH 179136, 13 JUN 2004, f, alc, Berqish; FMNH 179137, 13 JUN 2004, m, alc, Berqish; FMNH 179138, 13 JUN 2004, f, alc, Berqish; FMNH 179139, 13 JUN 2004, m, alc, Berqish; FMNH 179140, 13 JUN 2004, m, alc, Berqish; FMNH 179141, 13 JUN 2004, f, alc, Berqish; FMNH 179142, 15 JUN 2004, m, alc, Dibbin Nature Reserve; FMNH 179143, 15 JUN 2004, f, alc, Dibbin Nature Reserve; FMNH 179144, 15 JUN 2004, f, alc, Dibbin Nature Reserve; FMNH 179145, 15 JUN 2004, m, alc, Dibbin Nature Reserve; FMNH 179146, 15 JUN 2004, f, alc, Dibbin Nature Reserve. (m: male; f: female; sno. skin only, ssl. skull only, ssk. skin and skull, alc. specimen preserved in alcohol).

Tab. 1. Body and cranial measurements for specimens of *A. mystacinus* from Jordan (measurements in mm).

	average	STDV	min	max	number
TL	224.60	14.23	200	259	47
HB	106.43	7.36	92	121	51
T	117.52	9.38	103	139	48
HF	25.20	1.02	23	27	51
E	18.27	1.77	14	20	51
WT	30.80	5.56	21	45	51
GSL	30.27	0.98	28.2	32.2	26
CBL	29.45	1.07	27.13	31.7	26
BL	24.99	0.99	22.92	27.4	26
BB	13.38	1.11	12.6	18.6	26
IC	4.58	0.16	4.3	5	28
ZB	15.09	0.66	13.9	16.7	25
DL	7.92	1.03	6.8	12.6	27
MXT	4.68	0.16	4.33	5	28
APF	6.06	0.32	5.3	6.62	28
PPF	0.65	0.11	0.4	1	28
TBL	5.03	0.24	4.42	5.5	28
TBW	4.27	0.33	3.7	4.9	27
MD	3.72	0.24	3.2	4.29	27
M	15.47	0.77	14	16.9	27
MDT	4.70	0.13	4.52	5	25

This species is readily distinguished from other members of the genus by its robust size. Head-body length exceeding 92 mm (Table 1). The tail is slightly long, totalling 103–139 mm. Dorsal fur colour is dark greyish with faint brownish tinges on the sides of older individuals. Ventral side is white, with no chest spot; the dorsal-ventral line of demarcation is distinctly sharp. Ears are large. The skull is larger than those of the other representatives of the genus (Fig. 4). Skull length exceeds 28mm (28.2–32.2). The anterior palatal foramen is wide open, while the tympanic bulla is moderately large (Fig. 4).

A. mystacinus occurs throughout the natural forests of the Mediterranean mountains of Jordan, extending from the Yarmouk River area southwards to the Dana Nature Reserve and Petra, south east of the Dead Sea. It was found to prefer dense humid oak forests with or without the presence of pistachio trees or pines. High numbers of *A. mystacinus* were collected in thick-covered wadis in Zubya and Berqish areas (both on the ground and on trees). Burrows of this species were found under small rocky boulders or under piles of rocks, empty oak acorns always marked their openings. Open nests were also seen inside caves. Females showing perforated vagina were collected in October, while sub-adults were collected in July.

Discussion

In the southern Asiatic coasts of the eastern Mediterranean, the genus is represented mainly by three species, namely *Apodemus flavicollis*, *A. witherbyi* and *A. mystacinus*. Except for the problematic *A. "hermonensis"*, the other three species fall into the subgenus *Sylvaemus* group (MUSSEY & CARLETON, 2005). MUSSEY & CARLETON (2005) excluded *A. sylvaticus* from the fauna of the Middle East and considered the three species (*A. flavicollis*, *A. mystacinus* and *A. witherbyi*) as the only members of the genus *Apodemus* in the area. Distinguishing individuals from sympatric populations of three species according to external features has been stated as difficult and challenging by many authors as they show close resemblance in their morphological characters (MICHAX et al., 2001). FILIPPUCCI et al. (1996) used morphological features of the skin, skull and dentition to prove the occurrence of five species in western Anatolia. They demonstrated the usefulness of using crown lengths of upper molars and bulla lengths in distinguishing populations from western Anatolia (FILIPPUCCI et al., 1996). Body size, dorsal coloration and skull length were used by HARRISON & BATES (1991) and QUMSIYEH (1996) to differentiate between three species of the genus that are known to coexist in the area (*A. sylvaticus*, *A. flavicollis* and *A. mystacinus*).

Many recent studies have focused on the systematic, phylogenetic and morphometric analysis of the genus throughout its range (e.g. FILIPPUCCI et al., 1996, 2002; KRYŠTUFEK & STOJANOVSKI, 1996; MUSSEY et al., 1996; ORLOV et al., 1996; MEZHHERIN, 1997; ZAGORODNYUK et al., 1997; CHELOMINA, 1998; MICHAX et al., 1998; 2002; 2004; BELLINIA et al., 1999; SERIZAWA et al., 2000; MACHOLÁN et al., 2001; VOHRALÍK et al., 2002; BARĚIOVÁ & MACHOLÁN, 2006). Despite that, questions on the phylogenetic relationships within the *Sylvaemus* group remain unresolved (BARĚIOVÁ & MACHOLÁN, 2006). Allozymic and biometric analyses of species of the genus *Apodemus* resulted in the description of a new species, *Apodemus hermonensis* from Mount Hermon in the upper Golan Heights (FILIPPUCCI et al., 1989). The authors considered the new species to be morphologically and genetically closely related to *A. flavicollis*, which it displaces on Mt Hermon. QUMSIYEH (1996) considered *A. hermonensis* as a younger synonym of *A. flavicollis*, he considered the degree of genetic differentiation as insufficient to distinguish two separate species. KRYŠTUFEK (2002) showed that *A. hermonensis* is predated by several names, of which *Apodemus sylvaticus iconicus* Heptner, 1948 may represent the oldest name. This name was later replaced by another possible senior synonym (*Mus sylvaticus witherbyi* Thomas, 1902 from Iran) as the oldest avail-

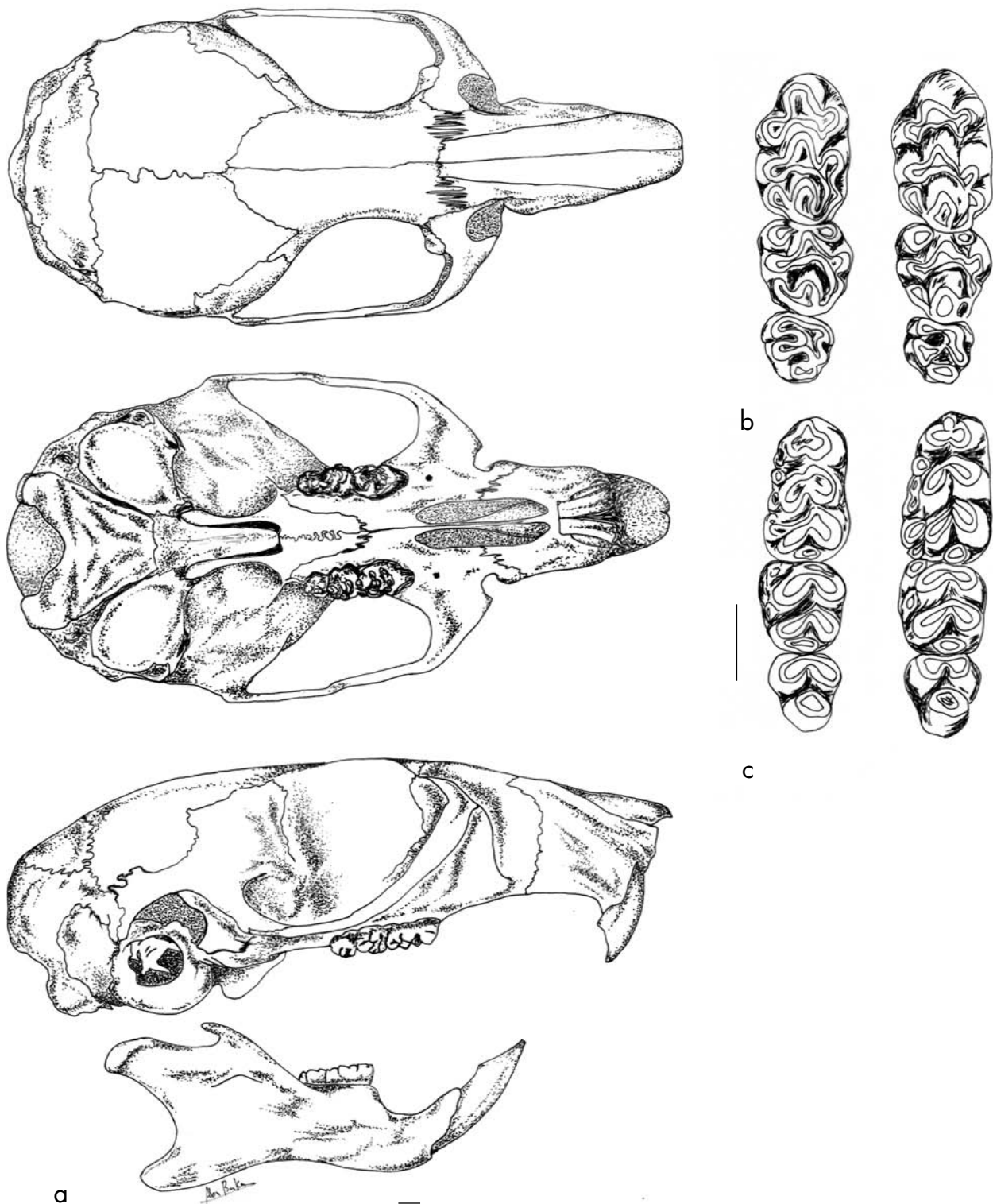


Fig. 4. a. Dorsal, ventral and lateral views of a skull and a lower jaw of *Apodemus mystacinus* from Jordan (specimen no. FMNH 179158), b. maxillary and c. mandibular tooth row. Scale bar 1mm.

able name for this species (KRYŠTUFEK & MOZETIČ FRANCKY, 2005). MUSSER & CARLETON (2005) considered *A. hermonensis* as a junior synonym of *Apodemus witherbyi* (THOMAS, 1902). KRYŠTUFEK & MOZETIČ FRANCKY (2005) are in support of the hypothesis that *A. sylvaticus* (LINNAEUS, 1758) is absent from the Asiatic coasts of the eastern Mediterranean, being repre-

sented instead by the newly described *A. hermonensis* FILIPPUCCI, SIMSON & NEVO, 1989.

Our findings of *A. flavicollis* represent the first record of this species from Jordan. The morphology of collected specimens compare well with previous reports from the Middle East and western Anatolia (HARRISON & BATES, 1991; FILIPPUCCI *et al.*, 1996). They are

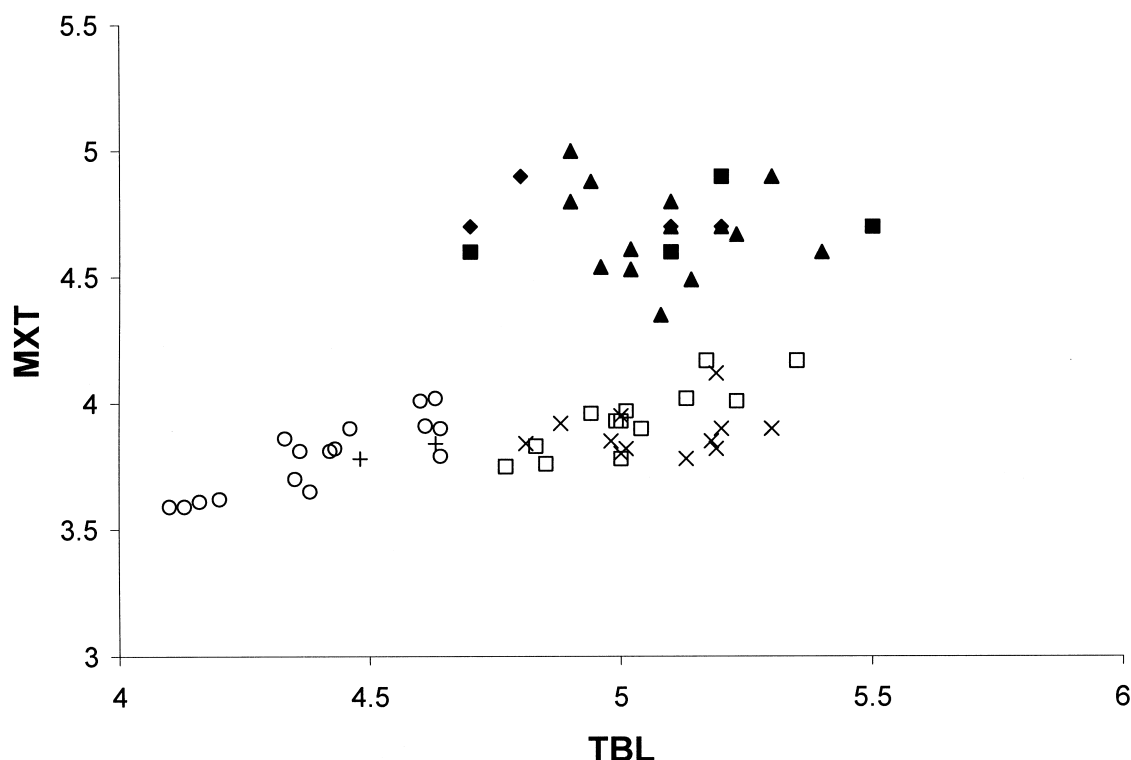


Fig. 5. Scattered diagram of cranial measurements (maxillary tooth-tow, MXT against tympanic bullae length, TBL) for populations of the genus *Apodemus* from Jordan compared with *A. hermonensis* (+) reported by BENDA and SADLOVA (1999), *A. hermonensis* (○) after FILIPPUCCI *et al.* (1996), *A. flavicollis* (□) after FILIPPUCCI *et al.* (1996). Specimens from Jordan also refer to: *A. mystacinus* collected from Kufr Khall (◆), Dibbin Nature Reserve (■) and Birqish (▲) and *A. flavicollis* collected from Kufr Khall and Birqish (x). Measurements in mm.

distinguished from *A. mystacinus* by both external characters and smaller cranial measurements and from *A. witherbyi* by their larger tympanic bulla (Fig. 5). In Europe *A. flavicollis* is characterized by a yellowish red complete collar, while in southern Europe and the Middle East it is reduced to a pectoral spot (FILIPPUCCI *et al.*, 1989). MENDELSSOHN & YOM-TOV (1999) stated that the throat spot of specimens classified as *A. flavicollis* is more similar to that shown by European *A. sylvaticus* than to the collar shaped spot reported for European *A. flavicollis*; as a consequence they suggested that these specimens should be referred to as *A. sylvaticus*.

External and cranial measurements of *A. flavicollis* specimens were found in agreement with those reported by FILIPPUCCI *et al.* (1996) for the same species (Fig. 2 and 5). For the same measurements, *A. hermonensis* specimens collected by BENDA & SADLOVA (1999) fits with those reported by FILIPPUCCI *et al.* (1996) for that species. Evidently, *A. flavicollis* from Jordan has larger measurements in all aspects than those reported for *A. hermonensis* by BENDA & SADLOVA (1999) and FILIPPUCCI *et al.* (1996), however, they lay within the same range for *A. flavicollis* collected elsewhere from Syria, Iraq and western Anatolia (HARRISON & BATES, 1991, FILIPPUCCI *et al.*, 1996), see Fig. 2, 5 and Table 2.

The records of *A. mystacinus* from the Dana Nature Reserve and Petra represent the actual southern distribution limit of the genus in Jordan (YOUSEF & AMR, 2005). In Jordan, this is the most common wood mouse in terms of distribution and abundance in a particular area.

Further investigations are needed to confirm the presence of the third species, *A. witherbyi*, in Jordan, since earlier records were based on cranial characters of only two subadult specimens. Additional specimens from Ajlun area should be collected and compared with *A. mystacinus* and *A. flavicollis* from surrounding populations. Additional material from Jordan should be included in future molecular studies especially in areas that represent its most southern range of distribution.

Acknowledgments

This work was funded in part by a grant from the Badia Research and Development Programme, Higher Council for Science and Technology, and the Field Museum of Natural History, Chicago, USA special thanks are extended to Dr. BRUCE PATTERSON. Support and encouragement by the Royal Society for the Conservation of Nature, Jordan is always appreciated.

References

- AMR, Z.S. & DISI, A.M. (1988): Jordanian Mammals Acquired by Jordan University Natural History Museum. – *Dirasat*, 32 pp.
- AMR, Z.S. (2000): Jordan Country Study on Biological Diversity, Mammals of Jordan. – United Nations Environment Programme, Amman, 116 pp.
- ATALLAH, S.I. (1978): Mammals of the eastern Mediterranean region: their ecology, systematics and zoogeographical relationships. – *Säugetierkundliche Mitteilungen*, 26: 1–50.
- BARĚIOVÁ, L. & MACHOLÁN, M. (2006): Morphometric study of two species of Wood Mice *Apodemus sylvaticus* and *A. flavicollis* (Rodentia: Muridae): traditional and geometric morphometric approach. – *Acta Theriologica*, 51(1): 15–27.
- BELLINIA, E., MUNCLINGER, P. & FLEGR, J. (1999): Application of the RAPD technique for a study of the phylogenetic relationships among eight species of the genus *Apodemus*. – *Folia Zoologica*, 48: 241–248.
- BENDA, P. & ŠADLOVÁ, J. (1999): New records of small mammals (Insectivora, hiroptera, Rodentia, Hyracoidea) from Jordan. – *Casopis Narodniho Muzea*, 166: 25–56.
- CHELOMINA, G.N. (1998): Molecular phylogeny of forest and field mice of the genus *Apodemus* (Muridae, Rodentia) based on the data on restriction analysis of total nuclear DNA. – *Genetika (Moscow)*, 34: 1286–1292 [In Russian with English summary].
- FILIPPUCCI, M.G., MACHOLÁN, M. & MICHAUX, J.R. (2002): Genetic variation and evolution in the genus *Apodemus* (Muridae: Rodentia). – *Biological Journal of the Linnean Society*, 75: 395–419.
- FILIPPUCCI, M.G., SIMSON, S. & NEVO, E. (1989): Evolutionary biology of the genus *Apodemus* Kaup, 1829 in Israel. Allozymic and biometric analyses with description of a new species: *Apodemus hermonensis* (Rodentia, Muridae). – *Bolletino di Zoologia*, 56: 361–376.
- FILIPPUCCI, M.G., STORCH, G. & MACHOLÁN, M. (1996): Taxonomy of the genus *Sylvaemus* in western Anatolia – morphological and electrophoretic evidence (Mammalia: Rodentia: Muridae). – *Senckenbergiana biologica*, 75: 1–14.
- HARRISON, D.L. & BATES, P.J. (1991): The Mammals of Arabia. – Harrison Zoological Museum Publication. Kent, England.
- KRYŠTUFEK, B. (2002): Identity of four *Apodemus* (*Sylvaemus*) types from the eastern Mediterranean and the Middle East. – *Mammalia*, 66: 43–51.
- KRYŠTUFEK, B. & MOZETIČ FRANCKY, B. (2005): Mt. Hermon field mouse *Apodemus iconicus* is a member of the European mammal fauna. – *Folia Zoologica*, 54(1–2): 69–74.
- KRYŠTUFEK, B. & STOJANOVSKI L. (1996): *Apodemus sylvaticus stankovici* is a synonym of *Apodemus flavicollis*. – *Folia Zoologica*, 45: 1–7.
- MACHOLÁN, M., FILIPPUCCI, M.G., BENDA, P., FRYNTA, D. & ŠADLOVÁ, J. (2001). Allozyme variation and systematics of the genus *Apodemus* (Muridae, Rodentia) in Asia Minor and Iran. – *Journal of Mammalogy*, 82: 799–813.
- MENDELSSOHN, H. & YOM-TOV, Y. (1999): Fauna Palaestina: Mammalia of Israel. – Israel Academy of Sciences and Humanities, Jerusalem.
- MEZHHERIN SV, 1997. Revision of mice genus *Apodemus* (Rodentia, Muridae) of Northern Eurasia. – *Vestnik Zoologii*, 31: 29–41. (In Russian, with English summary.)
- MICHAUX, J.R., LIBOIS, R., RAMALHINHO, M.G. & MAUROIS, C. (1998): On the mtDNA restriction patterns variation of the Iberian wood mouse (*Apodemus sylvaticus*): Comparison with other west Mediterranean populations. – *Hereditas*, 129: 187–194.
- MICHAUX, J.R., REYES, A. & CATZEFELIS, F. (2001): Evolutionary history of the most speciose mammals: molecular phylogeny of muroid rodents. – *Molecular Biology and Evolution*, 18: 2017–2031.
- MICHAUX, J.R., CHEVRET, P., FILIPPUCCI, M.G. & MACHOLAN, M. (2002): Phylogeny of the genus *Apodemus* with a special emphasis to the subgenus *Sylvaemus* using the nuclear IRBP gene and two mitochondrial markers: cytochrome b and 12s rRNA. – *Molecular Phylogenetics and Evolution*, 23: 123–136.
- MICHAUX, J.R., FILIPPUCCI, M.G. & LIBOIS, R. (2004): Phylogeographic history of the yellow-necked fieldmouse (*Apodemus flavicollis*) in Europe and in the Near and Middle East. – *Molecular Phylogenetics and Evolution*, 32: 188–198.
- MUSSER, G.G. & CARLETON, M.D. (2005): Superfamily Muroidea. Vol 2:894-1531, in: *Mammal Species of the World*, 3rd Edition (D. E. Wilson & D. M. Reeder, eds.). Johns Hopkins University Press, Baltimore, MD. 2 Volumes, 2141 pp.
- MUSSER, G.G., BROTHERS, E.M., CARLETON, M.D. & HUTTERER, R. (1996): Taxonomy and distributional records of Oriental and European *Apodemus*, with a review of the *Apodemus-Sylvaemus* problem. – *Bonner Zoologische Beiträge*, 46: 143–190.
- ORLOV VN, BULATOVA NS, NADJAFOVA RS, KOZLOVSKY AI, 1996. Evolutionary classification of European woodmice of the subgenus *Sylvaemus* based on allozyme and chromosome data. – *Bonner Zoologische Beiträge*, 46: 191–202.
- QUMSIYEH, M.B. (1996): Mammals of the Holy Land. Texas Tech. Univ. Press, Lubbock – USA.
- SERIZAWA, K., SUZUKI, H. & TSUCHIYA, K. (2000): A phylogenetic view on species radiation in *Apodemus* inferred from variation of nuclear and mitochondrial genes. – *Biochemical Genetics*, 38: 27–40.
- VOHRALIK, V., FRYNTA, D., MIKULOVA, P., BENDA, P. & NOVA, P. (2002): Multivariate morphometrics of *Apodemus mystacinus* in the Near east and its divergence from European *A. m. epimelas* (Mammalia: Rodentia). – *Israel Journal of Zoology*, 48: 135–148.
- YOUSEF, M.A. & AMR, Z.S. (2005): Altitudinal stratification and habitat selection of rodents in Dana Nature Reserve, Jordan. – *Zoology in the Middle East*, 35: 13–18.
- ZAGORODNYUK, I.V., BOYESKOROV, G.G. & ZYKOV, O.E. (1997): Variation and taxonomic status of the steppe forms of genus *Sylvaemus* “*sylvaticus*” (*falzfeini* – *fulvipectus* – *hermonensis* – *arianus*). – *Vestnik zoologii*, 31: 37–56. [In Russian with English abstract]

Tab. 2. Descriptive Statistics (range, mean, standard deviation and sample size) of external and cranial measurements of populations of *A. flavicollis* and *A. hermonensis* from the Middle East.

	Harrison and Bates 1991		Filippucci et al., 1989		Benda and Sadlova 1999		Filippucci et al., 1996		Filippucci et al., 1996		Present study	
	<i>(A. flavicollis)</i>		<i>(A. hermonensis)</i>		<i>(Apodemus sp.)</i>		<i>(A. hermonensis)</i>		<i>(A. flavicollis)</i>		<i>(A. flavicollis)</i>	
	Range (average)	N	Range (average)	N	Range (average)	N	Range (average)	N	Range (average)	N	Range (average)	N
TL	182-221 (199.6)	8									179-220 (197.75)	12
HB			77-93 (86)	11	85-88 (86.5)	3	76-103	52	77-107	57	89-106 (97.69)	13
T	94-123 (106.1)	8	81-99 (92)	7	92-93 (92.5)	3	83-115	52	85-120	57	89-116 (100.42)	12
HF	21-26 (22.9)	8	20.2-21.5 (20.7)	11	20.7-21.7 (21.2)	3	20-23.5	52	21-25	57	22-25 (22.82)	13
E	16-17 (16.9)	8	14.3-16.7 (15.3)	11	16.4-16.7 (16.57)	3					13-17 (15.72)	13
W			13.4-24.8 (18.6)	11	17-18 (17.5)	3					17-28 (23.54)	12
GSL	25.9-28.5 (27.3)	8			24.3-24.36 (24.33)	3					25-26.99 (26.21)	10
CBL	23.5-26.2 (24.9)	8	22.02-23.5 (22.89)	9	21.71-22.13 (21.92)	3	22.59-24.37 (23.07)	52	22.02-26.7 (23.77)	57	24.1-26.61 (25.73)	10
BB	11.7-12.6 (12.1)	8	11.3-12.04 (11.53)	8	11.37-11.43 (11.4)	3					11.17-12.19 (11.67)	12
IC	3.9-4.6 (4.2)	8	3.88-4.4 (4.1)	11	3.74-3.85 (3.79)	3					3.76-4.13 (4)	12
ZB	13-14.7 (14)	7	11.7-13.06 (12.6)	10	12.2-12.43 (12.32)	3					13-14.2 (13.56)	12
DL			6.14-7.18 (6.62)	11							5.95-7.03 (6.65)	12
APF			4.6-5.42 (4.91)	11			4.67-4.94 (4.82)	52	4.83-5.45 (5.08)	57	4.33-5.4 (4.85)	12
TBL							4.33-4.64 (4.37)	52	4.94-5.17 (5.01)	57	4.81-5.3 (5.07)	12
MXT	3.7-4.3 (4.1)	8	3.8-4.33 (4.11)	11	3.82-4.02 (3.92)	3	3.65-3.9 (3.8)	52	3.75-4.17 (3.96)	57	3.78-4.12 (3.88)	12
M	16.3-18.2 (17.2)	8			13.85-14.13 (13.99)	3					12.55-14.24 (13.45)	12
MDT	3.6-4.1 (3.9)	8	3.5-3.83 (3.71)	11	3.78-3.86 (3.83)	3					3.73-4.1 (3.93)	11