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NEW ACARID MITES OF THE GENUS *ACOTYLEDON* OUDEMANS (ACARI: ACARIDAE) FROM PAKISTAN

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Acarid mites exhibit very important concerns relating to deterioration in grains, which are integral part of our daily intake. They are responsible for postharvest losses in terms of quality and quantity of different grains and cereals which result in low nutritional value of food products. Genus *Acotyledon* Oudemans is reported as the most prevailing genus of acarid mites in storage structures. In this paper, two new species of the genus *Acotyledon* viz. *A. augokiensis* n.sp. and *A. haroonabadensis* n.sp., collected from *Triticum aestivum* L. (Poaceae) and *Oryza sativa* L. (Poaceae) are described here. A key to the species of the genus *Acotyledon* from Pakistan is also given.
Keywords: Acaridae, *haroonabadensis*, *augokiensis*, wheat, rice

INTRODUCTION

Mites are one of the most abundant and diversified group of arthropods which not only prevail in agro-ecosystem but also occupy storage structures and greenhouses (Bahrami *et al*., 2007). Family Acaridae got global attention due to its negative influence on stored grains as well as damaging different plant materials and acting as useful clues during forensic studies (Hughes, 1976). In Pakistan, farmers are unaware about the extent of damage caused by stored grain mites. They feed inside embryo of the grain and reduce grain quality by changing the proportion of nutrients inside it, which can also effect the germination of grain (Mahmood *et al*., 2013).

Stored grain mites have been reported all over the world comprising of almost 400 species of family acaridae (Collins, 2006; Darvishzadeh and Kamali, 2009; Haines, 1997; Hubert *et al*., 2004, 2006; Kucerova and Horak, 2004; Mahmood, 1992). From Pakistan, more than 70 species of family Acaridae have been recorded prevailing under storage structures (Ashfaq *et al*., 1985, 1986, 1999, 2000; Ashfaq and Chaudhri, 1983, 1984, 1986; Ashfaq and Sarwar, 1999, 2001; Ashfaq and Sher, 2002; Bashir *et al*., 2011, 2012; Sarwar *et al*., 1998; Sarwar and Ashfaq, 2002, 2004; Sher *et al*., 1991).

Genus *Acotyledon* Oudemans includes the most diversified members of family Acaridae. This genus was erected in 1903 by Oudemans with *A. paradoxa* as its type species. Later, number of acarologists made their contribution to the compilation of the genus *Acotyledon* and advocated its validity within family acaridae (Baker and Wharton, 1952; Eraky, 1999; Fain and Philips, 1978; Hughes, 1976; Klimov, 2000; Mahunka, 1973, 1974, 1978; Nesbitt, 1945; Rupes, 1967; Samsinak, 1957, 1966, 1968; Sevastianov and Rady, 1991; Womersley, 1955; Zachvatkin, 1941).

In this paper, two new species *A. augokiensis* n.sp. and *A. haroonabadensis* n.sp. are described and illustrated from this country. A key to the species of the genus *Acotyledon* from Pakistan is also given here.

MATERIALS AND METHODS

A comprehensive survey of different stored grains was carried out to explore the acarid mite from Punjab, Pakistan between the years 2011-2013. Different stored grains (wheat, rice, maize, gram) were sampled for mite collection. Grains were randomly sampled from grain markets and storage structures and each sample of 500 grams was sealed in plastic bags. The samples were brought to the laboratory and processed through Berlese's funnel. Acarid mites were sorted under a binocular microscope and permanent slides were prepared in Hoyer's medium. Illustrations were made with the help of an ocular grid by using a phase contrast microscope (MT4210H, Meiji Techno®, Japan). The mounted specimens were identified up to species level with the help of available literature and keys on this genus. Measurements of different body parts were done with the help of an ocular micrometer. All the measurements are given in micrometer.

RESULTS AND DISCUSSION

Key to species of the genus *Acotyledon oudemans* from Pakistan

1. Sternum 2 (*st2*) present ---------- 2
- Sternum 2 (*st2*) absent ---------- 16
2. Gnathosomal fused padipalpi not notched ---------- 3
- Gnathosomal fused padipalpi notched ---------- 10
3. Propodosomal shield dotted ----------4
- Propodosomal shield smooth ---------- 5
4. Metasternal seta (*mts*) present
----------***A. peshawariensis*** (Ashfaq *et al*., 1986)
- Metasternal seta (*mts*) absent
----------***A. falki*** (Ashfaq and Sher, 2002)
5. Apodeme 2 (*ap2*) meeting Apodeme 4 (*ap4*) ----------6
- Apodeme 2 (*ap2*) not meeting Apodeme 4 (*ap4*) ---------- 8
6. Metastrnal seta (*mts*) present
----------***A. wazirabadensis*** (Bashir *et al*., 2012)
- Metasternal seta (*mts*) absent ---------- 7
7. Genu III with 1 seta only
----------***A. lucarus*** (Ashfaq and Sarwar, 1999)
- Genu III with 2 seta only
----------***A. pytho*** (Ashfaq *et al*., 1986)
8. Dorsum with 3 pairs of visible pores
----------***A. dolichos*** (Ashfaq and Sarwar, 1999)
- Dorsum without 3 pairs of visible pores ---------- 9
9. Suctorial shield pointed posteriorly
---------- ***A. thysia*** (Ashfaq and Sarwar, 1999)
- Suctorial shield rounded posteriorly
---------- ***A. tariqi*** (Ashfaq *et al*., 1987)
10. Gnathosomal fused padipalpi not pear shaped --------- 11
- Gnathosomal fused padipalpi pear shaped ---------- 12
11. Propodosomal shield dotted; sternum 2 (*st2*) free anteriorly; coxal fields III and IV open
---------- ***A. infaustus*** (Ashfaq *et al*., 1986)
- Propodosomal shield smooth; sternum 2 (*st2*) meeting apodeme 4 (*ap4*); coxal fields III and IV closed
----------***A. thosmos*** (Ashfaq *et al*., 1986)
12. Coxal fields I-IV not all open ---------- 13
- Coxal fields I-IV all open ---------- 14
13. Coxal fields III and IV open
---------- ***A. ruditas*** (Ashfaq *et al*., 1986)
- Coxal fields III and IV closed
---------- ***A. hypeir*** (Ashfaq *et al*., 1986)
14. Seta *ve* present; tarsi III and IV each with 4 leaf-like setae
---------- ***A. stremma*** (Ashfaq *et al*., 1986)
- Seta *ve* absent; tarsi III and IV each with 3 leaf-like setae
----------15
15. Gnathosoma 2 segmented; sternum1 (*st1*) along with sharp tip ---------- ***A. distantis*** (Ashfaq *et al*., 1986)
- Gnathosoma 1 segmented; sternum1 (*st1*) short with blunt tip ---------- ***A. bellulus*** (Ashfaq and Sher, 2002)
16. *ω1* more than half the length of tarsi ----------17
- *ω1* less than half the length of tarsi ---------- 19
17. Dorsal setae long; setae d1 > d3; d1 = 32, d3= 49
----------***A. chakwaliensis*** (Honey *et al*., 2014)
- Dorsal setae short to medium in length; setae d1 < d3; both d1 & d3 less than 20 in length ----------18
18. Gnathosoma broad posteriorly; ap2 with swollen tip; ap3 not meeting ap4; *mG* on genu I and II measuring 12 and 11 respectively ---------- ***A. embio*** (Ashfaq *et al*., 1998)
- Gnathosoma notched posteriorly; ap2 with sharp narrow tip; ap3 meeting ap4; *mG* on genu I and II = 22 long
----------***A. haripuriensis*** (Ashfaq *et al*., 1987)
19. setae ve absent ----------20
- Setae ve present ----------21
20. Hysterosomal shield without dorso-lateral striations; ap2 not reaching to the anterior margin of ap4; coxal field III closed, dotted -------***A. kamokiensis*** (Bashir *et al*., 2012)
- Hysterosomal shield with strong dorso-lateral striations; ap2 reaching to the anterior margin of ap4; coxal field III open ----------***A. haroonabadensis*** **n.sp.**
21. Setae sci absent; gnathosoma elongate, I segmented
----------***A. ciceri*** (Honey *et al*., 2014)
- Setae sci present; gnathosoma broad, II segmented
----------***A. augokiensis*** **n.sp.**

1. *ACOTYLEDON AUGOKIENSIS* N.SP (Fig. 1: A-B)

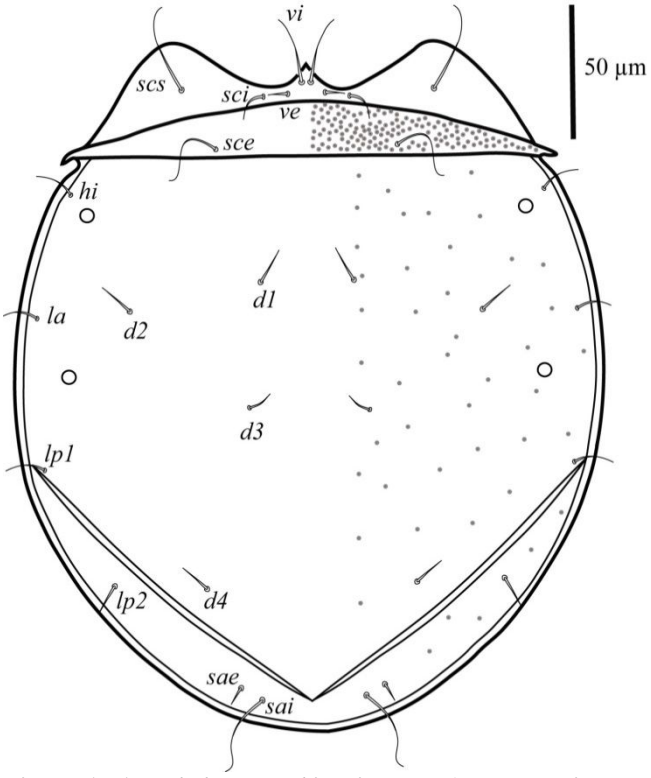

Figure 1. ***Acotyledon augokiensis*** **n.sp , A: Dorsal side**

Material examined**:** Holotype hypopus and three paratypes from *Triticum aestivum* L. (Poaceae) grains at grain market Augoki, Sialkot (Punjab province), 32.29° N, 74.27° E on 04th October, 2011. One paratype hypopus from *Oryza*

sativa L. (Poaceae) grains at govt. storage structures Narowal (Punjab province), 32.1° N, 74.88° E on 23rd September, 2012. All type specimens were deposited in Acarology Research Laboratory, Department of Entomology, University of Agriculture, Faisalabad, Punjab, Pakistan.

***Etymology*:** The species name is described on the basis of locality (Augoki) from where, this species was collected.

HYPOPUS

Dorsum (Fig. 1A).

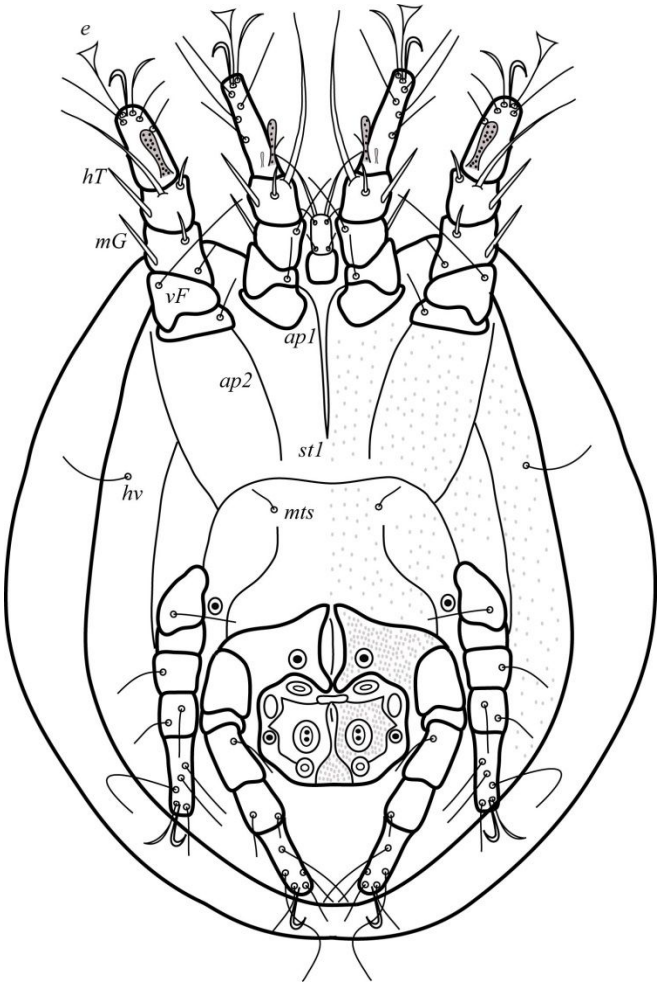

Figure 1. ***Acotyledon augokiensis*** **n.sp , B: Ventral side**

Body rounded, 255 long, 225 wide; divided into propodosomal and hysterosomal shields. Propodosomal shield 14 long, 181 wide provided with a small rostrum antero-medially**,** smooth; setae *vi*, *ve, sci*, *sce*, 12, 7, 15 and 27 long respectively, *sci-sci* 25, sce -sce 61 and *sci-sce* 22 apart. Setae *sci* and *sce* in semi-circular line. Hysterosomal shield 221 long, 215 wide, dotted; 2 pair visible pore. Setae simple, seta *d1*, *d2*, *d3*, *d4* on hysterosomal shield while seta *hi*, *la*, *lp1*, *lp2*, *sai* and *sae* located off the hysterosomal shield. Setae *d1* 12, *d2* 15, *d3* 10, *d4* 12, *hi* 12, *la* 12, *lp1*10, *lp2* 7, *sae* 7, *sai* 29 long; *d1-d1* 37, *d2-d2* 137, *d3 - d3* 47, *d4 - d4* 61, *d1-d2* 51, *d2- d3* 61 and *d3 - d4* 66 apart. Hysterosomal shield anterior margin overlapping propodosomal shield and overlapping area dotted.

Venter (Fig. 1B).

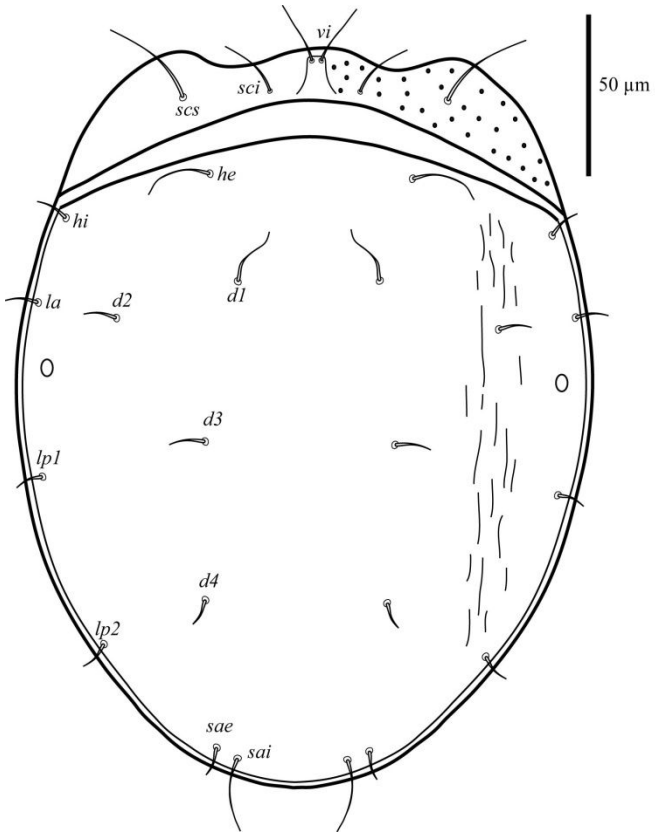

Figure 2. ***Acotyledon haroonabadensis*** **n.sp, A: Dorsal side**

Gnathosomal fused pedipalpi II segmented, 25 long, parallel laterally, rounded posteriorly, 1 pair arista, 37 long, 2 pairs small setae. Apodeme I (*ap* l) 10 long, V- shaped continuing with sternum I (*st* l). Sternum I (*st* l) free, pointed, 42 long. Apodeme 2 (*ap* 2) not meeting apodeme 4 (*ap* 4). Apodeme 3 (*ap* 3) meeting apodeme 4(*ap* 4). Apodeme 4 (*ap* 4) meeting medially making a semi-circular line. Sternum 2 (*st* 2) absent. Apodeme 5 (*ap* 5) converging medially not meeting apodeme 4 (*ap* 4). Metasternal seta (*mts*) 7. Coxal fields I, II, III and IV open and dotted. Area lateral to apodeme 3 (*ap* 3) and apodeme 4 (*ap* 4) dotted. Seta *hv* I pair 22 long. Genital shield dotted, genital slit elongated, genital suckers absent, I pair paragenital setae (*pr*) anterior to genital disc (*gdi3*) 7 long. Coxal discs *di1* and *di2* present. Suctorial shield concave antero-medially, rounded

posteriorly, 42 long, 49 wide, I pair anterior suckers, I pair anal suckers, 2 pairs each of lateral and posterior suckers.

Legs (Fig. 1B).

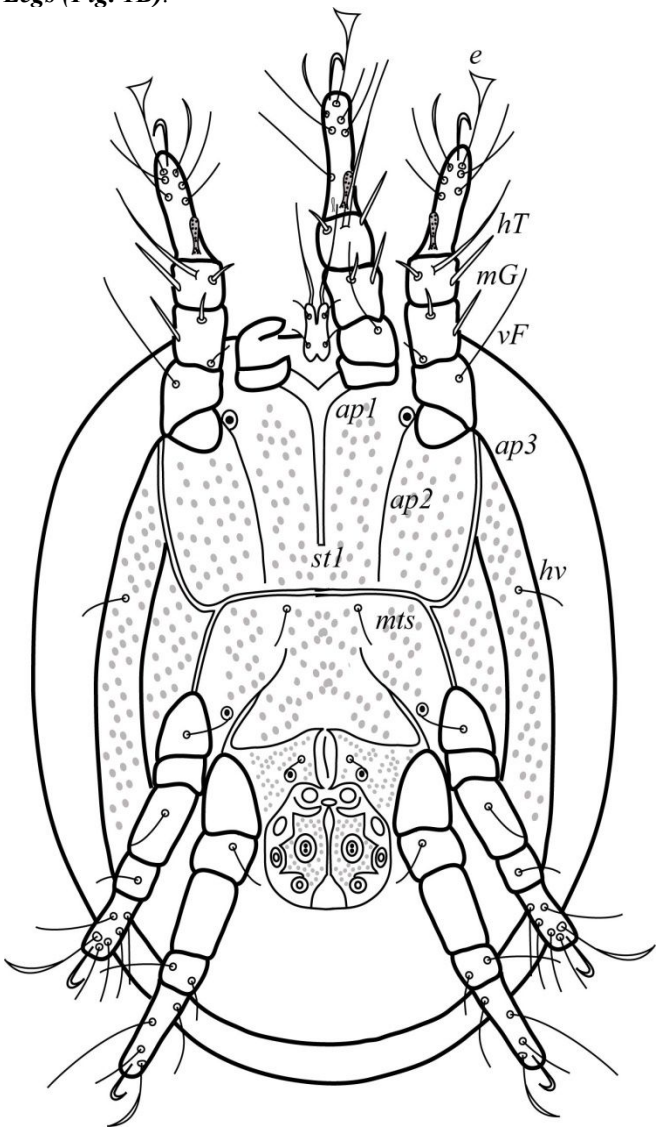

Figure 2. ***Acotyledon haroonabadensis*** **n.sp, B: Ventral side**

All of one type, I - IV measuring 93, 88, 83 and 88 in length respectively (Trochanter base to tarsus tip). Setae and solenidia on legs I - IV segments: Coxae 0-0-0-0, trochanters 0-1-1-0, femora 1-1-0-0, genua 2-3-1-1, tibiae 3-3-2-2, tarsi 7-5-5-5. Tarsi I-IV 37, 35, 36, 37 long, respectively. Seta *vF* on femora I and II 20, 44 long respectively, absent on femur III and IV. Seta *e* on tarsi I and II 25 long each, absent on femora III and IV. Seta *mG* on genua I and II 25 and 20 long, respectively, *hT* on tibiae I and II 25 and 22 long respectively. Solenidion ω on tarsi I and II 17 and 19 long, respectively. Setae φ on tibia I and II 66 and 47 long, respectively. Tarsi I-IV provided with I cup-shaped + 1 leaf-like + 3 lancet like; 1 cup shape + 1 leaf like + 2 lancetlike; 4 lancet like; 4 lancet-like setae, respectively.

Remarks:

This new species is very close to already known species *Acotyledon ciceri* (Honey *et al*., 2014) but can be differentiated on the basis of characters; new species exhibits II segmented gnathosoma (vs I segmented gnathosoma), setae Φ on tibia I & II measuring 66 and 47 respectively (vs 37 and 49), Overlapping area between propodosomal and hysterosomal shield dotted (vs smooth area), 2 pairs of pores (vs 3 pairs of pores), setae *sci* and *sce* present (vs both setae absent), *st1* with sharp tip (vs *st1* broad tip).

This new species can also be differentiated from *A. haripuriensis* Ashfaq *et al*. (1987) on the basis of characters; new species exhibits $\omega 1$ short, less than half the length of tarsi (vs $\omega 1$ long, extending beyond half length of tarsi), gnathosoma entire anteriorly (vs gnathosoma bifid anteriorly), hysterosomal shield dotted (vs hysterosomal shield with strong striations dors-o-laterally), *st1* with sharp tip (vs *st1* with lancet like tip).

Detailed measurements of different body characters in µm between *Acotyledon augokiensis* n.sp., *A. ciceri* (Honey *et al*., 2014) and *A. haripuriensis* (Ashfaq *et al.,* 1987) are given in Table 1.

2. ***ACOTYLEDON HAROONABADENSIS*** **N.SP. (Fig 2: A-B)**

Material examined**:** Holotype hypopus and four paratypes from *Triticum aestivum* L. (Poaceae) at govt. storage structures Haroonabad, Bahawalpur (Punjab province), 29.61° N, 73.12° E on 18th March, 2012. All type specimens were deposited in Acarology Research Laboratory, Department of Entomology, University of Agriculture, Faisalabad, Punjab, Pakistan.

Etymology**:** The species name is described on the basis of locality Haroonabad (Bahawalpur) from which this species was collected.

HYPOPUS

Dorsum (Fig. 2A).

Body elongated, 265 long, 206 wide; divided into propodosomal and hysterosomal shields. Propodosomal shield 17 long, 171 wide provided with a small rostrum antero-medially**,** dotted; setae *vi*, *sci*, *scs*, 25, 22 and 37 long respectively, seta *ve* and *scs* absent, *sci-sci* 32, *scs - scs* 98 and *sci-scs* 29 apart. Setae *sci* and *scs* in semi-circular line. Hysterosomal shield 240 long, 195 wide, smooth; 1 pair visible pore. Setae simple, seta *he*, *d1*, *d2*, *d3*, *d4* on hysterosomal shield while seta *hi*, *la*, *lp1*, *lp2*, *sai* and *sae* located off the hysterosomal shield. Setae *d1* 22, *d2* 12, *d3* 12, *d4* 10, *hi* 10, *he* 20, *la* 10*, lp1* 7, *lp2* 10, *sae* 10, *sai* 25 long; *d1-d1* 54, *d2-d2* 142, *d3 - d3* 66, *d4 - d4* 69, *d1-d2* 47, *d2- d3* 54 and *d3 - d4* 59 apart. Hysterosomal shield anterior margin separated from propodosomal shield.

Table 1. Measurements of different body characters in µm between *Acotyledon augokiensis* n.sp., *A. ciceri* (Honey *et al*., 2014) and *A. haripuriensis* (Ashfaq *et al.*, 1987).

Characters	*A. augokiensis* n.sp.	*A. ciceri*	*A. haripuriensis*
Dorsum length	255	284	265
Dorsum width	225	216	230
Propodosomal shield	Smooth	Smooth	Dotted
Hysterosomal shield	Dotted	Dotted	Dotted
vi	12	25	22
ve	7	17	--
sci	15	--	18
sce	27	--	28
scs	--	34	--
d1	12	12	16
d2	15	10	11
d3	10	12	11
d4	12	10	13
hi	12	10	9
he	--	12	9
la	12	10	7
lp1	10	10	9
lp2	7	10	6
sai	29	25	28
sae	7	12	8
Gnathosoma	II segmented, rounded posteriorly	I segmented, parallel	I segmented, elongate
mG I & II	25 & 20	20	22
hT I & II	25 & 22	27 & 25	26 & 23
e I & II	25	25	30 & 25
ω I & II	17 & 19	--	18
Φ I & II	66 & 47	37 & 49	72 & 52
Ti I setae	I cup-shaped + 1 leaf-like + 3 lancet like	I cup-shaped + 2 leaf-like + 2 lancet like	2 leaf-like + 1 lancet like
Ti II setae	1 cup shape + 1 leaf like + 2 lancetlike	1 cup-shaped + 1 leaf-like + 2 lancet like	I cup-shaped + 1 lancet like
Ti III setae	4 lancet like	1 cup-shaped + 1 leaf-like	3 leaf-like + 1 lancet like
Ti IV setae	4 lancet-like	1 cup-shaped + 1 leaf-like + 1 lancet like	2 leaf-like + 1 lancet like

Venter (Fig. 2B).

Gnathosomal fused pedipalpi I segmented, 39 long, parallel laterally, notched posteriorly, 1 pair arista, 39 long, 2 pairs small setae. Apodeme I (*ap* l) 12long, V- shaped continuing with sternum I (*st* l). Sternum I (*st* l) free, 49 long. Apodeme 2 (*ap* 2) not meeting apodeme 4 (*ap* 4). Apodeme 3 (*ap* 3) meeting apodeme 4(*ap* 4). Apodeme 4 (*ap* 4) meeting medially making a semi-circular line. Sternum 2 (*st* 2) absent. Apodeme 5 (*ap* 5) converging medially not meeting apodeme 4 (*ap* 4). Metasternal seta (*mts*) 15. Coxal fields I, II, III and IV open, dotted. Area lateral to apodeme 3 (*ap* 3) and apodeme 4 (*ap* 4) dotted. Seta *hv* I pair 20 long. Genital shield dotted, genital slit elongated, genital suckers absent, I pair paragenital setae (*pr*) anterior to genital disc (*gdi3*) 7 long. Coxal discs *di1* and *di2* present. Suctorial shield concave antero-medially, rounded posteriorly, 39 long, 49 wide, I pair anterior suckers, I pair anal suckers, 2 pairs each of lateral and posterior suckers.

Legs (Fig. 2B).

All of one type, I - IV measuring 100, 110, 100 and 113 in length, respectively (Trochanter base to tarsus tip). Setae and solenidia on legs I - IV segments: Coxae 0-0-0-0, trochanters 0-0-1-0, femora 1-1-0-1, genua 2-2-1-0, tibiae 3-3-1-2, tarsi 7-6-6-4. Tarsi I-IV 42, 37, 32, 38 long, respectively. Seta *vF* on femora I, II and IV 34, 49 and 20 long respectively, absent on femur III. Seta *e* on tarsi I and II 37 and 27 long,

Table 2. Measurements of different body characters in µm between *Acotyledon haroonabadensis* n.sp., *A. kamokiensis* (Bashir *et al*., 2012) and *A. embio* (Ashfaq *et al.*, 1998).

Characters	*A. haroonabadensis* n.sp.	*A. kamokiensis*	*A. embio*
Dorsum length	265	274	300
Dorsum width	206	225	238
Propodosomal shield	Dotted	Dotted	Dotted
Hysterosomal shield	Smooth with striations	Dotted	Dotted
vi	25	22	57
ve	--	--	--
sci	22	24	10
sce	--	34	13
scs	37	--	20
d1	22	15	9
d2	12	15	7
d3	12	12	7
d4	10	15	7
hi	10	12	8
he	20	17	8
la	10	10	8
lp1	7	7	27
lp2	10	10	27
sai	25	32	40
sae	10	15	06
Gnathosoma	I segmented, notched posteriorly	I segmented, rounded posteriorly	I segmented, broad at base & bifid anteriorly
mG I & II	20	22 & 20	12 & 11
hT I & II	25 & 22	24 & 20	21 & 17
e I & II	37 & 27	27	40 & 22
ω I & II	17 & 20	12 & 15	
Φ I & II	64 & 39	73 & 49	70 & 47
Ti I setae	I cup-shaped + 1 leaf-like + 3 lancet like	I cup-shaped + 1 leaf-like + 3 lancet like	3 leaf-like + 1 cup -shaped
Ti II setae	1 cup shape + 1 leaf like + 4 lancet like	2 lancet like	I cup-shaped + 3 leaf like
Ti III setae	1 leaf like	3 lancet like	3 leaf-like
Ti IV setae	1 leaf like	3 lancet like	3 leaf-like

absent on femora III, IV. Seta *mG* on genua I and II 20 and 20 long each, *hT* on tibiae I and II 25 and 22 long respectively. Setae σ on Genu I and II 12 long, Solenidion ω on tarsi I and II 17 and 20 long, respectively. Setae φ on tibia I and II 64 and 39 long, respectively. Tarsi I-IV provided with I cup-shaped + 1 leaf-like + 3 lancet like; 1 cup shaped + 1 leaf like + 4 lancet like; 1 leaf like; 1 leaf like setae.

Remarks:

This new species is very close to already known species *Acotyledon kamokiensis* (Bashir *et al*., 2012) but can be differentiated on the basis of characters; new species exhibits coxal field III open (coxal field III closed), apodeme 2 reaching to the anterior margin of apodeme 4 (vs ap2 not reaching to the anterior margin of ap4), gnathosoma notched posteriorly (vs gnathosoma straight posteriorly), dorsum with 1 pairs of pores (vs dorsum with 3 pairs of pores).

Detailed measurements of different body characters in µm between *Acotyledon haroonabadensis* n.sp., *A. kamokiensis* (Bashir *et al*., 2012) and *A. embio* (Ashfaq *et al.,* 1998) are given in Table 2.

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REFERENCES

Ashfaq, M. and F. Sher. 2002. Description of two new species (Hypopi) of genus *Acotyledon* Oudemans (Acarina: Acaridae) from Pakistan. Pak. J. Agri. Sci. 39: 38-46.

Ashfaq, M. and M. Sarwar. 1999. A new species (Hypopus) of the genus *Lackerbaueria* (Acarina: Acaridae) from Pakistan. Acarina 7: 53-56.

Ashfaq, M. and M. Sarwar. 2001. Description of two new species (Hypopus) of the genus *Corponomoia* Mahunka (Acari: Histiostomatidae) from Pakistan. Acarina 9: 125-130.

Ashfaq, M. and W.M. Chaudhri. 1983. Four new (Hypopi) species of genus *Caloglyphus* Berlese from Pakistan (Acarina: Acaridae). Pak. Entomol. 5: 61-78.

Ashfaq, M. and W.M. Chaudhri. 1984. Two new species of the genus *Forcellinia* Oudemans (Acarina: Acaridae) from Pakistan. Pak. Entomol. 6: 25-36.

Ashfaq, M. and W.M. Chaudhri. 1986. A new (Hypopus) species of genus *Glyphanoetus* Oudemans (Acarina: Histiostomatidae) from Pakistan. Sarhad J. Agric. 2: 211-238.

Ashfaq, M., M. Sarwar and A. Ali. 2000. Two new species (Hypopi) of genus *Histiostoma* (Acari: Histiostomatidae) from Pakistan. Pak. J. Agri. Sci. 37: 33-41.

Ashfaq, M., M. Sarwar and A. Parvez. 1998. A description of two new species (Hypopi) of the genus *Acotyledon* (Acariformes: Acaridae) from Pakistan. Acarina 6: 51-57.

Ashfaq, M., M. Sarwar and S. Akbar. 1999. Two new species of genus *Glyphanoetus* Oudemans (Acari: Histiostomatidae). J. Acarol. Soc. Japan 8: 21-26.

Ashfaq, M., W.M. Chaudhri and A. Parvez. 1986. Taxonomic studies on Hypopi of the genus *Acotyledon* Oudemans (Acarina: Acaridae) from Pakistan. Pak. Entomol. 8: 1-28.

Ashfaq, M., W.M. Chaudhri and A. Parvez. 1987. Two new (Hypopi) species of genus *Acotyledon* (Acarina: Acaridae) Oudemans from Pakistan. Pak. Entomol. 9: 31-40.

Ashfaq, M., W.M. Chaudhri and G.M. Aheer. 1985. Taxonomic studies on Hypopi of genus *Histiostoma* Kramer (Acarina: Histiostomatidae) from Pakistan. Pak. Entomol. 7: 17-50.

Bahrami, F., K. Kamali and Y. Fathipour. 2007. Life history and population growth parameters of *Tyrophagus putrescentiae* (Acari: Acaridae) on *Fusarium graminearum* in laboratory conditions. J. Entomol. Soci. Iran 26: 7-18.

Baker, E.W. and G.W. Wharton. 1952. An introduction to Acarology. The MacMillan Company, New York.

Bashir, M.H., M. Afzal, S.F. Honey and B.S. Khan. 2011. First Evidence of the genus *Rhizoglyphus* (Acari: Acaridae) from Pakistan. Pak. J. Life Soc. Sci. 9: 140–144.

Bashir, M.H., M. Afzal, S.F. Honey and M. Ashfaq. 2012. Description of two new species (Hypopi) of genus *Acotyledon* Oudemans (Acarina: Acaridae) from Pakistan. Pakistan J. Zool. 44*:* 745-751.

Collins, D.A. 2006. A review of alternatives to organophosphorus compounds for the control of storage mites. J. Stor. Product Res. 42: 395-426.

Darvishzadeh, I. and K. Kamali. 2009. Faunistic survey of Mite (Acari) associated with grapevine in Safiabad, Khuzestan. Iran. J. Entomol. Res. 1: 79-93.

Eraky, S.A. 1999. Five new hypopial nymphs (Acari, Acaridae, Histostomatidae) described from different habitats. Folia Ent. Hung. 60: 45-56.

Fain, A. and J.R. Philips. 1978. Astigmatic mites from nests of birds of prey in the U.S.A. IV. Description of the life cycle of *Acotyledon paradoxa* Oudemans, 1903. Zool. Meded. 53: 29-39.

Haines, C.P. 1997. Insects and arachnids in Indonesian food stores- Biodiversity in a man-made environment. Proc. Symp. Pest Manage. Stored Food and Feed, 4-7 September, 1995, Seameo Biotrop, Bogor, Indonesia.

Honey, S.F., Z.M. Sarwar, M.H. Bashir, S. Ali, M. Kamran and M. Afzal. 2014. Two New species of *Acotyledon* Oudemans, 1903 (Acari: Acaridae) infesting stored chickpea, *Cicer arientinum*, from Pakistan. Pakistan J. Zool. 46: 479-484.

Hubert, J., V. Stejskal, Z. Munzbergova, A. Kubatova, M. Vanova and E. Zdarkova. 2004. Mites and fungi in heavily infested stores in Czech Republic. J. Econ. Entomol. 97: 2144-2153.

Hubert, J., Z. Munzbergova, Z. Kucerova and V. Stejskal. 2006. Comparison of communities of stored product mites in grain mass and grain residues in the Czech Republic. Exp. Appl. Acarol. 39: 149-158.

Hughes, A.M. 1976. The mites of stored food and houses. Tech. Bull. No. 9. Ministry of Agric. Fisheries and Food., London. pp.400.

Klimov, P.B. 2000. A review of acarid mites of the tribe *Caloglyphini* (Acaridae, Acariformes) with description of a new genus and species from Siberia and Russian Far East. Vestnik Zool. 34: 27-35.

Kucerova, Z. and P. Horak. 2004. Arthropod infestation in samples of stored seeds in Czech Republic. Czech J. Genetics Plant Breed. 40: 11-16.

Mahmood, S.H. 1992. Mite fauna of stored grain seeds in central Iraq. J. Stored Product Res. 28: 179-181.

Mahmood, S.U., M.H. Bashir, M. Abrar, M.A. Sabri and M.A. Khan. 2013. Appraising the changes in nutritional value of stored wheat, *Triticum aestivum* L. infested with acarid mite, *Rhizoglyphus tritici* (Acari: Acaridae). Pak. J. Zool. 45: 1257-1261.

Mahunka, S. 1973. Auf insekten lebende Milben (Acari: Acarida: Tarsonemida) aus Afrika II. Acta Zool. Hung. 19: 289-337.

Mahunka, S. 1974. Auf insekten lebende Milben (Acari: Acarida: Tarsonemida) aus Afrika III. Acta Zool. Hung. 20: 137-154.

Mahunka, S. 1978. Schizoglyphidae fam. n. and new taxa of Acaridae and Anoetidae (Acari: Acarida). Acta. Zool. Hung. 24: 107-131.

Nesbitt, H.H.J. 1945. A revision of the family Acaridae (Tyroglyphidae) order Acari, based on comparative morphological studies. Canad. J. Res. 23: 139-188.

Rupes, M.A. 1967. Contribution on the genus *Acotyledon* Oudemans, 1903 (Acarina, Acaridae), with description of two new species: *A. calcis* sp. n. and *A. samsinaki* sp. n. Vest. esk. Spol. Zool. 31: 250-259.

Samsinak, K. 1957. *Acotyledon tetramorii* n.sp. Eine neue myrmecophile Tyroglyphidae (Acari). Acta Soc. Ent Cechosl. 54: 396-399.

Samsinak, K. 1966. Die Neuerrichtung der Gattung *Cosmoglyphus* Oudemans, 1932, gleichzeitigein Beitragzum Problem der "Copra Itch". Zool. Anz. 176: 27-42.

Samsinak, K. 1968. A new acaridoid mite *Acotyledon palaeorhizae* n. sp. Pacific Insects 10: 271-273.

Sarwar, M. and M. Ashfaq. 2002. Contribution towards the taxonomic study on the mites (Hypopus) of the genus *Histiostoma* Oudemans (Acari: Histiostomatidae) from Pakistan. Balochistan J. Agric. Sci. 3: 25-35.

Sarwar, M. and M. Ashfaq. 2004. Two New *Caloglyphus* Berlese mites (Astigmata: Acaridae) recorded in Pakistan. Pak. J. Sci. Ind. Res. 47: 455-461.

Sarwar, M., M. Ashafq and M. Aslam. 1998. Two new species of gneus *Histiostoma* from Pakistan (Acari: Histiostomatidae). Pak. Entomol. 20: 1-7.

Sevastyanov, V.D. and G. Rady. 1991. New species of entomophilous mites family Acaridae (Sarcoptiformes) of Lower Egypt fauna. Zool. Z. 70: 133-139.

Sher, F., M. Ashfaq and A. Parvez. 1991. Two new (Hypopi) species of genus *Caloglyphus* Berlese (Acarina: Acaridae) from Pakistan. Pak. Entomol. 13: 27-34.

Womersley, H., 1955. The acarine fauna of muttonbirds' nests on a Bass Strait island. Aust. J. Zool. 3: 412-38.

Zakhvatkin, A.A. 1941. Fauna of USSR Arachnoidea VI (1) Tyroglyphoidea (Acari). Zool. Inst. Acad. Sci. USSR, New Ser. No. 28. English Translation by Rateliffe, A., Hughes, A.M., 1959. Amer. Inst. Biol. Sci., 573 pp.