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Taxonomy of Subfamily Tenebrioninae (Latreille, 1802) and Pimeliinae (Latreille, 1802) (Coleoptera: Tenebrionidae) with New Record from Sindh, Pakistan

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ABSTRACT

Background: Darkling beetles cause economic damage to several agricultural crops due to their common prevalence. This study has been designed because still no detailed study has been carried out on this topic in Sindh, Pakistan. This research has been done to investigate the distribution, diversity and taxonomic status of two sub-families Tenebrioninae (Latreille, 1802) and Pimeliinae (Latreille, 1802) of family Tenebrionidae.

Methods: Species of subfamily Tenebrioninae and Pimeliinae were collected from the different parts of lower Sindh with the help of pitfall trap, light trap and hand-picking methods from 2018 to 2020. The most sources of collection for these species were the soil surface of diverse ranches, beneath the shaken and mountain regions, the stockpiles area/godown and the soil surface of the Wilderness range.

Result: During the present study 300 individuals of Tenebrionidae were accumulated and classified into two subfamilies: Pimeliinae which consisted of *Pimelia capito* and *Trachyderma phalistinia* species and Tenebrioninae which consisted of *Uloma excise* and *Aphitobius diaperinus* species. However, *Pimelia capito* and *Trachyderma phalistinia* were recorded as new records for the first time from Sindh province. It has been observed that several of the larger species were flightless and unable to do high flight. *i.e.*, *Ulomo excise*. However, this object is under inspection and requires further research in the future.

Key words: Darkling beetles, Fauna, New records, Sindh, Tenebrionidae.

INTRODUCTION

Tenebrionidae is the fifth largest and one of the most diverse family within the order Coleoptera that contains more than 18,000 insect species (15000 described) worldwide (Matthews and Bouchard, 2007 and 2008). The large group of Tenebrionidae is nocturnal therefore typically called as “Darkling Beetles”. Therefore, this object will be deliberated tentative only. The three corroborated and recognized major branches were Pimeliiformes, Lagriiformes and Tenebrioniformes. On the other hand, they were identified as Informa Pimelioid, informal Lagrioid and Tenebrionoid branches by Matthews and Bouchard (2005). Particularly the greater numbers of these species found in hot climates in most of the arid regions such as in the deserts. The evolutionary period of species adapted to live in sternly high temperature and the diversity going to be prolonged drought. Beside this these data have caused the Tenebrionidae to be respected as the foremost profoundly advanced family (Cucujoidea Crowson, 1955). These beetles mostly live in torrid deserts and can easily tolerate the high temperature such as 50°C. They possess long legs that keep the beetle safe from hot sand and they are excellent burrowers immediately escape towards burrowing stones, leaf litters and bark (Schwaller, 1996; Bocuhard *et al.,* 2005). In Pakistan especially in Sindh province no taxonomic study of this family has been previously carried out. However, some of the scientific research regarding the description of some species had been mentioned in India (Hegde *et al.,* 2018). Darkling beetles widely existed in Pakistan and caused economic damage to the number of agricultural crops including diversity injure in bulk, mold/conditioning issues and regulatory issues surrounding foreign material, stored raw commodities ranging from loss of volumes (Schawaller, 2009; 2012). In the processing, manufacturing, distribution and retail segments, these pests pose a food safety risk for adulterating items produced or stored (Grimm and Schawaller, 2000). Still nothing exists on the said topic; therefore, the

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present study was planned. According to the catalogue given by Kaszab and Szekessy, (1953), a total number 70 species had been recorded from family Tenebrionidae in Pakistan from Baluchistan, Punjab, KPK and some species from Sindh province. In last few years, a large number of Tenebrionidae identified from the Highlands of Pakistan. After comprehensive studies by different experts, these Tenebrionidaea were identified as a new genus and species of the Laenini. The Laenini are Tenebrionids which are usually found in tropical regions (Schawaller, 1998).

Total four species of Aediotorix were identified by (Bates, 1968) in the regions of (Philippines, Pakistan, Indonesia and Malaysia). Ferrer and Moragues, (2000) reported three species and the scientists placed Pycnocerini within subfamily of Lagriinae and it was further subdivided into two sub tribes as Pycnocerina with truncate mandibles and Chiroscelina with bifid.

The present study is very helpful for the agriculture extension wing in the agriculture department and other agencies to adopt control measures at appropriate times. Its main purpose is to provide the reader academics, entomologists, farmers, researchers and extensionists, useful information on this group of insects of economic importance. An effective preventive management strategy for these pests relies on an improved knowledge of their taxonomy and ecology and on more efficient monitoring and control techniques. We believe that assembling of biodiversity information from available Tenebrionidae data will strengthen the national capacity of the country with regard to decision making and management in nature conservation and sustainable development.

MATERIALS AND METHODS

This study focused on different insect species of the Tenebrionidae family which includes subfamilies such as; Tenebrioninae and Pimillinae. However, the information of subfamily Tenebrioninae, captured by two species *Alphitobius diaperinus* and *Uloma excise* while sub family Pimillinae consist *Pimelia capito* and *Trachyderma phalistinia*. Which concerning specific name, description of species, locality and thecollection of species, the specimens were examined with a stereoscopic binocular microscope. Classification and nomenclature of Darkling beetles suggested by Matthews, Bouchard, Hegde, Grimm and Schawaller, Kaszab and Szekessy, Ferrer and Moragues, Ramussen, Constantinou and Thompson, Geden and Hogsette, Lambkin and Szczepanik.

Collection

Species of subfamily Tenebrioninae and Pimeliinae were collected from different parts of Sindh (Table 1) with the help of pitfall trap, light trap and hand-picking methods (Fig 1) from August 2018 to May 2020. The most sources of collection for these species were the soil surface of distinctive ranches, beneath the shaken and mountain zones, the stockpiles area/godown and the soil surface of Wilderness region. These traps were monitor every fortnight and all insect species examined at Entomology Bio-control Research lab (EBCRL) Department of Zoology, University of Sindh Jamshoro, Sindh, Pakistan.

However, the collected specimens were sorted out into 2 subfamilies and 4 species on the basis of their taxonomic characteristics (Fig 2).

RESULTS AND DISCUSSION

During the present study 300 specimens of Tenebrionidae were accumulated from Jamshoro, Hyderabad, Badin and Tando Jam regions of Sindh province during 2018 to 2020. Family Tenebrionidae was sorted out into two subfamilies: Pimeliinae which consisted of *Pimelia capito* and *Trachyderma phalistinia* species and Tenebrioninae which consisted of *Uloma excise* and *Alphitobius diaperus* species. Total, specimens of Pimeliinae were found highest in number (63.6%) as compared to Tenebrioninae (36.4%). While Species *Pimelia capito* was the most dominant species followed by the *Alphitobius diaperus* whereas *Uloma excise* was the least dominant species followed by the *Trachyderma phalistinia*. Regionally, the highest number of specimens of four species was recorded in Jamshoro (37.66%) followed by the Tando Jam (26.75%) whereas lowest number of specimens was recorded in Badin (13.8%) followed by Hyderabad (21.8%). However, *Pimelia capito* and *Trachyderma phalistinia* were recorded as new record for the first time from Sindh province (Table 2) (Fig 3).

In general, percentage of male specimens of every species was recorded as higher as compared to female specimens (Fig 3). Moreover, percentage of specimens of each species also has been mentioned (Fig 4).

Table 1: Methods of collection in various regions and habitats of Sindh.

Method	Region	Coordinates	Habitat
	Jamshoro	25°25'0.7248"N 68°16' 27.5052"E	Hills and mountains
	Hyderabad	25°23'32.71"N 68°22'25.18"E	Gardens and lawns
	Badin	24°39'20.5920"N 68°50' 14.0712"E	Agriculture and forests
	Tandojam	25°25'47.61" N 68°32'33.36"E	Poultry forms
Hand picking	Pitfall trap	Light trap	

Family: Tenebrionidae

Sub family: Pimeliinae

Pimelia capito

Diagnostic features

At the elixir of 8-9 mm with metal black color, the cartridge was oval in length around 22-24 mm. A concave section in the middle of the front was flattened. While Reniform composite eye. The distance between two eyes approximately 1.6-1.8 mm. Antennas and mouth parts with 11 antennomers, filiform form around. 6.5-6.8 mm in length. In antennomeres, segments from four to ten were almost same in length however the last segment was fusiform in shape. Labrum was oval, the tormal arm mesal was not extended, the epitorma was missing and the anterior edge was very low of black setae. Labium was mentally, semicircular in shape and three palpitations. Maxilla was with one lacinial, four-sectioned palpi and one apical tooth with a pyramidal shape. The front of pronotum had rounded side and transverse. Anterior and posterior borders were distinctly margined smooth surface and flat prosternum (Table 3) (Fig 5). Legs in this species were special, the basal part of the femur was blackish grey/ brown and the tarsomeres were covered with setae. Protibial was cylindrical in shape and smooth. The segments from one to four in tarsus were same in the size, the last segment was longer than the others and it carried two strong claws (Fig 5).

Remarks

The study carried out in North Africa showed that *Pimelia* are univoltine, with one generation per year. Species in North Africa emerge in January to begin mating, synchronously with floral bloom. Normally *Pimelia* are detrivores, but during mating season they may cannibalize other adults, larvae and eggs. This behavior may be due to the need for extra nutrients or simply to eliminate competitors (Ramussen *et al*., 1991).

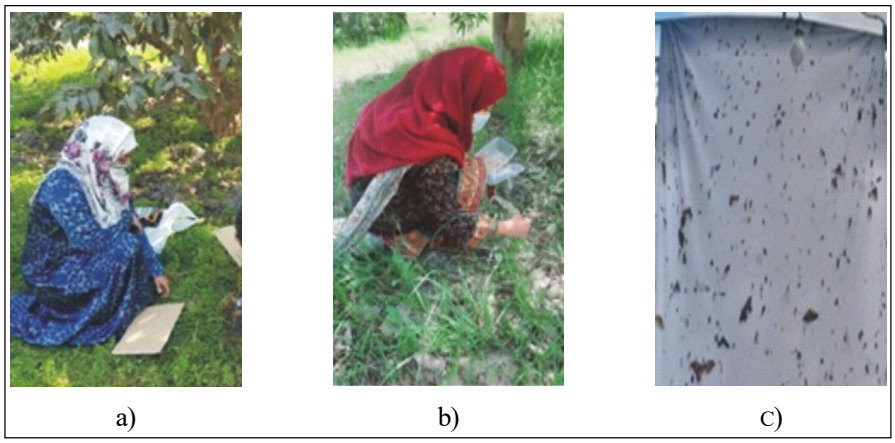

Fig 1: Methods of collection: a) Pitfall trap; b) Hand picking; c) Light trap.

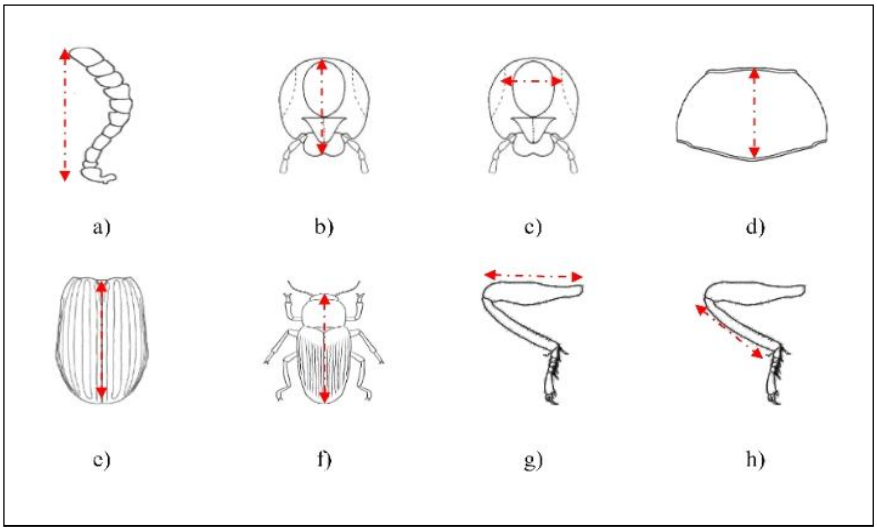

Fig 2: Taxonomic characteristics to identify the species: a) Antennal length; b) Length of head; c) Distance between eyes; d) Length of pronotum; e) Length of elytra; f) Total body length; g) Length of femur; h) Length of tibia.

Trachyderma phalistinia

Diagnostic features

Body was elongated-oval, very big in size with overall length was 26-28 mm and the width 10-12 mm however the color was blackish. The front was somewhat convex in the center like smooth plate sand. The compound eyes were prominent in reniform, with a spacing of 1.8-2 mm between eyes. In the middle the clypeus was concave and clypeo-labrus suture connected to the labrum. However, antennas with an overall length of 6.8 to 7.2 mm, which consisted of 11 segments. The base (Scape) was spherical and the apical section was suppressive, but in the second segment (Pedicel), the second part was somewhat cubic and the size of the three to seven segments was similar. Labrum was long,

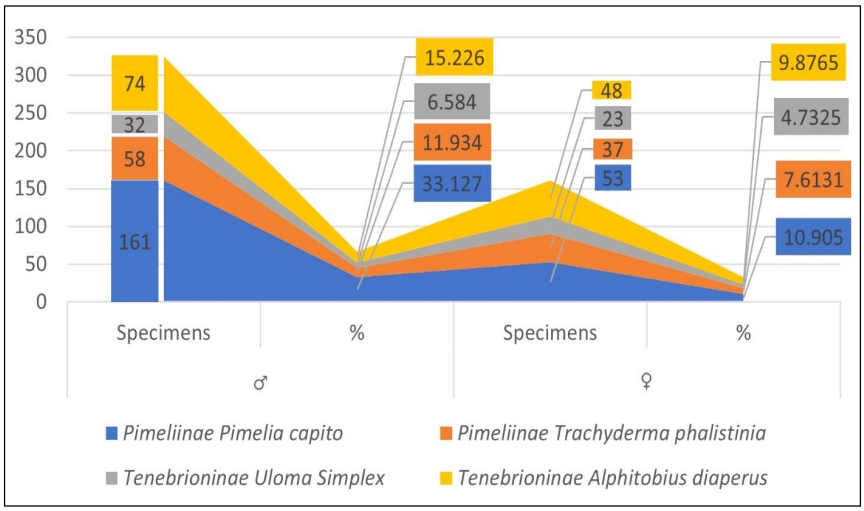

Fig 3: Percentage of male and female specimens of various species of Tenebrionidae.

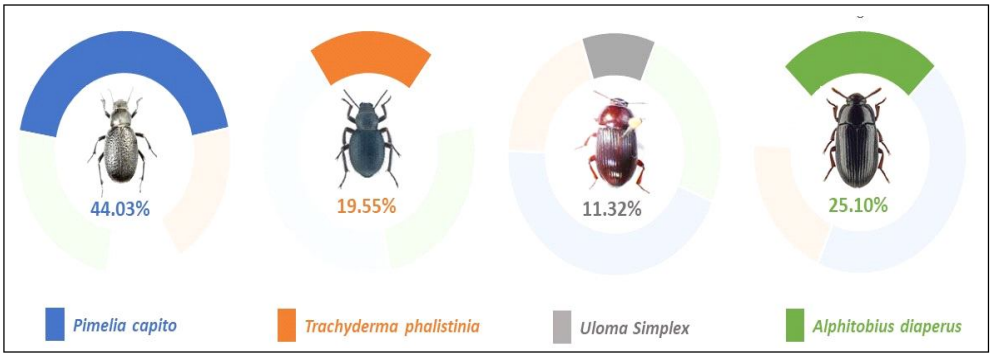

Fig 4: Percentage of specimens collected of each species.

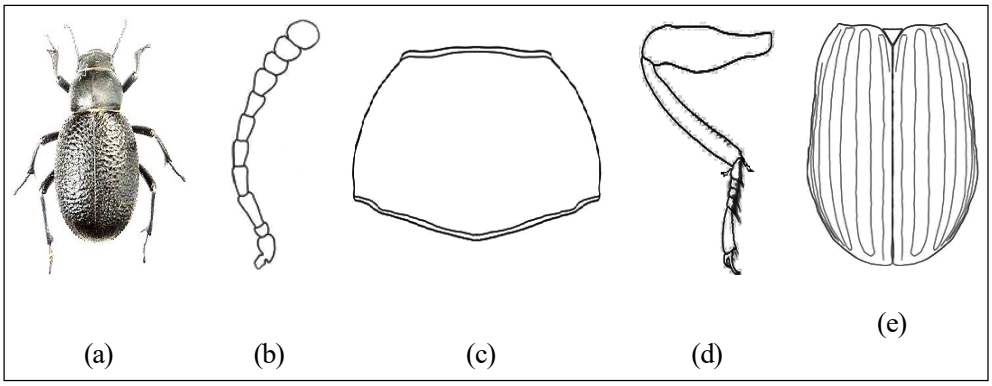

Fig 5: *Pimelia capito* (a) dorsal view; (b) Antennae (barline 0.5 mm); (c) Pronotum (barline 1.0 mm) and (d) Foreleg (barline 1.0 mm); (e) Elytra (barline 1.0 m).

Table 2: Abundance and distribution of various species of Tenebrionidae in various regions of Sindh

Family	Subfamily	Species	Regions of Sindh				Total	%
Tenebrionidae	Pimeliinae	*Pimelia capito*	97	61	20	36	214	63.6%
		Trachyderma phalistinia	22	11	20	42	95	
	Tenebrioninae	*Uloma excise*	17	10	12	16	55	36.4%
		Alphitobius diaperus	47	24	15	36	122	
Total			183	106	67	130	486	100%
Colors indicate regions:		Jamshoro	Hyderabad		Badin		Tando Jam	

mesal and not extended and epitorm was missing, the entire surface covered by greyish setae. Pronotum was transverse and quadrate form, anterior borders shallowly emarginated and carried a row of grayish setae, lateral borders strait, All borders were clearly marginalized and the surface was finely dispersed. Prosternum was slightly arcaded to the former, while the back borders with prosternal processes are flat (Table 4) (Fig 6). Protibiae had cylindrical thin shape; 5 different tarsus were made with coarse bristles on their inner surface; the segments were equal in size from one to three and Segment Four was quite small. Mesotibiae were narrowly shaped in cylindrical shape and widened somewhat from mid- to apical end. The setae had approximately the same size and last sector was longer (Fig 6).

Remarks

New record in Pakistan. In *T. philistina* there is a distinct projection which is even more accentuated. In most *T. philistina,* the pronotum is whitish in appearance, densely pubescent and waxy: in some specimens, however, it is shiny and almost naked. However, *T. philistina* is centered on the Arabian Peninsula (Constantinou *et al*., 1982); (Constantinou and Thompson, 2018).

Sub family: Tenebrioninae

Uloma excise

Diagnostic features

The body was oval, convex, 14-16 mm long, 5 mm wide and the reddish. The front was round, moderately sinuated, compound, oval eyes conspicuous, with a spacing of approximately 1.1-1.3 mm between the eyes. Antennas with 11 antennomers, filiform approximately 1.6-1.9 mm long, four to nine antennomers with a slightly pointy, sharp distal border on the internal side, gradually extended and the last segment circular in form, are provided as antennas. The torm arm mesal was not spread in the labrum, epitorm and ciliate were not seen on the surface with black scales. Labium was mentally composed by three segmented palps and maxilla with solitary lacinal uncus and mandibles were with single apical tooth. The pronotum was rather transverse and convex. The front and lateral edges were marginal, the sides were rounded and noticeably marginalized, the surface flat and prosternal (Table 5) (Fig 7). Protibia was dilated apically, the outer edge was pectinate and packed

Table 3: Morphometric analysis of various body parameters *Pimelia capito*.

Parameters	Mean±S.D (mm)	
	Male (n=10)	Female (n=10)
Antennal segment	11	11
Antennal length	4.02±0.60	4.24±2.44
Length of head	2.20±0.20	2.65±0.33
Distance between eyes	1.10±0.49	1.75±0.5
Length of pronotum	7.81±2.37	9.16±2.8
Length of elytra	12.66±3.01	15.8±3.16
Length of femur	5.09±2.13	6.7±2.16
Length of tibia	4.29±1.8	4.9±2.5
Total body length	22.3±2.39	26.3±2.29

Table 4: Morphometric analysis of various body parameters *Trachyderma phalistinia*.

Parameters	Mean±S.D (mm)	
	Male (n=10)	Female (n=10)
Antennal segment	11	11
Antennal length	6.6±5.5	7.3±4.03
Length of head	2.3±1.25	3.0±0.61
Distance between eyes	3.29±0.58	3.75±1.5
Length of pronotum	6.0±1.58	6.16±1.5
Length of elytra	16.5±2.8	17.3±2.16
Length of femur	8.8±3.43	8.9±3.75
Length of tibia	7.28±1.85	8.5±2
Total body length	24.15±2.8	26.2±2.5

Table 5: Morphometric analysis of various body parameters of *Uloma excise*.

Parameters	Mean±S.D (n=6) mm	
	Male	Female
Antennal segment	11	11
Antennal length	1.51±0.09	1.56±0.08
Length of head	1.7±0.1	1.73±0.1
Distance between eyes	1.2±0.1	1.2±0.1
Length of pronotum	3.8±0.1	3.8±0.09
Length of elytra	2.43±0.32	3.56±0.63
Length of femur	3.6±0.1	3.6± 0.16
Length of tibia	2.4±0.15	2.3± 0.16
Total body length	14.8±0.9	15±0.8

with fine setae on the ventral edge. All tarsus segments were nearly equal in size with two robust claws in the last segment. Mesotibiae had some spurs, both in length, the initial and last sections of the tarsus. While Metatibiae had a cylindrical shape and the initial and last segments were approximately equal in length along with four segments of the tarsus (Fig 7).

Remarks

The diagnostic characteristics were Figd and species key provided for this *U. excise* newly recorded species. The species typically lives under the barks of trees or rotten wood, even outside forests and in cultivated land (Darya *et al*., 2017).

Alphitobius diaperinus

Diagnostic features

Body was broadly-oval, moderately convex in structure, black in color, about 5-5.5 mm in length and maximum width of 2.5 mm at elytra. The surface has been deeply excluded from the front, a distinctive hip rivet and the eyes have also been marginalized. The antennae and the mouths are as shown in 11 filiform antennomers with a length of approximately 1, 3-1, 6 mm. The antennas were densely dressed in short yellowish hair, the end segment was lighter in color, the segments were progressively larger from 4-11 and the last segment oval in form. Labrum was long, the mesal of the tormal arms not expanded and the epitorm lacked, while the anterior margin of the ciliate was black with the setae. Labium had a mentum, a shape of chordates and three palps segmented. Maxilla had one uncus and palpi comprised of four segments but with apical tooth the mandibular shapes were pyramidal. At the bottom of the pronotum, it was double the width and somewhat narrowed to the top, with the sides curved. The apical angles showed the apex of the pronotum generally (Table 6) (Fig 8).

Protibiae was dilated apically and some Setae with dense, fine setae on the ventral edge. The segments of tarsus from one to four were nearly the same size and two strong claws were longer in the fourth segment. Mesotibiae had single spur. Tarsus segments were practically identical in length, with the last segment being longer, of one to four (Fig 8).

Remarks

New record in Sindh (Pakistan). Presently known worldwide, *A. diaperinus* is hypothesized to have originated in sub-Saharan Africa (Geden and Hogsette, 2001), (Lambkin, 2001) and is considered a tropical exotic species in North America where it has been introduced from Europe. The darkling beetle *Alphitobius diaperinus* Panzer (Coleoptera:

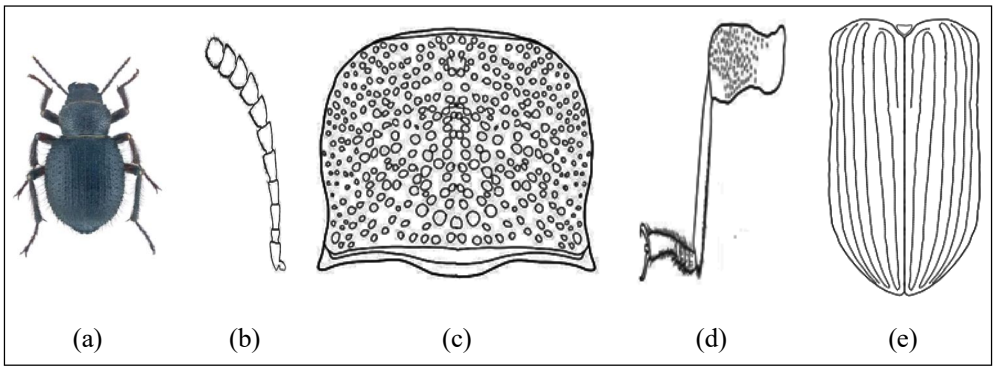

Fig 6: *Trachyderma phalistinia* (a) dorsal view; (b) Antennae (Barline 1.0 mm); (c) Pronotum (Barline 1.0 mm) and (d) Foreleg (Barline 2.0 mm); (e) Elytra Barline (2.0 m).

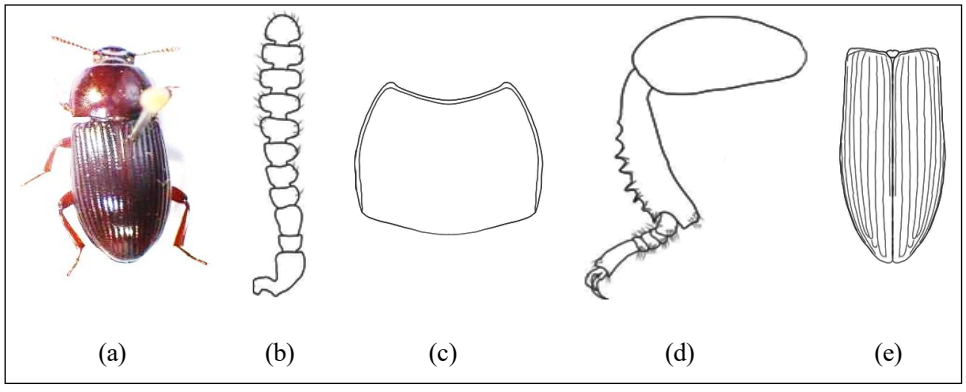

Fig 7: *Uloma excise* (a) dorsal view; (b) Antennae (Barline 0.2 mm); (c) Pronotum (Barline 0.5 mm) and (d) Foreleg (Barline 0.5 mm); (e) Elytra Barline (0.5 mm).

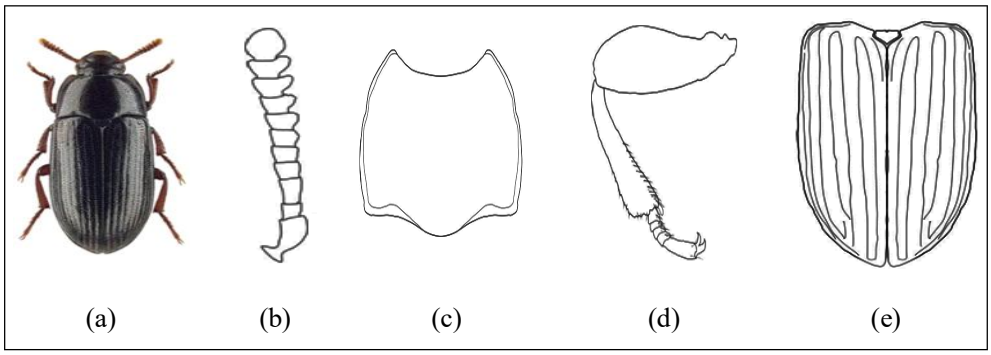

Fig 8: *A. diaperinus* (a) Dorsal view; (b) Antennae (Barline 0.2 mm); (c) Pronotum (Barline 0.2 mm) and (d) Foreleg (Barline 0.2 mm); (e) Elytra Barline (0.5 mm).

Table 6: Morphometric analysis of various body parameters *Alphitobius diaperinus*.

Parameters	Mean±S.D (mm)	
	Male (n=6)	Female (n=6)
Antennal segment	11	11
Antennal length	0.33±0.29	0.90±0.63
Length of head	1.41±0.12	1.24± 0.32
Distance between eyes	1.51±0.17	1.72±0.51
Length of pronotum	2.01±0.44	2.23±0.27
Length of elytra	2.40±0.31	3.58±0.68
Length of femur	2.34±0.27	1.63±0.29
Length of tibia	2.04±0.30	1.63±0.29
Total body length	3.32 ±0.25	5±1.24

Tenebrionidae) is one of the most common pests in poultry farms. The most common method to control this pest is the use of synthetic insecticides, mainly pyrethroids and organophosphates (Szczepanik *et al.,* 2008). These compounds are applied by spraying the floor and walls before the replacement of the litter for the next breeding cycle to avoid direct contact with birds (Salin *et al*., 2003).

CONCLUSION

The research paper provides a comprehensive taxonomy of subfamily Tenebrioninae and Pimeliinae, two important groups of beetles belonging to the family Tenebrionidae. The study includes detailed descriptions of 2 genera and 4 species, including a new record from Sindh, Pakistan. The authors used a combination of morphological and morphometric techniques to identify and classify the specimens. This study contributes to our understanding of the diversity and distribution of Tenebrionidae in the Pakistan province of Sindh and provides a valuable resource for future taxonomic and ecological research on these beetles. It was also noticed that many of the larger species are flightless and not capable of high flight. *i.e*., *Ulomo excise*. But this behavior is under observation so more research on this aspect in the future.

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Conflict of interest

The authors declare that they have no conflict of interest.

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