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# CLADISTIC ANALYSIS OF THE SPECIES OF THE GENUS *MELANOTUS* ESCHSCHOLTZ (ELATERIDAE: MELANOTINAE), FROM PAKISTAN

**Muhammad Atique Akhter[1], Syed Anser Rizvi[1], Zubair Ahmed[2] and Saima Naz[1]**

[1]*Department of Zoology, University of Karachi, Karachi, 75270. Pakistan.*
[2]*Department of Zoology, Federal Urdu University of Arts, Science and Technology, Karachi, Pakistan.*

## ABSTRACT

Eighteen species of the genus *Melanotus* (Elateridae: Melanotinae) have been analyzed cladistically on the basis of their apomorphies. Cladogram has been constructed to illustrate the closest relationship of currently included species. The relationship of these species has been discussed in the light of apomorphies found in the eighteen species. A key to the species of the genus *Melanotus* has also been given.

**Keywords:** Cladistic analysis; apomorphy; *Melanotus*; Elateridae; Coleoptera; Melatoninae; Pakistan.

## INTRODUCTION

Elaterids are a difficult group to study for many reasons. They are extremely difficult to distinguish morphologically on the species level whether as adults or as larvae (Riley and Keaster 1975; 1979; 1981; Lindroth and Clark, 2007). The complete identification key of all the genera of this group has been given by Smith and Enns (1977; 1978). The whole group of the genus *Melanotus* has been revised and reclassified on the basis of morphology by Quate and Thompson (1966) and Hayek (1990). Stibick (1979) had formulated the identification keys and given the diagnostic descriptions for subfamilies and tribe of the Elateridae, also described the phylogenetic relationships of the subfamilies and a synthesis of adult and larval characters is given.

The phylogenetic relationships and the classification of click beetles have been extensively worked out from past to now, however cladistic analysis of very few groups of Elateridae have been done (Nixon and Carpenter, 1993; Sagegami-Obe *et. al*., 2007; Casari, 2008). Beutel (2009) has analysed the Elateriformia on the basis of the larval morphology and anatomy and interpreted the whole group phylogenetically. The detailed external morphology of Melanotinae has been given by Van Zwaluwenburg (1922), which remains very helpful in the identification and extraction of characters for cladistic studies.

The exploration and description of new species of the genus *Melanotus* Eschscholtz from India, Pakistan and other Asian countries have been increasing in the taxonomical field (Hashmi and Tashfeen, 1992; Vats and Chauhan, 1991; Platia and Schimmel, 2001; Platia 2005; Akhter *et al.*, 2011a, 2011b), but the phylogenetic and cladistic analysis have not been strappingly put forward of the genus *Melanotus* and subfamily Melanotinae.

This work is an effort to make a conceptual study of cladistic analysis of the genus *Melanotus* on the basis of morphological characters and their apomorphies, within the eighteen species of the genus, recorded from Pakistan. The Cladogram (Fig. 1) has also been constructed on the basis of their apomorphies, derived from Casari (2008) . The eighteen species of the genus have also been keyed out for their easy taxonomical approach.

### Key to the known species of the genus *Melanotus* Eschscholtz of Pakistan

1. Last visible sternite with apex rounded……..… 2
- Last visible sternite with apex truncated…….…... *M. brunnipes* (Germar)
2. Pronotum broader than long……. 3
- Pronotum longer than broad……..…. 12
3. Elytral interstriae impunctate…… 4
- Elytra interstriae punctuate…….. 5
4. Sides of pronotum parallel for more than three-quarters of length …….. *M. riesei* Platia & Schimmel
- Sides of pronotum parallel for more than half of length……. *M. castanipus* (Paykull)
5. Two or more than two antennal segments reach at base of pronotum……..…. 6
- Less than two antennal segments reach at base of pronotum……..…. 9
6. Combined length of 2nd and 3rd antennal segments just shorter than 4th segment…...7
- Combined length of 2nd and 3rd antennal segments clearly shorter than 4th segment…8
7. Surface of pronotum glossy……..… *M. besucheti* Platia & Schimmel

- Surface of pronotum dull…… *M. planipennis* Candèze
8. Punctation on pronotum with uniform intervals…….*M. ocellatus* Platia & Schimmel
- Punctation on pronotum with variable intervals……..*M. thomasi* Platia & Schimmel
9. 2nd antennal segment as long as broad…….. *M. herticornis* (Herbst)
- 2nd antennal segment longer than broad…….. 10
10. Tip of last antennal segment pointed…… *M. pakistanicus* Platia & Schimmel
- Tip of last antennal segment rounded…… .11
11. Basal plate of male genitalia apically to base broad to narrow……..... *M. kalamensis* Akhter *et. al.*
- Basal plate of male genitalia apically to base parallel…..……*M. usrae* Akhter *et. al.*
12. Punctation on pronotum heterogeneous……*M. punctosus* (Walker)
- Punctation on pronotum homogenous…… 13
13. Basal margin of basal plate of male genitalia sub truncate……...*M. opicus* (Candèze)
- Basal margin of basal plate of male genitalia not sub truncate……14
14. 3-8 segments of antennae penultimate…….. 15
- 3-8 segments of antennae cylindrical…….. 16
15. Head with eyes narrower than anterior margin of pronotum……*M. zethneri* Platia & Schimmel
- Head with eyes broader than anterior margin of pronotum……*M. raziae* Akhter et al.
16. Clypeus with anterior margin arcuate.....*M. porioni* Platia & Schimmel
- Clypeus with anterior margin rounded..... 17
17. Elytra narrower than base of pronotum…….. *M. lobeli* Platia & Schimmel
- Elytra as broad as base of pronotum…….. *M. convexiusculus* Platia & Schimmel

**Characters of species of the genus *Melanotus* Eschscholtz of Pakistan**

$a_o$ Last visible sternite with apex subrounded.
$a_1$ Last visible sternite with apex rounded (*castanipes, besucheti, kalamensis, usrae, convexiusculus, herticornis, lobeli, opicus, ocellatus, pakistanicus, planipennis, porioni, punctosus, raziae, riesei, thomasi, zethneri*)
$a_2$ Last visible sternite with apex truncated (*brunnipes*)

$b_o$ Pronotum as long as broad.
$b_1$ Pronotum broader than long (*castanipes, besucheti, herticornis, kalamensis, ocellatus, pakistanicus, planipennis, riesei, thomasi, usrae*)
$b_2$ Pronotum longer than broad (*convexiusculus, lobeli, opicus, porioni, punctosus, raziae, zethneri*)

$c_o$ Elytral interstriae shallowly punctured.
$c_1$ Elytral interstriae impunctate (*castanipes, riesei*)
$c_2$ Elytra interstriae punctate (*besucheti, herticornis, kalamensis, ocellatus, pakistanicus, planipennis, thomasi, usrae*)

$d_o$ Sides of pronotum parallel of length
$d_1$ Sides of pronotum parallel for more than three-quarters of length (*riesei*)
$d_2$ Sides of pronotum parallel for more than half of length (*castanipes*)

$e_o$ Antennal length equal to the length of pronotum.
$e_1$ Two or more than two antennal segments reach at base of pronotum (*besucheti, ocellatus, planipennis, thomasi*)
$e_2$ Less than two antennal segments reach at base of pronotum (*herticornis, kalamensis, pakistanicus, usrae*)

$f_o$ Combined length of 2nd and 3rd antennal segments equal to length of 4th segment.
$f_1$ Combined length of 2nd and 3rd antennal segments just shorter than 4th segment (*besucheti, planipennis*)
$f_2$ Combined length of 2nd and 3rd antennal segments clearly shorter than 4th segment (*ocellatus, thomasi*)
$g_o$ Surface of pronotum smooth.
$g_1$ Surface of pronotum glossy (*besucheti*)
$g_2$ Surface of pronotum dull (*planipennis*)

$h_o$ Pronotum without punctations.
$h_1$ Punctation on pronotum with uniform intervals (*ocellatus*)
$h_2$ Punctation on pronotum with variable intervals (*thomasi*)

$i_o$ 2nd antennal segment broader than long.
$i_1$ 2nd antennal segment as long as broad (*herticornis*)
$i_2$ 2nd antennal segment longer than broad (*kalamensis, pakistanicus, usrae*)

$j_o$ Tip of last antennal segment sub rounded.
$j_1$ Tip of last antennal segment pointed (*pakistanicus*)
$j_2$ Tip of last antennal segment rounded (*kalamensis, usrae*)

$k_o$ Basal plate of male genitalia apically to base narrow to broad.
$k_1$ Basal plate of male genitalia apically to base broad to narrow (*kalamensis*)
$k_2$ Basal plate of male genitalia apically to base parallel (*usrae*)

$l_o$ Pronotum without punctations.
$l_1$ Punctation on pronotum heterogeneous (*punctosus*)
$l_2$ Punctation on pronotum homogenous (*convexiusculus, lobeli, opicus, porioni, raziae, zethneri*)
$m_o$ Basal margin of basal plate of male genitalia truncate.
$m_1$ Basal margin of basal plate of male genitalia sub truncate. (*opicus*)
$m_2$ Basal margin of basal plate of male genitalia not sub truncate. (*convexiusculus, lobeli, orioni, raziae, zethneri*)

$n_o$ 3-8 segments of antennae sub cylindrical.
$n_1$ 3-8 segments of antennae penultimate (*raziae, zethneri*)
$n_2$ 3-8 segments of antennae cylindrical (*convexiusculus, lobeli, porioni*)

$o_o$ Head with eyes as broad as anterior margin of pronotum.
$o_1$ Head with eyes narrower than anterior margin of pronotum (*zethneri*)
$o_2$ Head with eyes broader than anterior margin of pronotum (*raziae*)

$p_o$ Scutellum sub oval shaped.
$p_1$ Scutellum shield shaped (*zethneri*)
$p_2$ Scutellum subrectangular shaped (*raziae*)

$q_o$ Clypeus with anterior margin sub truncate.
$q_1$ Clypeus with anterior margin arcuate (*porioni*)
$q_2$ Clypeus with anterior margin rounded (*convexiusculus, lobeli*)

$r_o$ Elytra broader than base of pronotum.
$r_1$ Elytra narrower than base of pronotum (*lobeli*)
$r_2$ Elytra as broad as base of pronotum (*convexiusculus*)

**Character and Characterstates of the species of the genus *Melanotus* Eschscholtz of Pakistan**

Last abdominal sternite (a):

In *M. castanipes, M. besucheti, M. kalamensis, M. usrae M. convexiusculus, M. herticornis, M. lobeli, M. opicus, M. ocellatus, M. pakistanicus, M. planipennis, M. porioni, M. punctosus, M. raziae, M. riesei, M. thomasi* and *M. zethneri* last visible sternite with apex rounded shows its synapomorphic condition ($a_1$) while last visible sternite with apex truncated in *M. brunnipes* shows its autapomorphic condition ($a_2$).

Size of pronotum (b):

In *M. castanipes, M. besucheti, M. herticornis, M. kalamensis, M. ocellatus, M. pakistanicus, M. planipennis, M. riesei, M. thomasi* and *M. usrae* pronotum broader than long shows its synapomorphic condition ($b_1$) while pronotum longer than broad in *M. convexiusculus, M. lobeli, M. opicus, M. porioni, M. punctosus, M. raziae* and *M. zethneri* shows its derived synapomorphic condition ($b_2$).

Punctation on elytral interstriae (c):

In *M. castanipes* and *M. riesei* elytral interstriae impunctate show their synapomorphic condition ($c_1$) while elytral interstriae punctate in *M. besucheti, M. herticornis, M. kalamensis, M. ocellatus, M. pakistanicus, M. planipennis, M. thomasi* and *M. usrae M. usrae* show their derived synapomorphic condition ($c_2$).

Sides of pronotum (d):
In *M. riesei* sides of pronotum parallel for more than three-quarters of length shows its autapomorphic condition ($d_1$) while sides of pronotum parallel half of length in *M. castanipes* shows its autapomorphic condition ($d_2$)

Length of antennae (e):
In *M. besucheti, M. ocellatus, M. planipennis* and *M. thomasi* two or more than two antennal segments reach at the base of pronotum show their synapomorphic condition ($e_1$) while less than two antennal segments reach at the base of pronotum in *M. herticornis, M. kalamensis, M. pakistanicus,* and *M. usrae* show their synapomorphic condition ($e_2$).

Combined length of 2nd and 3rd antennal segments (f):
In *M. besucheti* and *M. planipennis* combined length of 2nd and 3rd antennal segments just shorter than 4th segment show their synapomorphic condition ($f_1$), while combined length of 2nd and 3rd antennal segments clearly shorter than 4th segment in *M. ocellatus* and *M. thomasi* show their synapomorphic condition ($f_2$).

Surface of pronotum (g):
In *M. besucheti* surface of pronotum glossy shows its autapomorphic condition ($g_1$) while surface of pronotum dull in *M. planipennis* shows its autapomorphic condition ($g_2$).

Punctation intervals on pronotum (h):
In *M. ocellatus* punctation on pronotum with uniform intervals shows its autapomorphic condition ($h_1$) while punctation on pronotum with variable intervals in *M. thomasi* shows its autapomorphic condition ($h_2$).

Size of 2nd antennal segment (i):
In *M. herticornis* 2nd antennal segment as long as broad shows its autapomorphic condition ($i_1$) while 2nd antennal segment longer than broad in *M. kalamensis, M. pakistanicus,* and *M. usrae* show their synapomorphic condition ($i_2$).

Tip of last antennal segment (j):
In *M. pakistanicus* tip of last antennal segment pointed shows its autapomorphic condition ($j_1$) while tip of last antennal segment rounded in *M. kalamensis* and *M. usrae* show their synapomorphic condition ($j_2$).

Shape of basal plate of male genitalia (k):
In *M. kalamensis* basal plate of male genitalia apically to base broad to narrow shows its autapomorphic condition ($k_1$) while basal plate of male genitalia apically to base broad in *M. usrae* shows its autapomorphic condition ($k_2$).

Punctations on pronotum (l):
In *M. punctosus* punctations on pronotum heterogeneous shows its autapomorphic condition ($l_1$) while punctations on pronotum homogenous in *M. convexiusculus, M. lobeli, M. opicus, M. porioni, M. raziae* and *M. zethneri* show their synapomorphic condition ($l_2$).

Margin of basal plate of male genitalia (m):
In *M. opicus* basal margin of basal plate of male genitalia subtruncate shows its autapomorphic condition ($m_1$) while basal margin of basal plate of male genitalia not subtruncate in *M. convexiusculus, M. lobeli, M. porioni, M. raziae* and *M. zethneri* show their synapomorphic condition ($m_2$).

Shape of last three antennal segments (n):
In *M. raziae* and *M. zethneri,* 3-8 segments of antennae penultimate show their synapomorphic condition ($n_1$), while 3-8 segments of antennae cylindrical in *M. convexiusculus, M. lobeli* and *M. porioni* show their derived synapomorphic condition ($n_2$).

Size of head (o):
In *M. zethneri* head with eyes narrower than anterior margin of pronotum shows its autapomorphic condition ($o_1$) while head with eyes broader than anterior margin of pronotum in *M. raziae* shows its derived autapomorphic condition ($o_2$).

Shape of scutellum (p):
In *M. zethneri* scutellum shield shaped shows its autapomorphic condition ($p_1$) while scutellum subrectangular shaped in *M. raziae* show its derived autapomorphic condition ($p_2$).

Clypeus margin (q):
In *M. porioni* clypeus with anterior margin arcuate shows its autapomorphic condition ($q_1$), while clypeus with anterior margin rounded in *M. convexiusculus* and *M. lobeli* shows its synapomorphic condition ($q_2$).

Elytral length (r):
In *M. lobeli* elytra narrower than base of pronotum shows its autapomorphic condition ($r_1$), while elytra as broad as base of pronotum in *M. convexiusculus* shows its derived autapomorphic condition ($r_2$).

**Discussion on cladogram of the species of the genus *Melanotus* Eschscholtz:**
The genus *Melanotus* Eschscholtz presently represented by eighteen species, found in Pakistan. These are *M. brunnipes* (Germar), *M. riesei* Platia & Schimmel, *M. castanipes* (Paykull), *M. besuchti* Platia & Schimmel, *M. planipennis* Candèze, *M. ocellatus* Platia & Schimmel, *M. thomasi* Platia & Schimmel, *M. herticornis* (Herbst), *M. pakistanicus* Platia & Schimmel, *M. kalamensis* Akhter *et al.*, *M. usrae* Akhter *et al.*, *M. punctosus* (Walker), *M. opicus* Candèze, *M. zethneri* Platia & Schimmel, *M. raziae* Akhter *et. al.*, *M. porioni* Platia & Schimmel, *M. lobeli* Platia & Schimmel and *M. convexiusculus* Platia & Schimmel. In these species, *M. brunipes* plays out group relationship with the rest of the species of genus *Melanotus* in having the apomorphy of last visible sternite with apex truncated ($a_2$), whereas the other 17 species share a common apomorphy of last visible sternite with apex rounded ($a_1$), and further fall into two groups (Fig. 1).

The group I comprises 10 species, *viz., M. riesei, M. castanipes, M. besuchti, M. planipennis, M. ocellatus, M. thomasi, M. herticornis, M. pakistanicus, M. kalamensis* and *M. usrae,* plays out group relationship with the species of group II, in having the apomorphy of pronotum broader than long ($b_1$). The group I further falls into two evolutionary lines. The line I bears two species, *M. riesei* and *M. castanipes,* which play sister group relationship with each other and out group relationship with the remaining species of this group in having apomorphy of elytral interstriae impunctate ($c_1$). The *M. riesei* shares its derived apomorphy of sides of pronotum parallel for more than three-quarters of length ($d_1$), whereas *M. castanipes* shares its derived apomorphy of sides of pronotum parallel for more than half of length ($d_2$).

The line II of the group I further falls into two subgroups, sharing the common apomorphy of elytra interstriae punctate ($c_2$). The subgroup I comprises four species, *viz., M. besuchti, M. planipennis, M. ocellatus* and *M. thomasi,* plays out group relationship with the species of subgroup II in having the apomorphy of two or more than two antennal segments reach at base of pronotum ($e_1$). This line falls into two clades. The clade I consists of *M. besuchti* and *M. planipennis,* play sister group relationship with each other and also play out group relationship with the species of clade II in having apomorphy of combined length of 2nd and 3rd antennal segments just shorter than 4th segment ($f_1$), whereas *M. ocellatus* and *M. thomasi* play sister group relationship with each other in having the apomorphy of combined length of 2nd and 3rd antennal segments clearly shorter than 4th segment ($f_2$). The *M. besuchti* shares its derived apomorphy of surface of pronotum glossy ($g_1$), where as *M. planipennis* shares its derived apomorphy of surface of pronotum dull ($g_2$). Similarly *M. ocellatus* shares its derived apomorphy of punctation on pronotum with uniform intervals ($h_1$) while *M. thomasi* shares its derived apomorphy of punctation on pronotum with variable intervals ($h_2$).

The subgroup II of the group I comprises four species, *viz., M. herticornis, M. pakistanicus, M. kalamensis* and *M. usrae,* in which *M. herticornis* plays an out group relationship with the rest three species in having apomorphy of 2nd antennal segment as long as broad ($i_1$). Among the three species of the genus *Melanotus*, *M. pakistanicus* plays out group relationship with in having apomorphy of tip of last antennal segment pointed ($j_1$), whereas *M. kalamensis* and *M. usrae* play sister group relationship with each other in having the apomorphy of tip of last antennal segment rounded ($j_2$). The *M. kalamensis* shares its derived apomorphy of basal plate of male genitalia apically to base broad to narrow ($k_1$), while *M. usrae* shares its derived apomorphy of basal plate of male genitalia apically to base parallel ($k_2$).

The group II include seven species, *M. punctosus, M. opicus, M. zethneri, M. raziae, M. porioni, M. lobeli* and *M. convexiusculus* plays out group relationship with the species of group I in having the apomorphy of pronotum longer than broad ($b_2$). Among these species, *M. punctosus* plays out group relationship with the rest of the species of the genus *Melanotus* in this group, in having the apomorphy of puncation on pronotum heterogeneous ($l_1$). Among the remaining six species, the *M. opicus* plays out group relationship with the remaining species on its parallel clade in having the apomorphy of basal margin of basal plate of male genitalia sub truncate ($m_1$).

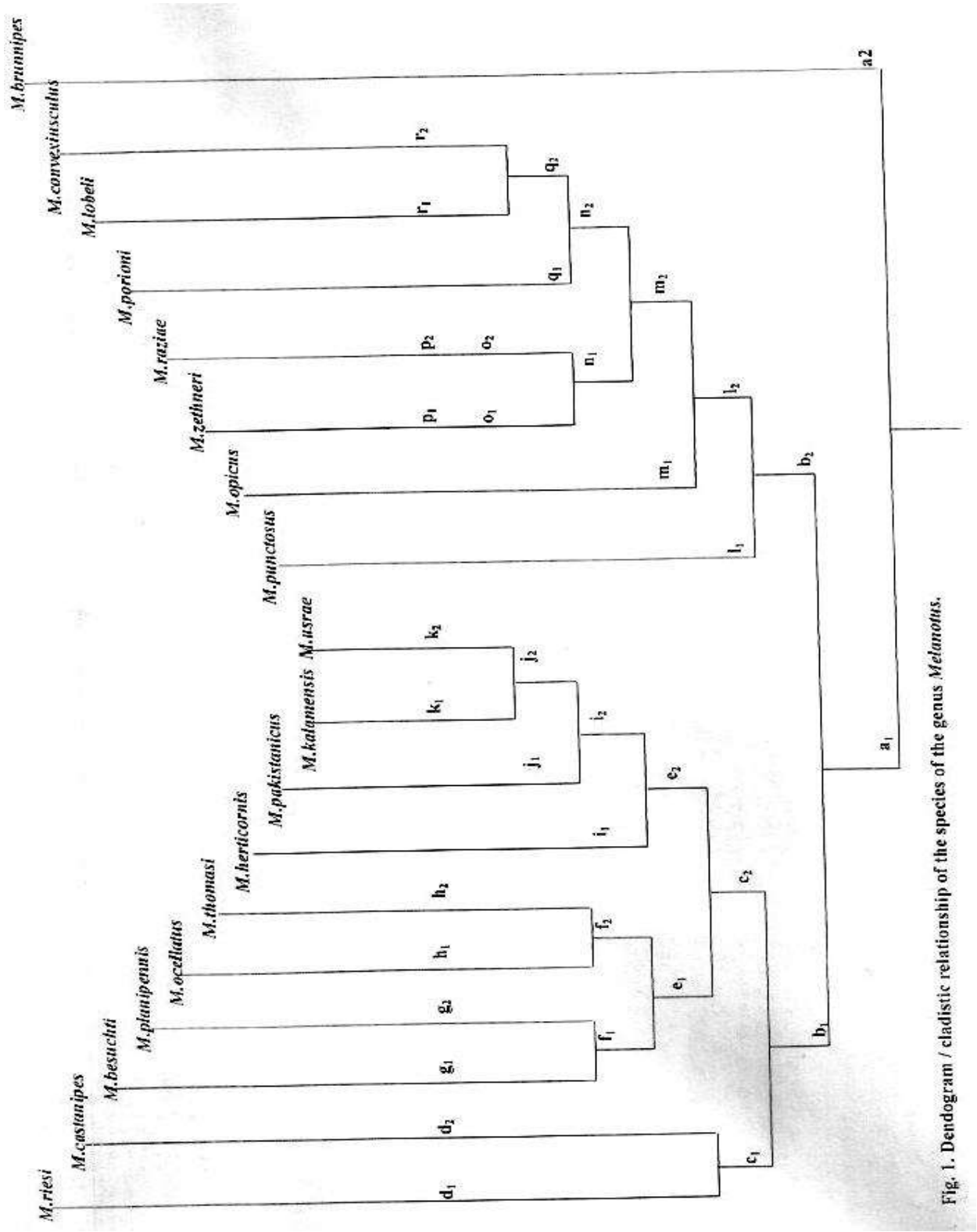


Fig. 1. Dendogram / cladistic relationship of the species of the genus *Melanotus*.

The remaining five species of the group II share a common apomorphy of basal margin of basal plate of male genitalia not sub truncate ($m_2$) and fall into two evolutionary lines. The line I comprises two species, *M. zethneri* and *M. raziae*, which plays out group relationship with the species of line II in having the apomorphy of 3-8 segments of antennae penultimate ($n_1$). The *M. zethneri* shares its derived apomorphies of scutellum shield shaped ($p_1$) and Head

with eyes narrower than anterior margin of pronotum ($o_1$), where as *M. raziae* shares its derived apomorphies of scutellum subrectangular shaped ($p_2$) and Head with eyes broader than anterior margin of pronotum ($o_2$).

The line II comprises three species, *M. porioni*, *M. lobeli* and *M. convexiusculus* plays out group relationship with the line I in having the apomorphy of 3-8 segments of antennae cylindrical ($n_2$), in which *M. porioni* plays out group relationship with the other two species in having the apomorphy of clypeus with anterior margin arcuate ($q_1$), whereas *M. lobeli* and *M. convexiusculus* play sister group relationship with each other in having the apomorphy of clypeus with anterior margin rounded ($q_2$). The *M. lobeli* shares its derived apomorphies of elytra narrower than base of pronotum ($r_1$) while *M. convexiusculus* shares its derived apomorphies of elytra as broad as base of pronotum ($r_2$).

**REFERENCES**


Akhter, M. A., G. Platia, S.A. Rizvi and A. Zubair (2011a). A new species of *Melanotus* (Eschscholtz, 1829) with notes on other species of the genus from Pakistan (Coleoptera: Elateridae). *Pakistan Journal of Zoology*. 43(3): 581-585.

Akhter, M. A., G. Platia, S.A. Rizvi and A. Zubair (2011b). Two new species of the genus *Melanotus* Eschscholtz (Coleoptera, Elateridae, Melanotinae) from Pakistan. *Zootaxa*, 3101: 47-52.

Beutel, R. G. (2009). Phylogenetic analysis of Elateriformia (Coleoptera: Polyphaga) based on larval characters; *Journal of Zoological Systematics and Evolutionary Research*; DOI: 10.1111/j.1439-0469.1995.tb00969.x

Casari, S. (2008). A phylogenetic study of the subtribe Dicrepidiina (Elateridae, Elaterinae, Ampedini); *Revista Brasileira de Entomologia*, 52 (2): 182-260.

Hashmi, A. A. and A. Tashfeen (1992). Coleoptera of Pakistan. *Procedings of Pakistan Congress of Zoology,* 12: 133-170.

Hayek, C. M. F. von (1990). A reclassification of the *Melanotus* group of genera (Coleoptera: Elateridae). *Bulletin British Museum Natural History (Entomolgy),* 59: 37-115.

Lindroth, E and T. Clark (2007). *Molecular Diagnostics of Economically Important Wireworm Species (Coleoptera: Elateridae) in the Midwestern United States*. M.Sc. Thesis, Faculty of the Graduate School at the University of Missouri-Columbia.

Nixon, K. C. and J.M. Carpenter (1993). On out groups. *Cladistics,* 9: 413–426.

Oba, R. S., Y. Oba and H. Ôhira (2007). Phylogenetic relationships of click beetles (Coleoptera: Elateridae) inferred from 28S ribosomal DNA: Insights into the evolution of bioluminescence in Elateridae; *Molecular Phylogenetics and Evolution*, 42 (2): 410-421.

Platia, G. (2005). Descrizione di Nuove Specie di Melanotini della Regione Indomalese, con note Geonemiche (Coleoptera, Elateridae, Melanotinae). *Boletin Sociedad Entomológica Aragonesa*, 36 : 85-92.

Platia.G and R.Schimmel (2001). Revisione delle specie orientali (Giappone e Taiwan esclusi) del genere *Melanotus* Eschscoltz,1829 (Coleoptera, Elateridae, Melanotinae).*Museo Regionale di Scienze Naturali*, Torino-Monografie, 27: 638pp.

Quate, L.W. and S.E. Thompson (1961). Revision of click beetles of genus *Melanotus* in America north of Mexico (Coleoptera: Elateridae). *Proceeding U.S. Natural Museum*, 121: 1-83, 1 pl.

Riley, T.J. and A.J. Keaster (1975). Six species of wireworms of the genus *Melanotus* associated with corn in Missouri (Coleoptera: Elateridae). *Journal of Kansas Entomological Society,* 48: 503.

Riley, T.J. and A.J. Keaster (1979). Wireworms associated with corn: identification of larvae of nine species of *Melanotus* from the north central states. *Annuls Entomology Society of Amarica,* 72: 408-414.

Riley, J.J. and A.J. Keaster (1981). *A pictorial field key to wireworms attacking corn in the Midwest*. USDA/SEA Extension Integrated Pest Management Program.

Smith, J. W. and W. R. Enns (1977). The Click Beetle Subfamilies Agrypninae, Pyrophorinae, and Melanotinae (Coleoptera: Elateridae) in Missouri: Part I. *Journal of the Kansas Entomological Society*, 50 (3): 436-468.

Smith, J.W. and W.R. Enns (1978). The click beetle subfamilies Agrypninae, Pyrophorinae, and Melanotinae (Coleoptera: Elateridae) in Missouri - Part II. *Journal of the Kansas Entomological Society,* 51: 42-74.

Stibick, J. N. L. (1979). Classification of the Elateridae (Coleoptera) relationships and classification of the subfamilies and tribes. *Pacific Insects,* 20 (2-3): 145-186.

Van Zwaluwenburg, R.H. (1922). External anatomy of the elaterid genus *Melanotus* (Coleoptera) with remarks on the taxonomic value of certain characters. *Proceeding Entomological Society Washington*, 24: 12-29.

Vats, L.K. and R.L.Chauhan (1991). Species of *Melanotus* Eschscholtz (Elateridae: Coleoptera). *Journal of Entomological Research*, 15(3):187-196.


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