UNIVERSITI PUTRA MALAYSIA

TAXONOMIC REVISION OF STINOCHIINAE, TENEBRIONINAE AND DIAPERINAE (COLEOPTERA:TENEBRIONIDAE) FROM MALAYSIA

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TAXONOMIC REVISION OF STINOCHIINAE, TENEBRIONINAE AND DIAPERINAE (COLEOPTERA:TENEBRIONIDAE) FROM MALAYSIA

By

DARYA KAREEM HWAYYIZ

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

I would like to dedicate to my beloved husband who helped me all the time during my study. Similarly, many thanks go to my father, brothers and sisters who supported me with prayers and endured the pain of being away for four years. In last, I also would like to dedicate my friends, who helped me with all what they got and these are the people whom I will never forget.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Doctor of Philosophy

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March 2017

Chairman : Associate Professor Nur Azura Adam, PhD
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This study established the current taxonomic status of 30 species of darkling beetles (Coleoptera: Tenebrionidae) in Malaysia. A total of 392 specimens were examined. Thirty species has been identified belonging to three subfamilies, nine tribes and 17 genera with four potential new species and one potential new genus. A total number of 16 species were recorded for the first time in Malaysia namely *Amarygmus metallicus, A. ovoides, Derosphaerus aeruginosus, Gonocephalum hispidocostatum, Leprocaulus rotundicollis, Promethis semisulcata, P. coracina, P. punctulator, P. opaca, Pseudonautes vagevittatus, Pseudoblaps javana, Strongylium erythrocephalum, S. orientale, S. various, Uloma sextuberosa* and *U. excise.* A total of 42 internal and external morphological characteristic have been described for each species. Eleven structures for each species were illustrated based on their specific state namely antenna, labrum, labium, mandible, maxilla, pronotum, fore-leg, mid-leg, hind-leg, elytra, aedeagus. Taxonomic key to genera of subfamily Stinochiinae, genera of subfamily Tenebrioninae and the species of the genera *Promethis*, *Strongylium*, *Eucyrtus*, *Gauromaia*, *Amargymus*, *Uloma*, *Tribolium* species has been successfully developed. The distribution of Tenebrionidae species in Malaysia were shown in the maps for each species. The most common species is *Tribolium castanum, Tribolium confusum,* some species of the genus *Promethis,* the less common species is *Uloma excisa*, and rare species is *Strongylium varians*. A comprehensive checklist of Malaysian Tenebrionidae was developed for the first time with the total number of 207 species belonging to 64 genera. The highest number of the species has been found in Borneo followed by Penang and Malacca. The less number of the species have been found in Perak. The taxonomical effort produced from this study will be helpful for enhancing the species discovery while maintaining species inventories of Malaysian Tenebrionidae.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

SEMAKAN TAKSONOMI STINOCHIINAE, TENEBRIONINAE DAN DIAPERINAE (COLEOPTERA:TENEBRIONIDAE) DARI MALAYSIA

Oleh

DARYA KAREEM HWAYYIZ

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Pengerusi : Profesor Madya Nur Azura Adam, PhD
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Kajian ini telah memperihalkan status semasa taksonomi 30 spesies kumbang Tenebrionidae (Coleoptera) di Malaysia. Sejumlah 392 spesimen telah diperiksa. Sebanyak 30 spesies telah diperihal tergolong dalam tiga subfamili, sembilan tribus dan 17 genus dengan potensi tiga spesies baru dan satu genus baru. Sejumlah 16 spesies telah direkodkan buat kali pertama di Malaysia iaitu *Amarygmus metallicus, A. ovoides, Derosphaerus aeruginosus, Gonocephalum hispidocostatum, Leprocaulus rotundicollis, Promethis semisulcata, P. coracina, P. punctulator, P. opaca, Pseudonautes vagevittatus, Pseudoblaps javana, Strongylium erythrocephalum, S. orientale, S. various, Uloma sextuberosa* and *U. excise*. Sebanyak 42 ciri morfologi dalaman dan luaran telah diperihalkan bagi setiap spesies. Sebanyak 11 struktur bagi setiap spesies telah diilustrasi berdasar kepada ciri spesifiknya iaitu antena, labrum, labium, mandibel, maksila, pronotum, kaki hadapan, kaki tengah, kaki belakang, elitra dan aedegus. Taburan spesies Tenebrionidae di Malaysia ditunjukkan dalam peta. Spesies paling umum ialah *Tribolium castanum, Tribolium confusum* dan sebahagian spesies di bawah genus *Promethis* manakala spesies kurang umum ialah *Uloma excisa*, manakala spesies langka ialah *Strongylium varians*. Satu senarai semak yang komprehensif telah dibangunkan buat pertama kalinya untuk spesies Tenebrionidae di Malaysia di mana jumlah spesies Tenebrionidae Malaysia adalah sebanyak 207 spesies terdiri daripada 64 genera. Jumlah spesies terbanyak dijumpai di Borneo diikuti oleh Pula Pinang dan Melaka. Perak mempunyai bilangan spesies terendah. Usaha kajian taksonomi daripada kajian ini membantu dalam meningkatkan penemuan spesies di samping menyelenggara inventori spesies Tenebrionidae di Malaysia.

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I certify that a Thesis Examination Committee has met on 31 March 2017 to conduct the final examination of Darya Kareem Hwayyiz on her thesis entitled "Taxonomic Revision of Stinochiinae, Tenebrioninae and Diaperinae (Coleoptera: Tenebrionidae) from Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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This is to confirm that:

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LIST OF ABBREVIATIONS

IMUMS	Insect museum of Universti Malaysia Sabah
IMUPM	Insect Museum of Universti Putra Malaysia.
CIS	Center of Insect Systematic Universiti Kebangsaan Malaysia.
KCCS	Kinabalu Commercial College Sabah.
FRC	Forest research Center in Sabah, Sandakan
NRMS	Swedish of Natural history museum

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Tenebrionidae is the fifth largest and one of the most diverse families within order Coleoptera that contains more than 18,000 insect species (15,000 described) world wide (Matthews & Bouchard, 2008) and exhibits an extraordinary wide range of superficial dissimilarity. It makes up the large group of nocturnal beetles and usually referred as "Darkling Beetles" that is a common name for this large family.

Family Tenebrionidae is of a great economic importance as it contains insect pests that are cosmopolitan in nature and most imperatively are associated with stored products (Martin *et al.,* 2012). Generally, these insect pests feed on plant materials including decaying matter, wood, leaf litters, pollen, fungal and algal matters. Some are also scavengers whereas few of them are predatory especially the wood boring beetles. In Tenebrionidae, insect species are mostly large in size and flightless beetles however other insect species within similar family living in rotten wood and stored products are also small in size (Soldati & Soldati, 2003).

The greater numbers of these species occur in warmer climates particularly in the more arid regions such as in the Namib and Gobi deserts. The varied adaptations of the species enable them to survive in extreme high temperature and the periods of prolonged drought. These facts have caused the Tenebrionidae to be regarded as the most highly evolved family of the Cucujoidea (Crowson, 1955). These darkling beetles that inhabit in the most torrid deserts can survive in a temperature of 50°C, they normally burrow under the stones, bark and leaf litters and they have long legs that keep their bodies at a safe distance from the burning sand and enable them to move speedily, many of these are excellent burrowers and can bury themselves in the sand immediately to escape from the heat (Schawaller, 1996; Bouchard *et al.,* 2005).

The great importance of family-group names for the classification and nomenclatural stability of Coleoptera was clearly demonstrated by Lawrence and Newton (1995). But, due to close resemblances to the members of other families, some of the adults in family Tenebrionidae have been often wrongly identified in a preliminary sorting stage especially in most Carabidae (Chrysomelidae) identification (Watt, 1974). Previously, the most systematic work has been carried out at the specific and generic levels and few have attempted to improve the higher classification within the family.

The morphological diversity of the members of this family is very difficult to diagnose the entire fauna (Aalbu *et al.,* 2002), however a synthetic treatment of the taxonomy, biology and distribution of Tenebrionidae has been previously presented. But it still largely comprises a synthesis of the classifications given by Leconte & Horn (1883)

and Lacordaire (1859) which were mostly based on adults because of the great similarities between the species of this family so it was important to show the different characters of the species, larvae in this family tend to be more uniform and easily recognisable superficially.

Therefore, this study has been attempted to provide a stable classification scheme for the family Tenebrionidae especially for three Subfamilies such as Stinochiinae, Tenebrioninae and Diaperinae with a synoptic classification of the world fauna that summarizes recent knowledge about the relationships among suprageneric groups as well as a catalogue of family-group names especially in Malaysian agro-ecosystem.

1.2 Significance of the study

Due to the economic damages caused by some of the species of the subfamilies Stinochiinae, Tenebrioninae and Diaperinae, it is essential to conduct a study for their proper identification. There is still a gap in their taxonomical study of the insect species from these subfamilies especially in Malaysia therefore it is an important to identify these species in order to control their damages.

1.3 Research Objective(s)

The objectives of this study are:

1- to identify the selected species of family Tenebrionidae and study their distribution in Malaysia.
2- to construct the keys of selected species of family Tenebrionidae in Malaysia.
3- to describe and illustrate the selected morphology characters of each species and to describe the genitalia.
4- to develop a checklist of Malaysian Tenebrionidae.

1.4 Outline of thesis

This thesis is divided into five chapters. After an introductory Chapter 1, Chapter 2 presented some background of the research with a literature addressing two important topics of taxonomy and key identification. In Chapter 3, material and methods are presented while Chapter 4 postulated the construction of the keys of each species, identification, description, illustration and a checklist are also provided. Finally, in Chapter 5, summary of this study and recommendations for future research have been presented.

REFERENCES

Aalbu, R. L. (2005, b). The pimeliine tribe Cryptoglossini: classification, biology and inferred phylogeny (Coleoptera: Tenebrionidae). In*Annales Zoologici* (Vol. 55, No. 4, pp. 677-756). Museum and Institute of Zoology, Polish Academy of Sciences.

Aalbu, R. L. (2006). where are we at: Assessing the currents state of tenebrionidae systematics on a global scale (Coleoptera: Tenebrionidae).*Cahiers scientifiques-Muséum d'histoire naturelle de Lyon*, (10), 55-70.

Aalbu, R. L., Triplehorn, C. A., Campbell, J. M., Brown, K. W., Somerby, R. E., & Thomas, D. B. (2002). Tenebrionidae Latreille 1802 [pp. 463–509].*American beetles*, *2*.

Aalbu., R. L., Triplehorn, C. A., Campbell, J. M., Brown, K. W., Somerby, R. E. & Thomas, D. B. (2002 b). 106. Tenebrionidae Latreille 1802. Pp. 463–509 in Arnett, R. H., Jr., Thomas, M. C., Skelley, P. E. & Frank, J. H. (eds.) American Beetles. Vol. 2. Polyphaga: Scarabaeoidea through Curculionoidea. CRC Press, Gainesville, Florida.

Abu-Asab, M. S., Peterson, P. M., Shetler, S. G., & Orli, S. S. (2001). Earlier plant flowering in spring as a response to global warming in the Washington, DC, area. *Biodiversity & Conservation*, *10*(4), 597-612.

Allsopp, P. G. (1979). Identification of false wireworms (Coleoptera: Tenebrionidae) from southern Queensland and northern New South Wales. – Journal of the Australian Entomological Society 18: 277–286.

Allsopp, P. G. (1980 a). The biology of false wireworms and their adults (soil-inhabiting Tenebrionidae) (Coleoptera): a review. – Bulletin of Entomological Research 70 (3): 343–379.

Allsopp, P. G. (1981). Development, longevity and fecundity of the false wireworms Pterohelaeus darlingensis and P. alternatus (Coleoptera: Tenebrionidae). 1. Effect of constant temperature. – Australian Journal of Zoology 29 (4): 605–619.

Allsopp, P. G. (1982). Development, longevity and fecundity of the false wireworms Pterohelaeus darlingensis and P. alternatus (Coleoptera: Tenebrionidae) 2. Effect of food type. – Australian Journal of Zoology 30 (2): 233–242.

Allsopp, P. G. (1986 a). Development, longevity and fecundity of the false wireworms Pterohelaeus darlingensis and P. alternatus (Coleoptera: Tenebrionidae) 4. Models for larval and pupal development under fluctuating temperatures. – Australian Journal of Zoology 34 (6): 815–825.

Allsopp, P. G. (1986 b). Identification of an additional false wirewormCestrinus trivialis Erichson (Coleoptera: Tenebrionidae) from south Queensland. – Journal of the Australian Entomological Society 25: 137–140.

Allsopp, P. G., Adams, G. D. & Butler, D. G. (1980). Response of larvae of Pterohelaeus darlingensis Carter (Coleoptera: Tenebrionidae) to moisture, temperature and gravity. – Journal of the Australian Entomological Society 19 (4): 281–285.

Ardoin, P. (1961). Contribution à l'étude des ténébrionides malgaches. Deux nouveaux genres d'Adeliini malgaches. – Bulletin de l'Académie Malgache (N.S.) 37: 31–33.

Arentt, R. H. (1963). The beetles of the United States. Catholic Univ. of America Press, Washington, D.C. (No. 595.76 A75).

Bates, F. (1868). Descriptions of New Genera and Species of Heteromera. *Transactions of the Royal Entomological Society of London*,*16*(4), 309-326.

Beutel, R. G., & Leschen, R. A. B. (2005). Handbook of Zoology: A Natural History of the Phyla of the Animal Kingdom. Volume IV Arthropoda: Insecta, Part 38. Coleoptera, Beetles. Volume 1: Morphology and Systematics (Archostemata, Adephaga, Myxophaga, Polyphaga partim).

Bouchard, P., & Löbl, I. (2008). Case 3401 Delognatha Lacordaire, 1859 (Insecta, Coleoptera): proposed conservation. *Bulletin of Zoological Nomenclature*, *65*, 3.

Borchmann, F. (1910 a): Coleopterorum Catalogus. Pars 2. Nilionidae, Othniidae, Aegialitidae, Petriidae, Lagriidae. 32 pp. W. Junk, Berlin.

Borchmann, F. (1910 b): Coleopterorum Catalogus. Pars 3. Alleculidae. 80 pp. W. Junk, Berlin.

Bouchard, P., Lawrence, J. F., Davies, A. E., & Newton, A. F. (2005, b). Synoptic classification of the world Tenebrionidae (Insecta: Coleoptera) with a review of family-group names. In *Annales Zoologici* (Vol. 55, No. 4, pp. 499-530). Museum and Institute of Zoology, Polish Academy of Sciences.

Bouchard, P., Löbl, I., & Merkl, O. (2007, September). Nomenclatural notes on tenebrionid beetles of the Palaearctic Region (Insecta: Coleoptera). In*Annales zoologici* (Vol. 57, No. 3, pp. 385-394). Museum and Institute of Zoology, Polish Academy of Sciences.

Böving, A. G., & Craighead, F. C. (1931). Illustrated synopsis of the principal larval forms of the order Coleoptera.

Brendell, M. J. D. 1975. Hand books for the identification of British insects. London published by the society and sold at its rooms 41, queens gate, S.W. Vol. V. Part 10 .

Brown, J. W. (2001). Species turnover in the leafrollers (Lepidoptera: Tortricidae) of Plummers Island, Maryland: Assessing a century of inventory data. *Proceedings-Entomological Society of Washington*,*103*(3), 673-673.

Calkins, C. O., & Kirk, V. M. (1973). Distribution and movement of adult false wireworms in a wheat field. *Annals of the Entomological Society of America*, *66*(3), 527-532.

Carl, M. (1992). A revision of the genus Micriotelus Solier , (Coleoptera – Tenebrionidae). Zoology in the middle East 69-87.

Chernei, L. S. & Fedorenko, V. P. (2006). Identification keys to the darkling beetles (Coleoptera, Tenebrionidae) of the Ukrainian fauna. 248 pp.

Crowson, R. A. (1955). The Natural Classification of the Families of Coleoptera. 187 pp. *Nathaniel Lloyd, London*.

Curran, L. M., Trigg, S.N., McDonald, A.K. et al. (2004) "Lowland Forest Loss in Protected Areas of Indonesian Borneo." Science, 303 (5660), 1000–1003. doi:10.1126/science.1091714.

Dobie, P. (1991). Host-plant resistance to insects in stored cereals and legumes. *Ecology and Management of Food-Industry Pests*, 373-383.

Doyen, J. T. & Tschinkel, W. R. (1982). Phenetic and cladistic relationships among tenebrionid beetles (Coleoptera). Syst Entomol. 7: 127–183.

Doyen, J. T. (1972). Familial and subfamilial classification of the Tenebrionoidea (Coleoptera) and a revised generic classification of the Coniontini (Tentyriidae). *Quaestiones entomol*. 8: 357–376.

Doyen, J. T., & Lawrence, J. F. (1979). Relationships and higher classification of some Tenebrionidae and Zopheridae (Coleoptera).*Systematic entomology*, *4*(4), 333-377.

Doyen, J. T., & TSCHINKEL, W. R. (1982). Phenetic and cladistic relationships among tenebrionid beetles (Coleoptera). *Systematic entomology*, *7*(2), 127-183.

Doyen, J. T., Matthews, E. G. & Lawrence, J. F. (1990). Classification and annotated checklist of the Australian genera of Tenebrionidae (Coleoptera).– Invertebrate Taxonomy 3 (1989): 229–260.

Drinkwater, T. W. (1999). Regional distribution of Gonocephalum species (Coleoptera: Tenebrionidae) in maize fields in South Africa. *African entomology*, *7*(2), 183-187.

Drinkwater, T. W., Giliomee, J. H., & Pringle, K. L. (1990). The geographical distribution of false wireworms, Somaticus species (Coleoptera: Tenebrionidae) associated with maize in South Africa. *Journal of the Entomological Society of Southern Africa*, *53*(2), 127-136.

Drinkwater, T. W., Giliomee, J. H., & Pringle, K. L. (1996). Development rates of the false wireworm, Somaticus angulatus (Faehraeus)(Coleoptera: Tenebrionidae), at different temperatures. *African entomology*, *4*, 21-24.

Drinkwater, T.W.(1989). Occurrence of soil-inhabiting Tenebrionidae (Coleoptera) in maize fields in South Africa. – Phytophylactica 21 (4): 397–398.

Endrödy-Younga, S. & Schawaller, W. (2002). First record of Laenini (Coleoptera: Tenebrionidae) from South Africa, with descriptions of two genera and several new species. – Annals of the Transvaal Museum 39: 9–21

Erwin, T. L. (1981). The ground beetles of a temperate forest site (Coleoptera: Carabidae): An analysis of fauna in relation to size, habitat selection, vagility, seasonality, and extinction. *Bulletin of the Biological Society of Washington*, *5*, 104-224.

Fairmaire (1899). et description d'une nouvelle espèce de Borneo (Coleoptera, Tenebrionidae). Nouv. Rev. Ent. (N. S.) 17(3): 233–244

Fernald, H. T. and Sheparo, H. H. (1955). Applied Entomology An Introduce text book of insect in there relations to man. Mc Grawltill book company, Inc. New xork. 385 p.

Ferrer, J. and Degard, O. (2005). New species of darkling beetles from central America with systematic notes (Coleoptera:Tenebrionidae). Annales Zoologici, (Warszawa), 55(4): 633-661

Ferrer, J. (1995). Contribution to the knowledge of the Tenebrionidae of Somalia (Coleoptera). *Frustula Entomologica, Nuova, Serie*, *18*, 1-76.

Ferrer, J. (2006). Constitution du groupe indo-africain des Falsocossyphini, tribus nova, et description d'un nouveau genre hypogee du Vietnam. Coleoptera, Tenebrionidae. *Cahiers scientifiques-Muséum d'histoire naturelle de Lyon*, (10), 75-83.

Ferrer, J., & Moragues, G. (2000). Révision des espèces appartenant au genre Pheugonius Fairmaire (1899). et description d'une nouvelle espèce de Borneo (Coleoptera, Tenebrionidae). *Nouv. Rev. Ent.(NS)*, *17*(3), 233-244.

Freeman, I. (1980). Common insect pest of stored food productos . 6th ed. Br. T. M. *(Nat. Hist.) Econ. Ser. No.* 15. 100

Gall, A. (1980) Are lesser mealworms worth the trouble they cause. Poultry Digest Feb: 76/77.

Gebien, H. (1937). Katalog der Tenebrioniden. Teil 3, Unterfamilie Asidinae.*Publicazioni del Museo entomologico "Pietro Rossi*, 663-791.

Gebien, H. (1944). *Katalog der Tenebrioniden (Coleoptera heteromera)*. Verlag J. Pfeiffer.

Grimm, R. (2004 a). Die Arten der Gattung Ulomina Baudi di Selve, mit Beschreibungen von drei neuen Arten aus Laos und Thailand (Coleoptera: Tenebrionidae: Palorinae). – Stuttgarter Beiträge zur Naturkunde. Ser.A664: 1–10.

Grimm, R. (2004 b). Neve Arten der Gallung Palorinus Blair, 1930 und Paloropsis Masumoto et Grimm, 2004 aus Indien und Thailand (Coleoptera, Tenebrionidae, Palorinae). – Entomologica Basiliensia 26: 293–298.

Grimm, R. (2008). Guanobius borneensis n. gen., n. sp. from Borneo (Coleoptera: Tenebrionidae: Alphitobiini). *Stuttgarter Beiträge zur Naturkunde A, Neue Serie*, *1*, 375-379.

Halstead, D. G. H. (1967): A revision of the genus Palorus (sens. lat.) (Coleoptera: Tenebrionidae). – Bulletin of the British Museum (Natural History), Entomology 19: 61–148.

Hill, D. S. (2008). Pests of crops in warmer climates and their control. *Springer Science & Business Media*.

Hiremath, I. G., Lingappa, S., Viraktamath, C. A., & Ali, T. M. M. (1986). Occurrence of the ground beetle, Gonocephalum hofmannseggi (Coleoptera: Tenebrionidae) on finger millet (Eleusine coracana (L.) Gaertn). *Journal of soil biology & ecology*. *6* (1): 62–66.

Hoffman, R. L., & Steiner, W. E. (2005). Jadera haematoloma, another insect on its way north (Heteroptera: Rhopalidae). *Banisteria*, *26*, 7-10.

Horion, A. (1956). Faunistik der mitteleuropäischen Käfer. Band V. Heteromera.. *Museum G. Frey, Tutzing bei München. xv* + 336 pp.

Imms, A. D. 1964. A General Textbook of Entomology. Ninth Edition. London: Methuen and Co. Ltd. 886 pp.

Junk, W., & Schenkling, S. (1910). Coleopterorum catalogus. W. Junk.

Junk,W.(1911).Coleopterorum Calalogus.Berin W. I5, Kurfuerstendamm 20I. 24. III. 1911.

Kaszab, Z. (1980). Neue Tenebrioniden (Coleoptera) aus Sri Lanka. I. II. – Acta Zoologica Academiae Scientiarum Hungaricae 26 (1–3, 4): 123–196, 285–375.

Kaszab, Z. (1985). Beiträge zur Kenntnis der Pazifischen Tenebrioniden (Coleoptera). *Folia Entomol. Hung*, *46*(1), 23-63.

Kaszab, Z.(1979): Tenebrioniden aus Südindien (Coleoptera). – Acta Zoologica Academiae Scientiarum Hungaricae 25 (3–4): 259–310.

Kobayashi, T., & Aguero, G. D. (1988). Singular occurrence of soybean insect pests and the control of them under the severe drought condition in Paraguay. *JARQ, Japan Agricultural Research Quarterly*, *22*(2), 157-160.

Koch, C. (1955). *Monograph of the Tenebrionidae of southern Africa* (No. 7). Transvaal Museum.

Koh, L.P., Wilcove D.S. (2008) Is oil palm agriculture really destroying tropical biodiversity? Conserv Lett 1, 60–64.

Krombein, K. V. (1963). Annotated list of the wasps (Hymenoptera): Bethyloidea, Scolioidea, Vespoidea, Pompiloidea, Sphecoidea). *Natural history of Plummers Island, Maryland. Proceedings of the Biological Society of Washington* 76:255–280

Lacordaire, T. (1859). Rhipiphorides. *Histoire naturelle des insectes. Genera des Coldopteres. Librairie Encyclop6dique de Roret, Paris*, *5*(pt 1), 616-633.

Latreille, P. A. (1802). Histoire naturelle, générale et particulière des crustacés et des insectes. *Familles naturelles des genres*. Vol. 3. 387 pp. 16–37 pls. F. Dufart, Paris.

Lawrence, J. F. (1994). The larva of Sirrhas variegatus, sp. nov., with notes on the Perimylopidae, Ulodidae (stat. nov.), Zopheridae and Chalcodryidae (Coleoptera: Tenebrionoidea). *Invertebrate Systematics*, *8*(2), 329-349.

Lawrence, J. F., & Slipinski, S. A. (1999). Phylogeny and classification of Zopheridae sensu novo (Coleoptera: Tenebrionoidea) with a review of the genera of Zopheridae (excluding Monommatini). In *Annales zoologici* (Vol. 49, pp. 1-53).

Lawrence, J. F., Newton, A. F., Pakaluk, J., & Slipinski, S. A. (1995). *Families and Subfamilies of Coleoptera: With Selected Genera, Notes, References and Data on Family-group Names*. Museum i Instytut Zoologii PAN.

LeConte, J. L., Horn, G. H., & Henshaw, S. (1883). *Classification of the coleoptera of North America* (Vol. 26, No. 4). Smithsonian institution.

Lillig, M., & Pavlíček, T. (2003). *The Darkling Beetles of the Sinai Peninsula: Coleoptera: Tenebrionidae (excl. Lagriinae Et Alleculinae)* (Vol. 1). Kasparek Verlag.

Lillig, M., Barthet, H. B., & Mifsud, D. (2012). An identification and informative guide to the Tenebrionidae of Malta (Coleoptera). *Bulletin of the entomological Society of malta*, *5*, 121-160.

Löbl, I., Ando, K., Bouchard, P., Egorov, L. V., Iwan, D., Lillig, M., ... & Petterson, R. (2008). Family Tenebrionidae Latreille, 1802. *Catalogue of Palaearctic Coleoptera*, *5*, 105-352.

Martin, O. Y., Gubler, A., Wimmer, C., Germann, C., & Bernasconi, M. V. (2012). Infections with Wolbachia and Spiroplasma in the Scathophagidae and other Muscoidea. *Infection, Genetics and Evolution*, *12*(2), 315-323.

Masumoto, K (1996). Fourteen new Laena (Coleoptera, Tenebrionidae) from China, Vietnam and Thailand.– Bulletin of the National Science Museum, Series A, 22 (3): 165–178.

Masumoto, K (2001). Anew genus and species of the Tribe Adeliini (Coleoptera, Tenebrionidae) from the Upper Hypogean Zone of Southwest China. – Journal of the Speleological Society of Japan 26: 44–49.

Masumoto, K. & Grimm, R. (2004). A new genus and species of the Palorinae (Coleoptera: Tenebrionidae) from Japan. – Entomological Review of Japan 59 (1): 127 – 130.

Masumoto, K.(1990): New Himalayan species of Laena (Coleoptera, Tenebrionidae) preserved in the collection of the National Science Museum, Tokyo. – Bulletin

Matthews, E. G. & Bouchard, P. (2007). Australian Faunal Directory. Checklist for Tenebrionidae Coleoptera. (http://www.environment.gov.au/cgibin/abrs/fauna/details.plpstrVol=TENEBRIONIDAE;pstrTaxa=131;pstrChecklistMode=1). (Accessed 30 October 2008.)

Matthews, E. G. (1986). A revision of the troglophilic genus Brises Pascoe, with a discussion of the Cyphaleini (Coleoptera, Tenebrionidae). *Records of the South Australian Museum*, *19*(6), 77-90.

Matthews, E. G. (1998). Classification, phylogeny and biogeography of the genera of Adeliini (Coleoptera: Tenebrionidae). *Invertebrate Taxonomy*, *12*, 685-824.

Matthews, E. G. (2003 b). The Palorus group – a new subfamily of Tenebrionidae. – Spixiana 26: 49–55.

Matthews, E. G., & Bouchard, P. (2008). Tenebrionid beetles of Australia: description of tribes, keys to genera, catalogue of species. *Australian Biological Resources Study.* viii + 398 pp.

Matthews, E. G., & Bouchard, P. (2008). *Tenebrionid beetles of Australia: description of tribes, keys to genera, catalogue of species*. Australian Biological Resources Study. . viii + 398 pp.

Mccolloch, J. W. (1918). Notes on false wireworms with especial reference to Eleodes tricostata Say. *Journal of Economic Entomology*, *11*, 212-224.

Mccolloch, J. W. (1919). Eleodes opaca Say, an important enemy of wheat in the Great Plains area. *Journ. Econ. Ent*, *12*, 183-194.

Medvedev, G. S. (1968). Coleoptera. *Darkling beetles (Tenebrionidae). Subfamily Opatrinae. Tribes Platynotini, Dendarini, Pedinini, Dissonomini, Pachypterini, Opatrini (part) and Heterotarsini*, *19*(Part 2), 1-285.

Medvedev, G. S. (1973). position of the genera Leichenum Dej. and Idisia Pask.(Coleoptera, Tenebrionidae) in the system, and the description of new genus from the northern Karakums. *Entomological review*.

Medvedev, G. S. (2006). To the systematics and nomenclature of tenebrionid beetles of the tribes Phaleriini, Lachnogyini, Klewariini, and Blaptini (Coleoptera, Tenebrionidae). *Entomological Review*, *86*(7), 820-839.

Nabozhenko, M. V. (2001). On the classification of the tenebrionid tribe Helopini, with a review of the genera Nalassus Mulsant and Odocnemis Allard (Coleoptera, Tenebrionidae) of the European part of CIS and the Caucasus. *Entomological Review*, *81*(8), 909-942.

Pascoe, F. P. (1869). Descriptions of New Genera and species of Tenebrionidae from Australia and Tasmania.– Annals and Magazine of Natural History (4) 3:29–45.

Peck, S. B. (2005). A checklist of the beetles of Cuba with data on distributions and bionomics. *Insecta, Coleoptera. Arthrropods of Florida and neighboring land areas*, *18*, 1-214.

Peck, S. B.(2006). The Beetles of the Galápagos Islands, Ecuador: Evolution, Ecology, and Diversity (Insecta: Coleoptera). 314 pp. NRC Research Press, Ottawa, Ontario, Canada.

Reddy, M. V., Kumar, V. K., & Reddy, B. K. (1992). Occurrence of Gonocephalum sp.(Tenebrionidae: Coleoptera) as a pest of groundnut in India. *Tropical Pest Management* 38 (1): 108.

Reitter, E. (1917). Bestimmungs-Tabelle der palaearktischer Coleopteren. 82.*Heft: Tenebrionidae, Unterfamilie Asidini. Sonderabdruck aus dem*, *55*, 1-74.

Robertson, L. N., & Simpson, G. B. (1989). Sampling and dispersion of Pterohelaeus alternatus Pascoe and Gonocephalum macleayi (Blackburn)(Coleoptera: Tenebrionidae) larvae in soil. *Queensland Journal of Agricultural and Animal Sciences*, *45*(2), 189-193.

Schawaller, W. (1992). Leochrini (Coleoptera: Tenebrionidae) aus dem Nepal-Himalaya. *Stuttgarter Beitr. zur Naturkunde. Ser. A, Biologie*. 482: 1–15.

Schawaller, W. (1996). Tenebrionidae (Coleoptera) aus Nord-Griechenland: Habirare, Artengesellschaften und Verbreitung. *Entomologische Blatter fur Biologie und Systematik der Kafer*, *92*(1), 3-17.

Schawaller, W. (1996). Tenebrionidae (Coleoptera) aus Nord-Griechenland: Habitate, Artengeselschaften und Verbreitung. *Entomologische Blätter*, 92: 3-18.

Schawaller, W. (2001a). Nepalolaena kira gen. nov., sp. nov. from the Nepal Himalayas (Coleoptera, Tenebrionidae). *Entomologica Basiliensia* 23: 277–282.

Schawaller, W. (2002). The genus Laena Latreille in Nepal, with taxonomic and faunistic notes on species from the adjacent Himalayas (Coleoptera: Tenebrionidae). *Staatl. Museum für Naturkunde. Serie A (Biologie)* 641: 1–69.

Schawaller, W. (2008). The genus Laena Latreille (Coleoptera: Tenebrionidae) in China (part 2), with descriptions of 30 new species and a new identification key. *Stuttgarter Beiträge zur Naturkunde Serie A (Biologie)*, *1*, 387-411.

Schawaller, W.(1998 a). Borneolaena gen. n. riedeli sp. n. from Sarawak, the first species of Laenini (Coleoptera: Tenebrionidae) from the Sunda Islands. – Stuttgarter Beiträge zur Naturkunde, Ser. A (Biologie) 575: 1–8.

Skopin, N. G. (1964). *Die Larven der Tenebrioniden des Tribus Pycnocerini (Coleoptera Heteromera)*. Koninklijk Museum voor Midden-Afrika. Sciences Zoologiques 127: 1–35, 16 pls.

Snodgrass, R. E. (1935). Principles of insect morphology. McGraw-HillBook company , Inc. New York and London 664 pp.

Soldati, F., & Soldati, L. (2003). Réactualisation de la liste systématique des Coléopteres Tenebrionidae (Alleculinae exclus) de France continentale et de Corse. *Bulletin mensuel de la Société linnéenne de Lyon*,*72*(10), 331-349.

Sodhi, N.S., Koh L.P., Brook B.W., Ng P.K.L. (2004) Southeast Asian biodiversity: an impending disaster. Trends Ecol Evol 19, 654–660.

Steiner, W. E. (1999). Flightless beetles in Appalachian “deserts”: studies on the distribution and localized habitats of some species of Tenebrionidae (Coleoptera). *Virginia Museum of Natural History Special Publication*, *7*, 125-144.

Swenk, M. H. (1909). Eleodes as an enemy of planted grain. *Journal of Economic Entomology*, *2*(5), 332-336.

Tschinkel, W. R., & Doyen, J. T. (1980). Comparative anatomy of the defensive glands, ovipositors and female genital tubes of tenebrionid beetles (Coleoptera). *International Journal of Insect Morphology and Embryology*,*9*(5), 321-368.

Wade, J. S. (1921). Notes on ecology of injurious Tenebrionidae (Col.). *Ent. News*, *32*, 1-6.

Wade, J. S., & ST George, R. A. (1923). Biology of the false wireworm.*Eleodes suturalis*.

Watt, J. C. (1967). A review of classifications of Tenebrionidae (Coleoptera).*Entomologist's Monthly Magazine*, *102*(1966), 80-86.

Watt, J. C. (1974). A revised subfamily classification of Tenebrionidae (Coleoptera). *New Zealand journal of zoology*, *1*(4), 381-452.

Watt, J. C. (1987). The family and subfamily classification and New Zealand genera of Pythidae and Scraptiidae (Coleoptera). *Systematic entomology*, *12*(1), 111-136.

Zhang, D. Z., YU, Y. Z., & Ren, J. Z. (2003). The biological characters and behavior of Mantichorula semenowi [J]. *Entomological Knowledge*, *4*, 011.