Indian J. Syst. Ent. 7(2): 103-115 (1990)

CLASSIFICATION AND PHYLOGENY OF THE FAMILY APHELINIDAE (HYMENOPTERA : CHALCIDOIDEA)

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ABSTRACT : The subdivision of the family Aphelinidae into subfamilies and tribes as adopted by earlier workers is discussed. The family is defined. Check-list of subfamilies, tribes and genera along with distribution of genera in six Zoogeographical regions of the world are given. Key to subfamilies, tribes and genera based on conventional and genitalic characters is given. Six subfamilies and seven tribes are recognised as valid, and five family-group names are proposed as new synonyms under the family Aphelinidae and are as follows: Eriaporinae : Eriaporini, Myiocnemini; Coccophaginae : Coccophagini (=Physinae syn. n.), Azotini, Prospaltellini (=*Encarsini* syn. n.); Aphelininae : Mariettini (=*Eriaphytinae* syn.n.), Aphelinini (=*Aphytinae* syn.n., *Centrodorini* syn.n.); Eretmocerinae; Pteroptricinae and Calesinae. Four new generic synonymies are proposed and are indicated within parenthesis after the names of valid genera: Aphelinus Dalman (*Samariola* Hayat syn.n.), Pteroptrix Westwood (*Bardylis* Howard syn.n. *Dahmsiella* Hayat syn.n. and *Neocasca* Girault syn.n.) The genus, Syediella Shafee is revalidated. Lastly, the phylogeny of the family Aphelinidae and its allied families is proposed. The families Aphelinidae and Elasmidae are probably an off shoot of the family Euryischidae.

INTRODUCTION

Thomson (1876) proposed the name Aphelinina in the family Pteromalidae for the genus *Aphelinus* Dalman. Howard (1881) raised Aphelinina to the rank of subfamily Aphelininae. Ashmead (1904) recognized Aphelininae as subfamily of Eulophidae and divided it into two tribes : Aphelinini and Pteroptricini, principally based on the number of tarsal segments. This was followed by Howard (1907), Mercet (1912) and Girault (1915). Vierek (1916) raised the subfamily Aphelininae to the rank of family Aphelinidae. Further, he elevated the tribes : Aphelinini and Pteroptricini to the rank of subfamilies : Aphelininae and Pteroptricinae respectively. Mercet (1930) added a third subfamily Calesinae to the family Aphelinidae in order to accommodate the genus *Cales* Howard. De Santis (1948) dividid the family Aphelinidae into three subfamilies : Calesinae, Aphelininae and Coccophaginae. He dropped the subfamily Pteroptricinae and distributed its gen-

era to the subfamilies : Aphelininae and Coccophaginae. Alam (1956) emphasized for the first time the generic importance of pronotum, subgenital plate and external female genitalia. Ferriere (1965) added the subfamily Eriaporinae, thereby putting four subfamilies: Pteroptricinae, Aphelininae, Coccophaginae and Eriaporinae within the family Aphelinidae. Nikolskaya and Yasnosh (1966)divided the family into five subfamilies: Calesinae, Aphelininae, Coccophaginae, Azotinae and Prospaltellinae. They excluded the subfamily Eriaporinae from the family Aphelinidae. Yasnosh(1976) recognized seven subfamilies: Aphelininae, Coccophaginae, Calesinae, Prospaltellinae, Azotinae, Physcinae and Aphytinae in the family Aphelinidae, the last two were proposed as new subfamilies by himself. Shafee and Khan (1978) proposed a new subfamily Eretmocerinae in the family Aphelinidae. Further, they divided Coccophaginae and Aphelininae into tribes as follows: Coccophaginae into two tribes: Coccophagini and prospaltellini; Aphelininae into two tribes: Mariettini and Aphelinini. Hayat (1983) followed Nikolskaya (1952) and Peck *et al.* (1964) and gave an artificial key to genera of the family Aphelinidae. Recently, Shafee and Rizvi (1984) recognized six subfamilies: Eriaporinae, Coccophaginae, Aphelininae, Pteroptricinae, Eretmocerinae and Calesinae under the family Aphelinidae; two tribes: Eriaporini and Myiocnemini under Eriaporinae; three tribes: Coccophagini, Azotini and Prospaltellini under Coccophaginae; two tribes: Mariettini and Aphelinini under Aphelininae. Viggiani and Battaglia (1984) based on the study of male genitalia also recognized six subfamilies: Aphelininae, Eretmocerinae, Coccophaginae, Pteroptricinae, Calesinae and Eriaporinae. In the present study Shafee and Rizvi (1984) system of dividing the family Aphelinidae into subfamilies and tribes is adopted. An attempt has been made to assign the genera under their respective subfamilies and tribes.

FAMILY APHELINIDAE THOMSON

Diagnosis : Body small, usually less than 1 mm long; antennae less than 8-segmented; mandibles bidentate or tridentate; maxillary palpi 2 to 3-segmented, labial palpi 1 to 2-segmented; mesoscutum with complete parapsidal furrows; metanotum narrow; propodeum of uniform width; fore wings with marginal vein long, postmarginal and stigmal veins usually short, rarely long; tarsi 4 to 5-segmented; hind coxae normal, never flattened and disc-like. Members of the family Aphelinidae are usually parasitic on coccids, aleyrodids, rarely on aphids and on eggs of other insects.

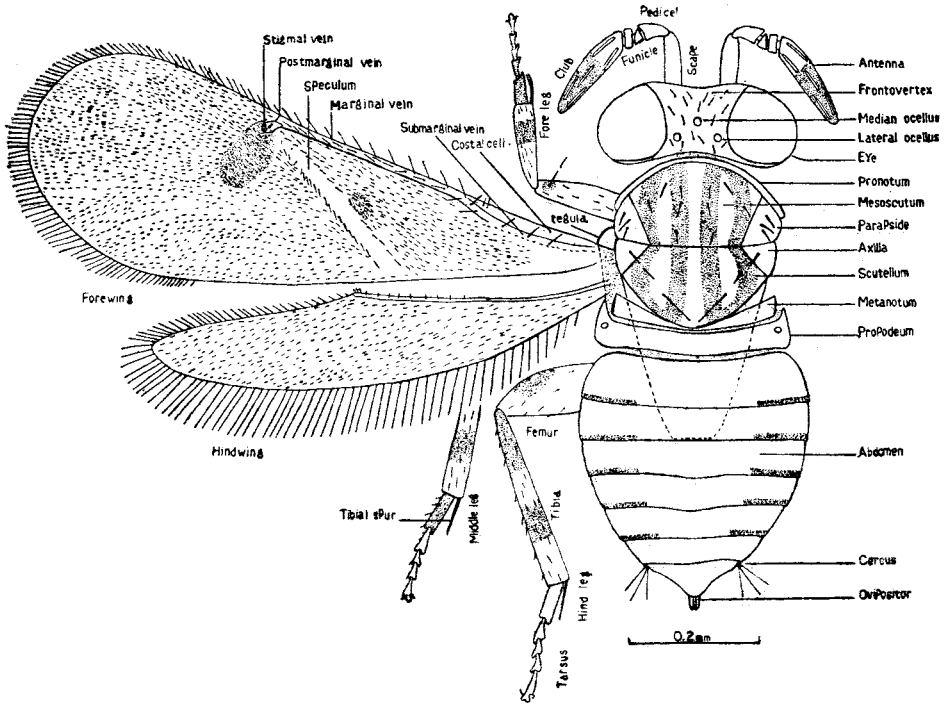

Fig. 1. *Syediella maculata* Shafee, ♀

CHECK-LIST OF SUBFAMILIES, TRIBES AND GENERA OF THE FAMILY APHELINIDAE ALONG WITH DISTRIBUTION DATA OF GENERA IN SIX ZOOGEOGRAPHICAL REGIONS OF THE WORLD

	Australian	Ethiopian	Nearctic	Neotropical	Oriental	Palearctic
A. Subfamily ERIAPORINAE Ghesquiere, 1955						
Tribe ERIAPORINI Ghesquiere, 1955						
1. Promuscidea Girault, 1917		×			×	
Syn. *Eriaporus* Waterston, 1917						
Eurymyiocnema Compere, 1947						
2. Eunotiscus Compere, 1928		×				
Tribe MYIOCNEMINI Shafee, 1975						
3. Myiocnema Ashmead, 1900	×		×		×	
Syn. *Paramyiocnema* Girault, 1917						
4. Euryischomyia Girault, 1914	×				×	

	Australian	Ethiopian	Nearctic	Neotropical	Oriental	Plaearctic
B. Subfamily COCCOPHAGINAE Foerster, 1878						
Tribe COCCOPHAGINI Foerster, 1878 =*PHYSCINAE* Yasnosh, 1976						
5. Coccophagus Westwood, 1833	×	×	×	×	×	×
Syn. *Aneristus* Howard, 1895						
Ataneostigma Girault, 1914						
Heptacritus De Santis, 1960						
Onophilus Brethes, 1918						
Parencarsia Mercet, 1930						
Polycoccophagus Sugonjaev, 1976						
Prococcophagus Silvestri, 1915						
Taneostigmoidella Girault, 1915						
6. Coccobius Ratzeburg, 1852	×	×	×	×	×	×
Syn *Encyrtophyscus* Blanchard, 1948						
Physculus Yasnosh, 1977						
Physcus Howard, 1895						
7. Aclerdaephagus Sugonjaev, 1969						×
8. Lounsburyia Compere & Annecke, 1961		×				
9. Timberlakiella Compere, 1936					×	
10. Euxanthellus Silvestri, 1915		×				
Tribe AZOTINI Nikol' skaya & Yasnosh, 1966						
11 Ablerus Howard, 1894	×	×	×	×	×	×
Syn. *Azotus* Howard, 1898						
Dimacrocerus Brethes, 1914						
12. Myiocnemella Girault, 1913	×					
Tribe PROSPALTELLINI Nikol' skaya & Yasnosh, 1966 =*ENCARSINI* Viggiani syn. n.						
13. Encarsia Foerster, 1878	×	×	×	×	×	×
Syn. *Aleurodiphilus* DeBach & Rosen, 1981						
Aspidiotiphagus Howard, 1894						
Doloresia Mercet, 1912						
Encarsiella Hayat, 1983						
Mimatomus Cockerell, 1911						

	Australian	Ethiopian	Nearctic	Neotropical	Oriental	Palearctic
Paraspidiotiphagus Alam, 1956						
Prospalta Howard, 1894						
Prospaltella Ashmead, 1904						
Prospaltoides Brethes, 1914						
Trichaporus Foerster, 1856						
14 Coccophagoides Girault, 1915	×		×		×	×
Syn. *Diaspiniphagus* Silvestri, 1927						
Primaprospaltella DeBach & LaSalle, 1981						
C. Subfamily APHELININAE Thomson, 1876						
=APHYTINAE Yasnosh, 1976						
Tribe MARIETTINI Shafee & Khan, 1978						
=*ERIAPHYTINAE* Hayat, 1978 syn.n.						
15. Eriaphytis Hayat, 1972					×	
16. Marietta Motschulsky, 1863	×	×	×	×	×	×
Syn. *Perissopterus* Howard, 1895						
Pseudaphelinus Brethes, 1918						
Tribe APHELININI Thomson, 1876						
=*APHYTINI* Yasnosh, 1976						
=*CENTRODORINI* Yasnosh, 1976						
17. Aphelinus Dalman, 1820	×	×	×	×	×	×
Syn. *Agonioneurus* Westwood, 1833						
Anozus Foerster, 1856						
Eriophilus Haldeman, 1851						
Meroligon Rondani, 1877						
Mesidia Foerster, 1856						
Mesidiopsis Nowicki, 1930						
Myina Nees, 1834						
Samariola Hayat, 1983 syn n						
18 Centrodora Foerster, 1878	×	×	×	×	×	×
Syn *Debachiella* Gordh & Rosen, 1973						
Microeupelmus Otten, 1941						
Oolathron De Santis, 1981						
Paraphelinus Perkins, 1906						
Pechlaneria Soyka, 1948						

		Australian	Ethiopian	Nearctic	Neotropical	Oriental	Placarctic
	Plastocharella Girault, 1913 *Tumidiscapus* Girault, 1911						
19.	Marlattiella Howard, 1907					×	×
20.	Hirtaphelinus Hayat, 1983					×	
21.	Aphytis Howard, 1900 Syn. *Paraphytis* Compere, 1926 *Prospaphelinus* De Gregorio, 1914	×	×	×	×	×	×
22.	Botryoideclava Subba Rao, 1980					×	
23.	Syediella Shafee, 1970					×	
D.	Subfamily ERETMOCERINAE Shafee & Khan, 1978						
24.	Eretmocerus Haldeman, 1850 Syn. *Ricinusa* Risbec, 1951	×	×	×	×	×	×
E.	Subfamily PTEROPTRICINAE Ashmead, 1904						
25.	Pteroptrix Westwood, 1833 Syn. *Artas* Howard, 1907 *Bardylis* Howard, 1907 syn.u. *Casca* Howard, 1907 *Dahmsiella* Hayat, 1979 syn.n. *Neocasca* Girault, 1915 syn.n.	×	×		×	×	×
26.	Metacasca Girault, 1934	×					
27.	Aphelosoma Nikol'skaya, 1963						×
28.	Archenomus Howard, 1898 Syn. *Archenomiscus* Nikol'skaya, 1966 *Apteroptrix* Girault, 1915 *Hispaniella* Mercet, 1911 *Oa* Girault, 1929 *Pseudopteroptrix* Fullaway, 1918 *Pteroptrichoides* Fullaway, 1913	×	×		×	×	×
F.	Subfamily CALESINAE Mercet, 1929						
29.	Cales Howard, 1907 Syn. *Diaspidophilus* Brethes, 1914 *Paranthemus* Girault, 1915	×			×		×

KEY TO SUBFAMILIES, TRIBES AND GENERA OF APHELINIDAE

1. Tarsi 5-segmented.....2
— Tarsi 4-segmented; pronotum(fig. 2M)divided medially into two sclerites...4
2. Antennae usually without ring segments; fore wings with premarginal vein never enlarged; postmarginal vein absent, rarely developed.....3
— Antennae with ring segments; fore wings with premarginal vein usually enlarged, with thick setae; postmarginal and stigmal veins long.....ERIAPORINAE Ghesquiere, 1955. 6
3. Fore wings without speculum; prepects entire (divided in Azotini); club usually 2 to 3-segmented, rarely entire; male genitalia with digiti reduced or absent, apical claspers absent.....COCCOPHAGINAE Foerster, 1878. 9
— Fore wings usually with speculum, rarely absent; prepectus divided medially into two sclerites; club usually entire, rarely 2-segmented; male genitalia with digiti well developed, apical claspers present.....APHELININAE Thomson, 1876. 18
4. Fore tibial spur curved; disc of fore wings with setae not arranged in longitudinal rows; male genitalia with phallobase.....5
— Fore tibial spur straight; disc of fore wings with setae arranged in two longitudinal rows; male genitalia (Viggiani & Battaglia, 1984 : fig. 1, 9) without phallobase, represented only by the aedeagus.....CALESINAE Mercet, 1929
Cales Howard, 1907
5. Fore wings with speculum; prepectus divided medially into two sclerites; antennal club long and entire; male genitalia with digiti long and narrow, claspers present, aedeagus with apodemes usually separated.....ERETMOCERINAE Shafee & Khan, 1978
Eretmocerus Haldeman, 1850
— Fore wings without speculum; prepectus entire; antennal club small, 2 to 3-segmented; male genitalia with digiti small, claspers absent, aedeagus with apodemes fused .....PTEROPTRICINAE Ashmead, 1904. 25
6. ERIAPORINAE : Mesonotum without postaxillae; propodeum narrow; outer margin of hind tibiae without row of thick bristles.....ERIAPORINI Ghesquiere, 1955. 7
— Mesonotum with distinct postaxillae; propodeum broad; outer margin of hind tibiae with row of thick bristles.....MYIOCNEMINI Shafee, 1975. 8
7. ERIAPORINI : Antennae 9-segmented, excluding ring segments; head and scutellum with few setae.....**Promuscidea** Girault, 1917
— Antennae 7-segmented, excluding ring segments; head and scutellum with numerous short setae.....**Eunotiscus** Compere, 1928
8. MYOCNEMINI : Fore wings with costal cell and basal one-third of disc

setose; premarginal vein enlarged; postmarginal vein longer than the length of marginal vein .....**Myiocnema** Ashmead,1900

— Fore wings with costal cell and basal one-third of disc almost bare; premarginal vein never enlarged; postmarginal vein much shorter than the length of marginal vein; maxillary and labial palpi each 2- segmented.....
.....**Euryischomyia** Girault, 1914

9. COCCOPHAGINAE : Prepectus entire; club 2 to 3-segmented; fore wings with stigmal vein small; male genitalia with long and narrow phallobase...10

— Prepectus divided medially into two sclerotic pieces; club entire; forewings with stigmal vein long; male genitalia with short and broad phallobase.....
.....**AZOTINI** Nikolskaya & Yasnosh, 1966..11

10. Pronotum (fig, 2 C,D) formed of one continuous sclerotic piece; fore wings with dise densely setose.....COCCOPHAGINI Foerster, 1878. 12

— Pronotum (fig 2 L)formed of two separate sclerotic pieces; fore wings with usually sparsely setose...PROSPALTELLINI Nikolskaya & Yasnosh,1966. 17

11. AZOTINI : Middle tibia and basitarsus normal; female subgenital plate with antero-lateral apodemes, notch of posterior margin followed by laterally directed ridges.....**Ablerus** Howard, 1894

— Middle tibia and basitarsus flattened and expanded.....
.....**Myocnemella** Girault, 1913

12. COCCOPHAGINI : Antennae 7 or 8-segmented.....13

— Antennae 9-segmented (1,1,4,3); stigmal vein with a long neck.....
.....**Euxanthellus** Silvestri, 1915

13. Antennae 8-segmented.....14

— Antennae 7- segmented (1,1,3,2); mesopleuron large, undivided; subgenital plate moderately broad, central notch of posterior margin with laterally directed ridges.....**Coccobius** Ratzeburg,1852

14 Body normally convex, except some *Coccophagus* spp.....15

— Body flattened; head prognathous; fore wings 3 times as long as wide.....
.....**Aclerdaephagus** Sugonjaev, 1969

15. Subgenital plate not pointed at apex and not extending to apex of abdomen..
.....16

— Subgenital plate sharply pointed and extending to apex of abdomen.....
.....**Lounsburyia** Compere & Annecke, 1961

16. Scutellum not extending over base af abdomen; metanotum without a membranous extension overlapping first abdominal tergum; submarginal vein not enlarged; female subgenital plate narrow, posterior margin deeply concave medially; body moderately setose.....**Coccophagus** Westwood, 1833

— Scutellum large, posteriorly overlapping base of abdomen; metanotum with

membranous extension overlapping first abdominal tergum; submarginal vein proximally enlarged; body with abundant short setae.....
.....**Timberlakiella** Compere, 1936

17. PROSPALTELLINI : Antennae differently and variously formed, club usually differentiated from funicle; marginal vein usually longer than costal cell; stigmal vein with apex hardly enlarged.....**Encarsia** Foerster, 1878
— Antennal flagellum spindle-shaped, apical segment conical with pointed apex; marginal vein distinctly shorter than costal cell; stigmal vein with an expanded apex.....**Coccophagoides** Girault, 1915

18. APHELININAE : Pronotum (fig. 2 G,H) entire, consisting of single sclerotic piece .....MARIETTINI Shafee & Khan, 1978. 19
— Pronotum (fig. 2 I,J,K) formed of two sclerotic pieces.....
.....APHELININI Thomson, 1876. 20

19. MARIETTINI : Antennae 6-segmented; fore wings usually with coarse and hyaline setae, postmarginal vein absent, stigmal vein rudimentary; female subgenital plate with anterior margin prolonged medially; phallobase with short and narrow parameres.....**Marietta** Motschulsky, 1863
— Antennae 7-segmented, club 2-segmented; fore wings with normal setae, postmarginal and stigmal veins well developed; female subgenital plate with anterior margin straight, posterior margin with a wide notch medially; phallobase without parameres..... **Eriaphytis** Hayat, 1972

20. APHELININI : Antennae 5 to 6-segmented.....21
— Antennae 4-segmented, funicle and club each 1-segmented.....
.....**Marlattiella** Howard, 1907

21. Antennae 6-segmented.....2
— Antennae 5-segmented, funicle 2-segmented, club 1-segmented.....
.....**Syediella** Shafee, 1970

22. Subgenital plate reaches to middle of abdomen; ovipositor uncovered and straight.....23
— Subgenital plate reaches to apex of abdomen covering the ovipsitor excpt apex which is curved upward; female subgenital plate V-shaped with greatly reduced posterior margin, antero-lateral apodemes distinct; male genitalia with elongate phallobase, parameres absent, digiti short each with two apical claspers; parasites of aphids.....**Aphelinus** Dalman, 1820

23. Fore wings with marginal vein longer than costal cell; parasites of diaspids; male genitalia without parameres, digiti each with one clasper..... 24
— Fore wings with marginal vein not longer than costal cell; male genitalia with narrow parameres, digiti each with two claspers; parasites of eggs.....
.....**Centrodora** Foerster, 1878

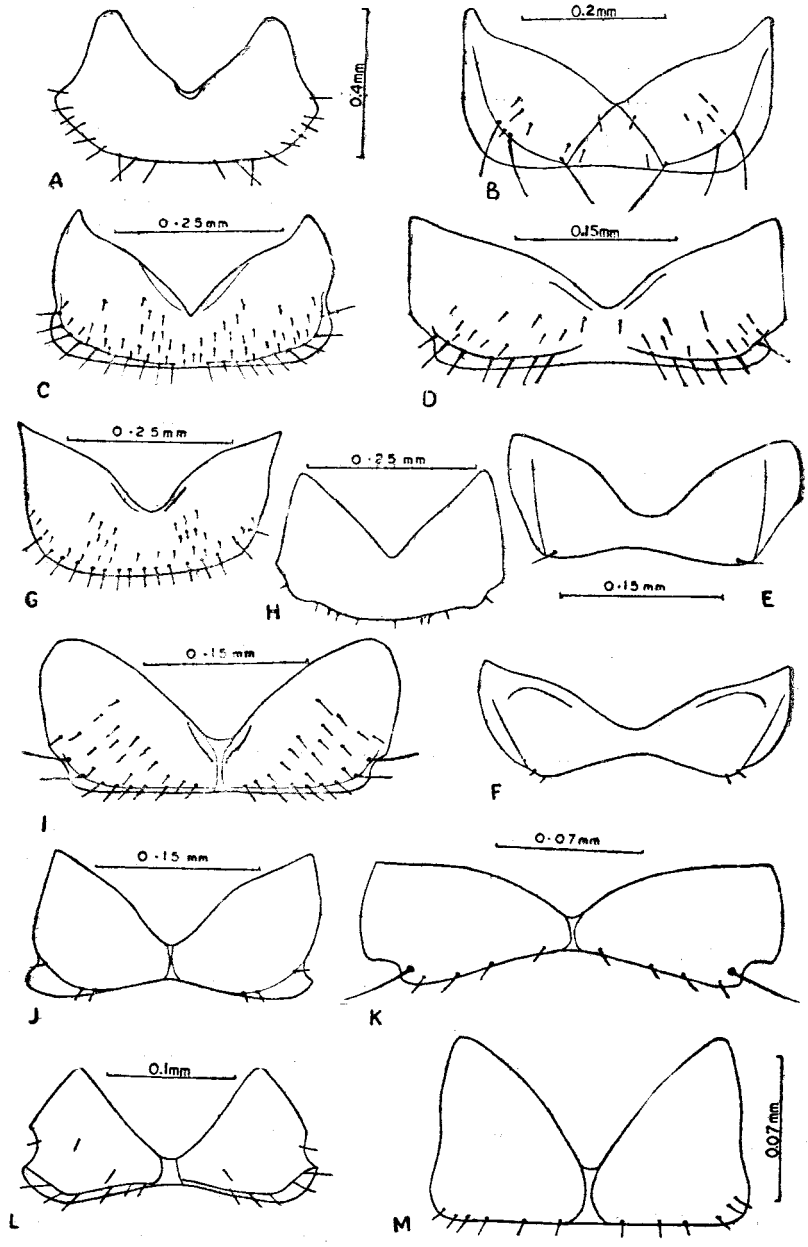

Fig. 2. Female pronotum : A, *Promuscidea unfaciativentris* Girault; B, *Euryischomyia alami* Shafee; C, *Coccophagus ceroplastae* (Howard); D, *Coccobius gunturensis* (Ahmad & Shafee); E, *Ablerus bimaculatus* (Khan & Shafee); F, *Ablerus aonidiellae* Hayat; G, *Eriaphytis orientalis* Hayat; H, *Marietta javensis* (Howard); I, *Aphelinus mali* (Haldeman); J, *Centrodora azizi* Hayat; K, *Aphytis alami* Agarwal; L, *Encarsia narayanani* Agarwal; M, *Eretmocerus aligarhensis* K han & Shafee.

24. Fore wings with speculum clearly defined; pronotum short; male genitalia with digiti short.....**Aphytis** Howard, 1900
— Fore wings with speculum not clearly defined; pronotum at least half the length of mesoscutum; male genitalia with digiti long.....**Botryoideclava Subba Rao**, 1980
25. PTEROPTRICINAE : Antennae 7-segmented.....26
— Antennae 8-segmented.....27
26. Fore wings with costal cell narrow, premarginal vein slightly curved; hind wings usually narrow (as in *Encarsia*) and sparsely setose with long marginal fringe.....**Pteroptrix** Westwood, 1833
— Fore wings with costal cell broad, premarginal vein strongly curved; hind wings broad (as in *Coccophagus*) and densely setose with short marginal fringe.....**Metacasca** Girault, 1934
27. Body normal,never flattened; pronotum shorter than mesonotum.....**Archenomus** Howard, 1896
— Body flattened; pronotum as long as mesonotum.....**Aphelosoma** Nikolskaya, 1963

PHYLOGENY

Phylogeny (fig. 3) is proposed mainly based on investigations of comparative morphology of the body structures. The characters viz., large body size, 5-segmented tarsi. much enlarged hind coxae, much enlarged metanotum and propodeum, spinose legs, coarse setae on body and wings, curved fore tibial spur, undivided condition of pronotum, long digiti on male genitalia are regarded as primitive characters. On the other hand, 4-segmented tarsi,normal coxae, normal metanotum and propodeum, fine setae on body and wings,straight fore tibial spur, divided condition of pronotum are regarded as evolved characters. Based on primitive and evolved characters Phylogeny of Aphelinidae and allied families is proposed. Tribe Myiocnemini represent the most primitive and evolved from euryischid-like ancestor, Eriaporini is also rather primitive representing an off shoot of the former. The subfamilies : Coccophaginae and Aphelininae have evolved independently from the tribe Eriaporini. The subfamilies: Eretmocerinae and Pteroptricinae are probably evolved from the tribes : Aphelinini and Prospaltellini respectively. Calesinae is probably the most highly evolved subfamily of Aphelinidae representing an off shoot of Pteroptricinae.

The family Elasmidae is also primitive occupying an intermediate position between Euryischidae and Eulophidae or more likely representing an off shoot of the former. The families Pteromalidae and Trichogrammatidae are probably evolved from Eriaporini and Calesinae respectively.

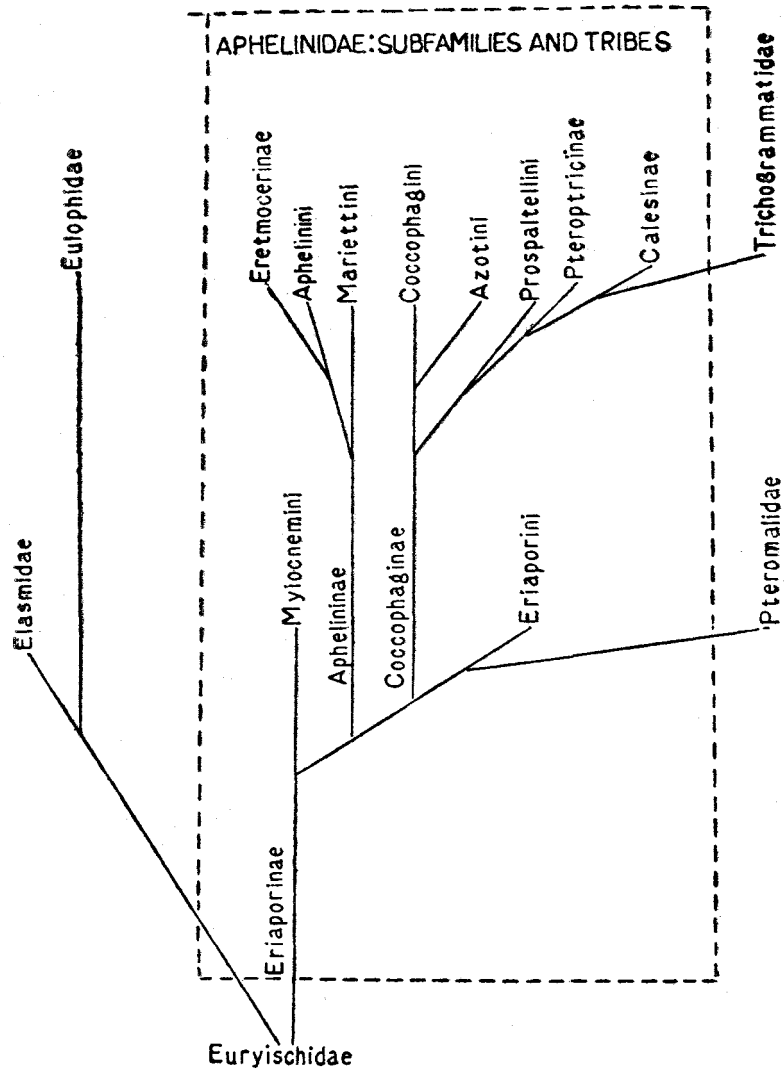

Fig. 3. Phylogeny of Aphelinidae and allied families

ACKNOWLEDGEMENT

The authors are greatly indebted to the Chairman, Department of Zoology for providing research facilities.

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(Published : 5. 12. 1990)