

CLADISTIC ANALYSIS OF GENERA OF THE SUB-FAMILY GRYLLINAE (ORTHOPTERA: GRYLLIDAE) FROM PAKISTAN

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خلاصہ

ذیلی خاندان گریلائی کے چودہ اجناس کا تقابلی جائزہ بدرشکلی خصوصیات کو مد نظر رکھتے ہوئے جو اسکے بیرونی خصوصیات اور مادہ تاسلی اعضاء کے حوالے سے پیش کیا گیا ہے۔ نیز اسکے مل شکلی اور خود شکلی کے حوالے سے ایک کلید و گرام بھی بنایا گیا ہے۔

Abstract

A cladistic analysis of the fourteen genera of sub-family Grylline is attempted using apomorphic characters which was selected from their external morphological characters, male and female genital components. A cladogram is also made and discussed their synapomorphies and autapomorphies.

Introduction

Gryllids are regarded as important agricultural and domestic pests throughout the world, more particularly in Pakistan. The morphotaxonomic work on the Gryllids attempted by Hinton and Corbel (1949), Alexander and Thomas (1959), Chen *et al.*, (1967) and Furukawa (1970). Wagner trees are one possible generalization of the most parsimonious trees of deducing branching sequencing phylogeny evolution (Camin and Sokal, 1965). The ground plan –analysis method for estimating evolutionary trees has been employed in Zoological evolutionary taxonomy (Kluge and Farris 1969). Farris (1970) discussed some methods for computing Wagner tree. This article derived some properties of Wagner tree and network and described computational procedures for prime networks with the help of algorithms. The ground-plan divergence method of constructing phylogenetic trees was created during 1950s for illustrating systematic principles, the method attempts to deduce pathways of genetic change on the basis of phonetic evidences (Wagner, 1980, Gorokhov 1981, Gross *et al.*, 1989, and Yasuhiro 1990). But the cladistic analysis of this group was not attempted till now. Recently a cladistic analysis of the Nemobine crickets is attempted including 14- species of 5- genera from Pakistan, (Kamaluddin and Khan, 2012)

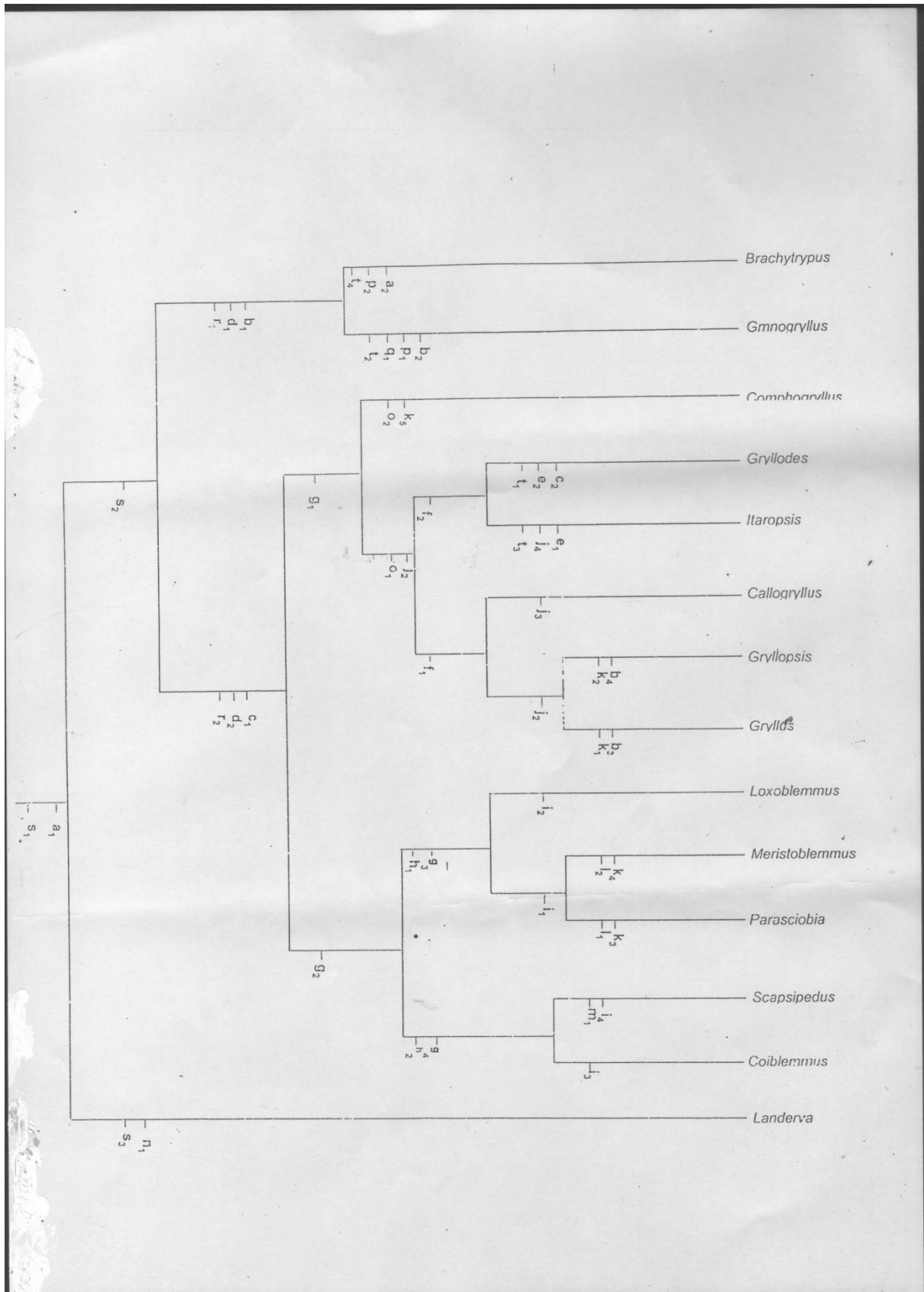
Kamaluddin *et al.*, (2001) discussed the external morphology of *Gryllus bimaculatus* (DeGeer) and compared with the representative of sub-family Nemobiinae and also described the apomorphic characters to build a background for their cladistic. Kamaluddin and Khan (2005) described three new species of Genus *Pteronemobius* of the Sub-family Nemobiinae from Pakistan with a key and their cladistic relationship. Khan and Kamaluddin (2006) studied the external morphology of head, thorax and abdomen and their appendages of *Pteronemobius indicus* (Walker) and compared with those of other crickets in the literature and tribal apomorphies are established with their phylogeny. Khan and Kamaluddin (2009) described two new species of Genus *Scottiola* Uvarov of Nemobiinae from Pakistan in detail with special reference to their genital components and also presented a key of Pakistani genera with their cladistic relationship. Kai Li and Xianwel (2010) described four new species of Nemobiinae from China.

Materials and Methods

The characters of included taxa were coined from all body structures including head thorax, abdomen and ovipositors and also from available literature. These characters were coded as a, b, c and so on. The numbers 1, 2, 3, etc represent derived, more derived and further more derived states, whereas zero shows the plesiomorphic state which is not included in discussion. On the basis of these characters a cladogram is constructed which shows the relationship of included taxa.

Character codes

a ₀	Moderate sized species
a ₁	Large species (A11)
a ₂	Very large species (<i>Brachytrypus</i>)
b ₀	Body shape normal
b ₁	Body almost globular (<i>Brachytrypus</i> and <i>Gymnogryllus</i>).
b ₂	Body less stout (<i>Gymnogryllus</i>)
b ₃	Body slightly convex (<i>Gryllus</i>)
b ₄	Body very convex (<i>Gryllopsis</i>)
c ₀	Body without pubescent.
c ₁	Body usually more or less pubescent (<i>Comphogryllus</i> to <i>Coiblemmus</i>)
c ₂	Body pubescent (<i>Grylloides</i>)
d ₀	Ocelli present
d ₁	Ocelli disposed in straight line (<i>Brachytrypus</i> and <i>Gymnogryllus</i>).
d ₂	Ocelli disposed as a triangular (<i>Comphogryllus</i> to <i>Coiblemmus</i>).
e ₀	Head convex above.
e ₁	Head small and rounded (<i>Itaropsis</i>).
e ₂	Head somewhat flattened above (<i>Grylloides</i>).
f ₀	Head with rounded frontal rostrum.
f ₁	Head with wide frontal rostrum (<i>Callogryllus</i> , <i>Gryllopsis</i> and <i>Gryllus</i>).
f ₂	Head with narrow frontal rostrum (<i>Grylloides</i> and <i>Itaropsis</i>).
g ₀	Face highly convex.
g ₁	Face convex in both male and female species. (<i>Comphogryllus</i> to <i>Gryllus</i>).
g ₂	Face more or less flattened in males (<i>Loxoblemmus</i> to <i>Coiblemmus</i>).
g ₃	Males with strongly flattened face (<i>Loxoblemmus</i> to <i>Parasciobia</i>).
g ₄	Males with flattened or somewhat concave face (<i>Scapsipedus</i> and <i>Coiblemmus</i>).
h ₀	Forehead normal.
h ₁	Forehead with more or less strongly prolonged (<i>Loxoblemmus</i> to <i>Parasciobia</i>).
h ₂	Forehead small (<i>Scapsipedus</i> and <i>Coiblemmus</i>).
i ₀	Front of the rostrum smooth.
i ₁	Front of rostrum strongly projecting in males, corneous or presenting a membranous process (<i>Meristoblemmus</i> and <i>Parasciobia</i>).
i ₂	Front of the rostrum of male projecting but simply angular (<i>Loxoblemmus</i>).
i ₃	Front of rostrum subangulate in male (<i>Coiblemmus</i>).
j ₀	Elytra well developed in both sexes.
j ₁	Elytra well developed at least in males (<i>Grylloides</i> to <i>Gryllus</i>).
j ₂	Elytra of males with well-developed mirror (<i>Gryllopsis</i> and <i>Gryllus</i>).
j ₃	Elytra of males with indistinct or small mirror displacement towards the apex (<i>Callogryllus</i>).
j ₄	Elytra very simple in males (<i>Itaropsis</i>).
k ₀	Females with highly developed elytra.
k ₁	Females with more or less perfectly developed elytra (<i>Gryllus</i>).
k ₂	Females with short lateral elytra (<i>Gryllopsis</i>).
k ₃	Females with very short elytra (<i>Parasciobia</i>).
k ₄	Females with highly reduced elytra (<i>Meristoblemmus</i>).
l ₀	Membranous process smooth.
l ₁	Membranous process non-divided unilobed (<i>Parasciobia</i>).
l ₂	Membranous process divided into two large lobes (<i>Meristoblemmus</i>).
m ₀	Mandibles of the male normal.
m ₁	Mandibles of the males very strong and lengthened (<i>Scapsipedus</i>).
n ₀	Tympanum absent.
n ₁	Tympanum on the internal face (<i>Landreva</i>).
o ₂	Anterior tibiae smooth.
o ₁	Anterior tibiae perforated with one or two foramina (<i>Grylloides</i> to <i>Gryllus</i>).
o ₂	Anterior tibiae non-perforated (<i>Comphogryllus</i>).
p ₀	Anterior metatarsi very long.
p ₁	Anterior metatarsi moderately long (<i>Gymnogryllus</i>).
p ₂	Anterior metatarsi very short (<i>Brachytrypus</i>).



q ₀	Anterior and middle tibiae smooth.
q ₁	Anterior and middle tibiae beset with long hairs (<i>Gymnogryllus</i>).
r ₀	Posterior femora very long.
r ₁	Posterior femora long, usually as long as tibiae and tarsi together (<i>Brachytrypus</i> and <i>Gymnogryllus</i>).
r ₂	Posterior femora shorter than tibiae and tarsi together (<i>Comphogryllus</i> to <i>Coiblemmus</i>).
s ₀	Posterior tibiae entirely smooth.
s ₁	Spines of the posterior tibiae immovable (All Grylline).
s ₂	Posterior tibiae smooth at base (<i>Brachytrypus</i> to <i>Coiblemmus</i>).
s ₃	Posterior tibiae serrated at base, proximal with insertion of the spines (<i>Lendreva</i>).
t ₀	Ovipositors of moderate size.
t ₁	Ovipositors very long (<i>Grylloides</i>).
t ₂	Ovipositors usually long (<i>Gymnogryllus</i>).
t ₃	Ovipositors abortive (<i>Itaropsis</i>).
t ₄	Ovipositors usually short (<i>Brachytrypus</i>).

Characterstates:

Body size (a): Body usually large sized in all the representatives of the sub-family Gryllinae show their synapomorphic condition (a₁). In *Brachytrypus* body very large sized shows its autapomorphic conditions (a₂).

Body shape (b): Body almost globular in *Brachytrypus* and *Gymnogryllus* shows their synapomorphic condition (b₁). Body less stout in *Gymnogryllus* shows its autapomorphic condition (b₂). In *Gryllus* body slightly convex shows its derived autapomorphic condition (b₃). Body highly convex in *Gryllopsis* shows its more derived autapomorphic state (b₄).

Body structures (c): Body usually more or less pubescent in *Comphogryllus*, *Grylloides*, *Itaropsis*, *Callogryllus*, *Gryllopsis*, *Gryllus*, *Loxoblemmus*, *Meristoblemmus*, *Parasciobia*, *Scapsipedus*, and *Coiblemmus* show their synapomorphic condition (c₁). In *Grylloides* body pubescent shows its autapomorphic condition (c₃).

Ocelli (d): Ocelli disposed in a straight line in *Brachytrypus* and *Gymnogryllus* show synapomorphic condition (d₁). In *Comphogryllus*, *Grylloides*, *Itaropsis*, *Callogryllus*, *Gryllopsis*, *Gryllus*, *Loxoblemmus*, *Meristoblemmus*, *Parasciobia*, *Scapsipedus*, and *Coiblemmus* the ocelli disposed as a triangular shape show their derived synapomorphic condition (d₂).

Head shape (e): Head small and rounded in *Itaropsis* shows its autapomorphic condition (e₁). In *Grylloides* the head somewhat flattened above shows its derived autapomorphic condition (e₂).

Suture on head (f): Head with wide frontal rostrum in *Callogryllus*, *Gryllopsis*, and *Gryllus*, show their synapomorphic condition (f₁). In *Grylloides* and *Itaropsis* head with narrow frontal rostrum show their derived synapomorphic state (f₂).

Shape of the face (g): Face convex in both male and female specimens in *Comphogryllus*, *Grylloides*, *Itaropsis*, *Callogryllus*, *Gryllopsis*, and *Gryllus* show their synapomorphic condition (g₁). In *Loxoblemmus*, *Meristoblemmus*, *Parasciobia*, *Scapsipedus*, and *Coiblemmus* the face more or less flattened in males show their derived synapomorphic condition (g₂). Face strongly flattened in males in *Loxoblemmus*, *Parasciobia* and *Scapsipedus* show their more derived synapomorphic condition (g₃). In *Scapsipedus* and *Coiblemmus* the face flattened or somewhat concave in males show their further more derived synapomorphic condition (g₄).

Fore head (h): Fore head with more or less strongly prolonged in *Loxoblemmus*, *Meristoblemmus* and *Parasciobia*, show their synapomorphic condition (h₁). In *Scapsipedus*, and *Coiblemmus* fore head small show their derived synapomorphic state (h₂).

Front of rostrum (i): Front of rostrum strongly projecting in males, corneas or presenting a membranous process in *Meristoblemmus* and *Parasciobia* show their synapomorphic condition (i₁). In *Loxoblemmus* front of the rostrum of male projecting but simply angular shows its autapomorphic condition (i₂). Front of the rostrum subangulate in males in *Coiblemmus* shows its derived autapomorphic condition (i₃). In *Scapsipedus* front of the rostrum convex shows its more derived autapomorphic state (i₄).

Elytra (j): Elytra well developed at least in males in *Grylloides*, *Itaropsis*, *Callogryllus*, *Gryllopsis*, and *Gryllus* show their synapomorphic condition (j_1). In *Gryllopsis* and *Gryllus* elytra of male with well developed mirror show their derived synapomorphic condition (j_2). Elytra of male with indistinct or small mirror displacement towards the apex in *Callogryllus* shows its autapomorphic condition (j_3). In *Itaropsis* the elytra very ample in males shows its derived autapomorphic state (j_4).

Position of wings (k): Females with more or less perfectly developed elytra in *Gryllus* shows its autapomorphic condition (k_1). In *Gryllopsis* females with short lateral elytra shows its derived autapomorphic condition (k_2). In females elytra very short in *Parasciobia* shows its more derived autapomorphic condition (k_3). In females elytra very much reduced in *Meristoblemmus* shows its further more derived autapomorphic condition (k_4). Both males and females are apterous form in *Comphogryllus* shows its specially derived autapomorphic condition (k_5).

Membranaceous process (l): Membranaceous process unilobed in *Parasciobia* shows its autapomorphic condition (l_1). In *Meristoblemmus* the membranaceous process deeply divided into large lobes shows its derived autapomorphic condition (l_2).

Mendibles (m): Mandibles of males very strong and lengthened in *Scapsipedus* shows its autapomorphic condition (m_1).

Tympanum (n): Tympanum is present on the internal face in *Landreva* shows its derived autapomorphic condition (n_1).

Anterior tibiae (o): Anterior tibiae perforated with one or two foramina in *Grylloides*, *Itaropsis*, *Callogryllus*, *Gryllopsis*, and *Gryllus* show their synapomorphic condition (o_1). In *Comphogryllus* the anterior tibiae smooth and non-perforated shows its autapomorphic state (o_2).

Anterior metatarsi (p): Anterior metatarsi moderately long in *Gymnogryllus* shows its autapomorphic state (p_1). In *Brachytrypus* the anterior metatarsi very short shows its derived autapomorphic condition (p_2).

Anterior and middle tibiae (q): Anterior and middle tibiae beset with long hairs in *Gymnogryllus* shows its autapomorphic condition (q_1).

Posterior femora (r): Posterior femora long, usually as long as tibiae and tarsi together in *Brachytrypus* and *Gymnogryllus* show their synapomorphic condition (r_1). In *Comphogryllus*, *Grylloides*, *Itaropsis*, *Callogryllus*, *Gryllopsis*, *Gryllus*, *Loxoblemmus*, *Meristoblemmus*, *Parasciobia*, *Scapsipedus*, and *Coiblemmus* the femora shorter than tibiae and tarsus together show their synapomorphic condition (r_2).

Posterior tibiae (s): Spines of the posterior tibiae immovable in all the representatives of the sub-family Gryllinae show their synapomorphic condition (s_1). In *Brachytrypus*, *Gymnogryllus*, *Comphogryllus*, *Grylloides*, *Itaropsis*, *Callogryllus*, *Gryllopsis*, *Gryllus*, *Loxoblemmus*, *Meristoblemmus*, *Parasciobia*, *Scapsipedus*, and *Coiblemmus* the posterior tibiae smooth at base show their derived synapomorphic condition (s_2). In *Landreva* the posterior tibiae serrated at base and proximally with insertion of the spines shows its autapomorphic state (s_3).

Ovipositors (t): Ovipositors very long in *Grylloides* shows its autapomorphic condition (t_1). In *Gymnogryllus* ovipositors are usually long shows its derived autapomorphic condition (t_2). Ovipositors abortive in *Itaropsis* shows its more derived autapomorphic condition (t_3). In *Brachytrypus* ovipositors usually short shows its further more derived autapomorphic condition (t_4).

Result and Discussion

Kamaluddin and Khan (2012) have been studied the apomorphic character of Nemobine crickets of the family Gryllidae using autapomorphic and Synapomorphic characters.

The present cladogram represents the cladistic analysis of fourteen genera of the Sub-family Gryllinae. The members of the sub-family appear to be their out group from the sub-family Nemobiinae in having large or rather larger sized body (a_1) and spines of the posterior tibiae immovable (s_1).

Among Gryllinae the genus *Landreva* appears to exhibit sister group relationship with other genera. Among these *Brachytrypus* and *Gymnogryllus* appears to be sister group with those of others out group genera viz. *Comphogryllus*, *Grylloides*, *Itaropsis*, *Callogryllus*, *Gryllopsis*, *Gryllus*, *Loxoblemmus*, *Meristoblemmus*, *Parasciobia*, *Scapsipedus*, and *Coiblemmus*. All these genera divided into two sub-groups.

The first group includes *Comphogryllus*, *Grylloides*, *Itaropsis*, *Callogryllus*, *Gryllopsis* and *Gryllus*. The *Comphogryllus* plays out group relationships with sister group relationships of the other five genera. Among these *Grylloides* and *Itaropsis* play sister group relationships to each other and out group relationships with *Callogryllus*, *Gryllopsis* and *Gryllus*. The *Gryllopsis* and *Gryllus* plays sister group relationships to each other and out group relationships with *Callogryllus*.

The second group includes *Loxoblemmus*, *Meristoblemmus*, *Parasciobia*, *Scapsipedus*, and *Coiblemmus*. Among these the *Scapsipedus* and *Coiblemmus* plays sister group relationships to each other and out group relationships with other genera. *Meristoblemmus* and *Parasciobia* play sister group relationships to each other and out group relationships with *Loxoblemmus*.

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