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STUDIES ON TRIBAL AFFINITIES WITHIN ARCHEOCOCCOIDEA

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Recent morphologic studies of adult males have indicated that Steingelinae is available under Phenacoleachiidae. On similar grounds the sub-family concepts of Kuwaninae of Mac Gillavary 1921, Neomargarodinae, Jakubsky 1965, under Margarodidae and Pitiococcinae Beardsley 1969 as the third sub-family under Phenacoleachiidae, have to be accepted.

An hitherto unrecognized postulate of compactness of Monophlebinae, Drosichinae, Iceryinae, and Ilaveinae as a group, leading to the resurrection of the family statuts of Monophlebidae needs to be reintroduced.

The tribes, considered constituting the families Ortheziidae, Margarodidae, Monophlebidae, and Phenacoleachiidae have been arranged phylogenetically and suitably illustrated.

INTRODUCTION

The Archeocoddoidea were generally regarded to comprise the families Margarodidae and the Ortheziidae until recently. But Borchsenius (1958) in his phylogenetic illustration (See Quayyoom, 1974b) also included Phenacoleachiidae with a single nominal genus under this taxon. The exact relationship of *Phenacoleachia* Cockerell 'has been a problem since it was described' (Williams, 1969). A comprehensive study of its adult male has indicated that it has some relationship with the genus *Steingelia* Nassov, which seems doubtfully placed under Margarodidae. This genus *Steingelia* was also shown to be abberant (Theron, 1962). 'It seemed possible that the genera *Steingelia* and *Phenacoleachcia* both be included in the same family for which Phenacoleachidae has priority. Moreover, the sub-family name Steingelinae is also available within the family' (Williams, 1969).

When the features of the male *Eleterococcus*, a fossil referable to the extent Pityococcinae (Beardsley, 1969) were compared with the two other phenacoleachids viz: *Phenacoleachia* and *Steingelia*, by the senior writer,

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it emerged that this pityococcine male shared many features with *Phenacoleachia*. The Pityococcinae, therefore, seems also referable to Phenacoleachiidae as the third constituent sub-family.

Lastly, the concept of compactness of Monophlebidae (Quayyoom, and Chaudhry 1967) as a family level taxon needs to be reintroduced on account of sufficient divergence in the margarodid and monophlebid rami, a fact being hitherto not fully realized.

In order to resolve some of the issues just alluded to, the cephalic features of some 20 margarodid+monophlebid taxa have been compared and discussed as follows :

METHODS AND MATERIALS.

The published material on the families, Ortheziidae (Morrison, 1952), Margarodidae (Morrison, 1928, Quayyoom, 1974a, Jakubsky, 1965) Monophlebidae (Dantzig, 1972), and Phenacoleachiidae (Theron, 1962) has been freely drawn upon. Prepared slides of *D. stebbingi* by the writers, of *P. tamarindus* by Rahman and Latif and of the adult males of *M. papillosus* Green, *D. tanganyicus* Jak., *N. erythrocephala* Green, *N. trabuti* Marchal, and *P. polonica* (L.) received through the courtesy of Dr. D. J. Williams, B.M.N.H. London, have been examined by the senior writer.

RESULTS AND DISCUSSION

Results :

The cephalic features as viewed from the dorsal aspect in some 20 taxa comprising the families Ortheziidae, Porphyrophoridae (= Margarodidae) Monophlebidae, and Phenacoleachiidae have been compared from the standpoint of phylogeny in the present paper. The salient features of the considered taxa were compared also with those of *Aphis* (Sehlee, 1969) head.

1. *Aphis* : The head of *Aphis* is elliptical, broader than long bearing compound eyes (ce) laterally and two pairs of lateral ocelli (lo) on narrowed longitudinal pieces or oculata (oeu) disposed mesally to the eyes. A median ocellus (mo) is also present. The paired ocelli (o) located anteromedially as well as postero-laterally. The head is bordered posteriorly by a 'cervical band' (cb) (PLATE-I, Fig.1).

2. *Orthezia* : The cephalic features in *Orthezia* compare favourably with those of *Aphis*. The shape is elliptical tending to be conical anteromedially. The compound eyes (ce) are bean-shaped in *Aphis*, but

here these are basally conical, and anteriorly bulging and bear only a single pair of lateral ocelli (lo); each ocellus being located on the posterolateral aspect of the compound eye. (PLATE-1, Fig. 2).

3. *Neomargarodes*: The head-shape is quite comparable with that of *Orthezia*. The compound eyes (ce) have, however, assumed larger size, obliterating most of the area of the epicranium found in other genera. Like *Orthezia*, no signs of the posterior cervical sclerite (cs) discernible. This coupled with the apparent absence of a lateral ocellus (lo) associated with the compound eye (ce) as well as the structure of the antennnae, imparts a distinct position and justifies a raise of this taxon, to the sub-family level, advocated by Jakubsky (1965) on other grounds (PLATE-1, Fig. 3).

4. *Callippapus*: The head is essentially similar in shape to those of the taxa considered hitherto. Larger, berry like compound eyes immediately suggest a margarodid affinity. Mid-cranial ridge (mcr) incompletely developed. The posteriorly located cervical band (cb) is arcuated in structure. Lateral ocelli (lo) disposed only on the postero-medial aspect of each compound eye (ce). (PLATE-2, Fig. 4).

5. *Margarodes*: The head is elliptical but the basal scapes (scp) of the antennae become approximated. The epicranium (aepc) in between gets reduced. The compound eyes (ce) are oval-berry like swellings each bearing on its postero-lateral aspect a pedunculated ocellus (o), (cf: Aphis) A post-occipital suture (pos) (Theron, 1958) cutting a narrow horizontal strip of the post-occiput (poc), posteriorly. (PLATE-2, Fig. 5) is present.

6. *Matsucoccus*: The head shape is oval. The compound eyes (ce) berry like and bulging. The lateral ocelli (lo) are essentially of the same shape and disposition as in the case of Callippapus, but differ as they are disposed on horizontal oculta (ochz), being bordered above by dorsomedial part of the epicranium (dmep). The appearance of this band signifies the beginning of the development of transverse oculata (oct) bearing ocelli (o) in margaroids. Mid-cranial ridge (mcr) incompletely formed (PLATE-2, Fig. 6).

A7. *Xylococculus*: Differentiation of vertical oculata (ocv), carrying the lateral ocelli (lo) discernible. These ocelli develop by eliminating some of the area normally to be occupied by the compound eyes (ce). This feature in the evolution of margarodis betrays the course of dispensing with part of

the facet bearing areas (af.) Mideranial ridge (mcr) completely formed and is joined posteriorly to horizontally disposed post-occipital suture (pos) (PLATE-3, Fig. A7.)

7. *Neosteingelia :* An incompletely formed primary mid-cranial ridge (mcr), and better differentiated secondary pre-ocular (procr) and pre-oral (pror) ridges as well as a weakly indicated cranialapophysis (ca) supporting the antennal (ant) and cephalic muscles (Theron, 1958) present. The lateral ocelli (lo) arising from thick stub like oculata (ocu) disposed posteromedially to each compound eye (ce), reminiscing their position as in *Callippapus*. Post-occipital suture (pos) ill-defined. These features warrant a further raise in this taxon. (PEATE-3, Fig. 7). (See Quayyoom 1972)

8. *Ultracoelostoma :* Portrays a combination of features which foreshadows their reduplication in most of the taxa considered hereafter indicating the phylogenetic importance of this pattern. Part of the facet bearing areas (af) of the compound eyes (ce) have been taken up by triangular oculata (octg), carrying posteriorly disposed lateral ocelli (lo). The mid-cranial (mcr), pre-ocular (procr) and pre-oral (pror) as well as post-occipital (por) ridges are well-developed (PLATE-3, Fig. 8).

9. *Coelostomidia :* The features observed in this taxon, carry the features alluded to in the previous taxon further in the mhnophlebid direction. The lateral ocelli (lo) arise one each on the mesad aspect of the compound eye (ce), being borne on vertically disposed human eye-shaped oculata (cce). The mid cranial (mcr), as well as pre-ocular (procr), and pre-oral (pror) ridges distinctly formed. No signs of the development of a cranial apophysis (ca) as observable in most tribes of Monophlebinae as well as Drosichinae ,PLATE-3, Fig. 9), indicated.

10. *Aspidoproctus :* Features closely resembling with those of Coelostomidia present. Development of hexagonal-shaped oculata (ochx) bearing stalked (stk) ocelli (o). The mideranil ridge (mcr) bifid anteriorly, and pre-ocular ridge (procr) well-formed. The former merged with the complex constituted by the confluence of flattened type of cranial apohysis (ca) and the pre-oral ridges (pror). The ocular sclerites (ocs) are similar to those of *Pseudoaspidoproctus* (Theron, 1958), (PLATE-4, Fig. 10).

11. *Labioproctus :* This taxon obviously is quite similar with that of *Aspidopsoctus:* Head anteromedially conical, mideramial ridge (mcr) transversely disposed pre-ocular (procr) and diagonally located pre-oral

(pror) ridges well-developed. These ridges coalesce mesally giving an impression of the formation of a cranial apophysis (ca). The oculata (ocu) rimmed mesally and are triangular in shape (PLATE-5, Fig. 13).

12. *Drosicha* : Head anterioriy conical, the mid-cranial ridge (mcr) developed to meet the pre-ocular ridges (procr) which conjoined mesially assume an inverted horse-shoe shaped sturucture. The pre-oral ridges (pror) get confluent with a well-formed cranial apophysis (ca). The oculata (ocu) broadly triangular, mesally oval margined. Like Coelostomidia these seem to be cut off from compound eyes (ce) (PLATE-4, Fig. 12).

13. *Drosichoides* : The general features of the head compare favourably with *Aspidoroproctus* with the provision that the oculata (ocu) bearing the ocelli (lo) are more compressed (occ) and stalks (stk) carrying the ocelli are thicker compared with the former insect (PLATE-4, Fig. 11).

14. *Monophlebulus* : Compared with *Labloproctus*,, the morphologic features of the head of *Monophlebulus* seem, apomorphic but degenerative. The primary mid-cranial (mcr) as well a the secondary pre-ocular (procr) and pre-oral ridges (pror) seem to be lost. Similarly the rimmed boder of the oculata (ocmb) seem also obliterated, resulting in the ocelli (o) appearing to originate from the undifferentiated surface of the epicranium (PLATE-5, Fig. 14).

15. *Llavela* : The anterior end of the head broadly conical. The ocelli (o) disposed antero-mesally to the compound eyes (ce) : signs of oculata (ocu) bearing these being poorly defined. Only parts of a pre-ocular ridge (procr) seem visible. Other ridges seem lost. (PLATE-5, Fig.15).

16. *Iceryia* : The anterior end of the head broadly conical. The ocelli (o) are sunk further posteriorly to a mesal position on the inner border of compound eyes (ce) : signs of primary and secondary ridges, not discernible. The ocular sclerites (ocs), however, somewhat developed (PLATE-5, Fig. 16).

17. *Phenacoleachia* : Head hexagonal in shape. Mid-cranial ridge (mcr) incompletely developed bifurcated posteriorly. The compound eyes (ce) represented by dorso-ventrally disposed arcuated rows of simple eyes (se). A lateral ocellus (lo) and ocular selerite (ocs) fused with each oculata (ocu). Neck region reinforced by a transverse medially furrowed pronotal ridge (pnr) (PLATE-6, Fig. 17).

18. Electrococcus : Markedly constricted neck region. Head triangular in shape bluntly rounded anteriorly. Midcranial ridge (mcr) indistinctly developed. The anterior component of dorsomedial part of the epicranium (dmep) well-developed. Ocular sclerites (ocs) bear an arcuate dorsovental row of 5 simple eyes (se) together with a single larval eye (le) or stemma laterally (aepc). The lateral ocelli (lo) indistinct. The pronotal ridges (pnr) are in the form of small triangular notches disposed laterally. This feature might be taken to betray a stage intermediate to both *Phenacoleachia* and *Steingelia* and probably also closest to the ancestral form (PLATE-6, Fig.18).

19. Steingelia : Head rather triangulated. Midcranial ridge (mcr) thickened posteriorly and narrowed anteriorly. The compound eyes (ce) represented by dorsoventrally disposed rows of simple eyes (se) supported laterally by a lateral ocellus (lo) studded in each oculata (ocu). Ocular sclerites (ocs) appended to the oculata postero-laterally. The cervical region braced by an acutely angulated pronotal ridge (pnr). The sclerotized dorsomedial area of the epicranium (dmep) seems obliterated. (PLATE-6, Fig. 19).

DISCUSSION

I. The salient events of the evolutionary history of the archeococcoid tribes at present known to constitute the families Margarodidae : Morrison, 1927. (=Porphyrophoridae Signoret, 1875*) Ortheziidae Amyot & Serville, 1843; Monophlebidae: Maskell, 1880, and Phenacoleachiidae: Williams, 1969 in so far as it is betrayed in the fairly constant morphologic features of the adult male head, in the constituent taxa, may be described seriatim (A) : Development/Appearance of (i) Well formed berry like compound eyes (ii) At least a single pair of lateral ocelli at various places in association with the compound eyes in most cases (iii) Progressive obliteration of the facet bearing area of the compound eye by its replacement by the ocellus bearing oculata (iv) Primary or mid-cranial ridge (v) Secondary or pre-ocular and pre-oral ridges (vi) Dorsomedial sclerotized areas of the epicranium, and cranial-apophysis. (B); After the attainment of the above features, then in some neo-margarodid as well as monophlebid entities progressive Disappearance/Obliteration of : (i) Primary and secondary ridges (ii) Cranial apophysis. (iii) Facet bearing area of compound eyes. (iv) Dorsomedial part of epicranium.

*The family name Porphyrophoridae of priority".

II. As sensory receptors, compound eyes and ocelli are of paramount importance and keeping in view the short non-feeding life span of males in margaroids, whose main function may be regarded as the continuation of the species-groups by their role in seeking and fertilizing the females. In a study of phylogenesis of the group, the value of a study of modifications of these structures and others like cranial, oral and ocular ridges, which are otherwise fairly constant, is rather obvious and hence needs not be over emphasized.

III. The morphologic features of the taxa considered under serial numbers 10—16 are rather consistent and distinctly divergent from those enumerated under serial numbers (1—9), which as a group are also equally constant. The only suitable method to express this obvious gap is to reacquire the concept of Monophlebidae as advocated by Maskell in 1880. This curtails the Margarodidae (sensu Morrison, 1927) and adds a fourth family level taxon (Monophlebidae Comb. Nov.) under Archecococcidea after Margarodidae. Dantzig (1972) has employed the concept of Monophlebidae in the same sense, as also the senior writer (Quayyoom, 1972, 1973, 1974,b) earlier.

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INDEX OF ABBREVIATIONS USED IN FIGURES: aepc: area of the epicranium; af: facet bearing area of the compound eye. ant: antenna; ca: cranial apophysis; cb: cervical band; ce: compound eye; cs:

cervical sclerite; dmep: dorsomedial part of the epicranium; le: larval eye; lo: lateral ocellus; mcr: mid cranial ridge; mo: median ocellus; mop: mouth opening; o: ocellus; occ: compressed oculata; oce: eye shaped oculata; ocs: ocular sclerite; ocu: oculata; ocv: vertical oculata; ochx: hexagonal shaped oculata; ochz: horizontal oculata; oct: trasverse oculata; ocmb: mesal rimmed border of occulata; octg: triangulated occulata; pnr: pronotal ridge; poc: post-occiput; por: post occipital ridge; pos: post-occipital suture; procr: pre-ocular ridge; pror: pre-oral ridges; scp: scape; se: simple eye; stk: stalk.

PLATE. I ♂ ADULT MALE HEAD FEATURES IN APHIS, ORTHEZIA AND NEOMARGARODES

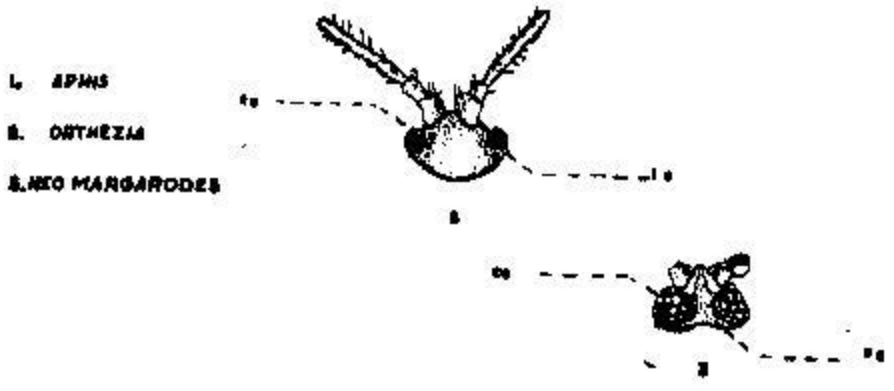


PLATE. II HEAD FEATURES IN MARGARODES, CALLIPPAPUS AND MATSUCOCCUS ADULT MALES

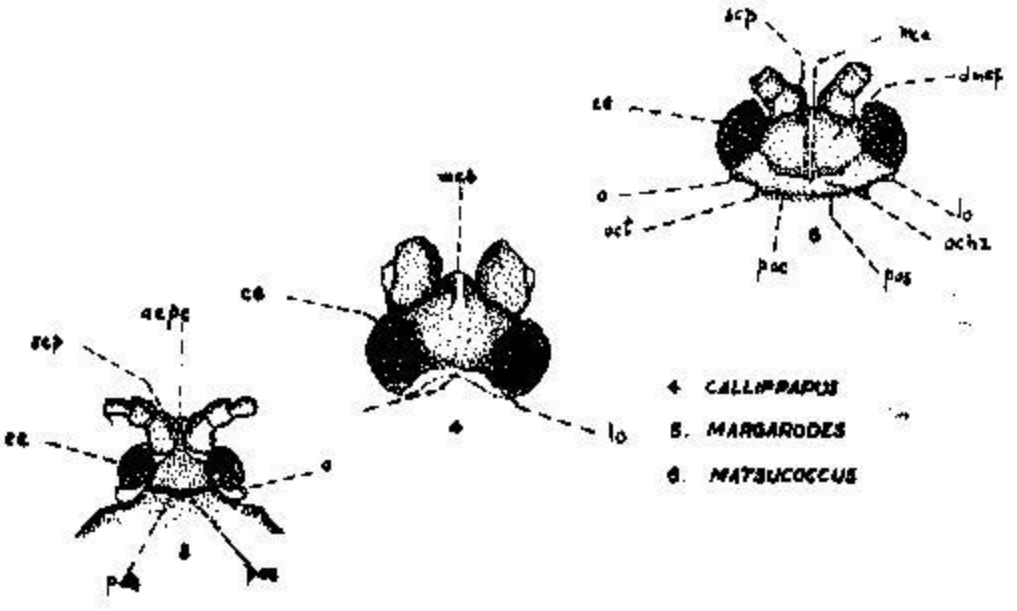


PLATE. X HEAD FEATURES IN NEOSTEINGELIA, ULTRACOELOSTOMA AND COELOSTOMIDIA, AND XYLOCOCCULUS ADULT MALES

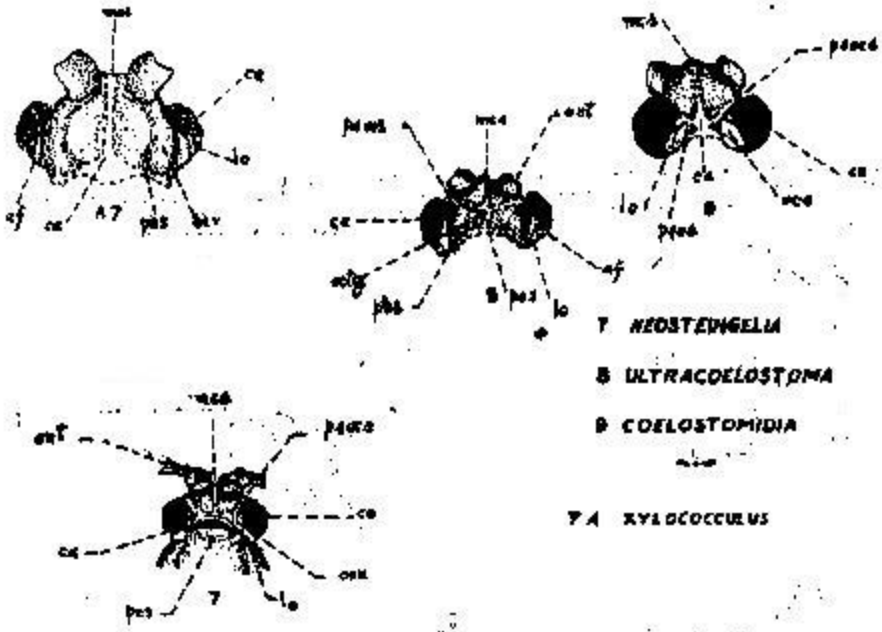


PLATE. XI ASPIDOPROCTUS, DROSICHOIDES & DROSICHA HEAD FEATURES IN ADULT MALES

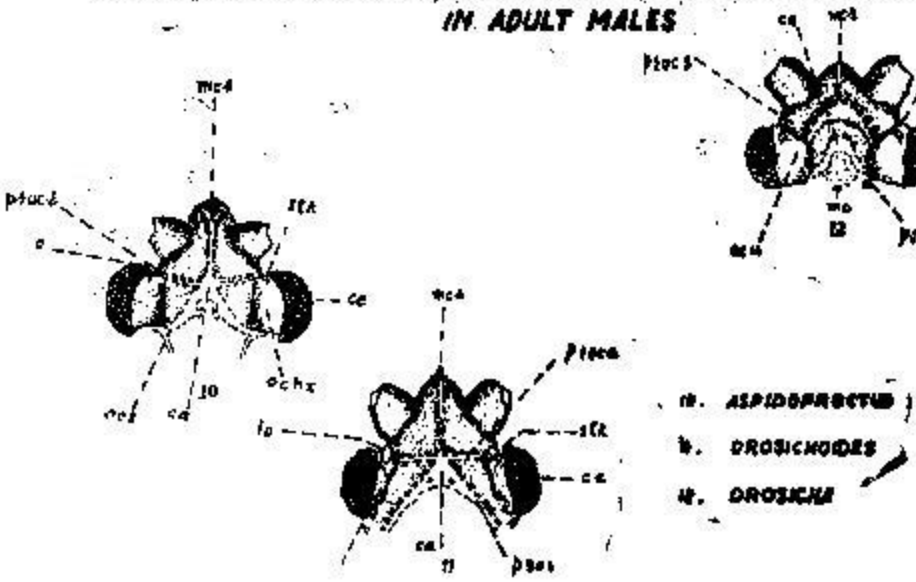
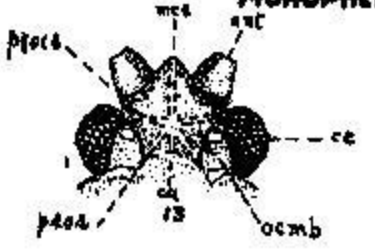


PLATE V CEPHALIC CHARACTERISTICS IN LABIOPROCTUS, MONOPHLEBULUS & LLAVEIA AND ICERYIA



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13. LABIOPROCTUS
14. MONOPHLEBULUS
15. LLAVEIA
16. ICERYIA

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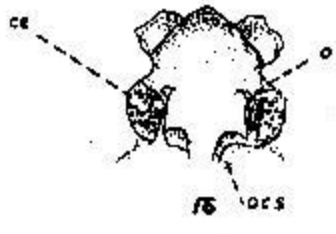

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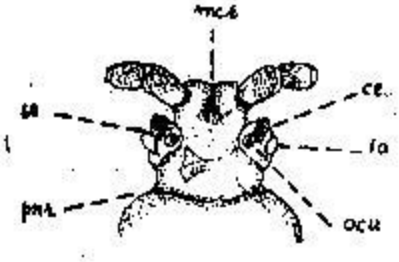
PLATE. XI ADULT MALE CEPHALIC FEATURES IN PHENACOLEACHIA, ELECTROCOCCUS AND STEINGELIA



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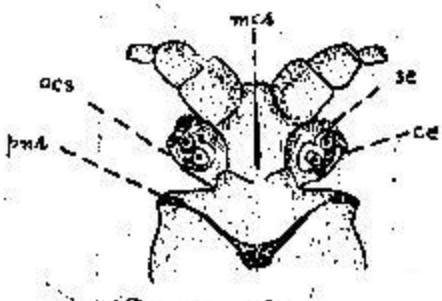

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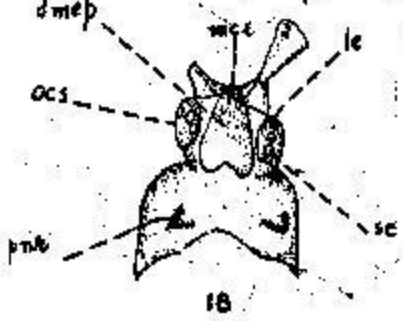
17. PHENACOLEACHIA

18. ELECTROCOCCUS

19. STEINGELIA



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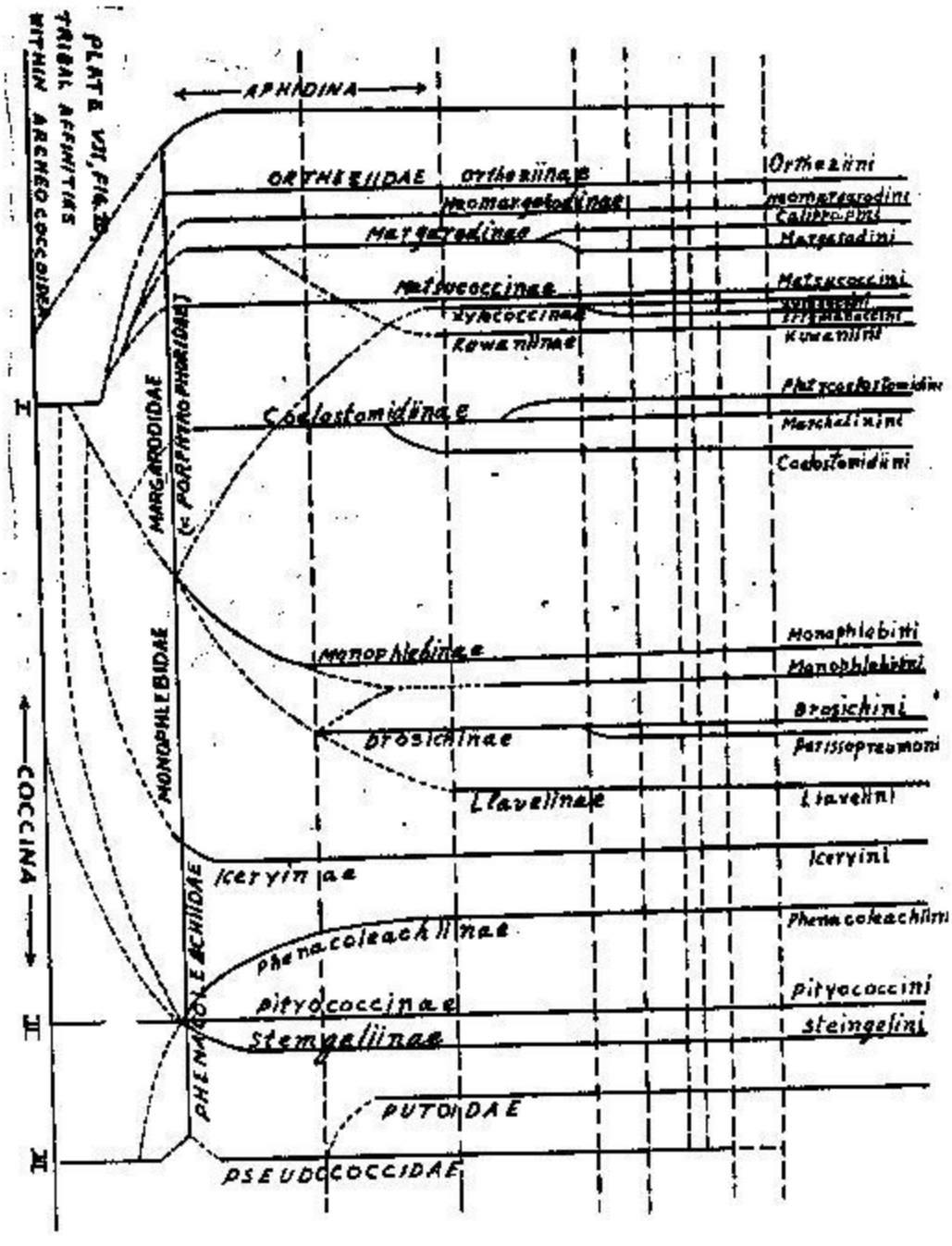
PLATE VII, FIG. 3
TRIBAL AFFINITIES
WITHIN ARCHEOCOCCIDAE
APHIDINA
ORTHEZIIDAE
Orthezia
Orthezinae
Orthezini
Margarodinae
Margarodini
Metaxycoccinae
Metaxycoccini
Xylococcinae
Kuwaniinae
Kuwaniini
Phenacoleachiinae
Phenacoleachiini
Coelostomidiinae
Coelostomidiini
MARGARODIDAE
(= PORPHYROPHORIDAE)
MONOPHLEBIDAE
Monophlebinae
Monophlebini
Drosichinae
Drosichini
Llaveiinae
Llaveiini
Icerya
Iceryinae
Iceryini
PHENACOLEACHIIDAE
Phenacoleachiinae
Pityococcinae
Pityococcini
Steingeliinae
Steingeliini
PUTORIDAE
PSEUDOCOCCIDAE
COCCINA
I
II
III