

Chapter 1

Introduction

Aims of the study

The primary aim of this study is a new investigation on the family Typhlopidae in the Iranian plateau. Notably, the latest study on this family, in Iran, has been done about more than two scores ago; the need of a new examination on this subject is noticeable, completely. In this study, the specimens were studied from different localities: West Azerbaijan, Kermanshah, Ilam, Lorestan, Khuzestan, Markazi, Tehran, Fars, Kerman, Golestan, Mazanderan and Razavi Khorasan provinces, on the most part of Iran, and Turkey and Turkmenistan countries. According to this fact that large samples of *Typhlops vermicularis* specimens were studied in this thesis, a new review was done on this species.

Another aim of this study is the exact examination of species of the family Typhlopidae in the Iranian Plateau, comparison them and finding possible new species, to help increasing the knowledge about the snake fauna in the Iranian Plateau (and the entire world).

1- Introduction

Herpetology is the study of amphibians and reptiles, two distinct clades of vertebrates. Both clades arose within the Tetrapoda (Greek for "four feet"), a clade of bony fish appearing first in the Paleozoic Era. Tetrapods are the fish that took the first "step" from fin to limb—from water to land—and one of their earliest divergent groups became the amphibians. In the Carboniferous, another divergent group of tetrapods, the anthracosaurs, appeared; they evolved modifications for propagation on land in the absence of water, and, perhaps coincidentally, developed an effective skin barrier to reduce rapid and excessive water loss. Today, this group is represented by the reptiles (including birds) and mammals.

1- 1- Taxonomy and systematics

The study of organic diversity has changed its objectives and enlarged its scope in the course of history, as happens in any branch of science. The ancients look for a natural order (*kosmos*) which would explain the bewildering of phenomena. They attempted to discover the true "nature" of things and approached the classification of inanimate objects and living beings by the procedures of logic. The major purpose of a classification was to serve as an identification key, and the philosophy of the early taxonomists was well suited for the utilitarian purposes of taxonomy. Imperceptibly a new branch of biology began to emerge, *the study of diversity of organism*.

The ultimate result of these developments has been the recognition that the universe of the taxonomist is far greater than was previously envisioned. The term taxonomy is derived from the Greek words *taxis*, arrangement, and *nomos*, law, and was first proposed, in its French form by de Candolle (1813) for theory of plant classification.

We follow Simpson's (1961) modern redefinition of this term: "Systematics is the scientific study of the kinds and diversity of organisms and of any and all relationships among them," or more simply, systematics is the science of the diversity of organisms.

Place of Systematics in Biology. Systematics is unique among the biological sciences in its dominant concern with diversity. One of the major preoccupations of systematics is to determine, by comparison, what the unique properties of every species and higher taxon are. Another is to determine what properties certain taxa have in common with each other, and what the biological causes for the differences or shared characters are. Finally, it concerns itself with variation within taxa. In all these concerns systematics hold the unique and indispensable position among the biological science. Classification makes the organic diversity accessible to the other biological disciplines. Without it most of them would be unable to give meaning to their findings.

Systematics deals with populations, species, and higher taxa. No other branch of biology occupies itself in a similar manner with this level of integration in the organic world. It not only supplies urgently needed information about these level but, more important, it cultivates a way of thinking, a way of approaching biological problems which is tremendously important for the balance and well-being of bio0logy as a whole (Mayer, 1968).

1- 2 History of the origin of the snakes

The evolutionary origin of snakes (or Serpentes) has been discussed for over 130 years and their phylogenetic position within squamates is still debated. Around 2700 snake species are alive today and these are divided into three main groups (Pough, et al.1999; Rage, 1987; Greene, 1997): tiny fossorial (burrowing) scoleophidians (blindsnakes); anilioids (pipesnakes), which are mostly semi-fossorial; and macrostomatans, which include more familiar taxa, such as boas, pythons, vipers and cobras.

Hypotheses concerning snake interrelationships fall into two main groups. For some researchers, snakes descend from terrestrial squamates that developed fossorial (burrowing) habits. Two groups of lizards exhibiting such habitats, amphisbaenians and dibamids, have often been regarded as snakes' closest living relatives (Hallermann, 1998) Specializations shared by snakes (Fig. 1-1a), amphisbaenians (Fig. 1-1b) and dibamids

include loss, reduction and consolidation of skull bones; braincase enclosure; dorsal displacement of jaw-closing muscles; loss or reduction of limbs and girdles; and increased uniformity along the vertebral column. Furthermore, differences between the eyes of lizards and snakes are consistent with a model in which structures that were barely useful in a burrower underwent progressive reduction.

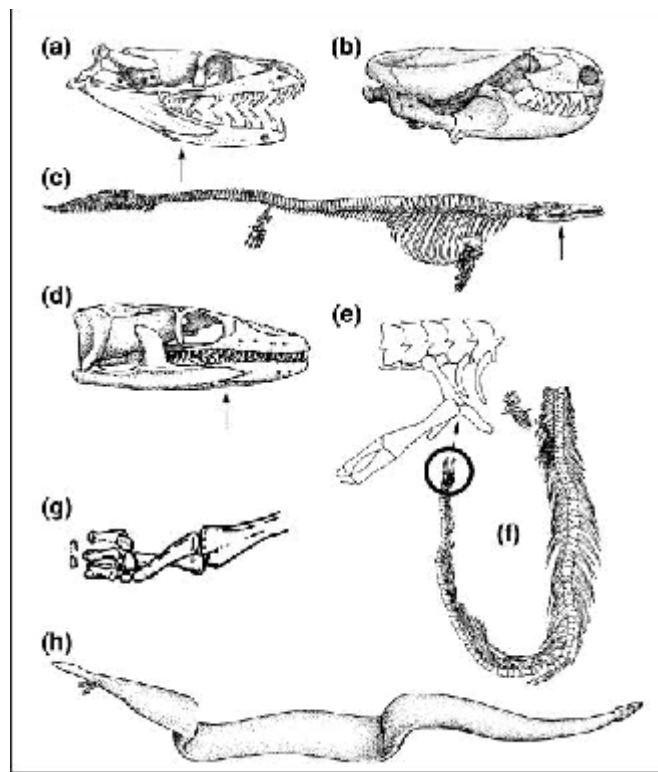


Fig. 1- 1. (a) Skull of a macrostomatan snake (*Python*) in lateral view. Modified, with permission, from Ref. 1. (b) Amphisbaenian skull in lateral view. Modified, with permission, from Ref. 27. (c) Mosasaur (*Plotosaurus*) skeleton in lateral view. Modified, with permission, from Ref. 6. (d) *Pachyrhachis problematicus*: skull in lateral view. Modified, with permission, from Ref. 7. (e) *Pachyrhachis problematicus*: reconstructed sacrum, pelvis and hind limb. Modified, with permission, from Ref. 14. (f) *Pachyrhachis problematicus*: HUI-PAL 3775, showing hindlimb in articulation. Modified, with permission, from Ref. 7. (g) The hindlimb of *Haasiophis terrasanctus*, HUI-PAL EJ 695. (h) *Podophis descouensi*: reconstruction, reproduced, with permission, from Ref. 15.

Abbreviations: HUI-PAL, Palaeontological Collections, Hebrew University of Jerusalem. Arrows indicate level of intramandibular articulation; circle frame indicates remains of diminutive limb.

Alternative hypotheses (Caldwell and Lee, 1997) postulate that snakes are related to mosasauroids (Fig. 1-1c): spectacular marine reptiles from the upper half of the Cretaceous period, some 65–100 Mya⁶. Mosasauroids and snakes share reduced ossification of the pelvis and hindlimbs as well as specialized features of the jaw suspension and intramandibular joint kinetics (presence of a hinge allowing a degree of lateral movement within the lower jaw; Fig 1-1 a, c, d; Fig. 1-2, red circle). Phylogenetically, mosasauroids would be the nearest monophyletic sister group of snakes, with varanoid lizards (monitors) as the immediate sister group to this pair. Given this theory of relationships, the latest common ancestor of mosasaurs and snakes has been argued to have been a limbed, aquatic or semiaquatic squamates (Caldwell and Lee, 1997; Lee and Caldwell, 1998; Lee, 1998; Lee, 1997; Lee et al.1999; Caldwell, 1999). Note that the implied ecological shift from an aquatic to a terrestrial environment in snake ancestry suggests that mosasaurs' (implied) aquatic habits were also primitive for Serpentes. Subsequently, snakes reduced and lost their limbs, although rudiments of the posterior pair remain in some forms, such as pythons.

Renewed interest in the origin of snakes has been triggered by the recognition and discovery of three remarkable fossil forms with hind legs. Each of these ancient snakes is around 97 My old and originates from lowermost Upper Cretaceous sediments in the Middle East.

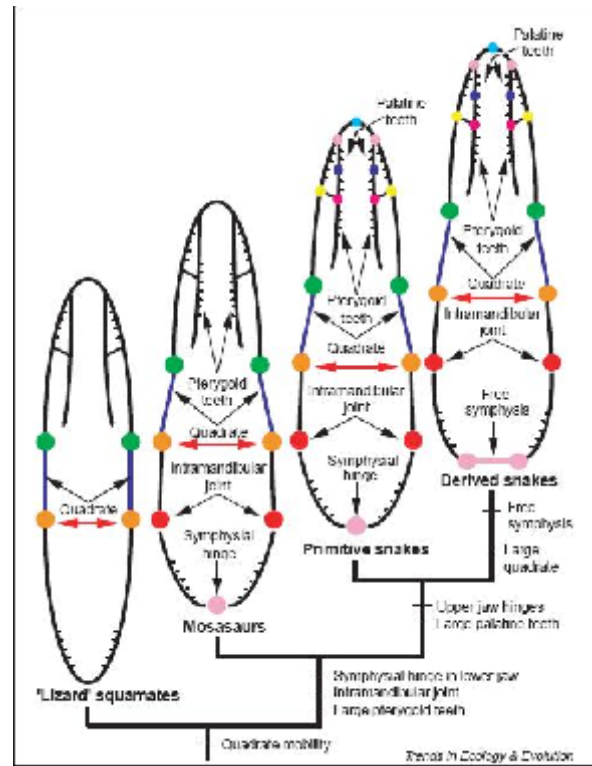


Fig. 1- 2. The evolution of snakes' gapes: hypothesis of the anatomical transformations involved in the evolution of snakes' jaw-hinge mechanisms, plotted on to a simplified version of Lee and Caldwell's7 phylogeny. Modified, with permission, from Ref. 10. Each diagram represents a gaping mouth opened at 180° and facing the observer. Black, curved lines represent upper and lower jaws. Orange circles represent hinges between the upper and lower jaws. Red circles represent the intramandibular joint. Pink circles represent the symphyseal hinge. The symphyseal hinge is replaced by a free symphysis in derived snakes, allowing wide separation between the anterior tips of the two lower jaw halves (compare with macrostomatan gape shown in Fig. II, Box 1). Small colored circles represent additional hinges in the upper jaw of primitive and derived snakes.

Pachyrhachis problematicus, from Israel (Fig. 1-1), rapidly assumed a central position in debates about snake phylogeny (Carroll, 1988; Lee and Caldwell, 1998; Haas, 1980). A second limbed snake from Israel, *Haasiophis terrasanctus*, reported by Tchernov *et al.* (Tchernov et al. 2000), displays the most completely preserved hindlimbs of all three species. These limbs include remnants of at least four digits (Fig 1-1g). Most recently, Rage and Escuillié (Rage and Escuillié, 2000) described *Podophis descouensi* from Lebanon (Fig 1-1h).

Although its pelvis is disrupted, the hindlimb long bones are well preserved, but like *Pachyrhachis*, nothing remains beyond the scattered ankle bones.

1-2- 1 Scenarios for squamates

Evolution trees will continue to be tested and modified by the addition of novel characters and taxa, as well as revised interpretations of existing data. Different branching patterns have the potential to change evolutionary scenarios, implying different estimates of ancestral biogeography, patterns of anatomical transformation, and rates of macroevolutionary change. Thus it is noteworthy that the new discoveries and phylogenies remain consistent with earlier theories (Greene, 1997) that implied an origin and early radiation of snakes in equatorial regions of the southern supercontinent Gondwana. This predicts potential sources of further primitive members of the clade Serpentes.

Some of the fossil snakes considered by Scanlon and Lee (Scanlon and Lee, 2000) are of particular interest in this respect, especially *Wonambi*, from the Pleistocene of Australia. This is one of the last surviving members of a snake group (the Madtsoiidae) at least as old as *Pachyrhachis*. Scanlon and Lee argue that genera such as *Wonambi* (and *Dinilysia*), although more derived than *Pachyrhachis*, must have branched from the main lineage of snake ancestry before the radiation of the modern groups (i.e. scolecophidians, anilioids and macrostomatans) (Fig. 1-3). None of these fossils is interpreted as displaying evidence of a burrowing lifestyle. Instead, they are thought to show fully aquatic (e.g. *Pachyrhachis*) or surface active terrestrial adaptations (e.g. *Dinilysia* and *Wonambi*). The advent of modern burrowers (e.g. scolecophidians) is therefore reconstructed as occurring after the divergence of Serpentes from an aquatic or semiterrestrial ancestor. Consequently, Scanlon and Lee favor large aquatic reptiles with voracious habits, rather than small fossorial squamates, as snake ancestors. But the data are equivocal, and it has been pointed out that a scenario in which mosasaurs and *Pachyrhachis* entered independently into an aquatic existence is just as plausible (i.e. equally parsimonious) (Greene and Cundall, 2000).

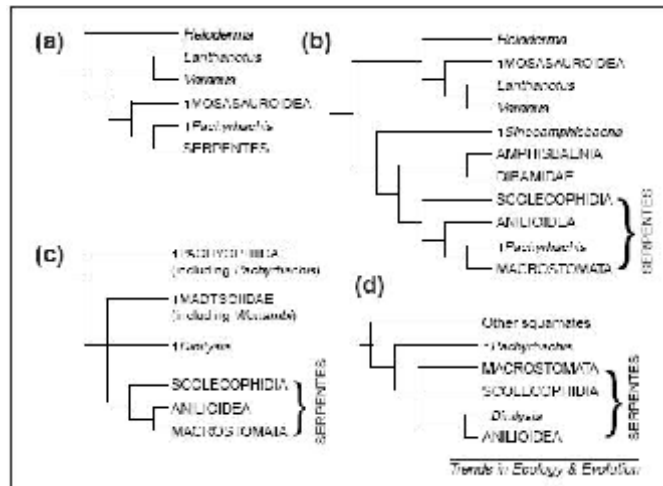


Fig. 1- 3. (a) Hypothesis of squamate phylogeny after Lee (Lee, 1997). (b) Hypothesis of squamate phylogeny after Rieppel and Zaher (Rieppel and Zaher, 2000) (c) Strict consensus of snake relationships after Caldwell (Caldwell, 2000) (d) Hypothesis of snake relationships after Scanlon and Lee (Scanlon and Lee, 2000). † indicates extinct taxa.

Alternatively, Rieppel and Zaher (Rieppel and Zaher, 2000) reconcile the presence of hindlimbs in *Pachyrhachis* with its seemingly derived position as a basal macrostomatian by arguing that it represents either an undiscovered lineage of persistently limbed macrostomatans or a secondarily aquatic clade that re-evolved hindlimbs. Zaher and Rieppel (Zaher and Rieppel, 1999), followed by Tchernov et al. (Tchernov, et al. 2000), address limb loss in greater detail and, in each case, favour a scenario of limb redevelopment. But no adaptive explanation is offered, and is this transformation developmentally plausible? Cohn and Tickle's (Cohn and Tickle, 1999) investigation of python vestigial limb buds demonstrated some (conserved) potential for appendage growth and development. They linked the evolution of limblessness with the embryonic repatterning responsible for snakes' extraordinarily uniform postcranial skeletons (Fig 1-4). Thus, the occurrence of limbs in *Pachyrhachis* could indicate that in the ancestry of this genus, legs were formed *ex novo* from limb rudiments. However and perhaps less controversially, given the lack of compelling evidence for limb re-evolution in any vertebrate clade, independent losses of limbs in the various snake lineages cannot be ruled out. Alternatively, analyses by Caldwell (Caldwell, 2000), and Scanlon and Lee (Scanlon and Lee, 2000) make it unnecessary to invoke any sort of limb reacquisition or repeated losses in snake phylogeny whatsoever. Cohn and Tickle's (Cohn and Tickle,

1999) theory of snake developmental evolution exemplifies the way in which experimental data can be optimized (mapped) on a phylogenetic framework – in this case, Caldwell and Lee’s hypothesis (Fig. 1-3a) (Caldwell and Lee, 1997; Lee and Caldwell, 1998; Lee,1998; Lee, 1997). However, the heated arguments over snake phylogeny emphasize a real need for those addressing questions about comparative biology, from development to behavior, to

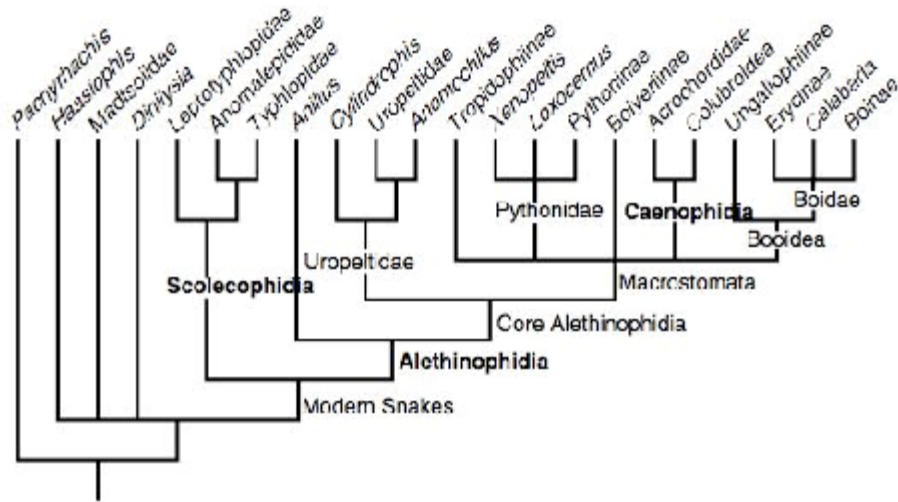


Fig. 1- 4. Recent model of squamate phylogeny by Lee et al. (2007) based on combined morphological and molecular data.



Fig. 1- 5. *Typhlops vermicularis*, X-ray photography, illustrating complete absence of pectoral girdle and limb; postcranial skeletal uniformity is interrupted only at rear extremity, in pelvic and caudal regions.

respond to conflicting theories of relationships (Lee et al. 2007; Fig. 1-5). Future phylogenies using character sets other than conventional anatomical and molecular data (see Schwenk's work on squamate tongue structure Schwenk, 1988), and the impact of soft tissue data in other areas of intense systematic debate (Gura, 2000) could considerably modify our understanding of squamate evolution.

1- 3- Classification of snakes

Within the suborder Serpentes a major dichotomy exists between its two infraorders, Alethinophidia (typical snakes) and Scolecophidia (blindsnakes, wormsnakes, and threadsnakes). Alethinophidia, with approximately 12 families and 2400 species, includes the primitive or lower taxa, such as boas and pythons, plus the derived or higher taxa, a minority of which are the venomous elapids, viperids, and atractaspids (Table 1). Scolecophidia, with three families, 12 genera and more than 350 species, represents 20% of the families and 13% of all extant species of snakes. Although the scolecophidians are an important group based upon their basal position and number of taxa, most research has centered on taxonomic descriptions, identification keys, and range extensions.

Scolecophidians are primarily restricted to tropical areas of the Neotropical, Ethiopian, and Australasian Regions, only marginally entering the subtropical or temperate Nearctic and Palearctic. Anomalepididae in the Neotropics has 17 species in four genera (*Anomalepis*, *Helminthophis*, *Liotyphlops*, *Typhlophis*), New and Old World Leptotyphlopidae have 100 species in two genera (*Leptotyphlops*, *Rhinoleptus*), and the cosmopolitan Typhlopidae has 240 species in 12 genera (*Acutotyphlops*, *Afrotyphlops*, *Austrotyphlops*, *Cathetorhinus*, *Cyclotyphlops*, *Grypotyphlops*, *Letheobia*, *Megatyphlops*, *Ramphotyphlops*, *Rhinotyphlops*, *Typhlops*, *Xenotyphlop*).

Table 1- 1. Classification of snakes

Suborder Ophidia (Serpentes) Linnaeus, 1758

Infraorder Scolecophidia Duméril and Bibron, 1844

Superfamily Typhlopoidea Merrem, 1820

- Family Anomalepididae Taylor, 1939

Anomalepis Jan, 1860 in Jan and Sordelli, 1860 –1866

Helminthophis Peters, 1860

Liotyphlops Peters, 1881

Typhlophis Fitzinger, 1843

- Family Typhlopidae Merrem, 1820

Acutotyphlops Wallach, 1995

Afrototyphlops Broadley & Wallach, 2009

Austrototyphlops Wallach, 2006

Cathetorhinus Duméril & Bibron, 1844

Cyclotyphlops Bosch and Ineich, 1994

Grypotyphlops Peters, 1881

Letheobia Cope, 1868

Megatyphlops Broadley & Wallach, 2009

Ramphotyphlops Fitzinger, 1843

Rhinotyphlops Fitzinger, 1843

Typhlops Schneider and Oppel, 1811

Xenotyphlops Wallach and Ineich, 1996

Superfamily Leptotyphlopoidea Stejneger, 1891

- Family Leptotyphlopidae Stejneger, 1891

Leptotyphlops Fitzinger, 1843

Rhinoleptus Orejas-Miranda, Roux-Estève, and Guibé, 1970

Superfamily Acrochordoidea

Family [Acrochordidae](#) Bonaparte 1831

Superfamily Uropeltoidea s.l. (Pipe snakes and Sunbeam snakes)

- Family [Anomochiliidae](#) (Dwarf Pipe Snakes) Cundall, Wallach and Rossman, 1994

- Family [Cylindrophiiidae](#) (Asian Pipe Snakes) Fitzinger, 1843

- Family [Uropeltidae](#) (Shield-tail Snakes) Müller, 1831
- Superfamily Pythonoidea s.l. (Pythons and relatives)
- Family [Loxocemidae](#) (Mexican Burrowing Pythons) Cope, 1861
 - Family [Pythonidae](#) (Pythons) Fitzinger, 1826
 - Family [Xenopeltidae](#) (Sunbeam Snakes) Bonaparte, 1845

Superfamily Booidea Gray, 1825

- Family [Boidae](#) (Boas) Gray, 1825
- Subfamily Boinae (Boas) Gray, 1825
 - Subfamily Ungaliophiinae (Dwarf Boas) McDowell, 1987
 - Subfamily Erycinae Bonaparte, 1831

Superfamily Colubroidea Opperl, 1811

- Family [Colubridae](#) (Colubrids) Opperl, 1811
- Subfamily Colubrinae ("Colubridae")
 - Subfamily Grayiinae Subfamily Calamarinae

- Family Dipsadidae Bonaparte 1840
- Subfamily Dipsadinae Bonaparte 1840
 - Subfamily Heterodontinae Bonaparte 1845
 - Subfamily Xenodontinae Bonaparte 1845

- Family Natricidae Bonaparte 1840
- Family Pseudoxenodontidae McDowell 1987

Superfamily Elapoidea (tentative)

- Family [Elapidae](#) Boie 1827
- Subfamily Elapinae Boie 1827 (Cobras, Coral Snakes, etc.)
 - Subfamily Hydrophiinae Fitzinger 1843 (Sea Snakes)
- Family Lamprophiidae Fitzinger 1843
- Subfamily [Atractaspidinae](#) Günther 1858 (Mole Vipers)
 - Subfamily Lamprophiinae Fitzinger 1843
 - Subfamily Psammophiinae Bonaparte 1845
 - Subfamily Pseudoxyrhopiinae Dowling 1975

Superfamily Homalopsoidea

- Family Homalopsidae Bonaparte 1845

Superfamily Pareatoidea Romer 1956

- Family Preatidae Romer 1956

Superfamily Viperioidea

- Family [Viperidae](#) Oppel 1811 (Vipers and Pit Vipers)

Subfamily Azemiopinae Liem, Marx and Rabb 1971

Subfamily Causinae Cope 1860

Subfamily Crotalinae Oppel 1811

Subfamily Viperinae Oppel 1811

Superfamily Xenodermatoidea

- Family Xenodermatidae Gray 1849

Currently not assigned to any Superfamily:

- Family [Aniliidae](#)/Ilysiidae (Pipe Snakes)
- Family [Bolyeriidae](#) (Round Island Boas)
- Family [Tropidophiidae](#) (Dwarf Boas)

1- 4- Serpentes

Based upon a review of the literature, Serpentes can be defined and distinguished from other living squamate reptiles (Sauria and Amphisbaenia), as presently understood, by the following unique characters: (1) quadrate lacking condylar articulation to paroccipital process, medial surface ligated (without intervening meniscus or synovial sac) to surface of ear capsule, usually a dermal bone identified as either the tabular or supratemporal; (2) bony braincase formed by lateral subolfactory downgrowths of frontals and parietals that are sutured to the lateral edge of the parasphenoid (parabasisphenoid) with ophthalmic and profundus branches (V1) of trigeminal nerve enclosed within braincase by parietals meeting the prootic; (3) braincase platytrabic, interorbital septum absent, paired trabeculae cranial in the orbital region but united anteriorly and joining the nasal septum, emerging from the basisphenoid and running forward on either side of the parasphenoid rostrum (except modified platytrabic condition

in Scolecophidia where trabeculae are fused into a single rod at the mid-orbital level due to telescoping of nasal and orbital regions); (4) exoccipitals meet middorsally to exclude the supraoccipital from border of the foramen magnum; (5) absence of posterolateral processes of parietal; (6) absence of ascending process of supraoccipital; (7) absence of quadratojugal; (8) closed capsule for Jacobson's organ, and its opening (fenestra vomeronasalis externa), formed only by lateral edge of vomer and mesial edge of septomaxilla; (9) optic foramen fully enclosed in bone; (10) crista circumfenestralis present, forming juxtastapedial recessus and enclosing stapedial footplate and juxtastapedial sinus; (11) fenestra perilymphatica (perilymphatic duct exits into juxtastapedial sinus formed by crista circumfenestralis) present; (12) extracolumella (or insertion plate) of the middle ear absent; (13) tympanic recess of quadrate absent; (14) palatine with medially projecting process along middle of bone; (15) one mental foramen on dentary; (16) maxilla-palatine contact non-sutural and mobile; (17) maxilla-vomer contact non-sutural and mobile; (18) maxilla-septomaxilla contact non-sutural and mobile; (19) vomer-palatine contact non-sutural and mobile; (20) vomer is anterior and medial to palatines; (21) absence of synovial joints in three cephalic articulations: palatobasal articulation (between pterygoid and basisphenoid), pterygoquadratal articulation (between pterygoid and quadrate), and quadrate suspensorium (between quadrate and braincase); (22) presence of a rectangular flange of palate; (23) angular-coronoid contact on medial surface of mandible; (24) surangular, prearticular and articular fused into single compound bone plus angular and splenial present as distinct elements; (25) marginal teeth ankylosed to rims of shallow alveoli; (26) absence of axial and appendicular epiphyses; (27) absence of pectoral girdle and forelimbs; (28) absence of paraseptal cartilage; (29) viscerocranium consisting solely of mandibular and bronchial arch I, lacking hyoid arches [or mandibular and hyoid arches, lacking bronchial arches; (30) pelvis (when present) lies within rib case; (31) absence of transversalis muscle in iris of eye; (32) absence of retractor bulbi, bursalis, and depressor palpebralis inferior muscles in eye; (33) jaw adductors inserting entirely on dorsal surface of parietal; (34) absence of M. elevator pterygoidei; (35) adductor mandibulae externus medialis (MAMEM) arising from both the braincase and quadrate; (36) origins of three heads of adductor mandibulae externus (MAME) arranged anterior to posterior (superficialis,

medialis, posterior); (37) limbus and lagenae not joined in cochlear duct; (38) larynx thrust into fleshy choanal passage as defined by palatal velum; (39) left systemic arch with larger diameter than right; (40) thymus glands immediately anterior to the heart and far from the head; (41) gall bladder adjacent to compact pancreas and spleen, all of which are separated from the liver; (42) adrenal glands with wedge-shaped, radially arranged cortical cells; (43) absence of palatine oral glands; (44) absence of nictitating membrane; (45) C24 bile salts conjugated with taurine; (46) trigeminal (V) foramen without artery passing through it; (47) in species possessing two lungs, anastomoses present between the left and right pulmonary arteries; (48) posterior colliculi of mesencephalon with paratorus; (49) thymus gland develops from pharyngeal pouches 3-5; (50) Harder's gland large and extending beyond orbi into temporal region; (51) limbus and lagenae not joined in cochlear duct; (52) absence of lachrymal gland; (53) hepatic duct and cystic duct uniting to form common bile duct to pancreas; (54) rhomboidal V1 medialis nerve exiting nasal capsule ventral to nasal cupola; and (55) interocular distance/head width >10% (Wallach, 1998).

1-4- 1- Scolecophidia

For various reasons scolecophidians have been neglected by most systematists, partly because of their small size, the difficulty of examining head shields and counting scale rows and their rarity in collections. Occurrence in the fossil record is dependent upon factors such as length of fossil history, dispersal capacity, abundance, habitat range, and chances of fossilization, including size. Among the many features that influence the distribution of a group through time, the most important is its dispersal capacity (Keast, 1973). As previously noted, the dispersal capacity of scolecophidians seems poor in contrast to alethinophidians, which are for the most part more mobile and can cover large distances in one day or season. Scolecophidians have existed for a long time period geologically, may be abundant where they occur (but their occurrence seems to be sporadic), and are likely to be fossilized due to their subterranean lifestyle. However, they have poor dispersal ability, are specialists, live in a restricted habitat, and are extremely small (for vertebrates), all of which reduce their chances of preservation. Because of the sparse and practically non-informative fossil record of scolecophidians,

we must rely on present distributions to analyze the group's evolutionary history and reconstruct its past distributional history.

1-4- 2- Characteristics

Classification and phylogenetic relationships of higher snakes (Caenophidia) in general are poorly resolved (see Underwood, 1967; Dowling and Duellman, 1978; McDowell, 1987), but it is the Scolecophidia that is the least understood group. There is considerable evidence for monophyly in Scolecophidia. In contrast to Alethinophidia, Scolecophidia shares the following characteristics (many of which are probable synapomorphies): (1) trigeminal foramen without artery passing through it, facial carotid artery coursing ventral to trigeminal (V) nerve and entering skull lateral to sphenoid; (2) main descent of frontals post-optic and lateral to ophthalmic (V1) branch of trigeminal nerve, trabecula communis at level of eyes, skull tropitric; (3) maxillary (V2), mandibular (V3) and pterygoid (V4) branches of trigeminal nerve in single trigeminal foramen between parietal and prootic; (4) frontoparietal suture open, potentially mobile, with mesokinetic joint; (5) shape of parietal in dorsal view more or less parallel sided; (6) quadrate articulates with paroccipital region of fused exoccipital-opisthotic (otic capsule) of skull by a single condyle; (7) quadrate nearly horizontal and slanting forward; (8) Vidian canal reduced to groove or absent due to sphenoid lacking basiptyergoid processes and lateral wings absent, palatine nerve canal located at lateral edge of sphenoid; (9) orbitonasal partition longitudinal, directed anterolaterad; (10) nasals immovably sutured to frontals, with transversely expanded ascending process of frontal forming dorsal horizontal lamina that overlaps nasal, lacking prokinetic nasofrontal joint; (11) lachrymal foramen lacking, lachrymal duct not enclosed in prefrontal; (12) ventral surface of premaxilla broadly expanded transversely; (13) sella turcica of sphenoid shallow, near posterior border of sphenoid, or absent; (14) cultiform process of sphenoid absent; (15) common aperture between descending processes of frontals for left and right olfactory (I) nerves, frontal pillars or median vertical septum lacking; (16) maxillary and dentary tooth tips visibly projecting from oral mucosa; (17) pterygoid not approaching quadratomandibular joint; (18) lower jaw less than half the length of the skull; (19) mandibular condyle of quadrate far anterior to cephalic condyle; (20) surangular of compound bone not projecting far into dentary along lateral surface, which is lacking

deep bifurcation; (21) mandible length less than 80% of skull length; (22) shape of coronoid in medial view as enlarged triangular plate; (23) vertebral condyle facing dorsally, not visible in ventral view; vertebral cotyle facing ventrally; (24) absence of subcentral ridges on ventral surface of centrum; (25) lacking external spurs of vestigial pelvis and hindlimbs; (26) hyomandibular branch of facial (VII) nerve pierces crista circumfenestralis to enter juxtastapedial fossa with intracranial route through otic capsule; (27) absence of superior and inferior oblique muscles of eye; (28) hyotrachealis present but origin not from hyoid cornua; (29) geniomucosalis muscle present; (30) transversus branchialis muscle medial to geniotrachealis; (31) absence of costomandibularis and neurocostomandibularis muscles; (32) quadrate tendon of adductor mandibulae externus posterior (MAMEP) reduced or absent; (33) epaxial muscle bundles in helical arrangement; (34) independent segregation of axial and cutaneous musculature; (35) intermandibularis muscle broad and transverse; (36) posterior tongue lacking circular muscle dorsally; (37) tongue lacking muscle ventral to hyoglossus; (38) tongue with central, vertical connective tissue septum anteriorly by which transverse and vertical muscles attach; (39) tongue lacking hyoglossal nerve branch in transverse muscle; (40) hyoglossal muscle bundles of tongue terminate prior to bifurcation of tongue; (41) free part of foretongue bifurcate from 20-40%; (42) superior orbital artery absent; (43) facial carotid artery with ventral course to mandibular (V3) and maxillary (V2) branches of trigeminal nerve; (44) left systemic arch junction with dorsal aorta cranial of ventricular apex; (45) left and right systemic arches forming asymmetrical F-shaped configuration [rather than Y-shaped]; (46) infralabial glands entirely mucous; (47) caudal extension of Harder's gland well beyond posterior edge of orbit; (48) one pair of thymus glands; (49) adrenal glands oval or oblate in shape, length/width ratio 1.5-5.0; (50) lacking biologically active dental glands; (51) fundic glands of Type III in stomach, lacking neck cells and light mucous cells; (52) internal relief of small intestine; (53) skin lacking horny layer in second generation, consisting only of a thin "Oberhäutchen" and thin loose horny layer; (54) epidermal lipid glands present along at least the bases of the anterior most head shields; (55) cephalic sense organs with collar; (56) lacking enlarged ventral scutes, midventral scale row not noticeably differentiated from costals; (57) free margin of distal edge of midbody scales

greater than 20% of scale length; (58) all body scales smooth, glossy, pitless, imbricate, cycloid, and undifferentiated; (59) mouth small, ventral, and countersunk, with angle below or anterior to eye when open; and (60) specialized diet of soft-bodied arthropods, particularly ant and termite eggs, larvae, pupae and adults, ingested by inertial feeding in large quantities (Wallach, 1998).

1-4- 3- Typhlopidae

Examination of speciation in geographical regions reveals strikingly different patterns among the three families. More than 75% of anomalepidid species inhabit South America and less than 25% occupy Central America. The greatest number of species of typhlopids occurs in Asia (30%) and Africa (25%), with 20% in Australia, 15% in the Americas, and 10% in Madagascar. It is well known that islands are conducive to rapid speciation and diversity (MacArthur and Wilson, 1967). Not surprisingly, nearly 45% of the total Asian species occur on Indonesian islands, and 60% of the New World total occurs on the Caribbean islands. High insular species/genus (S/G) ratios are present in typhlopids in Asia, with Indonesia at 15.5 compared to India at 9.0 and Indo-China at 7.0, and America, with the Caribbean at 13.5 compared to 9.0 for South America and 5.0 for Central America (Wallach, 1998).

This family has 12 genera that the name of them and their species are in follow:

ACUTOTYPHLOPS

A.banaorum, A.infralabialis, A.kunuaensis, A.solomonis, A.subocularis

AFROTYPHLOPS

A.Angeli, A.angolensis, A.bibronii, A.blanfordii, A.cngestus, A.elegans, A.fornasinii, A.usambaricus, A.gierrai, A.kaimosae, A.liberiensis, A.ineolatus, A.nanus, A.manni, A.tanganicanus, A.punctatus, A.nigrocandidus, A.schmidti, A.rondoensis, A.steinhausi

AUSTROTYPHLOPS

A.affinis, A.australis, A.aspina, A.batillus, A.bicolor, A.bituberculatus, A.broomi, A.chamodracaena, A.centralis, A.ammodytes, A.diversus, A.endoterus, A.grypus, A.ganei, A.hamatus, A.guentheri, A.kimberleyensis, A.howi, A.leucoproctus, A.leptosomus, A.ligatus, A.longissimus, A.margaretae, A.micrommus, A.nema, A.nigroterminatus, A.nigrescens, A.minimus, A.nigricaudus, A.pinguis, A.pilbarensis, A.robertsi, A.proximus,

A.silvia, A.tovelli, A.waitii, A.unguirostris, A.troglodytes, A.splendidus, A.wiedii, A.yirrikalae, A.yampiensis

CATHETORHINUS

C.melanocephalus

CYCLOTYPHLOPS

C.deharvengi

GRYPOTYPHLOPS

G.acutus

LETHEOBIA

L.cutirostrata, L.ataeniata, L.caeca, L.crossii, L.debilis, L.decorosa, L.episcopa, L.erythraea, L.faeae, L.goundae, L.gracilis, L.graueri, L.jubana, L.katangensis, L.keanaensis, L.kibarae, L.largeni, L.leucostictus, L.lumbriciformis, L.newtoni, L.obtusa, L.pallida, L.pauwelsi, L.pembana, L.praeocularis, L.rufescens, L.scorteccii, L.simoni, L.somalica, L.stejnegeri, L.sudanensis, L.swahilica, L.toritensis, L.uluguruensis, L.unitaeniata, L.wittei.

MEGATYPHLOPS

M.anomalous, M.schlegelii, M.mucruso, M.brevis.

RAMPHOTYPHLOPS

R.acuticaudus, R.albiceps, R.angusticeps, R.becki, R.cumingii, R.depressus, R.erycinus, R.exocoeti, R.flaviventer, R.lineatus, R.lorenzi, R.mansuetus, R.marxi, R.multilineatus, R.olivaceus, R.ozakiae, R.polygrammicus, R.similis, R.suluensis, R.supranasalis, R.willeyi

RHINOTYPHLOPS

R.anomalous, R.brevis, R.lalandei, R.mucruso, R.schinzi, R.schlegelii

TYPHLOPS (Old World)

T.albanalis, T.andamanensis, T.andasibensis, T.arenarius, T.ater, T.beddomii, T.betsimisarakia, T.bisubocularis, T.boettgeri, T.bothriorhynchus, T.canlaonensis, T.castanotus, T.ceylonicus, T.coecatus, T.collaris, T.comorensis, T.conradi, T.cuneirostris, T.decorsei, T.depressiceps, T.diardii, T.domerguei, T.ductuliformes, T.etheridgei, T.exiguus, T.fantsona, T.filiformis, T.fletcheri, T.floweri, T.fredparkeri, T.fuscus, T.giadinhensis, T.hades, T.hedraeus, T.hypogius, T.hypsobothrius, T.inornatus,