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By J. M. Anderson

Introduction

To date, fourteen Procynosuchid specimens have been discovered, thirteen from the *Cistecephalus* beds in the New Bethesda and Murraysburg districts in the Southern Karroo and one very poor specimen from the Ruhuhu Beds to the N.E. of Lake Malawi. Five genera, including eight species, have been created. This paper briefly describes the history of the classification within the family and notes some of the difficulties encountered.

History of the Classification

Broom (1937) gave a preliminary description of a skull with primitive Cynodont characteristics and named it *Procynosuchus delaharpeae* (Fig. 1a). In 1938 he gave fairly detailed descriptions of this form together with a second specimen which he found sufficiently different to warrant the creation of a new species—*Procynosuchus rubidgei* (Fig. 1b).

The following differences were noted:

Procynosuchus rubidgei has relatively much larger nasals, much broader frontals having a broad articulation with the parietals, smaller parietals, larger pineal foramen, less elevated intertemporal crest and jugular foramina situated a little farther back.

Broom (1940) gave a very brief description of a fairly complete small skull which he named *Paracynosuchus rubidgei* (Fig. 1c). Although there are clear affinities with *Procynosuchus*, the skull is far more slenderly built and there are only 7 "molars" as against 8 in the two species of *Procynosuchus*.

Broom (1948) created three new genera and species, *Leavachia duvenhagei* (Fig. 1d), *Galeophrys kitchingi* (Fig. 1g) and *Galecranium liorhyncus* (Fig. 1h) and Broom and Robinson (1948) created a new genus and species *Aelurodraco microps*. They were all recognised to be related to one another and to *Procynosuchus* and *Paracynosuchus*.

Broom attached very great importance to the upper dental formula in his classification.

i.e. *Paracynosuchus* $i^5c^2m^7$
Procynosuchus $i^6c^2m^{10}$

Aelurodraco	$i^6c^2m^8$
Leavachia	$i^6c^3m^8$
Galeophrys	$i^6c^3m^9$
Galecranium	$i^6c^3m^{11}$

Von Huene (1950) gave a very brief description of a poor anterior fragment of a skull found in the Ruhuhu Beds to the N.E. of Lake Malawi. He correlated it with *Procynosuchus delaharpeae*.

Brink and Kitching (1951) after further preparation of the type of *Aelurodraco microps* stated that it had a dental formula of $i^6c^3m^8$ and that in general proportion it was remarkably similar to *Leavachia*. They announced the existence of a second specimen in the collection of the Bernard Price Institute identical to the type in size and proportions and noted that it also had a dental formula of $i^6c^3m^8$. They therefore sank the generic name *Aelurodraco* and created a new combination for the two specimens of *Leavachia microps*. At the same time a third specimen which agreed perfectly in general proportions with *Leavachia duvenhagei and Leavachia microps* (Fig. 1e) and was of the same size as the latter was described. They found sufficient differences however to create a third species, *Leavachia gracilis* (Fig. 1f) (Table 1).

TABLE 1

	L. duvenhagei	*L. microps*	*L. gracilis*
Backward extension of post orbitals	to level of posterior border of pineal foramen	to level well in front of pineal foramen	to anterior margin of pineal foramen
Position of postorbitals just anterior to pineal foramen	postorbitals well separated	postorbitals nearly meet each other	postorbitals well separated
Shape of nasals	posterior breadth only slightly greater than anterior breadth	condition intermediate between *L. d.* and *L. g.*	large difference between anterior and posterior breadths of nasals
Overlap of squamosal on parietals	appears to be no overlap	condition intermediate between *L. d.* and *L. g.*	considerable overlap

In the same paper they set out a table of characteristics showing the differences between the four genera, *Procynosuchus*, *Leavachia*, *Galeophrys* and *Galecranium*. They excluded dental formulae since they felt that the number of "molars" changes with maturity (Table 2).

TABLE 2

	Procynosuchus	*Leavachia*	*Galeophrys*	*Galecranium*
Breadth/length ratio of skull	59%	71%	64%	60%
Parietal region	Short	intermediate	intermediate	long
Posterior extension of post-orbitals	terminate well in front of pineal foramen	extend past pineal foramen	extend to middle of pineal foramen	extend to anterior margin of pineal foramen
Length of Snout	Long	Short	Short	Long

Brink and Kitching (1953) re-described the type specimen of *L. duvenhagei* after further preparation and gave a brief account of a second specimen which was slightly smaller than the type but in all other respects exactly similar.

They found the following important factors relating to dental formulae within the genus *Leavachia*:

Leavachia duvenhagei (type) $i^5c^3m^8$

Leavachia duvenhagei (2nd spec.) $i^5c^3m^{7+1}$ apparently not yet erupted

Leavachia gracilis (type) $i^5c^3m^7$

Leavachia microps (type) $i^5c^3m^8$

Leavachia microps (2nd. spec.) $i^5c^3m^8$

They also described a second more complete specimen of *Galecranium liorhyncus* and a second specimen of *Procynosuchus rubidgei*. The *Galecranium* specimen agreed in every detail with the type. They gave a dental formula of $i^5c^3m^{11}$ and (not having seen the type) believed that Broom probably counted one too many incisors, just as he had in the type of *Leavachia duvenhagei*.

The second specimen of *Procynosuchus rubidgei* was slightly smaller than the type. They expressed the opinion that the only real difference between *Procynosuchus delaharpeae* and *Procynosuchus rubidgei* was in the shape of the frontals and that the two species were possibly synonymous. Since the shape of the frontals in the new specimen agreed better with the latter species they referred to it as *Procynosuchus rubidgei*. This specimen they found to have a dental formula of $i^5c^3m^{10}$ and not $i^6c^2m^{10}$ as Broom gave for both types. They stated that the

new specimen showed very distinctly the suture between the maxillary and premaxillary passing in front of the second small tooth anterior to the large canine and expressed doubt (again without having investigated the type) as to Broom's interpretation.

Brink (1963) gave a detailed description of an excellently preserved third specimen of *Leavachia duvenhagei*. It was exactly the same size as the type. He gave a dental formula of $i^5c^3m^{10}$ which differed in the number of "molars" from the type and the second specimen. In the new specimen the postorbital extended backwards only to the level of the anterior end of the pineal foramen.

He suggested that the upper dental formula for all the Procynosuchidae might well be $i^5c^3m\pm^{10}$ and concluded that it was difficult apart from general proportions to distinguish between the different genera.

Discussion

Broom differentiated his genera on upper dental formulae and general proportions and size. It has since been shown that many faulty counts have been made regarding dental formulae. Also, when it is considered how much the general proportions and size can vary according to maturity, sex, environmental conditions and postmortem distortion, it would seem that many more specimens must be found before a reasonably decisive sub-division of the family Procynosuchidae can be reached.

Specific diagnoses have rested more on the sizes, shapes and relationships between the various bones of the skull, none of which would appear very reliable, considering the paucity of comparative material.

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KEY TO FIGURES

All diagrams half natural size.

FIG. 1

a) *Procynosuchus delaharpeae* (Type. After Broom 1938).
b) *Procynosuchus rubidgei* (Type. After Broom 1938).
c) *Paracynosuchus rubidgei* (Type. After Broom 1940).
d) *Leavachia duvenhagei* (3rd specimen. Drawn from specimen).
e) *Leavachia microps* (Type. After Broom and Robinson 1948).
f) *Leavachia gracilis* (Type. After Brink and Kitching 1951).
g) *Galeophrys kitchingi* (Type. After Broom 1948).
h) *Galecranium liorhyncus* (Type. After Broom 1948).

KEY TO ABBREVIATIONS

ASPH.	Alisphenoid.
F.	Frontal.
IP.	Interparietal.
J.	Jugal.
L.	Lachrymal.
MX.	Maxillary.
N.	Nasal.
P.	Parietal.
PMX.	Premaxillary.
PO.	Postorbital.
PRF.	Prefontal.
PRO.	Prootic.
PT.	Pterygoid.
SQ.	Squamosal.
pin f.	Pineal foramen.

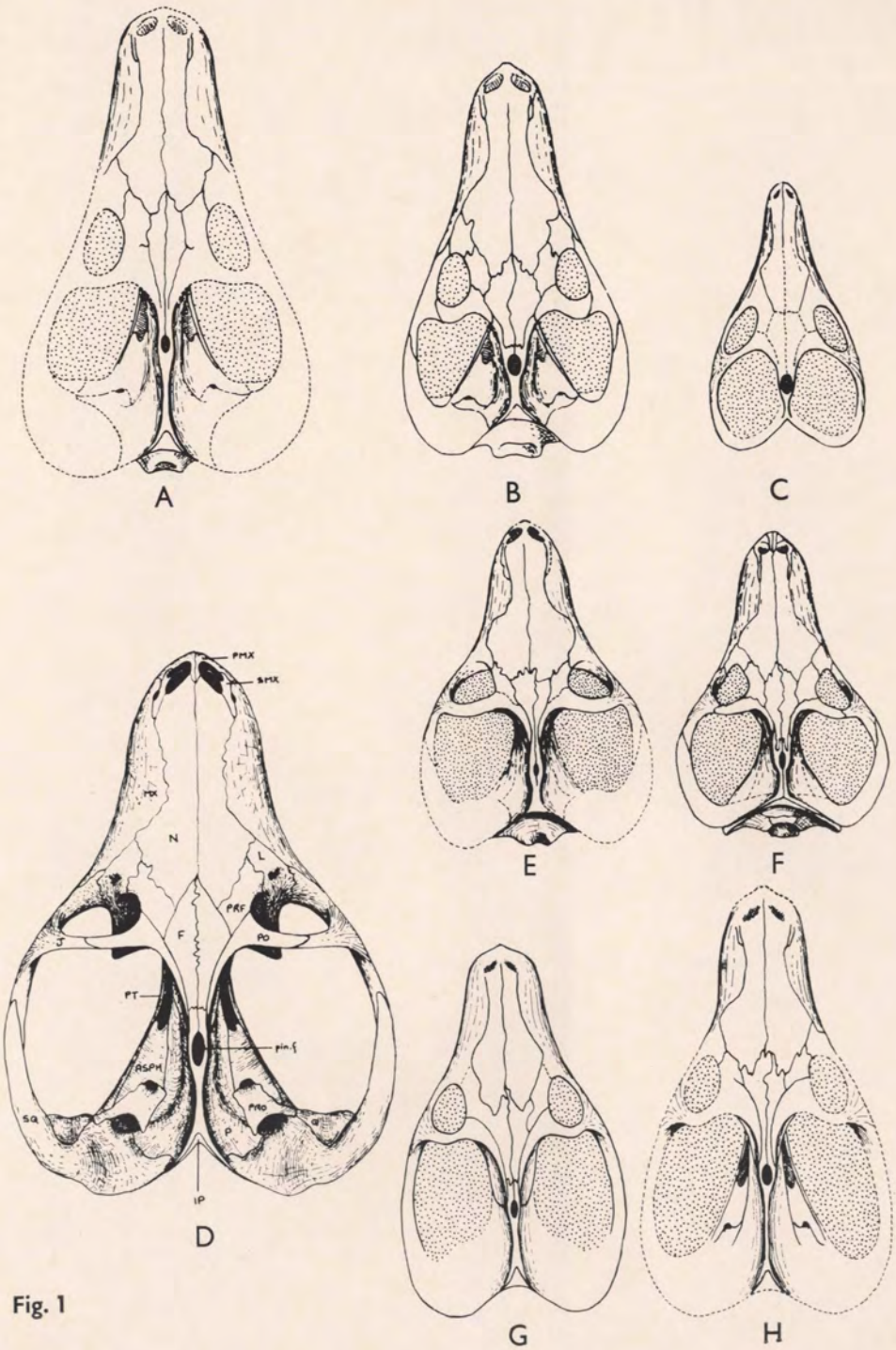


Fig. 1

TABLE 3

		FARM LOCALITY	NUMBER AND COLLECTION	REMAINS AND CONDITION OF SPECIMEN	DESCRIPTIONS AVAILABLE					
					Author	Dorsal skull	Ventral skull	Occiput	Lower jaw	Posterior skeleton
Leavachia duvenhagei	Type	Doornkloof	Number 92 Rubidge Collection	good skull with lower jaw nearly complete skeleton	*a*) Broom 1948	fairly good	—	fairly good	fairly good	fairly good
					b) Brink & Kitching 1953	notes on dentition	brief	—	—	—
	2nd spec.	Doornbosch	Number 304 Rubidge Collection	skull with posterior portion weathered away	Brink & Kitching 1953	notes on similarity with type	—	—	—	—
	3rd spec.	Town Commonage New Bethesda	Number 357 B.P.I.	complete skull and lower jaw	Brink 1963	very detailed	very detailed	very detailed	very detailed	brief
Leavachia microps	Type	Ringfontein	Number 8 B.P.I.	good skull lacking the arches lower jaw in place	*a*) Broom & Robinson 1948	good	—	brief	brief	—
					b) Brink & Kitching 1951	notes on dentition	—	—	—	—
	2nd spec.	Hoeksplaas	Number 226 B.P.I.	skull	Brink & Kitching 1951	notes on dentition	—	—	—	—
Leavachia gracilis	Type	Leeufontein	Number 234 B.P.I.	good skull with lower jaw partial skeleton	Brink & Kitching 1951	good	—	brief	good	brief
Procynosuchus delaharpeae	Type	The Glen	Number 5 Rubidge Collection	good skull lacking the arches	*a*) Broom 1937	brief	brief	—	—	—
					b) Broom 1938	good	good	brief	—	—
	2nd spec.	(East Africa) Ruhuhu Beds	K. 92 Tübingen Collection	poor anterior section of snout	Von Huene 1950	very brief	very brief	—	—	—
Procynosuchus rubidgei	Type	Afrikanerskloof (Garnora)	Number 12 Rubidge Collection	well preserved skull. Arches of right side missing	Broom 1938	good	good	brief	—	—
	2nd spec.	Seekoegat	Number 306 Rubidge Collection	somewhat crushed skull	Brink & Kitching 1953	brief	—	—	—	—
Galecranium liorhyncus	Type	Afrikanerskloof (Garnora)	Number 87 Rubidge Collection	good skull lacking the arches	Broom 1948	brief	—	—	—	—
	2nd spec.	Karreelaagte	Number 305 Rubidge Collection	skull with right arch missing	Brink & Kitching 1953	brief	—	—	—	—
Galeophrys kitchingi	Type	Town Commonage New Bethesda	Number 72 Rubidge Collection	nearly complete skull somewhat crushed. Much of neck present	Broom 1948	brief	—	—	—	—
Paracynosuchus rubidgei	Type	Grootdriefontein	Number 17 Rubidge Collection	fairly complete skull weathered on one side. Lower jaw present	Broom 1940	very brief	—	—	—	—