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PRELIMINARY NOTES ON THE TAXONOMY OF *TARENTOLA ANNULARIS* AND *T. EPHIPPIATA* (SAURIA: GEKKONIDA)

by

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(With Plates I-III, and one textfigure)

Among a large collection of West African lizards sent to me for identification early in 1952 by l'Institut Français d'Afrique Noire were a number of individuals belonging to the genus *Tarentola*. The latest taxonomic treatment of *Tarentola* available at that time was by Loveridge (1947). In his study he had considered *Tarentola annularis* and *T. ephippiata* to be geographical races of a single species, the subspecies *annularis* occurring in Egypt, Sinai, Eritrea, Ethiopia and British Somaliland and the subspecies *ephippiata* occurring to the west of these areas, in Nigeria, French West Africa, Portuguese Guinea and Gambia. He also synonymised *T. senegalensis* Boulenger with *ephippiata* and suggested that *T. hoggarensis* Werner might be a synonym too. Thus, according to Loveridge, on geographical grounds the I.F.A.N. specimens should have been referable to the western race *ephippiata* but it was evident from an examination of the individuals that they belonged to two forms, neither of which agreed with the characters given by Loveridge for *annularis* or *ephippiata*, and that the forms were occuring together at the same localities. However, an analysis of his tabulated data on the scale counts for *ephippiata* and *annularis* showed no clear cut differences between the two races except on the scansor count of the first toe. Furthermore, an examination of the type of *T. senegalensis* (B.M. 1946. 8. 9. 88) which was described from Gorée, Senegal, showed that the scale counts of the interorbitals, tubercle rows, scansors under the first and fourth toes and the gulars (18 : 14 : 18 : 17 : 23) fell within the same limits

the range of variation of the cotypes of *T. ephippiata* (14 : 15/16 : 14/16 : 14/15 : 16/17). It was apparent that Loveridge had not examined the type material of either *senegalensis* or *ephippiata* and the reliability of his study was therefore seriously doubted.

It was obvious to me that an extensive and detailed study of *Tarentola,* based on large series bearing ecological data, would be necessary before the complexities of the status, relationships and distribution of the two forms could be unravelled, so it was considered prudent, pending the completion of such a stpdy, to defer making a decision on the status of the individuals in the I.F.A.N. collection and merely refer them in my 1956 paper to "*Tarentola annularis-ephippiata* complex".

During the last few years, several papers that are relevant to the study of the complex have been published. In 1959 Pasteur described from S.W. Morocco a new species of *Tarentola, T. panousei,* which he maintained was distinguishable from both *T. annularis* and *T. ephippiata* and in the same year Bons recorded both *panousei* and *ephippiata* in his list of species occurring in S.W. Morocco. In both papers it was stated that *annularis* and *ephippiata* are valid and distinct species but no support for their belief was given. Bons provided a photograph of the dorsal integument of what he considered to be *ephippiata.* By 1960 Pasteur and Bons had changed their minds on the status of *T. panousei* and in their catalogue they reduced it to the rank of a subspecies of *hoggarensis* without however giving their reasons for the status change or for reinstating *hoggarensis.* It is possible that an explanation is given in a later paper by Pasteur published in Bull. Soc. Sci. nat. Phys. Maroc. 40 which is quoted in their bibliography but unfortunately this volume has not yet reached the British Museum library. A further contribution to the *Tarentola* taxonomic tangle is by Wake and Kluge (1961) who after recording three examples of *annularis* from Chad Territory go on to say that "on the basis of our material we find it impossible to consider the forms [*T. annularis* and *T. ephippiata*] con-

Tarentola annularis (Geoffroy)

Gecko annularis Geoffroy Saint-Hilaire, 1827, p. 130. Egypt.
Tarentola senegalensis Boulenger, 1885, p. 414. Gorée, Senegal.
Tarentola ephippiata (non O'Shaughnessy) Boulenger, 1895, p. 166. Inland of Berbera.
Tarentola annularis Anderson, 1898, p. 89. Egypt (various localities).
Tarentola senegalensis Pellegrin, 1910, p. 22. Tintan.
Tarentola annularis Wake & Kluge, 1961, p. 10. Oum Chalouba, Arada, Gongo, Chad Terr.

The salient diagnostic characters of this species are:

1. Arrangement and number of the tubercle rows on the dorsum. The tubercles are arranged in regular, longitudinal rows, those of the four dorsal rows being somewhat elongate, distinctly keeled and surrounded by a homogeneous assemblage of granules while more laterally the tubercles are somewhat conical and set in rosettes of single rings of granules which are larger than the adjacent ones. In the vertebral region three or four granules separate each row of tubercles and there are two or three granules between each tubercle; the granules between the more lateral tubercle rows are more numerous and from five upwards. There is a marked disparity in the linear size of tubercles and granules (approximately 4 : 1). Tubercle rows range from 11-16 (M = 13.5 : N = 102). The specimens having 16 rows were collected at L. Abbé and Berbera.

2. Number of interorbital scales in a transverse series range from 16-20 (M = 17.84 : N = 103).

3. Number of gular scales in a transverse series between the ears. As there was no significant variation in the ratio of body length to the length from eye to ear (as measured from the posterior border of the eye to the anterior border of the ear), the eye to ear distance was used as an index by which the gular scales could be counted. Range 18-38 (M = 25 : N = 25). A trend from a higher count in individuals collected in the east (Eritrea) to a lower count in those from the west was noted.

4. Numbers of scansors under the first and fourth toes.
1st Toe: Range 15-23 (M = 18.9 : N = 152).
4th Toe: Range 17-22 (M = 19.74 : N = 103).

5. Tail shape. The tail is flattened ventrally, is distinctly broad at its base and tapers rapidly. The lowermost tubercles are strongly projecting and form a lateral serration.

6. Head shape. The temporal region is broad and swollen in both sexes; the snout in profile is sharply oblique with marked concavities in the nasal

regions above the 1st and 2nd upper labials, and also in front of the lower half of the eyes in the loreal region.

7. Pattern. The four, equidistant, dark-edged, white, scapular spots as described by Loveridge (1947) for *T. a. annularis* are fairly typical of the whole series of *annularis* and are present also in juveniles.

8. Maxillary tooth count and nasal region of the skull.

Tooth counts were made on 33 examples of *T. annularis* of a body size ranging from 28.5-128.5 mm. Although there is considerable variation in the number of teeth at a given size, there is also some evidence of ontogenetic increase. The life span of *T. annularis* in the wild is unknown but assuming it to be four years and that the body size of the individuals examined represents the size range of the species then by taking the diminution factor $^4/_5$ to allow for asymptotic growth the average range of size in the four periods would be:

Age group 1	28.5- 62.4 mm.	Increase	33.9 mm.
„ „ 2	62.4- 89.4 mm.	„	27.0 mm.
„ „ 3	89.4-111.1 mm.	„	21.7 mm.
„ „ 4	111.1-128.4 mm.	„	17.3 mm.

By applying the number of teeth to the body size of the individuals in these arbitrary age units, there is found to be an increase with age in the average number of teeth.

Age group 0-1	average number of teeth 62
„ „ 1-2	„ „ „ „ 75.6
„ „ 2-3	„ „ „ „ 76.8
„ „ 3-4	„ „ „ „ 79

TABLE I

Ontogenetic increase in the teeth of *T. annularis*

	Body length	Number of teeth	
	28.5	56	
	30.4	56	
	36.9	58	
	40.3	64	
	42.0	62	
Age 0-1 (arbitrary units)	43.0	62	Average 62
	46.0	68	
	46.4	65	
	47.8	60	

	Body length	Number of teeth	
	48.0	60	
	50.0	74	
	65.8	80	
	70.0	70	
	70.0	74	
	72.0	76	
	75.0	74	
	76.0	72	
Age 1-2 (arbitrary units)	77.0	70	Average 75.6
	78.0	80	
	80.0	79	
	82.0	78	
	82.0	70	
	86.0	82	
	89.0	78	
	90.0	72	
	90.0	76	
	95.5	78	
Age 2-3 (arbitrary units)	97.2	75	Average 76.8
	105.6	80	
	107.8	77	
	110.0	80	
Age 3-4 (arbitrary units)	116.5	76	Average 79
	128.5	82	

The length of the premaxilla from the anterior edges of the nasal cavities to the front of the nasal bones is equivalent to the length of the more posterior portion of the premaxilla, the portion that forms sutures with the paired nasal bones themselves. The nasal cavities are large and in dorsal view the posterior-ventral border of the premaxilla can be clearly seen and well forwards from the front of the nasals. Further study based on a much larger series of skeletal material is required to determine the value of these characters as a means of distinguishing this species from *T. ephippiata.*

Loveridge (1947) appears to attach some importance to the number of internasal granules and to the scales surrounding the nostril. In his tabulated data for the species of *Tarentola* he gives 0-1-2 internasals as being usual in ***annularis*** and says that although two or three nasals and the first upper labial always enter the nostril, the rostral may sometimes be excluded. Of 136 individuals that I have examined 64% have one internasal, 35.3% have no internasal and 0.7% (one individual) has two internasals while out of 100 examples all but four have three nasals entering the nostril (the exceptions from Gao and Timbuktu, Niger, have four) and in only

fourteen examples (from localities throughout the range of the species) is the rostral excluded; in every specimen the first upper labial enters the nostril.

It should be mentioned that no significance can be attached to the absence of an ear denticulation which is an extremely variable character in individuals of *annularis* from throughout the range.

The only record of the occurrence of this species in Algeria is a Leiden Museum specimen from Algiers (no. 5453) which was determined as *T. annularis* and whose identification I have verified. Its scale counts are 16 : 14 : 20 : 20 : 28. As the locality is so far removed from the known distribution of *annularis* and as there is no trustworthy evidence that the species occurs in Algeria the record is omitted from the map of the distribution of the study material.

Tarentola ephippiata (O'Shaughnessy)

T. ephippiata O'Shaughnessy, 1875, p. 264. West Africa.
T. ephippiata Anderson, 1896, p. 99. Durrur, Suakin.
T. ephippiata Anderson, 1898, p. 88. Durrur, Suakin.
T. ephippiata Pellegrin, 1910, p. 23. Between Tintan and El Aïoudj.
T. ephippiata de Witte, 1930, p. 616. To the south of In Ouri, Tilemsi.
T. ephippiata Angel, 1932, p. 385. Mt. Baghezan, Aïr.
T. ephippiata Angel & Lhote, 1938, p. 356. Segou, Soudan.
T. ephippiata Monard, 1940 (part). Mansoa and Contubo El, Port. Guinea.
T. ephippiata Angel, 1950, p. 332. Agadez and Azzel, Aïr.
T. delalandii hoggarensis Werner, 1937, p. 33. Hoggar Mountains.
T. delalandii hoggarensis Loveridge, 1947, p. 330. Hoggar Mountains.
T. panousei Pasteur, 1959, p. 41. Hamada du Dra, Morocco.
T. panousei Bons, 1959, p. 50. Hamada du Dra, Morocco.
T. hoggarensis panousei Pasteur & Bons, 1960, p. 33. Hamada du Dra, Morocco.

The salient diagnostic characters of this species are:

1 Arrangement and number of the tubercle rows on the dorsum and sides of the body. The dorsal tubercles are oval in shape, smooth or only very faintly keeled; along the vertebral region they are flat but tend to be somewhat raised towards the sides of the body. The longitudinal rows of tubercles are not as regularly arranged as in *T. annularis* and the number of scales separating each tubercle and each tubercle row varies from 1-3. The scales are unequal in size particularly in the vertebral region but are generally 1/3-half the linear size of the tubercles. The lateral five rows of tubercles are more widely spaced and are separated from each other by 3 or 4 scales. The number of longitudinal series of tubercles varies from 14-18 (M = 15.75 : N = 49). The specimens that have only 14 rows were

collected at Wushishi, Nigeria; Diafarabé, Niger; Pergola, Tambacounda and Kedougou, Upper Senegal; Tintane, Mauritania. Those with 18 rows were taken in S.W. Senegal at Joal and Sebikotane.

2. Number of interorbital scales in a transverse series range from 11-16 (M = 13.1 : N = 51). Two specimens, from Goundam, Niger and from Baguezan, Aïr have 11 and one from Sebikotane and five from Kedougou, Senegal have 16.

3. Number of gular scales in a transverse series between the ears. (Measurement taken as explained under *T. annularis.)* Range 13-20 (M = 16.6 : N = 33).

4. Number of scansors under the first and fourth toes.
1st Toe: Range 11-17 (M = 14.1 : N = 50).
4th Toe: Range 13-17 (M = 15.0 : N = 51).

5. Tail shape. The tail is rounded at the sides and elliptical in section. The anterior part of the tail has rows of large but not very prominent tubercles the lowermost of which is ventral, and not lateral as in *annularis*, and does not project noticeably.

6. Head shape. In both sexes the head is narrow with a broadly rounded snout which is not depressed as in *annularis* and does not have the marked concavities behind the nostrils nor in front of the eyes.

7. Pattern. There is a ladder-like arrangement of brown or red crescent-shaped patches from the nape, down the back and as far as the tail. There is also a brown streak that runs from the tip of the snout, through the eye to join with the first cross bar on the shoulder region.

8. Maxillary tooth count and nasal region of the skull. Tooth counts were made on 28 examples of *T. ephippiata* of a body length ranging from 49.2-85.7 mm (Table II). By using the same arbitrary age groups as employed with the *annularis* figures, a comparison can be made of the average number of teeth in the two species.

The nasal cavities are comparatively small and the premaxillary "bridge" is only 1/3 the length of the more posterior portion of the premaxilla. As mentioned in the section dealing with *annularis,* skeletal material was inadequate and too much emphasis should not be placed on the value of these characters.

Loveridge (1947) gives the internasal granules as 0-1 and states that three nasals and the first upper labial always enter the nostril while the rostral may occasionally be excluded. One of the syntypes of *T. ephippiata*

has an internasal granule while the other has none. Of 48 other examples of this species that were examined, the granule is absent in 14 and present in 34; one individual, collected at Tidjikja, Mauritania has two internasals. In all the specimens examined except one the rostral, first upper labial and three nasals enter the nostril; the exception (collected at Azzel, S. Aïr) has a fourth nasal on one side.

None of the specimens that have been examined has an ear denticulation.

Dr. G. Pasteur kindly allowed me to compare the holotype of *T. panousei* with the syntypes of *T. ephippiata* and there is no doubt that *panousei* should be relegated to the synonymy of *T. ephippiata* O'Shaughnessy. The

TABLE II

Ontogenetic increase in the teeth of *T. ephippiata*

Age 0-1 (arbitrary units)			Age 1-2 (arbitrary units)		
Body length (mm)	Number of teeth		Body length (mm)	Number of teeth	
49.2	62	Average 65.1 (av. 62 in *T. annularis*)	63.5	66	Average 67.7 (av. 75.6 in *T. annularis*)
49.8	64		63.8	66	
56.8	62		64.5	68	
57.0	68		65.2	64	
60.2	69		65.4	64	
60.3	64		66.7	70	
61.1	62		67.1	64	
			68.0	68	
			68.9	70	
			69.3	68	
			70.5	66	
			71.5	74	
			71.8	68	
			72.0	68	
			73.5	68	
			74.0	68	
			74.8	68	
			79.4	64	
			82.1	68	
			83.3	68	
			85.7	74	

numbers of interorbital scales, tubercle rows, scansors on the first and fourth toes and gular scales in the eye to ear distance are 13 : 15 : 12 : 15 : 13 which are well within the range of variation noted in *ephippiata* and no other character remains by which *T. panousei* can be distinguished from *T .ephippiata.*

Although Werner (1938) stated categorically that the holotype of *T. delalandii hoggarensis* is distinct from *T. ephippiata*, there is no evidence among British Museum records that he ever compared it or had it compared with the syntypes of *T. ephippiata* and now that the holotype is lost a direct comparison as impossible. Nevertheless I strongly suspect that *T. d. hoggarensis* is synonymous with *T. ephippiata* for, while the description given by Werner is both vague and scanty, a dark postocular bar is mentioned as well as a less pointed snout, larger head shields and a narrower temporal region than the nominate form of *delalandii*. All these characters suggest *ephippiata* and from a geographical standpoint also it is likely that Werner's *hoggarensis* is a synonym of *T. ephippiata* rather than a race of *T. delalandii*.

"Mixed" Population

At a few places in areas where typical *annularis* and *ephippiata* occur

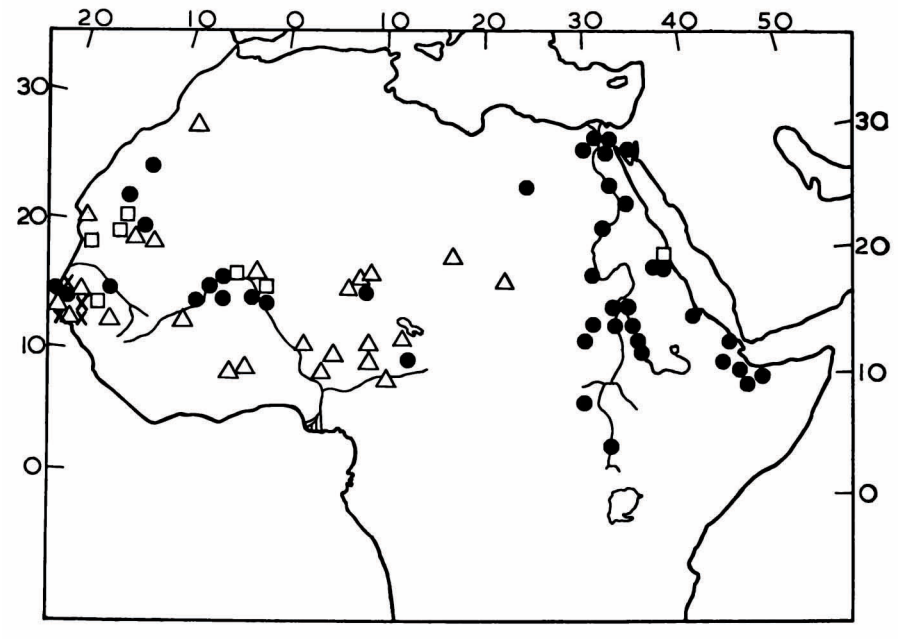

Fig. 1. Distribution of the specimens studied.
● *T. annularis*; △ *T. ephippiata*; □ Both *T. annularis* and *T. ephippiata*; × "Mixed" *Tarentola* population.

a small number of examples of *Tarentola* were collected that could not confidently be refered to any known species, yet had obvious affinities with

both *annularis* and *ephippiata*. The localities where these specimens were found are Dakar, Yelimané and Messirah (Senegal), McCarthy Island (Gambia) and Enxale and Bafata (Portuguese Guinea); the areas are indicated on the map by a cross.

In these specimens the *ephippiata*-like arrangement of the tubercle rows, the shape of the tubercles and the size of the granules separating them and the sturdy *annularis*-like proportions of the head and body are constant but other features of the lepidosis that are of taxonomic importance vary from resembling one or the other of these species. Whilst the number of interorbital scales is consistently high (17-19), that is *annularis*-like, five of the specimens have 13 or 14 tubercle rows and four specimens have 16 or 17. The scansor count on the individuals having a low number of tubercle rows is 16-18 (1st toe) and 17-19 (4th toe) while in the second group the scansors vary from 14-16 (1st toe) and from 15-17 on the 4th toe. None of the individuals has any distinguishable pattern but this may be due to bleaching as each is a uniform pale cream.

Even in the early stages of this study it was known that in two instances *annularis* and *ephippiata* had been taken at the same locality (Atar and Nouackchott, Mauritania), but since none of the *Tarentola* from throughout the known range bore ecological data it was considered possible that the species were confining themselves to different ecological habitats wherever a choice was available, the one being perhaps arenicolous and the other arboreal, and that only in the southwest of the range did their ecological isolating mechanism break down and produce a mixed population of parental species and occasional hybrids. Such an explanation, however, does not now seem likely for recently examples of both *annularis* and *ephippiata* have been collected in the same house and at the same time at Gao, Niger.

Temperature and also humidity are believed to be potential influences on scale characters but although experimentally it has been shown (Fox 1948) that higher scale counts and variations in the character of the scale can be produced by increasing the temperature, there is as yet no proof that environmental factors produce similar scale variation in natural populations.

In the Senegal-Guinea region the diurnal and seasonal fluctuations in temperature and the maximum and minimum temperatures are fairly similar to those of Mauritania, N. Nigeria and Aïr where no "intermediate" population occurs. The environmental factors that do differ widely, however, are mean annual rainfall and relative humidity and it is conceivable that in the south-west the high humidity has a direct effect on the lepidosis of certain

broods of *Tarentola* and produces smaller scales in much the same way as an increase in temperature is believed to do. The facts however do not suggest that these "intermediate" individuals are the progeny of parents of either *annularis* or *ephippiata* which have developed a higher number of scales than is usual in the parent species, for their scale counts are not consistently high but instead may be typical in one scale character, high in a second and low in a third.

A more reasonable explanation would be that the different climatic conditions prevailing in this region have caused a breakdown in whatever mechanism isolates *annularis* from *ephippiata*. The mechanism may be different breeding times and in the south-west where *annularis* and *ephippiata* have had to adapt themselves to a different set of environmental conditions the breeding times may coincide and occasional hybridisation take place. Such a situation would account for the presence in the same area of one or other parental species as well as individuals with "mixed" characters. Unfortunately there is no corroborating evidence and meanwhile no conclusions can be drawn.

SUMMARY

250 examples of *Tarentola* of the *annularis-ephippiata* group from localities representative of the whole geographic range have been examined and there is no evidence to suggest that there is any geographical or ecological segregation of *annularis* and *ephippiata*. On the contrary, with the exception of a population that inhabits the Senegal, Gambia and Portuguese Guinea region where some individuals have characters resembling both species, *T. annularis* and *T. ephippiata* are morphologically distinct, without intergradation and are almost completely sympatric. The diagnostic morphological characters of both species are given and the value of characters previously considered to be significant are discussed. *T. senegalensis* Blgr. is considered a synonym of *T. annularis* Geoffroy, *T. delalandii hoggarensis* Werner and *T. panousei* Pasteur are considered conspecific with *T. ephippiata* O'Shaughnessy. It is suggested that a breakdown in the isolating mechanism between *annularis* and *ephippiata* perhaps associated with heavier rainfall and higher humidity may be responsible for the presence of mixed characters among some individuals occurring in the south-west of the range of the two species.

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EXPLANATION OF PLATES

Plate I. Dorsal views

Fig. 1. *Tarentola annularis* Geoffroy
Fort Gouraud, Mauritania

Fig. 2. *Tarentola ephippiata* O'Shaughnessy
Zouar, Tibesti

Fig. 3. *Tarentola panousei* Pasteur (holotype)
Hamada of Dra, S.W. Morocco

Plate II. Ventral views

Fig. 1. *Tarentola annularis* Geoffroy
Fort Gouraud, Mauritania

Fig. 2. *Tarentola ephippiata* O'Shaughnessy
Zouar, Tibesti

Plate III. Enlarged photographs of dorsal skin

Fig. 1. *T. annularis,* Abangharit, Aïr

Fig. 2. *T. ephippiata,* Bou Genduz, Mauritania


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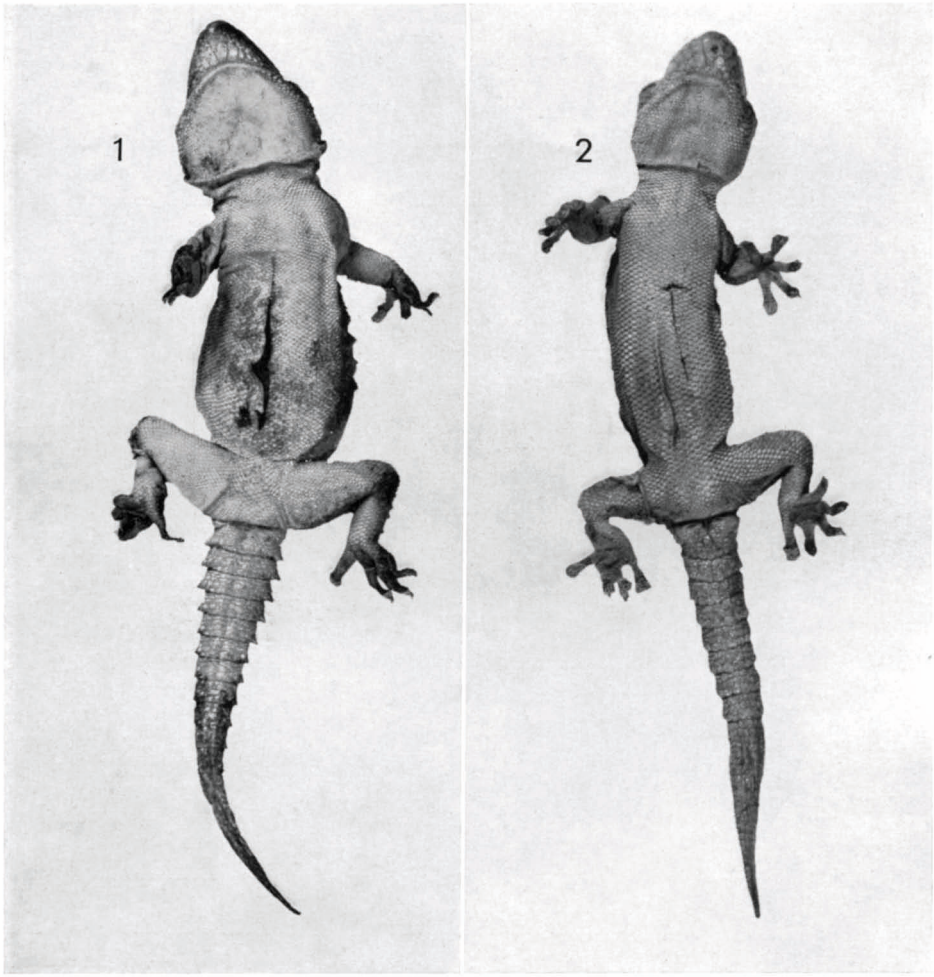
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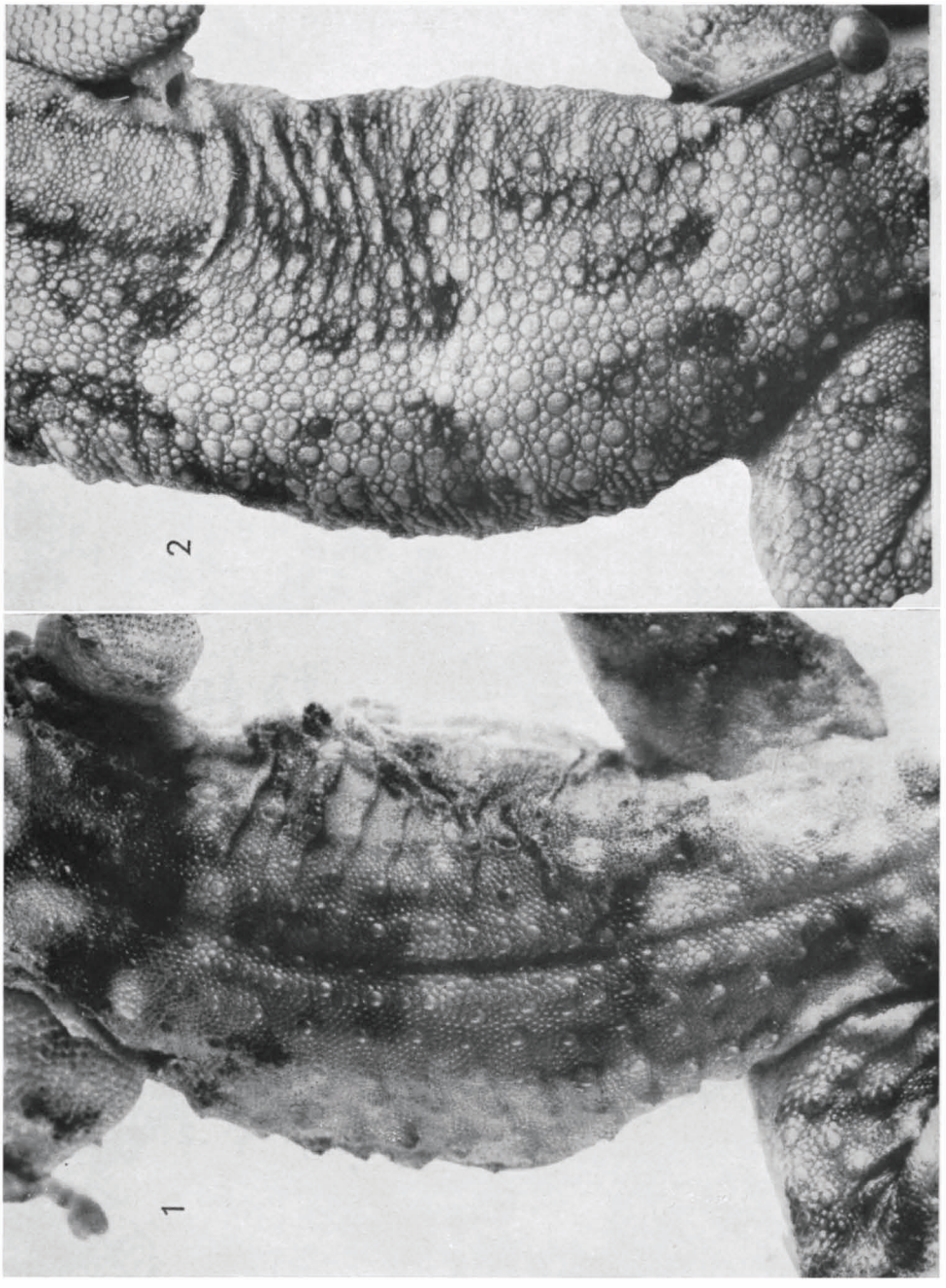
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