

BEAUFORTIA

SERIES OF MISCELLANEOUS PUBLICATIONS

ZOOLOGICAL MUSEUM - AMSTERDAM

No. 156

Volume 13

February 25, 1966

Notes on chameleons III The chameleons of southern Arabia

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INTRODUCTION

The literature on the chameleons of Arabia, especially of southern Arabia, is a succession of confusions and mistakes. Three species have been mentioned from southern Arabia, i.e. *Chamaeleo calypratus* Duméril & Duméril, 1851, *Chamaeleo calcarifer* Peters, 1871 and *Chamaeleo arabicus* (Matschie, 1893). Many authors have come to the conclusion that only two of these names are valid and several authors even have meant that only one species could be found in southern Arabia: *Chamaeleo calypratus*, and that all the other names have to be regarded as synonyms.

A short survey:

- 1851 A. & C. DUMÉRIL give the first description of *Chamaeleo calypratus* in the Cat. Mus. Paris Rept.: 31. As locality is given: Région du Nil.
- 1852 A. DUMÉRIL repeats "Région du Nil" as provenance of three type specimens of *Chamaeleo calypratus* and gives a good picture.
- 1854? W. PETERS (:615) gives a simple note on *Chamaeleo calypratus*: "Westküste von Madagasar (sic) (Bay Bombatuka)." Probably 1854 is not the year of publication in print, as it was in November 1854 that Peters gave his lecture. The volume gives no date of publication.
- 1869 (published 1870) W. PETERS corrects his previous determination of the Chameleon from "Bembatuka": he considers it now as the type of a new species: *Ch. calcaratus*.
- 1870 (published 1871) W. PETERS corrects again: he has discovered that Merrem used the name *Ch. calcaratus* already in 1768 and so (curiously enough as a note to *Ch. namaquensis*) he calls his chameleon now *Ch. calcarifer*.
- 1882 W. PETERS publishes a fine picture of his *Ch. calcarifer*, plus a recapitulation of the description in "Reise nach Mossambique". WERNER (1911) mentions this as the original publication of *Ch. calcarifer* and he gives a wrong year (1852) as the date for publication.
- 1885(a) Some chameleons are caught by Major Yerbury in the neighbourhood of Aden.

Received: October 25, 1965.

- BOULENGER identifies them as *Ch. calcarifer*. The first doubts rise on the provenance of the type specimen: "The typical example described by Dr. Peters. . . is said to have been obtained in Madagascar, but it can hardly be believed that a Chameleon of the same species can occur in two such different localities" (I used a similar reasoning in 1959 as to the discontinuous distribution of *Ch. calyptratus* in Egypt and Arabia).
- 1885(b) In reply to a question of the secretary of the Menagerie of the Zoological Society of London Major Yerbury writes about the chameleon: "There is no doubt of its locality, as I caught it myself. . ." and he mentions several more specimens and one "example of another species of Chameleon". The latter is interesting in connection with our problem.
- 1887 In BOULENGER's Catalogue *Ch. calcarifer* is regarded as a South Arabian chameleon.
- 1893 (publ.?) MATSCHIE describes a new chameleon (*Chamaelon* (sic) *arabicum*) from Lahadsch, Aden. He does not agree with Boulenger that the above mentioned specimens of Major Yerbury have to be regarded as belonging to *Ch. calcarifer*. His arguments are first that the type specimen of *Ch. calcarifer* was caught at "Bombetoka", Madagascar and some differences in characters, of which the more important ones seem to me: occipital flaps in *Ch. calcarifer* narrower than in the Arabian form; the occipital flap in *Ch. calcarifer* bordered with flat scales, in the Arabian form with a distinct row of pointed cones. It has to be considered that Matschie had "free access to the type of *Ch. calcarifer*" (see ANDERSON, 1895).
- 1895 J. ANDERSON gives a good summary of the literature on *Ch. calcarifer*. He suggests that Matschie's conclusion on the distinctness of *Ch. arabicus* "seems to have been somewhat influenced by Peters' statement that its native country was Madagascar". After inspecting the log of H.M.S. "Cleopatra", on board of which Lieut. F. L. Barnard sailed, the collector of the type-specimen of *Ch. calcarifer*, Anderson considers it probable that "Barnard may have obtained it either at Mozambique or more probably at Zanzibar. To the latter port it might have been carried in a native dhow, either from Aden, or from Makulla, in the Hadramut, in which latter Sultanate the species is quite as common as at Aden, judging from the number of fine specimens brought back by my collector.
- It does not seem, in view of Peters' description and figure of *Chamaeleo calcarifer*, that Herr Matschie has satisfactorily established the specific distinctness of the Aden chameleon, and, until more convincing evidence is adduced, I adhere to the view first expressed by Mr. Boulenger."
- In later publications (e.g., STEINDACHNER, 1900) *Ch. arabicus* is at best regarded as a synonym of *Ch. calcarifer*.
- 1898 ANDERSON: "I am, however, not quite satisfied that, with larger materials, the differences that now are supposed to separate *C. calcarifer* from *C. calyptratus* may not eventually break down. If, however, they should not, then the two, as now, must be regarded as very closely allied species."
- 1953 SCHMIDT (on *Ch. calyptratus*): "Fifty-four specimens, all from Ta'izz. With this large series at hand, Anderson's suggestion that *calcarifer* Peters is a synonym of *calyptratus* Dum. & Dum. seems to be amply confirmed."
- 1959 I myself added to the confusion in constructing a hypothesis according to which *Ch. calyptratus* does not live in southern Arabia but — as the original description reads — in the "région du Nil". Then *Ch. calcarifer* would be the only South Arabian chameleon. This hypothesis was based among other things on the many doubts concerning the localities mentioned by Anderson and others and the improbability that *Ch. calyptratus* would occur in two widely separated areas. As will be shown in this paper this idea of mine was wrong, although I still hold that *Ch. calyptratus* does not live in two areas so widely apart.

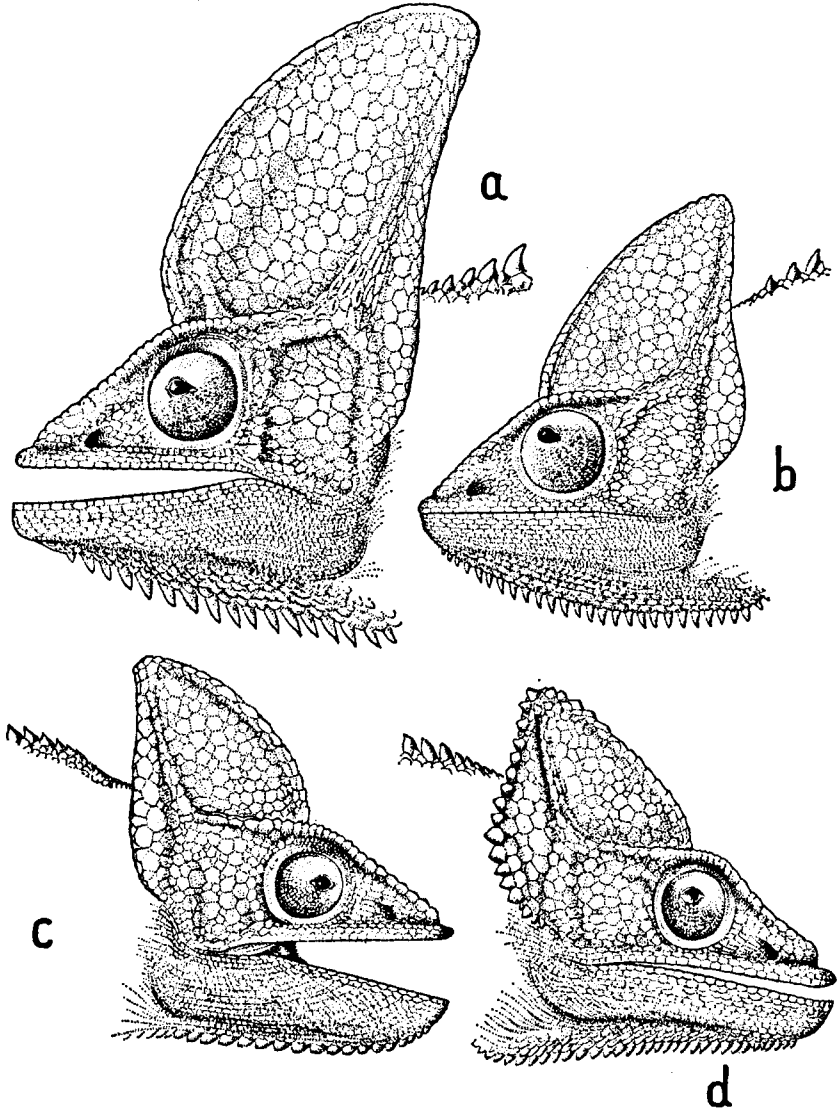


FIG. 1. a, head of *Chamaeleo calypttratus* Dum. & Dum. ♂; b, head of *Ch. calypttratus* ♀ (a and b from Ta'izz); c, head of type specimen of *Ch. calcarifer* Peters; d, head of type specimen of *Ch. arabicus* (Matschie). Drawing by J. A. Mastro.

So the problem is : how many forms are living in South Arabia : one, two or three (there is sufficient evidence that there are indeed chameleons living in southern Arabia) and if one of them (and if so, which) may be regarded as a subspecies of *Ch. chamaeleon* (in my 1959 paper I regarded *Ch. calcarifer* as a subspecies of *Ch. chamaeleon*). In connection with the latter question I compared specimens of *Ch. chamaeleon musae* (Steindachner, 1900) and *Ch. chamaeleon orientalis* Parker, 1938, which have — from North to South respectively — intermediate distributions between typical *Ch. chamaeleon* and the South Arabian chameleons. All together I have seen 145 specimens, amongst which the types of *Ch. calyptratus* from the Paris Museum, *Ch. calcarifer* from the Berlin Museum, *Ch. arabicus* from the Berlin Museum, specimens of *Ch. chamaeleon musae* from the Vienna Museum and *Ch. chamaeleon orientalis* from the British Museum, London. I am very grateful to Miss Alice G. C. Grandison, Dr. Josef Eiselt, Dr. Robert F. Inger and Dr. Günther Peters for lending me specimens from respectively British Museum (Natural History), London; Naturhistorisches Museum, Wien; Chicago Natural History Museum; and Zoologisches Museum der Humboldt Universität zu Berlin. Moreover I must thank Mr. Inger for looking up a detail which proved to be of importance after I had sent back the whole series, to Dr. Jean Guibé for his hospitality when I examined the types of *Ch. calyptratus* at the Muséum National d'Histoire Naturelle, Paris, and to Drs. H. Sleurink, of the Amsterdam University Library, for his help on geographical matters.

MEASUREMENTS

The following measurements were taken:

1. Length of head and body, measured from the tip of the snout to the anterior border of the vent.
2. Length of the tail, measured from the anterior border of the vent to the end of the tail.
3. The height of the casque, measured from the corner of the mouth to the top of the casque.
4. The length of the beak, measured from the corner of the mouth to the tip of the snout.
5. The width of the occipital flap, measured at its widest, on a lateral line on the side of the flap which is turned to the body, between the fusion with the skin of the neck and the border of the flap.
6. The size of the longest cone of the gular crest.
7. The size of the longest cone of the ventral crest.

Furthermore I took notice of the colour pattern (only seldom discernible), of presence or absence of tarsal spurs, of the form of the posterior border of the occipital flap, of the development of the dorsal crest (i.e. how far the crest continues on the dorsal keel). I also counted the number of scales on the occipital flap on a lateral line between the posterior border and the fold

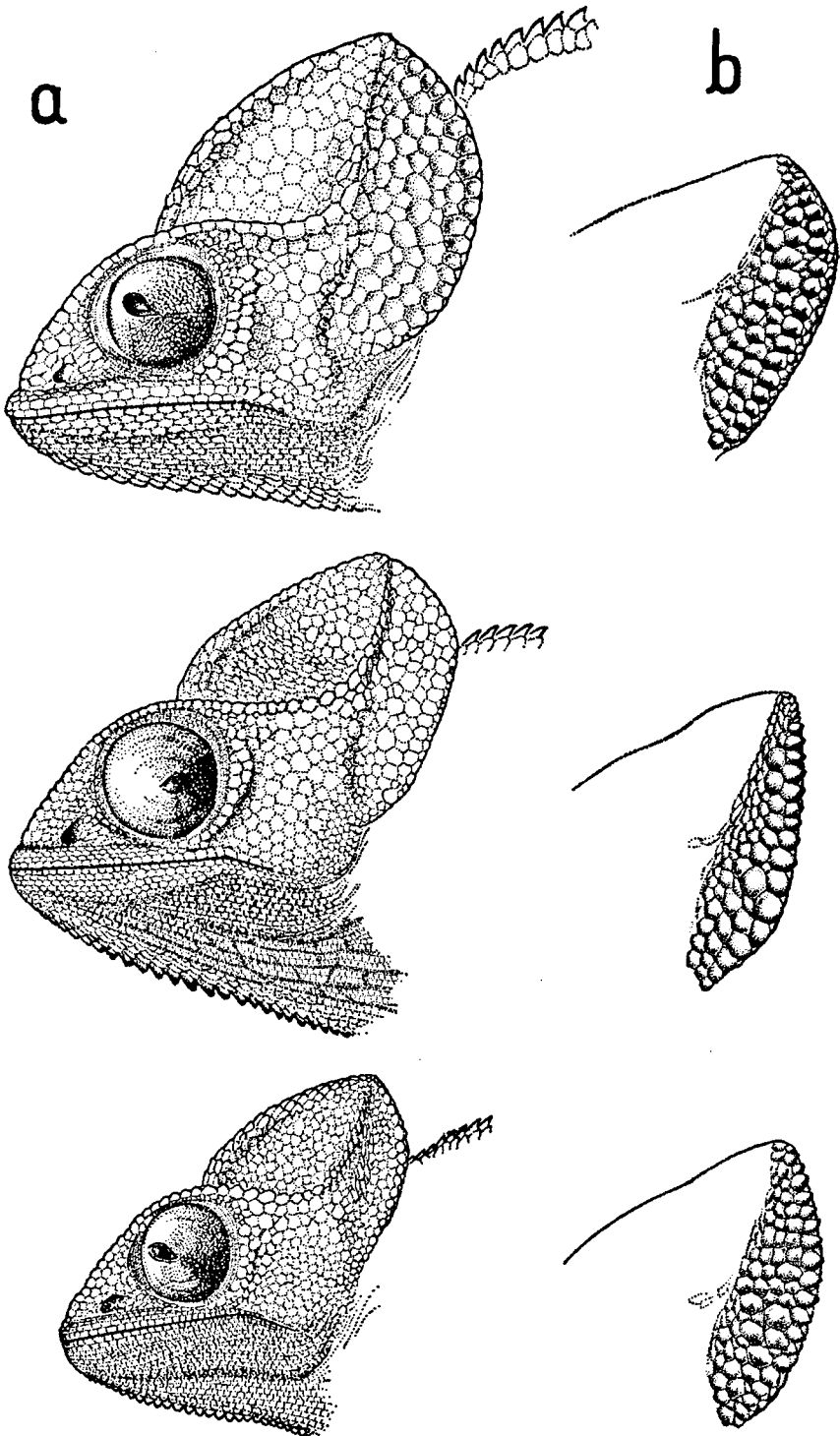


FIG. 2. a (left), heads of *Ch. chamaeleon orientalis* Parker, from above downwards from Abha, Taif and Barad; b (right), occipital flaps of *Ch. chamaeleon musae* (Steindachner). Drawing by J. A. Mastro.

along which the flap is movable, approximately at the same place (though on the other side) where the width was measured. Finally I tried to determine the sex. This was not always easy, but in the cases in which I succeeded I found nearly always that the males possess spurs and the females do not. The only clear exception — a male with protruding hemipenises and without spurs — was an exception in other respects too (see page 105, remarks on the specimen from Rada). I therefore felt justified to use the absence or presence of spurs as an indication of female or male sex, respectively.

THE DIFFERENCES

Apart from a few exceptions, which will be dealt with separately, the chameleons I examined from southern Arabia fall into two groups, differing in a number of characters, one group matching in most details the type specimen of *Ch. calyptratus*, the other matching just as clearly the type specimen of *Ch. arabicus*. The most easily discernible of the differences is the absence or presence of a row of larger, pointed cones on the free border of the occipital flaps (see fig. 1).

For practical reasons I consider in the following notes the first specimens as belonging to *Ch. calyptratus* and the second as belonging to *Ch. arabicus*. Later on we will see in how far the use of this nomenclature is justified, then the position of *Ch. calcarijer* will also be considered.

Tail index

There is a slight difference in the tail index (length of tail \times 100 in proportion to length of head + body): the specimens of *Ch. arabicus* have an average tail index of 110, the specimens of *Ch. calyptratus* have an average tail index of 107. This result, however, is influenced by the fact that of the 44 specimens of *Ch. arabicus* only 13 are females, whereas of the 76 specimens of *Ch. calyptratus* 35 are females. As the tail indices of males and females are different it seems better to compare indices of the same sex only.

The average tail index of 31 $\delta \delta$ of *Ch. arabicus* is 112 (range 98—123) of 41 $\delta \delta$ of *Ch. calyptratus* 109 (range 92—126). The average tail index of 13 $\text{♀} \text{♀}$ of *Ch. arabicus* is 106 (range 95—116), of 35 $\text{♀} \text{♀}$ of *Ch. calyptratus* 105 (range 88—121).

The picture becomes clearer when we consider the tail index in relation to the length of head + body, as is done in fig. 3. Especially when we compare in that manner the tail indices of the male specimens of *Ch. arabicus* and *Ch. calyptratus* we find in the first case the suggestion of a tail index decreasing with the length of head + body, whereas in the males of the second group we find a contrasting tendency. When head + body are less than 120 mm the largest tail indices are found in male specimens of *Ch. arabicus* whereas when head + body exceed 150 mm the largest tail indices are found in male specimens of *Ch. calyptratus*. In female *Ch. calyptratus* we find a tendency parallel with that in the male *Ch. calyptratus*, but

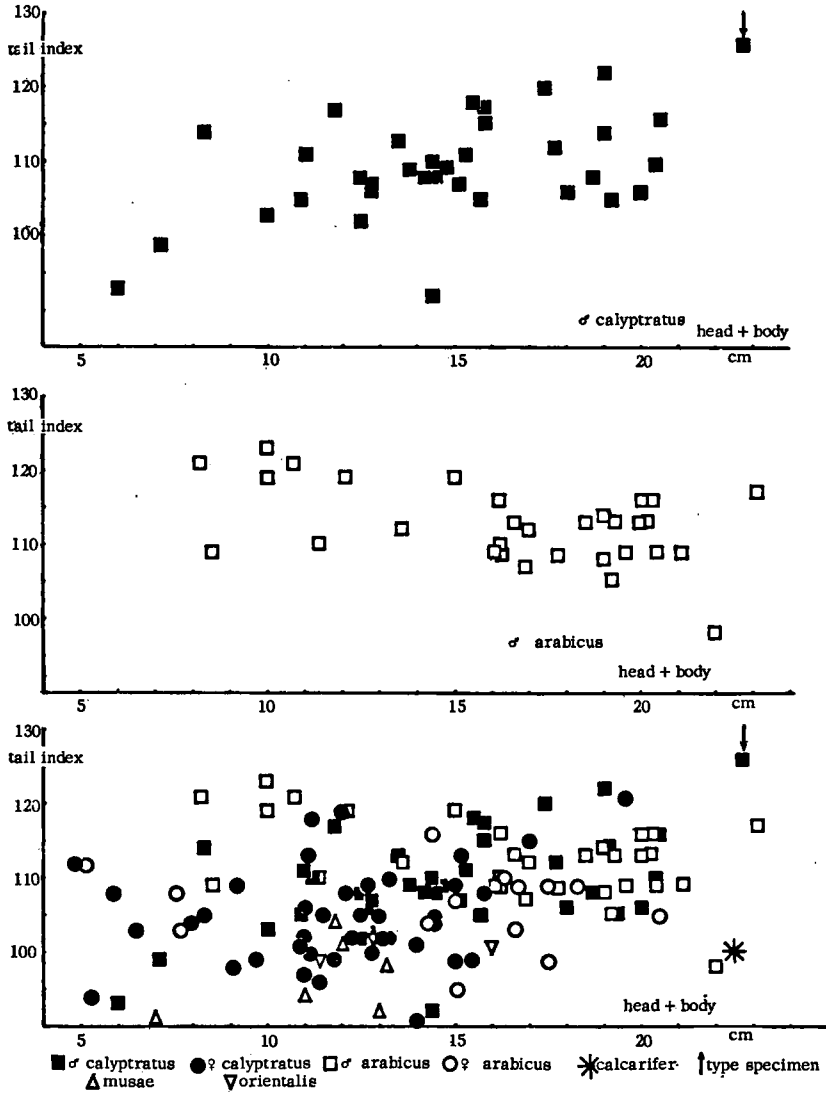


FIG. 3. Tail indices plotted against length of head + body. In the upper and middle figure the tail indices of male *calyptratus* and *arabicus* have been taken apart. 1, specimen from Rada; 2, specimen from San'a.

in the female *Ch. arabicus* no such tendency could be found, probably because of the small number of specimens available. The tail of the type specimen of *Ch. arabicus* is damaged, so that we cannot compare the tail index with the others, but the tail index of the type specimen of *Ch. calyptratus* is the highest of them all, the tail index of the type specimen of *Ch. calcarifer* is a rather low one and thus corresponds most with *Ch. arabicus*.

The height of the casque

Ch. calyptratus is known since long as the chameleon with the highest casque and this feature proves to be true also when comparing it with the casque of *Ch. arabicus*, although this species possesses also a relatively high casque. In all sizes the casque of the male *Ch. calyptratus* is higher than casques of female *Ch. calyptratus* as well as casques of both sexes of *Ch. arabicus* (see fig. 4). The relative height of the casque (height of the casque $\times 100$ in relation to the length of the beak) increases with the growth of the animal, as is shown in fig. 5 and the differences between *Ch. calyptratus* and *Ch. arabicus* become even clearer.

The type specimens of *Ch. calyptratus* and *Ch. arabicus* fit very well in this picture. The type specimen of *Ch. calcarifer* clearly corresponds (in respect of this character at least) with the specimens of *Ch. arabicus*. All specimens of *Ch. chamaeleon orientalis* and *Ch. chamaeleon musae* I examined possess a relatively low casque and correspond in this respect more with *Ch. arabicus* than with *Ch. calyptratus* (see fig. 4). This is even clearer when we consider the relative height of the casque (fig. 5): the specimens of *Ch. chamaeleon orientalis* are closer to *Ch. arabicus* than are the specimens of *Ch. chamaeleon musae*.

The occipital flaps

(In this and following characters no significant differences are found between the sexes).

The width of the occipital flaps is distinctly larger in *Ch. arabicus* than in *Ch. calyptratus*. In figure 6 the width of the occipital flaps has been plotted against the height of the casque. It might be misleading in this picture that the heights of the casques differ so much in these species, but we also find a clear distinction between *Ch. arabicus* and *Ch. calyptratus* when we take the relative width of the flap (width of flap $\times 100$ in relation to the length of the beak); in most cases, when comparing animals of the same size, the relative width of the occipital flap is larger in *Ch. arabicus* than in *Ch. calyptratus* (see fig. 7). As is shown in this figure, the relative width of the flap increases with the growth of the animal, in *Ch. arabicus* more so than in *Ch. calyptratus*. The type specimens of *Ch. calyptratus* and *Ch. arabicus* fit well in this picture. The type specimen of *Ch. calcarifer* corresponds in this respect with the specimens of *Ch. calyptratus*. The specimens of *Ch. chamaeleon orientalis* and *Ch. chamaeleon musae* also possess wider flaps than *Ch. calyptratus* and correspond in this respect most with *Ch. arabicus*.

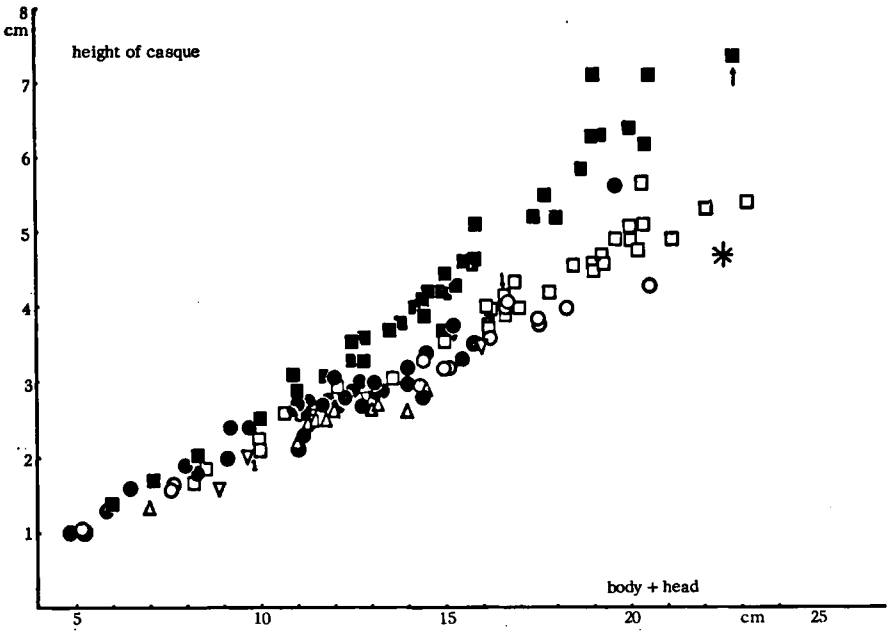


FIG. 4. Height of casque plotted against length of head + body. Meaning of symbols see fig. 3.

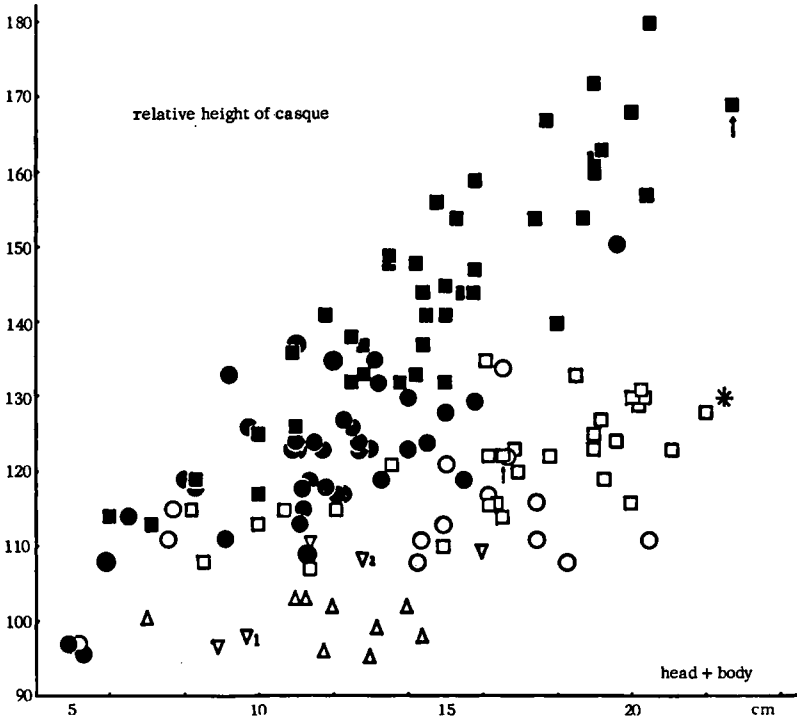


FIG. 5. Relative height of casque plotted against length of head + body. Symbols see fig. 3.

The width of the occipital flaps is also indicated by the number of scales that can be found on them (see p. 94), probably this number does not change with the growth of the animal. The average number of scales on the occipital flap of *Ch. arabicus* is 5.6 (range 5—7 to 8) and of *Ch. calyptratus* 4.4 (range 3—5). In general the number is 5 or more in *Ch. calyptratus* and 5 or less in *Ch. arabicus*. In the type specimens of *Ch. arabicus*, *Ch. calyptratus* and *Ch. calcarifer* these numbers are 6, 5, and 4 respectively. In *Ch. chamaeleon orientalis* these numbers are 7 to 8, 7, and 7 and in *Ch. chamaeleon musae* 6, 5, 5 to 6, 5 to 6, 5, 5 to 6, 5 to 6, 5, 5 to 6.

The shape of the free border of the occipital flap is in *Ch. arabicus* rounded, in most specimens of *Ch. calyptratus* straight, in a few specimens of *Ch. calyptratus* the lower side of the border of the flap is rounded (see fig. 1b). The type specimen of *Ch. calcarifer* distinctly corresponds in this respect with *Ch. calyptratus* (see fig. 1c). The specimens of both *Ch. chamaeleon musae* and *Ch. chamaeleon orientalis* also have a rounded border of the occipital flap, therefore corresponding more with *Ch. arabicus* than with *Ch. calyptratus* (see fig. 2).

The gular crest

All Arabian chameleons possess a gular crest. In general the cones of this crest are pointed in *Ch. calyptratus*, blunt in *Ch. arabicus*, as well as in the type specimen of *Ch. calcarifer* and in the two subspecies of *Ch. chamaeleon*.

As is shown in fig. 8, the size of the gular cones increases more or less regularly with the size of the body. The relative size of the gular cones (the size of the longest cone \times 100 in relation to the length of the beak) is distinctly larger in *Ch. calyptratus* than in *Ch. arabicus*. The type specimens of these species fit well in this picture. The type specimen of *Ch. calcarifer* corresponds in this respect with *Ch. arabicus*, also the specimens of *Ch. chamaeleon orientalis* and *Ch. chamaeleon musae* correspond most with *Ch. arabicus*.

The ventral crest

Both species and also two specimens of *Ch. chamaeleon orientalis* possess a ventral crest. A third specimen of the latter subspecies and all (8) specimens of *Ch. chamaeleon musae* lack this crest. The size of the ventral cones increases regularly with the growth of the animal. As shown in fig. 9, the relative size of the ventral cones (size of the largest ventral cone \times 100 in relation to the length of the beak) is distinctly larger in *Ch. calyptratus* than in *Ch. arabicus*. The type specimens of both species fit well in this picture. The type specimen of *Ch. calcarifer* corresponds in this respect with *Ch. arabicus*; the same holds good for the two specimens of *Ch. chamaeleon orientalis*. The third specimen of *Ch. chamaeleon orientalis* and all the specimens of *Ch. chamaeleon musae* — in lacking the ventral crest at all — correspond in this respect more with *Ch. arabicus* than with *Ch. calyptratus*.

Colouration

Many chameleons belonging to the group of species around *Ch. chamae-*

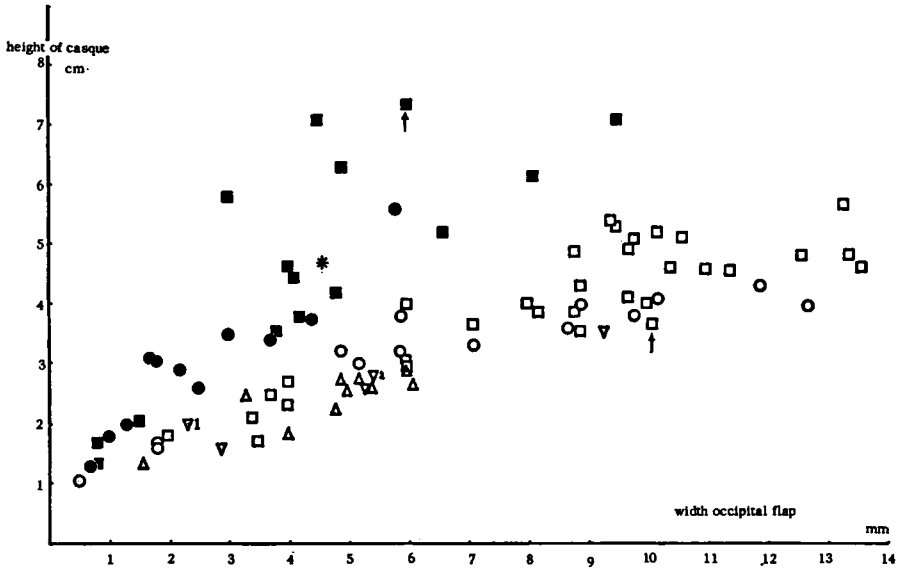


FIG. 6. Width of occipital flap plotted against height of casque. Symbols see fig. 3.

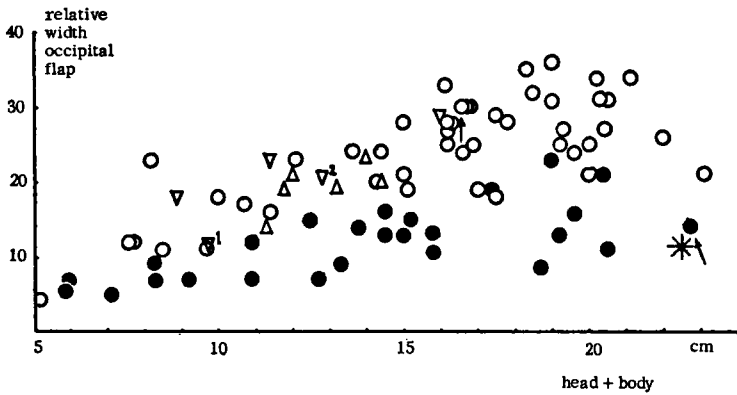


FIG. 7. Relative width of occipital flaps plotted against length of head + body. Black circles *Ch. calyptratus*, open circles *Ch. arabicus*, other symbols see fig. 3.

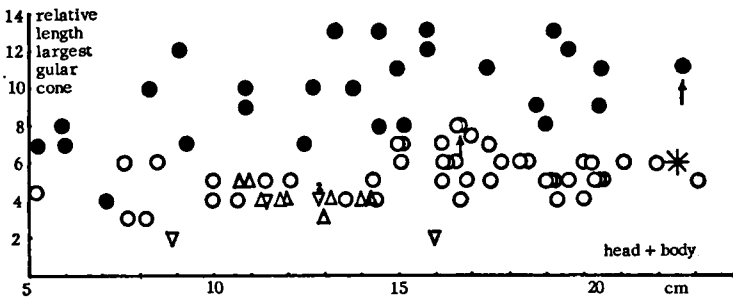


FIG. 8. Relative length of largest cone of gular crest plotted against length of head + body. Symbols see fig. 7.

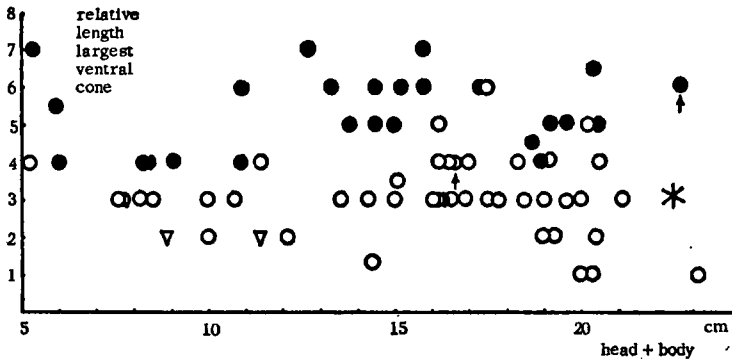


FIG. 9. Relative length of largest cone of ventral crest plotted against length of head + body. Symbols see fig. 7.

leon possess a horizontal line on the flank, or an indication of such a line, for instance a number of white patches. This line or these patches can often be discerned in specimens of *Ch. calyptratus* and *Ch. arabicus*, but in a number of *Ch. calyptratus* we find another pattern — beautifully illustrated in Anderson (1895) — the colour of the flank being broken up in a number of alternate lighter and darker broad vertical bands. Out of 47 specimens of *Ch. arabicus* none showed a trace of this feature, out of 24 specimens of *Ch. calyptratus* 14 showed it more or less clearly, among which the type specimen. The type specimen of *Ch. calcarifer* showed no pattern at all, the whole body being bleached dull grey. None of the specimens of *Ch. chamaeleon musae* and *Ch. chamaeleon orientalis* possess a trace of this pattern.

The dorsal crest

As to the length or relative length of the cones of the dorsal crest I found no significant difference between *Ch. calyptratus* and *Ch. arabicus*. The forms of the dorsal cones differ slightly; those of *Ch. calyptratus* are more pointed than those of *Ch. arabicus*. There is also a difference as to the extent of the dorsal crest: in 21 out of 28 specimens of *Ch. calyptratus* the crest reaches the pelvic region (i.e., the scales on the dorsal keel are pointed and thus — though in some cases rather small at the end of the back — distinct from normal scales). Five out of 7 specimens in which the dorsal crest does not extend farther than to two thirds or less of the dorsal keel, are juveniles.

In *Ch. arabicus* in 9 only out of 46 specimens the dorsal crest is continuing up to the pelvic region. In the type specimen of *Ch. calcarifer* the dorsal crest covers less than half of the dorsal keel, corresponding in this respect most with *Ch. arabicus*. In all specimens of *Ch. chamaeleon musae* and in two of the three specimens of *Ch. chamaeleon orientalis* the dorsal crest does not continue till the pelvic region, in *musae* most of the dorsal crest does not even reach the middle of the dorsal keel, in *orientalis* the crest is somewhat longer, in one specimen of *orientalis* it continues till the pelvic region.

CONCLUSIONS

As has been shown, the specimens provisionally referred to as *Chamaeleo calyptratus* and *Ch. arabicus* differ in the following details:

- 1, tail index (see fig. 3);
- 2, relative height of casque (see fig. 5);
- 3, relative width of occipital flap (see fig. 7);
- 4, number of scales on the width of the occipital flap;
- 5, shape of the free border of the occipital flap;
- 6, pointed cones or smooth scales on the free border of the occipital flap;
- 7, the relative size of the largest cone of the gular crest (see fig. 8);
- 8, the relative size of the largest cone of the ventral crest (see fig. 9);
- 9, more or less in the colouration, as the pattern of vertical lighter and darker bands only occurs in a number of specimens of *Ch. calyptratus*;
- 10, the extent of the dorsal crest.

We find in all these cases (at least when the characters are discernible) that in the type specimens of *Ch. calyptratus* and *Ch. arabicus* the differences are most distinctly expressed, typically indeed.

The type specimen of *Ch. calcarifer* looks in general most like *Ch. calyptratus* and corresponds with it in the characters mentioned above under numbers 3, 4, 5, and 6 and with *Ch. arabicus* in numbers 1, 2, 7, 8, and 10. I did not find one character in the type specimen that did not occur in either *Ch. calyptratus* or *Ch. arabicus*. Therefore I think it most probable that the type specimen of *Ch. calcarifer* is a hybrid of *Ch. calyptratus* and *Ch. arabicum* and that the latter two forms are two well separated species, between which — apart from the type specimen of *Ch. calcarifer* — no other intermediate forms are known. Theoretically the possibility exists that *Ch. calcarifer* is not a South Arabian chameleon, as it was caught in Bombatoka. But — added to the resemblance with both *Ch. calyptratus* and *Ch. arabicus* — I think that Anderson's reasoning about the South Arabian origin is right.

As I mentioned in the introduction, between the range of the South Arabian chameleons and the main range of *Ch. chamaeleon* we find two subspecies of the latter : *Ch. chamaeleon musae* in the North (neighbourhood of Suez, etc.) and *Ch. chamaeleon orientalis* (southern Hedjaz) (see fig. 10). The question is if one of the South Arabian forms may be regarded as belonging to this series of subspecies of *Ch. chamaeleon*. As far as possible I have compared specimens of *Chamaeleo chamaeleon musae* and *Chamaeleo chamaeleon orientalis* with *Chamaeleo calyptratus* and *Chamaeleo arabicus*.

As to point 1 of the above-mentioned characters, the measurements are inconclusive (see fig. 3).

As to points 2, 3, 4, and 5 both subspecies correspond more with *Ch. arabicus* than with *Ch. calyptratus*.

As to point 6, the structure of the free border of the occipital flap : as fig. 2b shows, some specimens of *Chamaeleo chamaeleon musae* possess an indication of cones and when such cones are absent, a continuous row of

scales is present of which some at least are somewhat pointed. At first sight it seems strange that this row is not always the outermost one on the flap, but when we compare several specimens I think it is clear that indeed this row is homologous with the row of pointed cones in *Ch. arabicus*. In the three specimens of *Ch. chamaeleon orientalis* — contrary to the expectation, because *orientalis* lives much closer to the range of *arabicus* than *musae* — this feature is much less clearly expressed. It is difficult indeed to decide with which of the two species *Ch. chamaeleon orientalis* has most in common (fig. 2a).

As to point 7 both subspecies have most in common with *Ch. arabicus*.

As to point 8 : in lacking a ventral crest at all, both subspecies have most in common with *Ch. arabicus* : this species possesses, in comparison with *Chamaeleo calypttratus*, the smallest cones on the ventral crest.

As to point 9 : none of the specimens of *Ch. chamaeleon musae* and *Ch. chamaeleon orientalis* possess a trace of the *calypttratus*-pattern, so, rather negatively, the subspecies have more in common with *Ch. arabicus*.

As to point 10 : the subspecies have more in common with *Ch. arabicus* than with *Chamaeleo calypttratus*.

So in 9 out of 10 characters *Ch. chamaeleon musae* has more in common with *Chamaeleo arabicus* than with *Chamaeleo calypttratus*, in 8 out of 10 characters *Chamaeleo chamaeleon orientalis* has more in common with *Chamaeleo arabicus* than with *Chamaeleo calypttratus*. Considering this together with the general habitus of *Ch. chamaeleon musae* and *Ch. chamaeleon orientalis*, as well as their geographic range, which lies between the range of *Chamaeleo arabicus* and typical *Chamaeleo chamaeleon*, I feel justified in regarding *arabicus* the southernmost subspecies of *Ch. chamaeleon* in Arabia. I am hesitating as to the validity of the separation of *Ch. chamaeleon musae* from *Ch. chamaeleon orientalis*, but until more material is known — especially from the intermediate regions — it seems better to leave things as they are.

Though *Chamaeleo calypttratus* is in many details clearly related to the group around *Ch. chamaeleon* (more or less homogeneous squamation, white midventral line, a dorsal crest, a single row of scales on the keel of the back, a gular and a ventral crest, tarsal spurs, no temporal crests, no axillary pits, absence of horns and other cranial protuberances, fin-shaped dorsal keel and other conspicuous features — though the casque of *Ch. calypttratus* might be called conspicuous) it differs in so many characters from *Ch. chamaeleon arabicus*, whereas their ranges are adjacent, that I regard it as a true species.

Probably the species arose from an earlier invasion of North African chameleons, from the same stock from which later on — in a second invasion — *Ch. chamaeleon arabicus* developed. The differences were then assumably too large already, so that the two forms did not interbreed, apart from rare cases. Perhaps we may regard *Ch. calcarifer* as such an exception. The type locality of *Ch. calypttratus*, "Region du Nil", has probably no more significance than several other provenances mentioned in earlier literature, e.g. Socotra and Abyssinia, and which are not taken seriously either, nowadays.

I examined two other, deviating specimens, one of the Chicago-collection (nr. 66164, from San'a, 7100, Yemen) the other of the collection of the British Museum (1963, 805, Rada, Yemen). Both clearly do not belong to either *Ch. calyptratus* or *Ch. arabicus*. The specimen from Rada is a relatively small male with protruding penises. Length of head and body 97 mm, length of tail 80 mm, which means a tail index (82) far below that of the other chameleons from this region. Height of casque 20.0 mm (see fig. 4), length of beak 20.4 mm; relative height of casque 98 (see fig. 5). The dorsal crest continues only till the middle of the dorsal keel. Width of occipital flap 2.3 mm (see fig. 6), relative width 11 (see fig. 7). The cones of gular and ventral crest are so small that I could not measure them, though there is a trace of them. Of the tarsal spurs only a faint indication is present. The number of scales on the width of the dorsal flap is 5 to 6. No trace of vertical colour bands. The free border of the occipital flap does not have a row of pointed cones, but there is a distinct row of larger scales, more or less comparable with that in *Ch. chamaeleon musae*. The free border of the occipital flap is rounded.

Though Rada lies close to the range of *Ch. calyptratus* and *Ch. arabicus* (see 1 in fig. 10) I think it is justified to regard this specimen from Rada as the most southern representative of *Ch. chamaeleon orientalis*.

The specimen from San'a (this is the specimen mentioned by SCHMIDT, 1953 as *Chamaeleo chamaeleon chamaeleon*), a little more to the North (see 2, in fig. 10), probably a male, resembles even more *Ch. chamaeleon orientalis*. Length of head + body 128 mm, length of tail 131 mm, tail index 102. Height of casque 28.3 mm, length of beak 26.3 mm, relative height of casque 108. Dorsal crest only on anterior third of the dorsal keel. Width of occipital flap 5.4 mm (see fig. 6), relative width 21 (see fig. 7). Number of scales on the width of the occipital flap 6 to 7, length of largest cone of the gular crest 1.0 mm, relative length 4 (see fig. 8). Though there is a trace of a ventral crest, the length of the cones is too small to be measured. Only on the right hind foot a faint indication of a tarsal spur. No trace of vertical colour bands. No pointed cones on the free border of the occipital flap, contrary to the specimen from Rada no distinct row of larger scales is discernible. So also this specimen corresponds in most respects with *Ch. chamaeleon orientalis*.

GEOGRAPHICAL REMARKS (see fig. 10)

I found the following localities recorded for specimens of *Ch. chamaeleon arabicus*: Aden (type locality); Sheikh Othman; Milwah Alaud, Dhufar; Dhala; Arabian coast S. of Muscat; Abian country; Lahej; Dhofar, Hadramaut; Wadi Makhia, N. Jol of Hadramaut, 4080 ft.; W. Nihaz, Hadramaut; Azzân. I could not find all these localities on the maps, but enough to suggest the fairly large range of this subspecies. It may be added that the specimen from South of Muscat is not strikingly different from specimens from Aden, the type locality.

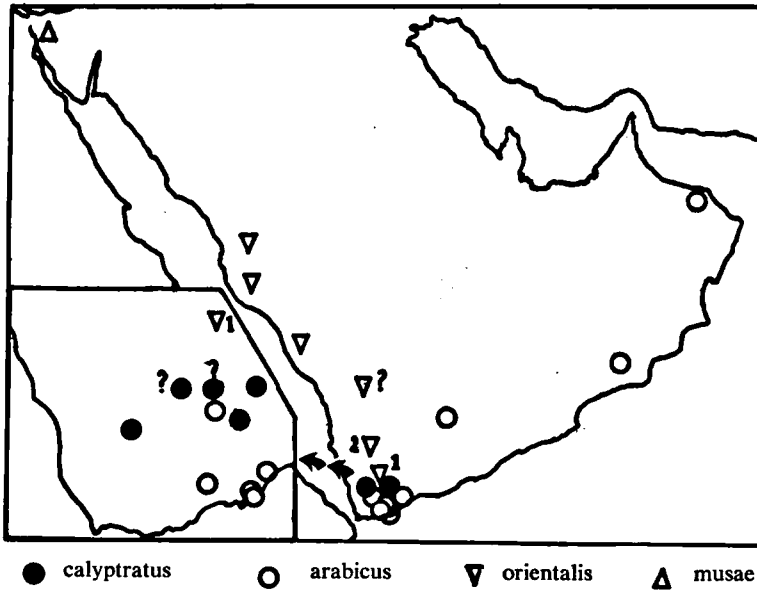


FIG. 10. Map of Arabia. Distribution of *Chamaeleo calyptratus*, *Ch. chamaeleon arabicus*, *Ch. chamaeleon orientalis*, *Ch. chamaeleon musae*. 1, Rada; 2, San'a, black circles with question-mark from left to right: Usaifa (Usaifira?) and Al Kubain (El Kubar?). Triangle with question-mark Barat (Barad?).

Several localities are mentioned for specimens of *Ch. calyptratus*: Hardaba Valley, Upper Hushabi; Jebel Harrir, 5000 ft., W. Aden Protectorate; El Kubar, near Yemen frontier; Ta'izz and Usaifira, 4100 ft., Yemen. There exist several places of which the names might be written down phonetically as El Kubar: Khobar or Al Khobar, Qubara, El Khubar. None of these localities lies in the neighbourhood of the Yemen frontier, in fact all lie in the Southeast of the peninsula. Perhaps Al Kubain is meant, which lies indeed near the Yemen frontier (black circle with a ? on the right). Perhaps with Usaifira is meant Usaifa (black circle with a ? on the left).

To the four localities mentioned by Parker as provenances of *Ch. chamaeleon orientalis*: Taif, 5500 ft (type locality); Ashaira, 4000 ft.; mountains around Abha; and Barad, 7000 ft. (perhaps this is the same place as Barat, see triangle with questionmark in fig. 10), I have added Rada (see 1 in fig. 10) and San'a (2 in fig. 10).

Ch. chamaeleon musae was described from the neighbourhood of Suez. There are indications that this form has a larger distribution, also to the North (Israel).

Striking is the height on which most of these chameleons have been found, 4000 ft. or more, one specimen of *Ch. chamaeleon orientalis* even at 7000 ft. Another striking phenomenon is that the range of *Ch. calyptratus* is small, compared with those of the Arabian subspecies of *Ch. chamaeleon*. As we suggested that *Ch. calyptratus* has been derived earlier from the same stem as *Ch. chamaeleon arabicus*, it might be that *Ch. calyptratus* could not cope with the latter form and has to be regarded a relict. This is corroborated by the fact that up to now specimens of *Ch. calyptratus* and *Ch. chamaeleon arabicus* were never found in the same locality. Perhaps this is also the reason why the confusion about the South Arabian chameleons could continue for such a long period.

SCHMIDT (1953) remarks: "It may well be that the relation of the herpetological fauna of southwestern Arabia is with Somaliland rather than with Eritrea". In the case of the South Arabian chameleons it is clear that the relation with African forms only exists via the North, via the isthmus of Suez. None of the known chameleons from either Eritrea or Somaliland can be regarded as closely related to the South Arabian chameleons.

SUMMARY

Three chameleons have been described from southern Arabia: *Chamaeleo calyptratus* Duméril & Duméril, 1851; *Chamaeleo calcarifer* Peters, 1871 and *Chamaeleo arabicus* (Matschie, 1893).

Chamaeleo arabicus is clearly connected with typical *Chamaeleo chamaeleon* by intermediate forms: *Chamaeleo chamaeleon orientalis* Parker, 1938 and *Chamaeleo chamaeleon musae* Steindachner, 1900 and it thus may be regarded a subspecies of *Chamaeleo chamaeleon* itself. *Chamaeleo calyptratus*, though in many respects clearly related to the group around *Ch. chamaeleon*, shows so many differences, whereas the range lies in the midst of the range of *Ch. chamaeleon arabicus*, that it is considered here as a true species. *Chamaeleo calcarifer* possesses a mixture of characters of *Ch. chamaeleon arabicus* and *Ch. calyptratus*, whereas no single character may be mentioned that is typical for this form only. Probably it is to be considered a hybrid of these two species, though the provenance is unknown.

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