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Notes on chameleons V. The chameleons of North Africa and adjacent countries, *Chamaeleo chamaeleon* (Linnaeus) (Sauria: Chamaeleonidae)

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ABSTRACT

The regional variation of *Chamaeleo chamaeleon* is conspicuous, as might be expected, considering the wide distribution. This paper mainly deals with the chameleons of the Mediterranean populations. Though the range of variation per region is rather large, some clear clines can be discerned. In several characters we find a two-winged clinal variation with the centre in Egypt and Sinai. This might be an indication of the road along which *Chamaeleo chamaeleon* reached the Mediterranean, probably coming along the Nile from eastern Africa and spreading along the coast. Apart from the Indian and Arabian subspecies (*zeylanicus, orientalis, arbicus*) the only populations that seem to be isolated enough to have the status of subspecies are those of the Sinai (*musae*). *Ch. chamaeleon recticrista* is a synonym of *Ch. chamaeleon chamaeleon*.

INTRODUCTION

The common chameleon, *Chamaeleo chamaeleon* (Linnaeus) has the largest distribution of all chameleons: from Morocco and southern Spain, over the whole of North Africa, the Near East to Turkey, Cyprus, to Southern Arabia and — perhaps with a gap in Persia — to India and Ceylon.

It is to be expected that in such a large area many clear differences occur, so clear indeed that the almost isolated forms *zeylanicus* Laurenti (India, Ceylon), *arabicus* (Matschie) (Southern Arabia) and *orientalis* Parker (central west Arabia) are recognized as separate subspecies (Hillenius, 1959, 1966; Mertens, 1966). But for the greater part of the range there seems to be much less isolation and it is doubtful whether the subspecies described from this area (*recticrista* Boettger, *saharicus* Müller, *musae* Steindachner and some more) have to be maintained. On the other hand it may be reasonable to consider the distribution of the characters described as typical for these forms, because this may give an indication of the history of the species and its

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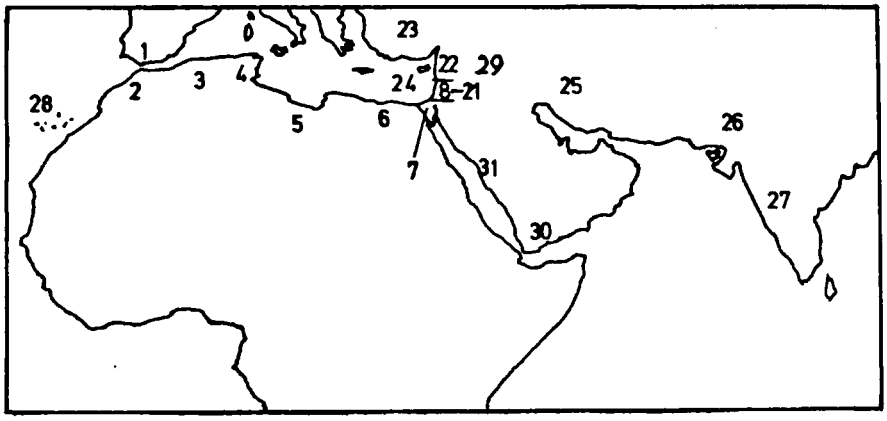

Fig. 1. The range of *Chamaeleo chamaeleon* (L.). 1-Southern Spain, 2-Morocco, 3-Algeria, 4-Tunesia, 5-Lybia, 6-Egypt, 7-Sinai *(musae)*, 8 to 21 - zones of Israel from south to north, 22-Libanon and western Syria, 23-Turkey, 24-Cyprus, 25-Persia, 26-Balutchistan, 27-India and Ceylon *(zeylanicus)*, 28-Canary Islands, 29-eastern Syria, 30-southern Arabia *(arabicus)*, 31-central west Arabia *(orientalis)*. (drawing J. A. Mastro).

distribution. In 1963 Mr. J. Hoofien (Tel Aviv, Israel) forwarded a large package with data of ± 150 Israelian chameleons. In 1964 he published some preliminary conclusions. In his opinion (1961, 1964, 1967) three subspecies are living in the southeastern corner of the Mediterranean; *recticrista* in Israel, *musae* in the Sinai, *chamaeleon* in Egypt, west of the Sinai.

However, considering the limited area of this region in relation to the whole of the range, I thought it unlikely that three subspecies would occur there. Therefore I tried to compare the data of Hoofien with as much material as possible from other regions. I did not succeed in getting a comparable large number of specimens from outside Israel, though I examined all specimens of *Chamaeleo chamaeleon* in the collections of London, Paris, East Berlin, Genoa, Leiden, Vienna, Amsterdam. In total I collected data of more than 500 specimens. In an earlier paper (1966) I dealt with the Arabian subspecies of *Ch. chamaeleon* and their relationship with the separate species *Ch. calyptratus*. The Indian subspecies *zeylanicus* will also be left out, because it is isolated and rather uniform. In this paper I will try to cover the almost uninterrupted populations from Spain, Morocco, Algeria, Tunis, Libya, Egypt, Sinai, Israel, Libanon, Syria, Turkey, Cyprus (fig. 1).

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 length of the mouth, measured from the corner of the mouth to the tip of the snout,
4. the height of the casque, measured from the corner of the mouth to the top of the casque,
5. the length of the head, measured from the tip of the snout to the top of the casque,
6. the width of the casque: the distance of the orbital crests measured between the points straight above the centre of the eye-socket,
7. 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.

Furthermore notes were taken on the form of the border of the occipital flap (more or less resembling the flaps in *Ch. chamaeleon musae* or in *Ch. chamaeleon arabicus*, see figs. 1 and 2 in Hillenius, 1966), absence or presence of a tarsal spur on the hind foot, the state of development of the ventral crest, the presence of a curved or straight parietal crest, the presence of one or more horizontal lines of white spots on the flank, the presence of the *saharicus*-character (a few cones forming a small crest on the middle of the head, between the eyes, see fig. 10 left).

The sex of the specimens was concluded from the presence (♂) or absence (♀) of a swollen base of the tail. When in doubt, the body was opened to look for ovaries or testes.

Results

The measurements were made comparable in relating them to the length of the head + body, or to the length of the mouth. Though there are indications that some parts of the body grow faster than for instance head + body (see fig. 5 and also figs. 3, 4 and 7 in Hillenius, 1966) this phenomenon cannot explain the widely divergent values that are sometimes found in each region.

Maxima and minima in some regions are even so widely apart that I at first doubted the sense of publishing the data before I had examined much more material. However, as stated above, since all the material present in the large European collections was studied, it is not to be expected that much more specimens will be available in the near future. Moreover — notwithstanding great fluctuations — clear clinal lines may be discerned in some cases, e.g. from Morocco to Egypt, or from Sinai to Turkey. Especially when the relative lengths in connection with each other and with the degree of development of other characters are considered, interesting parallels may be found. In the figures 2—11 the averages of the relative measurements and the percentages of absence or presence of certain characters are shown per country. Due to the fact that Mr. Hoofien collected so many data from Israelian chameleons, he was able to divide Israel in 14 zones, from south to north (in the figures the regions 8—21 respectively). On the graphs this gives too heavy an accent on

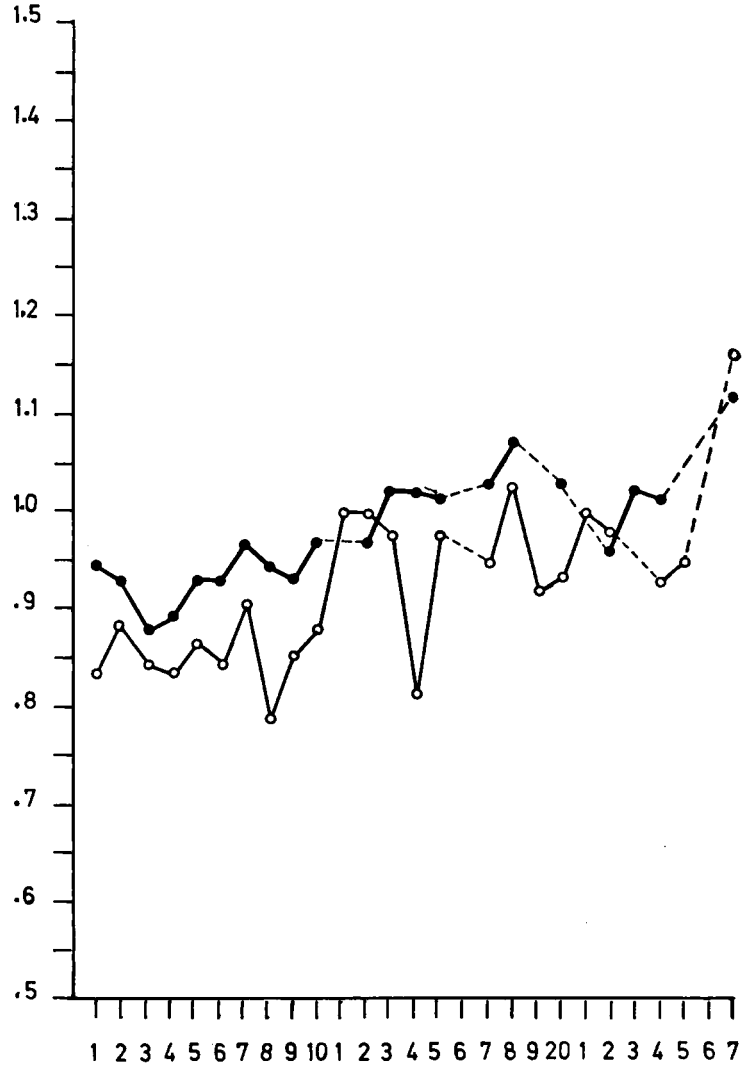

Fig. 2. Average relative length of tail (in relation to length of head + body) per region. For references see fig. 1. Black dots males, open circles females.

the situation in Israel. But because in some cases a conspicuous north-south cline can be found in Israel (see figs. 2, 6, 7, 8, 9, 11) Hoofien's division is accepted here. It is possible of course that in other regions comparable clines may be found when a comparable large number of specimens is available.

Relative tail length (length of tail: length of head + body, see fig. 2).

As in many other lizards it is noted that in general males have a longer tail

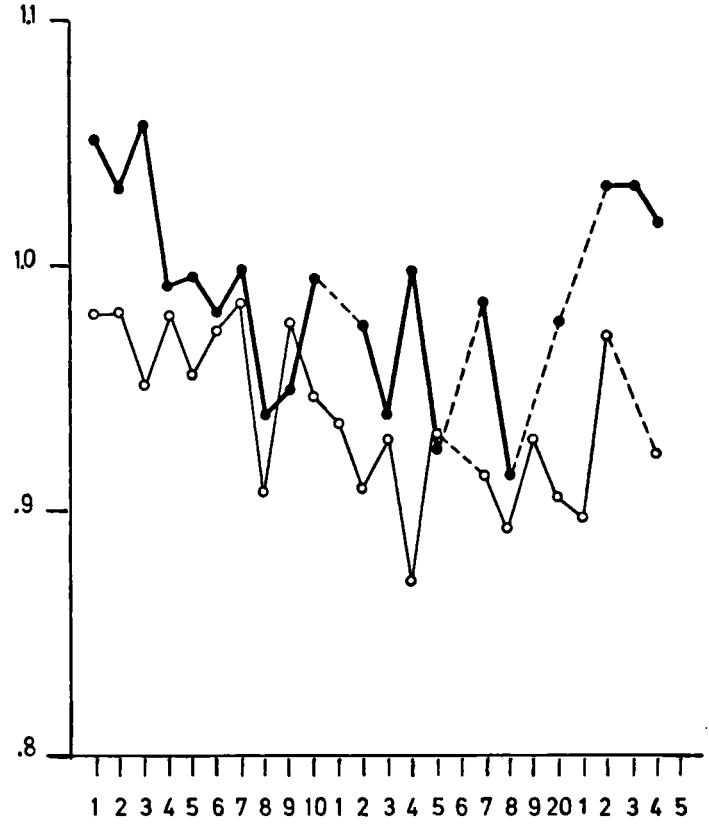

Fig. 3. Average relative height of casque (in relation to length of mouth) per region.

than females. On the other hand not too much importance may be attributed to this figure because of the large range of values per region: for instance in Moroccan male specimens (16) the tail-index varies from 0.756 to 1.036, average 0.932, standard deviation 0.67. Still it is possible to see an eastward tendency (in males as well as in females) towards longer tails, the more so when the most eastern subspecies *zeylanicus* from India and Ceylon (region 27) is taken into consideration as well. The relative top in males as well as in females from Sinai (region 7) probably is not accidental, for going southward in Arabia first the subspecies *orientalis,* with the high tail-indices 0.97 (♀) and 1.0 (♂) is encountered and next the subspecies *arabicus* with tail-indices 1.06 (♀) and 1.12 (♂) (Hillenius, 1966).

Relative height of casque (height of casque: length of mouth, see fig. 3).

Here also some sexual dimorphism is found, in general the males have a larger casque. At least in males, the casques of Northwest Africa and Spain

are higher than those of Israel and Libanon. The casques of Turkey and Cyprus are almost as high as those of Northwest Africa.

Relative length of head (length of head: length of mouth, see fig. 4).

In principle the same picture as the foregoing: an almost equal middle part with a clear western and a less clearer eastern wing.

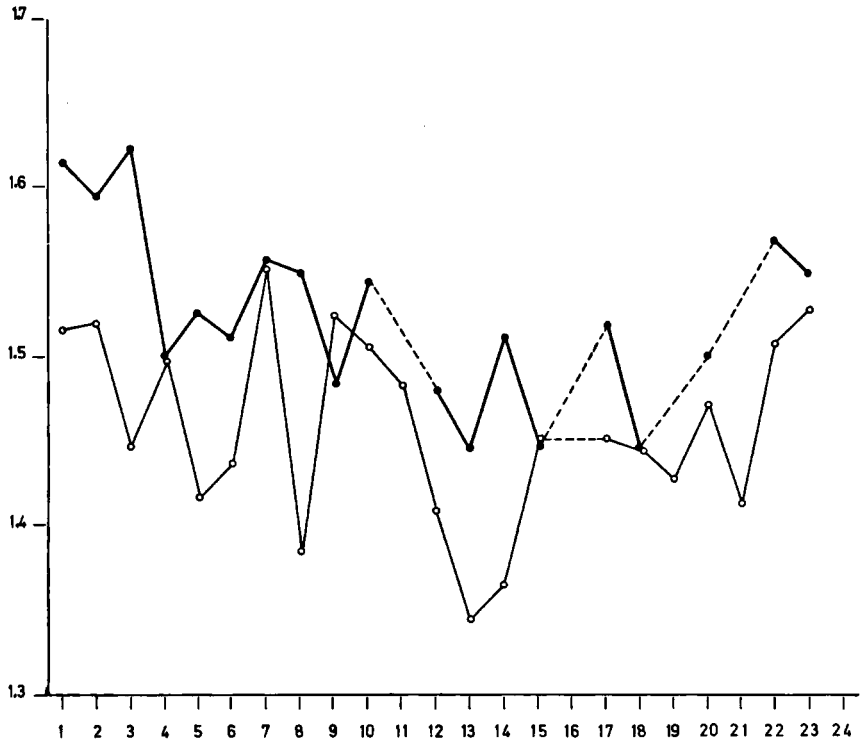

Fig. 4. Average relative length of head (in relation to length of mouth) per region.

Relative width of the occipital flaps (width of occipital flap: length of beak, see figs. 5 and 6).

In the chameleons of Arabia I observed the taxonomic importance of the relative width of the occipital flaps. There are indications that the relative width of the flaps increases with the growth of head + body (see fig. 5 a,b,c). In these figures also the great range of the values can be seen (especially in Israel, region 15). However, the disturbing effect on the relative growth is probably negligible because only a few small animals were measured (head + body less than 8 cm). The large range of values remains a problem, but still it seems worth-while to show them, because especially from Sinai through Israel a clear clinal variation can be observed. The top value in Sinai (7)

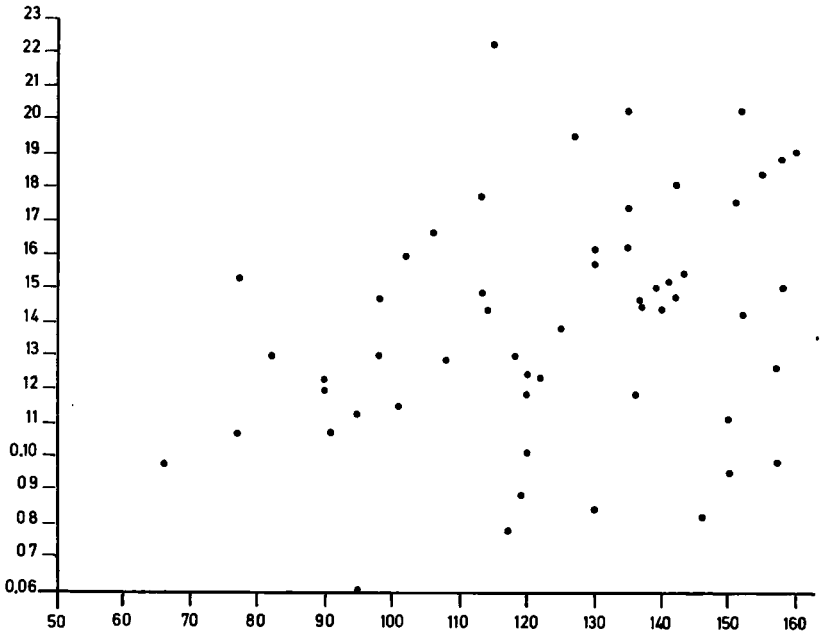

Fig. 5a. Relative width of occipital flaps (in relation to length of mouth) plotted against length of head + body (x-axis) in Moroccan *Ch. chamaeleon.*

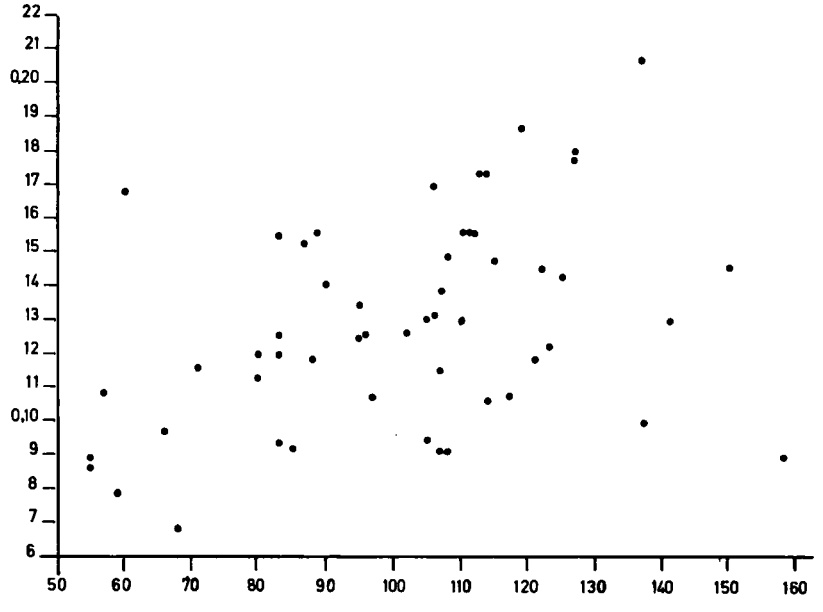

Fig. 5b. Relative width of occipital flaps (in relation to length of mouth) plotted against length of head + body (x-axis) in Libyan *Ch. chamaeleon.*

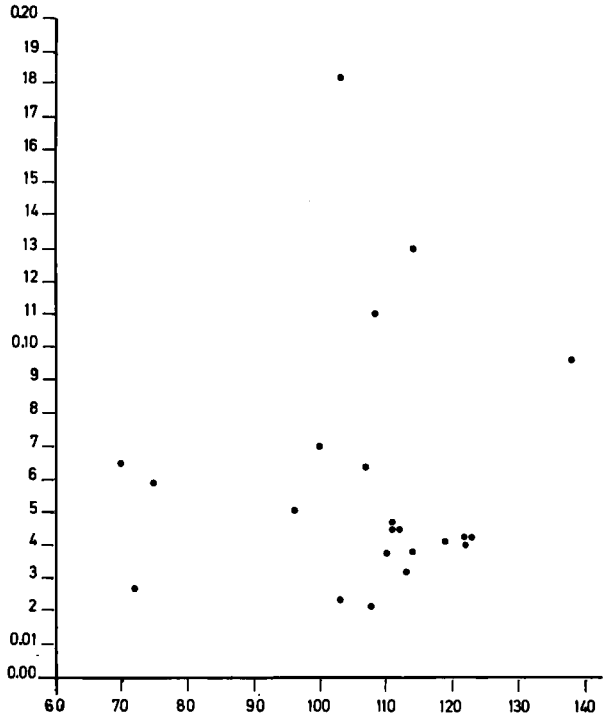

Fig. 5c. Relative width of occipital flaps (in relation to length of mouth) plotted against lenght of head + body in Israeli *Ch. chamaeleon.*

probably is not accidental, considering the geographically closely connected subspecies (in southeastern direction) *orientalis* and *arabicus*. The Sinai top seems so be the beginning of a development that reaches its maximum in South Arabia.

In this case a two-winged curve of the variation is found as well, one west from Israel, the other to the north and east.

The exceptional value of 28 (Canary Islands) is remarkable and cannot easily be explained.

Tarsal spurs (fig. 7).

The males of some subspecies of *Ch. chamaeleon (arabicus* and *zeylanicus)* possess clearly developed tarsal spurs on the hind feet, just as the males of closely related species *Ch. dilepis, calyptratus, gracilis,* etc. According to the official description (Werner, 1911) the forms around the Mediterranean lack spurs in both sexes. Still it is possible to detect at least a trace of a spur in many specimens. Clearly developed spurs only occur in some zones of Israel and on Cyprus, but indications of their presence are much more common. In fig. 7 the line indicating a small trace of spurs roughly parallels the line of the

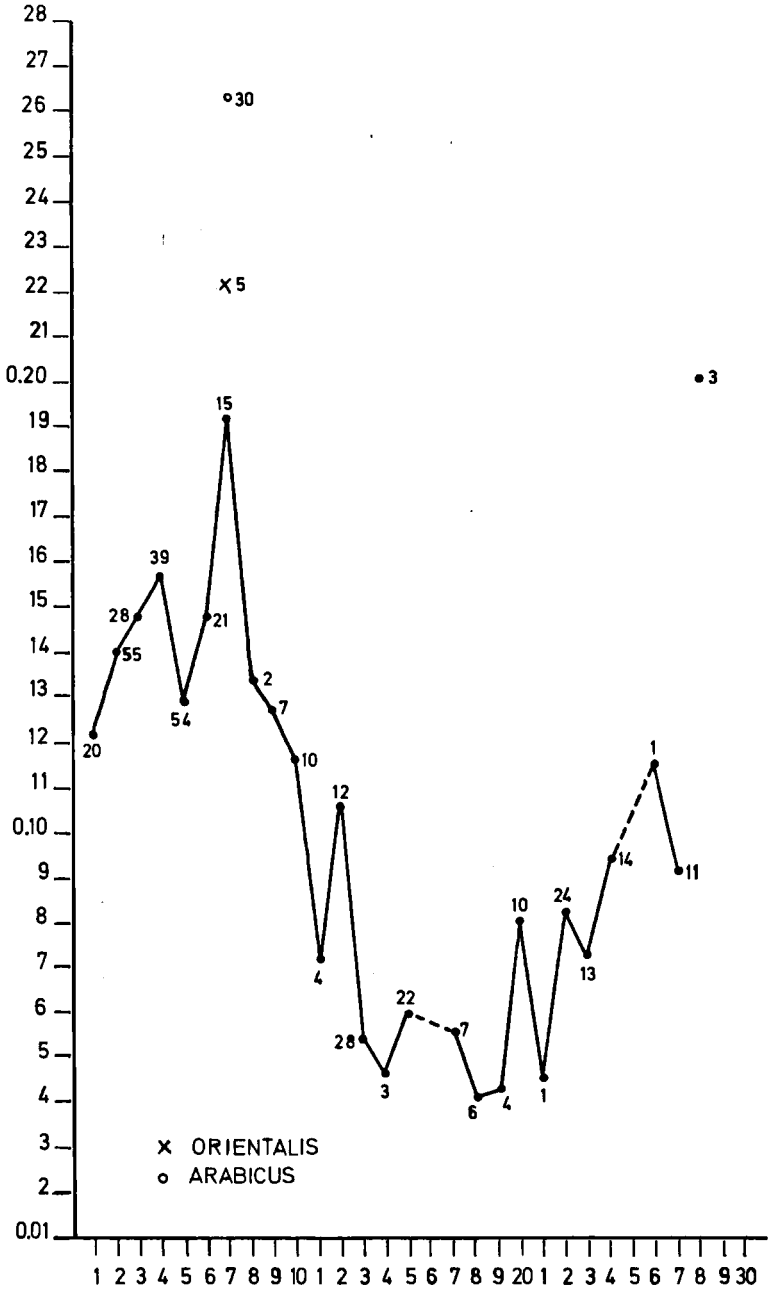

Fig. 6. Average relative width of occipital flaps (in relation to length of mouth) per region. Numbers in the graph indicate numbers of specimens examined.

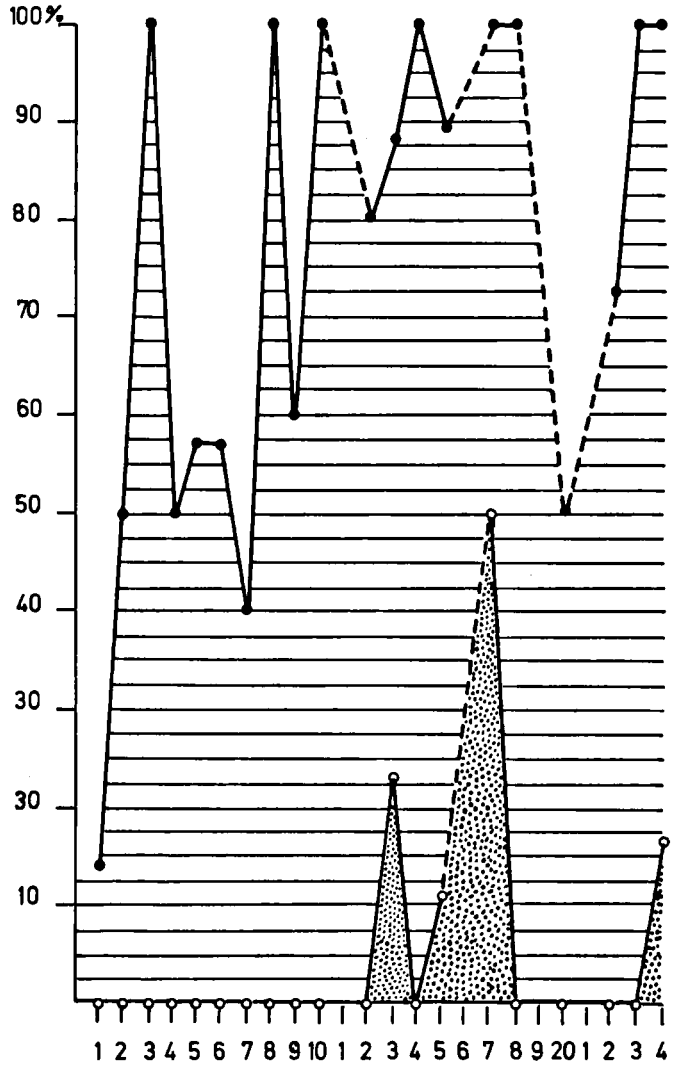

Fig. 7. Percentages of male specimens possessing tarsal spurs (dotted), per region. The percentages of specimens having traces of this character (horizontal lines) are juxtaposed on the former. The remaining white zones indicate percentages of specimens with no spurs at all.

clearly developed ones. The latter might indicate a connection with an influence of the Indian subspecies, in which the males all possess clearly developed tarsal spurs.

The decreasing presence to the west of even the debilitated forms of this character also fits this picture.

Ventral crest (fig. 8).

A real ventral crest is seldom, if ever, present in Mediterranean chameleons, but perhaps a remnant of a ventral crest may be seen in the slightly stronger development of the scales on the white midventral line. This character can be evaluated by counting the number of ordinary body scale rows corresponding to 10 consecutive scales on the white midventral line between umbilicus and sternum. Hoofien (1964) found average values of "about 15/10 in chameleons from Galilee as against 12/10 south of the line running from Gaza to Be'er Sheva". This is confirmed by my findings, but as fig. 8 shows, this cline does not continue to the north, neither to the west. In fact, also in this case a roughly two-winged pattern of variation with a centre in Sinai and southern Israel is found. The top in region 14 and in general the higher values from the northern regions probably point to a connection with the Indian subspecies *zeylanicus*, which with 16.6 has a value that is higher than anywhere else.

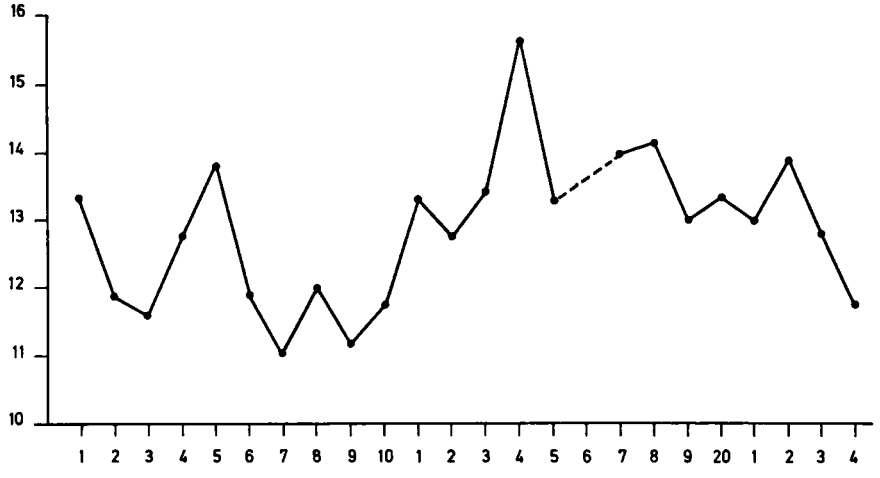

Fig. 8. Average number of ordinary body scale rows corresponding to 10 consecutive scales on the white midventral line between umbilicus and sternum, per region.

The profile of the occipital casque (the curvature of the parietal crest, see figs. 9 and 10).

Most specimens of *Ch. chamaeleon* s.l. possess a curved parietal crest such that the profile of the occipital casque is arched. In some specimens, however, the parietal crest is almost straight. As fig. 9 shows straight crests occur in small percentages in almost all regions. Only in Sinai and the adjacent part of Israel this character is found in its purest form for 100%. Going to the west as well as to the north an increasing percentage of curved parietal crests is found. Especially when the specimens with less straight casques are added to those with curved casques the separateness of the Sinai

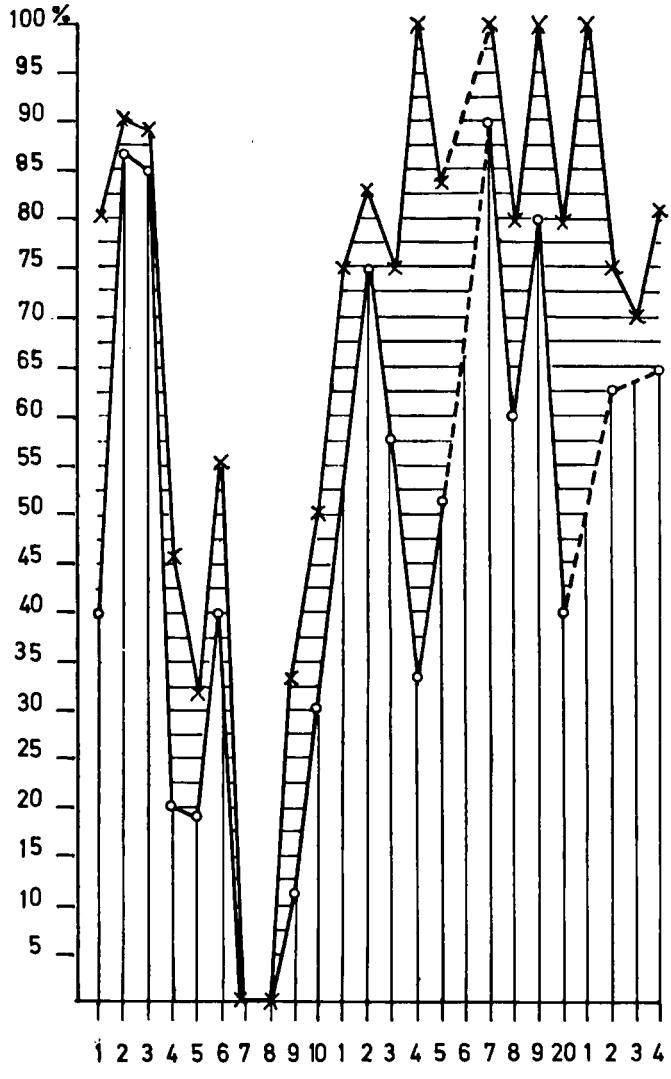

Fig. 9. Percentages of specimens possessing a curved parietal crest (vertical lines) per region. Juxtaposed on it the percentages of specimens in which the parietal crest is only slightly curved, or almost straight. So the white zones indicate the percentages of specimens possessing a straight parietal crest.

populations (with pure straight casques) stands out clearly. As chameleons of this region also possess occipital flaps that are strikingly wider than in any other region (apart from those of the isolated subspecies in Arabia) there is good reason to consider *Chamaeleo chamaeleon musae* a valid subspecies. A nomenclatorial problem remains as the straight parietal crest also occurs in Boettger's original description of *Ch. chamaeleon recticrista.*

This problem will be dealt with in the Conclusions.

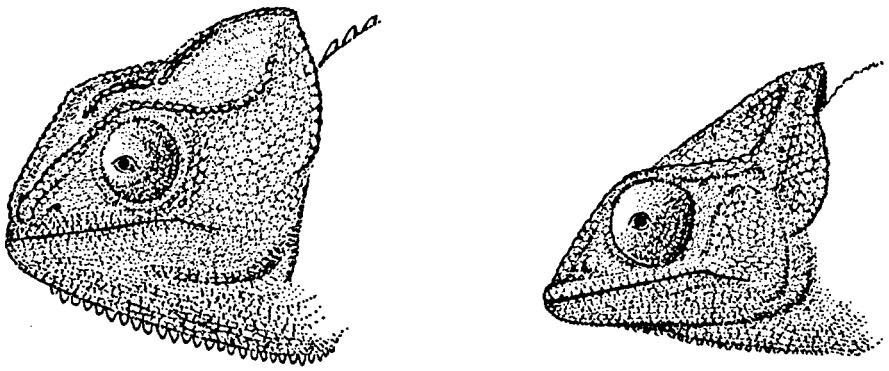

Fig. 10. (left). Head of the type specimen of *Chamaeleo chamaeleon saharicus* Müller with well developed *saharicus*-character (little crest between the eyes) and with a curved parietal crest. (right) Head of *Ch. chamaeleon* with a straight parietal crest. (drawing J. A. Mastro).

Lateral rows of white (or lighter) spots (fig. 11).

Most specimens of *Ch. chamaeleon* possess one or more horizontal rows of white (or yellowish) spots on the flank. Here also a two-winged pattern of distribution is recognized. In the western part of the range as well as in the northern part a small percentage of animals occurs with a single row of white spots. Most animals show two rows of spots, but the western and northern range are clearly separated by a zone with mainly three rows of spots.

Saharicus-character (figs. 10 and 12).

In 1890 F. Müller described the form *saharicus*, characterized by "eine zweite vordere Mediancrista zwischen den Orbitae und durch die eigentümliche Bekleidung der Rücken- und Bauchfirst". The type specimen came from Boussaada, southern Algeria.

I have seen the type specimen and indeed the little crest between the eyes, in front of the parietal crest is evident, though the dorsal and ventral crest of this specimen are not strikingly different from the many other specimens seen from other regions.

The *saharicus*-character itself also has a wide distribution over almost the whole range of the species, at least around the Mediterranean (it is missing in the subspecies *zeylanicus* and *arabicus*). Indeed, it is best developed in the North African specimens, but in diminished form (sometimes only two or three somewhat enlarged scales between the eyes) it is common also in the Near East. The two-winged pattern of distribution is remarkable. Between the two wings a zone exists in Israel (10 and 11) in which the character is completely absent (from the zones 8 and 9 we have no data concerning this character).

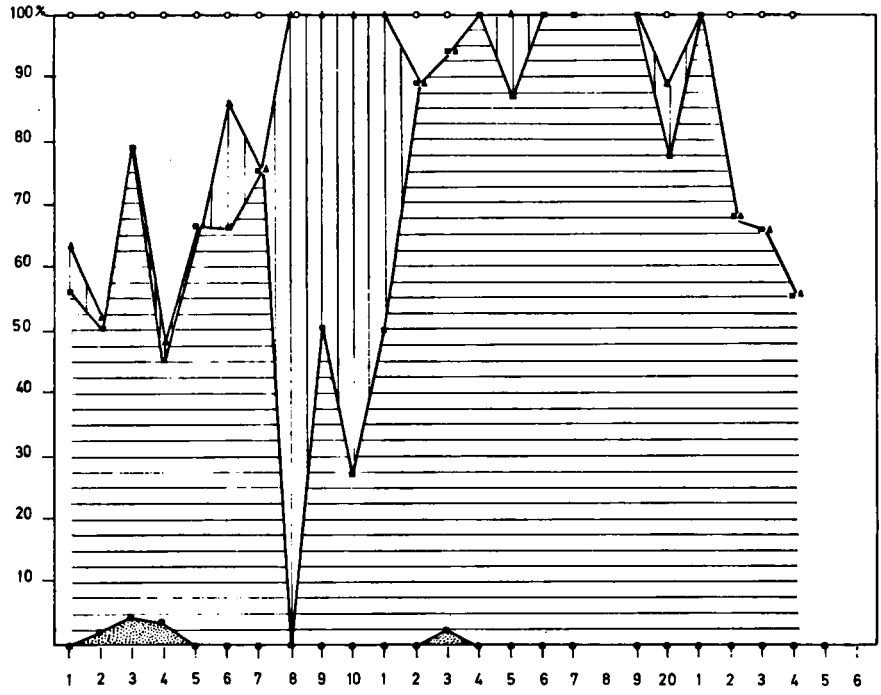

Fig. 11. The occurrence of horizontal row(s) of lateral spots in percentages per region. Dotted zones — a single row; horizontal lines (juxtaposed on the former) — two rows of spots; vertical lines (juxtaposed on the former) — three rows of spots; the remaining white zones — no spots at all.

Conclusions

No doubt many of the irregular waves in the figures are the result of having too few specimens from such a large area. Indeed the wide range of the variation per region seems to confirm this. On the other hand, as was pointed out already in the discussion of several characters, some peaks probably do have significance. They may indicate gene exchange with subspecies with more deviating characters as *zeylanicus* (figs. 2, 7, 8) and with *Ch. arabicus* (figs. 2 and 6).

Often there was cause to remark that the distribution shows a two-winged pattern with a centre in Sinai and/or southern Israel. Partly this may be the result of the relatively strong isolation of the Sinai Peninsula: characters that originated there only slowly seeping to the west and to the north. This may be true for the characters straight parietal crest, broad occipital flaps, three lateral rows of spots, absence of the *saharicus*-crest, but it probably does not hold for the wider, clinal wings, starting somewhere in Egypt, Sinai, southern Israel and showing a more or less similar decrease or increase going to the west or to the north from this region (relative width of casque, relative length

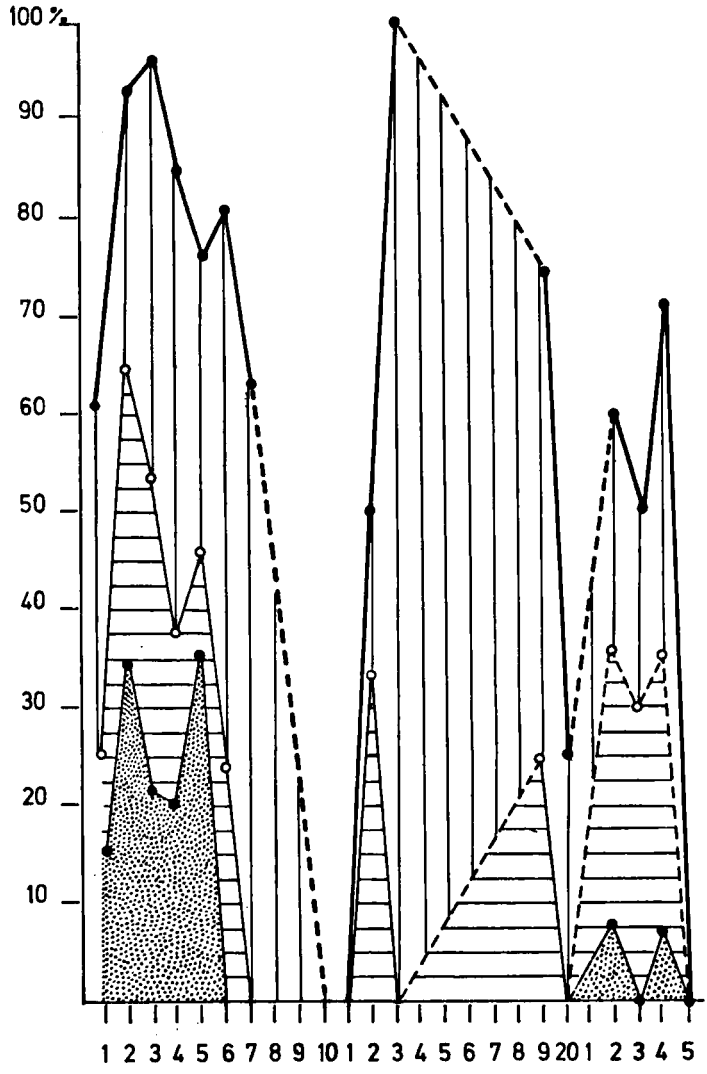

Fig. 12. The occurrence of the *saharicus*-character in percentages per region. Dotted — clearly developed; horizontal lines (juxtaposed on the former) — poorly developed; vertical lines (juxtaposed on former) — only a trace of the character; the remaining white zones — no *saharicus*-trait at all.

of head, in a lesser degree the development of the occipital flaps, perhaps the development of the scales on the midventral line, and the *saharicus*-crest). In my opinion this pattern suggests the road along which *Ch. chamaeleon* arrived in these regions. As I argued before (1959, 1963) it is likely that the genus *Chamaeleo* originated in East Africa and spread from there. The ancestors of *Ch. chamaeleon* may have reached the Mediterranean, emigrating along the Nile and spreading along the coastal regions to the west and to the east and north. The southeast corner of the Mediterranean then being a secundary centre of dispersal, characters that originated here would slowly flow as well to the west as to the east and north, resulting in a two-winged pattern of distribution for these characters. The probability of emigration along the Nile northward may also be concluded from the distribution of *Ch. basiliscus* Cope, as published by Flower (1933).

Musae or *recticrista?*

As argued on p. 46 I consider the populations of Sinai sufficiently different and isolated to hold up the status of a separate subspecies. Officially the subspecies bound to this region was described by Steindachner in 1900 as *Chamaeleon vulgaris* var. *musae,* characterized by occipital flaps more strongly developed than in the common form (confirmed by our findings, see fig. 6) and by parietal crests strikingly slower rising to the top of the casque, so that the form of the head looks much longer and lower than in the common chameleon. Steindachner mentions the picture in Anderson (1898) as a particularly good one of his new variety.

On plate XXIX of Anderson's book two chameleons are pictured, one of Marsa Matru, in all aspects the common form with a clearly curved parietal crest (like in fig. 10 left) and one of the "Wells of Moses, Suez", with a low, straight casque and strikingly broad occipital flaps, the latter typical for Steindachner's form. A little nomenclatorial problem remains, because Boettger (1889) described a form ("Lokalvarietät") *recticrista* from Haifa, Jerusalem, Beyrut and Cyprus, characterized by "die geringeren Dimensionen, die stete Gelbfleckung der Körperseiten in zwei ziemlich regelmässigen Längszonen und die fast gradlinig verlaufende Helmcrista". The smaller dimensions can hardly be called characteristic, neither can the two rows of lateral spots (see fig. 11). But as presently known, at least in a number of specimens the straight parietal crest is a more or less locally bound clear character (fig. 10).

In 1922 Mertens selected a specimen from the surroundings of Jerusalem as lectotype of the subspecies *recticrista.* At the same time he stated "Identisch mit dem typischen *Chamaeleon chamaeleon* Linnaeus". In his revised edition of the Reptiles of Israel (1961) Hoofien resurrects the name *recticrista* for the subspecies of Israel.

In his list of 1966 Mertens adopts this viewpoint and accepts *recticrista* as a valid subspecies of Israel, Libanon, Cyprus. Probably Mertens was convinced by the arguments of Hoofien's unpublished "Random notes on the status and

the nomenclature of the Chameleons of Israel" that he sent to interested herpetologists in 1963. His main argument for the resurrection of the name *recticrista* is a zoogeographical one. Because of the existence of a clearly deviant form in Sinai *(musae)* the populations of Israel and farther to the north and east are separated from the nominal form. Hoofien wrote: "Accepting Mertens' statement that the Palestine chameleon is identical with the typical subspecies — we would arrive at an absurd pattern of distribution, as follows: C — M — C" (i.e. *Ch. chamaeleon chamaeleon — Ch. ch. musae — Ch. ch. chamaeleon*).

Hoofien thought this pattern of distribution without precedent, "theoretically as good as inconceivable. I therefore theorized that, Mertens notwithstanding, the Israel chameleon *must* somehow differ from the North African..."

Because Hoofien recognized *Ch. ch. musae* as different from the greater part of Israel chameleons (in fact his own data on the straightness of the parietal crests and the widths of the occipital flaps confirm this) he cannot have seen much difference between the chameleons of Israel and those of North Africa. Considering the strong isolation of Sinai both from Israel as well as from North Africa, the thought that in this region a separate form could develop seems less absurd than Hoofien states.

The problem then was: although in general the chameleons from the neighbourhood of Jerusalem (region 13 in our figures) are not strikingly different from those of other regions (confirmed by the fact that Mertens (1966) gives as range Israel, Libanon and Cyprus), one character is mentioned that is typical for the subspecies of Sinai: the straight casque. This could mean that, although the type specimen did not come from the range of the subspecies, the subspecies of Sinai should be called *recticrista* because of priority. The problem was easily solved by examining the type specimen and the other 6 specimens of the same lot from which Mertens selected the type specimen. Only the juveniles, with lengths of head + body less than 60 mm, possess casques with almost straight parietal crests. But this is a common phenomenon in juvenile chameleons which in adult state have clearly curved parietal crests (for instance in *Ch. oustaleti*). The type-specimen (S.M.F. 16151), however, an adult male (head + body 98 mm, tail 102 mm) possesses a normally curved parietal crest. Only one of the three remaining specimens (head + body 82, 83 and 88 mm) has a parietal crest that is less curved than the common form, the others both have curved parietal crests. The relative width of the occipital flap of the type specimen is 0.11 and of the other specimens 0.08, 0.07, 0.06, 0.10 and 0.05. In one specimen the occipital flap was too small and too close to the body to be measured. The average (0.08) as well as the maximum (0.11) is quite below the average relative width of the occipital flap of the specimens of Sinai (more than 0.19), so that evidently in two of the most characteristic features, straightness of the parietal crest and width of the occipital flap *Ch. chamaeleon musae* is not identical with *Ch. chamaeleon recticrista*. So *musae* remains the name for the clearly recognizable

subspecies of Sinai and as to the form *recticrista* this paper should give enough evidence to return to Mertens' conclusion of 1922: "Identisch mit dem typischen *Chamaeleon chamaeleon* Linnaeus".

In other words I consider *Ch. chamaeleon recticrista* Boettger to be a synonym of *Chamaeleo chamaeleon chamaeleon* (Linnaeus).

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