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On the parapatric existence of two species of the *Pedioplanis undata* group (Reptilia: Sauria: Lacertidae) in the central Namib desert (Southwest Africa) with description of the new species *Pedioplanis husabensis*

Über das parapatrische Vorkommen von zwei Arten der *Pedioplanis undata* Gruppe (Reptilia: Sauria: Lacertidae) in der zentralen Namib Wüste (Südwestafrika) samt der Beschreibung von *Pedioplanis husabensis*

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ABSTRACT: In the course of a survey of the reptile fauna in the central Namib desert near the lower reaches of the rivers Khan and Swakop a yet undescribed lizard of the *Pedioplanis undata* complex was found to exist parapatrically with *Pedioplanis undata inornata*. Pronounced discontinuity of morphological and biochemical features of the specimens of the contact area proves that the new form is genetically sufficiently separated from *Pedioplanis undata* to be regarded as a species of its own (*Pedioplanis husabensis* n. sp.)

ZUSAMMENFASSUNG: Im Rahmen einer Untersuchung der Reptilienfauna der zentralen Namib Wüste im Bereich der Unterläufe der Flüsse Khan und Swakop wurde eine bisher unbeschriebene Eidechse aus dem *Pedioplanis undata* Komplex entdeckt. Die Form lebt parapatrisch mit *Pedioplanis undata inornata*. Die konstante Diskontinuität morphologischer und biochemischer Merkmale bei den Individuen in der Kontaktzone beweist eine sehr effektive genetische Isolation und damit die artliche Eigenständigkeit gegenüber *Pedioplanis undata*. Die neue Art wird als *Pedioplanis husabensis* n. sp. beschrieben.

KEYWORDS: Lacertidae, *Pedioplanis husabensis* n. sp., *Pedioplanis undata inornata*, parapatry, electrophoresis, protein differences, Namibia, Southwest Africa.

INTRODUCTION

The lizards, so far assigned to *Pedioplanis undata* (SMITH, 1838), in reality form a complex of parapatric species and subspecies (MAYER & BERGER-DELL'MOUR 1987). In the course of a survey of the reptile fauna in the central Namib desert around the rivers Swakop and Khan from February 1984 to October 1985 a considerable number of specimens was collected and investigated morphologically and electrophoretically.

MATERIAL AND METHODS

A total of 308 specimens was taken from various localities between 22° to 24° latitude south and 14° 50' to 16° longitude east. Seven specimens from the Senckenberg Museum (Frankfurt, FRG) and 40 specimens from the Transvaal Museum (Pretoria, RSA) were included in the morphological investigation.

The following 16 proteins from blood, liver, muscle respectively were investigated by means of electrophoresis using lizards from the area around the Rössing uranium mine: lactate dehydrogenase 1 and 2, malate dehydrogenase, α -glycerophosphate dehydrogenase, creatine phosphokinase, glucosephosphate isomerase, glutamate oxalacetate transaminase, phosphoglucomutase 1 and 2, isocitrate dehydrogenase 1 and 2, alcohol dehydrogenase, hemoglobin, esterase, one non-enzymatic muscle-protein and albumin.

Enzymes were run on 12% starch gel (bridgebuffer: 0.135 mol/l Tris, 0.16 mol/l citric acid, pH = 7; gelbuffer: 3% bridgebuffer), albumin was run on 15% acrylamide gel (0.1 mol/l glycine/Tris pH = 7.8). The enzyme bands were stained according to SHAW & PRASAD (1970), the albumin band with amido black.

RESULTS AND DISCUSSION

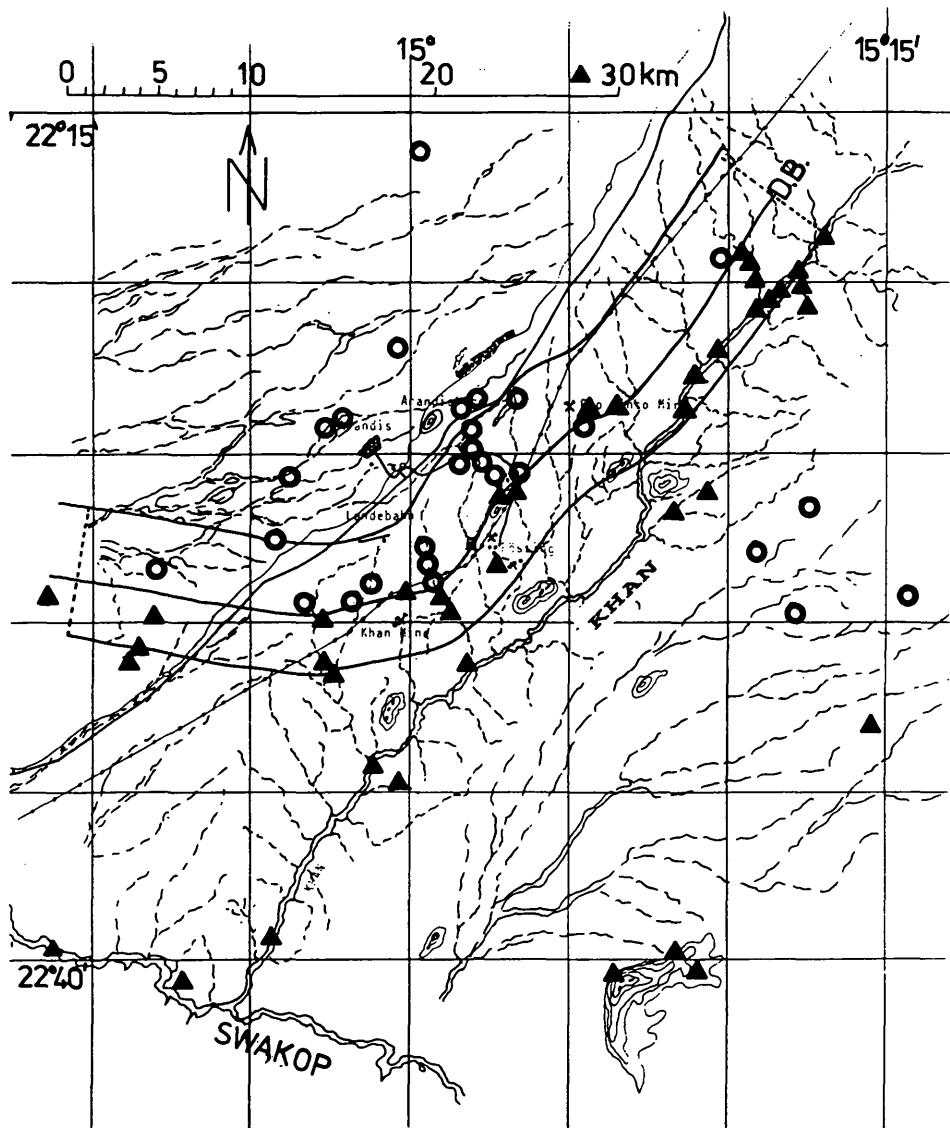
In correlation with its origin (fig. 1), the material from the Rössing mine area was clearly separable into two categories according to three morphological features: size of the tympanic shield (fig. 2), shape and coloration of the lower eyelid scales, and presence or absence of a series of yellow lateral spots.

In lizards from northwestern parts of this area the lower eyelid comprises two greatly enlarged, transparent and dark edged scales which are al-

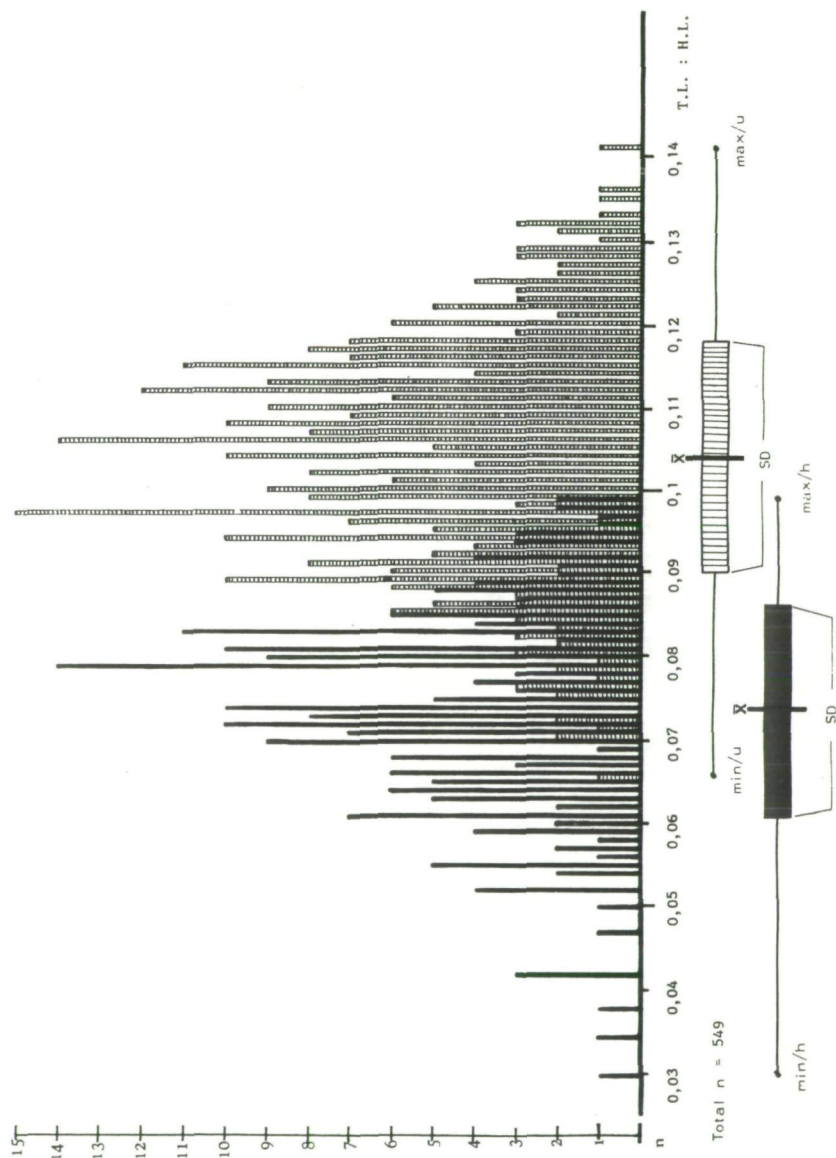
Fig. 1: Distribution of *Pedioplanis undata inornata* and *Pedioplanis husabensis* n. sp. in the vicinity of the Rössing mine. To assess the degree of hybridization material from the indicated 7 km broad strip along the distribution border (D. B.) was used.

Abb. 1: Verbreitung von *Pedioplanis undata inornata* und *Pedioplanis husabensis* in der Umgebung der Rössing Mine. Zur Feststellung des Ausmaßes an Hybridisierung wurde Material aus dem markierten 7 km breiten Streifen entlang der Verbreitungsgrenze (D. B.) herangezogen.

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ways much larger than those in the scale row below. The tympanic shield is moderate to large, and there is a series of yellow spots on the flanks. This form is almost identical with *Pedioplanis undata inornata* (ROUX, 1907) from southern Namibia (fig. 4).

In specimens from the southeastern parts of the Rössing mine area the lower eyelid shows an upper row of 3-4 but slightly enlarged scales which are opaque, never dark-edged, and equal in size to - or only slightly larger than - the scales of the lower row. The tympanic shield is moderate to small; lateral series of yellow dots are lacking (although irregularly arranged white speckles may occur) (fig. 5).

Proteinelectrophoretic investigations yielded three additional almost constant differences between the two forms (table 1).

| Protein | <i>P. undata inornata</i> | <i>P. husabensis</i> n. sp. |
|---------|---------------------------|-----------------------------|
| Albumin | b | a |
| PGM-2 | a, c, d | b |
| LDH-1 | a | b |

Table 1: Electromorphs found in *Pedioplanis undata inornata* from central Namib desert and in *Pedioplanis husabensis* n. sp. The variants are ranked according to their anodic electrophoretic mobility.

Tab. 1: Bei *Pedioplanis undata inornata* aus der zentralen Namib Wüste und bei *Pedioplanis husabensis* n. sp. gefundene Elektromorphen. Die Reihung der Varianten erfolgte entsprechend ihrer anodischen elektrophoretischen Mobilität.

Fig. 2: Histogram representing frequency distribution of standardized tympanic shield length of *Pedioplanis husabensis* n. sp. (black) and *Pedioplanis undata inornata* (hatched) from the central Namib desert (n = 275).

Vertical axis (n): frequency; horizontal axis: standardized tympanicum length (tympanicum length TL / head length HL); left and right measures treated separately. Below: maximum and minimum values for each species (thin horizontal line), mean (vertical line) and standard deviation (SD).

Abb. 2: Histogramm der Häufigkeitsverteilung der relativen Tympanicumlängen von *Pedioplanis husabensis* n. sp. (schwarz) und *Pedioplanis undata inornata* (schraffiert) aus der zentralen Namib Wüste (N = 275).

Ordinate (n): Häufigkeit; Abszisse: Relative Länge des Tympanicums (Tympanicumlänge TL / Kopflänge HL); die Messungen an der linken und rechten Kopfseite wurden gesondert berücksichtigt. Unten: maximaler und minimaler Wert für jede Art (dünne horizontale Linie), Mittelwert (vertikale Linie) und Standardabweichung (SD).

Amongst 94 lizards (45, 59 respectively) from the border area (a strip of about 40 km length and 7 km width; fig. 1) no more than 12 specimens showed signs of hybridisation. No gene transgression was observed in albumin. One specimen of *P. u. inornata* was heterozygote in LDH-1, 2 *P. u. inornata* and 8 *Pedioplanis* spec. nov. were heterozygote in PGM-2, and 1 *P. u. inornata* was homozygote in PGM-2, showing the electromorph that is characteristic of *Pedioplanis* spec. nov. (fig. 3).

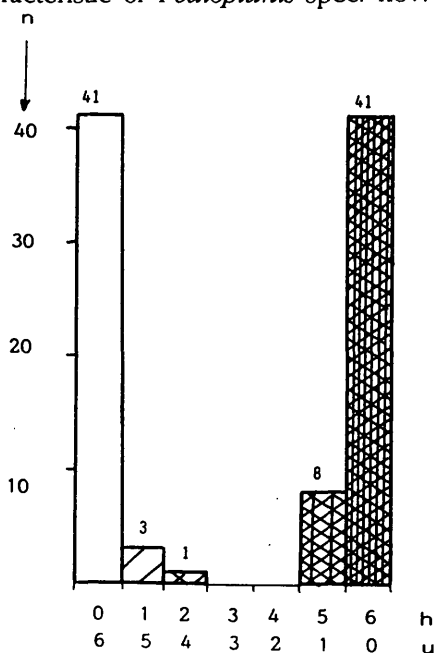


Fig. 3: Frequency of "pure" specimens of *Pedioplanis undata inornata* (= 6u) and *Pedioplanis husabensis* n. sp. (= 6h) and of those of "mixed" character from a 40 km x 7 km strip along the distribution border determined by electrophoresis (n = 94). According to the electrophoretic pattern of three diagnostic loci, specimens were assigned to 7 categories (6u to 6h).

Abb. 3: Elektrophoretisch bestimmte Häufigkeit (n = 94) von "reinen" Exemplaren von *Pedioplanis undata inornata* (= 6u) bzw. *Pedioplanis husabensis* n. sp. (= 6h) und Exemplaren mit Mischcharakter verschiedenen Ausmaßes aus einem 40 km mal 7 km messenden Streifen entlang der Verbreitungsgrenze. Gemäß den elektrophoretischen Ergebnissen für drei diagnostische Loci wurden die Exemplare auf 7 Kategorien aufgeteilt (6u bis 6h).

The small number of allospecific alleles (13 out of 564 investigated) in the contact populations, and the fact that no primary hybrid (heterozygote in all three loci) has ever been found, both indicate a very low hybridization probability, and thus effective reproduction barriers between members of the two populations.

Both populations show a strictly parapatric distribution pattern in the study area; a range overlap of more than a few hundred meters has never been found. Because of the constancy of the features in the contact area both forms have to be considered as representatives of two different species, i. e. *Pedioplanis undata inornata* and a new species to be described below for which we used the provisional name *Pedioplanis* "Mt. Husab" before (MAYER & BERGER-DELL'MOUR 1987, 1988).

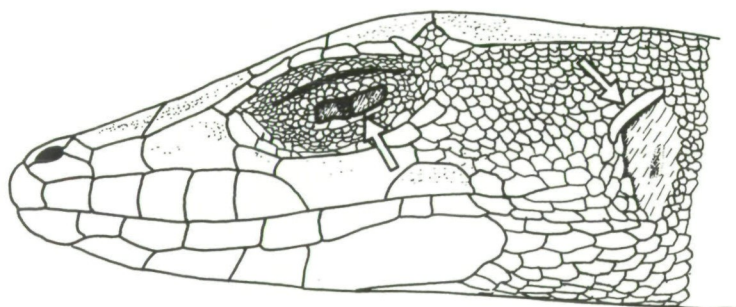
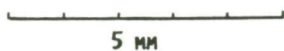
Pedioplanis husabensis n. sp.

Holotype: adult male, SMWN (State Museum Windhoek, Namibia) 4424, coll. H. BERGER-DELL'MOUR, January 11, 1985; northern side of Husab Mountain, Namib Park, Swakopmund Dist., S. W. A./ Namibia, 22° 40' S, 15° 08' E, 750 m above sea level. 20 paratypes, SMWN 4420-4423, 4425-4426, 4529-4530, and 5307-5318, all from the same locality as holotype.

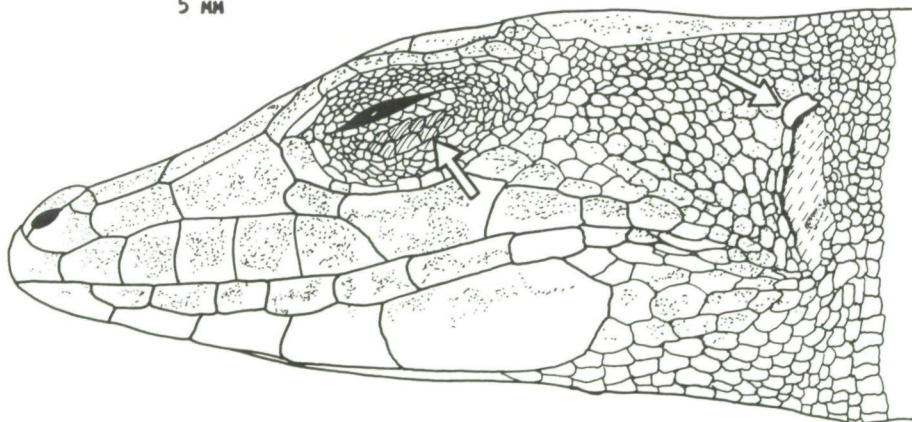
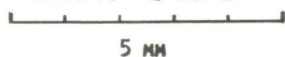
Diagnosis: General features and coloration very similar to *Pedioplanis undata inornata* (ROUX, 1907) from the lower Khan area. Differs from it in four morphological characters:

1. Disk in lower eyelid not transparent but opaque to semitransparent with a copper shimmer (which may fade in preserved specimens), its scales not even feebly edged with black. Four (rarely three) moderately large scales in its upper part instead of two greatly enlarged ones (in *P. u. inornata*), not or but slightly larger than the 4-5 feebly enlarged scales beneath (figs. 4 and 5).
2. Tympanic shield small, the ratio of its length to head length (tip of snout to anterior border of ear opening) being 0.03 to 0.09 (0.07 to 0.14 in *P. u. inornata* from adjoining areas) (figs. 2, 4, and 5).
3. Without longitudinal series of yellow spots on the flanks as in *P. u. inornata*. No traces of yellow pigmentation in ventral and posterior parts of thighs. (In preserved specimens of *P. u. inornata* the yellow

SMWN. 3960



SMWN 4424



spots fade but can always be distinguished as a series of rather large, often dark edged, light dots).

4. 33-38 (based on type series) gular scales in a straight line between symphysis of chin shields and median collar plate (26-35 in *P. u. inornata*).

Description of holotype: Length of head (tip of snout to anterior border of ear opening) 14.5 mm, snout-vent-length 59.3 mm, length of tail 16 + 96 (regenerate) mm.

For head scales see figs. 5, 6, and 7. Ratio of tympanic shield diameter to head length: 0.062/0.066. 37 gular scales in a straight line between symphysis of chin shields and median collar plate. Collar straight, composed of 10 plates. 67 dorsal scales across the middle of body. Ventral plates in 10 longitudinal and 30 transverse rows (from collar to groin). 15/14 femoral pores. 29/29 subdigital lamellae under the fourth toes. Colour very similar as in *P. u. inornata* but without series of yellow or green lateral dots.

Etymology: *Pedioplanis husabensis* is named after the type locality.

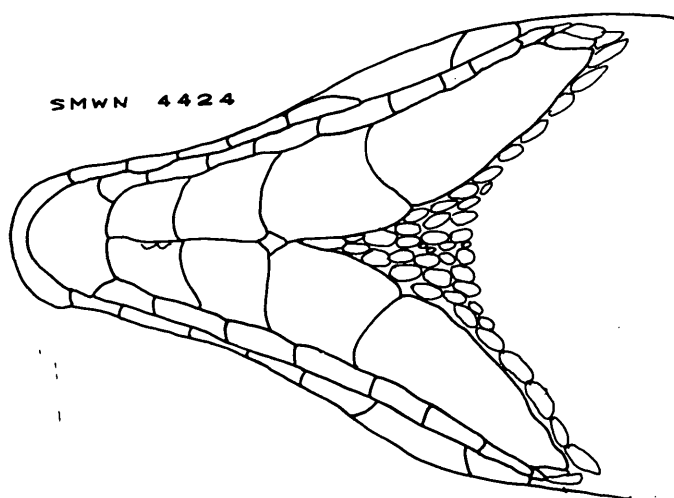
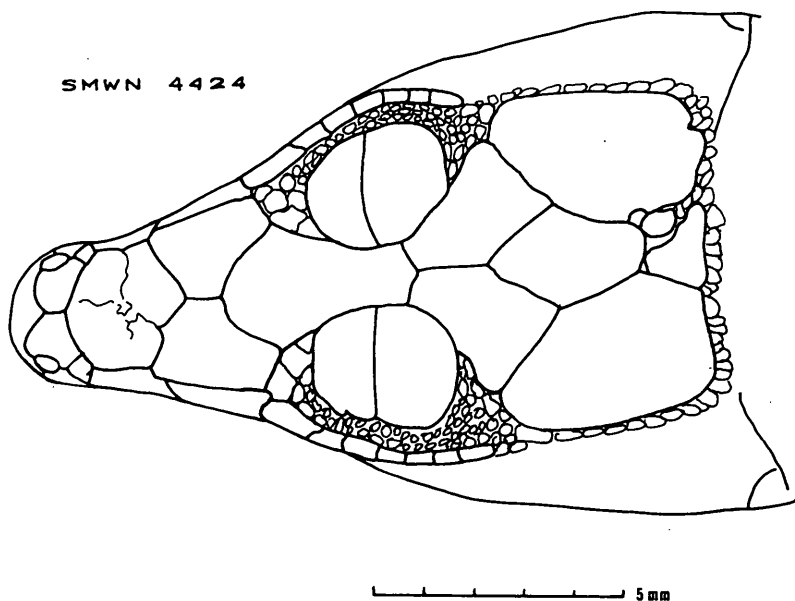
Distribution: *P. husabensis* inhabits a strikingly small area. Beginning with the conjunction of the dry beds of the rivers Swakop and Khan, it extends to about 25 km southwest of Usakos (22° 08' S, 15° 25' E) along the ridges of the Khan; following the Swakop, it stretches at least 10 km downstream, and reaches upstream to at least 22° 40' S, 15° 24' E (the species has not been found upstream of this point). The area additionally includes some ridges in contact with the mountains bordering the two

Fig. 4: Head of *Pedioplanis undata inornata* from lower Khan river area, lateral view (arrows indicate the lower eyelid and the tympanicum both being diagnostic features).

Abb. 4: Seitenansicht des Kopfes von *Pedioplanis undata inornata* aus dem Gebiet des unteren Khan-Flusses (Pfeile weisen auf das untere Augenlid und das Tympanicum als diagnostische Merkmale hin).

Fig. 5: Head of *Pedioplanis husabensis* n. sp. (holotype) from Husab mountain, lateral view (arrows indicate the lower eyelid and the tympanicum both being diagnostic features).

Abb. 5: Seitenansicht des Kopfes von *Pedioplanis husabensis* n. sp. (Holotyp) vom Berg Husab (Pfeile weisen auf das untere Augenlid und das Tympanicum als diagnostische Merkmale hin).



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rivers: Langer Heinrich and Blood Koppie (south of the Swakop); Husab Mts. and Pforte Mts. (between Khan and Swakop); southern part of the Rössing Mts. (west of the Khan).

The distribution area of *P. husabensis* on all sides is surrounded by that of *P. u. inornata* (perhaps with the exception of the lowest parts of the Swakop and west of the Rössing Mts., where lizards of the *P. undata* complex can probably not be found at all (fig. 8).

It is remarkable that for a long distance along the river Khan obviously a very small strip is occupied by *P. husabensis*. In this area the species inhabits the lowest parts of the mostly very steep slopes of the river and the lower sections of the tributary valleys, whereas *P. u. inornata* lives mainly in the upper and flatter sections. At the northeastern boundary of distribution, near the farms Tsawisis 16 and Stinkbank 62 (22° 40' S, 15° 24' E), where the mountains bordering the Khan slope to the plain upstream, the boundary line was found to cross the last flat limestone hills on both banks of the Khan. At present, the distribution of *P. husabensis* along the Swakop is only proved by a few samples but will most probably turn out to be very similar to that one along the Khan.

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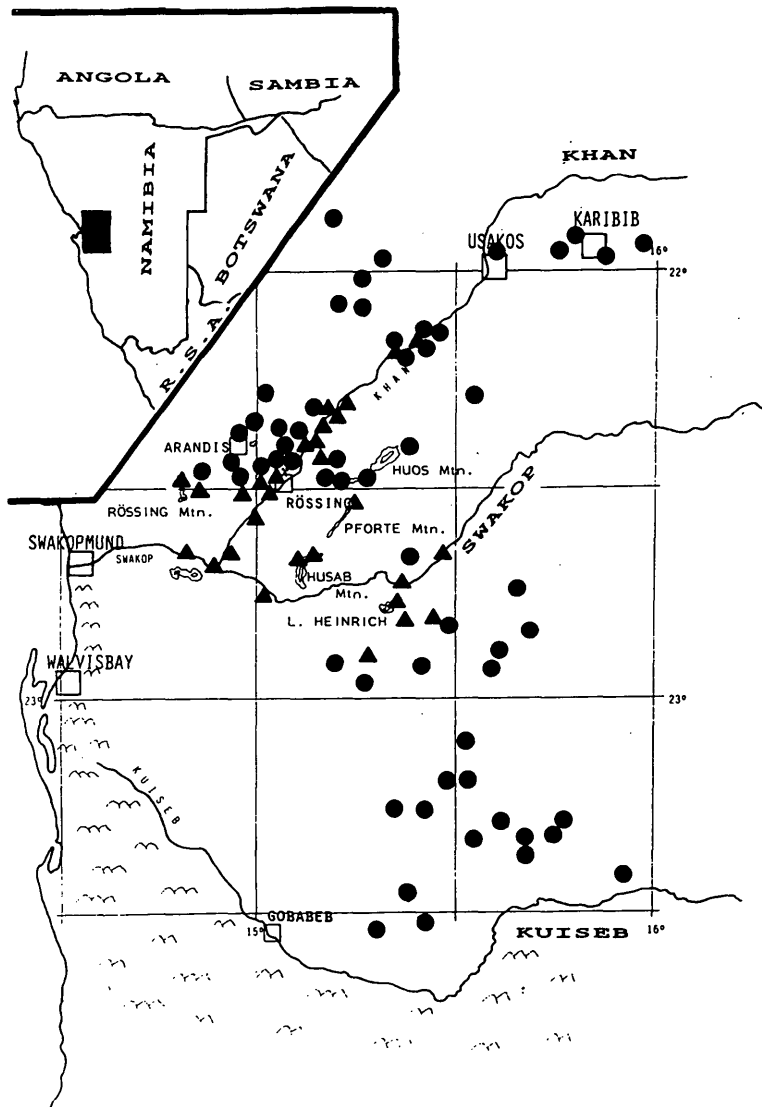
Fig. 6: Head of *Pedioplanis husabensis* n. sp. (holotype) dorsal view.

Abb. 6: Dorsalansicht des Kopfes von *Pedioplanis husabensis* n. sp., (Holotyp).

Fig. 7: Head of *Pedioplanis husabensis* n. sp. (holotype) ventral view.

Abb. 7: Ventralansicht des Kopfes von *Pedioplanis husabensis* n. sp., (Holotyp).

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Fig. 8: Locality records of *Pedioplanis undata inornata* (circles) and *Pedioplanis husabensis* n. sp. (triangles) in the central Namib desert.

Abb. 8: Nachweise von *Pedioplanis undata inornata* (Kreise) und *Pedioplanis husabensis* n. sp. (Dreiecke) in der zentralen Namib Wüste.

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