

**A REVIEW OF THE GECKO GENUS PTENOPUS  
WITH THE DESCRIPTION OF A  
NEW SPECIES**

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Die Gecko-genus *Ptenopus* is hersien, en 'n nuwe soort, *P.carpi*, word beskryf. Talle etologiese en ekologiese waarnemings is aangeteken. Die werk is gebaseer op uitgebreide versamelings gemaak gedurende die Carp-Transvaalmuseum-ekspedisie na die Namibwoestyn (1959) en vroeëre ekspedisies in Suidwes-Afrika. Die tipeeksemplare is versamel op die terrein van die Woestynnavorsingstasie by Gobabeb. Alle tipe-eksemplare is in die Transvaalmuseum, Pretoria.

Die Einteilung der Gecko-Gattung *Ptenopus* wird revidiert und eine neue Art, *P.carpi*, beschrieben. Zahlreiche ethologische und ökologische Beobachtungen sind vermerkt. Die Arbeit grundet sich auf die umfangreichen Sammlungen der Carp-Transvaalmuseum-Expedition in die Wüste Namib (1959) sowie früherer Expeditionen nach Südwestafrika. Die gesammelten Exemplare wurden auf dem Gelände der Wüstenforschungsstation in Gobabeb gefunden. Alle gesammelten Stücke sind im Transvaalmuseum in Pretoria.

## INTRODUCTION

Geckos of the genus *Ptenopus* are unique among South African lizards for their well-developed ability to produce sounds; their loud and penetrating calls can be heard from a considerable distance. The genus is endemic to Southern Africa and is restricted to the dry, sandy areas where the rainfall is usually well below 20 inches per annum. For many years it was thought that a single species, *garrulus*, existed and that it could be split into two races. In the course of the Carp-Transvaal Museum Namib Desert Expedition, however, some time was spent at Gobabeb, the site of the proposed Desert Research Station, and a large collection of whistling geckos was made there. It was found that these specimens were easily divisible into two distinct species; in the course of describing the new species it seemed desirable to review the whole genus and to examine as many specimens as possible. This has been done and the results are presented below.

## GENUS: PTENOPUS

1865, Gray. Proc. Zool. Soc. Lond. p. 640, pl. XXXVIII, fig. 1, (type *maculatus*).

## DIAGNOSIS:

Upper extra-brillar fringe well-developed, lower distinct; almost connivent. Pupil vertical. Digits, long, slender and free, strongly clawed. Fingers fringed laterally with spinose scales, toes fringed with combs of long spinose scales. Body lepidosis of small, subequal and smooth granules or scales. Tail cylindrical and tapering. Pre-anal and femoral pores absent. Post-anal sacs present.

## RANGE:

Northern Cape Province, extending into Bechuanaland, Northern Transvaal and South West Africa. Endemic to Southern Africa.

## TAXONOMIC HISTORY:

A. Smith (1849) described a specimen from "the sandy districts of the interior of Southern Africa" as *Stenodactylus garrulus*. In 1865 a specimen from Damara-land was described as *Ptenopus maculatus* by Gray and was placed in the family Agamidae. During the same year Gunther (1865) synonymised *maculatus* and *garrulus*. Three years later, Cope (1868) pointed out that, on osteological grounds, *Ptenopus* should be removed from the Agamidae and placed in the Gekkonidae. FitzSimons (1935) revived *maculatus* as a subspecies of *P. garrulus*. The evidence presented in this review suggests that the differences between *garrulus* and *maculatus*, viewed in a long series, do not warrant subspecific status. A new species, *P. carpi*, however, is described from the Central Namib Desert of South West Africa.

## KEY TO SPECIES :

Limbs relatively short (see measurements); toes strongly fringed laterally (Plate 1d); lower labials 6—10, mean 8; nostril partly closed by sand-catching device peritoneal lining pigmented and black; apparently restricted to a sandy habitat.

. . . *P.garrulus*

Limbs long and slender (see measurements); toes weakly fringed laterally (Plate 1e); lower labials 9—14, mean 12; nostril fully open; peritoneal lining unpigmented; apparently restricted to a gravelly substrate.

. . . *P.carpi*

## PTENOPUS GARRULUS (Smith)

## SYNONYMY :

1849 *Stenodactylus garrulus* A. Smith, p. 6.

1865 *Stenodactylus garrulus* Gunther, (not Gray), p. 149.

1865 *Ptenopus maculatus* Gray, p. 640.

1885 *Ptenopus garrulus* Boulenger, p. 15.

1935 *Ptenopus garrulus garrulus* FitzSimons, p. 524.

1935 *Ptenopus garrulus maculatus* FitzSimons, p. 525.

## TYPES :

All are in the British Museum (Nat. Hist.).

## COMMON NAMES :

Whistling gecko, Klein grondgeitjie (Afrikaans).

## DESCRIPTION :

A squat, somewhat stout ground gecko; limbs well-developed. Head swollen posteriorly, snout usually blunt but profile somewhat variable (Plate 1a).

Upper labials 6—9, mean 8 (sample 112 specimens). Lower labials 6—10, mean 8 (sample 112 specimens). Nostril usually surrounded by 2 nasals (sample 114 specimens; 109 individuals with 2 nasals, 4 with 3 and 1 with imperfect separation between 2); smaller nasal partly obstructing nostril internally (Fig. 1a). Nasals usually separated above rostral by one granule, rarely 2 or 3. Pupil vertical; upper brillar fringe well-developed, lower distinct, both almost connivent over spectacle. Ear opening an oblique slit, length less than diameter of orbit. Rostral and mental entire. No distinct chin-shields present.

Lepidosis generally of granular and flattened scales; specialised scales present on head, tail-base and digits. Many scales bearing sensory pits (see below). Toes and fingers fringed laterally with spinose scales, those on the toes being long and comb-like (Plate 1d). Tail cylindrical and tapering, covered with flat juxtaposed scales larger than those on body; apparently dropped at any point along its

## *Cimbebasta*

length: 24 % of a sample of 113 specimens showed regenerated or incomplete tails. One specimen (T.M. 20949, Oranjemund, S.W.A.) showed double regeneration of the tail tip. Peritoneal lining pigmented black; post-anal sacs present; femoral pores absent.

### SIZE :

The largest specimen quoted by Loveridge (1947) had a length of 90 mm. (s-v: 56; t: 34). Several specimens from Gobabeb, S.W.A., are larger: eg. T.M. 25947, 115 mm. (61 + 54). Most usual body length appears to be between 40 and 50 mm. (60 specimens out of a sample of 113). Mean proportion of tail to head and body length is 70 % (sample: 86 specimens with unregenerated tails).

### COLOUR :

Very variable and dependent on that of the sand. From cream or pinkish-brown to reddish-brown, either plain or with darker markings. These may form irregular crossbars on body and tail but are usually interrupted along the vertebral line. Creamy-white below; males have bright sulphur-yellow throats.

### SEXUAL DIMORPHISM :

Both sexes have enlarged tubercles projecting laterally on either side of the tail-base; those in males are much more prominent and larger than in females. Number of tubercles varies from 1 to 5 per side, most specimens have 2 (44 % of the sample of 129 specimens).

Sexual dichromatism is marked: throats of adult males are sulphur-yellow, females creamy-white.

### OSTEOLOGY :

Cope (1868) has discussed the skull, dentition and vertebrae of a specimen from the Cape Province. Further mention of skull structure is made by Hewitt (1935 p. 311).

### SENSORY PITS :

Many of the scales show small circular pits, some of which appear to enclose minute hairs or bristles. It is provisionally assumed that these are tactile organs. The pits are present on virtually all the ventral scales of body, throat and tail, one pit usually occurring per scale. The greatest concentration of pits is on the head scales, adjacent to the labials, where it is common for one scale to contain 5 pits. Practically all dorsal head scales show pits, but these are rare on dorsal body scales although present again on all surfaces of the tail. The minute hairs, contained by the pits, can best be seen if individual scales are removed, mounted on a slide and viewed through a microscope with transmitted light. Pits on the



(a)



(b)



(c)



(d)

(e)

Plate 1. (a) *Ptenopus garrulus*, an adult specimen from Alexander Bay. — (b) *Ptenopus carpi*, on the gravel plain at Gobabeb, S.W.A. — (c) Characteristic threat attitude of *P. carpi*. — (d) Toe-fringing of *P. garrulus* (Left hind foot). — (e) Toe-fringing of *P. carpi* (Left hind foot).

scales are considerably emphasised if the surface of the gecko is moistened with a dye such as methylene blue.

Further work on the structure and function of the organs is planned.

#### ACTIVITY TIMES AND FUNCTION OF THE EXTRA-BRILLAR FRINGE :

Although *Ptenopus* is largely a nocturnal gecko, there is evidence to believe that it is sometimes active by day. Mertens (1954) mentions specimens seen on the surface at Sossus Vlei (Namib Desert, S.W.A.) during daylight, but suggests that this may be an exceptional occurrence following rain. Personal observations show that *P. garrulus* may occasionally be collected while actively moving on the surface in the afternoon while the sun is still high but the sand temperature is not excessive. Numerous specimens were taken at Gobabeb under such conditions. By far the greatest numbers can, however, be seen at night and are then easily collected with the aid of a paraffin pressure lamp.

It has already been pointed out that *Ptenopus* shows sexual dichromatism — the males having yellow throats. There is little doubt that the coloured throat acts, as in *Chamaeleo dilepis*, as a social releaser and in both reptiles is particularly emphasised during threat. Should this be so, it is reasonable to assume that *Ptenopus* is capable of colour vision, to some extent at least, but at the same time it is known that, at low light intensities, colour vision fails to operate. It is suggested therefore that social behaviour such as courtship is carried out by day, but probably at times when the lighting is somewhat subdued.

Bellairs (1948) has shown that the extra-brillar fringes of *Ptenopus* contain muscle fibres allowing the animal almost to close the fringes over the spectacle. Observations on live specimens have shown that when the animals are placed in bright light they tend to lower the upper fringe, thus giving rise to the characteristic 'frowning look' of *Ptenopus*. When lowered, the upper brillar-fringe appears to function as a sun-shield, protecting the eye from illumination that might otherwise be undesirably bright. It is possible that the ability, which *Ptenopus* possesses, to lower the upper fringe may facilitate diurnal courtship.

Various authors (FitzSimons 1943, Loveridge 1947, Bellairs 1948, Underwood 1954, Mertens 1954) have pointed out that the upper and lower fringes may sometimes practically meet over the spectacle. This is often observed in preserved material, but only twice have I seen it in life: on the first occasion a captive *Ptenopus* had consistently refused food and closed its fringes shortly before expiring; on the second, a healthy specimen was seen to emerge from loose sand with fringes closed. On reaching the surface, the fringes were opened. Bellairs (1948) suggests "that the movable extra-brillar fringes play some part in protecting the surface of the brille from the abrasive action of sand particles". This suggestion seems altogether likely.

#### VOCALITY :

Loveridge (1947) has reviewed the different descriptions of the call of *P. garrulus*. Some of them are as follows: "squee-chi-chi-chi", "gack-gack", "schick-

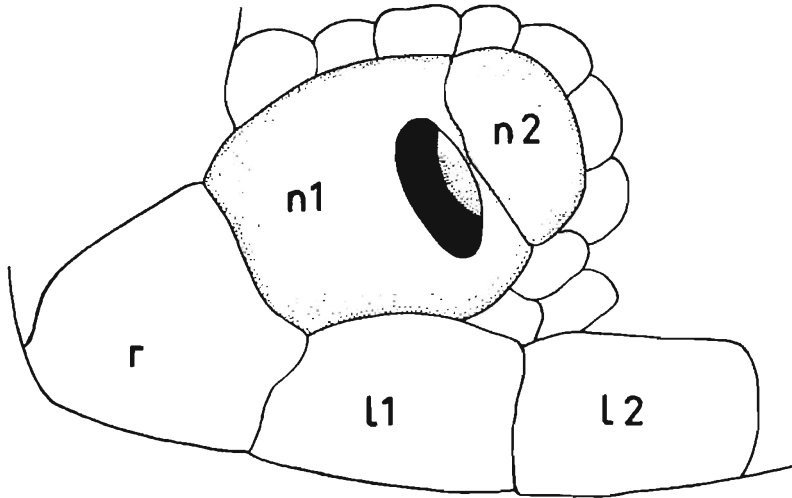
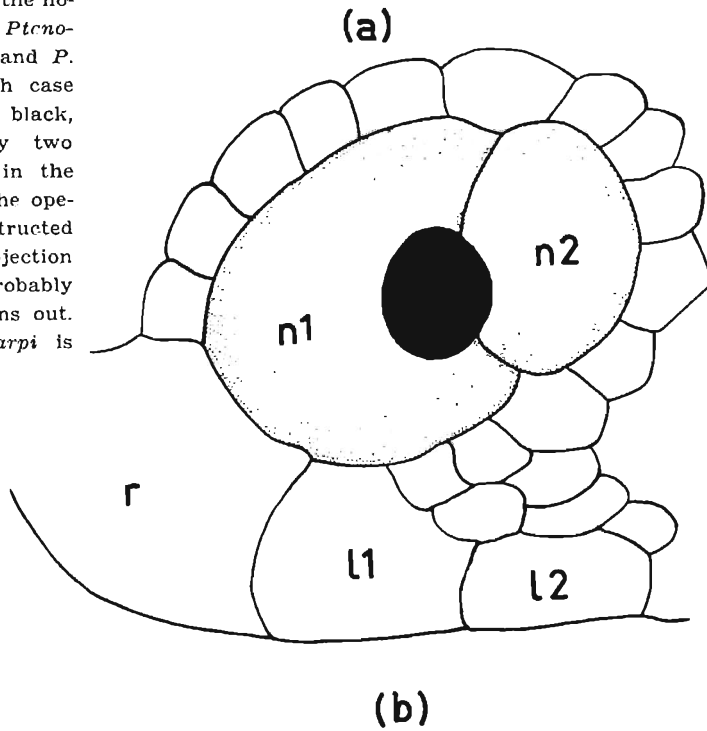


FIGURE 1

Diagrams to show the nostril structure of *Ptenopus garrulus* (a) and *P. carpi* (b). In each case the nostril, shaded black, is surrounded by two nasal scales but in the case of *garrulus* the opening is partly obstructed by an internal projection of n2, serving probably to keep sand grains out. The nostril of *carpi* is fully open.



schick", "chick-chick" and "whick-whick". Personal observations suggests that "gack-gack-gack" is as good a description as any. In the Kalahari National Park, where the geckos were most often heard, it was noticed that the individual "gack" note might be repeated in sequence from 3 to 6 times, the most usual numbers being 4 or 5.

According to Loveridge (1947), the loud and penetrating sound is presumably produced by "sudden removal of the fleshy tongue from contact with the palate". Further work on the mechanism is required. It is presumed that only males call, although confirmation has not been possible since none of the specimens kept under observation would call at all.

Under natural conditions, most calling is done in the late afternoon, reaching a maximum towards sundown and then dying away rather abruptly as darkness falls. Occasional calls may be heard throughout the day as well as the night.

The writer was fortunate in being able to observe a calling *Ptenopus* through binoculars during early evening in the Kalahari National Park. The burrow had been dug into flat white sand of the Nossob R. course and, when about to call, the gecko would emerge from the burrow entrance, until about half its length was visible. In this case the call was "gack-gack-gack-gack" repeated at intervals of about 2 minutes. At each "gack" the mouth was opened widely and the head was shaken backwards with an action very similar to that of a barking dog. Between bouts of calling, the gecko retired into its burrow.

The function of the sound is uncertain; Mertens (1954) suggests that it has to do with defining a territory. Further investigation is required, but would have to be done where the geckos occur. In captivity they make burrows but do not call.

#### HABITAT AND BURROW STRUCTURE:

*P. garrulus* appears to be restricted to a sandy environment where the burrow can be made fairly easily. In areas such as Little Namaqualand, which are essentially rocky, the geckos are found along dry water-courses, where some depth of sand is available. The burrow, dug by the gecko itself, appears to be invariably spiral in form. FitzSimons (1943) states that burrows "vary from a foot to eighteen inches in depth and are usually set at a steep winding angle, under the lee of small bushes, shrubs, or tufts of grass". Hewitt (1935) quoting R. D. Bradfield from Okahandja, S.W.A. states "the hole slopes down, forming three parts of a spiral to a depth of 15 inches, then divides into an upper and a lower passage. The upper passage ends blindly: the lower one, choked up at the junction, proceeds in the opposite direction and at the end the gecko may generally be found. This end is directly beneath the surface entrance, and the easiest way of securing the lizard is by digging vertically from the entrance to a depth of 15 inches".

During May 1959 two occupied burrows were investigated at Gobabeb, S.W.A. Both had been dug in rather loose sand sloping down to the Kuisib River and both took the form of right-hand spirals ending approximately under the entrances at depths of 14 and 15 inches respectively. The spiral diameter was about 12 inches. One burrow showed three tangential dead-end branches leading from the spiral at



different depths but the other was devoid of these. A temperature measurement was taken at the end of the 14 inch burrow and was found to be 23.5 deg. C. while the simultaneous surface temperature was 33.0 deg. C. suggesting that the burrow would provide efficient thermal insulation from excessive midday heat. The entrances of the two burrows studied at Gobabeb were completely exposed, there being no vegetation of any sort on the sandy plain. From this it is clear that the temperature of the sand surface would frequently exceed the lethal maximum of *P. garrulus*.

#### TOE - FRINGING :

The lateral fringes of elongate scales on the toes and fingers appear to assist the gecko in two ways: when walking over an unstable surface of loose sand they reduce sinking in and, secondly, they facilitate digging. Burrow-digging may be observed readily in captive geckos and the method used is similar to that of the web-footed form, *Palmatogecko rangei*. Sand is excavated with the forefoot on one side, to be pushed backwards by the hindfoot on the same side. After some time, the animal makes use of the limbs on the opposite side. It is possible that the fringe system of *Ptenopus* is even more efficient in digging than the webbing of *Palmatogecko*. since, when pushing sand on the backward stroke the fringe expands fully due to flattening of the individual scales while on the forward stroke the fringes fold inwards, thereby minimising drag.

#### DIET :

Stomach contents of several preserved specimens consisted of termites. Bradfield (quoted by Hewitt, 1935) states that whistling geckos at Okahandja feed on ants. Personal observations on *P. garrulus* in captivity have shown that the animals are generally reluctant to feed but will take termites, moths and mealworms. Drops of water are lapped readily from stones and leaves.

#### PREDATORS :

Whistling geckos have been found in the stomachs of two species of sand snake (*Psammophis*) and a common house snake (*Boaedon fuliginosus*), the latter from Aus, S.W.A. They have also been readily taken by *Bitis peringueyi* and *Bitis caudalis*. two South West African sidewinders.

Over part of its range, *P. garrulus* occupies the same habitat as the large ground gecko *Chondrodactylus angulifer*. In captivity, the latter animal will feed on a variety of insects, but seldom shows the same enthusiasm as when offered a whistling gecko. Even adult specimens would be grasped in the jaws, shaken vigorously and then swallowed whole. The dry river beds of the Kalahari National Park support large populations of both *Chondrodactylus* and *Ptenopus*. It is likely that here *Chondrodactylus* represents the main predator of *Ptenopus*.

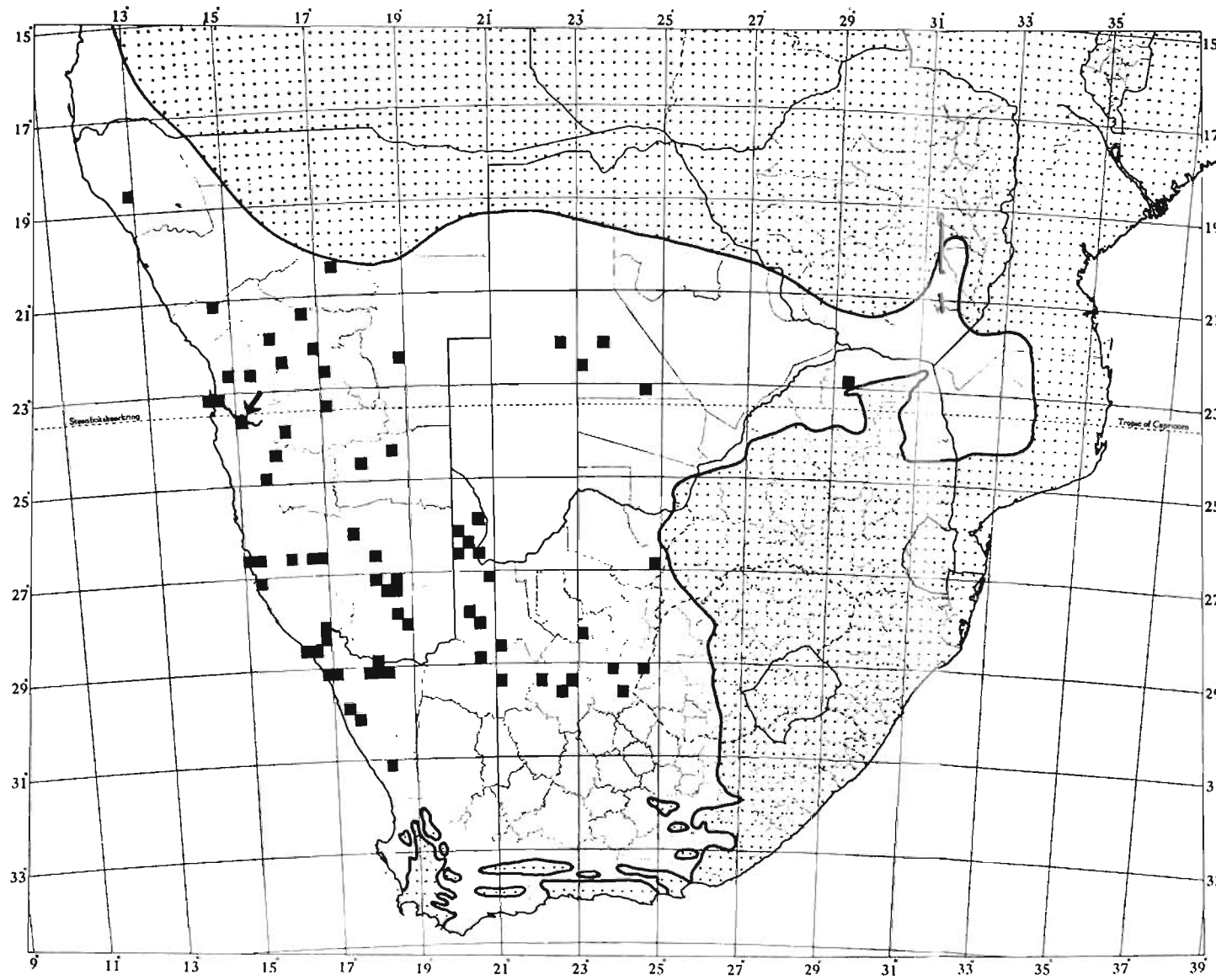


FIGURE 2

Map of Southern Africa showing the distribution of *P. garrulus*. The dotted area represents those parts of the country receiving more than 20 inches of rain per annum. The arrow indicates the location of Gobabeb, S.W.A., where *P. carpi* was found.

THREAT ATTITUDE :

When captured, some whistling geckos are pugnacious and assume a characteristic threat attitude, if confronted by the observer or by other geckos. The legs are straightened, raising the body high off the ground and the throat is expanded so that, in males, its yellow colouration becomes strikingly apparent. In extreme threat, the animal opens its mouth, hisses and snaps its jaws. The attitude appears the same in both *P. garrulus* and *P. carpi* (See Plate 1c).

ACTIVITY TEMPERATURES AND TOLERANCE :

During May 1959 body temperature measurements were made on 6 specimens of *P. garrulus* during normal nocturnal activity in the Namib Desert. The range of body temperatures was from 11.6 — 20.0 deg. C. (52.9 — 68.0 deg. F.) with a mean of 15.2 deg. C. (59.1 deg. F.). It was somewhat surprising to find the geckos moving actively on the surface with body temperatures as low as 11.6 deg. C.

In order to establish the temperature which could be tolerated by *P. garrulus*, six live specimens were collected at Gobabeb, S.W.A. and critical maximum determinations were done on them. Full details of procedure are described elsewhere but the critical maximum figures given here represent the body temperatures at which the first signs of heat-rigor were exhibited. Each gecko was then immediately cooled and recovered completely. The range of the six measurements was 43.6 — 45.5 deg. C. (110.5 — 113.9 deg. F.) with a mean of 44.2 deg. C. (111.6 deg. F.). As each gecko was being warmed up, its body temperature was also measured at the stage when panting started. The range of these temperatures was 35.0 — 39.7 deg. C. (95.0 — 103.5 deg. F.) with a mean of 37.4 deg. C. (99.3 deg. F.).

RANGE :

South West Africa, through Bechuanaland Protectorate, the sandy regions of the northwestern Transvaal and the Northern Cape Province. Recorded localities are plotted on a distribution map (Figure 2) and it will be seen that all fall within the area receiving less than 20 inches of rain per annum. Some of the localities receive only slightly less than 20 ins. p. a.; others in the coastal Namib Desert receive less than 2.

LOCALITIES :

A list of recorded localities follows. Initials after a locality refer to the institution housing the specimen, abbreviations being: AM : Albany Museum, Grahamstown; KM : McGregor Memorial Museum, Kimberley; MCZ : Museum of Comparative Zoology, Harvard; PEM : Port Elizabeth Museum; SAM : South African Museum, Cape Town; SMK, Senckenbergische Naturforschende Gesellschaft, Frankfurt a. M.; TM : Transvaal Museum, Pretoria.

*Bechuanaland Protectorate:*

Damara Pan, TM; Gomodimo Pan, TM; Kaotwe Pan, TM; Kuke Pan, TM; M.C.Z.; Ky-Ky, KM, TM, MCZ.

*Cape Province:*

Adendorp, Graaf Reinet Dist., PEM (very doubtful record); Aggenys, nr. Pofadder, TM; Askham, MCZ, TM; Auob, R., TM; Brandkaross, TM; Douglas AM; Goodhouse, SAM; Henkries, SAM; Jakhalswater-Vioolsdrift, SAM; Kakamas, SAM; Kamaggas, TM; Kimberley, MCZ; Kraaiwater, SAM; Kuboos, KM; Louisvale, AM; Lower Molopo, KM; Mata-Mata, TM; Naroep, SAM; Niekerkshoop, KM; Orangemund, TM; Port Nolloth, TM; Port Nolloth-Klipfontein, TM; Rietfontein, AM, MCZ; Sendelingsdrift, TM; Soebatsfontein, TM; Steinkopf-Ramansdrift, SAM; Swartmodder, SAM; Twee Rivieren, TM; Upington, SAM; Vaalpoort, Posmasburg, KM; Vryburg dist., TM; Witdraai-Middelputs, AM; Wolferton, SAM.

*South West Africa*

Abbabis Nauzerus, KM; Alt Wasserfal farm, TM; Aus, KM, SAM; Aus-Bethanie, TM; Berseba dist., Gt. Fish R. Valley, TM; Chous Mountains, SMK; Dassiefontein-Noakabib, TM; Goanikontes, Swakoptal, SMK; Gobabeb, TM; Great Karasberg, TM; Haalenberg, TM; Kalkfontein, SAM; Kanus, MCZ, TM; Karibib, TM; Keetmanshoop, AM, MCZ, SAM, TM; Klein Karasberg, TM; Lüderitzbucht, AM, MCZ, SMK, TM; Mariental, AM; Narudas Sud, Gt. Karas Mountains, SAM, TM; Noachabab, TM; Okahandja, SMK, TM; Omatoko R., AM; Otjitambi, Kaokoveld, SAM; Quickborn, Okahandja dist., TM; Rooibank, TM; Rossing, AM, TM; San Remo, Gobabis dist., SMK; Sesriem, 50 miles E. of Sossus Vlei, TM; Sossus Vlei, SMK; Walvis Bay, SMK; Waterberg, TM; Welwitchia Flache, Brandberg area, SMK.

*Transvaal:*

Great Saltpan, Waterpoort dist., MCZ, TM.

#### DISCUSSION ON THE PREVIOUSLY RECOGNISED SUBSPECIES GARRULUS AND MACULATUS:

FitzSimons (1943) states that *maculatus* is distinguishable from *garrulus* on "the more obtuse snout; dorsal and ventral scales distinctly larger and more flattened; gular scales, though small, are flattened and not granular". Loveridge (1947) pointed out that the snout profile is too variable for it to be of use as a subspecific character. There is no doubt that many of the specimens from South West Africa (*maculatus* group) do have proportionately larger scales, particularly the gulars. However, after an examination of a South West African series, Mertens (1954) concluded that the size of the dorsal and ventral scales varied so much as to allow many specimens to be placed in the nominate race. Personal observations bear out this conclusion; there appears to be a good deal of variation between individual populations and a great many South West African specimens do have proportionately larger scales, but no clear-cut distribution pattern emerges. Unfortunately, few localities have yielded series of specimens:

*Cimbebasia*

those which have are tabulated below. The specimens were divided into three classes according to the relative size of gular scales, small, medium and large. It was found that the scales of the throat region were easily compared between different specimens and gave a fair indication of scale size generally. Results are tabulated below:

Subspecies	Locality	Gular scaling			Total
		Small	Medium	Large	
<i>maculatus</i>	Gobabeb, S.W.A.	9	6	8	27
<i>maculatus</i>	Luderitzbucht, S.W.A.	2	3	3	8
<i>maculatus</i>	Nochaben, S.W.A.	—	1	4	5

Subspecies	Locality	Gular scaling			Total
		Small	Medium	Large	
<i>garrulus</i>	Askham, N. Cape	4	14	—	18
<i>garrulus</i>	Ky Ky, B. P.	8	1	—	9
<i>garrulus</i>	Central Kalahari	6	—	—	6
<i>garrulus</i>	Northern Transvaal	—	3	1	4

In conclusion, the differences which exist between South West African and other populations are not regarded as sufficiently consistent or adequate for subspecific separation.

**P T E N O P U S C A R P I sp. nov.**

**CARP'S WHISTLING GECKO.**

Named after Mr. Bernard Carp, leader and sponsor of the Carp-Transvaal Museum Namib Desert Expedition (on which the type specimens were collected) and numerous earlier expeditions to the arid regions of South Western Africa.

**H O L O T Y P E :**

Adult ♂, TM 25973, collected May 1959 on gravel plain approximately 1 mile north of the Kuisib R. at Gobabeb, Central Namib Desert, S.W.A.

**A L L O T Y P E :**

Adult ♀, TM 25971, same locality as holotype.

**P A R A T Y P E S :**

26 specimens, TM 25966 — 70, 25972, 25974 — 25979, 25981 — 86, 25990 — 93, 25995, 25997 — 8, 26207. 10 adults, 10 subadults and 6 juveniles, all from the same locality as the holotype.

All types in the Transvaal Museum, Pretoria.

## DESCRIPTION :

*Holotype*: Somewhat similar in build to *P. garrulus* but with more elongate limbs (see measurements below). Total length 96.5 mm (56.5 + 40.0 mm). Tail amounts to 70 % of snout-vent length.

Upper labials 10, lower 13; Nostrils open and surrounded by 2 nasals (Fig. 1 b). Larger nasal on each side separated above rostral by 2 granules. Pupil vertical, spectacle partly covered by well-developed extra-brillar fringes; ear opening a short oblique slit; rostral and mental entire. No distinct chin-shields present but gular scales, adjacent to mental, larger than those further back. Lepidosis generally of small granular to flattened scales, many bearing sensory pits. All digits strongly clawed, fringed laterally with spinose scales, those of toes much longer than of fingers (Plate 1 e).

Tail tapering, rather bluntly pointed, covered with regular plate-like scales; two pronounced swellings just posterior to vent containing hemipenes, A group of enlarged and pointed tubercles on either side of tailbase (3 large and several smaller per side). Peritoneal lining unpigmented and white; post-anal sacs present, femoral pores absent.

Colour in life, creamy white above, pure white below, finely speckled dorsally with orange-brown and marked with bold, brown transverse stripes. 3 on body, 7 on tail. Dorsal interorbital head surface blue-grey; poorly defined cross-banding on hind limbs and toes. Throat sulphur-yellow, iris pale buff, marked with darker irregular vertical lines (see Plate 1 b).

*Allotype*: Total length 105 mm. (58.5 -- 45.0); ratio tail snout-vent length 70 %. Upper labials 9, lower 13 and 11, larger number being on right side. Other features as in holotype except as follows: tail-base not swollen, with lateral tubercles small and only 2 per side. Throat pure white.

*Paratypes*: Points of difference from holotype as follows: Total lengths 57.6 — 103.5 mm. Mean proportion tail to snout-vent length 72.7 %, range 67.0 — 77.0 %. Upper labials 8 — 11, mean 10; lower labials 9 — 14, mean 12. Nostril surrounded by 2 nasals, only 1 specimen showing 3. Right and left nasals separated above rostral by 1 — 3 granules, most frequently 2. Colouration as in holotype, but tail-bars 7 — 9 in number.

## SEXUAL DIMORPHISM :

As in *P. garrulus*, tail-base tubercles are larger and more numerous in males than females. Throat yellow in adult males, white in females.

## VOCALITY :

No conclusive statement can yet be made on the call of *P. carpi*. During May, 1959 all the geckos at Gobabeb were silent and none of the captive specimens has called since. Dr. C. Koch (personal communication) states that on previous visits to Gobabeb in summer he repeatedly heard an unusual gecko-call in which 8 notes were repeated in quick succession in place of the normal 4—5 for *P. garrulus*.

## *Cimbebasia*

Further field investigation is necessary before the call can be definitely attributed to *P. carpi*.

### ACTIVITY TEMPERATURES AND TOLERANCES :

During May 1959, body-temperature measurements were taken on 16 specimens of *P. carpi* when they were discovered running over the surface of the gravel plain at night. The body temperature range was 10.2 — 19.0 deg. C (50.0 — 66.2 deg. F), mean 16.5 deg. C (61.7 deg. F). The geckos were still normally active with temperatures of 50 deg. F which seems unusually low. Temperatures were measured rectally with a fast-registering thermometer.

Critical maximum determinations were done on 6 recently captured specimens at Gobabeb, to determine the temperatures which could be tolerated. Measurements were taken at the onset of heat-rigor; each gecko was then rapidly cooled and recovered completely. The range of the 6 critical maxima was 42.0 — 43.5 deg. C. (107.6 — 110.3 deg. F), mean 42.7 deg. C (108.9 deg. F). As the geckos were warmed up, temperatures were also measured at the first signs of panting: range 31.0 — 38.2 deg. C (87.8 — 100.8 deg. F), mean 34.8 deg. C (94.6 deg. F). All these figures are appreciably lower than those for *P. garrulus* (see above).

### THREAT ATTITUDE :

As for *P. garrulus*, described above (Plate 1 c). At night, specimens of *P. carpi* were seen moving about normally on the surface of the gravel plain just north of Gobabeb. On being approached closely however, the geckos would invariably "freeze", sinking down onto the ground surface with a characteristic sideways shaking of the body, then lying motionless. They would then be efficiently camouflaged and extremely difficult to pick out.

### BURROW STRUCTURE :

An occupied burrow of *P. carpi* was found on the gravel plain just north of Gobabeb. The ground surface was covered with small white stones while below these was hard and solidly compacted silty sand containing occasional larger particles. The burrow entrance, about  $\frac{3}{4}$  inch high and 1 inch across faced south, leading down at a fairly steep angle in a left-hand spiral to a depth of 10 inches. The subadult male gecko was found at the end of the burrow which terminated approximately 11 inches to the left of the surface entrance. (In this respect the burrow differed in form from the typical one of *P. garrulus*, which usually terminates directly below its entrance). In the course of its downward spiral, the burrow gave off two short dead-end branches. The sand temperature at the end of the burrow was found to be 23.0 deg. C, while that of the ground surface was 25.5 deg. C. The ground was extremely hard and it is difficult to imagine how the gecko could have dug such an extensive burrow into it.

### HABITAT :

All 28 specimens were found on the white gravel plain. The Kuisib R. course forms a spectacular dividing line between the moving-dune country to the south

and the sand-free gravel areas to the north. *P. carpi* appears to be restricted entirely to the gravel area, while *P. garrulus* is common both in the river bed and among the dunes. In May the gravel plain was completely devoid of vegetation, except for a few small bushes at wide intervals. The geckos were consequently found on an exposed surface between occasional granite outcrops. After rain, it is likely that the countryside would be covered with low grass.

#### LOCALITY :

Gobabeb, Central Namib Desert, S.W.A. Is likely to be found further north as well, as the habitat continues unchanged for a great distance.

#### MAGNITUDE AND SIGNIFICANCE OF DIFFERENCES BETWEEN *P. GARRULUS* AND *P. CARPI* :

The morphological differences between the two species may be summarised as follows: in *P. carpi* the lower labials are more numerous, the limbs are longer, toe fringes are shorter, the nostril is fully open and the peritoneal lining is unpigmented.

*Magnitude:* Mayr, Linsley and Usinger (1953) have suggested the use of the Coefficient of Difference (CD) and the % Joint-non-overlap derived therefrom (% J.N.O.) in the comparing of subspecies. The use of these values in the present case is not intended to be diagnostic, but merely as a convenient means of indicating the magnitude of size-difference.

When the numbers of lower labials in 28 specimens of *P. carpi* (M : 11.5, SD : .8932, M :  $\pm 3$  :  $\pm 9$  — 14) from Gobabeb are compared with those of 22 specimens of *P. garrulus* from the same locality (M : 7.9, SD : .7705, M  $\pm 3$  :  $\pm 6$  — 10) the CD is 2.182. This implies a % J.N.O. of well over 96.

When the ratios of forelimb lengths to snout-vent lengths in *P. garrulus* (M : 24.5, SD : 2.937, N : 23) are compared with those in *P. carpi* (M : 29.8, SD : 2.119, N : 28) the CD is 1.048 which indicates a % J.N.O. of 85 — 86 %. When the same ratios are compared for hind limb lengths, the following results are obtained: *P. garrulus*: M : 29.6, SD : 2.305, N : 23. *P. carpi*: M : 37.6, SD : 2.226, N : 28. The CD is 1.765 which implies a % J.N.O. in excess of 96.

#### FUNCTIONAL SIGNIFICANCE :

Although no suggestion is made as to the functional significance of the more numerous labials in *P. carpi*, some of the other differences between the two species may be attributed to habitat. As was previously stated, *P. garrulus* is usually found on sand, while all specimens of *P. carpi* so far collected were living on gravel. When examined closely, the surface of the gravel plain at Gobabeb is found to be very uneven in comparison to that of a sand-flat, since many of the gravel particles are  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in diameter. There is little doubt that a long-legged gecko would have less difficulty in traversing the gravel surface than would a short-legged one. In *Ptenopus* populations there is a good deal of inherent



limb-length variation so that in the case of *P. carpi* selection may well have operated in favour of long-legged individuals.

The comparative absence of loose sand on the gravel plain is likewise taken to explain the shorter toe-fringes in *P. carpi* and the fully open nostril. The elongate fringes in *P. garrulus* are clearly important in preventing the animals from sinking into loose sand as well as when digging a burrow, while partial closure of the nostril prevents the entry of sand grains into the nose. Such modifications are not nearly as necessary for animals living on the gravel plains.

It has been pointed out that peritoneal pigmentation is present in *P. garrulus* but absent in *P. carpi*, and that the former species appears to have a slightly higher heat tolerance than does the latter. Functional significance of the pigmentation is obscure, particularly in view of the conclusion, drawn by Hunsacker and Johnson (1959) that such internal pigmentation does not serve as a protection against ultra-violet radiation.

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