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Threats facing southern Africa's unique scorpion fauna

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The southern African scorpion fauna is well studied and very speciose. The region contains 8 % of the world's genera and at least 10 % of the world's species—a high proportion when compared with similar values for larger temperate regions such as North Africa, with 12 % and 3 %, and Australo-Papua, with 5 % and 3 %. Southern African scorpion species richness values are also high in comparison with the values of tropical regions such as India, with 15 % and 9 %, and Venezuela, with 15 % and 6 %. Moreover, 38 % of the genera and at least 86 % of the species of southern African scorpions are endemic to the region.

Three southern African scorpion genera—*Hadogenes* (Ischnuridae), *Opisthophthalmus* (Scorpionidae) and *Parabuthus* (Buthidae)—are remarkable for several reasons. First, these genera dominate the southern African scorpion fauna, together comprising approximately 67 % of the described species, although this percentage will be far greater, based on forthcoming revisions of *Opisthophthalmus* and *Hadogenes*, in which additional species are to be recognised. Second, each is characterised by numerous morphological novelties, compared with related genera. For example, *Opisthophthalmus* and *Parabuthus* possess uniquely different stridulatory [sound-producing] organs on the chelicerae [jaws] and metasomal [tail] segments, respectively. *Hadogenes* exhibit the highest trichobothrial [sensory setae] counts of any known scorpion, and some species of *Opisthophthalmus* display the lowest pectinal [sensory organs unique to scorpions] tooth counts. Third, all three genera are characterised by a preponderance of unusually large species, although each genus also includes species of 'average' size. *Hadogenes* includes the world's longest scorpions, e.g. *H. troglodytes*, which reaches a length of 210 mm and a mass of 32 g. *Parabuthus* includes the world's largest buthid scorpions—*P. granulatus*, *P. schlechteri*, *P. transvaalicus* and *P. villosus*—which can reach a length of 140 mm and a mass of 14 g. Several species of *Opisthophthalmus* are also exceptionally large, e.g. *O. gigas* commonly reaches 160 mm in length. Finally, many species in these genera are characterised by exaggerated sexual dimorphism. Species of *Opisthophthalmus* often display marked dimorphism in the shape of pedipalp chelae [pincers] and the pectinal tooth counts, whereas many species of *Hadogenes* are characterised by marked dimorphism in metasomal length.

Unfortunately, this diversity is becoming increasingly threatened as habitat destruction continues unabated and new threats (e.g., harvesting for the exotic pet trade) arise. At least one southern African scorpion species appears to be extinct, while several others are critically endangered. The threats faced by many of these unique but extremely range-restricted scorpions makes the task of inventorying their diversity and distribution an urgent priority if steps towards their conservation are to be implemented without further delay.

What follows is a brief account of known threats facing the species of southern Africa's three most diverse scorpion genera, in the hope that this will stimulate public awareness and encourage conservation authorities to implement steps towards their conservation. Ongoing research by the author into the phylogeny, taxonomy, distribution and conservation status of southern African scorpions—in which IUCN Red List criteria are being assigned to species on the basis of the number of known locality records, extent of the distributional range, occurrence inside and outside of protected areas, and prevailing land uses that might be construed as threats to their future survival—should also assist in the formulation of a conservation strategy for these unique arthropods.

Hadogenes (Flat Rock Scorpions)

Approximately 20 species of *Hadogenes* are currently recognised. These remarkable, extremely dorsoventrally compressed scorpions inhabit the narrow cracks, crevices and exfoliations of weathered rock outcrops from South Africa to Tanzania. All species are restricted to regions of rugged, mountainous topography and readily subject to allopatric speciation when mountain ranges become separated through erosion. Consequently, most species are associated with specific geological formations or mountain ranges and are highly range restricted.

As with other southern African scorpions, species of *Hadogenes* are faced with two main threats: habitat destruction and collection for the international trade in exotic pets. *Hadogenes* species are especially vulnerable to the former because they commonly occur on granitic inselbergs, which are quarried in many parts of South Africa to provide gravestones, chipstone and other materials requiring fine-grained igneous rock. For example, the habitats of the range-restricted species *H. gracilis* (North West Province of South Africa) and *H. newlandsi* (Northern Province of South Africa) have been extensively quarried. The quarry industry results in complete annihilation of *Hadogenes* habitat. Mining for heavy metals poses a similar threat to *Hadogenes* habitat in other areas, especially Namibia and the Northern Cape Province of South Africa. Fortunately, species inhabiting sedimentary geology are less vulnerable to these land uses, but may still be eradicated by urbanisation, as is the case with *H. gunningi*, a threatened species that inhabits sandstones and quartzites in the highly urbanised Gauteng Province of South Africa (including the cities of Johannesburg and Pretoria). As the demand for expensive houses and apartment complexes with a view over the city continues, fewer and fewer quartzite ridges of the once labyrinthine Witwatersrand system remain connected, and existing populations of *H. gunningi* become increasingly fragmented.

Hadogenes species that occur at higher altitudes, principally along the eastern escarpment of South Africa face the additional threat of habitat destruction through afforestation, a land-use practice that is not conducted in the regions of lower rainfall occupied by savannicolous species. Afforestation, especially with conifers, alters the vegetation composition (and hence also the chemical composition of the substratum) sufficiently to lead to the eradication of *Hadogenes*. The related ischnurid genus, *Opisthacanthus*, which inhabits montane regions, temperate and subtropical forests along the mesic eastern coast of southern Africa, is similarly affected by afforestation.

In addition to habitat destruction, *Hadogenes* scorpions are extremely vulnerable to overharvesting for the international pet trade. They are much sought after as exotic pets because of their large size, unusual, flattened appearance, generally docile temperament and mild venom. However, their specialized ecological requirements make them poor candidates for prolonged survival under captive conditions. Whereas these scorpions may live for more than 30 years in the wild, captive specimens seldom survive more than a few years, even when apparently healthy. Moreover, unlike other common pet scorpion species, e.g. *Pandinus imperator* (Scorpionidae), *Hadogenes* are notoriously difficult to breed in captivity, with the result that wild populations are placed under continued pressure from harvesting. Wild populations are expected to be slow to repopulate after harvesting for the following reasons. Females have gestation periods of up to 18 months and produce small broods ($0 = 20$) compared with other scorpions. Young are relatively altricial, spending several months on their mother's terga [back] before their first ecdysis [moult] and subsequent departure, thereby further protracting the period before a female can give birth to her next brood. Age to sexual maturity is 8–10 years in these scorpions, during which period juveniles must run the gauntlet of natural predation (including cannibalism).

Presently, the most commonly imported pet trade species appears to be *H. troglodytes*, usually mistakenly sold under the name *H. bicolor*. However, other southern African species (e.g. *H. granulatus*) and an unidentified species from Tanzania (possibly *H. paucidens*) are also offered. Traders have been unwilling to divulge their sources of southern African material, but wild-caught specimens are suspected to have originated in Mozambique, Zimbabwe and the Northern Province of South Africa.

Opisththalmus (Southern African Burrowing Scorpions)

All of the nearly 80 species of *Opisththalmus*, distributed from the Cape Peninsula of South Africa to Mount Kilimanjaro in Tanzania, are obligate burrowers, excavating burrows under stones or in

open ground. Burrows vary from shallow scrapes to elaborate, spiralling tunnels reaching depths of more than 1 m below the surface, depending on the species. Each species constructs burrows in substrata of specific hardness and composition, varying from unconsolidated sand dunes to compacted clayey soils, depending on the species. Most species in the genus are therefore narrowly endemic to particular geological formations, and their distributional ranges may be extremely restricted as result.

Habitat destruction through agriculture (ploughing), afforestation and urbanisation poses the greatest threat to species of *Opisthophthalmus*, most of which are ecologically specialized (thus only occurring in pristine habitat), and range restricted. As part of an ongoing taxonomic revision of the genus, the conservation status of each species was recently evaluated by means of a GIS analysis using available spatial data sets of existing protected areas and land uses, supplemented with “ground-truthed” field data collected during the course of the investigation. Two indices of conservation status (percentage of locality records vs. percentage area of the distributional range occurring on “intact” land, inside and outside of protected areas) were used to assign IUCN Red List Categories to each species, and recommendations for their conservation provided, where necessary.

“Hotspot” analyses revealed that most foci of *Opisthophthalmus* species richness and endemism in Namibia and South Africa fall outside the boundaries of existing protected areas. At least one (presently undescribed) species of *Opisthophthalmus* from the Citrusdal end of the Olifants River Valley (Western Cape Province of South Africa) appears to be extinct. Several others, notably *O. chaperi*, *O. fossor*, *O. fuscipes*, *O. intermedius* and another undescribed species, all of which are endemic to the Western Cape Province of South Africa, are critically endangered. *Opisthophthalmus fossor*, *O. fuscipes* and the undescribed species inhabit the renosterveld vegetation type, which has largely been eradicated, whereas *O. chaperi* and *O. intermedius* inhabit succulent Karoo in the Breede River Valley. *Opisthophthalmus intermedius* is the most severely threatened of all. Only a single population, inhabiting an area of less than 10 km² in an isolated valley near Worcester, still exists. Outside of the Western Cape Province, other species, e.g. *O. pugnax*, the known range of which falls mostly within the highly urbanised Gauteng Province of South Africa, are also endangered. It is hoped that, working in consultation with the relevant provincial conservation agencies, a strategy can be developed for the protection of these unique species before they also become extinct.

The international trade in exotic pets poses a small, but ever-increasing threat to the future survival of *Opisthophthalmus* species, given their increasing popularity as pets on the one hand, and their extremely restricted distributional ranges, together with the continued destruction of their habitat, on the other. Two species, *O. glabrifrons* (the “Yellow-legged burrowing” or “Shiny burrowing” scorpion) and *O. wahlbergii* (“Wahlberg’s Tri-colored scorpion”), allegedly imported from Mozambique, are commonly available in Europe, the U.S.A. and Japan. Given that the distributional range of *O. wahlbergii* does not extend to Mozambique, and that the form offered occurs only in eastern Botswana, southern Zimbabwe and the Northern Province of South Africa, these scorpions are probably illegally collected and exported from one of the latter countries. A third species, *O. boehmi*, which has been advertised as the “Tri-coloured scorpion” in the U.S.A. and as the “Kilimanjaro mustard scorpion” in Japan, is occasionally imported from Tanzania and perhaps Kenya, although its occurrence in the latter country remains unconfirmed. More often, female specimens of *Pandinus cavimanus*, which also occurs in Kenya and Tanzania, are mistakenly advertised as *O. boehmi*. Specimens of the southern population of *O. boehmi*, which occurs in western Mozambique, southern Zimbabwe and the Northern Province of South Africa have also appeared occasionally in the pet trade.

The increasing appearance of such species and others, e.g., *O. carinatus* (pictures of an endemic Namibian colour form of which were recently posted on a prominent website for scorpion enthusiasts), in international collections is a matter of concern, given the frequency with which invertebrates are being smuggled illegally, along with insects and reptiles, out of southern African countries. The presence in the international pet trade of scorpions that originated from South Africa has always been difficult to verify given the fact that the distributional ranges of most species traded (including *Opisthophthalmus*) extend beyond South African borders, and dealers usually cite

neighbouring states with relaxed collecting and export regulations (e.g., Mozambique) as sources. However, a recent article in a Czech aquarium magazine on captive husbandry of the endemic South African *O. latimanus*, provides conclusive evidence that scorpions have been collected and exported (illegally) from South Africa. As with other most other scorpions imported for the pet trade, species of *Opisthophthalmus* are not CITES-listed and there is little or no regulation on their harvesting from the wild, a situation that is clearly inadequate for safe-guarding their future survival. Wild populations are vulnerable to overharvesting due to their long gestation period (at least 7 mo), small brood sizes (30–35), age to sexual maturity (4–7 yr) and parental care. The extremely restricted ranges of many species are further cause for concern.

***Parabuthus* (Burrowing Thick-tail Scorpions)**

Approximately 30 species of *Parabuthus*, 20 of which are endemic to the arid regions of southern Africa, are currently recognised. The remaining species are endemic to the arid regions of northeastern Africa and the Arabian Peninsula. All members of the genus are characterized by the ability to burrow (using the thickened metasoma, rather than the chelicerae as in *Opisthophthalmus*), and are highly venomous. Envenomation by some *Parabuthus*, e.g. *P. granulatus* and *P. transvaalicus*, is potentially lethal.

Due to their occurrence in predominantly arid areas, with low agricultural potential, *Parabuthus* species are largely unthreatened by habitat destruction. However, the international pet trade threatens several species, which have recently become extremely popular among amateur enthusiasts, remarkably because they are large, highly venomous and notoriously aggressive! Two southern African species, *P. mossambicensis* (the “Mozambique fat-tailed” scorpion, often mistakenly advertised as *P. capensis*) and *P. transvaalicus* (the “S.A. giant fat-tailed” scorpion), allegedly imported from Mozambique, are commonly available in Europe, the U.S.A. and Japan, while specimens of *P. granulatus* and *P. villosus* (pictures of which have been posted on the internet) were probably also acquired from the pet trade. Three *Parabuthus* species from east Africa (*P. heterurus*, *P. leiosoma* and *P. pallidus*) are also offered periodically. As with most other scorpions imported into the pet trade, species of *Parabuthus* are not CITES-listed and there is little or no regulation on their harvesting from the wild.