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Rotifers of the genus *Proales* from saline springs in the Namib desert, with the description of a new species

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Abstract

The occurrence of *Proales* rotifers in saline springs in the Namib desert, Namibia, is documented. The salinity tolerated by *P. similis similis* is shown to be 98‰ or almost three times the concentration of sea water. *P. namibiensis*, a new species from a saline spring supporting a colony of foraminifera, is described and figured.

Introduction

In the central Namib desert of Namibia there occur several saline or hypersaline springs, mostly within 100 km of the coast from Cape Frio (18° 15′ S/11° 56′ E) in the north to Gobabeb (23° 34′ S/15° 03′ E) in the south. The waters of these springs are often extremely salty, with total dissolved solids exceeding 200 gl^{-1} (Day & Seely, 1988).

Rotifers of the genus *Proales* have recently been found to occur in three such springs in the vicinity of Gobabeb, the research station where the Desert Ecological Research Unit of Namibia is housed. *P. similis* has been found at Hosabes and Foram springs, while a new species *P. namibiensis* occurs at Ubib spring (Fig. 1).

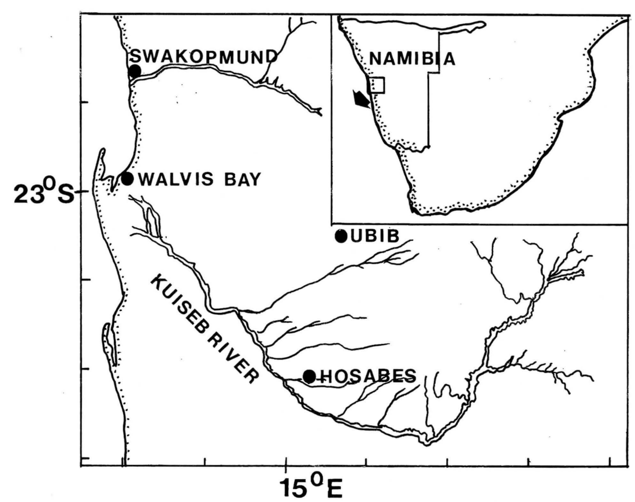

Fig. 1. Map showing the positions of Hosabes and Ubib springs in the Namib desert.

Proales similis at Hosabes spring

The presence of *P. similis similis* in the hypersaline Hosabes spring, and its distribution within the water body, make it possible to assess the salinity tolerance of this species. The physical and chemical conditions in this spring have been investigated in detail (Day & Seely, 1988).

Hosabes spring lies in the bed of the Sout River, 5 km north of Gobabeb (Fig. 2). The environment is extremely arid, with a mean annual rain-

Fig. 2. A general view of the Hosabes spring looking upstream. The shallow water flows over a crust of gypsum and salt.

fall of less than 30 mm per year, a maximum summer temperature of about 43 °C and mean pan evaporation of 3168 mm per year. The valley bedrock consists of mica schist of the Damara sequence and, at the spring, the valley is about 35 m wide, with a floor consisting of 'puffy ground' – a thin, 5–10 mm, dry crust of sand and gypsum raised 50–300 mm above the moist clayey sediment below. The flowing part of the stream extends longitudinally for up to 100 m and forms a braided channel, 0.5–3 m wide, interspersed with slower-flowing pools, the largest with a surface area of 5–6 m^2 and a depth of up to 260 mm. The stream has been seen to change its course from time to time.

The edges and parts of the bottom of the stream are encrusted with salt, largely NaCl, in which unicellular green algae are embedded. The bottom of the deeper pool is covered with a microbial mat up to 120 mm deep, and the water is extremely clear and green-tinged. Daily evaporation varied from 5.0–8.2 mm through the year, with an average of 6.2 mm, which gives a mean annual evaporation from the spring surface of 2287 mm. The flow rate from the stream varied from 0.012–0.023 m s^{-1}, and the spring discharge varied from 0.22–0.75 l s^{-1}. The length of the stream was invariably greater at night than during the day and varied by about 30% from 92–65 m.

Temperatures in the pools showed an inverted pattern, the surface layers being considerably cooler than those near the bottom, with a day temperature of 50 °C being recorded at a water depth of 178 mm. Although the crust surrounding the pools is largely gypsous, the spring water is dominated by NaCl as a result of precipitation of $CaSO_4$ in the highly concentrated water.

As shown in Fig. 3, *Proales similis* occurs in the upper reaches of the stream for a maximum distance of 20 m from the source. In December 1990 the spring water emerged at a salinity of 48‰ and a conductivity of 86.4 mS, but rapidly became

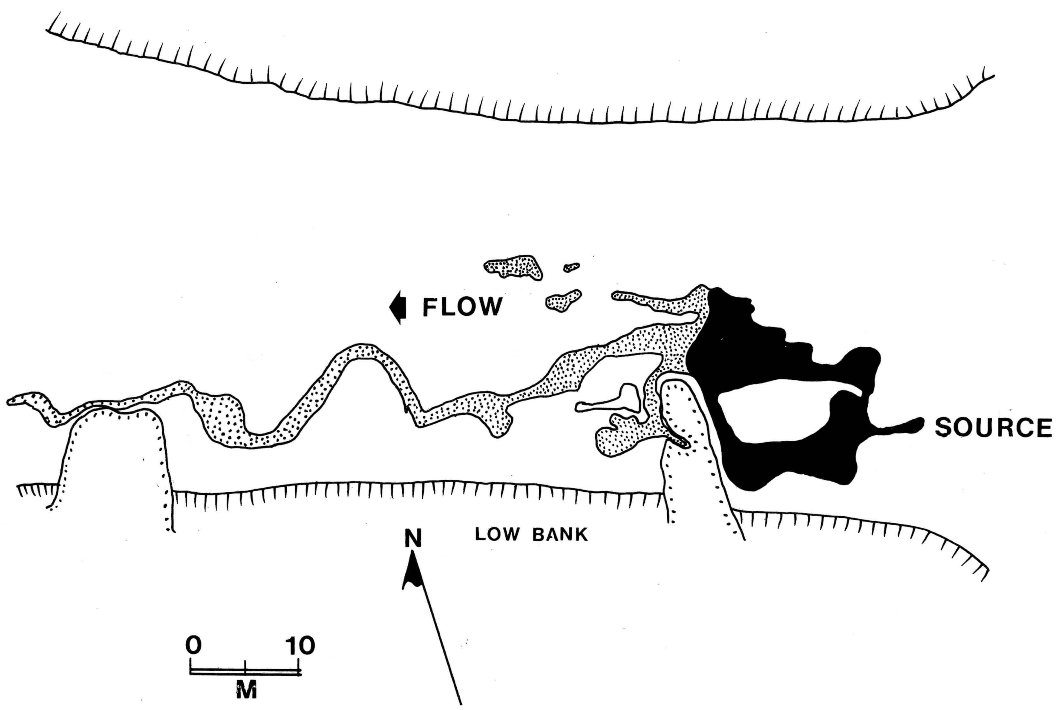

Fig. 3. A plan of the Hosabes spring, with the distribution area of *Proales similis* shaded black.

more concentrated downstream. The rotifer's distribution appears to end where the water reached a salinity of 98‰ and a conductivity of 163.0 mS. The pH of these waters varied from 7.4–8.3.

Proales namibiensis at Ubib spring

Proales namibiensis Koste & Brain 1991
Figures: 4 a, b and 5 c–h.

Material: 12 females preserved in 4% formalin after being relaxed with 2% Lignocaine.

Holotype: One adult loricated female collected 9.12.85 by C. Brain and V. Watson. Preserved slide No LIV 1, Transvaal Museum, Pretoria.

Paratypes: 3 preserved slides in the Koste Collection, Senckenberg Museum, Frankfurt/M., West Germany, Reg. No SMF GP Rot 7263–7265.

Type locality: Ubib spring, central Namib Desert, Namibia, (23° 06′ S/15° 10′ E).

Description. The body has its greatest width in the middle and is arched dorsally (Fig. 4b). The head is long, broad and truncate anteriorly. It is separated by a well-defined double fold immediately behind the mastax. The foot is two-jointed, with the basal joint lying under the almost sickle-shaped projection of the caudal dorsal plate of the lorica. The terminal, short foot joint is trapezoidal from all aspects. The toes are moderately curved towards the ventral side and relatively long. Each has a bulbous enlargement near the posterior end and terminates in a long slender, acutely pointed claw. The integument is rigid. In dorsal view there is a triangular plate with a short keel in front of a caudal depression of the lorica (Fig. 4a). In lateral view there are furrows on each side between cuticular plates (figs. 4b, 5c). The oblique corona is without projecting lips. The mastax is spherical.

The trophi (Fig. 5d) have a structure related to the malleate type. The fulcrum (Fig. 5g) is short. The rami are roughly triangular (Fig. 5h); two acutely pointed alulae are present (Fig. 5d) with no visible denticulation on their inner edges. Each uncus has four teeth (Fig. 5h). The manubria are

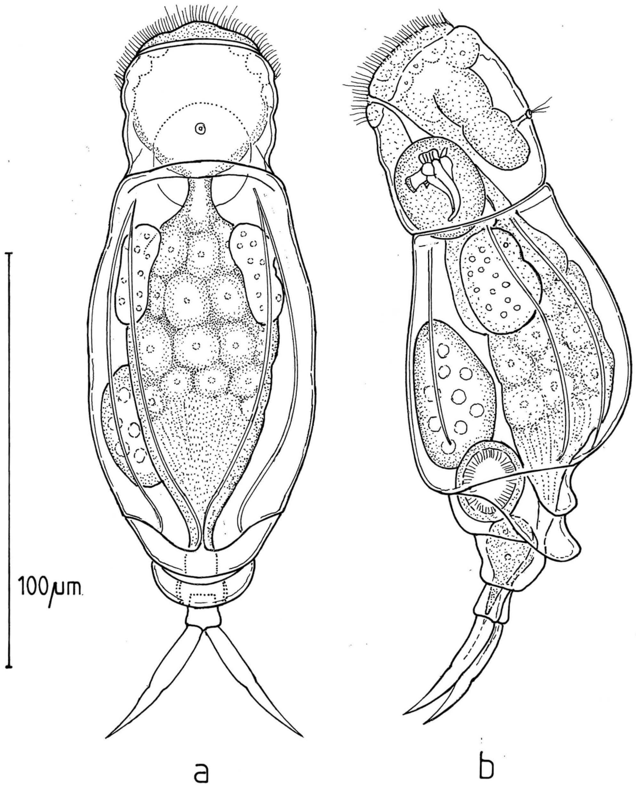

Fig. 4. Proales namibiensis Koste and Brain 1991 from Ubib spring. a: female, dorsal; b: lateral. Drawing by W. Koste.

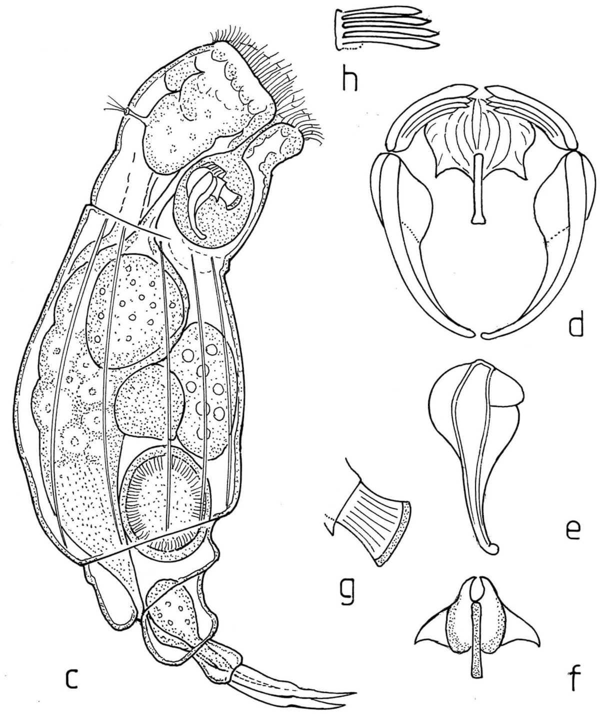

Fig. 5. Proales namibiensis Koste and Brain 1991. c: female; d: trophi, ventral; e: manubrium; f: uncus from below; g: fulcrum, lateral; h: left uncus. Drawing by W. Koste.

broad and each has three lamellar cells (Fig. 5e) with the largest of these at the inner edge and terminal end of the ramus.

The oesophagus (Fig. 5c) is moderately long. The large gastric glands are almost dumbell-shaped in dorsal view (Fig. 5a), but in lateral view are mostly triangular and compressed (Fig. 5c). There is a faint division (Fig. 4a) between the cellular stomach and the intestine. The vitellarium is normal for the genus, and the circular bladder is variable in size. The foot glands are balloon-shaped, and there is a small reservoir (Figs. 4b, 5c) in the terminal foot joint. The ganglion is saccate. From the middle of the dorsal caudal part a nerve fibre runs to the papilla of the dorsal antenna. No retrocerebral sac is visible, nor could a lateral antenna be observed. An eye-spot, present in the living animals, seems to have been bleached out by the formalin.

Measurements. Total length 125–144 µm, toes 33–36 µm, fulcrum 8 µm, greatest ramus width 12 µm, terminal foot joint 20 µm.

Ecology. Ubib spring is a small, permanent water source in a broad gypsous valley, similar in many respects to Hosabes spring. After emergence, the water flows for 30–50 m in a westerly direction with a depth of 3–21 mm. The edges of the stream are encrusted with salt and gypsum (Fig. 6), and the bottom is covered with gelatinous yellow algae in which there is a thriving colony of foraminiferans and cladocerans. The salinity of the water is typically 30‰, the conductivity is 38.6 mS and the pH 8.1. There is surprisingly little variation in these parameters along the 30 m length of the stream. Typical summer day temperatures in the water are 25–30 °C, but these decline to 10 °C on winter nights. As foraminiferans are apparently unable to resist desiccation, the spring is presumably permanent. The rotifers appear to have a fairly even distribution along the length of the stream.

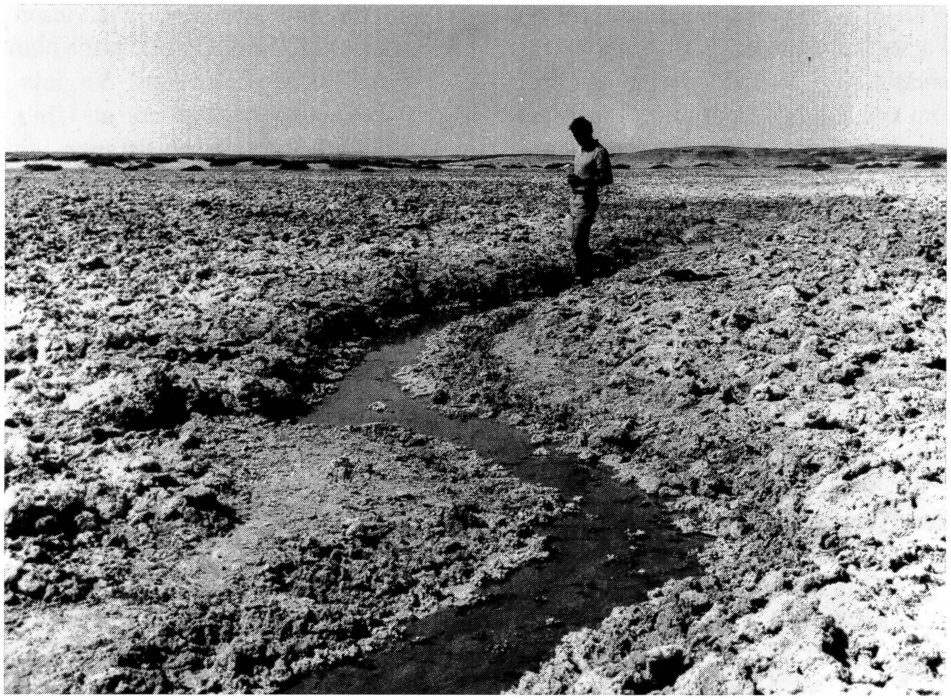

Fig. 6. A view of the Ubib spring with the shallow water flowing over a crust of gypsum and salt.

Discussion. The new species belongs to the alkalophilic group in the genus *Proales* Gosse 1886. This taxon clearly needs revision as it is a collective genus, a 'Sammelgattung', uniting vermiform, spindle-shaped and spherical forms which are characterized by a mastax resembling the mal-

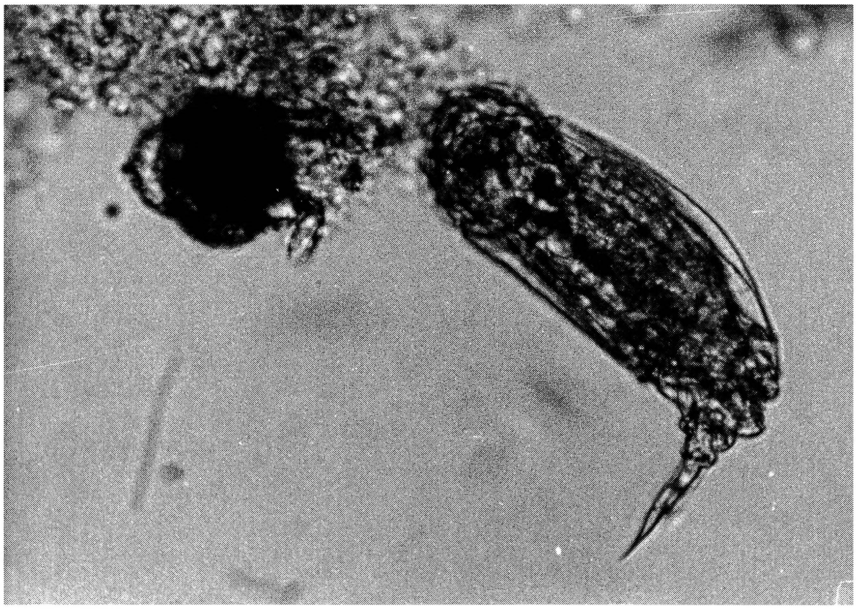

Fig. 7. A live specimen of *Proales namibiensis*, with a foraminferan also visible.

leate type. With one previous exception, all the species have a soft integument. Only one species *Proales commutata* Althaus 1957, which has been described from the mesopsammon of the Black Sea in southeastern Europe, has short cuticular plates on the caudal part of its body (see Koste, 1978: 274; pl. 89: 8a–e). In contrast to this species, the new *Proales* has a loricated body with cuticular plates, while the form of the toes is unique in the genus. The anatomy, especially of the trophi, the digestive system and other internal organs, is typical of *Proales*. When contracted, *P. namibiensis* looks superficially similar to a *Lecane*, but representatives of the genera may be distinguished by the fact that the foot segments in *Proales* are freely movable; in *Lecane*, the first foot segment is united with the caudal ventral plate. Concerning the trophi, the *Proales* fulcrum is short and board-shaped, while in *Lecane* it is comparatively long.

Etymology. The species name *namibiensis* is derived from the name 'Namib', the desert where the spring occurs.

Acknowledgements

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