

9.4 A ROTIFER-EATING AMERONOTHROID (ACARI: AMERONOTHRIDAE) MITE FROM EPHEMERAL POOLS ON THE COLORADO PLATEAU

Roy A. Norton¹, Tim B. Graham², and Gerd Alberti³

¹SUNY College of Environmental Science and Forestry, Syracuse, NY 13210; ²National Biological Survey, Cooperative Park Studies Unit, University of California, Davis, CA 95616; ³Zoologisches Institut, Universität Heidelberg, D-69120 Heidelberg, Germany.

Ephemeral freshwater pools support a variety of invertebrates that endure extended inactive periods under desiccating conditions. Perhaps best known are the anhydrobiotic rotifers, tardigrades and branchiopod crustaceans that survive severe water loss, but two oribatid mite species are known to be associated with such pools. *Aquanothrus montanus* inhabits vegetated pools on sandstone at 1,700-2,000 m in mountains of Orange Free State in South Africa (Engelbrecht 1975). *Chudalupia meridionalis* inhabits pools on granite near a mountain summit in southwestern Australia (Wallwork 1981, Bayly 1982). Both are members of the Ameronothridae (*sensu* Weigmann and Schulte 1977), an ecologically interesting group mostly associated with intertidal marine or polar terrestrial habitats (Schulte and Weigmann 1977). Herein we discuss a third species (Figs. 1-5, description in preparation) that could be included in a broadened concept of *Aquanothrus*, and we report preliminary observations on its biology and adaptive morphology.

MATERIALS AND METHODS

We observed behavior in the field and laboratory and studied gut contents of dissected specimens. Mites and sediment were kept in a variety of small jars and Petri dishes and rainfall was simulated with dechlorinated tap water. Electron microscopy procedures were described by Alberti and Fernandez (1990).

RESULTS AND DISCUSSION

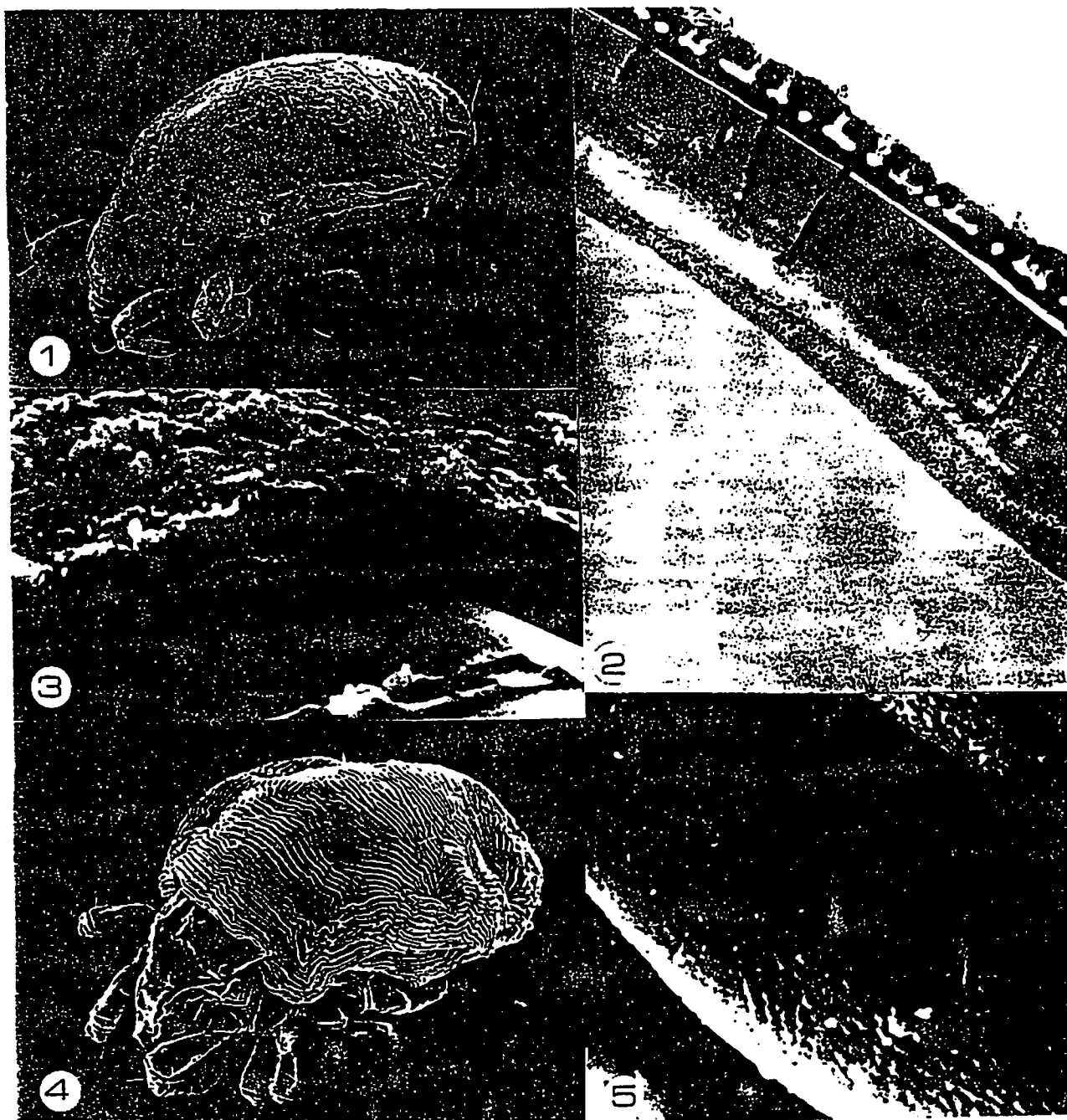
Distribution and habitat

The new mite is known only from a small area of the Colorado Plateau encompassing southeastern Utah (Emery, Grand, Wayne, Garfield and San Juan Counties) and extreme western Colorado (Mesa Co.). We examined seemingly appropriate habitat on the Plateau in adjacent counties and states without finding the mite. It inhabits very shallow weathering depressions ("pans") on barren sandstone that collect and hold precipitation for hours to several days, depending on weather. Most collections have been from Navajo formation sandstone of

Jurassic age, elevations 1125-2100 m. The area is desert, with mean annual precipitation of 23 cm and monthly averages from about 1 cm (February) to 3 cm (October) (Ashcroft *et al.* 1992). The average frost-free period is from mid-April to mid-October, though freezing can occur from mid-September to mid-May. Pans inhabited by mites are typically 2-5 cm deep, less than a meter in diameter, and contain fine sandy sediment. Mites were not found in the deeper, longer-lived rock pools that are commonly inhabited by branchiopod crustaceans.

Activity and feeding

When pans have standing water, mites can be seen moving on the sediment surface, pushing aside sand grains in what appear to be digging or exploratory motions. Their small mass and weak grasping ability make them appear very clumsy, and often they overturn, righting themselves with difficulty. Eddies due to wind can cause mites to roll uncontrollably in the water. Like many other Oribatidae they are opportunistic feeders; fungal spores, hyphae and algal fragments were found among the gut contents: though they were not dominant in any specimen examined. Much of the material is fragmented brown organic matter of unknown origin. They also ingest conspicuous orange bdelloid rotifers that inhabit the pans, as evidenced by the very frequent occurrence of the mastax (grinding organ) of rotifers in mite gut contents (boli may be wholly composed of these) and the accumulation of orange pigment in the mites' tissues. The color is especially apparent in translucent, teneral adults. The contents of all observed mite eggs were also bright orange, a color not previously reported for eggs of Oribatidae. Feeding was not observed, but considering the clumsy behavior of the mites and the rapid swimming of disturbed rotifers, it seems unlikely that healthy rotifers are captured on the sand surface. The rotifers penetrate deeply into the sediment, and during their awkward burrowing the mites may encounter them in more constrained environments. Mites may eat only dead, dying or otherwise immobile rotifers, but anecdotal observations suggest otherwise. Small jars left for several days with mites and sediment in standing water no longer have active rotifers. Whether this directly results from mite predation is unknown, but Rockett and Woodring (1966) showed that selective feeding by orib-



Figs. 1-5. Undescribed ameronothrid mite, near *Aquanotirus*, from ephemeral pools in southern Utah. 1. Adult, dorsolateral aspect, SEM. 2. Section of notogastral cuticle, TEM (note chambered cerotegument layer to upper right). 3. Fractured edge of cerotegument exposing underlying procuticle, SEM. 4. Nymph, dorsolateral aspect, SEM. 5. Same, enlargement of hysterosomal plications, showing openings to cerotegument air-chambers.

atid mites can deplete a supply of nematodes in culture tubes in a short time. Also, the rotifers can be so abundant that they form conspicuous orange patches on the sediment, but does not seem to happen in pans with mites present.

Dry periods

In the laboratory mites burrow into the sediment as standing water evaporates. As drying progresses, a precipitate firmly cements the sandy sediment, entombing the mites. This alone would prevent activity, but specimens gently dug from the sediment usually remain immobile even when prodded. When such individuals are immersed in water they immediately become active if the dry period was only a few days. If the dry period was more extended, they revive in 10-20 seconds, with initial activity restricted to slow flexing of the legs. When dry sediment is wetted, the cement dissolves quickly but several minutes may pass before all living mites are released and active.

Mortality occurs when dry periods are extended. Samples kept air-dry for several months have many shrunk, obviously dehydrated specimens that never revive, although in two instances a few adult mites have revived from samples kept dry for one year. Slightly shrunk mites sometimes also revive, suggesting that they can withstand slight desiccation. At least two aspects of cuticular morphology apparently aid in resisting desiccation. The exposed cuticle is thin and flexible, even in mature adults, yet it is unusually tight, almost homogeneous, with hardly discernable lamination and few, thin pore canals (Fig. 2). The thin, continuous cerotegument that completely ensheaths the cuticle is complex, with air-filled chambers open to the surface (Figs 2, 3, 5). Its structure probably is responsible for iridescence that characterizes both adults and immatures, and it likely is associated with plastron respiration (see Pugh *et al.* 1987). The legs have a rare cuticular adaptation; each has a fine, long trachea that opens through a femoral stigma and passes distally into the tarsus, as well as a shorter trachea contained in trochanters III and IV. Tracheae may reduce water loss that would otherwise occur across the normal respiratory porose areas of oribatid mite legs, but they may also increase respiratory efficiency during active, immersed periods.

Comparisons with other species

Several parallels exist between this species and the two other ameronothrids noted earlier, in addition to their

ephemeral rock pool microhabitat. Geographic and habitat distributions suggest that each is a relictual species, living only at modest elevation on plateaus in semi-arid or arid regions. Both South African and Utah mites are found on exposed cross-bedded sandstones of Triassic-Jurassic age. These three aquatic species are the only ameronothrid mites known to have a lenticulus, a secondary light receptive organ at least superficially similar to that in the common aquatic family Hydrozetidae (Alberti and Fernandez 1990). Based on the study of paratypes, *Aquanothrus montanus* has leg tracheae similar to those of the new species. *Chudalupia meridionalis* does not; it retains the usual pattern of porose areas on the four femora and trochanters III and IV.

Unlike those of most ephemeral pool invertebrates, generation times of oribatid mites are generally quite long. Even in moist soil microhabitats a generation may last a year or longer in temperate regions and up to four years or more in colder climates (Norton 1994). These species might be at the higher end of this range (or even exceed it) due to long periods of inactivity. Alternatively, a diet rich in rotifers or other small animals, combined with high summer temperatures, may counter this to some degree.

SUMMARY

An undescribed ameronothroid oribatid mite inhabits shallow weathering depressions on bare sandstone on the Colorado Plateau southeastern Utah, USA. It is active only when the depressions contain rainwater and its broad diet includes orange bdelloid rotifers. Leg tracheae and an unusual cuticle seem to be adaptations that retard desiccation during dry periods. The mite's closest known relative inhabits larger ephemeral pools in mountainous areas of South Africa.

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