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Research Program: Biological ground water survey of the Sultanate of Oman

List of sampling stations March-April 1996

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Introduction

The Sultanate of Oman is an arid country, forming the south-eastern margin of the Arabian peninsula, with coast lines on the Gulf of Oman in the north-east and the Arabian Sea in the south-east. In the interior, it is bordered on the Emirates in the north-west, Saudi-Arabia in the west, and Yemen in the south-east.

Although today large parts of the Sultanate are formed by hot desert, this has not always been the case in its geological history. The occurrence of huge karst caves shows that precipitation must have been much higher in the past. On the other hand, ancient glacial deposits show that it lay closer to the South Pole some 600 million years (My) and again 300 My ago.

Discovery of fossils of tropical, marine origin high in the mountains, as well as coal deposits (45 My) form proof of tropical phases in Oman's past (Hanna, 1995).

Once, Oman formed part of the vast Tethys Sea, which lasted for more than 500 million years from the Lower Cambrian to the Tertiary (Late Miocene) (Ekman, 1935). The Tethys Sea extended world-wide along the equator as a continuous tropical ocean, hosting the world's richest biota. The present Gulf of Oman is one of its remnants that remained after the break-up and closure of the Tethys Sea.

Oman has submitted several vertical movements, both regressions and transgressions. Of course, ground water can not exist when the land is flooded by sea water (transgression). For the purpose of our present ground water studies, it is important that the dry land (mountains) of Oman were formed some 25 My ago (Oligocene-Miocene boundary), but the uplift (regression) has continued until present time. These rocks consist of shallow marine limestones (Hanna, 1995). Suitable biotopes for ground water organisms are accordingly available in Oman since that period, coinciding with the latest period of existence and start of the closure of the Tethys Sea.

Apparently, during the construction of dry land, Oman's climate has been much wetter than to-day, resulting in limestone dissolution testified by numerous caves, springs, and fossil subterranean water reservoirs. At the same time, the positive movements of the land with regard to the sea (regression) caused "stranding" of pre-adapted marine organisms living in shallow coastal waters at the boundary of the Arabian peninsula, followed by radiation of these marine ancestors into the brackish near-coastal ground water and finally into the fresh ground water. For this model of evolutionary adaptation to the ground water, the term Regression Model was coined (Stock, 1977, 1980). The model proved valid repeatedly, especially for the Tethys region (e.g., Boutin & Coineau, 1990; Notenboom, 1991; Boutin, 1994).

The Research Program

Oman fulfils all necessary requirements for successful study of the origin and evolution of the ground water biota according the Regression Model: tectonic uplift, causing stranding of marine ancestors, availability of such ancestors during the last phase of the Tethys Sea, suitable calcareous substrates. The research initiative was patronised by the Research Department of the Ministry of Water Resources (MWR), Ruwi, Oman (Director: Mr. Zaher Khalid Al Suleimani), resulting in a field study of 4 weeks in March-April 1996.

Without the support of the Ministry, the results would have been only a fraction of what is achieved now. The involvement of the Ministry comprised:

- administrative assistance in obtaining visa and permits;
- financial participation in the costs of air transport of personnel, gear, and samples;
- lodging facilities in the various MWR guesthouses;
- logistic support by 4-wheel drive surface transportation;
- participation in the fieldwork by Mr. Ahmed Al Malki and Mr. Abdul Mutey of the Ruwi Office;
- guidance of several Regional Officers in exploring the country's ground water off the beaten tracks;
- substantial help by Mr. John A. Kay, MWR Training Advisor.

Additional support was provided by several persons (in alphabetical sequence): Dr. D.T. Bosch (Muscat), Dr. P.S. Bosch (Ruwi), Mr. D.A. Clayton (Al Khoud), Prof. Dr. H. Dumont (Ghent, Belgium), Mr. M.D. Gallagher (Muscat), Mr. M.A. Moh'd Al Amri (Salalah), Mr. R. Moolenbeek (Amsterdam), Dr. M. Stern (Sultan Qaboos University), Prof. Dr. R. Victor (Sultan Qaboos University), and many "ordinary" Omani people who granted permission to visit their land and water resources.

As result of these co-operative efforts some 130 ground water samples could be taken throughout a large part of Oman, not at all a bad result for a desert country, yielding an unsuspected wealth in biodiversity.

The microscopical examination and classification of the stygofaunal samples obtained, in which several scientists from the international community participate, will take some time, but the preliminary results indicate that there are many records new to Arabian peninsula or the Middle East, whereas several species were completely unknown before, thus new to Science. The results of these taxonomic studies will be published in the specialized, scientific biological literature.

Habitats of stygofauna

It is impossible, of course, to sample intensively during a 4-weeks fieldwork program an entire country, which extends over some 1300 km from the north-east (Sohar) to the south-west (Salalah), but 9 different zones were more closely examined (Muscat-Barka-Halban zone, Sohar zone, Rustaq-Nakhal zone, Quriat-Fens zone, Semail zone, Nizwa zone, Ibra zone, Salalah zone, desert zone between Adam and Thumrait).

Habitats sampled include: (a) ground water in the interstitia of coarse sediments of the bed of otherwise dry streams (the so-called wadis); (b) interstitial waters on the shore of lagoons; (c) man-made wells; (d) bore holes; (e) natural open springs; (f) captured springs; (g) aflaj (= underground man-made water channels); (h) cave waters in anchihaline and limnic caves.

Of each station, a provisional inventory of the stygofauna is provided, but it must be borne in mind that the material is still under examination of specialists for firm identification. A to-date complete, world-wide review of stygofaunal organisms is provided by Botosaneanu (1986).

Gear and methods

In habitats (a) and (b) of the above list, a biophreatical pump (a so-called Bou-Rouch pump, B.Rh. pump) was used (see Bou, 1974, for description). In some cases, ground water accumulating in hand-dug holes was filtered (the so-called Karaman-Chappuis method). In habitats (c), (d), and (g) we used a self-closing vertical net, a so-called Cvetkov (Cv) net, mesh 0.30 mm of different diameters (also described by Bou, 1974), and in habitats (e), (f), and (h) hand nets of various mesh sizes were employed. The formalin-preserved samples were later sorted in the laboratory under a dissecting microscope and transferred to 70% ethanol.

In the field, some physico-chemical parameters were directly measured, viz. temperature (t in °C), electric conductivity (eC in $\mu\text{S}/\text{cm}$ or mS/cm ; 1 mS = 1000 μS), and total salinity (S in parts pro thousand, p.p.t.).

The geographical position of almost every sampling station was read from a GPS (Geographical Positioning System) device, which provides satellite-determined UTM (Universal Transverse Mercator) coordinates. In some cases, only the MWR code number of a well had to be utilized.

Altitudes (alt. in m above sea level) are derived from readings on the topographical (military) maps or were recorded directly in the field, based on air pressure readings.

Pollution

As a by-product of our studies, we analysed the water quality at different stations, using bio-indicators as a measure for clean ground water or for ground water polluted in various ways. The ground water in Oman can sustain (1) *biological* (organic) contamination by fallen leaves or animal droppings, usually shown by a rich development of green, often filamentous algae on the surface; human pollution by garbage, detergents, or waste water, resulting in a decrease in biodiversity and absence of those organisms that characterise pure ground water; or (2) *chemical* pollution, caused by (over)use of fertilisers or pesticides, by over pumping of coastal resources resulting in raised salinity, by chemical waste disposal of industries or mining, and by oil spills (near wells often of diesel oil used for the water pump).

Invariably, chemically polluted waters have a very low biodiversity, or even completely absence of macroscopic organisms. Some organisms can survive in, or even show preference to, polluted waters, especially when the pollution is caused by raised chlorinity or oligoxia; examples of such tolerant organisms are blue-green algae, fly and mosquito larvae, certain red-coloured oligochaetes of the family Tubificiidae, certain hydrobiid snails, and some of the larger cycloids.

In clean, unpolluted ground water numerous stygobionts, often in large numbers, were observed. Such indicators are small organisms like Thermosbaenacea, stenasellids, *Stygocyathura*, Gnathostenetroidea, anthurideans, hadziid and bogidiellid amphipods, and freshwater polychaetes. They contribute to the self-cleaning process in the water.

Classification of ground water types

Biological classification of water types has one major advantage: it shows if environmental conditions for organisms are right throughout the life cycle. Chemical analyses of the water just show the momentary condition of the tested water; it does not show if the water suffers from any kind of pollution from time to time, although it may recover in between pollution waves by influx of fresh ground water.

Based on the present observations in Oman, the typology of the ground water comprises 10 different classes, Quality Class (QC) 1 being the best. Like all biological classification schemes, the typology classes are not absolutely clean-cut, a water type can show most characteristics of, for instance, QC 1, but some features of QC 2.

We recognized for Oman the following Quality Classes:

(QC 1) Good ground water, as shown by a high biodiversity of 'the right' stygobiont organisms; biological self-purification good; salinity low.

(QC 2) Rather good; fewer stygobionts, both qualitatively and quantitatively (water often might be taken too close to the surface).

(QC 3) Moderate to suspect (vegetal, animal or human pollution not excluded).

(QC 4) Suitable only for agricultural use, not for human consumption.

(QC 5) Malaria risk (mosquito larvae abundant).

(QC 6) Risk of Bilharziosis (intermediate hosts, i.e snails, especially *Lymnaea*) abundant.

(QC 7) Poor to unsuitable because of high salinity (sometimes suitable only for farm use, e.g. bananas, donkeys or goats); biological self-purification might be OK.

(QC 8) Unsuitable because of high pollution, e.g. garbage, insecticides or oil.

(QC 9) Unsuitable because of high pollution *and* high salinity

(well first disused because of salinity, and later used as refuse dump).

(QC 10) Not classified for various reasons (sample size insufficient, thermal pollution...).

In the following list of sampling stations, these Quality Classes have been mentioned in parentheses.

Maps

The UTM co-ordinates are shown on the military maps (in many sheets) of the Sultanate, produced under the direction of the Director of Military Survey, Ministry of Defence, UK.

(1983), scale 1: 100,000, or on the maps 1:250,000 produced by same agency (1985).

A more generalized map, scale 1:300,000 is published in two versions, Arabic and English, by the National Survey Authority of Oman (1992).

Since the military maps are 'classified' (not freely obtainable), and the UTM coordinates are not shown on an ordinary atlas, we had them converted into °N(northern latitude) and °E (eastern longitude). We are indebted to Dr. Gijs Mesman Schulz, Faculty of Geographical Sciences, University of Amsterdam, for executing the conversions. The UTM data remain the basic source of information, however.

The Arab names of localities have, where possible, transliterated into English in accordance with BGN/PCGN system, under omission of diacritical marks, but in many cases there appeared to be no uniform way of transliteration possible; in some of such cases the alternative spelling is added in brackets.

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Station list

- 96-01. Wadi Taww, *ca.* 2 km S of Halban; in coarse sediment (boulders, gravel, sand, loam) of small resurgence left of stream bed; B.-Rh. pump; probe at 50 cm below sediment surface; 50 l filtered; t 29.0°; S < 1 ppt; 23 March 1996; UTM 0604748/2606459 (*ca.* 23°34'N 58°01'E). Composition: Planaria, Oligochaeta, Cyclopidae, insects. (QC 2/3.)
- 96-02. Near 96-01, but probe at 75 cm below sediment surface in gravelly bank of main bed of wadi; 50 l filtered; t 28.1°; eC 567 μ S. 23 March 1996. Composition: Ostracoda, Cyclopidae, Amphipoda, isopoda, Thermosbaenacea, Acari, Oligochaeta, Gastropoda. (QC 1.)
- 96-02bis. Same place as 96-02, but fine hand net in surface water of wadi; t 28.5°. Composition: insects, Gastropoda (*Lymnaea*). (QC 6.)
- 96-03. Falaj just N. of 96-01; Cv. net in covered vertical shaft, 3 m deep; t 29.1°; eC 696 μ S; 23 March 1996. No organisms. (QC 10.)
- 96-04. Open, rectangular well, 3 x 1.5 m, just N. of Halban; Cv. net; water surface at 4 m, water column 15 m; UTM 0605021/ 2607501 (*ca.* 23°34'28"N 58°01'45"E); t 28.1°; eC 898 μ S; 23 March 1996. Composition: insect larvae, many mosquito larvae; Ostacoda, Acari. (QC 4/5.)
- 96-05. Wadi Taww, N. of Halban; UTM 065000/2607401 (*ca.* 23°34'25"N 58°01'44"E); in gravel of dry bank, *ca.* 3 m above wa-ter line; B.Rh. pump, probe at 0.9 m, 50 l filtered; t 29,0°C; eC 572 μ S; 23 March 1996. Composition: insect larvae, asellids. (QC 3.)
- 96-06. Open well of plantation; rectangular, 2 x 3 m, with electric pump; UTM 0523089/2616883 (*ca.* 23°39'45"N 57°13'35"E); Cv. net; t 31.6°; eC 5.82 mS (= *ca.* 4 ppt); 24 March 1996. Composition: some filamentous algae, Gastropoda. (QC 4, 6, 7.)
- 96-07. Covered well of plantation, with diesel pump; village Ash Sharadi, A'Raudah Street (Seeb) *ca.* 100 m from the sea; UTM 0623319/2617433 (*ca.* 23°39'47"N 58°12'33"E); water surface at 3.5 m, water column 6.5 m; Cv. net; t 29.7°; eC 7.77 mS; 24 March 1996. Composition: some filamentous algae, mosquito larvae. (QC 5, 7.)
- 96-08. Wadi Al-Luwami (= S. of Seeb); plantation well, square, 1.25 x 1.25 m, covered, with diesel pump; water surface at 3 m, water column 3 m; UTM 0622723/2618141 9 (*ca.* 23°40'10"N 58°12'12"E); t 30.3°; eC 8.34 mS; 24 March 1996. Composition: Thermosbaenacea. (QC 1.)
- 96-09. Wadi Al-Buhayys (Seeb); covered plantation well with diesel pump, rectangular, 2 x 3 m; water surface at 8 m, water column 3.5 m; UTM 0621107/2618186 (*ca.* 23°40'12"N 58°11'15"E); Cv. net; t 31.8°; eC 2.85 mS; 24 March 1996. No organisms. (QC 10 (or 8?).)
- 96-10. Al-Ma'bailah (Seeb), covered well; water surface at 6 m, water column 2.5 m; UTM 0616333/2618865 (*ca.* 23°40'35"N 58°08'27"E); Cv. net; t 31.8°; eC 2.85 mS; 24 March 1996. Composition: 1 snail. (QC 10 (or 8?).)
- 96-11. Covered well near 96-10, but unused (too salty); water surface at 3.5 m, water column 4.5 m; UTM 0616318/2619292 (*ca.* 23°40'49"N 58°08'27"E); Cv. net; t 30.3°; eC 16.86 mS; 24 March 1996. Composition: mosquito larvae. (QC 5, 7.)
- 96-12. Hay Aseim (Barka), open well with diesel pump, on spring; rectangular, 2.5 x 3.5 m; water surface at 15 m, water column 2.5 m; UTM 0598303/2919547 (*ca.* 23°41'01"N 57°57'51"E); Cv. net; t 31.5°; eC 2.63 mS; 24 March 1996. No organisms. (QC 10 (?.).)
- 96-13. Same area as 96-12, open well, half-round, diameter 2.5 m; water surface at 13 m,

water column 2.5 m; UTM 0598090/2619618 (ca. 23°41'04"N 57°57'43"E); Cv. net; t. 31.6°; eC 5.81 mS; 24 March 1996. No organisms. (QC 10, 7.)

96-14. Barka, open well with stairs, MWR no. 201/354; water surface at 13.5m, water column 2 m; UTM 0589832/2618449 (ca. 23°40'28"N 57°52'52"E); Cv. net; t 24.7°; eC 4.43 mS; 24 March 1996. Composition: mosquito larvae. (QC 5, 7.)

96-15. Barka, open well, not in use, MWR no. 202/684; rectangular, 3.5 x 2.5 m; water surface at 10.5 m, water column 1.5 m; UTM 0590874/2620531 (ca. 23°41'35"N 57°53'29"E); Cv. net; t 25.1; eC 7.68 mS; 24 March 1996. Composition: large Cyclopidae, mosquito and fly larvae. (QC 5, 7.)

96-16. Barka, open well, rectangular, 3.5 x 2 m; water surface at 10 m, water column 1.5 m; UTM 0590982/2620531 (ca. 23°41'44"N 57°53'33"E); Cv. net; t 29.1°; eC 3.64 mS; 24 March 1996. Composition: Cyclopidae, mosquito (*Culex*) larvae. (QC 5, 7.).

96-17. Barka, covered well not far from the sea, square, 1.5 x 1.5 m, MWR no. 203/166; depth not recorded; UTM 0588282/ 2621563 (ca. 23°42'09"N 57°51'57"E); Cv. net; t 28.6°; eC 18.46 mS; 24 March 1996. Composition: almost nothing (1 mosquito larva, 2 small gastropods). (QC 9.)

96-18. Quiryiat, Table Spring (Daghmar al Hajir); spring from sea cliff, in tidal zone; partly captured in pipes; UTM 0703697/ 2563902 (ca. 23°10'17"N 58°59'24"E); small handnet; t 13.5°; eC 7.58 mS; 25 March 1996. Composition: barnacles, mosquito larvae, amphipods, crab, mussel. (QC 7.)

96-19. Tiwi cave (or Deep Hole), N. of Fens; huge karstic collapse cave, some 700 m from marine littoral; UTM 0712319/2549008 (ca. 23°02'10"N 59°04'19"E); 25 March 1996. (QC 7.)

19A. B.Rh. pump in sandy and gravelly shore of cave lake (day light); probe at 50 cm below sediment surface; t 36.8°; eC 35.6 mS; 100 l water filtered. Composition: Amphipoda (Bogidiellidae, Melitidae), Polychaeta.

19B. B.Rh. pump in loamy gravel on shore of cave lake (day light); probe at 50 m; 60 l filtered; t 29.5°; S 22 ppt. Oculate amphipods and isopods, Oligochaeta.

19C. Handnet in cave lake, day light; t 36.7°; eC 36.0 mS. Div. sp. Amphipoda, Isopoda, Ostracoda (div.sp.) Gastropoda, Oligochaeta, Polychaeta, div. sp. sponges, fish.

96-20. Small coastal lagoon, just N of previous station; UTM 0712109/2550127 (ca. 23°02'46"N 59°04'12" E); during high tide, sea water enters through gravel bar; B.-Rh. pump in coarse sand and gravel; probe at 1 m below sediment surface; 50 l filtered; t 27.2°; eC 53.6 mS; 25 March 1996. Composition: marine gastropods, bogidiellids, oculate isopods and amphipods, ostracod. (QC 7.)

96-21. Large lagoon behind sand and gravel bar; slightly N of 96-20; UTM not determined; B.-Rh.pump in coarse sand and gravel; probe at 1m below sediment surface; 100 l filtered; water muddy; t 27.0°; eC 39.3 mS; 25 March 1996. Composition: callianassid, oculate amphipods, bogidiellids, cirolanids, div. sp. gastropods, oligochaetes. (QC 7.)

96-22. Open shallow well, round, with diesel pump, at Dibab; UTM 0710630/2554426 (ca. 23°04'31"N 59°03'22"E); MWR no. 293/393; Cv. net; bottom sand and gravel; t 24.2°; eC 4.67 μS; 25 March 1996. Composition: various mosquito larvae, bogidiellid, green filamentous algae. (QC 3, 7.)

96-23. Dibab, open well, square, 1 x 1 m.; water surface at 2.5 m, water column 0.8 m; Cv. net; rock; UTM 0700988/2553839 (ca. 23°04'52"N 58°57'44"E); t 25.7°; eC 0.4 mS; 25 March 1996. Composition: oligochaetes, cyclopids, gastropods (*Planorbis* and others). (QC 3, 6.)

96-24. Falaj Al-Samdi, at Elayat-Samail ; UTM 0600327/ 2576779 (ca. 23°17'50"N

57°58'52"E); B.-Rh. pump in muddy gravel of bottom; 50 l filtered; t 30.7°; eC 0.77 mS; 26 March 1996. Composition: insect larvae, snails. (QC 4, 6.)

96-25. Closed, square well, 1.5 x 1.5 m, MWR no. 304/765; Salem Abdullah Al-Naabi (Samail); water surface at 4 m, water column 3 m; UTM not recorded; Cv. net; t 27.1°, eC 1.11 mS; 26 March 1996. Composition: mosquito larvae. (QC 4, 5.)

96-26. Falaj Al-Dahgale, Sfalat Samail; originating from spring; B.-Rh. pump in fine and coarse gravel; probe at 60 cm below sediment surface; UTM 0601614/2578073 (ca. 23°18'32"N 57°59'38"E); t 28.0°; eC 1.19 mS; 26 March 1996. Composition: polychaete, small isopods, amphipods. (QC 2.)

96-27. Ain Werd (spring), ca. 15 m downstream of 96-26; water comes from the calcareous rocks; handnet; t 28.0°; eC 1.6 mS; 26 March 1996. Composition: amphipod, planarian, div. sp. gastropods, mosses and algae. (QC 2, 6.)

96-28. Al Khobar, recently constructed well with concrete lid and electric pump, MWR no.310/358; 1.80 m to water surface, 3 x 3 m; water level at 7.5 m, water column 14.5 m; UTM 0555392/2535260 (ca. 22°55'28"N 57°31'50"E); alt. ca. 500 m; Cv. net; t 28.2°; eC 1.30 mS; 26 March 1996. Composition: Large, white amphipods. (QC 2.)

96-31. Nizwa, Musala Saeed; very small spring in ophiolite rock; alkaline; UTM 0550067/2536948 (ca. 22°56'23"N 57°29'18"E); small handnet; bottom of stony debris; t 30.2°; eC 658 µS; 26 March 1996. Composition: larvae of chironomids, stenasellid; surface water with frogs and insects. (QC 3.)

96-32. Nizwa, Al-Gumor; open well with diesel pump; rectangular, 2 x 4 m; shady; UTM 0554894/2537653 (ca. 22°56'46"N 57°32'08"E); calcite incrustations; Cv. net; t 28.3°; eC 743 µS; 26 March 1996. Composition: white, blind amphipods. (QC 2.)

96-33. Halban area, wadi Taww; UTM 0604750/2606459 (ca. 23°34'N 57°01'E); alt. ca. 90 m; B.-Rh. pump in shallow puddle (water depth 20 cm); probe at 60 cm below sediment surface; gravel; 50 l filtered; t 28.9°; eC 601 µS; 28 March 1996. Composition: Thermosbaenacea, Isopoda (2 sp.), oligochaetes, ostracod, insect larvae. (QC 1/2.)

96-34. As 96-33, but 1.5 m away; on dry gravel bank; probe at 50 cm; 50 l filtered; t 28.7°; eC 587 µS; 28 March 1996. Composition: Thermosbaenacea, amphipods (div. sp.), sten-asellids (2 sp.), insect larvae. (QC 1.)

96-35. As 96-34, but probe at 75 cm; 50 l filtered; t 28.7°; eC 591 µS; 28 March 1996. Composition: Thermosbaenacea, stenasellids (2 sp.), oligochaetes. (QC 1.)

96-36. 150 cm away from 95-34, on dry gravel bank; probe at 50 cm below sediment surface; 50 l filtered; t 28.9°; eC 593 µS; 28 March 1996. Composition: Thermosbaenacea, chironomid larvae, stenasellids. (QC 1/2.)

96-37. Same place as 96-36, but probe at 1 m below sediment surface; 50 l filtered; t 28.7°; eC 581 µS; 28 March 1996. Composition: Thermosbaenacea, cyclopids, amphipods (2 sp.), isopods (2 sp.), Coleoptera. (QC 1.)

96-38. Same place as 96-36, but 150 cm further on the gravel bank; probe at 50 cm below the surface; 50 l filtered; t 28.6°; eC 583 µS; 28 March 1996. Composition: small amphipods, stenasellids (2 sp.), oligochaetes. (QC 1/2.)

96-39. Same place, but probe at 110 cm below the substrate surface; 50 l filtered; t 28.7°; eC 565 µS; 28 March 1996. Composition: Thermosbaenacea, asellid isopods (2 sp.), amphipods, cyclopids, oligochaetes. (QC 1.)

- 96-40. Sayh Al Afiyah (Ibra); open well, square, 2.5 x 2.5 m; water surface at 4.4 m, water column 24 m; UTM 0659217/2509245 (ca. 22°40'58"N 58°33'00"E); Cv. net; t 30.0°; eC 447 μ S; 27 March 1996. No organisms. (QC 10.)
- 96-41. Wadi Ibra (dry in summer); UTM 0657559/2500877 (ca. 22°36'27"N 58°31'58"E); B.-Rh. pump, in sand and fine gravel; probe at 50 cm below sediment surface; 50 l filtered; t 30.4°, eC 3.82 mS; 27 March 1996. Composition: only surface organisms (green filamentous algae, frogs). (QC 3.)
- 96-42. Same place as 96-41, but probe at 100 cm below sediment surface; 50 l filtered; 27 March 1996. Composition: small isopods. (QC 2, 3.)
- 96-43. Wadi Naam (Ibra region); open well, MWR no. 245/351; water surface at 7.0 m, water column 0.60 m; UTM 0662331/2513322 (ca. 22°43'10"N 58°34'50"E); Cv. net; t 28.2°; eC 683 μ S; 27 March 1996. Composition: insect larvae, snails. (QC 3, 6.)
- 96-44. Shannah (Ibra region); open well in wadi, MWR no. 258/054; water surface at 3 m, water column 1.1 m; UTM 0675230/25227700 (ca. 22°50'52"N 58°42'28"E); altitude 700 m; Cv. net; t 29.5°; eC 420 μ S; 27 March 1996. Composition: amphipods (2 sp.), various isopods. (QC 1, 2.)
- 96-45. Wadi A'seigani; UTM 0610424/2569793 (ca. 23°14'01"N 58°04'46"E); altitude 450 m; B.Rh. pump in fine and coarse gravel; probe at 50 cm; 50 l filtered; t 28.3°; eC 767 μ S; 27 March 1996. No organisms. (QC 10.)
- 96-46. Wadi A'seigani, 100 m upstream of 96-45 (19 km S of Bid Bid); altitude 450 m; B.-Rh. pump in gravel; probe at 50 cm below sediment surface; 50 l filtered; t 27.7°; eC 771 μ S; 27 March 1996. Composition: small asellotes, ostracod, insect larvae. (QC 3.)
- 96-47. Village Sakur (on road 23); large, old well with stone stairs down to the water; MWR no. 301/824; water surface at 7.5 m, water column 2 m; UTM 0614427/2581672 (ca. 23°20'26"N 58°07'10"E); altitude 330 m; t 27.6°; eC 624 μ S; 28 March 1996. Composition: larvae of mosquito's (*Anopheles* and *Culex*), and of other Diptera. (QC 3, 5.)
- 96-48. Wadi Taww, S. of Halban (continuation of transect of 96-38); 1.5 m further on gravel bank; UTM 0604748/2606459 (ca. 23°34'N 58°01'E); B.-Rh. pump, probe at 60 cm below sediment surface; 50 l water filtered; t 28.5°; eC 576 μ S; 28 March 1996. Composition: isopods (2 sp.), amphipods, Thermosbaenacea, cyclopids, ostracods, Acari, snails. (QC 1.)
- 96-49. Same place as 96-48, but probe at 1.25 m below sediment surface; 50 l filtered; t 28.4°; eC 566 μ S; 28 March 1996. Composition: isopods (2 sp.), Thermosbaenacea, cyclopids, Acari, oligochaetes. (QC 1.)
- 96-50. Same place as 96-49, but 1.5 m further down on gravel bar (distance to wadi 1 m); probe at 50 cm; 50 l filtered; t 28.2°; eC 575 μ S; 28 March 1996. Composition: Thermosbaenacea, isopods (2 sp.), cyclopids. (QC 1/2.)
- 96-51. As 96-50, but probe at 1 m below sediment surface; water loamy; 100 l filtered; t 28.5°; eC 568 μ S; 28 March 1996. Composition: small amphipods, isopods (div. sp.), Thermosbaenacea, cyclopids, Acari, gastropods, oligochaetes. (QC 1.)
- 96-52. As 96-50, 1.5 m further down, in gravel and loam of wadi Taww; depth of wadi 0.10 m; probe at 60 cm below sediment surface; 50 l filtered; t 28.3°; eC 557 μ S; 28 March 1996. Composition: Thermosbaenacea, isopods, small amphipod, insect larvae, oligochaetes, polychaete, Acari, snails. (QC 2.)
- 96-53. Halban, open well (key-hole-shaped), 4 x 2 m; diesel pump; MWR no. 206/489; water

surface at 4 m, water column 12.5 m; UTM 0605256/2607586 (ca. 23°34'31"N 58°01'53"E); altitude 50 m; Cv. net; t 29.2°; eC 2.39 mS; 28 March 1996. Composition: insect larvae, Acari, oligochaetes. (QC 4.)

96-54. Nakhal, Thuwarah, on bank of wadi; B.-Rh. pump in fine gravel and sand just above water line; probe at 50 cm below sediment; 15 l filtered; 23°22.68'N 57°49.67'E; t 27.2°; eC 634 µS; 29 March 1996. Composition: Asellota, white amphipod. (QC 2.)

96-55. Wadi Bani Awf, permanently running; 23°14.32'N 57°25.97'E; B.-Rh. pump in fine gravel; probe at 75 cm below sediment surface; 50 l filtered; t 25.1°; eC 707 µS; 29 March 1996. Composition: ostracods, planarians, chironomid and other insect larvae. (QC 2.)

96-56. Same place as 96-55, somewhat more upstream; B.-Rh. pump, probe at 50 cm, in gravel on rock; 50 l filtered; t 25.1°; eC 707 µS; 29 March 1996. Composition: same as 96-55. In surface stream: *Lymnaea natalensis*. (QC 2, 6.)

96-57. Wadi 1 km upstream of Al Qsmitien; 23°16.41'N 57°27.62'E; B.-Rh. pump in gravel and slate; probe at 60 cm below sediment surface; 50 l filtered; t 27.0°; eC 713 µS; 29 March 1996. Composition: various amphipods and isopods; ostracods, insect larvae; snail. (QC 2, 6.)

96-58. Nearly 1000 m downstream of 96-57; 23°16.95'N 57°27.95'E; B.-Rh. pump in gravel on border of wadi; 50 l filtered; t 25.1°; eC 671 µS; 29 March 1996. Composition: Thermosbaenacea, Amphipoda (2 sp.), Isopoda, snails, chironomid larvae. (QC 2, 6.)

96-59. Entrance of Wadi Bani Kharus, ca. 1 km from Awabi village, near the fort; 23°17.56'N 57°31.47'E; open well, in centre of dry wadi; water surface at 11 m, water column 2.5 m; Cv. net; t 29.5°; eC 619 µS; 29 March 1996. Composition: snail (*Lymnaea*). (QC 10, 6.)

96-60. Wadi Ahin at Sohar; B.-Rh. pump in gravel of the shore, ca. 1 m above the water line; probe at 70 cm; 50 l filtered; UTM 0454903/2660684 (24°03'28"N 56°33'23"E); alt. ca. 60 m; t 24.9°; eC 678 µS; 30 March 1996. Composition: Thermosbaenacea, stenasellids (2 sp.), amphipods, cyclopids, oligochaetes, chironomid-, mosquito-, and fly-larvae. (QC 2, 5.)

96-61. Village Al Shebabat, village well, covered, with pump, square, 1.5 x 1.5 m; water surface at 9.5 m, water column 8.5 m; UTM 0455047/2661546 (ca. 24°03'56"N 56°33'28"E); alt. 60 m; Cv. net; t 30.6°; eC 1576 µS; 30 March 1996. Composition: some small isopods. (QC 2/3.)

96-62. Well near 96-61; open round, diameter 1.5 m; water surface at 2.7 m, water column 7 m; MWR no. 226/317; alt. ca. 40 m; Cv. net; t 26.6°; eC 424 µS; 30 March 1996. Composition: some isopods, insect larvae (incl. mosquitos). (QC 3, 6.)

96-63. Sallan; oval, open well, 1.5 x 2 m, with diesel pump; MWR no. 209/055; water level at 2.5 m, water column 7 m; UTM 0471929/2697738 (ca. 24°23'34"N 56°43'23"E); Cv. net; t 30.5°; eC 3.33 mS; 30 March 1996. Composition: green filamentous algae, mosquito larvae, gastropods. (QC 6, 7.)

96-64. Plantation well at Sohar, MWR no. 214/658 (local no. SR-1); UTM 0476999/2688061 (ca. 24°18'19"N 56°46'24"E); covered, with electr. pump; water surface at 13 m, water column 3 m; Cv. net; t 29.2°; eC 1517 µS; 30 March 1996. No organisms. (QC 10.)

96-65. Well at Majaz Al Sugra (local no. MGS-2); on plantation; open, round, diameter 1 m; with diesel pump; UTM 0483567/2679077 (ca. 24°13'28"N 56°50'17"E); water surface at 7 m, water column 3.5 m; Cv. net; t 29.2°; eC 1004 µS; 30 March 1996. Composition: oligochaetes. (QC 3.)

96-66. Al Huwail (Saham area), covered well, MWR no 233/594; round, diameter 1 m; water surface at 16 m, water column 2.5 m; UTM 0487366/2669936 (ca. 24°08'31"N 56°52'32"E);

Cv. net; t 29.0°; eC 1117 μ S; 30 March 1996. No organisms (dirty well). (QC 9.)

96-67. Wadi Taww at Halban (about same place as 96-50); B.-Rh. pump in gravel; probe at 50 cm; 50 l filtered; 1 April 1996. Composition: isopods, amphipods (div. sp.), thermosbaenaceans, cyclopids, oligochaetes, div. insect larvae. (QC 1/2.)

96-68. Wadi Al Fara, Rustaq; B.-Rh. pump in gravel; probe at 60 cm; 50 l filtered; UTM 0545970/2595453 (ca. 23°28'06"N 57°27'00"E); t 28.0°; eC 1134 μ S; 1 April 1996. Composition: isopods, thermosbaenaceans, amphipod, water mites, planarian, insect larvae. (QC 1/2.)

96-69. Recently (= 1995) formed spring in Rustaq, Bait Qura; UTM 0443405/2587376 (ca. 23°23'44"N 67°25'29"E); B.Rh. pump in gravel, probe at 50 cm; 50 l filtered; t 28.0°; eC 818 μ S; 1 April 1996. Composition: oligochaetes, mosquito larvae. (QC 3, 5.)

96-70. Same place as 96-69, but probe at 70 cm; 50 l filtered; t 27.9°; eC 819 μ S; 1 April 1996. Composition: planarians, insect larvae (incl. mosquitos). (QC 3, 5.)

96-71. Rustaq, Bait Qura; old well, 2 x 4 m; water surface at 2 m, water column 3.7 m; very clear, blue water (calcium-rich?); UTM 0543641/2586851 (ca. 23°23'27"N 57°25'37"E); Cv. net; t 28.5°; eC 808 μ S; 1 April 1996. Composition: fish, gastropods (QC 6, 7.)

96-72. Rustaq, Bait Qura; covered plantation well, clear blue water (calcium-rich?); with electr. pump; water surface at 3.5 m, water column 13.8 m; UTM 0543714/2586858 (ca. 23°23'27"N 57°25'40"E); Cv. net; t 29.8°; eC 869 μ S; 1 April 1996. Composition: thermosbaenaceans, isopods, amphipod. (QC 2.)

96-73. Rustaq, near warm spring (Ain Al Khadra) at Wadi Sahtan-Alkhadra; UTM 0531705/2583435 (ca. 23°21'37"N 57°18'37"E); alt. ca. 350 m; not in spring itself but in gravel of wadi; 20 l filtered (method Karaman-Chappuis); t 31.0°; eC 1038 μ S; 1 April 1996. Composition: oligochaete, stenasellids. (QC 2, 3.)

95-74. Just opposite of 96-73; well MWR no. 275/751; round, diameter 2.5 m; with diesel pump; water surface at 3.8 m, water column 1 m; Cv. net; t 28.3°; eC 917 μ S; 1 April 1996. Composition: some Thermosbaenacea. (QC 2.)

96-75. Wadi Bani Henay; non-permanent; B.-Rh. pump in gravel; probe at 50 cm below sediment surface; 50 l filtered; UTM 0530687/2596020 (ca. 23°28'26"N 57°18'02"E); t 28.5°; eC 639 μ S; 1 April 1996. Composition: Thermosbaenacea, stenasellids, amphipods, oligochaete, chironomid larvae. (QC 2/3.)

96-76. Same place as 96-75, but probe at 1.20 m; t 26.7°; eC 655 μ S; 1 April 1996. Composition: Thermosbaenacea, small stenasellids, bogidiellids, cyclopid. (QC 1, 2.)

96-77. Wadi Bani Henay; B.-Rh. pump in gravel; probe at 90 cm below sediment surface; UTM 0533285/2599976 (ca. 26°30'35"N 57°19'34"E); alt. ca. 300 m; 50 l filtered; t 28.5°; eC 555 μ S; 1 April 1996. Composition: Thermosbaenacea, bogidiellids, stenasellids, chironomids. (QC 1/2.)

97-78. Wadi Al Hoqain-Al Manazil (Rustaq area), stream system of Wadi Bani Ghafer; open well, round, diameter 2.5 m; water surface at 2 m, water column 2 m; shady; muddy (plant debris); UTM 0533497/2601234 (ca. 23°31'19"N 57°19'41"E); t 30.8°; eC 530 μ S; 1 April 1996. Composition: small stenasellids, amphipod. (QC 2/3.)

96-79. Wadi Al Hoqain-Al-Hamamat (Rustaq area); B.Rh. pump in fine gravel; probe at 50 cm; UTM 0534015/2620789 (ca. 23°41'51"N 57°20'01"E); 50 l filtered; t 30.8°; eC 875 μ S; 1 April 1996. Composition: Thermosbaenacea, small stenasellids, ostracod, snail (*Lymnaea*). (QC 2, 6.)

96-80. Wadi Al Hoqain-Al Bilad (Rustaq area); open well, square, 1.5 x 1.5 m; water surface at 6.80 m, water column 6.0 m; UTM not recorded; t 29.5°; eC 1043 µS; 1 April 1996. Composition: large amphipods. (QC 2.)

96-81. Adam; Al Kharmosh, open well, MWR no. 266/530; square, 2.5 x 2.5 m; 4.8 m to water surface, water column 3.2 m; UTM 0553046/2475580 (ca. 22°23'07"N 57°30'55"E); Cv. net; t not recorded; eC 2.53 µS; 3 April 1996. Composition: green filamentous algae, snails. (QC 4, 6.)

96-82. Adam, Al Soumairat; open plantation well, MWR no. 272/901; square, 3 x 3 m; with electric pump; 10 m to water surface, water column 2.5 m; UTM 0555057/2473890 (ca. 22°22'12"N 57°32'05"E); Cv. net; t not recorded; eC 5.95 mS; 3 April 1996. Composition: 1 thermosbaenacean. (QC 7.)

96-83. Ain Hasheer (Marbat area); slowly running; in cement basin; some gravel; rich in calcium; small handnet; UTM 0245441/18877067 (ca. 17°03'14"N 54°36'30"E); t and eC not recorded; handnet; 4 April 1996. Composition: ostracods, larvae of Diptera. (QC 3, 7.)

96-84. Marbat; open well, MWR no. 001/616; in concrete shed, now disused; with some garbage; oldest well in town; water surface at 1.80 m, water column 0-1 m; Cv. net; UTM 0254392/1879929 (ca. 16°59'25"N 54°41'36"E); t 28.8°; eC 2.35 µS; 4 April 1996. Composition: 1 thermosbaenacean, some oligochaetes, some gastropods, mosquito larvae (*Culex*). (QC 5, 7.)

96-85. Marbat, covered well, disused, MWR 001/513; dirty; 6 m to water surface, water column 0.8 m; UTM 0254419/1879658 (ca. 16°59'16"N 54°41'37"E); t 29.5°; eC 2.51 mS; 4 April 1996. Composition: 4 thermosbaenaceans, various larvae of mosquitos and flies. (QC 5, 7.)

96-86. Two km S of Heno; open well, MWR no.001/514; with stairs; water column 0.3-0.5 m; bottom: stones, black mud; UTM 0258358/1876890 (ca. 16°67'48"N 54°43'51"E); t 28.8°; S 18 ppm; 4 April 1996. Composition: great amount of filamentous algae and diatoms. (QC 9.)

96-87. Wadi Darbat; B.-Rh.pump in muddy gravel; probe at 40 cm below sediment surface; UTM 0228930/1893635 (ca. 17°06'40"N 54°27'09"E); 50 l filtered; t 29.6°; eC 771 µS; 4 April 1996. Composition: div. sp. of gastropods, green filamentous algae, mosquito larvae (*Culex*). (QC 5, 6, 7.)

96-88. Same place as 96-87, but probe at 80 cm; 50 l filtered; 4 April 1996. Composition: Coleoptera, Acari. (QC 3.)

96-89. Wadi Darbat, downstream of 96-87; B.-Rh.pump in muddy gravel and peaty debris; probe at 65 cm below sediment surface; UTM 02229123/1893222 (ca. 17°06'27"N 54°27'16"E); t 27.0°; eC 114 µS. 4 April 1996. No organisms. (QC 10.)

96-90. Thaqah; open well in town, with 4 diesel pumps; MWR no. 201/428; 2.5 x 4.5 m; water surface, with oil film, at 6.1 m, surface at 3.8 m, water column 2.3 m; UTM 0221164/1885482 (ca. 17°02'12"N 54°22'50"E); Cv. net; t29.7°; eC 4.37 mS; 4 April 1996. Composition: fish, insect larvae, gastropods (2 sp.). (QC 3, 7.)

96-93. Khawr Thaqah; source of lagoon, karstic; rapidly flowing; marine influence at stormy weather; UTM 0220848/ 1885757 (ca. 17°02'20"N 54°22'40"E); handnet; t 30.0°; eC 10.1 mS; 4 April 1996. Composition: algae, div. sp. Amphipoda, Tanaidacea, anthurid isopod, prawns (*Caridina*). (QC 7.)

96-94. Ayn Toubraok (Wilayat Thaqah); big karst spring, production 20 l/sec; UTM 0215498/1896570 (ca. 17°08'10"N 54°19'34"E); handnet; t 29.2°; eC 567 µS; 4 April 1996.

Composition: some larvae of Diptera. (QC 3.)

96-95. Genof, near satellite station; open well, MWR no. 001/643; water surface at 6.5 m, water column 0.5 m; UTM 02209292/1885326 (ca. 17°02'07"N 54°22'43"E); Cv. net; 29.3°; eC 9.77 mS; 4 April 1996. Composition: some green algae, snails. (QC 7.)

96-96. Ain Arzat, Salalah region; strongest spring of Oman (up to 225 l/sec.); small lateral spring sampled; UTM 0206100/1896200; handnet; t 29.6°; eC 767 µS; 4 April 1996. Composition: insect larvae. (QC 2, 3.)

96-97. Salalah well field, near airport; open well, MWR no. 217/173; round, diameter 1.5 m; water surface at 20.5 m, water column 1.5 m; UTM 0193208/1888241; ca. 17°03'29"N 54°07'04"E); Cv. net; t 29.2°; eC 829 µS; 5 April 1966. Composition: hydrobiid snails. (QC 3.)

96-98. Salalah - Al Jadidah; well in house, with spiral staircase; MWR no. 202/382; electric pump; water level at 21 m, water column 2.8 m; UTM 0196783/1885753 (ca. 17°02'10"N 54°09'07"E); Cv. net; t and eC not determined; 5 April 1996. But for some algae, no organisms. (QC 10.)

96-99. Dahariz South; big open well, with 7 pumps; MWR no. 202/489; bottom: sand; UTM 0196965/1883319 (ca. 17°00'51"N 54°09'14"E); Cv. net; t 28.1°; eC 4.21 mS; 5 April 1996. Composition: green filamentous algae, oligochaetes. (QC 7.)

96-100. A'Muotazah area (Salalah centre); open well with diesel pump; MWR no. 210/724; rectangular, 2.5 x 3.5 m; water level at 6 m, water column 0.6 m; UTM 189032/1882511 (ca. 17°00'21"N 54°04'46"E); Cv. net; t 28.6°; eC 3.49 mS; 5 April 1996. Composition: green filamentous algae, oligochaetes. (QC 7.)

96-101. Auwqad South (Salalah west); open well with diesel pump; MWR no. 210/435; rectangular, 4 x 3.5 m; water level at 5.5 m, water column 1.2 m; oil film on water; UTM 0184857/1881731 (ca. 16°59'53"N 54°02'26"E); Cv. net; t 28.4°; eC 4.01 mS; 5 April 1996. Composition: oligochaetes, gastropods, larvae of Odonata, green filamentous algae. (QC 7.)

96-102. Spring named Ain [Janin] Sharshat; hardly running, captured in basin, 1 m deep; UTM 0189207/1893950 (ca. 17°06'32"N 54°04'46"E); Cv. net; t 23.8°; eC 501 µS; 5 April 1996. Composition: cyclopid, ostracods, mosquito larvae (*Culex*), oligochaetes, div. sp. snails (incl. *Planorbis*), diatoms. (QC 3, 5, 6.)

96-103. Ain Qeydah (spring head of Wadi Darbat catchment, in limestone mountains); UTM 0230717/1897256 (ca. 17°08'39"N 54°28'08"E); fine handnet, in gravel and roots; t 29.3°; eC 754 µS; 5 April 1996. Composition: oligochaetes, div. sp. snails, insect larvae. (QC 3, 6.)

96-104. Khawr A'Dehariz; B.-Rh. pump in coarse sand of closing bar of lagoon; probe at 50 cm; UTM 0199523/1882990 (ca. 17°00'41"N 54°10'40"E); water chalky; t 29.6°; eC 19.70 mS; 6 April 1996. Composition: ostracods, oligochaetes, gastropods, mosquito larvae. (QC 7.)

96-105. Ain Hamran (Salalah region); closed falaj; some 200 m downstream of the spring itself; water surface at 1.5 m, water column 2 m; UTM 0210593/1892171 (ca. 17°05'45"N 54°16'50"E); Cv. net; t 29.5°; eC 576 µS; 6 April 1996. Composition; gastropods, insect larvae. (QC 3, 6.)

96-106. Ain Hamran, spring itself (see 96-105); closed off by iron lid; slowly running into concrete basin; muddy sand and gravel; UTM 0210592/1892363 (ca. 17°05'51"N 54°16'50"E); handnet; 6 April 1996. Composition: green filamentous algae, fish, div. sp. snails, oligochaetes, ostracods, mosquito larvae (*Culex* and *Anopheles*). (QC 3, 5, 6.)

96-107. A'Saadah north; well in house; MWR no. 202/272; square, 2 x 2 m; electric pump;

UTM 0197086/1890374 (*ca.* 17°04'40"N 54°09'14"E); water surface at 29 m, water column 2 m; Cv. net; t 29.7°; eC 1082 μ S; 6 April 1996. Composition: Thermosbaenacea, small amphipod, ostracods, snails, some filamentous algae. (QC 2.)

96-108A. Dahariz north; closed well met iron lid, MWR no. 202/277; with electric pump; UTM 0197130/1884642 (*ca.* 17°01'34"N 54°09'19"E); water surface at 3 m, water column 1 m; Cv. net; t and eC not determined; 6 April 1996. Composition: Thermosbaenacea, small amphipods. (QC 2.)

96-108B. Dahariz north; closed well, MWR no. 202/304; square, 1.5 x 1.5 m; water surface at 7.5 m, water column 0.5 m; with electric pump; UTM 0197614/1884244 (*ca.* 17°01'21"N 54°09'35"E); Cv. net; t and eC not determined; 6 April 1996. Composition: large amphipods. (QC 2.)

96-109. Al Hafah-Salalah; closed well, MWR 210/287; water surface at 3 m, water column 0.5 m; electric pump; UTM 0192220/1882130 (*ca.* 17°00'10"N 54°06'34"E); Cv. net; t 29.4°; eC 3.30 mS; 6 April 1996. Composition: Thermosbaenacea, small amphipods, snail. (QC 2.)

96-110. Al Muatazah (Salalah town); Governmental Cold Well, no. LT 016/010, near mosque; water surface at 7.5 m, water column 0.25 m; UTM 0188373/1882585 (*ca.* 17°00'23"N 54°04'24"E); Cv. net; t 30.1°; eC 2.83 mS; 6 April 1996. Composition: Thermosbaenacea, mosquito larvae (*Culex*). (QC 2, 5.)

96-111. Al-Wadi (Salalah town), covered well of restaurant, MWR no. 210/339; with electric pump; water surface at 11.5 m, water column 0.8 m; UTM 0187789/1884259 (*ca.* 17°01'17"N 54°04'03"E); Cv. net; water smells bad; t 29.6°; eC 3.96 mS; 6 April 1996. Composition: some Thermosbaenacea, large numbers of mosquito larvae (*Culex*). (QC 8.)

96-112. Ain Jarziz, Wilayat Salalah; spring at bottom of shallow cave; moderately running; UTM 0188750/1893674 (*ca.* 17°06'23"N 54°04'31"E); handnet under stones, gravel and in roots; t 28.4°; eC 689 μ S; 6 April 1996. Composition: ostracods, insect larvae and larvae of mosquitos. (QC 3, 5.)

96-113. Heelat Al-Rakah (village Thumrait); big, open well with diesel pump; MWR no. 210/923; water surface at 2.5 m, water column 6 m; UTM 0807737/2025528 (*ca.* 18°17'50"N 59°54'39"E); Cv. net; t 29.8°; eC 3.64 mS; 7 April 1996. Composition: blue-green filamentous algae, snails. (QC 7.)

96-114. Same village as 96-113 (= 18 km W of route 31); big open well, *ca.* 5 x 5 m; MWR no. 210.868; 2.5 m to water surface, water column 3.5 m; UTM 0805136/2025996 (*ca.* 18°18'07"N 59°53'10"E); Cv. net; t 29.4°; eC 4.47 mS; 7 April 1996. Composition: blue-green filamentous algae, snails. (QC 7.)

96-115. Nakhal; "hot" spring, comes from stone wall; UTM 0584706/2585395 (*ca.* 23°22'34"N 57°49'44"E); handnet; t 37.5°; eC 662 μ S; 9 April 1996. Composition: fungi, chironomid larvae, polychaetes. (QC 3.)

96-116. Same place as 96-115; small spring next to closed well; handnet; t 37.5°; eC 662 μ S; 9 April 1996. Composition: polychaetes, stenasellids. (QC 2.)

96-117. Same place as 96-115; closed well; water column 0.75 m; Cv. net; t 37.0°; eC 662 μ S; 9 April 1996. Composition: small isopods, gastropods. (QC 2.)

96-118. Wadi Nakhal, just past the cataract in the middle of the stream bed; B.-Rh.pump in gravel; probe at 50 cm below sediment surface; 100 l filtered; UTM 0584648/25863664 (*ca.* 23°22'33"N 57°49'42"E); t 33.2°; eC 627 μ S; 9 April 1996. Composition: amphipods (div. sp.), isopods (div. sp.), poly-chaetes, snails. (QC 2, 6.)

96-119. Same place as 96-118, but probe at 60 cm below sediment surface; 100 l filtered; t 35.5°; eC 620 μ S; 9 April 1996. Composition: polychaetes, isopods (div. sp.), amphipods (2 sp.), snails. (QC 2, 6.)

96-120. Same place as 96-118, but in small side stream; B.-Rh. pump in fine gravel, probe at 70 cm below sediment surface; 100 l filtered; t 34.0°; eC 632 μ S; 9 April 1996. Composition: isopods, amphipods, ostracods, Acari, polychaetes, snails (2 sp.), chironomid larvae. (QC 2, 3, 6.)

96-121. Well at Nakhal Bap Al Dhofar; opposite mosque; UTM 0584761/2587866 (ca. 23°23'54"N 57°49'46"E); 5 m to water surface, water column 10 m; Cv. net; t 28.5°; eC 1350 μ S; 9 April 1996. Composition: blue algae, some hydrobiids. (QC 7.)

96-122. Well near 96-121, in house; clean; UTM 0584731/2587886 (ca. 23°23'55"N 57°49'45"E); Cv. net; t 28.5°; eC 1320 μ S; 9 April 1996. Composition: hydrobiids. (QC 7.)

96-123. Wadi Ma'awil, well at Mousalimat, for garden use: 10.5 m to water surface, water column 9.5 m; UTM 0583168/ 2590140 (ca. 23°25'08"N 57°48'51"E); Cv. net; t 30.5°; eC 3750 μ S. 9 April 1996; Composition: some Thermosbaenacea, some cyclopids, 1 small isopod, 1 amphipod, gastropods (2 sp.). (QC 2, 6.)

96-124. Wadi Ma'awil, covered well at Mousalimat, with electric pump; UTM 0582167/2590602 (ca. 23°25'24"N 57°48'15"E); 9 m to water surface, water column 4 m; water of blue colour; t 32.0°; eC 745 μ S; 9 April 1996. Only wood debris, no organisms. (QC 10.)

96-125. Wadi Ma'awil, open well at Mouhadeth; UTM 0582731/2590745 (ca. 23°25'28"N 57°48'35"E); Cv. net; rich in calcium; t 28.0°; eC 945 μ S; 9 April 1996. Composition: small isopods, amphipods (2 sp.), ostracods, Acari, snails (2 sp.). (QC 3, 6.)

96-126. Wadi Nakhal, near road; slowly running; B.-Rh. pump, probe at 75 cm; UTM 0584918/2592170 (ca. 23°26'14"N 57°49'53"E); 100 l filtered; t 31.0°; eC 1210 μ S; 9 April 1996. Composition: amphipods, isopods, ostracods, oligochaetes, Coleoptera, algae. (QC 3.)

96-127. Wadi Ma'awil at Lajal; open well, blue water (rich in calcium); with diesel pump; UTM 0594594/2600278 (ca. 23°30'36"N 57°55'35"E); Cv. net; t 30.2°; eC 3210 μ S; 9 April 1996. No organisms. (QC 7, 10.)

Further research

The present preliminary survey shows clearly that Oman has great possibilities in the field of stygobiology (groundwater biology).

Although several areas were sampled, a large part of the country remained unexplored (regions adjacent to the Saudi and Yemenite borders, the area around Fens, Ru'us al Jibal....). Definitely undersampled are the regions between Adam and Thumrait, cave waters, and the near-coastal zones in the central part of Oman.

