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**GEOLOGY AND PALAEOBIOLOGY OF THE
NORTHERN SPERRGEBIET, NAMIBIA**

by

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Freshwater and Terrestrial Mollusca from the Early Miocene deposits of the Northern Sperrgebiet, Namibia

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In the fluvio-paludal deposits of the Northern Sperrgebiet, freshwater and terrestrial molluscs are generally rare but in certain localities or horizons they are quite abundant. The commonest terrestrial snails are *Trigonephrus* and *Dorcasia* whilst urocyclid slug plates are rare, having been found at one locality only. Four freshwater snail genera have been identified, *Tomichia*, *Lymnaea*, *Bulinus* and *Succinea*, the latter being semi-terrestrial. The terrestrial assemblage has a distinct southwestern African cachet to it, but apart from *Tomichia* the freshwater snails belong to more widespread groups. The *Lymnaea* from the Sperrgebiet are by far the oldest known in Africa, only represented in other parts of the continent during the Middle and Late Miocene, Late Pleistocene and Holocene. The *Bulinus* from Langental are the earliest known in Africa.

Introduction

Wenz (1926) described freshwater and terrestrial snails from a variety of localities in the Sperrgebiet (Feld Lübeck, Prinzenbucht, Elfert's Tafelberg, Chalcedon Tafelberg, Gamachab, Eisenkieselklippenbake, Vlei 315 south of Lochkuppe and Klinghardtfelder 24 and an unnamed site near the Klinghardt Mountains). The Namibia Palaeontology Expedition has tried to relocate these localities, with limited success. Feld Lübeck appears to be what is today known as Fiskus, and the only molluscs found in the region are sub-fossil. At Elfert's Tafelberg the only sediments likely to yield fossils are consolidated aeolianites. These contain eggshells of *Struthio daberasensis*, indicating a Plio-Pleistocene age. Chalcedon Tafelberg is rich in fossils of *Tomichia* and *Lymnaea*. Gamachab is a travertine deposit with aeolianite intercalations. It appears to be unfossiliferous, but some sub-fossil *Trigonephrus* occur there. Molluscs found by the NPE in the vicinity of Eisenkieselklippenbake were in indurated aeolianites and calcrete and comprised abundant *Trigonephrus* and in Eocene limestones (*Tomichia* and a planorbid) and Miocene calcrete (*Succinea* *Bulinus*). A crater facies at Graben, in the foothills of the Klinghardt Mountains appears to be devoid of fossils, although further searches may yield specimens, the sediments being similar in appearance to those at Chalcedon Tafelberg which are rich in snails. Vlei 315 and Klinghardtfelder 24 were not relocated by the NPE, although the latter site might be in calcrete developed on the upper surface of Buntfeldschuh.

Beetz (1926, p. 50) mentioned Reuning's discovery of a freshwater snail at Strauchpfützfelder, and Corbett (1989) mentioned a similar fossil that he found in the same area, but neither of these specimens was identified. In 2003, the NPE discovered a rich deposit at this place containing *Lymnaea* and *Succinea*, but it is extremely localised. Most of the limestones in the area, which extend over more than 1

km², appear to be devoid of fossils. Corbett also found gastropods at Grillental 6, which is the only locality to yield both terrestrial and freshwater molluscs, although from different, but adjacent horizons. The freshwater gastropods at GT 6 are covered in ironstone overgrowths which make them extremely difficult to study, but a few specimens are well enough preserved for identification to be possible. This site is particularly rich in Early Miocene mammals.

The NPE discovered a good assemblage of terrestrial gastropods in the green sands at Elisabethfeld, where they are preserved in chocolate brown ironstone. It also recovered some interesting *Dorcasia* and *Trigonephrus* in the Glastal, not far west of Kalkrücken, in pedogenic carbonate nodules that also contain tortoise scutes. A rhinocerotid metapodial from this locality belongs to an Early Miocene form, *Brachypotherium heinzeli* (Guérin, 2003). In 2004, the first gastropods were found at Langental.

Systematic descriptions

Order Gastropoda

Superfamily Prosobranchia

Family Hydrobiidae

Genus *Tomichia* Benson, 1851

Species *Tomichia* aff *alabastrina* (Morelet, 1889)

Material: Chalcedon Tafelberg, CT 3'96 - 4'96, CT 7'96, CT 14'96 - CT 27'96, CT 29'96 - CT 31'96, CT 36'96 - CT 38'96, many shells preserved in blocks of silicified dolomite or limestone.

Description: Tiny, elongated snails preserved in silicified dolomite or limestone at Chalcedon Tafelberg are identified as *Tomichia* aff *alabastrina*. The largest specimens are 3.5-4 mm high by ca 2.2-2.5 mm wide (Pl. 2, Figs 1a-1d). The lateral part of the apertural margin appears to be slightly curved rather than straight, suggesting affinities with *Tomichia* rather than *Hydrobia*. The lower part of the lip is slightly

extended and the surface of most of the shells is smooth.

Discussion: Wenz (1926) already identified this snail at Chalcedon Tafelberg under the name *Hydrobia* aff *alabastrina*, and he mentioned the existence of the same kind of shell at Klinghardtfelder 24 SW. The palaeontology of *Tomichia* is poorly known, because, being such a small shell, it is often missed by collectors. At present the genus is characteristically southern African (Brown, 1980; Connolly, 1939) with only two records outside the southern part of the continent, one in Kivu (Congo) the other Lake Tanganyika. It is possible that the genus is another example of a lineage that evolved in Southern Africa, where it lived for many millions of years before spreading northwards into more tropical areas.

The East African genus *Mohariella*, first described from Sinda-Mohari, Congo, and subsequently identified at Ngorora, Kenya (Van Damme, pers. comm.; De Groeve, 2005) is known from Middle Miocene deposits near the equator, where it occurs in astronomical numbers. The affinities of this genus possibly lie with *Tomichia*, and if so, then it would represent another southern endemic lineage that managed to spread to the central parts of Africa during the Middle Miocene, only to disappear from there soon afterwards.

Superfamily Pulmonata

Family Lymnaeidae

Genus *Lymnaea* Lamarck, 1799

Species *Lymnaea* aff *natalensis* Krauss, 1848

Material: Grillental 6, GT 28'96, GT 32'96, GT 34'96, GT 38'96, GT 40 - GT 42'96, GT 45'96, GT 20'03, many shells covered in ironstone concretions.

Chalcedon Tafelberg, CT 8'96, CT 33'96 - CT 34'96, several shells in blocks of silicified dolomite and limestone.

E-Bay, 107 EP, impressions in green clay.

Strauchpfütz, 2003, many shells in white carbonate.

Langental, LT 147'04, 8 shells in pale yellow silty carbonate.

Description: The medium-sized freshwater gastropods from Grillental 6, Chalcedon Tafelberg, Langental and Strauchpfütz are close in overall morphology and size to extant *Lymnaea natalensis*. There are 5 rapidly expanding whorls, the last one of which is higher than the spire. The largest specimens from Strauchpfütz measure 24 mm high by 15 mm wide. There are many smaller specimens from the site which I take to be juveniles of the same species as they possess three or fewer whorls. The specimens from Grillental 6 are encrusted in nodular ironstone concretions (Pl. 1, Figs 3-6), and are thus difficult to measure accurately. However, the largest specimens are about 34 mm high by 23.3 mm wide.

The material from Chalcedon Tafelberg occurs in silicified dolomite or limestone, and is difficult to clear from its matrix. However, some naturally eroded specimens have left moulds of the external surface of the shell which can be cast in latex (Pl. 1, Fig. 7). The outer surface of the shell is preserved in some specimens, and shows the slightly puckered growth lines that occur in some individuals of the extant species (Connolly, 1939). These specimens are closely similar to the fossils from Strauchpfütz.

The specimen from the green clays at E-Bay Mine is a compressed internal mould. It is plausibly a *Lymnaea* but its preservation does not permit certainty in the determination. It is merely referred to the genus without conviction. It was associated with an Early Miocene mammalian fauna.

The Langental specimens are poorly preserved (Plate 3, Fig. 4) but are similar in size and shape to the specimens from Grillental.

Discussion: Wenz (1926) reported the presence of a large "*Lymnaeen*" at Chalcedon Tafelberg, but the remains were not well enough preserved to name. However, at Vlei 315 he identified *Radix* aff *natalensis*, a large extant form, now known as *Lymnaea natalensis*. He also identified *Galba* aff *truncatula* at the latter site.

If the identification of the snails from Grillental 6, Chalcedon Tafelberg and Strauchpfütz as *Lymnaea natalensis* is correct, then they are by far the oldest known in Africa. The next oldest record is from Ngorora, Kenya, aged 12 Ma (pers. obs. 2003; De Groeve, 2005) and the next oldest is from Ain el Bey, Algiers, Algeria (Pallary, 1901) which is thought to be Late Miocene. The genus does not reappear in the East African fossil record until the late Pleistocene and it is widespread in the Latest Pleistocene and Holocene of northern Africa (Van Damme, 1984). Various *Lymnaea*-like fossils have been described from Katanga and Angola in the so-called Grès Polymorphes and silicified limestones that have been correlated to the Kalahari Group (Leriche, 1925, 1928; Jamotte, 1940; Polinard, 1932, 1933a, b). Although the material is usually poorly preserved, some of it could represent *Lymnaea*.

Lymnaea has been reported from several localities in the Maghreb. Jodot (1953, 1954, 1955) recorded the genus at Oued Imassine (Pliocene, Morocco), Oued d'Assermo n'Aït Zarhar (Early Pliocene, Morocco) and many other localities in Algeria and Morocco.

At present *Lymnaea natalensis* is widespread in the Afrotropical realm, but it does not occur in Namibia nor in the East African coastal region (Brown, 1980). Its former abundance in the Northern Sperrgebiet provides evidence that the region was not as arid during the Early Miocene as it is today.

Lymnaea natalensis, like other species of the genus, is found in all kinds of stagnant and slow-flowing water courses (Brown, 1980; Van Damme,

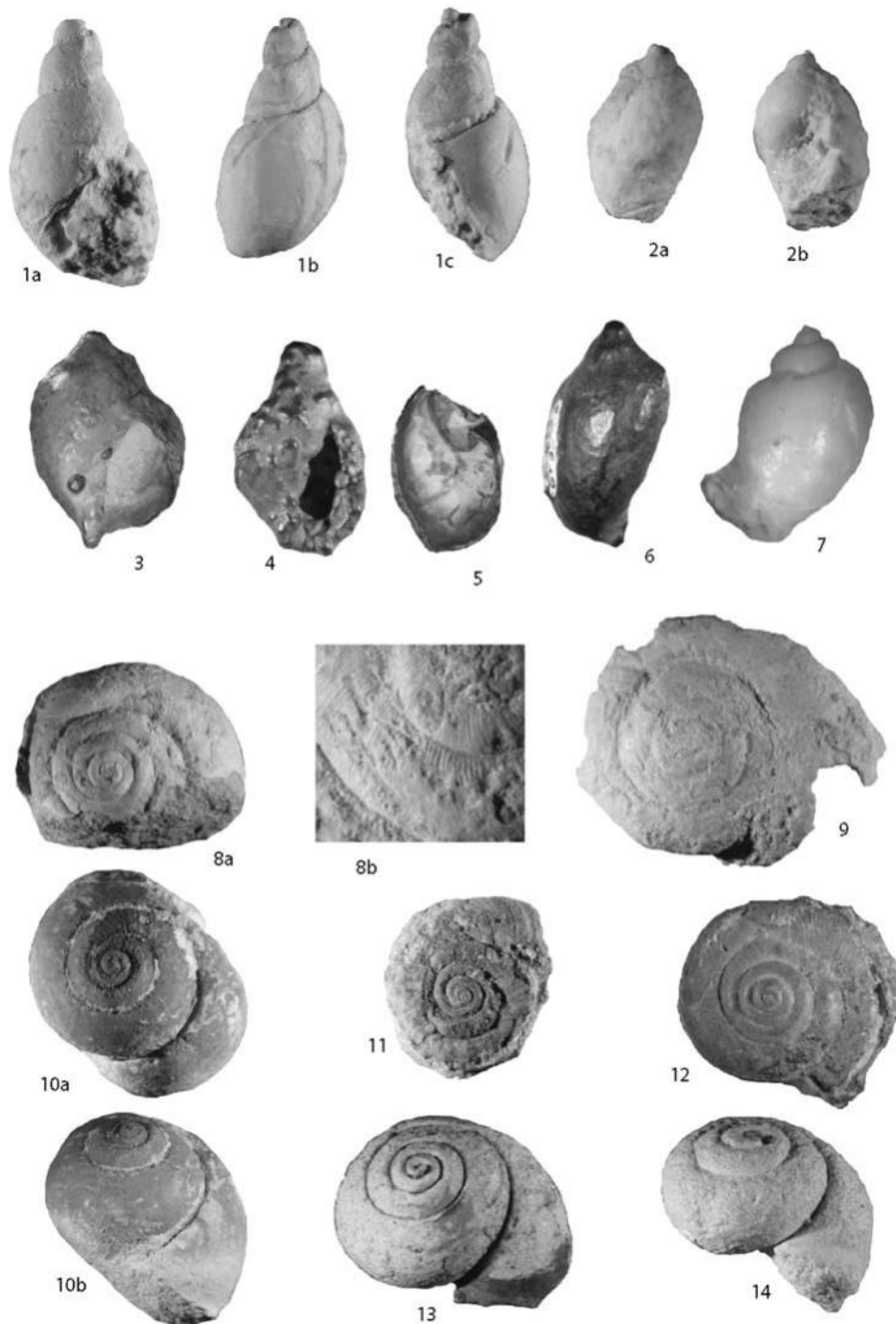


Plate 1. Early Miocene freshwater and terrestrial gastropods from the Northern Sperrgebiet, Namibia.

1. Strauchpfütz, *Lymnaea* aff *truncatula*, a) apertural, b) dorsal views.
2. Strauchpfütz, *Succinea* sp. a) dorsal, b) apertural views.
3. Grillental, GT 35'96, *Lymnaea* aff *natalensis* apertural view.
4. Grillental, GT 35'96, *Lymnaea* aff *natalensis* apertural view.
5. Grillental, GT 35'96, *Lymnaea* aff *natalensis* section through body and penultimate whorl.
6. Grillental, GT 35'96, *Lymnaea* aff *natalensis* dorsal view.
7. Chalcedon Tafelberg, CT 8'96, *Lymnaea* aff *natalensis*, dorsal view.
8. Grillental, GT 174'96, *Dorcasia* sp. a) dorsal view, b) close up of sculpture.
9. Grillental, GT 175'96, *Dorcasia* sp. dorsal view.
10. Grillental, GT 19'03, *Trigonephrus* sp. a) dorsal, b) oblique anterior views.
11. Elisabethfeld, EF 20'03, *Dorcasia* sp. dorsal view.
12. Elisabethfeld, EF 20'03, *Dorcasia* sp. dorsal view.
13. Grillental, GT 124'96, *Trigonephrus* sp. oblique anterior view.
14. Grillental, GT 123'96, *Trigonephrus* sp. oblique anterior view.

1984). It is rarely encountered in seasonal pools, but is reported to aestivate for up to six months (Bitakaramire, 1968).

Species *Lymnaea aff truncatula* (Müller, 1774)

Material: 2003, several internal moulds from Strauchpfütz. LT 146'04, a shell from Langental, LT 148'04, two shells from Langental.

Description: The Strauchpfütz shells are elongated, with the body whorl relatively smaller than in *Lymnaea natalensis* and with the whorls being more convex (Pl. 1, Fig. 1). The specimens are appreciably smaller than *L. natalensis*, being 14-15 mm high and 7.2 mm wide at the body whorl.

The specimens are unlikely to be the young of *Lymnaea natalensis*, as they possess 4 to 5 whorls and the whorls are more convex.

The specimens from Langental are similar to the Strauchpfütz material (Plate 3, Figs 2-3).

Discussion: Wenz (1926) reported the presence of this species at Vlei 315, a site that the Namibia Palaeontology Expedition did not relocate. The fossils from Strauchpfütz are the right size and shape to belong to *Lymnaea aff truncatula*, even though none of them retains the shell. If the determinations are correct, this would indicate that the lymnaeids were already quite diverse in southern Africa during the Early Miocene.

European *Lymnaea truncatula* has squatter, more steplike whorls than the Sperrgebiet specimens described here, and because of its more elongated turritiform shell it more closely resembles *Lymnaea palustris* (Müller). In consequence the material could instead belong to the *Stagnicola* group rather than the *Galba* one. Better preserved shells are required before a more confident identification can be made.

Family Planorbidae
Genus *Bulinus* Müller, 1781
Species indet.

Material: LT 145'04, several shells from Langental pale yellow carbonate.

Description: The shells are sinistral, small, with low spires and rapidly expanding whorls (Plate 3, Fig. 1a, 1b). A typical specimen is 4.5 mm high by 4.3 mm wide. Some individuals have slightly taller spires but not to the extent seen in *Lymnaea*.

Discussion: The bulinids from Langental are the earliest known in Africa. They are typically sinistral, low spired and with rapidly expanding whorls. All the specimens are small, suggesting stunted growth in sub-optimal environmental conditions.

Family Succineidae
Genus *Succinea* Draparnaud, 1801
Species *Succinea incertae sedis*

Material: Strauchpfütz, 2003, a single shell preserved in white carbonate.

Description: A single internal mould from Strauchpfütz has an extremely short spire and a vast body whorl (Pl. 1, Fig. 2). It consists of 3 whorls, is 13 mm high and 7.6 mm wide. The specimen recalls the semi-terrestrial genus *Succinea* which is common today in many parts of tropical and subtropical Africa, often surviving in seasonally water-logged areas such as pans. The genus has been collected from the Early Miocene of Kenya (Pickford, 1995) and the Namibian specimen provides another early record of it.

Family Urocyclidae
Genus and species indet.

Material: Grillental 6, a few slug plates preserved in calcite.

Description: In wet screening residues from Grillental 6, from which abundant Early Miocene micro-mammals were recovered, a few slug plates were found that resemble those that occur in urocyclid slugs.

Discussion: Although it is practically impossible to identify these remains beyond the family level, they are important in revealing that the Grillental area must have been considerably more humid at the time of deposition than it is now. At present the slugs that are geographically closest to Grillental are those from the East Coast of southern Africa (Connolly, 1939) where they inhabit seasonal woodland and forest. Since some slugs can aestivate in protected micro-environments (hollow logs, under stones etc.) they can survive in areas which are markedly seasonal, including areas that become quite cold, but they cannot survive in areas as dry as the Namib. Thus, their presence in the northern Sperrgebiet during the Early Miocene indicates that the area was appreciably more humid and better vegetated at that time than it is today.

Family Acavidae
Genus *Trigonephrus* Pilsbry, 1905
Species *Trigonephrus incertae sedis*

Material: Grillental 6, GT 116'96 - GT 122'96, GT 126'96 - GT 151'96, GT 153'96, GT 156'96 - GT 158'96, GT 160'96 - GT 173'96, GT 21'97, GT 12'00, GT 19'03, numerous shells preserved in a sandy marl, some with ironstone concretionary covers, others coloured superficially by iron oxides, others devoid of ferric influence, but all from the same horizon.

Elisabethfeld, EF 69'94, EF 256'01, EF 257'01, 14 small shells preserved in ironstone.

Glastal, GT 2003, an internal mould preserved in a pedogenic carbonate nodule.

Description: The collection from Grillental is comprehensive and gives an excellent idea of the range of variation in the species (Pl. 1, Figs 10, 13-14). The material is preserved as internal moulds. The shell is globose, with 5-5.5 whorls, the last of which descends rapidly towards the aperture, which in adults is reflected. The umbilicus is open. The specimens fall into the lower end of the size range of extant *Trigonephrus rosacea*, the tallest specimens reaching 30.5 mm but most ranging between 20 and 25 mm. The width is about the same as the height, with adult specimens measuring between 22 and 30.6 mm. A particularly well preserved specimen measures 23 mm high by 27.3 mm wide.

The specimens from Elisabethfeld are preserved with their shells, but these have often been sandblasted to the extent of removing any surface features that may have been present. However, a few specimens preserve patches of unabraded shell, and these show the characteristic broad radial growth ridges that typify *Trigonephrus rosacea* for example. The shells from Elisabethfeld are smaller than those from Grillental, most specimens being less than 25 mm in width.

The single specimen of *Trigonephrus* from Glastal is a poorly preserved internal mould (Pl. 2, Fig. 2). It is difficult to measure accurately on account of abrasion that it has suffered but it is evident that it was not a large specimen (ca 26 mm diameter). The body whorl shows the characteristic rapid descent towards the aperture, and it was evidently adult when it died.

Discussion: Wenz (1926) described and figured several specimens of *Trigonephrus* from southwest of Eisenkieselklippenbake. Shells of this genus are common in the Kalkrücken aeolianites and this is most likely the locality from which Wenz's material derived and as such it need not concern us further in this paper, being much younger than Early Miocene (probably Plio-Pleistocene). Other material from Elfert's Tafelberg and Vlei 315 is also most probably from aeolianite deposits as is material from "Feld Lübeck" (= ?Fiskus) and Gamachab. Thus none of the specimens described by Wenz came from the Early Miocene deposits. All this material was attributed by Wenz to the extant species *T. rosacea*.

Trigonephrus is a snail that is most typical of the winter rainfall belt of southern Africa (Connolly, 1939; Ward *et al.*, 1993) but it does extend into areas with summer rainfall, such as high Namaqualand. It reaches its greatest size range in the wetter parts of the winter rainfall belt such as southern coastal Namaqualand, but is usually appreciably smaller in areas near the edges of its distribution, such as in high

Namaqualand. The reduced shell size of the Grillental and Elisabethfeld populations suggests that conditions were not ideal for the genus, from which it may be deduced that during the Early Miocene the area was either at the edge of the winter rainfall belt or was in the belt that experienced both winter and summer rainfall or even just summer rainfall.

By the time that the Rooilepel Aeolianites began accumulating some 16 to 17 Ma (Pickford and Senut, 2000), the average size of the *Trigonephrus* increased considerably, from which it is inferred that from the Middle Miocene onwards the region lay well within the winter rainfall belt (Ward *et al.*, 1993).

Genus *Dorcasia* Gray, 1838 Species *Dorcasia incertae sedis*

Material: Grillental 6, GT 125'96, GT 154'96, GT 159'96, GT 13'00, four shells preserved in sandy marl.

Glastal, Glastal 2, Glastal 3, four shells preserved in pedogenic carbonate nodules.

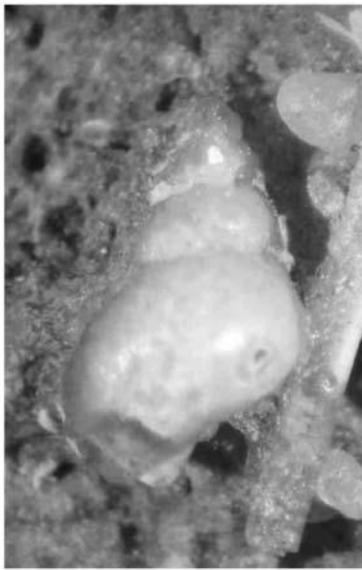
Elisabethfeld, EF 259'01, 9 small shells preserved in ironstone; EF 20'03, 2 shells in ironstone.

Description: The fossils from Grillental 6 are large and possess all the features of the genus *Dorcasia* including the open umbilicus, the flattened spire, rapidly descending body whorl in adults with the aperture facing ventrally and the fine closely spaced radial ribbing on the upper and lateral surfaces of the shell. Some of the specimens from the site are large (35+ mm wide) (Pl. 1, Figs 8-9).

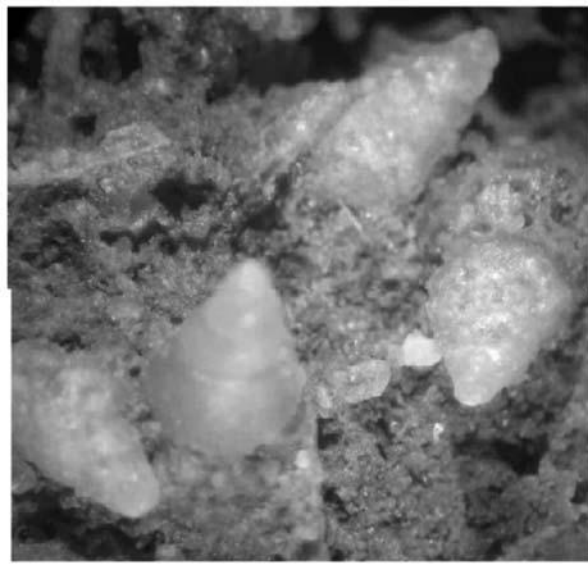
The fossils from Glastal are also typical of the genus, although the preservation is not as good, in most specimens the shell having been dissolved leaving internal moulds only, which have been sandblasted (Pl. 2, Fig. 3). However, the specimens are large (40.5, 37 and 41.3 mm in diameter by ca 23 mm high for the last specimen). One specimen retains some shell which shows the characteristic, closely spaced radial ridges.

Elisabethfeld has yielded a dozen small snails which in all features of the shell comply with the genus *Dorcasia* (open umbilicus, descending body whorl in adults, reflected aperture, fine, closely spaced radial ribbing on upper and lateral surface of the shells, slight angulation at shoulder of whorls). The fossils range in diameter up to 16 mm (Pl. 1, Figs 11-12), which is small for the genus and suggests a population that was surviving in marginal conditions.

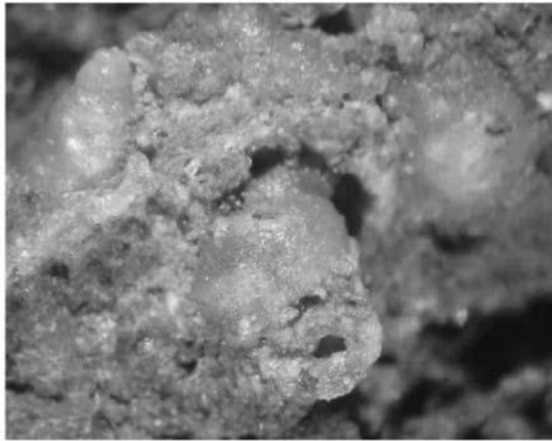
Discussion: Wenz (1926) described a well preserved specimen of *Dorcasia* from Gamachab, but the deposits there are considerably younger than Early Miocene, and do not concern us here. Wenz erected the species *D. kaiseri* Wenz, 1926, for this material. On the basis of specimens from indurated sandstone beneath Chalcedon Tafelberg, he erected another species *D. antiqua* Wenz, 1926, but this material is also



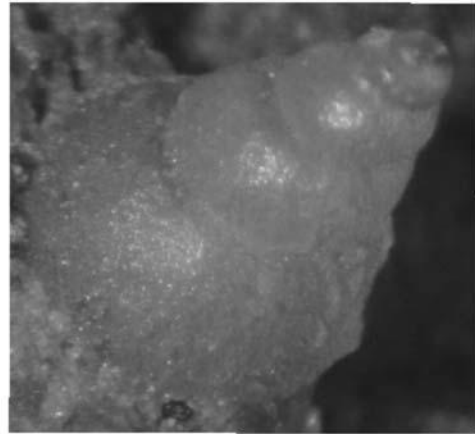
1a



1b



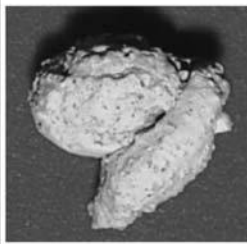
1c



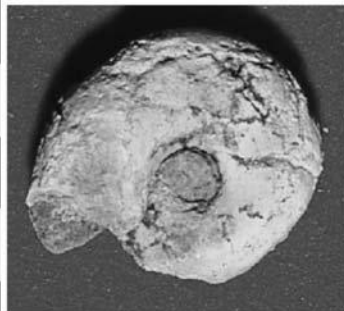
1d



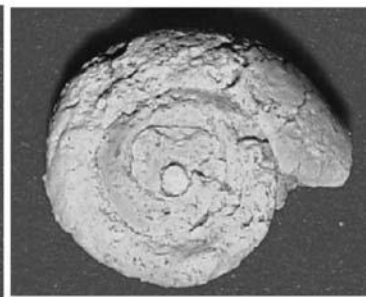
2a



2b



3a



3b

Plate 2. Freshwater and land snails from Chalcedon Tafelberg and Glastal.

1. Chalcedon Tafelberg, CT 3'96, *Tomichia* aff *alabastrina*, a) dorsal view, b) four individuals in various orientations, c) apertural view, d) oblique dorsal view.
2. Glastal, Glastal'03, *Trigonephrus* sp. eroded internal mould a) dorsal, b) inferior views.
3. Glastal, Glastal'03, *Dorcasia* sp. eroded internal mould, a) inferior, b) dorsal views.

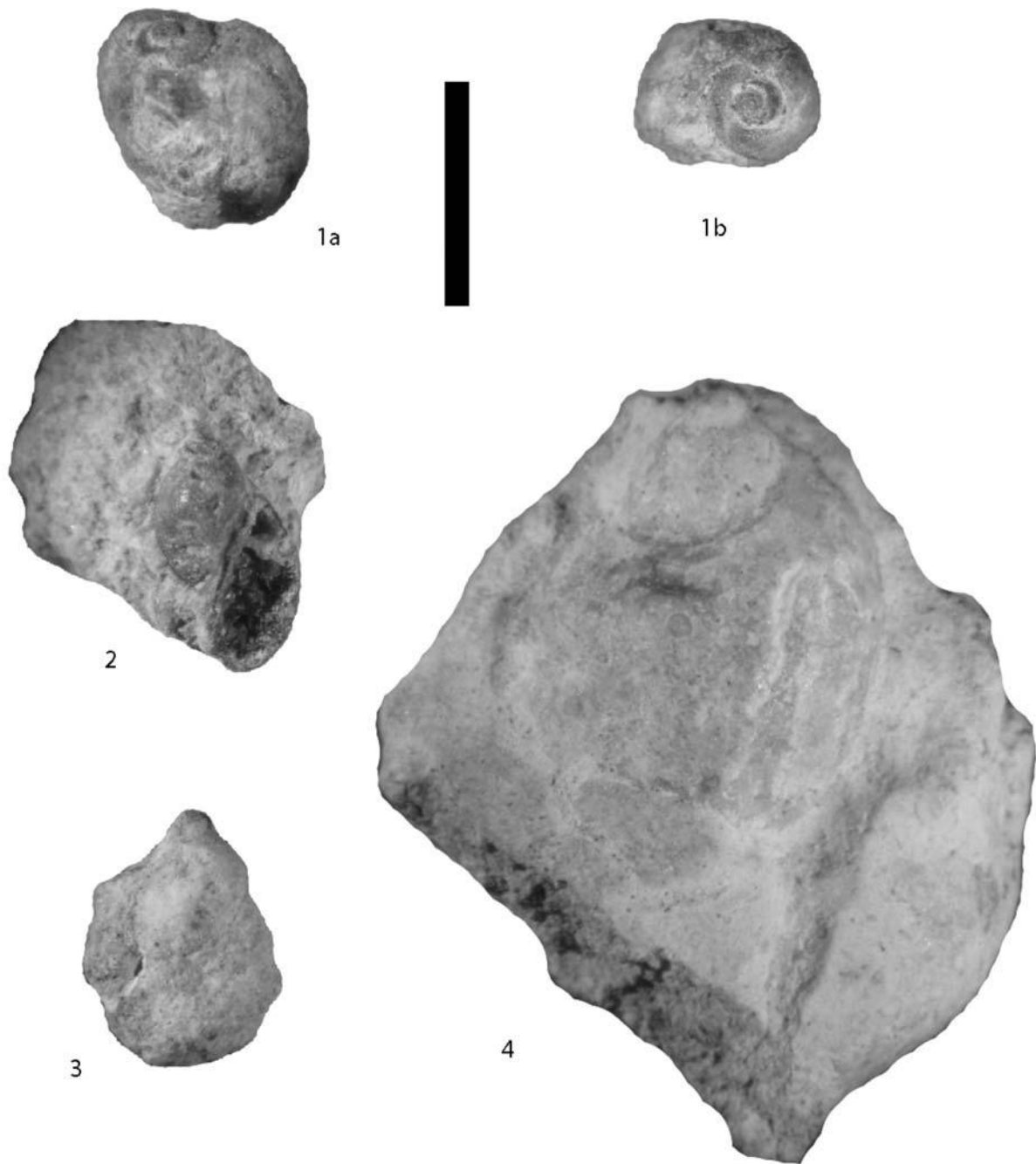


Plate 3. Freshwater snails from Langental (Scale Bar : 5 mm).

1. Langental, LT 145'04, *Bulinus* sp. sinistral shell, a) dorsal view (slightly oblique to show flattened spire), b) apical view.
2. Langental, LT 146'04, *Lymnaea* aff *truncatula*, ventral view.
3. Langental, LT 148'04, *Lymnaea* aff *truncatula*, dorsal view.
4. Langental, LT 147'04, *Lymnaea* aff *natalensis*, oblique dorsal view of a sand blasted specimen.

very young, probably Pleistocene. Thus none of the *Dorcasia* described by Wenz was from the Early Miocene deposits.

There are clearly two kinds of *Dorcasia* in the Sperrgebiet Early Miocene samples collected by the NPE. Those from Elisabethfeld are small and relatively flat, whilst those from Grillental 6 and Glastal

are very large. At present, the largest specimens of *Dorcasia* occur in summer rainfall areas, and the populations that live in winter rainfall zones tend to be small. This would suggest that during the Early Miocene Grillental and Glastal were within the summer rainfall belt, but Elisabethfeld is anomalous, in that the *Dorcasia* from there is small and more in-

dicative of winter rainfall areas or other marginal conditions for the genus.

Conclusions

The freshwater and terrestrial gastropods from the Early Miocene deposits of the Northern Sperrgebiet are of interest on two main counts - palaeoenvironment and biogeography.

The terrestrial snails, *Dorcasia* and *Trigonephrus*, are endemic to southern Africa, belonging to the family Acavidae. At present their ranges overlap in the latitude of the Orange River, *Dorcasia* being predominantly Namibian in distribution, and *Trigonephrus* South African (Pickford and Senut, 2000, Fig. 4-43). The range of *Dorcasia* thus lies mainly within the summer rainfall belt, with the shells of those in the winter rainfall area being generally smaller than those that inhabit the summer rainfall areas. In contrast, *Trigonephrus* is predominantly a winter rainfall form, but it does extend into neighbouring areas of summer rainfall, but in these areas its shell is appreciably smaller than those that occur well within the belt. Thus the presence of large *Dorcasia* and small *Trigonephrus* at sites such as Grillental 6 and Glastal, suggest that they lay within a summer rainfall belt, but not far removed from areas with winter rainfall. Elisabethfeld is somewhat different from Grillental 6 and Glastal, as both the *Dorcasia* and *Trigonephrus* from there are small, suggesting marginal conditions for both genera. We may thus surmise that in Southern Africa there was already a winter rainfall regime by the Early Miocene, but that its centre lay some distance to the south of the northern Sperrgebiet, which was most likely within a summer rainfall belt, but with evidence of winter rainfall not too far away. The presence of urocyclid slugs at Grillental 6 is also suggestive of sub-tropical conditions, with some relatively dense and (seasonally) humid vegetation cover. The extant urocyclids closest to the Sperrgebiet occur in Natal and Moçambique where the rainfall is over 510 mm per year.

Apart from the urocyclid slugs from Grillental 6, the Early Miocene terrestrial snails of the Sperrgebiet are firmly southern African in terms of their biogeographic affinities. The most common taxa found belong to the family Acavidae, a southern African endemic family (Connolly, 1939), the rarer urocyclid belonging to a group that is widespread in tropical and subtropical Africa.

The Early Miocene freshwater snails from the Sperrgebiet provide some information about the palaeoclimate. The two species of *Lymnaea* found there are similar in overall shape to the Eurasian species *L. peregra* (Europe - Middle East - NW Africa) and *L. palustris* (Eurasia) which today also occur in North Africa. Since they are spread by birds, distances are not limiting but temperature is (Van Damme, pers. comm.). Their presence (if the fossil species had the

same ecological requirements) would imply that at the time of their deposition, the climate in the Sperrgebiet was markedly seasonal with a protracted wet, cold period (as in the North African Mediterranean climatic zone). This indication agrees with other evidence that during the Early Miocene, the Sperrgebiet was close to or within a winter rainfall belt.

The lymnaeid snails are of interest from a biogeographic point of view. The genus *Lymnaea* is widespread today, living in unstable water bodies in many parts of the Old World. It has been recorded in Middle Miocene deposits of East Africa, but it only becomes common in that region in Pleistocene times. Yet it is well represented in the Early Miocene of the Sperrgebiet, especially at Grillental 6 where it is associated with mammals of that age. The genus is common in the Maghreb from early Pliocene times onwards, and it has a long fossil record in Europe and Asia.

The *Bulinus* from Langental is the earliest preserved assemblage from Africa. The small size of the individuals suggests sub-optimal growing conditions.

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Addendum

In the South African Museum there is a block of beige to yellow impure limestone (SAM PQ 3050) from Reuning breccia pipe, Klinghardt Mountains, Namibia, which contains several specimens of *Lymnaea* aff. *truncatula*. An anonymous letter accompanying the block explains that it "was found on the eastern flank of the Reuning breccia pipe approximately 7 km to the east of the Oranjemund - Lüderitz road, 100 km south of Lüderitz. The limestone appears to overlie the pipe and the associated phonolite

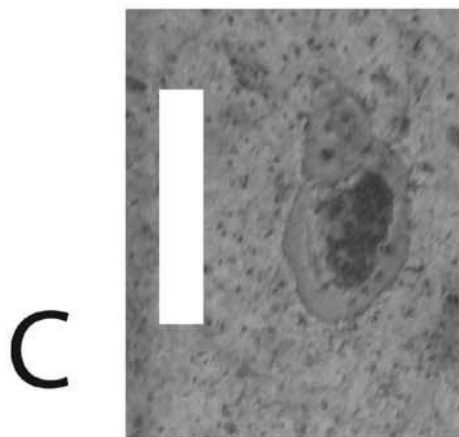
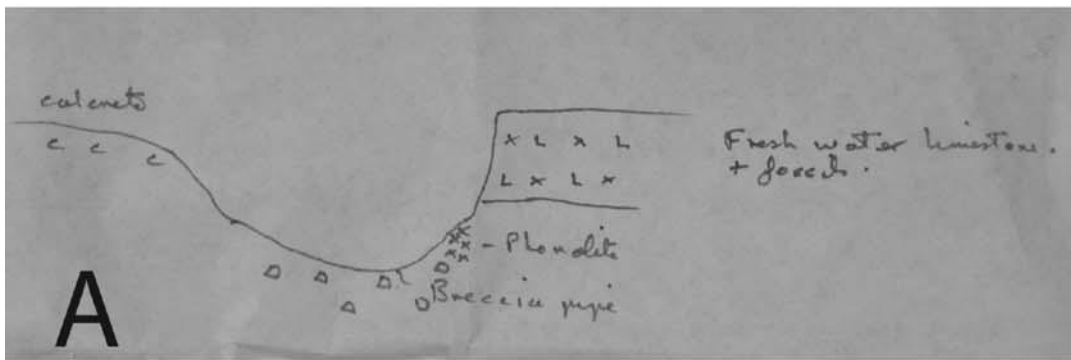


Plate 4: A) a sketch section of the Reuning breccia pipe limestone occurrence, B) the limestone block (scale 10 cm), and C) a detail of the one of the individuals of *Lymnaea* aff. *truncatula* (scale bar 10 mm).

body. Phonolites have been dated in this area at 37 m.y. +/- 2 m.y. It is thought that the freshwater limestone is in the region of 20 +/- m.y.”

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