First *Rhipidothyris* (Brachiopoda) from southern Africa: Biostratigraphic, paleoecological, biogeographical significance

První *Rhipidothyris* (Brachiopoda) z jižní Afriky: biostratigrafický, paleoekologický a biogeografický význam

(11 figs)

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Discovery and recognition of the terebratuloid brachiopod *Rhipidothyris* in the Karoopoort Formation of the uppermost Bokkeveld Group permits one to date that formation as of Givetian, later Middle Devonian age. Paleoecologically a low diversity, single species *Rhipidothyris* Community indicates a Benthic Assemblage 2, shallow subtidal position, with the presence of many articulated shells suggesting relatively quiet water conditions. *Rhipidothyris* is known elsewhere in Givetian age beds from Bolivia, New York, Pennsylvania, Nevada, Libya (including Devonian beds that Vlada published on), eastern Australia and possibly Fergana. The presence of *Rhipidothyris* in Bolivia and South Africa is consistent with the presence in each area of relatively warm water conditions, following after the demise of the cold water Malvinokaffric Realm of the Pragian through Eifelian (mid-Early through earlier Middle Devonian).

Key words: Devonian, South Africa, *Rhipidothyris*

Introduction

The Bokkeveld Group, the medial unit of the tripartite Cape Supergroup (Fig. 1), is well known for its fossiliferous content. The fossils from this sequence were first described from 1852 onwards and comprehensive reviews are given by Reed (1925), Theron (1972) and Oosthuizen (1984). The fossils are markedly endemic and typical of the Pragian-Eifelian Malvinokaffric Realm fauna of Gondwana (Boucot 1971, 1975).

However, because almost all these fossils come from the lower half of the Bokkeveld Group (the Gydo through Voorstehoek formations), the misconception arose that fossils with a marine affinity were not present in the upper part of the Group. This in turn was largely responsible for the long held belief that the upper part of the Bokkeveld and overlying Witteberg sequence represented estuarine or fluvial deposition (Du Toit 1954).

It was only from 1972 after the overall stratigraphic sequence was finally determined that it became clear that benthic marine invertebrate fossils in fact occurred in all of the formations up to the Waboomberg Formation (Fig. 2). Additionally, in 1983 a shallow water marine assemblage was described from the basal unit (Wagen Drift Formation) of the overlying Witteberg Group and more recently a variety of vertebrate mate-

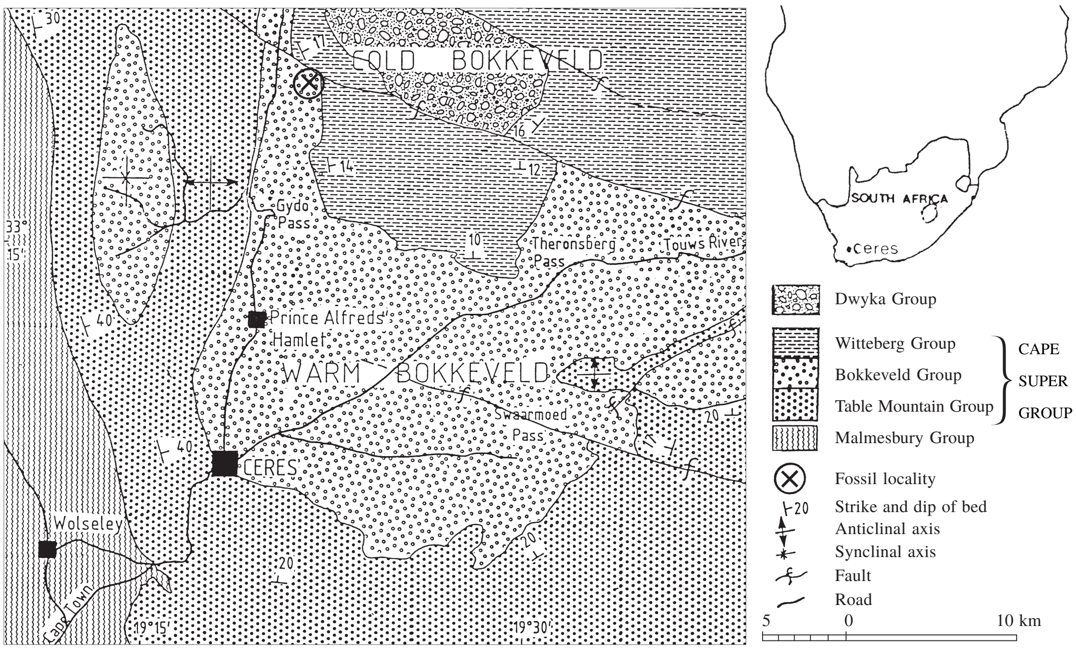

Fig. 1 Distribution of the Cape Supergroup in the Ceres area.

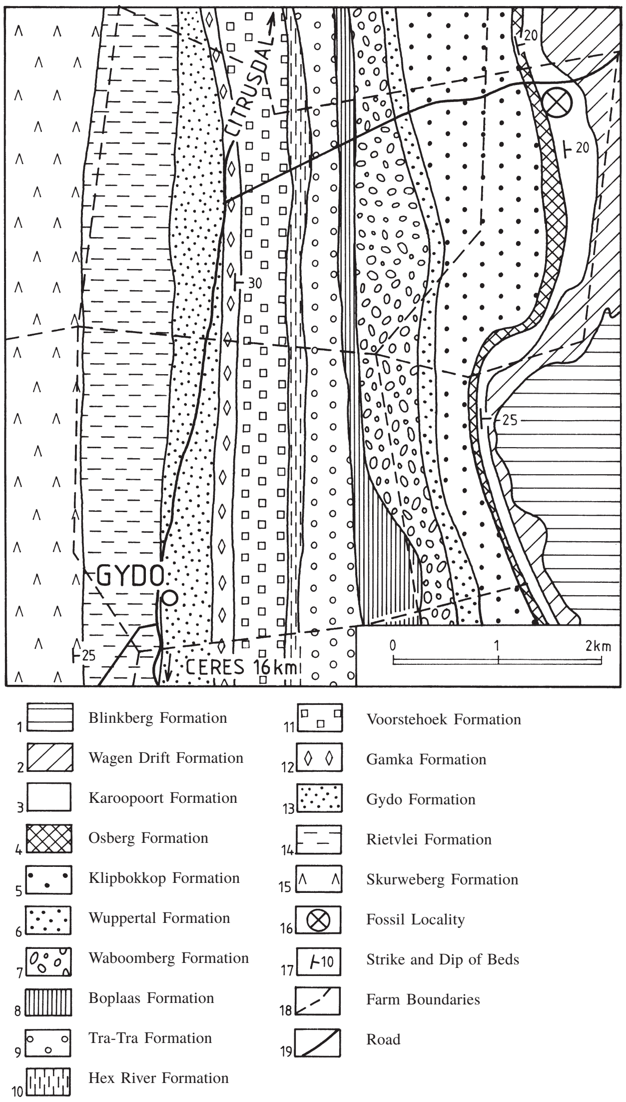

Fig. 2 Subdivision of the Bokkeveld Group in the Gydo area, with the fossil locality indicated.

rial (Anderson et al. 1999) from the Klipbokkop Formation (Fig. 2).

The present investigation is the culmination of a brief stop early in 1997 on the return from field work in the company of a former colleague (J. E. Almond) of the Council of Geoscience. A freshly excavated farm dam (Fig. 3) in the Karoopoort Formation next to the road and time to spare, resulted in one of us (JNT) finding a dark grey, well indurated mudstone lense packed with brachiopods that are the subject of this contribution.

Stratigraphic relations of the *Rhipidothyris* locality

Over most of the Western Cape the Karoopoort Formation, the uppermost unit of the Bokkeveld Group, generally forms a narrow, conspicuous, grassy, scree covered, recessive ledge directly below the vertical cliffs constituted by the lower Witteberg sandstones (Fig. 4). Good exposure of the unit, as present along the western flank of Gydo Mountain (Fig. 5), is therefore rare. The Karoopoort For-

Fig. 3 Fossil site (indicated with arrow) on the farm Klip Kopjes 325, about 27 km north of Ceres.

Fig. 4 Western flank of Gydo Mountain. The outcrop of the Karoopoort Formation is depicted by the thin grassy ledge directly below the Witteberg Sandstone cliffs.

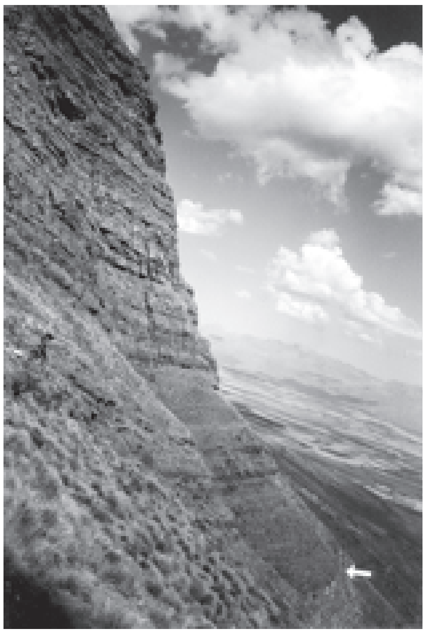

Fig. 5 Karoopoort outcrops at Gydo Mountain above the Osberg Formation (indicated with arrow) and grading upward into the Witteberg cliffs.

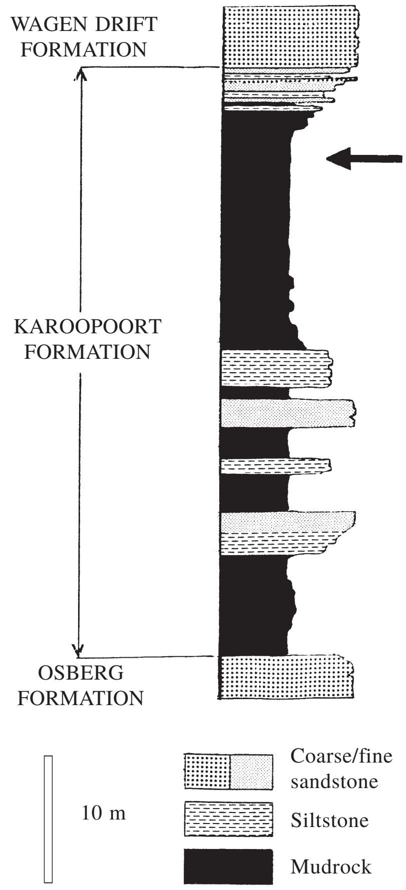

Fig. 6 Stratigraphic section of the Karoopoort Formation at Gydo (indicated level of the fossiliferous lense indicated by the arrow).

Fig. 7 Upward coarsening of the Karoopoort Formation on the farm Klip Kopjes 325.

mation consists locally of about 55 meters of laterally grading, alternating sandstone, siltstone and mudstone beds (Fig. 6). Thin intraformational conglomerate lenses are sometimes present as well. Interference and current ripple-marks and small scale scour-and-fill structures and ripple laminated beds alternate with extensively bioturbated units. *Spirophyton* is the most common trace fossil, but not in the same abundance as is characteristic of the overlying more arenitic Witteberg beds (Wagen Drift Formation). Plant stems also occur (Theron 1970). The cherty brachiopod bearing mudstone lense referred to above occurs in the upper part of the thicker mudstone zone.

The gradual upward coarsening trend which characterizes the Karoopoort Formation elsewhere as well as all the other pelitic formations of the Bokkeveld Group, appears at Gydo as well over the uppermost 15 meters (Fig. 6). The upper mudstone zone gradually becomes more silty until eventually thin (20–40 cm), light grey, fine grained, well sorted sandstone horizons, similar to the overlying Witteberg beds, appear in it. These sandstone horizons gradually become more prevalent (Fig. 7).

All of this suggests the action of relatively sluggish currents probably in a shallow marine environment. The appearance of the upper intercalated, light grey, more mature sandstone beds in turn obviously heralding the increased current action associated with the Witteberg transgressive episode.

Age

Elsewhere in the circum-Atlantic region where *Rhipidothyris* is known, it occurs only in Givetian age beds. Isaacson (1974) originally considered the Bolivian occurrence in the Cha-Kjeri Formation to be of “late Emsian, with a lesser possibility of mid-Eifelian.” age. More recent work, particularly palynological investigations (Blieck et al. 1996), permit us to place Isaacson’s locality in the Givetian. The North American and North African occurrences have all been placed within the Givetian.

It is of interest here that the slightly older Klipbokkop Formation contains vertebrates also considered to be of Givetian age (Anderson et al. 1999), whereas the Witpoort Formation in the upper Witteberg Group has yielded vertebrates of Famennian age (Anderson et al. 1999). The vertebrate data are thus consistent with a Givetian age for the Karoopoort Formation. Also significant is the occurrence of Givetian-Frasnian brachiopods in the basal Wagen Drift Formation of the Witteberg Group (Boucot et al. 1983).

Paleoecology

The Karoopoort Formation occurrence consists of a single bedding plane with prolific *Rhipidothyris* associated with a 3–4 cm interval yielding less abundant specimens of the genus. Some are articulated in the beak down position, suggesting that the specimens are largely in place. The absence of a growth series suggests that all of the specimens represent single spatfalls with a high survival rate. The occurrence is similar ecologically to those known from New York, Bolivia and Libya. The Queensland specimens (McKellar 1966) are from a very limited borehole sample that precludes any ecological remarks. The Nevada material (Johnson 1971) is from a medium diversity locality (FF-24) which belongs in BA 3–4, i.e. is ecologically very distinct from the New York, Bolivian (Isaacson 1974), Libyan (Boucot et al. 1983) and South African materials. All of the single taxon lo-

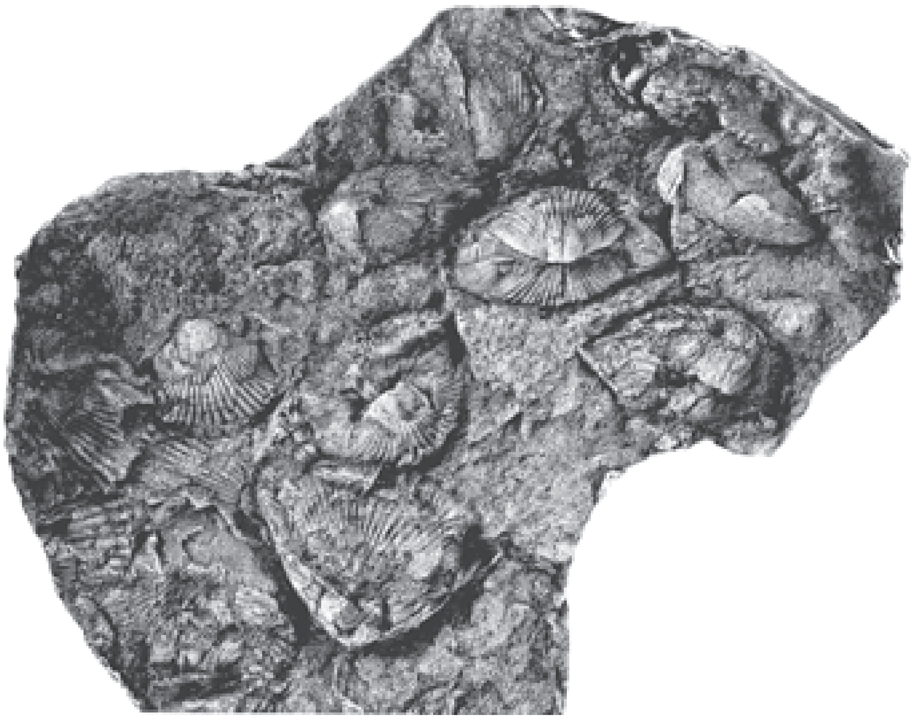

Fig. 8 *Rhipidothyris oosthuizeni* Boucot, sp. nov. Rubber replica of exteriors, x2. Note the ventral valve overhanging the dorsal valve, and the beak down position of many of the shells, indicating life position. Specimen No. GSO B5500.

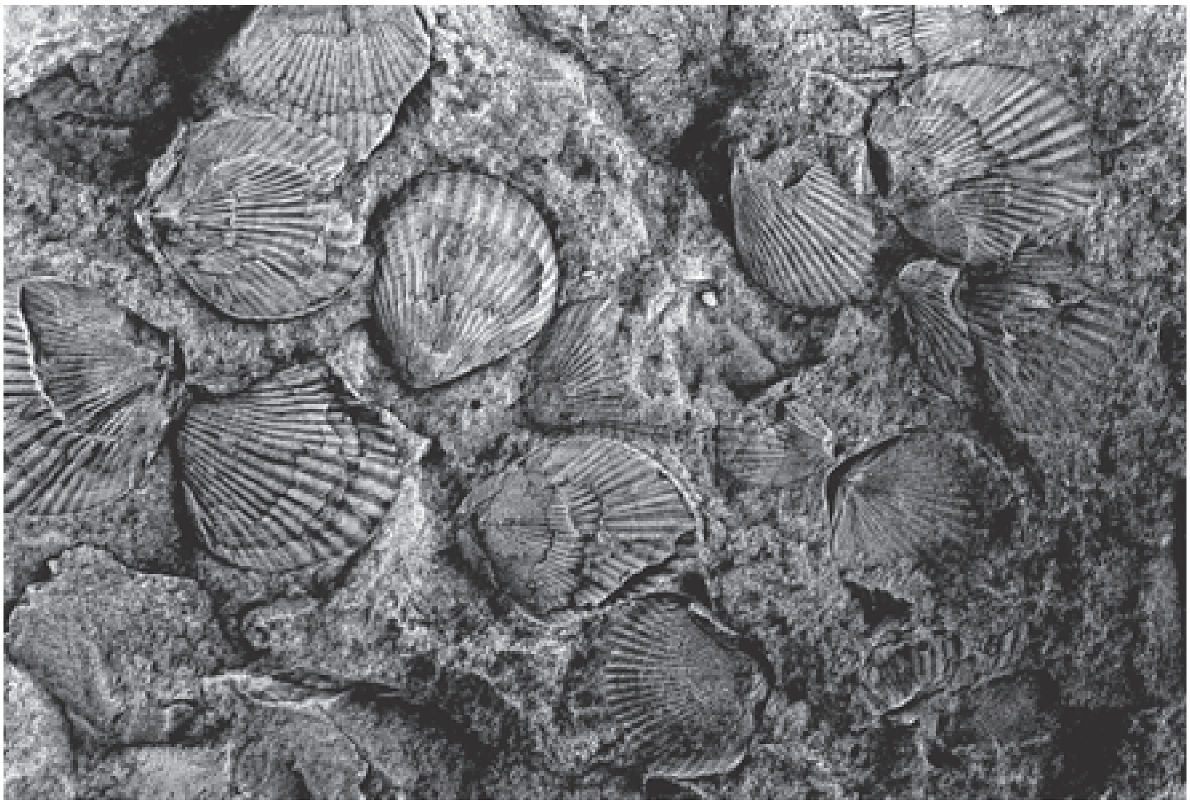

Fig. 9 *Rhipidothyris oosthuizeni* Boucot, sp. nov. Impression of interiors and exteriors, x2. Note the articulated dorsal valve, a little to the left of center, with a median septum and discrete deltidial plates. Specimen No. GSO B5501.

Fig. 10 *Rhipidothyris oosthuizeni* Boucot, sp. nov. Impression of dorsal valve exterior, x7, showing presence of punctae. Specimen No. GSO B5502.

Fig. 11 *Rhipidothyris oosthuizeni* Boucot, sp. nov. The holotype (Specimen No. GSO B5503) is the dorsal view of a specimen, roughly in the middle of a slab, with conjoined valves that shows the delthyrial area very well, including the apical foramen and the deltidial plates, x4. The holotype, and the other specimen on this slab with conjoined valves, might be prepared to show the presence of the septalium. However, owing to the rarity of this material we have not chanced the work, which might also reveal the presence of a loop. One of the impressions also shows fillings of punctae.

calities are assigned to BA 2 because they occur in very nearshore, shallow water positions that are most easily interpreted as subtidal. It is of importance ecologically to note that the closely related subfamily Globithyrinae, with the genera *Globithyris* and *Rhenorensselaeria* is also a nearshore, Benthic Assemblage 2 group, well known from western Europe and the Northern Appalachians at many localities. *Spirophyton* (=*Zoophycus*), that also occurs in the Karoopoort Formation commonly occurs in BA 3 (Boucot 1975).

Biogeography

Rhipidothyris is well known from New York, cited from Pennsylvania (Cloud 1942, p. 87), Nevada, Libya, Bolivia, Queensland, and possibly from Fergana. Nalivkin's (1930, p. 91) Fergana *Trigeria* (?) *lepida* is only questionably assigned, because the presence of a median septum is uncertain, although its Givetian age makes it unlikely that the shell is a mutationellinid. By the Givetian the highly endemic, cool climate Malvinokaffric Realm of the earlier Devonian had disappeared to be replaced by a relatively cosmopolitan Old World Realm, except for the Appohimchi Province of central and eastern North America plus northern South America. The South African *Rhipidothyris* is good evidence for the replacement of the Malvinokaffric Realm by the warmer water Old World Realm, as is also the case elsewhere in this realm, Bolivia being a good example. Suarez-Riglos (1967, unpublished) describes Brazilian, Parnaiba Basin material assigned questionably to *Rhipidothyris*, but the figures and description leave doubt as to the assignment.

Systematic paleontology

Family Rhipidothyridae Cloud, 1942
Subfamily Rhipidothyrinae Cloud, 1942

Genus *Rhipidothyris* Cooper et Williams, 1935

Rhipidothyris oosthuizeni Boucot, sp. nov.

Figs 8–11

Etymology: Named after Roy Oosthuizen of Zwartskraal, near Klaarstroom, east of Prince Albert, in recognition of his major, paleontological activities, including the collecting and recognition of many significant South African finds. His recent death deprives us all of not only a friendly colleague, but of one whose contributions have had global significance in terms of not only basic paleontology, but also finds of major paleogeographic significance.

Exterior: Medium size, gently ventribiconvex, subcircular to subovate outline with length exceeding width.

Anterior margin rectimarginate, crenulate. Lateral and anterior margins rounded. Ventral beak suberect to slightly incurved, with dorsal beak covered. Delthyrium open, bounded laterally by deltidial plates. Terebratulid cardinal margin, with relatively short ventral palintrope. Punctate, with punctae visible externally on several specimens owing to weathering. Ornamented by about 20 simple costae, originating at the umbo, that widen anteriorly, and have U-shaped crests and interspaces. A single concentric growth line may be prominent anteriorly.

Ventral interior: Short dental lamellae. Ventral muscle field unimpressed. Interior of valve strongly impressed by the external ornamentation.

Dorsal interior: A median septum is present, extending about one-third the distance to the anterior margin. Presence of a short cruralium not proved owing to the somewhat crushed nature of the specimens.

Comparison: *Rhipidothyris oosthuizeni* is costate from umbo to anterior margin, in contrast with the Bolivian specimens (Isaacson 1974) that tend to have smooth umbones. *R. plicata* Cooper et Williams, 1935, is very coarsely costate. *R. lepida* (Hall, 1860) is more coarsely costate and much smaller. *R. gowanensis* McKellar, 1966, is more coarsely costate. *R. circo* Johnson, 1971, is much smaller and has fewer costae. *Rhipidothyris africana* Boucot et Perry, 1983, from Libya is very coarsely plicate. Havlíček's (1984) *R. ensicostata* is a junior synonym of *R. africana*. *R. orchas* Havlíček, 1984, is more finely costate than *R. oosthuizeni*.

Occurrence: The farm where the fossils were collected is Klip Kopjes 325.

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První *Rhipidothyris* (Brachiopoda) z jižní Afriky: biostratigrafický, paleoekologický a biogeografický význam

Nález a determinace terebratulidního brachiopoda rodu *Rhipidothyris* v karoopoortském souvrství z nejvyšší části bokkevelské skupiny umožnil datovat toto souvrství jako svrchní střední devon (givet). Nálezové okolnosti tohoto výskytu *Rhipidothyris* (nízká diverzita, artikulace misek) ukazují na mořské, mělce subtidální prostředí, odpovídající typickému rhipidothyridnímu společenstvu v rámci bentického souboru 2. Rod *Rhipidothyris* je do současnosti znám z givetu Bolívie, New Yorku, Pennsylvánie, Nevady, Libye, východní Austrálie a pravděpodobně i Fergany. Přítomnost *Rhipidothyris* v Bolívii a jižní Africe je v souladu s existencí relativně teplovodních podmínek, které byly v těchto oblastech nastoleny po zániku chladnovodní malvinokaferské provincie, existující zde v předchozím období, v pragu až eifelu.