

9. GUEMBELITRIA AFF. STAVENSIS BANDY, A PALEOOCEANOGRAPHIC MARKER OF THE INITIATION OF THE CIRCUM-ANTARCTIC CURRENT AND THE OPENING OF THE DRAKE PASSAGE

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ABSTRACT

The paleoceanographic and stratigraphic distribution of *Guembelitra* aff. *stavensis* Bandy in oceanic sediments around Antarctica provides evidence of the initiation of the circum-Antarctic Current including the oldest date for the opening of the Drake Passage in the lower part of the upper Oligocene *G. (G.) euapertura* Zone. Paleontological events are correlated with K/Ar dates and it is postulated that the Drake Passage was open to the flow of oceanic water which supported plankton, at about 28 m.y.B.P.

INTRODUCTION

Guembelitra aff. *stavensis* Bandy (Plate 1, Figures 1-8) lived in the gulf between Australia and Antarctica from the late Eocene through to the lower part of the upper Oligocene (Ludbrook and Lindsay, 1969; Lindsay, 1969). With the final separation of the two continents at the eastern hinge of the austral gulf at the South Tasman Rise, *G. aff. stavensis* spread out eastwards into the south-western Pacific and lived only briefly (Figures 1,2) as previously reported by Jenkins (1974). The paleogeographic distribution of *G. aff. stavensis* in the southwestern Pacific and its migration around Antarctica to Site 360 of DSDP Leg 40 (latitude 35°50'S; longitude 18°05'E) provides the first fossil evidence of the separation of South America from Antarctica and the initial opening of the Drake Passage. The spread of *G. aff. stavensis* in the plankton around Antarctica marks the initiation of the circum-Antarctic Current, but it was probably some time later that the current assumed its major role as one of the largest oceanic currents (Kennett et al., 1975).

SYSTEMATICS

Following the work of Ludbrook and Lindsay (1969) the writer placed the Oligocene specimens of *Guembelitra* in *G. stavensis* Bandy (Jenkins, 1974) which had originally been described from the middle Eocene of Little Stave Creek, Alabama, USA. A topotype sample of *G. stavensis* has been obtained from the Department of Geology, Los Angeles, and a slide of the holotype plus six paratypes has been kindly loaned for examination by Dr. Alan Horowitz, Indiana University.

Specimens of the topotype sample are very small ranging in size from 0.19 to 0.09 mm in length, but the holotype is slightly longer at 0.21 mm in length.

Scanning electron microscope examination shows that specimens from DSDP Site 360 (Sample 29-2, 73-75 cm) (Plate 1, Figures 1-8) have distinct supplementary apertures which do not occur in the topotype

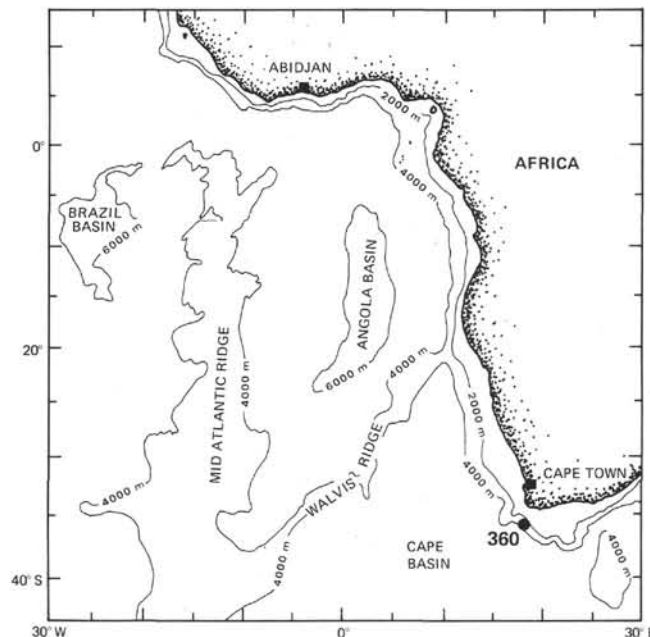


Figure 1. Location of Leg 40, Site 360.

specimens of *G. stavensis* (Plate 1, Figures 9-13). Also, the wall structure appears to be different (Plate 1, Figures 8, 13).

At this stage, it is safe to conclude that the specimens of *G. stavensis* from the middle Eocene of Alabama appear to be morphologically different from those obtained from the upper Oligocene of Site 360 and are consequently referred to as *G. aff. stavensis*. Further research is being undertaken into specimens of *G. aff. stavensis* from around Antarctica. This may result in the need for a new name for the southern species.

BIOSTRATIGRAPHY

The stratigraphic range of *G. aff. stavensis* has been previously plotted against the range of *Chiloguembelina cubensis* (Palmer) (Jenkins, 1974; see also Figure 3).

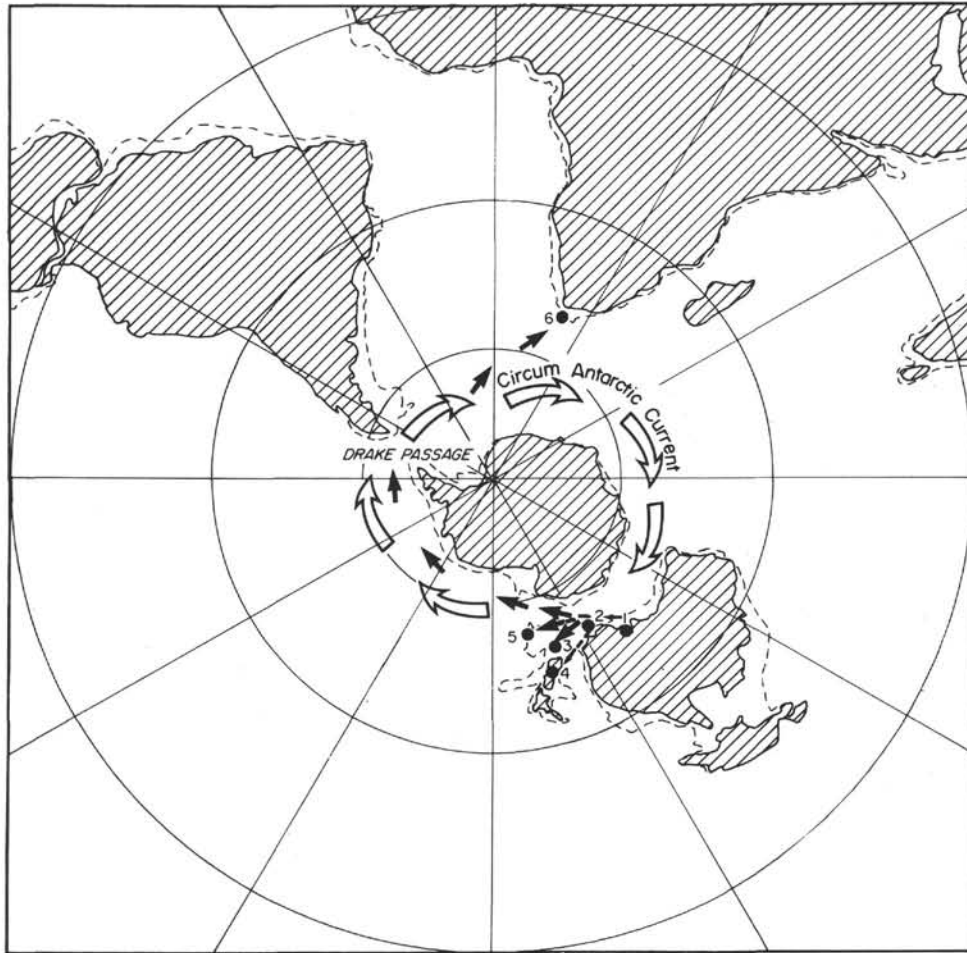


Figure 2. Map of the distribution of continents and oceans in the Southern Hemisphere and a plot of six localities and postulated migration of *G. aff. stavensis* in the Oligocene *G. (G.) euapertura* Zone. Map is after Smith and Briden (in press), but it is possible that the Drake Passage was much narrower at this stage in the Oligocene.

Once *G. aff. stavensis* migrated from the gulf between Antarctica and Australia, it lived only briefly in the lower part of the *G. (G.) euapertura* Zone. It became extinct before the extinction of *C. cubensis*, west of Tasmania (DSDP Site 282), on the western edge of the Campbell Plateau (DSDP Site 277) and on the east coast of the South Island of New Zealand. But at DSDP Site 360, in the southeastern Atlantic, *G. aff. stavensis* briefly survived the extinction of *C. cubensis*. Assuming that the extinction of *C. cubensis* was a synchronous event in the areas under investigation, then the later extinction of *G. aff. stavensis* at Site 360 could be due to the longer migration time it took to reach the site; it could also mean that the opening of Drake Passage was slightly later than the parting of the South Tasman Rise from Antarctica.

Confirmation of the correlation of the brief stratigraphic range of *G. aff. stavensis* in the areas beyond South Australia has come from a further examination of the planktonic foraminifer fauna. The writer described and illustrated the direct phyletic evolution of *Globorotalia munda* Jenkins into *Globigerina juvenilis* Bolli in the Earthquakes Section of the Kokoamu

Greensand, New Zealand (Jenkins, 1966). The evolutionary change in morphology occurs relatively rapidly, and at DSDP Sites 277 and 282 (Jenkins, 1975) and at Site 360, *G. aff. stavensis* occurs only during this transition of *G. munda* into *G. juvenilis*. Also, *G. aff. stavensis* appears to occur at the same level in Sample S127/f 403 from New Zealand.

PALEOECOLOGY

G. aff. stavensis migrated further north in the upper Oligocene in the southeastern Atlantic than in the New Zealand area. It was found at Site 360 (latitude 35°50'S), but is not present at Site 362 (latitude 19°45'S) in the Atlantic. In New Zealand *G. aff. stavensis* migrated only into the southern half of the South Island (latitude 44°30.6'S). It therefore seems probable that the oceanic water suitable for the survival of *G. aff. stavensis* spread further north along the coast of southwest Africa during the upper Oligocene than it did near New Zealand. It is further speculated that *G. aff. stavensis* may have preferred the cooler southern water.

INTERNATIONAL UNITS	SOUTH AUSTRALIA Lat. 35° 15.67'S Long. 138° 26.84'E (after Ludbrook and Lindsay 1969).	DEEP SEA DRILLING PROJECT LEG. 29	WEST OF TASMANIA SITE 282 Lat. 42° 14.76'S Long. 143° 29.18' E	WESTERN EDGE OF CAMPBELL PLATEAU SITE 276 Lat. 52° 13.43'S Long. 166° 11.48' E	EASTERN EDGE OF CAMPBELL PLATEAU SITE 275 Lat. 50° 48.11'S Long. 176° 48.40'E	NEW ZEALAND EAST COAST SOUTH ISLAND Lat. 44° 39.6'S Long. 170° 24'E	SOUTHEASTERN ATLANTIC DSDP Leg. 40 SITE 360 Lat. 30° 51' S Long. 18° 05' E
	(1)		(2)	(3)	(4)	(5)	(6)
	ZONES	ZONES				ZONES	ZONES
OLIGOCENE	UPPER G(G) euapertura G stavensis	G(G) euapertura				G(G) euapertura	G(G) euapertura
	LOWER C. cubensis	G(S) angiporoides angiporoides	C. cubensis	C. cubensis	C. cubensis	G(S) angiporoides angiporoides	G(S) angiporoides angiporoides
EOCENE	UPPER G(S) linaperta	G(G) brevis				G(G) brevis	G(G) brevis

Figure 3. Stratigraphic records of *G. aff. stavensis* in South Australia, three sites of DSDP Leg 29, one in New Zealand and one of DSDP Leg 40.

CIRCUM-ANTARCTIC CURRENT

Kennett et al. (1973, 1975) suggested that the circum-Antarctic Current started during the late Oligocene, based on an interpretation of a late Paleogene regional unconformity in the Tasman and Coral seas. Frakes and Kemp (1973) postulated that the Drake Passage opened by the middle Oligocene, and Baker et al. (1974) suggested that it was open by the middle-upper Miocene. Jenkins (1974) provided evidence that the paleogeographic and stratigraphic distribution of *G. aff. stavensis* was a key to the paleontological dating of the initiation of the current. Its further presence in the lower part of the *G. (G.) euapertura* Zone at Site 360 (Samples 29-2, 73-75 cm and 30-1, 97-99 cm) is additional evidence of its spread around Antarctica in the proto circum-Antarctic Current.

DATING THE EVENT

Berggren (1972) termed the extinction of *C. cubensis* as the "*Chiloguembelina* extinction Datum." This he placed in about the middle of the Oligocene *Globigerina angulifurcata*/*Globorotalia (Turborotalia) opima opima* Zone and correlated it with the type Chattian. Berggren (1972) recorded K/Ar dates on the type Chattian of the North German Basin with a range of 28.8-31.2 ± 1.5 m.y.B.P. Abele and Page (1974) reported a date of 26.5-27 m.y. on a basalt in Victoria, Australia. This basalt erupted somewhat later than the locally recorded extinction of *C. cubensis*, supporting Berggren's dating of the extinction of *C. cubensis* at 28 m.y.

CONCLUSIONS

The distribution of *G. aff. stavensis* in DSDP drill sites and elsewhere indicates that it migrated eastwards from the area of South Australia within the plankton of the proto circum-Antarctic Current, then around Antarctica, and eventually through the Drake Passage, reaching the southeastern Atlantic Site 360 about 28 million years ago.

More sites need to be drilled into suitable Oligocene *G. (G.) euapertura* Zone sediments between the Campbell Plateau south of New Zealand, the Drake Passage and Site 360 in the southeastern Atlantic to plot the paleoceanographic migration of *G. aff. stavensis* around Antarctica.

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PLATE 1

- Figures 1-5 *Guembelitra* aff. *stavensis* Bandy. Sample 360-29-2, 73-75 cm, upper Oligocene. *G. (G.) euapertura* Zone.
1. Side view, $\times 250$.
 2. Aperture, $\times 1000$.
 3. Aperture enlarged to show lip, $\times 2500$.
 4. Secondary aperture, $\times 1000$.
 5. Two secondary apertures, $\times 1000$.
- Figures 6-8 *Guembelitra* aff. *stavensis* Bandy. Sample 360-29-2, 73-75 cm, upper Oligocene. *G. (G.) euapertura* Zone.
6. Side view, $\times 250$.
 7. Aperture, $\times 1000$.
 8. Wall structure, $\times 2500$.
- Figures 9-11 *Guembelitra stavensis* Bandy. Little Stave Creek, Alabama, USA Locality 10, topotype sample, middle Eocene.
9. Side view, $\times 250$.
 10. Aperture, $\times 1000$.
 11. Wall structure, $\times 2500$.
- Figures 12, 13 *Guembelitra stavensis* Bandy. Little Stave Creek, Alabama, USA Locality 10, topotype sample, middle Eocene.
12. Side view, $\times 250$.
 13. Aperture, $\times 1000$.

PLATE 1

