

**GLYCYMERIS (GLYCYMERIS) RADIOLYRATA SP. NOV.
(MOLLUSCA, BIVALVIA, GLYCYMERIDIDAE)
FROM THE PLIOCENE OF THE NORTH SEA BASIN**

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A close examination of glycymeridid bivalves amongst fossil shell material washed ashore and dredged in the province of Zeeland (The Netherlands) has revealed the presence of a previously undescribed species. This new taxon [*Glycymeris (Glycymeris) radiolyrata* sp. nov.] appears to occur *in situ* in the middle Pliocene of Belgium and in the (unspecified) Pliocene of Dutch boreholes. Shells assignable to the new species from Brightwell and Ramsholt Cliff (Suffolk) attest to its occurrence in Pliocene strata in the United Kingdom.

Key words — Mollusca, Bivalvia, Glycymerididae, Pliocene, North Sea Basin, new species.

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INTRODUCTION

Fossil glycymeridid bivalve shells found washed ashore on certain beaches as well as dredged from the bed of the Westerschelde in the province of Zeeland (The Netherlands) have recently been studied in detail by members of the Werkgroep Geologie of the Koninklijk Zeeuwsch Genootschap der Wetenschappen (KZGW) at Middelburg (The Netherlands). The meetings of this group were presided by the authors of the present contribution; the results of these sessions were published by Moerdijk *et al.* (1992).

The fossil shell material from Zeeland is reworked

and originates from various deposits, mostly of Pliocene and younger age. The Werkgroep Geologie has concentrated mainly on the Pliocene glycymeridid material, which could not be subdivided in any satisfactory way using only shell form (outline and convexity), shell thickness and dimensions, since many intermediate forms occurred. However, a number of other characters have now been shown to provide a reliable basis for species differentiation:

- external ornament
- form and ornament of ligamental area
- form and position of adductor scars

By relying on a combination of external ornament and form/ornament of the ligamental area, (reasonably) well-preserved material could be divided into two groups; one having a ligamental area with distinct grooves and a very fine, obsolete external ornament and one with a virtually smooth ligamental area and a better developed external ornament, especially near the umbones. Other combinations of characters of external ornament and form/ornament of the ligamental area do not apply to our

material.

The form and position of the adductor scars in combination with shell form and thickness proved useful in subdividing the first group into two forms: one with fairly large scars touching the hinge plate, with an often thick, often inflated, equilateral and circular shell and a well-developed hinge [conspecific with *Glycymeris obovata* (Lamarck, 1819) *s. lat.* from the early Pliocene Kattendijk Formation, which is closely related to *G. obovata baldii* Glibert & van de Poel, 1965 from the Miocene of the Antwerp area, but not identical; it also appears to be related to the Pliocene *G. variabilis*], and one with slender adductor scars at some distance from the hinge plate, with a quite flat, thin, ovate and generally inequilateral shell, obviously representing *G. variabilis* (J. de C. Sowerby, 1824). Since there are many constant differences between the latter and Recent *G. glycymeris* (Linné, 1758) (*e.g.* shell form, external ornament, form and ornament of ligamental area), and transitional forms do not occur, *G. variabilis* is best raised to specific rank.

The second group could also be subdivided into two forms, one of them being represented by a few large and strongly inflated valves (*Glycymeris* sp. 2 *sensu* Moerdijk *et al.*, 1992). This form is not as common as the others and in need of further study. A detailed discussion will be presented in the revision of fossil European Glycymerididae currently in preparation. The other form of this group is almost as common as *G. variabilis* in our material; it has so far proved impossible to assign it to any of the known fossil glycymeridid taxa from the North Sea Basin.

In comparing our material with samples from various Pliocene strata in the Antwerp area (Belgium), it was found that the new species described herein had been collected *in situ* in considerable numbers from the Oorderen Member (Lillo Formation), 'Horizon met *Pinna*' of Gaemers & Janssen (1972), the *Pinna* being *Atrina fragilis kolloensis* Marquet & Vervoenen *in* Marquet, 1995. Subsequently it was also recognised amongst Pliocene material recovered from Dutch boreholes, as well as from the Coralline Crag and Red Crag of Suffolk (United Kingdom).

SYSTEMATIC DESCRIPTION

To denote the repositories of specimens the following abbreviations are used in the text:

RGD Rijks Geologische Dienst, Haarlem, The Netherlands;
KBIN Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels, Belgium;

RGM Nationaal Natuurhistorisch Museum, Leiden, The Netherlands (formerly Rijksmuseum van Geologie en Mineralogie).

Order Arcoidea Stoliczka, 1871
Superfamily Limopsacea Dall, 1895
Family Glycymerididae Newton, 1922
Subfamily Glycymeridinae Newton, 1922
Genus and
subgenus *Glycymeris* Da Costa, 1778

Type species — *Arca glycymeris* Linné, 1758.

Glycymeris (Glycymeris) radiolyrata sp. nov.

Pls 1-3; Text-fig. 1

- 1851 *Pectunculus glycymeris* Linnaeus — Wood, p. 66, pl. 9, fig. 1a ?, b ?, f.
1936 *Pectunculus glycymeris* L. — van Heurn, p. 22, pl. 8, fig. 3.
1937 *Glycymeris glycymeris variabilis* (J. Sow.) — van Regteren Altena, p. 55, pl. 3, figs 48, 49, 51.
v 1950 *Glycymeris glycymeris variabilis* (J. Sowerby, 1824) — Heering, p. 30, pl. 8, figs 5, 6.
v 1950 *Glycymeris glycymeris glycymeris* (Linné, 1758) — Heering, p. 32, pl. 8, figs 7, 8.
1957 *Glycymeris glycymeris* Linné sp., 1758 forme *variabilis* (Sowerby, 1824) — Glibert, p. 16, pl. 1, fig 3.
1962 *Glycymeris variabilis variabilis* (J. Sowerby, 1824) — van Regteren Altena *et al.*, p. 16 (*pars*).
1965 *Glycymeris (s.s.) glycymeris variabilis* (Sowerby, 1824) — Glibert & van de Poel, p. 83 (*pars*).
v 1992 *Glycymeris spec. 1 [sic]* — Moerdijk *et al.*, p. 17, pl. 4 (*Glycymeris spec. 1*).

Type — Holotype, a bivalved specimen (Pl. 1), is RGM 393 823 (leg. M. Vervoenen) in the collections of the Nationaal Natuurhistorisch Museum, Leiden (The Netherlands).

Paratypes: **Belgium, Antwerp area** (Pliocene, level unknown): 1/2 paratype (RGM 393 813, leg. G.J. van der Slikke, no. 2500); **Antwerp area** (Boudewijnsluis construction pit, from sediment dump, Pliocene, level unknown): 1/2 paratype (RGM 393 814, leg. H. van Haren, October 1988); **Antwerp area** (construction pit 5th harbour dock, from sediment dump, Pliocene, Kattendijkian and/or Scaldisian, level unknown): 1/2 paratype (RGM 100 395, leg. H. van Haren, 27 August 1958); **Antwerp area** (construction pit 5th harbour dock, from sediment dump, Pliocene, level unknown): 1/1 + 2/2 paratypes (RGM 393 808, leg. museumstaf, 24 August 1958, G. Kortenbout van der Sluys); **Antwerp area** (Hansadock, dredged, Pliocene, level unknown), 1/2

paratype (RGM 393 810, leg. museumstaf, 8 June 1961, G. Kortenbout van der Sluys); **Antwerp area** (construction pit 4th harbour dock, at quay no. 271, Pliocene, Lillo Formation, Oorderen Member): 1/2 paratype (RGM 393 820, leg. M. van den Bosch, 1969); **Antwerp area** (construction pit 6th harbour dock, Pliocene, Lillo Formation, Oorderen Member): 1/2 paratype (RGM 393 817, leg. M. van den Bosch, 1969); **Verrebroek** (construction pit Liefkenshoek tunnel segments, Pliocene, Lillo Formation, Kruisschans Member): 1/2 paratype (RGM 393 821, leg. A.W. Janssen, 9 July 1989); **Kallo** (Beveren tunnel construction pit, Lillo Formation, Oorderen Member, level with *Pinna*): 1/2 paratype (RGM 393 824, leg. M. Vervoenen), 1/2 paratype (Vervoenen Coll. F 251), 3/2 paratypes (van Nieulande Coll.), 1/1 paratype (RGM 393 827, leg. A.W. Janssen, 1974); **Kallo** (sea sluice construction pit): 2/2 + 1/1 paratypes (van Nieulande Coll.), 1/2 paratype (KBIN IST.5870, leg. van Nieulande), 19/2 paratypes (Vervoenen Coll., F 251 B); **Kallo** (construction pit Verrebroekdok, Horizon with *Angulus benedeni*, 1986): 2/1 + 2/2 paratypes (Marquet Coll.), 9/2 paratypes (Marquet Coll.), 9/2 paratypes (Vervoenen Coll. F 250 A), 3/2 paratypes (Vervoenen Coll. F 251 C), 1/2 paratype (van Nieulande Coll.), 2/2 paratypes (Garding Coll.); **Kallo** (Vrasenedok, Horizon with *Pinna*, 1981-1986): 1/1 paratype (Marquet Coll.); **Antwerp** (Boudewijnsluis, ex Gigase Coll.): 1/2 paratype (Marquet Coll.).

The Netherlands; Cadzand (washed ashore, Quaternary, reworked from Pliocene strata): 4/2 paratypes (RGM 114 800, leg. C.J. Verheij, 1966, no. 244), 4/2 paratypes (RGM 393 803, leg. C.J. Verheij, 1966, no. 244); **Domburg** (washed ashore, Quaternary, reworked from Pliocene strata): 2/2 paratypes (RGM 393 784, leg. A.B. van Deinse, August 1933), 2/2 paratypes (RGM 393 791), 1/2 paratype (RGM 393 795, leg. Umbgrove), 1/2 paratype (RGM 30 599, leg. Hofsteenge); **Domburg-Westkapelle** (washed ashore, Quaternary, reworked from Pliocene strata): 3/2 paratypes (RGM 393 801, leg. Rijksmuseum van Natuurlijke Historie), 9/2 paratypes (RGM 393 804, leg. J. de Visser); **Ritthem** (near Fort Rammekens, washed ashore, Quaternary, reworked from Pliocene strata): 7/2 paratypes (RGM 393 793, leg. A.C. Janse); **Ritthem** (Quaternary, reworked from Pliocene strata): 1/2 paratype (RGM 393 794, leg. D. van der Mark); **Westerschelde off Ellewoutsdijk** (dredged, Quaternary, reworked from Pliocene strata): 2/2 paratypes (RGM 75 129, leg. A.P. Audretsch), 1/2 paratype (RGM 82 521, leg. A.P. Audretsch, 1-4 November 1955), 38/2 paratypes (RGM 393 779, leg. Rijksmuseum van Natuurlijke Historie, ex 'Filiaalcollectie', no. 952, leg. J.A.W. Lucas), 30/2 paratypes (RGM 393 780, leg. Rijksmuseum van Natuurlijke Historie, ex 'Filiaalcollectie', no. 952, leg. J.A.W. Lucas), 4/2 paratypes

(RGM 393 792, leg. A.P. Audretsch), 2/2 paratypes (RGM 393 798, leg. museumstaf, 8 November 1966, G. Kortenbout van der Sluys), 3/2 paratypes (RGM 393 788, leg. A.P. Audretsch, 20 September 1955), 2/2 paratypes (RGM 393 787, leg. Rijksmuseum van Natuurlijke Historie, 1983), 2/2 paratypes (RGM 393 785); **Westerschelde** (off Nieuwe Sluis, dredged, Quaternary, reworked from Pliocene strata): 1/2 paratype (RGM 108 527, leg. Jacobs, 11 May 1962), 2/2 paratypes (RGM 393 796, leg. J.P. Jacobs, 8 July 1964); **Westerschelde, Everingen shoals** (washed ashore, Quaternary, reworked from Pliocene strata): 1/2 paratype (RGM 393 781, leg. J.A. van de Ree, November 1965); **Westerschelde, Everingen/Kaloot/Braakman** (washed ashore, Quaternary, reworked from Pliocene strata): 1/2 paratype (RGM 393 790, leg. J.A. van de Ree, November 1963); **Westerschelde** (off Ellewoutsdijk, 'Brielle', dredged, Quaternary, reworked from Pliocene strata): 3/2 paratypes (RGM 393 800, leg. M. van den Bosch, 1969); **'Zeeuwsche stroomen'** (reworked from Pliocene strata): 2/2 paratypes (RGM 13 991, leg. A.B. van Deinse, October 1933); **Flemish Banks/southern North Sea**, 1994: 7/2 paratypes (van Nieulande Coll., leg. P. de Jonge); **Sluisse Hompels** (sand supply Cadzandbad)/1988: 17/2 paratypes (Rijken Coll.); **sand supply Nieuwesluis/1989**: 25/2 paratypes (Rijken Coll.); **Westerschelde (Ellewoutsdijk)**: 32/2 paratypes (KZGW Coll. 638, leg. C. Brakman, 1969), 4/2 paratypes (KZGW Coll. 2326, leg. P.J. van der Feen); **Yerseke** (Westerschelde, Baarland, dredged/1990-1994): 29/2 paratypes (Moerdijk Coll.), 12/2 paratypes (KZGW GM 1995.00, leg. P.W. Moerdijk), 43/2 paratypes (van Nieulande Coll.); **Westerschelde, Hooge Springer/1983**: 2/2 paratypes (van Nieulande Coll.); **Hooge Platen/1986-1989**: 17/2 paratypes (Rijken Coll.); **Kaloot/1924-1938**: 48/2 paratypes (KZGW Coll. 683, leg. C. Brakman), 1972-1994: 8/2 paratypes (van Nieulande Coll.), 1983-1990: 6/2 paratypes (Moerdijk Coll.); **Zuid-Sloe**: 2/2 paratypes (KZGW Coll. 1995.003, leg. A. Haandrikman), 1972-1994: 7/2 paratypes (van Nieulande Coll.); **Domburg**: 26/2 paratypes (KZGW Coll. GM.1994001, leg. Beeftink), 1930-1940: 73/2 paratypes (KZGW Coll. 1808, leg. G.W.A. de Veer), 1983-1994: 20/2 paratypes (Rijken Coll.), **Domburg Zuid-strand/1925-1936**: 38/2 paratypes (KZGW Coll. 635, leg. C. Brakman), 1970-1983: 38/2 paratypes (van Nieulande Coll.); **Domburg-Westkapelle/1960-1967**: 29/2 paratypes (KZGW Coll. 640, leg. P.J. van der Feen), 1980-1990: 11/2 paratypes (Moerdijk Coll.); **Yerseke** (Roompot, dredged/1991-1994): 6/2 paratypes (Rijken Coll.); **Oranjezon/27-12-1987**: 1/2 paratype (Rijken Coll.); **Scheveningen**: 1 fragment (KZGW Coll. GM 1995.002).

The Netherlands; borehole material (RGD Coll.): **Haamstede, 42B/5**, 96.60-103.30 m below surface, 2/2

paratypes, 3 fragments (RGD Coll. Mol.652); **Haamstede, 42B/5**, 96.60-103.30 m below surface, 2/2 paratypes (RGD Coll. Mol.653); **Haamstede, 42B/5**, 96.60-103.30 m below surface, 1/2 paratype (Heering, 1950, pl. 8, figs 5, 6; RGD Coll. Mol.654); **Haamstede, 42B**, 2/2 defective paratypes (Schouwen, fauna 4, Boven-Pliocene, oudere zone; RGD Coll. Mol.655); **Haamstede, 42B**, 3/2 paratypes (Schouwen, fauna 4, 'Boven-Pliocene'; RGD Coll. Mol.656); **Dorst, 44D**, 115-166 m below surface, 2/2 + 2/2 defective paratypes, 1 fragment (RGD Coll. Mol.657); **Dorst, Boring I, 44D/86**, 122.00-135.00 m below surface, 3/2 paratypes, 1 fragment (RGD Coll. Mol.658); **Breda, Holl. Kunstzijde Industrie, 44D/55**, 123.00-126.00 m below surface, 1 fragment (RDG Coll. Mol.659); **Breda, Holl. Kunstzijde Industrie, 44D/55**, 154.00-156.00 m below surface, 1/2 paratype, 6 fragments (RGD Coll. Mol.660); **Breda, Holl. Kunstzijde Industrie, 44D/55**, 157.00-160.00 m below surface, 3/2 paratypes (RGD Coll. Mol.661); **Oss, 45E/9**, 32.50-52.00 m below surface, 4/2 paratypes (RGD Coll. Mol.662); **Biggekerke, 48A/1**, 27.10-31.00 m below surface, 2/2 paratypes (RGD Coll. Mol.664); **Biggekerke, 48A**, 2/2 paratypes (RGD Coll. Mol.665); **Biggekerke, 48A**, 3/2 paratypes (RGD Coll. Mol.666); **Vlissingen, 48C-48D**, 1/2 paratype (RGD Coll. Mol.667); **Bergen op Zoom, 49B/173**, 81.30-95.70 m below surface, 1/2 paratype (RGD Coll. Mol.668); **Bergen op Zoom, 49B/173**, 99.70-104.00 m below surface, 1/2 paratype (Heering, 1950, pl. 8, figs 7, 8; RGD Coll. Mol.669); **Seppe (near Hoeven), 49F/32**, 122.00-130.00 m below surface, 3/2 paratypes (RGD Coll. Mol.670); **Roosendaal, Melkinrichting 1915, 49F/73**, 86.80-106.50 m below surface, 1/2 paratype (RGD Coll. Mol.671); **Clinge, watervoorziening kleine winput, P.I. laag 7, 55A/153**, 9.10-10.45 m below surface, 1 fragment (RGD Coll. Mol.672); **Nijmegen**, 1/2 paratype, 1 fragment ('Midden-Pliocene'; RGD Coll. Mol.673).

United Kingdom; Ramsholt Cliff, River Deben (Suffolk, Pliocene, Coralline Crag Formation): 6/2 paratypes (RGM 393 815, leg. P. Cambridge); **mouth River Thames**: 1/2 paratype (Vervoenen Coll. F 1534).

Measurements (holotype) — height, width and semidiameter (in mm): 61.4, 62.5 and 14.9, respectively (right valve); 61.1, 62.2 and 14.8, respectively (left valve); diameter of the bivalved specimen: 29.8 mm.

Locus typicus — Temporary exposure during construction of the Beveren tunnel under the first canal dock at Kallo (municipality of Beveren-Waas, province of Oost Vlaanderen, Belgium), 1200 m north and 450 m west of the village church (see Janssen, 1974).

Stratum typicum — Lillo Formation, Oorderen Member (Pliocene, see de Meuter & Laga, 1976), horizon with

Pinna of Gaemers & Janssen (1972).

Derivatio nominis — *radio-*, from Lat. radiare, to radiate, and *lyrata*, from Lat. lyra, lyre, in allusion to the most distinctive feature being the irregular radial external ornament, which develops ('radiates') during growth from a few radial ribs into many fine lyrae.

Diagnosis — A species of *Glycymeris* (*Glycymeris*) with a subcircular, moderately large, moderately inflated shell, a smooth and near-equilateral ligamental area and an irregular radial external ornament, developed especially at the umbones, crossed by fairly regular concentric costae.

Description — Fully-grown specimens are generally c. 60 mm wide, but may reach up to c. 80 mm; moderately solid, not strongly inflated; near-circular outline, width exceeding height; umbones about central and slightly opisthogyr. Ornament near the umbones consisting of about 30-40 quite prominent, irregular, radiating ribs, which during growth become gradually weaker and increase in number both by division and intercalation. Primary ribs at the umbones do not entirely disappear during growth, but account for an irregular, undulose ornament. As in most Glycymerididae the radial ornament effaces slightly towards the shell posterior. The concentric ornament consists of quite regular and fine, flat wrinkles, which cause the radiating ribs near the umbones to appear tuberculate. These wrinkles become gradually weaker and finer during growth and together with the fine radial lyrae they form a reticulate pattern towards the shell margin. Ligamental area at first glance appearing smooth; under slanting light chevrons become visible, as do traces of juvenile dentition now incorporated in the ligamental area, which is slightly inequilateral, anterior portion slightly exceeding length of posterior portion; hinge plate moderately developed; adult specimens generally without teeth in the centre of the hinge plate. Adductor muscle scars relatively slender, longer in umbonal than in commarginal direction (especially so posteriorly) and not touching the hinge plate. Inner shell margin crenulate.

Range of variation — There is some variation in H/W ratio, equilaterality, shell inflation and number of hinge teeth; details of external ornament and ornament of ligamental area are quite constant. To illustrate this variation in dimensions we measured the height (H), width (W) and semidiameter (S; all in mm) of sixteen specimens/valves from various localities:

	H	W	S
— Kallo (Belgium)			
holotype	61.4	63.5	14.9 (right)
(RGM 393 823)	61.1	62.2	14.8 (left)

RGM 393 824	65.0	68.5	18.2
— Westerschelde (near Baarland; The Netherlands; KZGW collections GM 1995001; see Moerdijk <i>et al.</i> , 1992)			
paratypes	52.6	54.3	15.0
	45.9	50.2	14.8
	28.1	29.7	8.3
	43.7	47.8	14.0
	48.2	51.0	14.6
	49.8	49.8	16.2
	49.8	53.2	13.6
	52.0	54.8	15.8
	53.3	55.2	15.8
	58.5	61.5	16.6
	63.4	65.7	19.0
	53.0	51.4	14.2
— borehole 48A/Biggekerke (The Netherlands; RGD collections Mol. 665)			
paratype	50.3	51.5	13.8
— borehole Nijmegen (The Netherlands; RGD collections Mol. 673)			
paratype	4.2	4.3	1.1

Discussion — Careful reading of descriptions in earlier literature and comparison of illustrations indicate that *Glycymeris radiolyrata* was generally lumped with *G. variabilis* (Pl. 4), which superficially bears a close resemblance (shell thickness, hinge development, degree of shell inflation, position and outline of adductor scars) and with which it often co-occurs. These taxa may be distinguished as follows:

- *G. variabilis* invariably shows distinct grooves on the ligamental area, the external ornament consists of a very fine reticulate sculpture, tending to efface rapidly, and the shell is generally markedly inequilateral, being drawn out posteriorly. In juvenile specimens the umbo is quite prominent.

- *G. radiolyrata* has a principally smooth ligamental area and a distinctive external ornament consisting of well-developed radial elements especially near the umbones; towards the shell margin the reticulate ornament is less fine and more irregular. The shell is almost equilateral and circular in outline. The umbo of juvenile specimens is not prominent; their external ornament consists of coarse radial elements (Fig. 1) overprinted by concentric grooves. The ornament in juvenile *G. variabilis* is

decidedly finer.

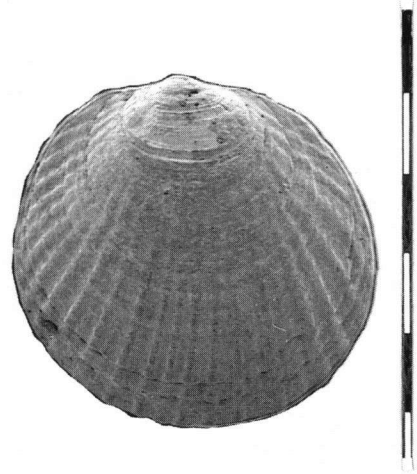


Fig. 1. *Glycymeris (Glycymeris) radiolyrata* sp. nov., paratype (van Nieulande Coll., no. 0041), Kallo, construction pit tunnel First Harbour Dock, Lillo Formation, Oorderen Member, level with *Angulus benedeni*, 4 October 1975, scale bar equals 5.5 mm.

On these features it is quite easy to separate the two species, with the exception of heavily worn specimens.

The new species appears to have much more in common with *G. glycymeris* (Linné, 1758) than with *G. variabilis*, in relation to shell form, smooth ligamental area and non-obsolete external ornament, but there are also notable differences. The ornament in *G. glycymeris* is much finer, more regular and at the umbones less prominent, the ligamental area is clearly inequilateral and the adductor scars are less slender and positioned close to the hinge plate. *Glycymeris glycymeris* and *G. radiolyrata* normally do not co-occur; the stratigraphically youngest deposit from which *G. radiolyrata* is now known is the Kruisschans Member (Lillo Formation), of late Pliocene age, where the species is already rare; but a limited number of valves are known (Marquet and van Nieulande Collns). Marquet (1993) did not list the species. Fossil shells of *G. glycymeris* found washed ashore on the Dutch coast are probably of late Pleistocene (? Eemian) age. However, *G. glycymeris* is found in the same sample as *G. radiolyrata* as well as *G. variabilis* in borehole Haamstede (42B/5, 0. 1070, 96.60-71.00 m below surface). This may be interpreted as contamination, *G. radiolyrata* and *G. variabilis* having come from middle or late Pliocene and *G. glycymeris* from early Pleistocene deposits. Differences in preservation of these shells as well as accompanying molluscan species appear to support such an explanation.

We have not seen any intermediate forms between *G. glycymeris* and *G. radiolyrata*.

Although the Pliocene molluscs of the North Sea Basin have been extensively studied and described, the present species, though occurring commonly, has apparently not been identified as a separate species by previous authors. The reason behind this may be that it is rather difficult to separate the various species of glycymeridids if no attention is paid to the details of external ornament and ornament of the ligamental area. All authors have noted the extreme variation displayed by Pliocene Glycymerididae, but obviously have been unable to subdivide their material into different species.

In view of the fact that we have recognised specimens of *G. radiolyrata* amongst material from Suffolk, we have studied Sowerby's (1824) and Wood's (1851) remarks on Glycymerididae from the English crags. Sowerby's description of the ligamental area and external ornament of *G. variabilis* shows beyond doubt, that he had exclusively *G. variabilis* at his disposal: none of the specimens illustrated resembles *G. radiolyrata*. A specimen illustrated under the name of *G. variabilis* in Wood (1851, pl. 9, fig. 1a, b) shows a quite equilateral ligamental area without incised chevrons; this specimen could thus belong to *G. radiolyrata*. However, the external ornament of this shell as figured does not really match that of our species, which is why refer this specimen here with a query. Wood's observation (1851, p. 68) that, 'The exterior is generally more or less ornamented with raised, radiating and distant striae, variable in number, ...' also suggests that he did have specimens of *G. radiolyrata* before him; in fact, the young specimen, 'with distinct and elevated costae (Wood, 1851, pl. 9, fig. 1f) is without any doubt conspecific with our new species.

Apparently, Nyst (1845) did not recognise *G. radiolyrata*; his 1881 paper does not include any reference to the *Glycymeris* shells he illustrated in his 1870 atlas. These specimens are referable to *G. variabilis* (1878, pl. 17, fig. 8a, b, c, f) and to *G. obovata* s. lat. (pl. 17, fig. 8e, g), clearly showing chevrons on the ligamental area. It is very unlikely that Nyst's material did not comprise *G. radiolyrata*, it being so common in the Belgian Pliocene.

The shells illustrated by van Regteren Altena (1937, pl. 3, figs 48, 49, 51) are near-circular in outline, and those of figs 48 and 51 do not show any chevrons on the ligamental area. Since *G. radiolyrata* is the only form known from the Westerschelde which displays these characters, these specimens probably should be assigned to this species as well. Van Regteren Altena *et al.*'s (1962) note of a fine, tuberculate radial ornament on a number of juvenile shells and on the umbones of well-

preserved shells, leaves no doubt that those authors based their observations pertinent to *G. variabilis* on the basis of mixed material of *G. variabilis* and *G. radiolyrata*.

We have studied the *Glycymeris* shells illustrated by Heering (1950): his *Glycymeris glycymeris variabilis* of pl. 8, figs 5, 6 as well as his *Glycymeris glycymeris glycymeris* of figs 7, 8 in fact both represent *G. radiolyrata*. A number of additional specimens listed by Heering under *G. glycymeris variabilis* and *G. glycymeris* could be proved to belong to *G. radiolyrata* as well (see list of paratypes).

The specimen figured by Glibert (1957) under the name of *G. glycymeris variabilis* undoubtedly belongs to *G. radiolyrata*; that author commented upon juvenile specimens with narrow, well-developed ribs, making reference to material illustrated by Heering (1950, pl. 7, figs 15, 16, 19 and 20, 'Glycymeris spec. 1a' (= *G. cf. spec. 2*, sensu Moerdijk *et al.*, 1992); pl. 8, figs 13, 14 and 20, 'Glycymeris sp. 1b' (= *G. variabilis*), but thought them to be more closely related to *Glycymeris glycymeris* f. *tumida* Bucquoy, Dautzenberg & Dollfus, 1891 (which probably is conspecific with *Glycymeris spec. 2* of Moerdijk *et al.*, 1992). Glibert's view may apply to some of the Belgian specimens he recorded, but at least part of this material must belong to *G. radiolyrata*, as this is the much more common species.

In Glibert & van de Poel's (1965) opinion, the specimen illustrated by Glibert (1957, pl. 1, fig. 3) and that figured by Wood (1851, pl. 9, fig. 1a, b), which in fact may belong to *G. radiolyrata*, should be assigned together with the genuine *G. variabilis* (making reference to Heering, 1950, pl. 8, figs 1-4 and Wood, 1851, pl. 9, fig. 1h, i) to the flat, and in their view, typical variety of *G. glycymeris variabilis*.

The specimen of *G. glycymeris variabilis* figured by Geys & Marquet (1979, pl. 15, fig. 1) is correctly identified.

GEOGRAPHICAL AND STRATIGRAPHICAL DISTRIBUTION

In the Antwerp area, *G. radiolyrata* has been collected *in situ* from the Oorderen Member of the Lillo Formation (middle Pliocene) at Kallo (Oost Vlaanderen, Belgium), where it first appears in the level with *Atrina fragilis kalloensis*. It is also known from the level with *Cultellus cultellatus* (Wood in Sowerby, 1844), and from the level with *Angulus benedeni* (Nyst & Westendorp, 1839); two valves have been collected from the Kruisschans Member (Lillo Formation, late Pliocene).

On Dutch territory, the new species has been recognised in the yield of several boreholes at Haamstede,

Biggekerke, Vlissingen and Clinge (all province of Zeeland), Dorst, Breda, Oss, Reek, Bergen op Zoom, Seppe (near Hoeven) and Roosendaal (all province of Noord Brabant) and at Nijmegen (province of Gelderland), its occurrence being associated with the Pliocene molluscan zone MOL D (Spaink *in* Zagwijn & van Staaldunin, 1975). It is also frequently washed ashore in Zeeland on the beaches near Domburg and De Kaloot (Borsele), having been recognised also amongst beach material from Hooge Springer, Zuid Sloe and Oranjezon, and in considerable numbers in material from sand supplies, *e.g.* at Cadzand-bad, Nieuwesluis, and transported from the Sluisse Hompels. Many well-preserved valves have been dredged from the bed of the Westerschelde near Ellewoutsdijk and Baarland, and a single, but unmistakable fragment (KZGW collections) is known from the beach at Scheveningen (province of Zuid Holland, The Netherlands). At Domburg and De Kaloot, where *G. radiolyrata* is common, other fossil shells of supposedly middle Pliocene age are common as well.

In the private collection of one of us (FADvN, leg. P. de Jonge) are seven valves of *G. radiolyrata*, dredged from the Flemish Banks, southern North Sea.

The collections of the Nationaal Natuurhistorisch Museum (Leiden) include five valves and a fragment from the Coralline Crag of Ramsholt Cliff, River Deben (Suffolk) and a bivalved specimen from the Red Crag (?) of Brightwell (Suffolk). Amongst gravel dredged from the mouth of the River Thames a single valve was found. The glycymeridid material that we have seen is too limited to draw conclusions on its stratigraphical and geographical distribution in the Pliocene of the United Kingdom; *G. radiolyrata* may in fact be more widespread.

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who have been actively involved in discussions on fossil Glycymerididae from Zeeland.

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PLATE 1

- Fig. 1. *Glycymeris (Glycymeris) radiolyrata* sp. nov., holotype (RGM 393 823; leg. M. Vervoenen, bivalved specimen), Lillo Formation, Oorderen Member, Pliocene (Scaldisian), construction pit Beveren tunnel at Kallo (Belgium); a, b - left valve; c, d - right valve, x 1.3.

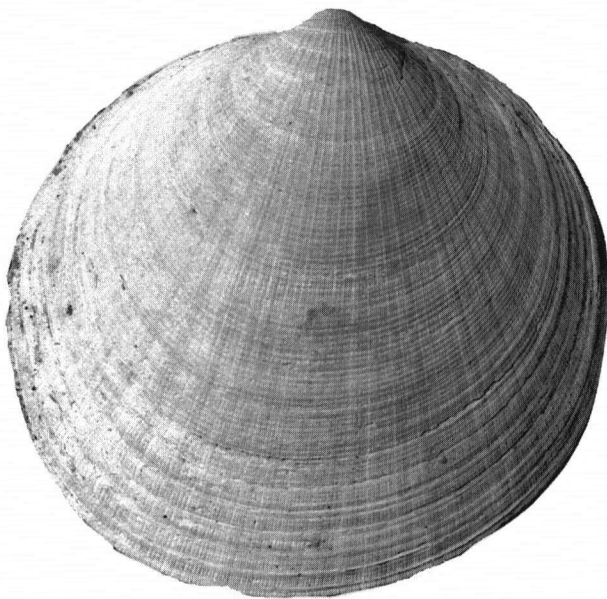
PLATE 1



1A



1B



1C



1D

PLATE 2

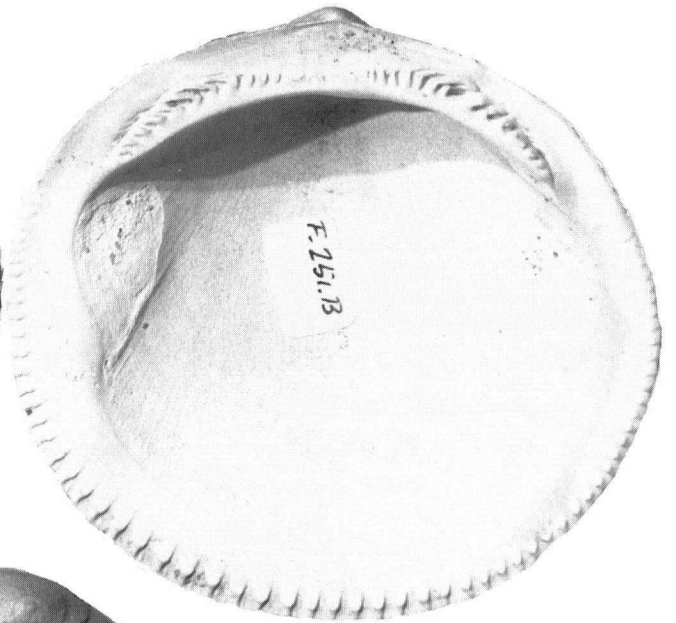
Glycymeris (Glycymeris) radiolyrata sp. nov.

- Fig. 1. Right valve, paratype (RGM 393 824, leg. M. Vervoenen), Lillo Formation, Oorderen Member, Pliocene (Scaldisian), construction pit Beveren tunnel at Kallo (Belgium), x c. 1.25; c - hinge; d - detail of external ornament.
- Fig. 2. Juvenile left valve (RGD Coll. Mol.673), Pliocene, borehole Nijmegen ('Midden-Pliocéen'), x c. 10.

PLATE 2



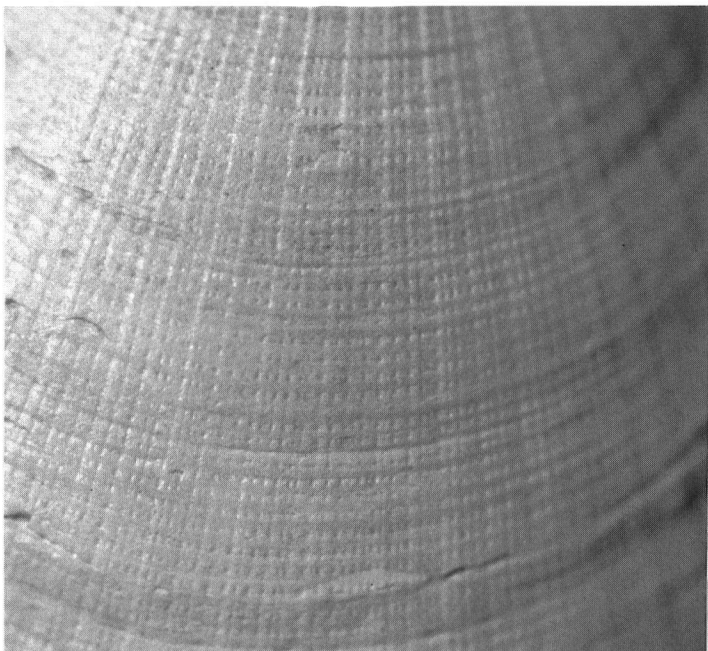
1 a



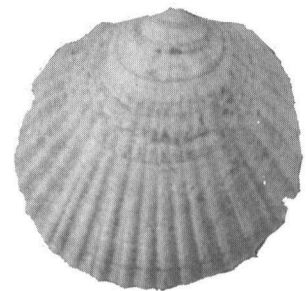
1 b



1 c



1 d



2

PLATE 3

Glycymeris (Glycymeris) radiolyrata sp. nov.

- Fig. 1. Left valve, paratype (RGM 393 825, leg. F.A.D. van Nieulande), Pliocene beach material, Domburg (The Netherlands), x 9.
- Fig. 2. Right valve (RGD Coll. Mol.665), Pliocene, borehole Biggekerke (The Netherlands), x 1.7.

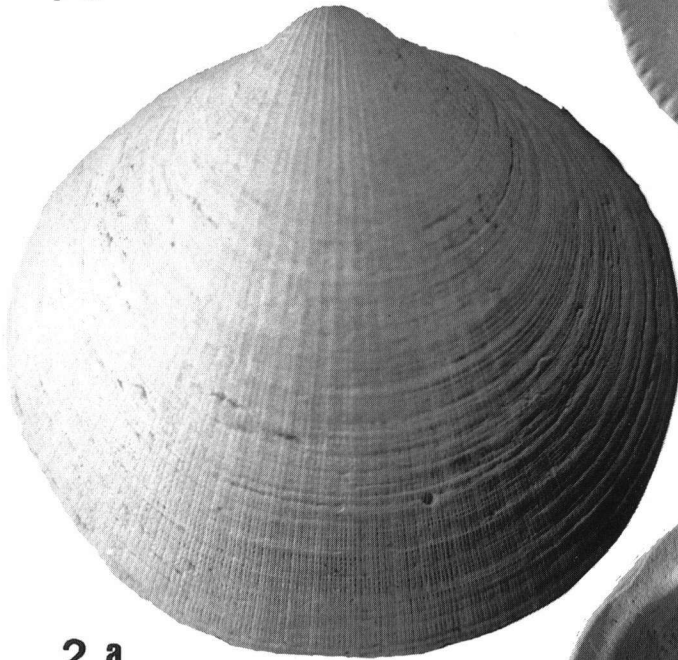
PLATE 3



1 a



1 b



2 a

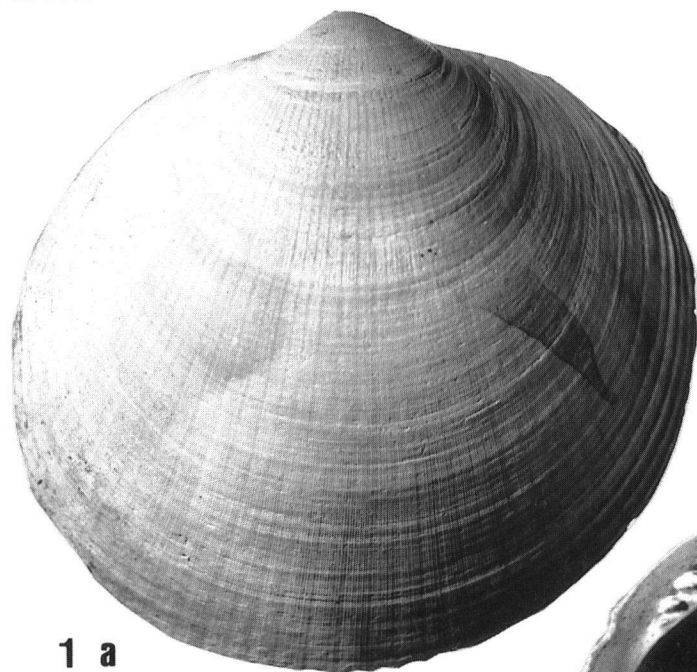


2 b

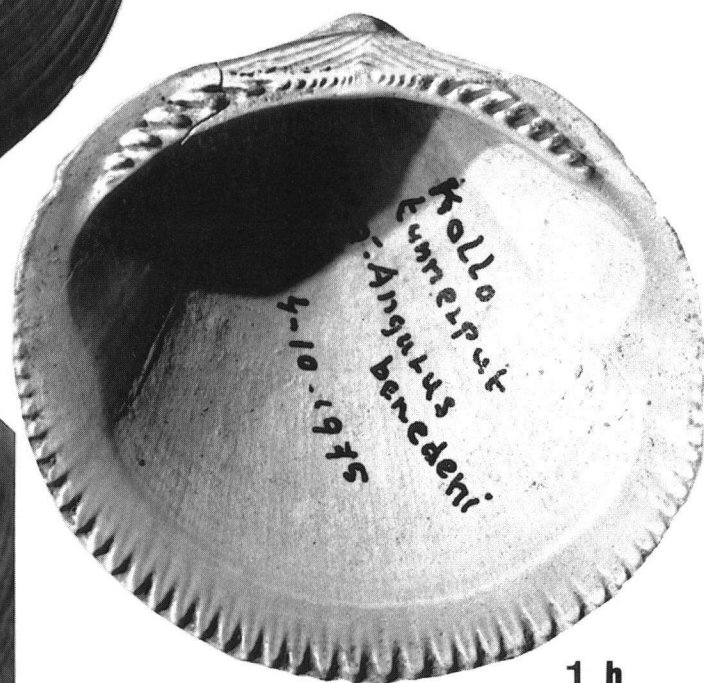
PLATE 4

Fig. 1. *Glycymeris (Glycymeris) variabilis* (J. de C. Sowerby, 1824), right valve (RGM 393 826, leg. M. Vervoenen), Lillo Formation, Oorderen Member (level with *Angulus benedeni*), Pliocene (Scaldisian), construction pit Beveren tunnel at Kallo (Belgium), x 1.7; c - detail of external ornament; d - hinge.

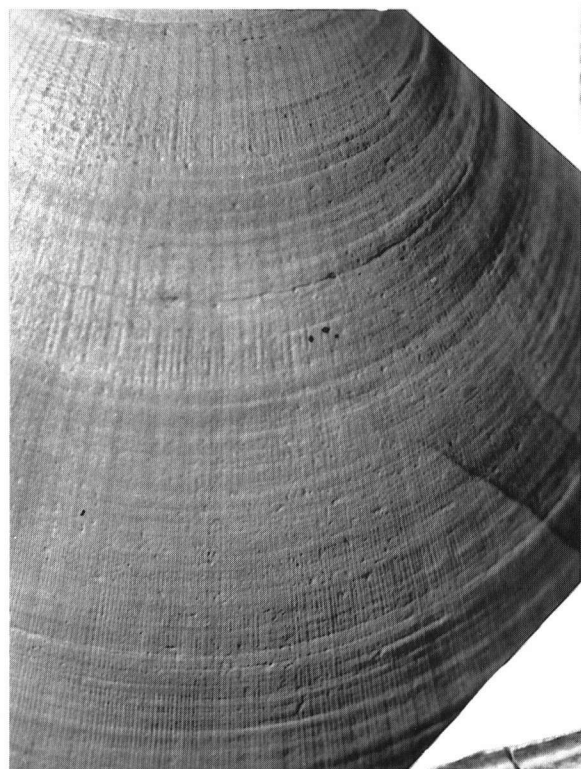
PLATE 4



1 a



1 b



1 c

1 d

