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REWORKED FOSSILS (MAINLY MOLLUSCS) FROM A FLUVIO-GLACIAL DEPOSIT NEAR DINXPERLO, PROVINCE OF GUELDERS, THE NETHERLANDS

by

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Reworked fossils from a Quaternary deposit were identified and a determination of their stratigraphical and geographical origin is attempted. Specimens of Mesozoic, Tertiary and Quaternary age were found. The Quaternary material is very probably of Weichselian age. The Tertiary fossils, mainly molluscs, originate from Oligocene (Chattien) deposits and from the Middle Miocene Aalten Member (*Astarte radiata* Acme Zone). More important parts have been reworked from the two upper biozones of the Aalten Member, the *Spisula* sp. Acme Zone and especially from the *Limopsis aurita* Acme Zone. The absence of fossils from the lowermost biozone of the Aalten Member (the *Hiatella arctica* Acme Zone) leads to the conclusion that the reworked fossils have been transported from the region of Bocholt-Dingden in Western Germany.

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SAMENVATTING

Begin 1977 vond de heer B. Elburg (Dinxperlo), in een tijdelijke ontsluiting nabij zijn woonplaats, verspoelde tertiaire fossielen in een fluvioglaciale afzetting. Via de Rijks Geologische Dienst, karteerdistrict Oost (Lochem) hoorde de heer M. van den Bosch (RGM) van deze vindplaats. Na zich ter plaatse op de hoogte te hebben gesteld, verzocht hij mij het betreffende materiaal te verzamelen, ten einde een poging te doen de stratigrafische herkomst van het materiaal vast te stellen.

In de tijdelijke ontsluiting was een profiel zichtbaar van ongeveer 2 m licht geelbruine zanden, met plaatselijk limonietconcentraties. De grondwaterstand was op dat moment ongeveer 1,90 m onder maaiveld. Op ongeveer 2 m onder maaiveld gaan de geelbruine zanden over in grovere grijze zanden, waarin een laagje grof zand met verspreid grind voorkomt. In dit grindhoudende sediment werden de fossielen aangetroffen.

Met behulp van een graafmachine en een zeeftafel met motorpomp werden ongeveer 4 à 5 m^3 van het fossielhoudende zand doorgezeefd, waarbij de grotere fossielen direct van de zeef werden verzameld. De residu's werden voor verder onderzoek meegenomen naar Leiden.

Het in eerste instantie verzamelde materiaal werd gebruikt voor verwerking in een intern rapport (Janssen, 1977), omdat het voldoende aanknopingspunten bood voor een benadering van de stratigrafische herkomst van het materiaal. Nu ook de fijnere fracties zijn uitgezocht lijkt het zinvol de conclusies te publiceren, ook al omdat deze een goede aanvulling geven op de door Sinnema-Bloemen (1977) gepubliceerde gegevens.

Er werden fossielen uit mesozoische, tertiaire en kwartaire afzettingen aangetroffen, alsmede enkele verontreinigingen in de vorm van recente mollusken uit de directe omgeving van de vindplaats.

Het mesozoische materiaal kon wat betreft herkomst niet nader worden geïnterpreteerd. Het tertiaire materiaal, hoofdzakelijk bestaande uit mollusken, is afkomstig uit oligocene en miocene afzettingen. Vooral de gastropode *Haustator goettentrupensis* is een bewijs voor de herkomst uit jongoligocene afzettingen van een deel van het verzamelde materiaal. Verreweg het grootste deel van de fossielen is echter van miocene ouderdom. Met behulp van de door Van den Bosch, Cadée & Janssen (1975) gepubliceerde fauna-gegevens kon worden vastgesteld, dat materiaal uit de *Hiatella arctica* Acme Zone van de Afzetting van Aalten vermoedelijk geheel ontbreekt. Een klein deel van de fossielen is afkomstig uit de *Astarte radiata* Acme Zone, maar vooral beide bovenste biozone's van de Afzetting van Aalten hebben de bestanddelen van de verspoelde fauna geleverd.

Omdat materiaal uit de *Hiatella arctica* Acme Zone geheel schijnt te ontbreken, kan een transportrichting uit de omgeving van Winterswijk nauwelijks worden aangenomen, omdat afzettingen waarin deze biozone voorkomt op grote schaal in de omgeving van Miste dagzomen. Daarom wordt aangenomen, dat het materiaal afkomstig is uit de omgeving van Bocholt-Dingden in West-Duitsland, waar een dagzoom van de *Hiatella arctica* Acme zone niet bekend is. De transportafstand zou dan tot iets meer dan 10 km kunnen bedragen, hetgeen gezien de conserveringstoestand en de sortering van de fossielen niet onaannemelijk is.

De kwartaire mollusken omvatten een aantal soorten, die alle uit relatief 'koude' afzettingen bekend zijn, enkele ervan (*Succinea antiqua* en *Vertigo genesii genesii*) zijn zelfs uitsluitend bekend uit dergelijke afzettingen. Het materiaal komt aardig overeen met een uit het Emscher-Lippe gebied beschreven fauna, die van Weichselien ouderdom is. De kwartaire soorten zijn gedeeltelijk afgebeeld op plaat 1.

INTRODUCTION

Early in 1977 Mr B. Elburg, an amateur geologist at Dinxperlo (province of Guelders, The Netherlands), discovered the presence of reworked Tertiary fossils in a fluvio-glacial deposit near his residence. He informed the State Geological Survey (Lochem department) and the Survey passed the information to my colleague, Mr M. van den Bosch, who is very well acquainted with the Tertiary geology of that part of the country.

Mr van den Bosch visited the locality and subsequently invited me to sample the deposit, with the purpose to determine the stratigraphical origin of the reworked fossils.

Together with Mr C. P. Strang (RGM) I visited the locality on 4 and 5 May 1977 and made rather extensive collections. The results are interesting and supply additional information to the paper of Sinnema-Bloemen (1977).

At first only the coarser fractions of the residues were inspected, which yielded enough points of contact to determine the main sources of the reworked fossil material. These preliminary results were recorded in an internal report (Janssen, 1977). As also the finer fractions have been investigated now, publication of the final results seems justified.

ACKNOWLEDGEMENTS

I like to thank Mr van den Bosch (RGM) for informing me about the locality and Mr B. Elburg (Dinxperlo) for further information on the site. Mr C. P. Strang assisted in the field campaign, for which I am grateful. The municipality of Dinxperlo put an excavator at my disposal for collecting large sediment samples. Mr T. Meijer (State Geological Survey, Haarlem) gave his opinion on some Quaternary molluscs and Mr P. A. M. Gaemers (Leiden) identified some otoliths. Dr H. K. Loose (RGM) kindly read the manuscript.

DESCRIPTION OF THE LOCALITY AND COLLECTING METHOD

The locality is situated in the municipality of Dinxperlo (see fig. 1), coordinates X = + 75 180, Y = - 30 300, map-sheet 41D, close to the Raterink farm. According to the topographical map the height of the surface is between 17.50 and 20.00 m above N.A.P. The RGM-file number of the exposure is 41D.1-5.

In a temporary exposure, made for the purpose of soil improvement, with a depth of about 2 m, light yellowish brown, rather fine to rather coarse quartz sands were visible, with locally limonite aggregations as a result of oxidisation. The groundwater level was about 1.90 m below surface.

Slightly below the groundwater level the yellowish brown sands change into grey, rather coarse sands, containing a thin level with still coarser sand and gravel up to 3 cms in diameter. In this latter level scattered fossils occur.

With an excavator about 4 to 5 m^3 of sediment was dug out. This material was subsequently washed, using a sieve-table and motor-pump. This method has been extensively described by Freudenthal, Meijer & van der Meulen (1976: 3). The mesh of the lower sieve was 1 mm. The larger fossils were picked from the sieve immediately, whereas the entire residue, mainly consisting of fine gravel, was transported to the laboratory for inspection.

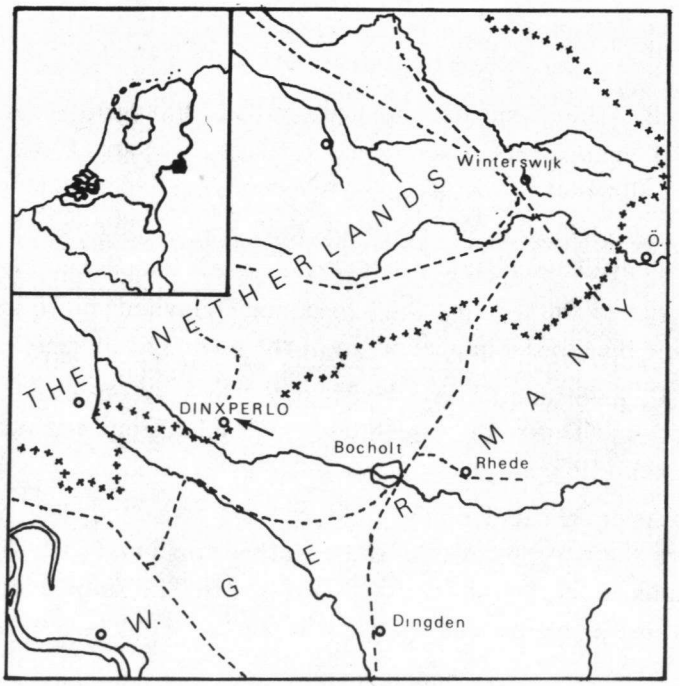

Fig. 1. Locality-map at 1 : 400.000. The arrow indicates the site near Dinxperlo.
Vindplaatskaart op schaal 1 : 400.000. De pijl geeft de vindplaats bij Dinxperlo aan

The reworked fossils are more or less worn and whitish in colour. The largest fragment reaches a diameter of about 3 cms. Most specimens are much smaller. At first glance it is obvious that Tertiary (mainly Miocene) fossils are abundant. A few Quaternary shells also were recognized during the field work. The laboratory investigation revealed some Mesozoic fossils.

IDENTIFICATION OF THE FOSSIL MATERIAL

The collected fossils consist largely of mollusc shells and fragments, but also several other groups could be recognized. In table 1 the results are summarized. For each species the number of specimens, defective specimens (def.) and/or fragments (fragm.) is given. During the investigation it soon became clear that the material originates from several stratigraphical levels. Therefore it was useless to make a quantitative analysis of the faunal elements, as was done by de Vogel (1970 - 1971) and others. Determination of the source levels of the Tertiary material was done qualitatively and with the help of the rough quantitative data given in table 1. The nomenclature of the Tertiary deposits is adopted from van den Bosch, Cadée & Janssen (1975).

The material is kept in the RGM collections under registration numbers RGM 221 873 to RGM 222 012.

Table 1. Summary of species encountered in fluvio-glacial deposits near Dinxperlo (The Netherlands), with indication of the number of specimens, defective specimens (def.) and fragments (fragm.); juv. = juvenile.
Overzicht van de in een fluvioglaciale afzetting bij Dinxperlo aangetroffen soorten, met vermelding van het aantal exemplaren, defecte exemplaren (def.) en fragmenten (fragm.); juv.= juveniel exemplaar.

Protozoa	
Foraminifera	5
Annelida	
? *Serpula* sp.	1 fragm.
Coelenterata, Anthozoa	
Flabellum sp.	1 def., 4 fragm.
Cylindrophyllia duncani (Reuss, 1871)	2
Stephanophyllia nysti Milne-Edwards & Haime, 1851	6 fragm.
Ceratocyathus granulatus (Goldfuss, 1826)	1 fragm.
Echinodermata	
spines of regular see-urchins	2 fragm.
Brachiopoda	
Discina fallens S. V. Wood, 1874	1
Bryozoa	
lunulitiform species	1, 40 fragm.
Mollusca, Bivalvia	
Nucula (Nucula) sp.	13 fragm.
Nuculoma sp.	7 fragm.
Nuculana (Saccella) westendorpi (Nyst, 1839)	2/2, 54 fragm.
Portlandia (Yoldiella) pygmaea (Von Münster, 1835)	2/2, 4 fragm.
Yoldia (Yoldia) glaberrima (Von Münster, 1835)	102 fragm.
Anadara (Anadara) diluvii (Lamarck, 1805)	1/2, 30 fragm.
Limopsis (Limopsis) aurita (Brocchi, 1814)	68/2, 3 fragm.
Limopsis (Pectunculina) lamellata Lehmann, 1885	32/3
Limopsis (Pectunculina) retifera Semper, 1861	43/2, 38 fragm.
Limopsis (s. lat.) sp. indet.	38 fragm.
Glycymeris (Glycymeris) lunulata baldii Glibert & van de Poel, 1965	2 fragm.
Korobkovia woodi (Nyst, 1861)	1 fragm.
Pectinidae sp. indet.	1 fragm.
Cavilucina droueti (Nyst, 1861)	4 fragm.
Lucinoma borealis (Linné, 1767)	1/2 def., 9 fragm.
Cyclocardia sp.	15/2, 16 fragm.
Astarte (Astarte) goldfussi Hinsch, 1952	2/2
Astarte (Astarte) gracilis convexior Anderson, 1959	9/2, 4 fragm.
Astarte (Astarte) radiata Nyst & Westendorp, 1839	32/2, 40 fragm.
Goodallia (Goodallia) angulata (Lehmann, 1885)	19/2
Goodallia (Goodallia) waeli (Glibert, 1945)	5/2
Parvicardium straeleni (Glibert, 1945)	11/2, 36 fragm.
Laevicardium (Habecardium) subturgidum subturgidum (d'Orbigny, 1852)	161 fragm.
Laevicardium (s. lat.) sp.	3 fragm.
Spisula sp.	2/2, 23 fragm.
Macoma (Psammacoma) elliptica (Brocchi, 1814)	2 fragm.

Abra (Abra) lehmanni Anderson, 1964	17 fragm.
Abra (Abra) cf. *sorgenfreii* Anderson, 1964	2 fragm.
Solecurtus antiquatus miocaenicus (Cossmann & Peyrot, 1909)	1 fragm.
Arctica islandica (Linné, 1767)	2 fragm.
Glossus (Glossus) lunulatus (Nyst, 1835)	10 fragm.
Venus (Dosina) multilamella (Lamarck, 1818)	2/2, 38 fragm.
Veneridae sp. indet.	1/2 def.
Gouldia minima (Montagu, 1803)	6 fragm.
Corbula (Varicorbula) gibba gibba (Olivi, 1792)	46/2, 71 fragm.
Hiatella arctica (Linné, 1767)	3/2, 8 fragm.
Panopea (Panopea) menardi Deshayes, 1828	2 fragm.
Turneria pusilla (Sorgenfrei, 1958)	1/2
Teredinidae sp. indet.	1/2 def.
Thracia (Thracia) sp.	12 fragm.
Cuspidaria (Cuspidaria) cuspidata (Olivi, 1792)	3 fragm.
Cardiomya costellata (Deshayes, 1832)	1 fragm.
Mollusca, Scaphopoda	
Dentalium (Dentalium) mutabile Hoernes, 1856	52 fragm.
Dentalium (Dentalium) sp.	64 fragm.
Laevidentalium sp.	9 fragm.
Mollusca, Gastropoda	
Circulus hennei Glibert, 1952	1 def.
Architectonica (Pseudotorinia) berthae (Cossmann, 1915)	1
Turritella (Archimediella) subangulata (Brocchi, 1814)	18, 28 fragm.
Haustator goettentrupensis (Cossmann, 1899)	10 fragm.
Bittium (Bittium) spina (Hoernes, 1855)	1, 1 fragm.
Cerithiella genei (Bellardi & Michelotti, 1840)	3 fragm.
Amaea (Acrilla) amoena subreticulata (d´Orbigny, 1852)	1 fragm.
Aporrhais alata (Von Eichwald, 1830)	1, 35 fragm.
Calyptraea chinensis (Linné, 1758)	1 fragm.
Xenophora deshayesi (Michelotti, 1847)	8 fragm.
Polinices (Polinices) miocolligens Sacco, 1891 s. lat.	1 def.
Polinices (Polinices) miopusillus (Kautsky, 1925)	2
Euspira protracta (Von Eichwald, 1830)	3
Natica tigrina Defrance, 1835	1
Naticidae sp. indet.	7, 7 fragm.
Phalium (Semicassis) bicoronatum (Beyrich, 1854)	1 fragm.
Eudolium dingdense Anderson, 1964	3 fragm.
Ficus conditus (Brongniart, 1823)	10 fragm.
Murex (Haustellum) inornatus Beyrich, 1854	4 fragm.
Typhis (Typhis) pungens (Solander, 1766)	1 def.
Lyrotyphis (Eotyphis) sejunctus priscus (Rutot, 1876)	6 def.
Mitrella (Macrurella) nassoides (Grateloup, 1827)	2, 1 fragm.
Anachis (Costoanachis) pulchella (Dujardin, 1837)	1 fragm.
Anachis (Costoanachis) corrugata (Brocchi, 1814)	1 def., 1 fragm.
Phos decussatus (Von Koenen, 1872)	2 fragm.
Hinia (Hinia) bocholtensis (Beyrich, 1854)	12
Hinia (Tritonella) tenuistriata (Beyrich, 1854)	5
Hinia (s. lat.) sp. indet.	22 fragm.

Latirus (Dolicholatirus) rothi (Beyrich, 1856)	5, 2 fragm.
Streptochetus (Streptodictyon) sexcostatus (Beyrich, 1856)	13, 18 fragm.
Streptochetus (Streptolathyrus) contiguus (Beyrich, 1856)	1 fragm.
Aquilofusus festivus (Beyrich, 1856)	1, 1 fragm.
Ancilla (Baryspira) obsoleta (Brocchi, 1814)	4 fragm.
Narona (Sveltia) varicosa (Brocchi, 1814)	2 fragm.
Babylonella fusiformis (Cantraine, 1835)	2 fragm.
Mitra (Tiara) substriatula (d'Orbigny, 1852)	2 juv.
Gemmula (Gemmula) zimmermanni (Philippi, 1846)	17, 8 fragm.
Gemmula (Gemmula) denticula borealis (Glibert, 1954)	1 fragm.
Gemmula (Gemmula) boreoturricula (Kautsky; 1925)	1
Turris (Fusiturris) flexiplicata (Kautsky, 1925)	6
Turris (Fusiturris) aquensis (Grateloup, 1832)	1 fragm.
Epalxis (Bathytoma) cataphracta jugleri (Philippi, 1846)	1, 2 fragm.
Crassispira borealis (Kautsky, 1925)	4, 3 fragm.
Brachytoma pannoides (Von Koenen, 1872)	1
Brachytoma obtusangula (Brocchi, 1814)	4 fragm.
Asthenotoma cf *festiva* (Hoernes, 1854)	1 fragm.
Boreodrillia hosiusi (Von Koenen, 1872)	2, 1 fragm.
Splendrillia selenkae (Von Koenen, 1872)	1, 2 fragm.
Haedropleura maitreja (Von Koenen, 1872)	1 fragm.
Pleurotomoides sp.	2 fragm.
Turridae sp. indet.	12
Conus (Conolithus) dujardini (Deshayes, 1845)	1, 3 fragm.
Strioterebrum basteroti (Nyst, 1845)	1 def.
Strioterebrum hoernesi (Beyrich, 1854)	1 juv.
Terebra (Myurellina) neglecta Michelotti, 1847	1 fragm.
Syrnola (Syrnola) neumayri (Von Koenen, 1882)	3 fragm.
Turbonilla (s. lat.) sp.	1
Pyramidella plicosa (Bronn, 1838)	2 def.
Ringicula (Ringiculina) buccinea (Brocchi, 1814)	3, 13 fragm.
Cylichna sp.	2 fragm.
Scaphander (Scaphander) grateloupi (Michelotti, 1847)	3 fragm.
Rhizorus acuminatus (Bruguière, 1789)	2 fragm.
Anisus (Anisus) leucostomus (Millet, 1813)	1
Vertigo (Vertigo) genesii genesii (Gredler, 1856)	1 fragm.
Pupilla (Pupilla) muscorum (Linné, 1758)	5 fragm.
Vallonia costata costata (Müller, 1774)	1 def.
Vallonia sp. indet.	2 juv.
Succinea (? Succinea) antiqua (Colbeau, 1865)	2 juv., 2 fragm.
Succinea (Succinella) oblonga Draparnaud, 1801	16, 4 fragm.
Succineidae sp. indet.	8 fragm.
Trichia (Trichia) hispida (Linné, 1758)	5, 15 fragm.
Helicigona (Arianta) arbustorum (Linné, 1758)	1 fragm.
Cepaea (Cepaea) sp. indet.	3 fragm.
Mollusca s. lat.	
unrecognizable shell fragments	1085
Vertebrata, Pisces, Teleostei	
Colliolus friedbergi (Chaine & Duvergier, 1928)	4 otoliths

? Macruridarum *debilis* Posthumus, 1923	4 otoliths
? Gobiidarum sp. indet.	1 otolith
Ctenodentex miocenicus (Weiler, 1942)	1 otolith
Genus et sp. indet.	2 fragm. of otoliths, 2 vertebrae
Mesozoic fossils (among which: Bryozoa, ? Echinodermata, Pectinidae sp, indet. and *Gryphaea* sp.)	25

THE STRATIGRAPHICAL ORIGIN OF THE MATERIAL

As stated above the material consists mainly of Tertiary specimens, but also some Quaternary and Mesozoic fossils could be recognized.

Mesozoic fossils

Some 25 partly silicified, mainly fragmentary fossils were found, that are presumably of Mesozoic age. Among them Bryozoa, Pectinidae sp., *Gryphaea* sp., and ? Echinodermata could be recognized. The origin of this material must remain uncertain. Mesozoic fossils are rather frequently found in Dutch Quaternary deposits.

Tertiary fossils

The Tertiary material consists of at least 102 species of marine molluscs and a small number of species belonging to other animal groups. The following analysis is based on the molluscs. The results are not contradicted by the other fossils.

All mollusc species are known from Late Oligocene and/or Miocene deposits, but there are only very few species that are restricted to Late Oligocene sediments. A species only occurring in Late Oligocene and Early Miocene faunas is the gastropod *Haustator goettentrupensis* (= *Turritella geinitzi* Speyer).

Some of the fragments identified as *Dentalium (Dentalium)* sp. closely resemble a species occurring in Late Oligocene deposits of the Lower Rhine area in Western Germany. The three fragments reported as *Laevicardium* (s. lat.) sp. could very well belong to the Oligocene species *Laevicardium (Habecardium) tenuisulcatum* (Nyst, 1836), which is represented in Late Oligocene deposits by its subspecies *cingulatum* (Goldfuss, 1837). Since Early Miocene sediments generally are regarded to be absent in this region it seems to be very probable that a small part of the fossils has been reworked from Late Oligocene (Chattian) deposits.

The major part of the molluscs, the Anthozoan species and the fish otoliths are beyond any doubt reworked from Middle Miocene deposits. Typical species from the *Hiatella arctica* Acme Zone (Aalten Member) are absent, although many other mollusc species known from this level, but also occurring in other biozones of the Aalten Member, were found at Dinxperlo.

One species, *Goodallia waeli*, is restricted to the two lower biozones, the *Hiatella arctica* Acme Zone and the *Astarte radiata* Acme Zone of the Aalten Member. Two other species, *Glycymeris*

lunulata baldii and *Arctica islandica*, both bivalves, are also known from these horizons and do not occur in the two upper biozones, but it can not be excluded that they may be derived from Late Oligocene deposits as well. However, from the rather frequent occurrence of the bivalve *Astarte radiata* it seems very likely that a part of the collected material originates from the *Astarte radiata* Acme Zone of the Aalten Member.

Three species, *Abra lehmanni, Eudolium dingdense* and *Aquilofusus festivus*, are only known from the *Spisula* sp. Acme Zone and the *Limopsis aurita* Acme Zone of the Aalten Member. The gastropod *Haedropleura maitreja*, mentioned by van den Bosch, Cadée & Janssen (1975: 89) as a species restricted to the two upper biozones of the Aalten Member, has now also been found in the lowermost biozone. No species restricted to the *Spisula* sp. Acme Zone or the *Limopsis aurita* Acme Zone have been found. However, the distinguishing mollusc species, as mentioned by van den Bosch, Cadée & Janssen (1975: 89 - 90) are all rare species, furthermore the *Limopsis aurita* Acme Zone is merely characterized by an impoverishment of the mollusc fauna. Therefore it can be assumed from the rather frequent occurrence of the bivalve *Spisula* sp. that at least a part of the reworked Dinxperlo fossils originates from the *Spisula* sp. Acme Zone. The greater part of the material certainly originates from the *Limopsis aurita* Acme Zone, as demonstrated by the frequent occurrence of the typical species.

Quaternary fossils

Several terrestrial and freshwater species were found that are derived from Quaternary deposits. I asked Mr T. Meijer (State Geological Survey, Haarlem) to give his opinion on this material which he kindly did. His results are incorporated in an internal report (Meijer, 1977) on which the following considerations are also based.

Some of the Quaternary specimens have a somewhat different state of preservation, because they still have their periostracum. This is the case with *Vallonia costata costata, Vallonia* sp. and one specimen of *Succinea oblonga*. Two other species, *Cepaea* sp. and *Helicigona arbustorum*, differ from the remaining material because they are only known from relatively warm faunas. It is very probable that all these species belong to the recent fauna and must be regarded as contamination, which is not surprising considering the rather rough collecting method.

Anisus leucostomus, Vertigo genesii genesii, Pupilla muscorum, Succinea antiqua, Succinea oblonga and *Trichia hispida* are all species that may occur in relatively cold faunas. *Vertigo genesii genesii* and *Succinea antiqua* are even restricted to such faunas, whereas *Trichia hispida* is represented by a rather small, somewhat conical form, which is typical for loess-deposits.

Succinea antiqua is a rather problematical species. It is known from Quaternary deposits in the Emscher-Lippe area in Western Germany, some 25 km from the Dutch-German border (see Steusloff, 1942) and also from loess-deposits at Nivelstein (province of Limburg, The Netherlands).

Summarizing, the Quaternary molluscs are assumed to be derived from a relatively cold fauna comparable with the fauna in the Weichselian deposit of the Emscher-Lippe area. The most important Quaternary species are represented on plate 1.

A summary of the conclusions on the stratigraphical origin of the Dinxperlo material is given in table 2.

Quaternary, Recent	some specimens
Quaternary, deposits of Weichselian age	a very small part of the material
Miocene, Aalten Member, *Limopsis aurita* Acme Zone	a large part of the material
Miocene, Aalten Member, *Spisula* sp. Acme Zone	a rather small part of the material
Miocene, Aalten Member, *Astarte radiata* Acme Zone	a rather small part of the material
Miocene, Aalten Member, *Hiatella arctica* Zone	not represented in the material
Oligocene, deposits of Chattian age	a small part of the material
Mesozoic, unknown deposit(s)	a very small part of the material

Table. 2. Summary of the stratigraphic origin of reworked fossils, found in a fluvio-glacial deposit near Dinxperlo (The Netherlands).
Overzicht van de stratigrafische herkomst van verspoelde fossielen uit een fluvioglaciale afzetting bij Dinxperlo.

GEOGRAPHICAL ORIGIN OF THE TERTIARY MATERIAL

In the neighbourhood of Dinxperlo Tertiary deposits are only found at rather considerable depth (about 40 m below the surface). The rather fair state of preservation of the fossils does not indicate transportation over very long distances. On the other hand the size of the specimens, which is on the average rather small, indicates that some sorting has taken place, resulting in the absence of large specimens in our material. Therefore in all probability the material has not been reworked from deposits in the immediate neighbourhood of the Dinxperlo locality.

In a northeastern direction (region of Winterswijk) and in a southeastern direction (Bocholt-Dingden region) Tertiary deposits occur closely below the present surface. If the material had been transported from the Winterswijk area species from the *Hiatella arctica* Acme Zone inevitably would have been found as common elements in the reworked material, since the sediments containing the *Hiatella arctica* Acme Zone fauna are present on a large scale on the line Dinxperlo - Winterswijk (hamlet Miste).

Transportation from the Bocholt - Dingden area seems to be much more acceptable, because the three upper biozones of the Aalten Member are known there, as well as Late Oligocene deposits, whereas the *Hiatella arctica* Acme Zone is known only from one boring in Bocholt (boring Atlantis I, see Tangerding, 1977).

Consequently, it seems very probable that the reworked material found at Dinxperlo has been transported from a southeastern direction from the Bocholt - Dingden area. The distance over which

the material will have been transported may be somewhat over 10 km. This agrees best with the composition of the fauna and the state of preservation.

REFERENCES

Bosch, M. van den, M. C. Cadée & A. W. Janssen, 1975. Lithostratigraphical and biostratigraphical subdivision of Tertiary deposits (Oligocene - Pliocene) in the Winterswijk - Almelo region (eastern part of the Netherlands). - Scripta Geol., 29 : 1 - 167, 37 figs, 10 tables, 23 pls, 2 enclosures.

Freudenthal, M., T. Meijer & A. J. van der Meulen, 1976. Preliminary report on a field campaign in the continental Pleistocene of Tegelen (The Netherlands). - Scripta Geol., 34: 1 - 27, 9 figs, 2 pls.

Janssen. A. W., 1977. Rapport betreffende een vindplaats van verspoelde tertiaire mollusken in een kwartaire afzetting te Dinxperlo (Gelderland). Rapport 46, afd. Caenoz. Moll. Europa, Rijksmuseum van Geologie en Mineralogie, Leiden, 4 pp. (not published).

Meijer, T., 1977. Kwartaire landmollusken uit een ontsluiting bij Dinxperlo (Gelderland). Rapport 1183, afd. Macro-palaeontologie Kaenozoicum, Rijks Geologische Dienst, Haarlem, 3 pp. (not published).

Sinnema-Bloemen, J., 1977. Erratische tertiaire mollusken uit het fluviatiele Kwartair van Nederland. - Meded. Werkgr. Tert. Kwart. Geol., 14 (4): 81 - 102, 2 tables, 3 pls.

Tangerding, M., 1977. Die Bohrung eines Mineralwasserbrunnens in Bocholt. - Unser Bocholt, 4, 7 pp., 7 figs.

Vogel, E. F. de, 1970 - 1971. A study of marine Miocene faunas in the 'Achterhoek' (Netherlands, province of Gelderland). - Meded. Werkgr. Tert. Kwart. Geol., 7 (2): 53 - 78; 7 (4): 106 - 127, appendix 1 - 26, 1971.

EXPLANATION OF PLATE 1

All specimens from fluvio-glacial deposits near Dinxperlo.
Alle exemplaren uit een fluvioglaciale afzetting bij Dinxperlo.

Fig. 1a-c *Succinea (Succinella) oblonga* Draparnaud, 1801
x 12. RGM 221 999.
Fig. 2a-d *Succinea (? Succinea) antiqua* (Colbeau, 1865)
x 12. RGM 221 996.
Fig. 3 *Succinea (? Succinea) antiqua* (Colbeau, 1865)
x 12. RGM 221 997.
Fig. 4a-c *Trichia (Trichia) hispida* (Linné, 1758)
x 6. RGM 222 003.
Fig. 5a-b *Vertigo (Vertigo) genesii genesii* (Gredler, 1856)
x 24. RGM 221 991.

Drawings made by the author with a Wild M 5 stereo-loupe and *camera lucida* device. Specimens are kept in the collections of the Rijksmuseum van Geologie en Mineralogie, Leiden, The Netherlands.

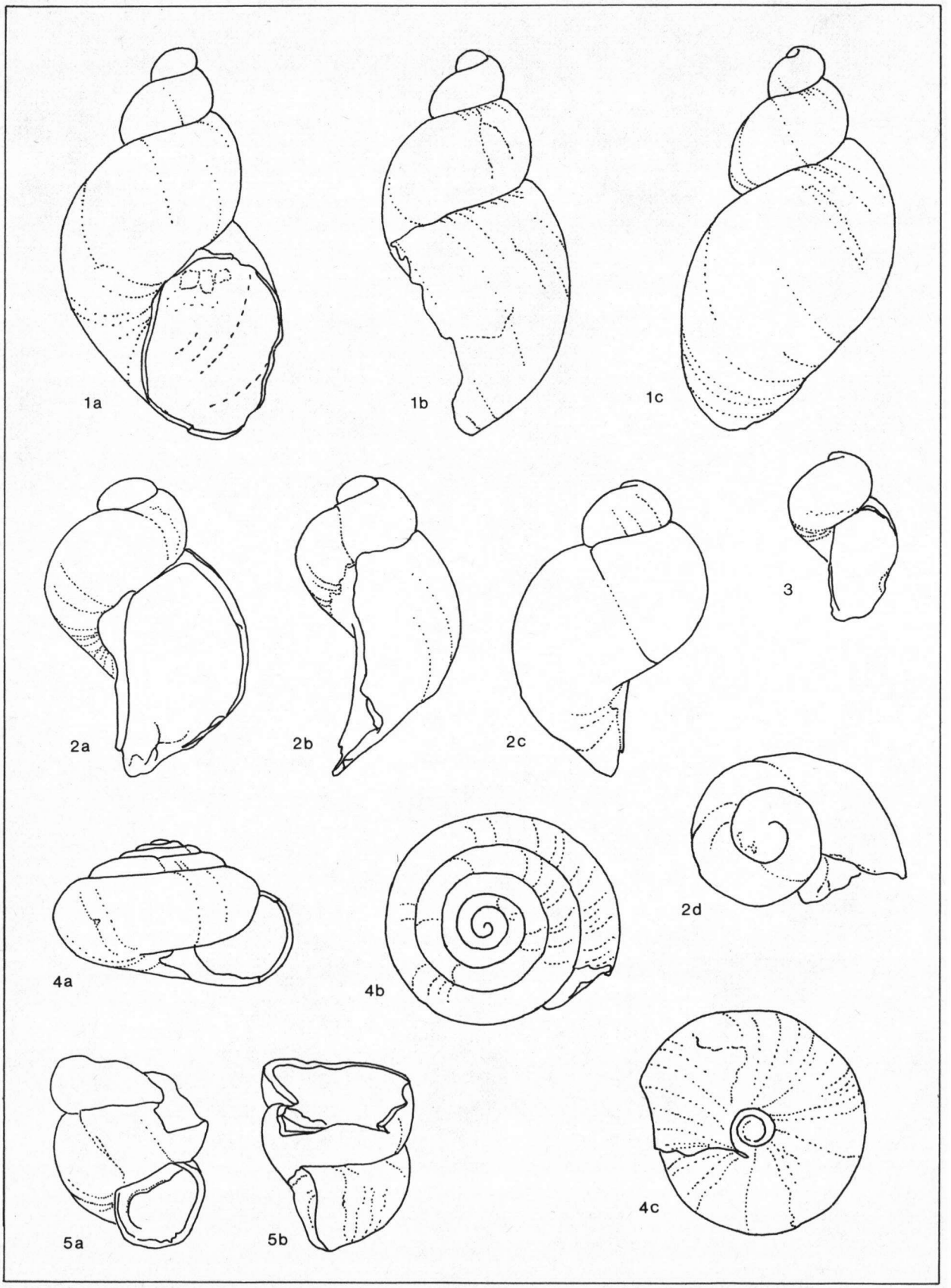

PLATE I